DOT HS-802 830

VEHICLE INTEGRATION AND EVALUATION OF ADVANCED RESTRAINT SYSTEMS Volume II: Phase B

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16. Abstract

This report presents the results of eight full-scale crash tests conducted to evaluate the performance of four advanced restraint systems; RSV Driver Airbag, RSV Passenger Airbag, Force Limited Airbelt, and the Force Limited 2-inch Belt, when structurally integrated into a production vehicle. The vehicle chosen by NTHSA for this was the Volvo 244. The tests consisted of car-to-car impacts using the Volvo 244 with Ford Torinos serving as bullet vehicles. These tests were conducted to help determine the performance limits of the four advanced restraint systems in terms of meeting the FMVSS 208 crashworthiness criteria.

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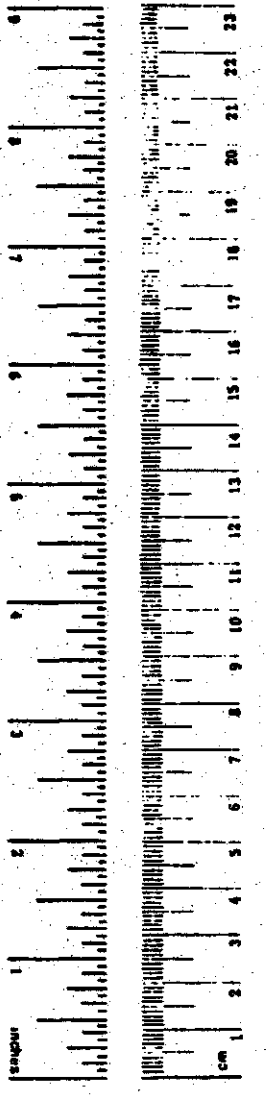
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

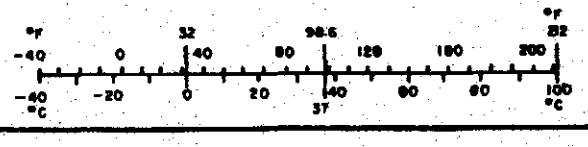
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	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	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286



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	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
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	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1.0 INTRODUCTION

A series of eighteen full-scale crash tests were conducted to evaluate the performance of four advanced restraint systems that were structurally integrated into the Volvo 244. These tests were split into two phases; Phase A consisted of car-to-car and car-to-barrier impact tests using only Volvo 244's as test vehicles while the Phase B impact test configurations were car-to-car using Volvo 244's with Ford Torinos serving as bullet vehicles. This report presents the test results from Phase B of the test series.

The advanced restraint systems tested were:

- RSV Driver Airbag System (DS)
- RSV Passenger Airbag System (PS)
- Force Limited Airbelt (AB)
- Force Limited, 2-Inch Belt (FLB).

These systems had been developed under previous NHTSA research and development efforts[1] and were selected to provide an indication of the limits of occupant protection performance criteria for small production vehicles.

For the Phase B tests, the RSV Driver Airbag and the RSV Passenger Airbag were installed together in one test vehicle (Airbag car) while the Force Limited Airbelt and Force Limited 2-Inch Belt were installed in a subsequent vehicle (Belt car). The two belt restraint systems were advanced restraints in the early stages of development and were active systems. Significant development work would be required to make either of these systems passive. They were both treated as passenger restraint systems, and there was no steering column at either occupant position.

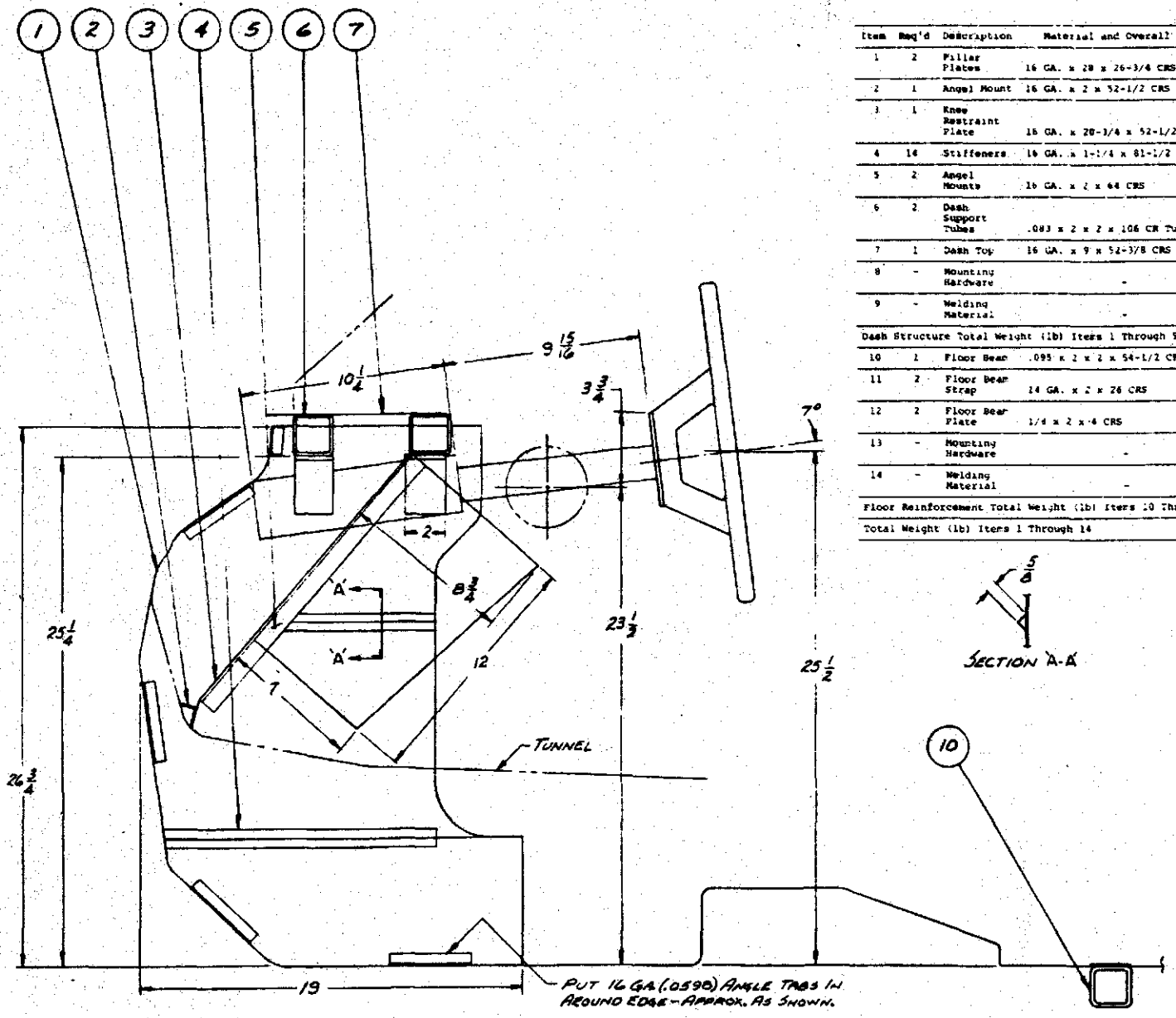
(1) DOT Contracts DOT-HS-4-00844 and DOT-HS-4-00917.

The Volvos used for the Torino-to-Volvo phase of the test series were structurally modified to provide mounting hardware for the restraint systems and to retain the structural integrity of the occupant compartment, particularly in the cowling region. The structural modifications for both cars evolved during Phase A to those shown in Figures 1-1 and 1-2. These modifications, as shown, were made to the Volvo airbag cars and the Volvo belt cars, respectively, for the Phase B tests.

A few words are in order concerning the philosophy and experimental nature of this program. The contractual work statement specified that four types of advanced restraints were to be integrated into a compact automobile which possessed a high degree of crashworthiness potential. The Volvo 244 was the automobile chosen by the NHTSA. The statement of work continued to specify that the selected vehicle with the advanced restraints installed would be crashed at speeds up to 50 mph to determine the performance envelope of the combined advanced restraints/vehicle structure occupant protection system. Based on the structural capabilities of even the better performing compact vehicle structures, the specification of the 50-mph goal for protection clearly indicated that some tests would have to be scheduled with the specific intent of exceeding the performance limits (specified by FMVSS 208 criteria) in order to define (bracket) the upper limit of performance for the integrated systems.

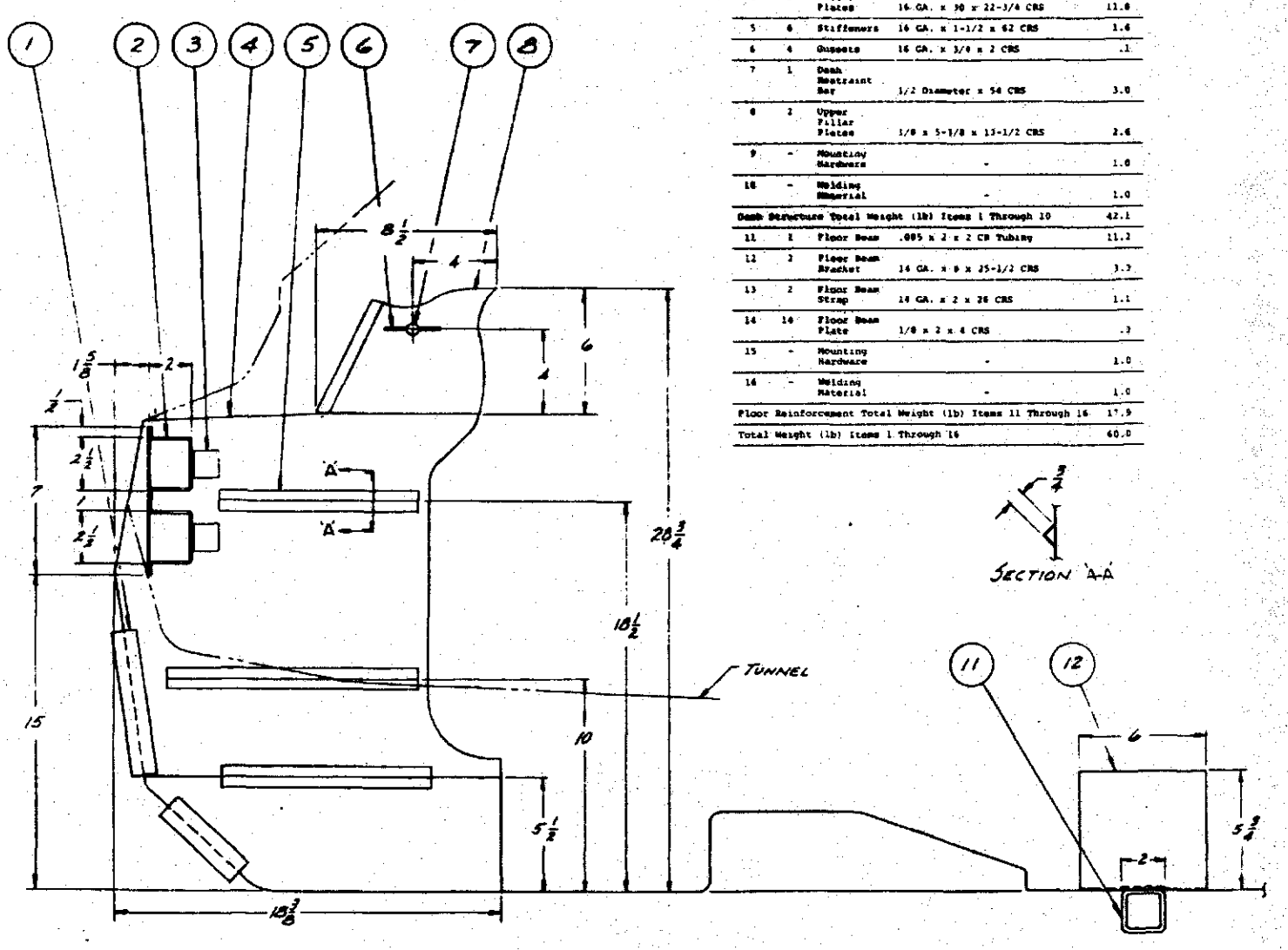
In certain tests, it was clear the vehicle structure was the limiting factor, while in other tests, restraint system capability restricted performance. In yet other tests, it was indeterminant whether improving either system (if indeed that were possible) would have improved the overall results.

The advanced airbag restraints used in the Volvos were those developed for the Minicar's Phase II RSV Program, and as such, the technical feasibility of the driver and passenger bag systems



Item	Req'd	Description	Material and Overall Size	Weight
1	2	Filler Plates	16 GA. x 28 x 26-3/4 CRS	13.0
2	1	Angel Mount	16 GA. x 2 x 52-1/2 CRS	1.8
3	1	Knee Restraint Plate	16 GA. x 20-3/4 x 52-1/2 CRS	19.0
4	14	Stiffeners	16 GA. x 1-1/4 x 81-1/2 CRS	1.8
5	2	Angel Mounts	16 GA. x 2 x 64 CRS	1.1
6	2	Dash Support Tubes	.083 x 2 x 2 x 106 CR Tubing	19.1
7	1	Dash Top	16 GA. x 9 x 52-3/8 CRS	8.2
8	-	Mounting Hardware	-	1.0
9	-	Welding Material	-	1.0
Dash Structure Total Weight (lb) Items 1 Through 9				66.0
10	1	Floor Bear	.095 x 2 x 2 x 54-1/2 CR Tubing	11.2
11	2	Floor Bear Strap	14 GA. x 2 x 26 CRS	1.1
12	2	Floor Bear Plate	1/4 x 2 x 4 CRS	.3
13	-	Mounting Hardware	-	1.0
14	-	Welding Material	-	1.0
Floor Reinforcement Total Weight (lb) Items 10 Through 14				14.6
Total Weight (lb) Items 1 Through 14				80.6

Figure 1-1. Final Structural Modification to Airbag Car.



Item	Req'd	Description	Material and Overall Size	Weight
1	4	Tabs	16 GA. x 1-1/2 x 23 CRS	.6
2	1	Mat Section	16 GA. x 22 x 53 CRS	20.2
3	4	Angle Tabs	16 GA. x 1-1/4 x 10 CRS	.2
4	2	Pillar Plates	16 GA. x 30 x 22-3/4 CRS	11.8
5	6	Stiffeners	16 GA. x 1-1/2 x 62 CRS	1.6
6	4	Gussets	16 GA. x 3/8 x 2 CRS	.1
7	1	Dash Restraint Bar	1/2 Diameter x 54 CRS	3.0
8	2	Upper Pillar Plates	1/8 x 5-1/8 x 13-1/2 CRS	2.6
9	-	Mounting Hardware	-	1.0
10	-	Welding Material	-	1.0
Dash Structure Total Weight (lb) Items 1 Through 10				42.1
11	1	Floor Beam	.095 x 2 x 2 CR Tubing	11.2
12	2	Floor Beam Bracket	14 GA. x 8 x 25-1/2 CRS	3.3
13	2	Floor Beam Strap	14 GA. x 2 x 26 CRS	1.1
14	16	Floor Beam Plate	1/8 x 2 x 4 CRS	.3
15	-	Mounting Hardware	-	1.0
16	-	Welding Material	-	1.0
Floor Reinforcement Total Weight (lb) Items 11 Through 16				17.9
Total Weight (lb) Items 1 Through 16				60.0

Figure 1-2. Final Structural Modification to Belt Car.

were demonstrated in that program. No additional developmental work on these systems was specified for this program, although continuing improvements were made as they suggested themselves. The force limited airbelt was developed under Contract No. DOT-HS-4-00917, "Inflatable Belt Development for Subcompact Car Passengers," and the force limited 2-inch belt was adapted from the Minicar's RSV rear seat restraint design. In both of the belt systems, low elongation, doubled-over, polyester webbing was used for additional strength, and no retractors were used. All of the restraint systems, airbag and belts, are in the very early stages of development and should be considered as experimental systems.

Of the four advanced restraints integrated and evaluated in the Volvos, the RSV passenger system seems to be the nearest to being producible by present day inflatable restraints technology. It used a production inflator and manifold, and the bag itself can be stowed in the same size compartment used by production Volvo bags. The RSV passenger bag is a unique dual (upper and lower) bag design that has shown a great deal of promise for individually tailoring the head and chest restraint requirements. However, various production stitching designs still need to be investigated to ensure maximum reliability if the bag is to be produced in large numbers.

The next most producible system is the Phase II, RSV driver system. The driver bag consists of a dual (inner and outer) bag which also has shown great promise for individually controlling the head and chest accelerations. The inner and outer bags taken individually, are of a standard driver bag design, only of different volumes, and are of the type which have been extensively used in production airbag systems. The driver system inflator is the same solid pyrotechnic unit GM used in their 13,000 airbag cars, with only a slight upload in charge. The most nonproducible aspects of the RSV driver system, by present-day automotive practice, are the steering column with a low angle of seven

degrees to the horizontal and the heavy mounting structure required to hold it in place. The mounting structure used in the Volvos was nearly idential in configuration to that used in the Minicar's RSV; however, some metal gages were heavier for the Volvos. No attempt was made to production-integrate the structural modifications into the Volvo firewall cowling area because of funding limitations in what was nominally an occupant protection program.

The hardware associated with RSV steering column concept is currently undergoing a production engineering process, and when completed, will be as producible as any steering column on the market today. Also, the RSV dual driver bag was shown in supplementary testing in this program to provide protection to 41 mph when used with the production Volvo column hardware. Higher speed performance is anticipated in future development, should varying of the column collapse load be allowed.

The experimental belt systems were the least production-feasible restraint systems evaluated in the program. Both the airbelt and 2-inch belts were active systems, and were hard-mounted to the Volvo floor and B-pillar anchor points through force limiters at each anchor point. The rationale was that in order to establish the theoretical limits of performance for the belt systems, no slack, such as that introduced by retractors or passive mechanisms, could be tolerated. These conditions for the belts were somewhat unrealistic from the standpoint of passivity or comfort features; however, a web locking device was tried in the Torino bullet cars and showed promise that such devices, sometime in the future, could permit the addition of retractors or passive mechanisms without degrading the performance of the belts (see Test 9).

Another developmental aspect of the belt systems is that the force limiters, such as the roller tape devices used at the Volvo

anchor points, have never been used in any production belt system, primarily because they are effectively excluded by the present FMVSS 209 standard. An entirely different production capability would have to be developed and appropriate rulemaking activity taken before force-limiting concepts could be adopted on a wide scale.

Both belt systems were run as passenger systems because no suitable production-oriented collapsible steering column was available that would not impact the belted occupants' head in these extremely high-speed crashes which were near the structural intrusion limits of the Volvo compartment.

With respect to the experimental reliability of all the systems, the hardware was research in nature and the uniform minimum requirements typical of production quality control were not maintained, simply because of the expense and time involved, and because, as in most pure R&D work, a deterministic decision was made to use the resources that would have been required to achieve high reliability instead of test under more varied conditions. Corrective measures were taken after each experimental anomaly, and subsequent tests were conducted only after reasonable assurances of success were in hand.

During the program, three of the belts failed because of improperly installed force limiters, and installation procedures were corrected for the remainder of the tests. Two airbag passenger bags failed during the testing, and the cause was traced to an improperly sewn seam, done by a company whose quality control procedures were not established for the special requirements of airbag manufacturing. Both the belts and bags performed as expected after the testing corrections were made.

A final word is in order here concerning the number of tests run in each crash mode, both with respect to repeatability of the results and the hardware development which inevitably takes place during any such research program.

This program was of a basic research nature, and as such, it was deterministically decided, in consultation with the NHTSA, that the emphasis in the program would be placed on testing under as many varied conditions as possible, considering the relatively limited funds available to conduct eighteen crash tests.

Subsequent programs to further develop these four advanced restraints would obviously include hardware nearer to production, but also should required that each test condition be repeated two or three times in order to demonstrate the repeatability of the systems and allow meaningful evaluation of the capabilities of the system should any testing anomalies occur during any one test.

Again, since the program's objectives included determining the upper limit of the impact velocity at which the injury measures of FMVSS 208 could be met, we necessarily conducted tests which exceeded the injury criteria limits. However, we should note that the velocity limits at which the systems no longer could be repeatably relied upon to meet the injury criteria are substantially in excess of the FMVSS 208 limit of 30 mph.

2.0 SUMMARY

The matrix of impact conditions covered by this test report is shown in Table 2-1 and a summary of test results is presented in Table 2-2. The complete data from each test are presented individually by test in the following section.

TABLE 2-1. TEST MATRIX - PHASE B

Test No.	Configuration	Impact Conditions		Restraint Configuration[1]			
				Vehicle A Occupants		Vehicle B Occupants	
		Speed (mph)	Angle (deg)	Left Front	Right Front	Left Front	Right Front
8	Torino-to-Volvo Head-on	77.0[2]	0	STD	STD	DS	PS
9	Torino-to-Volvo Head-on	78.6[2]	0	SWL	SWL	AB	FLB
10	Torino-to-Volvo Right Oblique	60.5[3]	30	STD	STD	DS	PS
11	Torino-to-Volvo Left Oblique	59.5[3]	30[4]	SWL	SWL	AB	FLB
12	Torino-to-Volvo Right Oblique	63.3[3]	30[4]	SWL	SWL	DS	PS
13	Torino-to-Volvo Left Oblique	65.8[3]	30[4]	STD	STD	DS	PS
14	Torino-to-Volvo Right Oblique	66.6[3]	30[4]	SWFL	SWFL	AB	FLB
16	Torino-to-Volvo Left Oblique	60.3[3]	45	None	None	DS	PS

(1) DS = RSV Driver System, PS = RSV Passenger Airbag System, AB = Force Limited Airbelt, FLB = Force Limited 2-Inch Belt, STD = Standard 3-Point Belt System, SWL = Standard 3-Point Belt System with Web Lockers, and SWFL = Standard 3-Point Belt System with Web Lockers and Force Limiters.
(2) Closing speed; both cars moving at the same speed.
(3) Torino's speed; Volvo stationary.
(4) Major resultant acceleration vector 30° to centerline of target vehicle.

TABLE 2-2. DATA SUMMARY - PHASE B

Test No.	Restraint System(1)	Head		Chest		Femurs		Velocity Change (mph)	Remarks
		Peak G (G)	HIC	Peak G (G)	CSI	LF (lb)	RT (lb)		
8	DS	55.1	550	59.8	623	1443	1590	46.5	Good test.
	PS	73.8	830	56.2	735	1033	1621	46.5	Good test.
9	AB	84.1	1061	51.6	632	1918	1379	49.9	Injury measures marginal. Severe crash pulse. Airbelt incorrectly positioned on shoulder, resulting in HIC exceeding criteria.
	FLB	81.3	1064	55.4	555	527	1703	49.9	HIC exceeded criteria limits.
10	DS	41.3	333	38.0	184	1795	1250	34.9	Column rotated upward 8 degrees. Good test.
	PS	63.3	365	57.6	293	1092	601	34.9	First test in oblique mode. Injury measures within specification, however, seam opened up in airbag; strongly suspect that one of the old airbags with weak seams used inadvertently.

(1) DS = RSV Driver Airbag System, PS = RSV Passenger Airbag System, AB = Force Limited Airbelt, and FLB = Force Limited 2-Inch Belt.

TABLE 2-2. DATA SUMMARY - PHASE B (CONTD)

Test No.	Restraint System(1)	Head		Chest		Femurs		Velocity Change (mph)	Remarks
		Peak G (G)	HIC	Peak G (G)	CSI	LF (lb)	RT (lb)		
11	AB	34.9	247	33.5	225	325	138	35.1	Good test.
	FLB	33.7	236	29.6	166	656	972	35.1	Good test.
12	DS	33.6	233	37.9	212	1103	1440	40.2	Good test.
	PS	39.5	219	30.5	204	672	744	40.2	Lowered inflator load 20 GM to 440 GM charge to further increase safety factor on bag integrity. Good test.
13	DS	40.0	206	38.3	234	1699	1278	42.5	Good test.
	PS	38.3	195	42.3	264	No Data	523	42.5	Good test.
14	AB	41.7	313	45.1	355	577	681	40.5	Good test.
	FLB	48.5	396	50.9	394	571	957	40.5	Good test.
16	DS	60.7	207	32.1	130	423	592	31.6	Good test.
	PS	117.3	1246	31.5	120	365	937	31.6	No dash padding over steel cowl structure. Dummy head hit steering wheel or dash on driver side late in the event (T=167 msec). Otherwise good test.

3.0 TEST DATA

3.1 TEST NUMBER 8

The impact conditions for Test 8 were:

Configuration	Closing Speed
Torino-to-Volvo Head-on	77.0 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Standard 3-Point Belt	RSV Driver Airbag
Right Front	Standard 3-Point Belt	RSV Passenger Airbag

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity and to accept the restraint systems that were installed in it. The extent of these modifications is shown in Figure 1-1.

The results of Test 8 are summarized in the following tables:

Table 3-1 - Summary of Vehicle Data (Test 8)

Table 3-2 - Injury Criteria Summary (Test 8)

Table 3-3 - Summary of Restraint System Data (Test 8)

Table 3-4 - Occupant Response Data (Test 8)

which are followed by Figure 3-1 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

TABLE 3-1. SUMMARY OF VEHICLE DATA (TEST 8)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 8/February 10, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		417	439
TEST WEIGHT (lb)		4632	3263
IMPACT VELOCITY (mph)		38.46	38.46
VELOCITY CHANGE (mph)		40.5 (1)	46.5 (1)
PEAK ACCELERATION (G @ msec)			
	LOCATION 1	42.9 @ 70	50.6 @ 61
	LOCATION 2	49.3 @ 59	62.2 @ 60
MAXIMUM STATIC CRUSH (in.)			
	LEFT	19.0	35.0
	CENTER	33.0	37.5
	RIGHT	19.0	29.0

(1) Velocity change found by film analysis.

TABLE 3-2. INJURY CRITERIA SUMMARY (TEST 8)

VEHICLE A - BELT CAR (TORINO)

OCCUPANT POSITION	LEFT FRONT		RIGHT FRONT	
RESTRAINT SYSTEM	STANDARD 3-POINT BELT		STANDARD 3-POINT BELT	
HIC	1496		1285	
HEAD G(1) @ msec	111.8 @ 108		111.6 @ 107	
CSI	608 @ 200		350 @ 200	
CHEST G(1) @ msec	57.1 @ 89		38.7 @ 86	
FEMUR LOAD (lb) (2)	LEFT NA	RIGHT NA	LEFT NA	RIGHT NA

VEHICLE B - AIRBAG CAR (VOLVO)

OCCUPANT POSITION	LEFT FRONT		RIGHT FRONT	
RESTRAINT SYSTEM	RSV DRIVER AIRBAG		RSV PASSENGER AIRBAG	
HIC	550		830	
HEAD G(1) @ msec	55.1 @ 84		73.8 @ 80	
CSI	623 @ 200		735 @ 200	
CHEST G(1) @ msec	59.8 @ 87		56.2 @ 91	
FEMUR LOAD (lb)	LEFT 1443	RIGHT 1590	LEFT 1033	RIGHT 1621

(1) 3 msec clip.
(2) No femur loads measured.

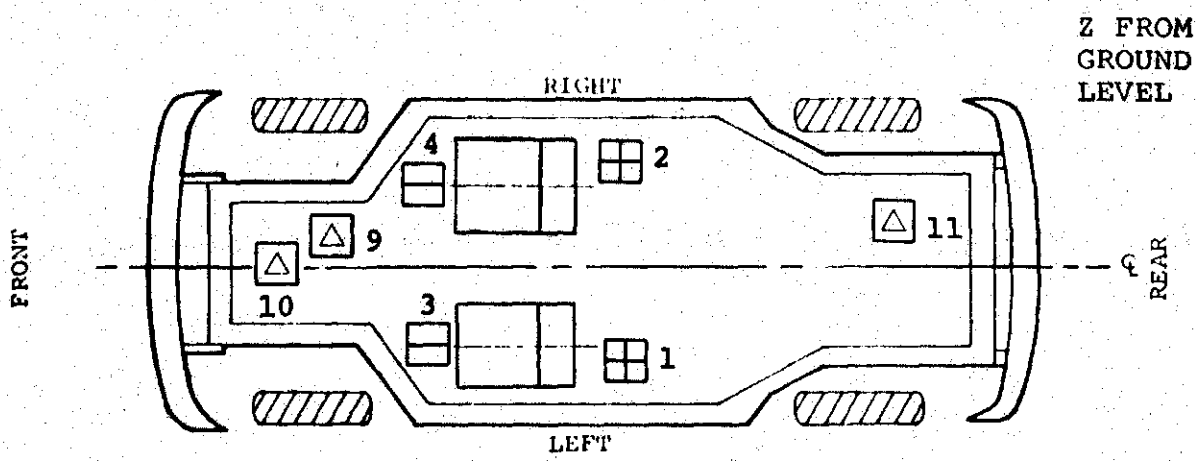
TABLE 3-3. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 8)

VEHICLE B - AIRBAG CAR (VOLVO)	
RSV DRIVER AIRBAG	
Peak Bag Pressure psi @ msec	22.2 @ 14
RSV PASSENGER AIRBAG	
Peak Bag Pressure psi @ msec	11.4 @ 82

TABLE 3-4. OCCUPANT RESPONSE DATA SUMMARY (TEST 8)

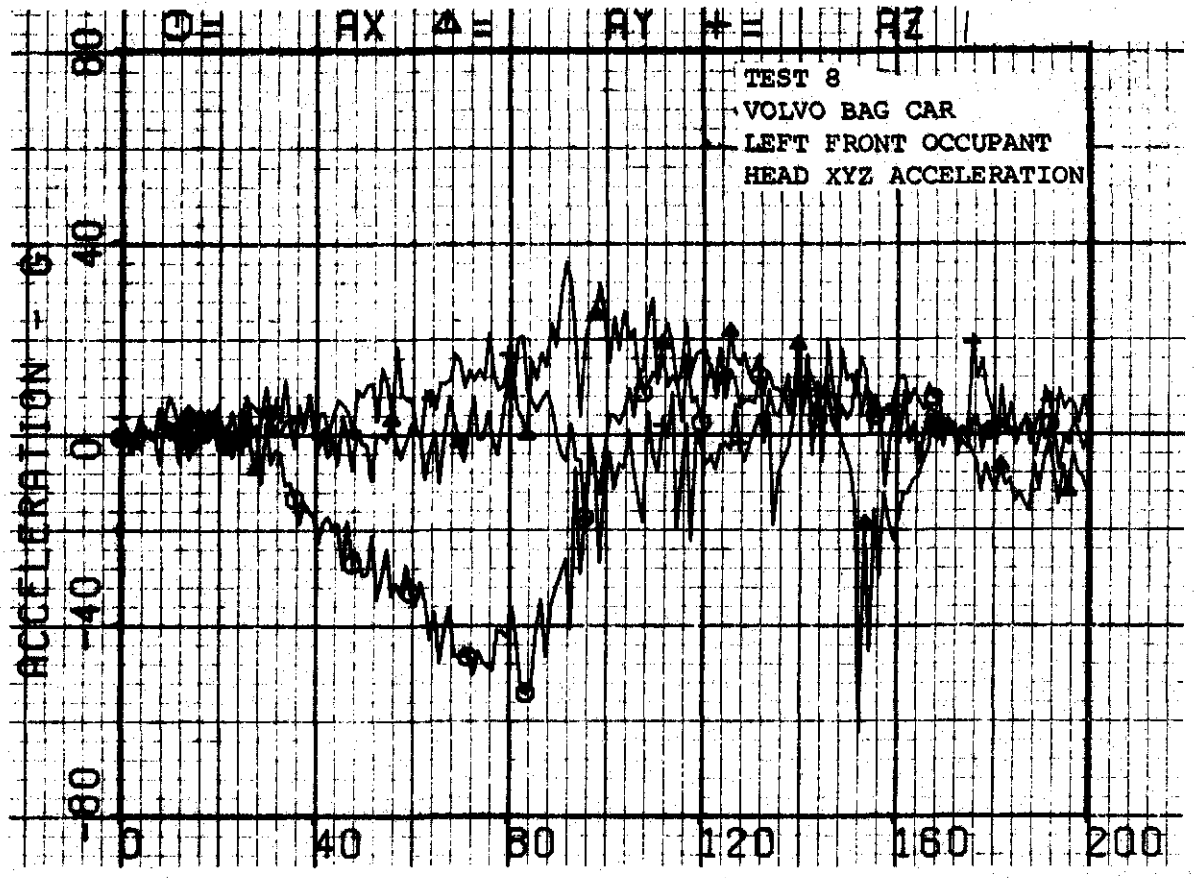
		VEHICLE A - BELT CAR (TORINO)				VEHICLE B - AIRBAG CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT		LEFT FRONT PASSENGER		RIGHT FRONT PASSENGER	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD									
	X	114.5	109	211.3	103	54.5	84	69.6	78
	Y	38.4	109	84.0	103	62.5	153	51.3	109
	Z	61.2	97	125.0	103	27.1	99	34.9	107
	R(1)	111.8	108	111.6	107	55.1	84	73.8	80
	HIC	1496 @ 89-118		1285 @ 102-109		550 @ 36-162		830 @ 60-90	
CHEST									
	X	61.0	87	38.4	85	58.0	82	59.2	92
	Y	12.4	92	17.7	121	18.9	90	10.7	160
	Z	23.1	107	24.8	121	33.5	95	27.1	102
	R(1)	57.1	89	38.7	86	59.8	87	56.2	91
	SI	608 @ 200		350 @ 200		623 @ 200		735 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS (2)									
	LF	NA		NA		1443	91	1033	92
	RT	NA		NA		1590	86	1621	92

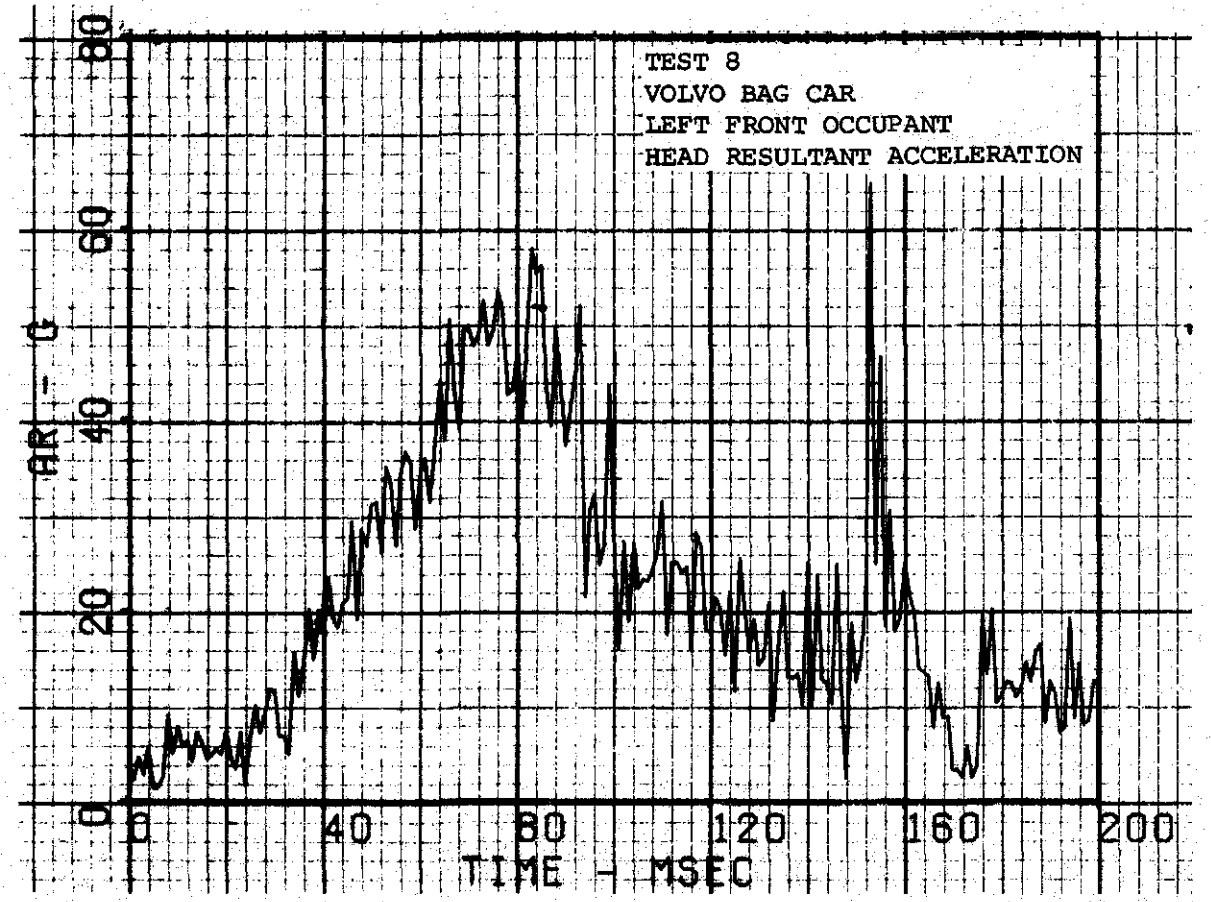
(1) 3 msec clip, components not clipped.
(2) No femur loads measured - Vehicle B.

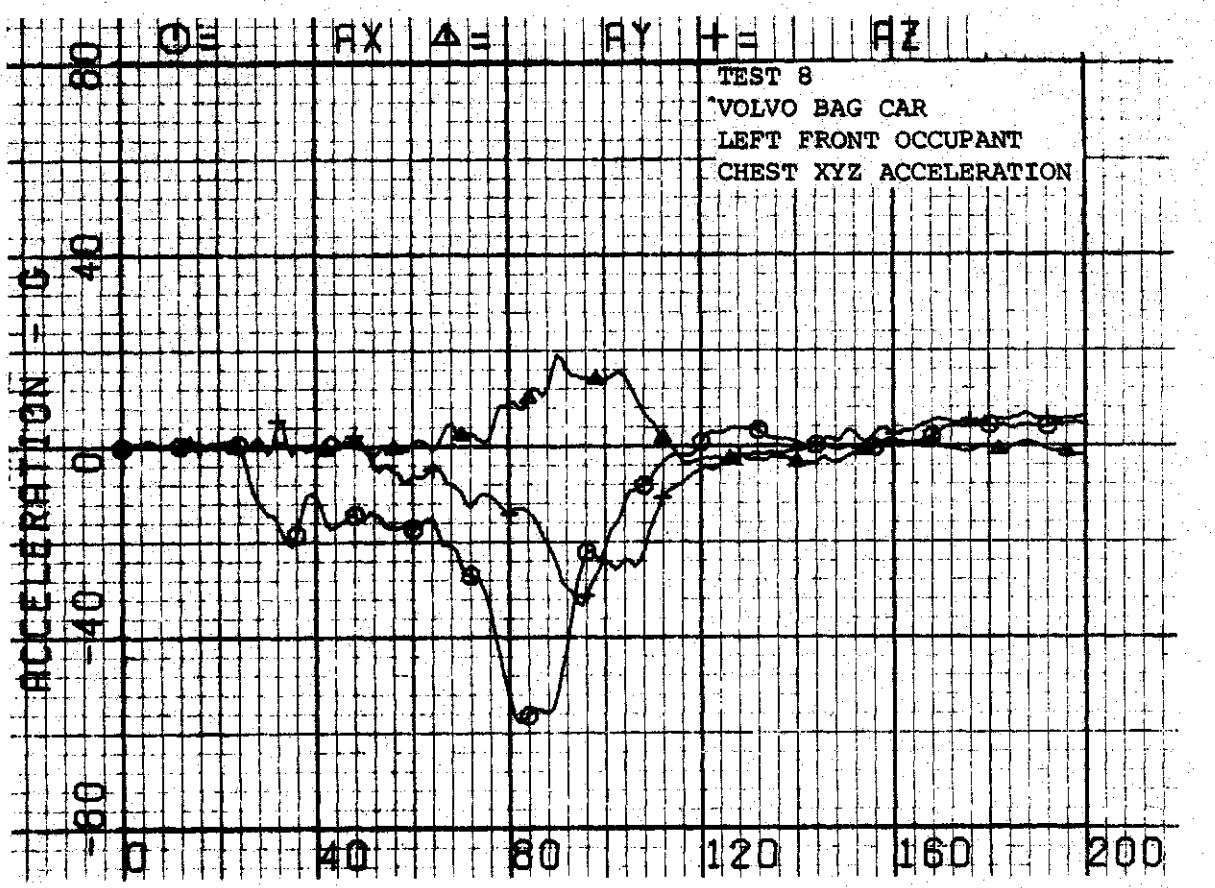


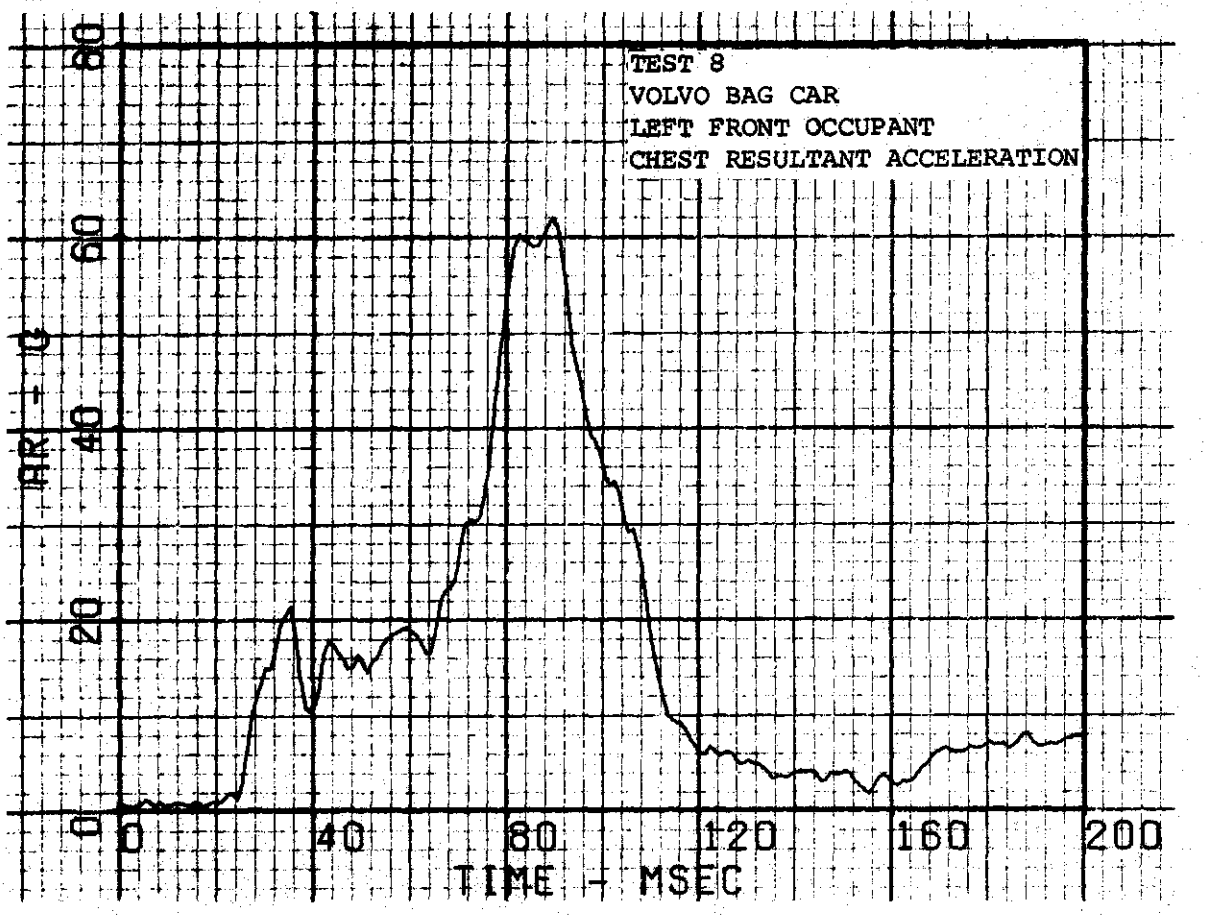
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
9	Engine Block	X	X	X
10	Front Crossmember	X	X	X
11	Rear Axle	X	X	X

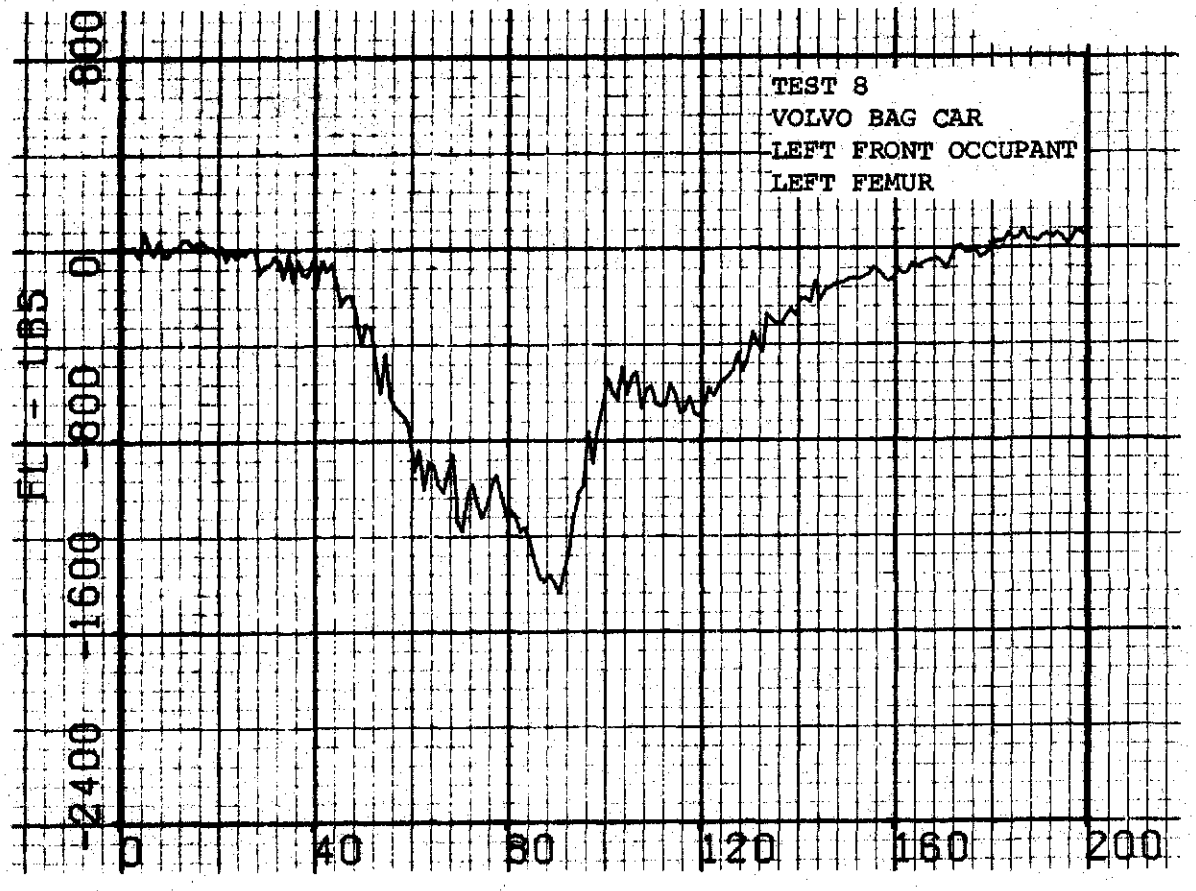
Figure 3-1. Vehicle Accelerometer Locations - Test 8.

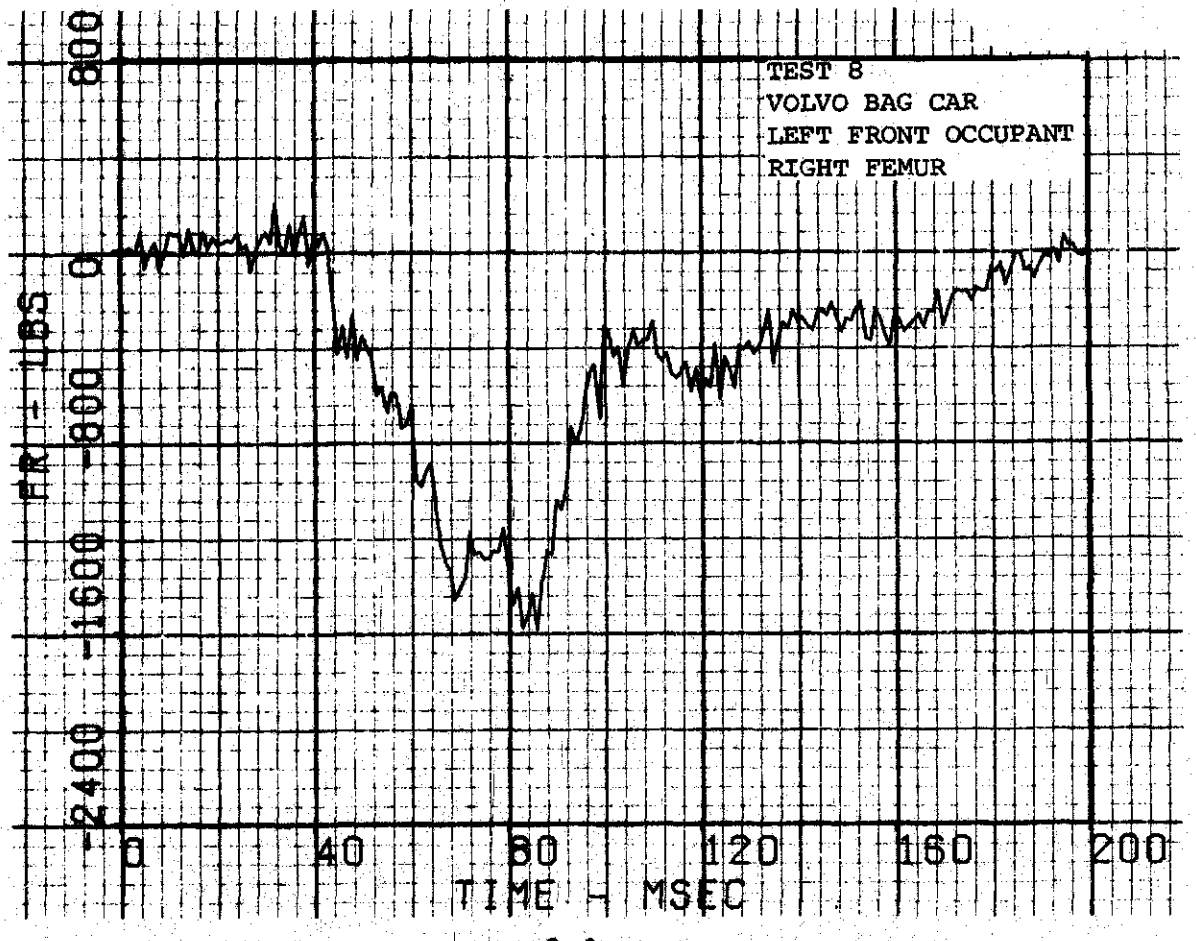

AX
AY
AZ
TEST 8
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

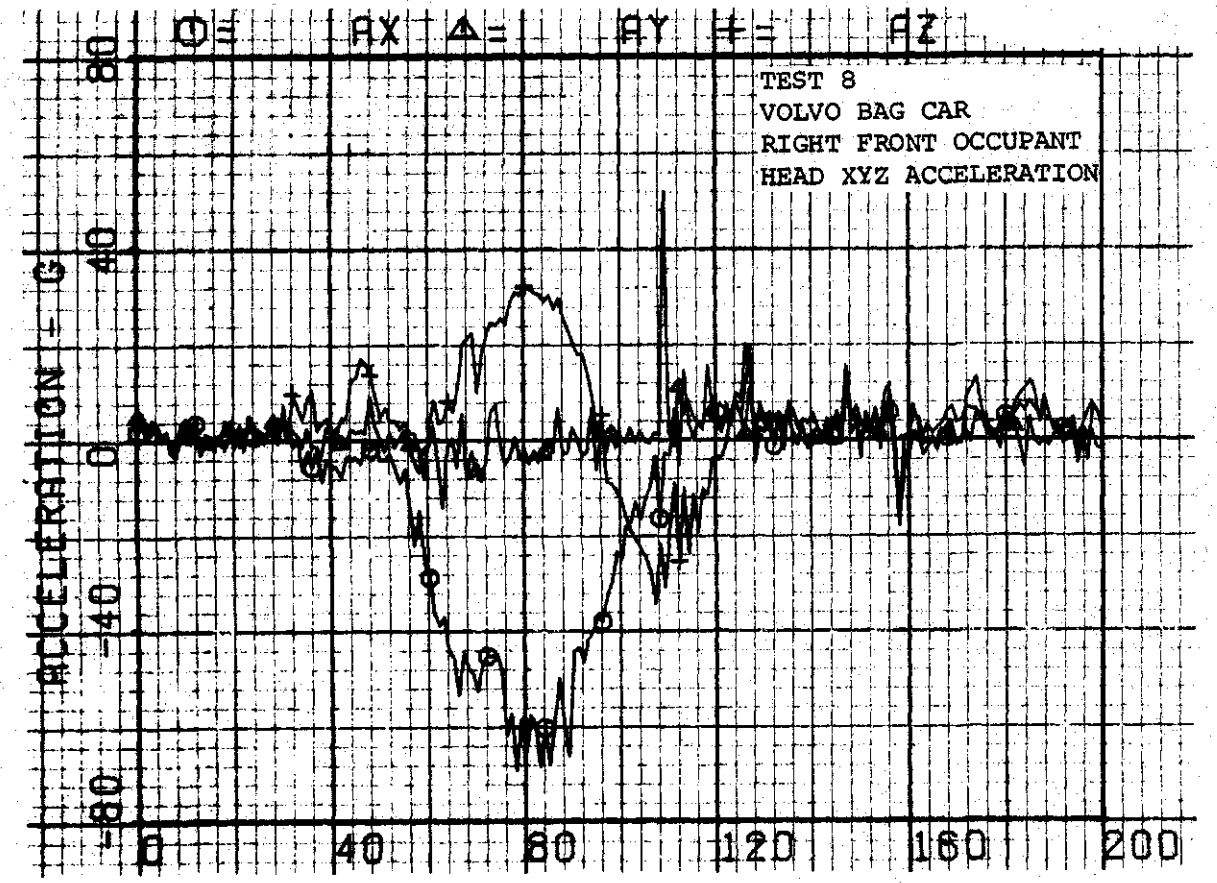

TEST 8
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

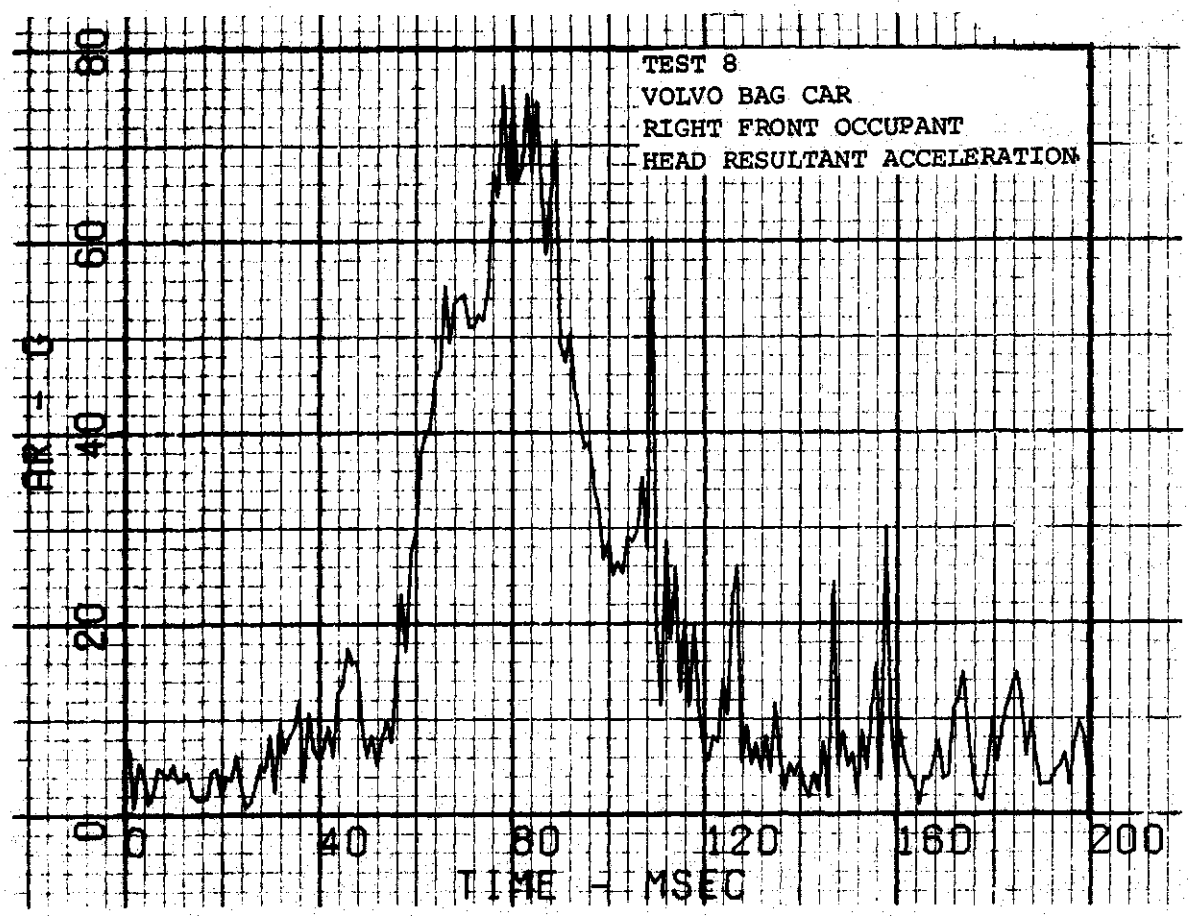

○= AX △= AY += AZ
TEST 8
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

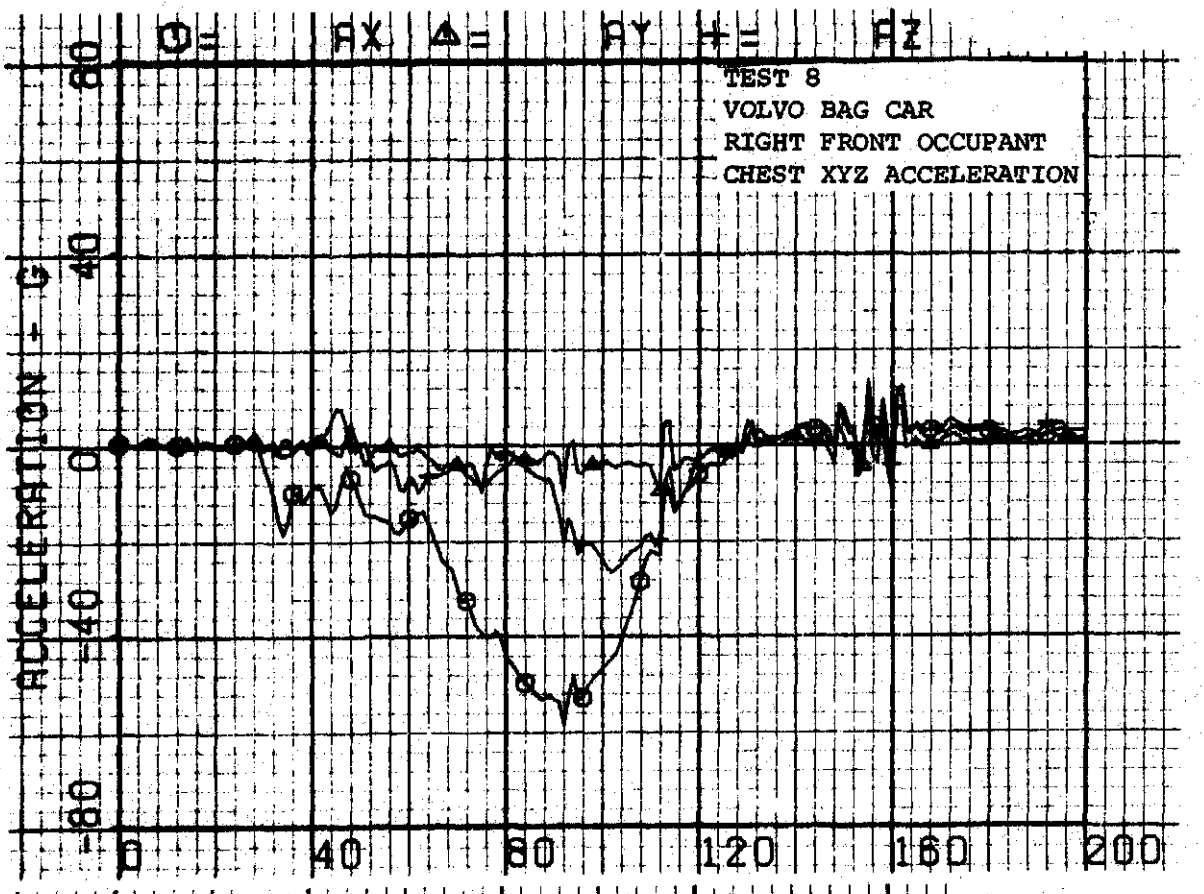

TEST 8
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

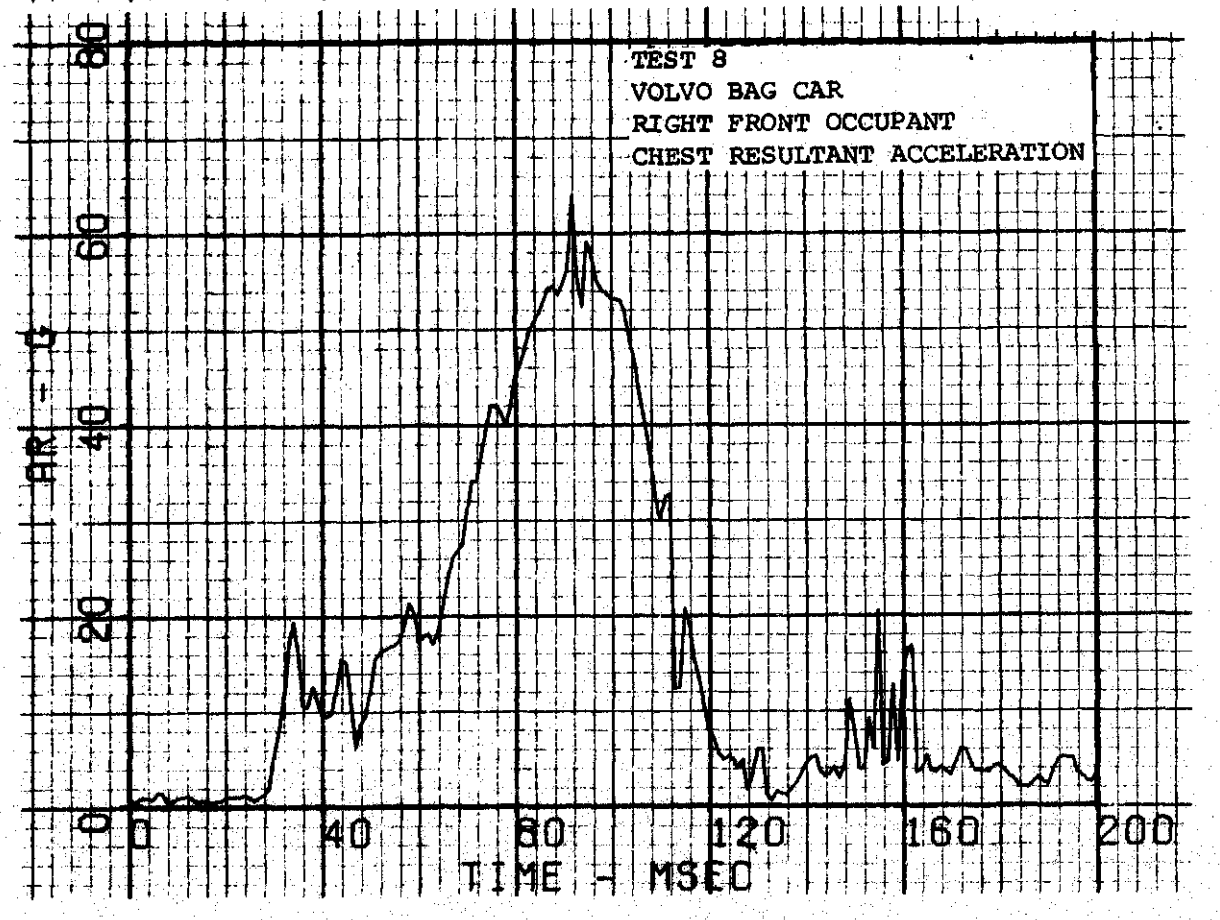

TEST 8
VOLVO BAG CAR
LEFT FRONT OCCUPANT
LEFT FEMUR
FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200

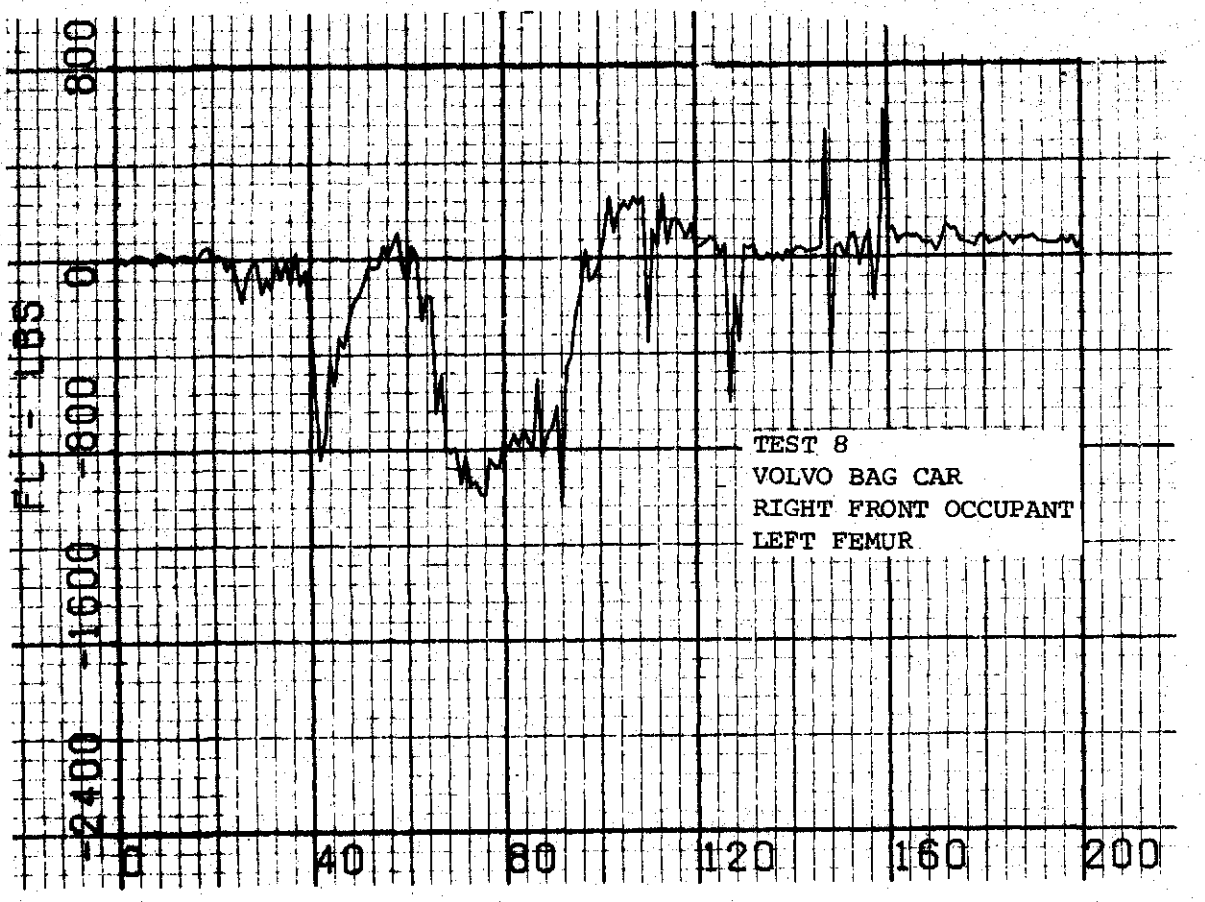

TEST 8
VOLVO BAG CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC

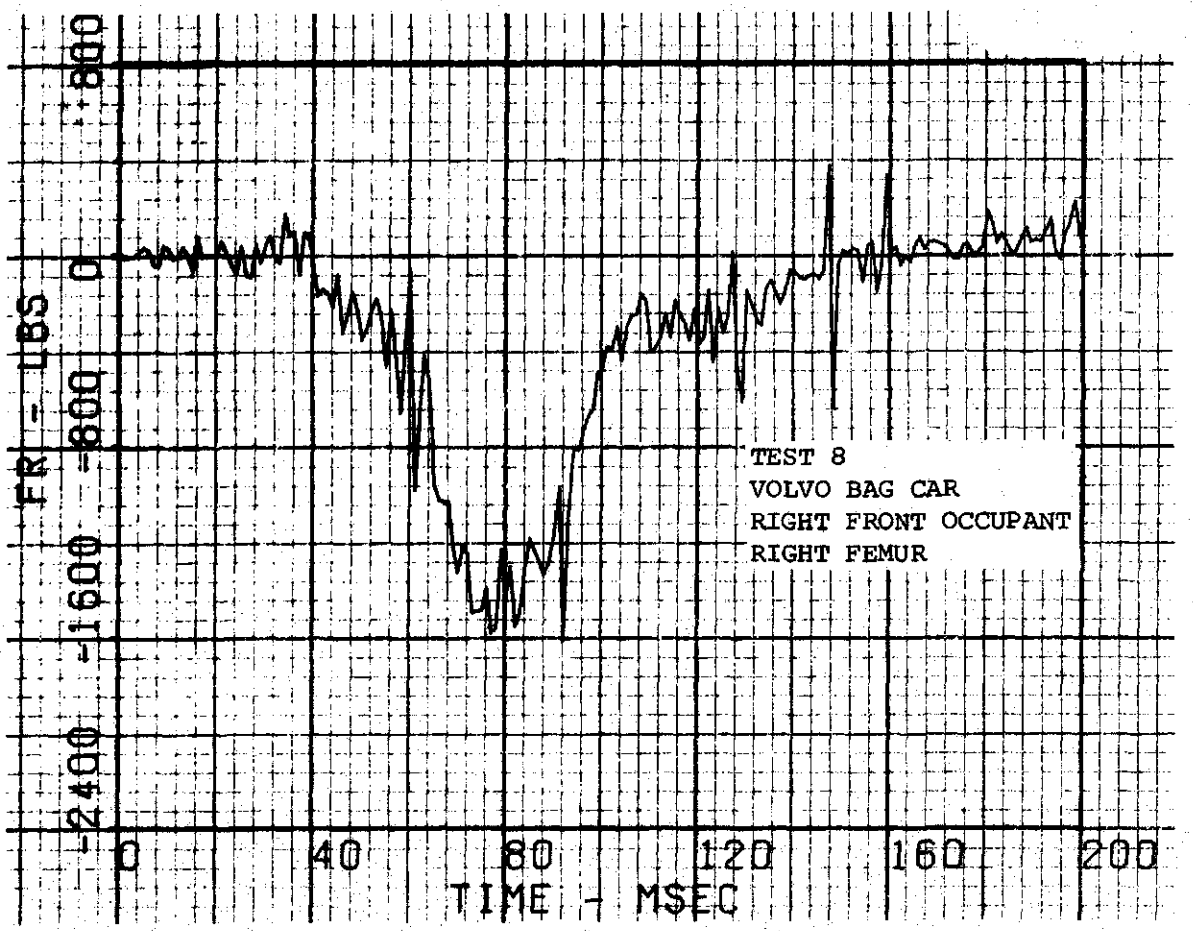

□= AX △= AY += AZ
TEST 8
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

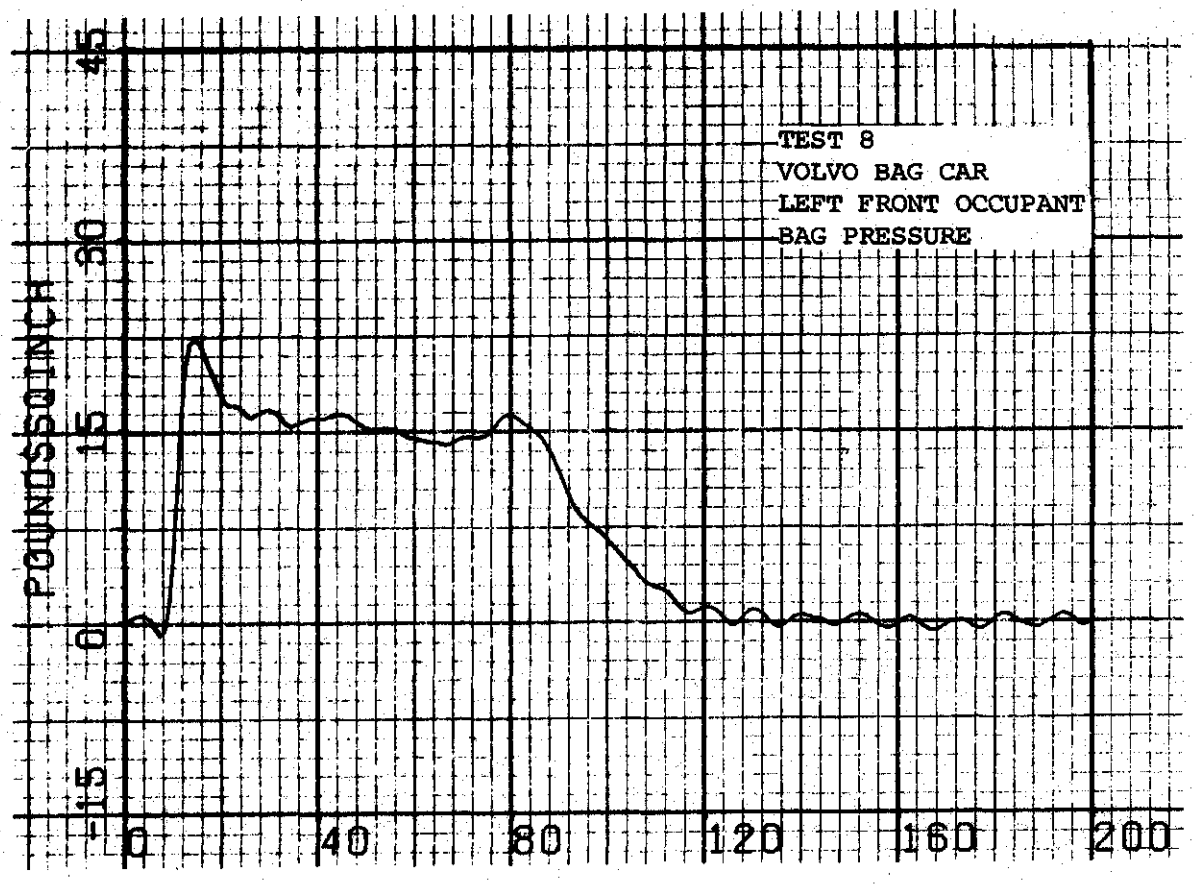

TEST 8
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

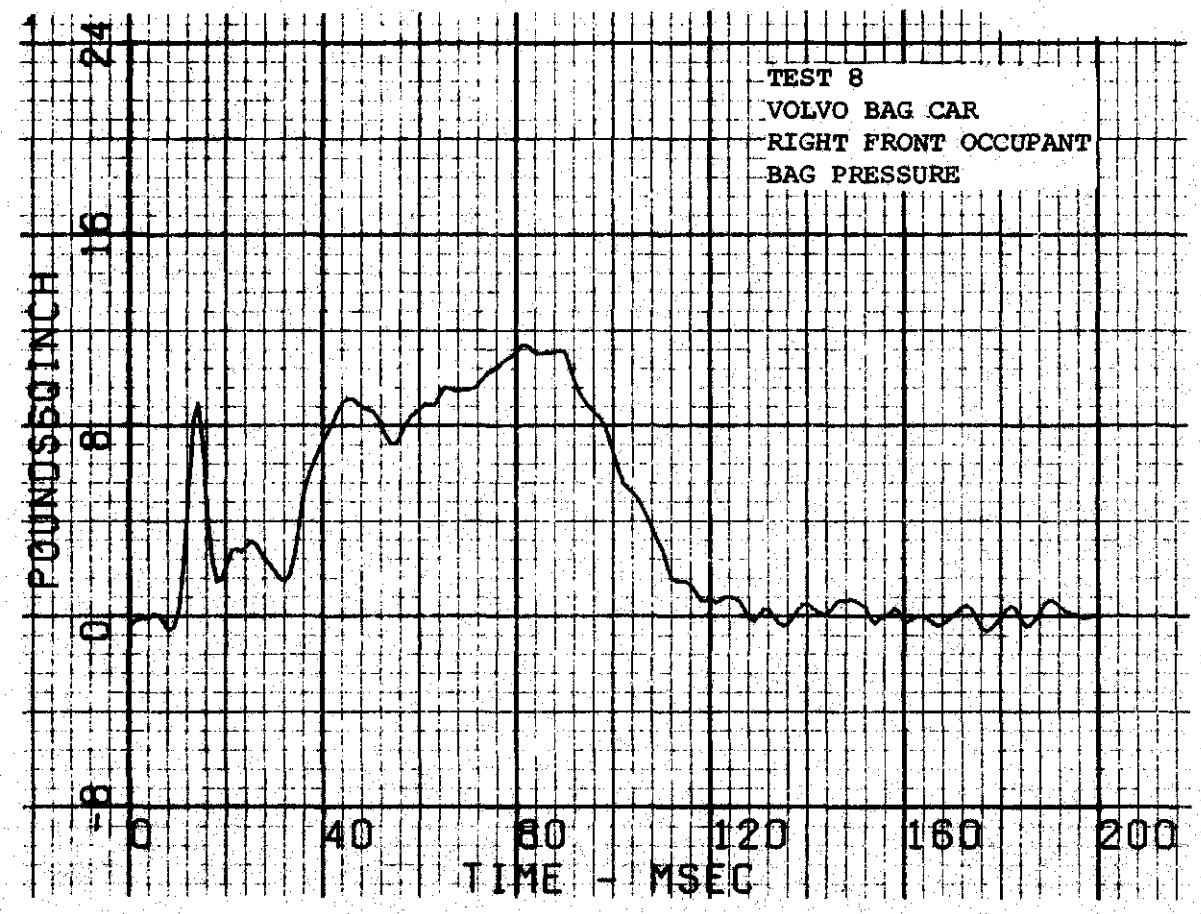

□= AX Δ= AY ○= AZ
TEST 8
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

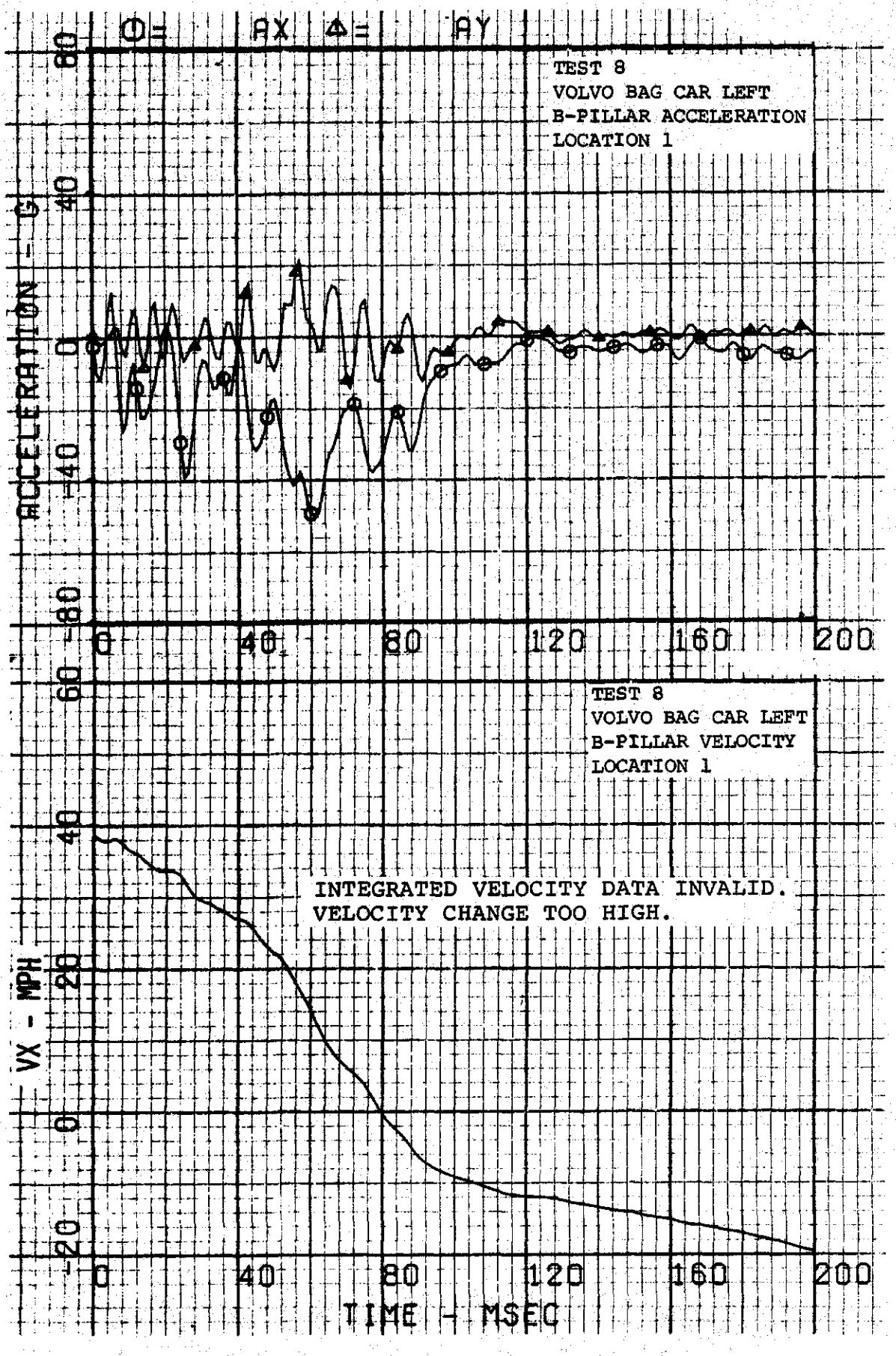

TEST 8
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

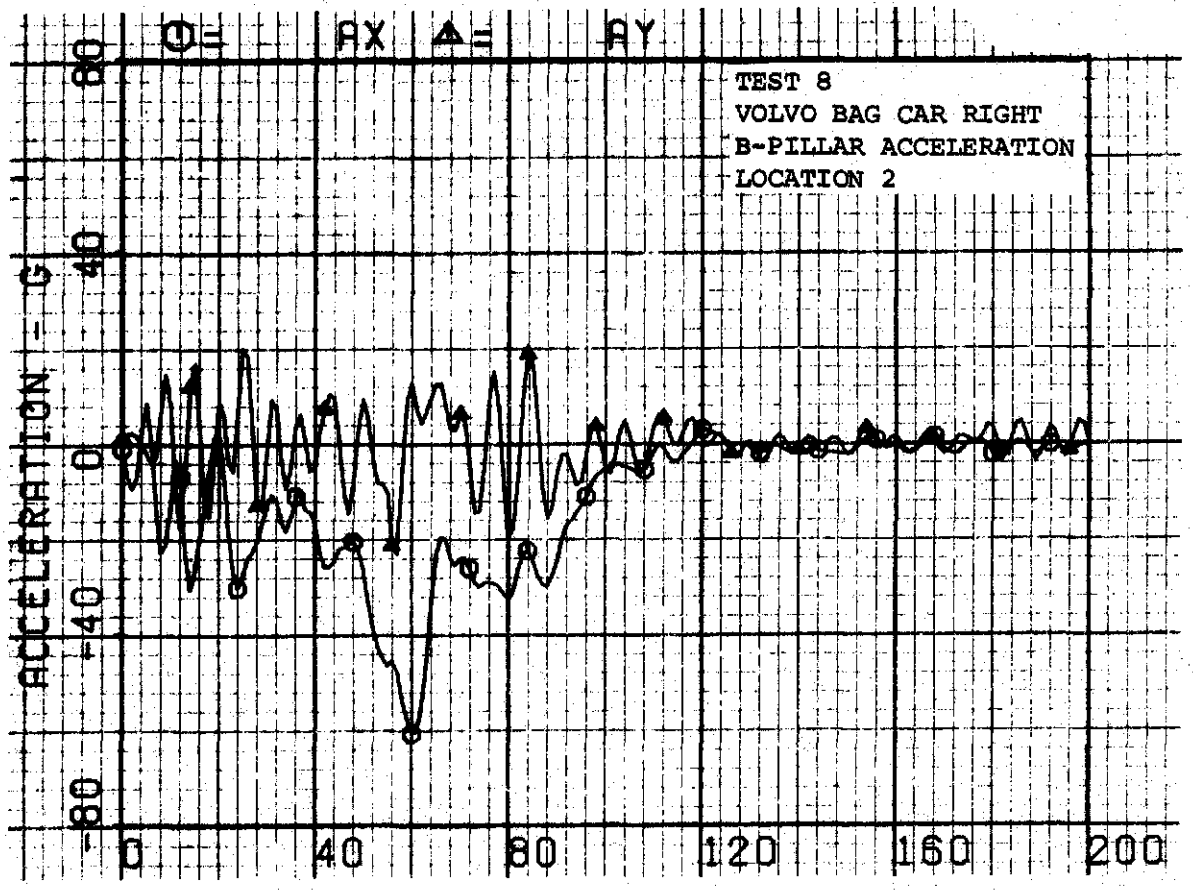

FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 8
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR

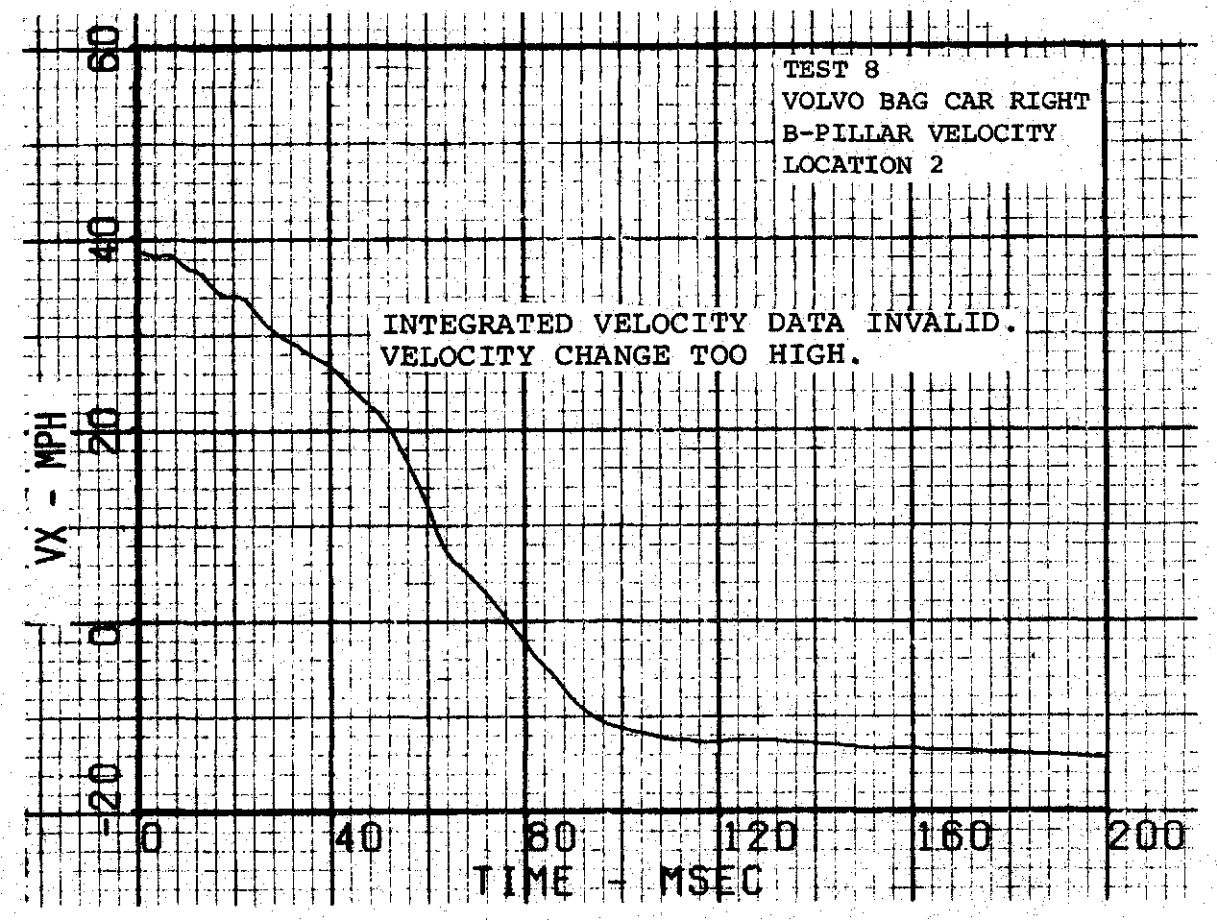

FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC
TEST 8
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
RIGHT FEMUR

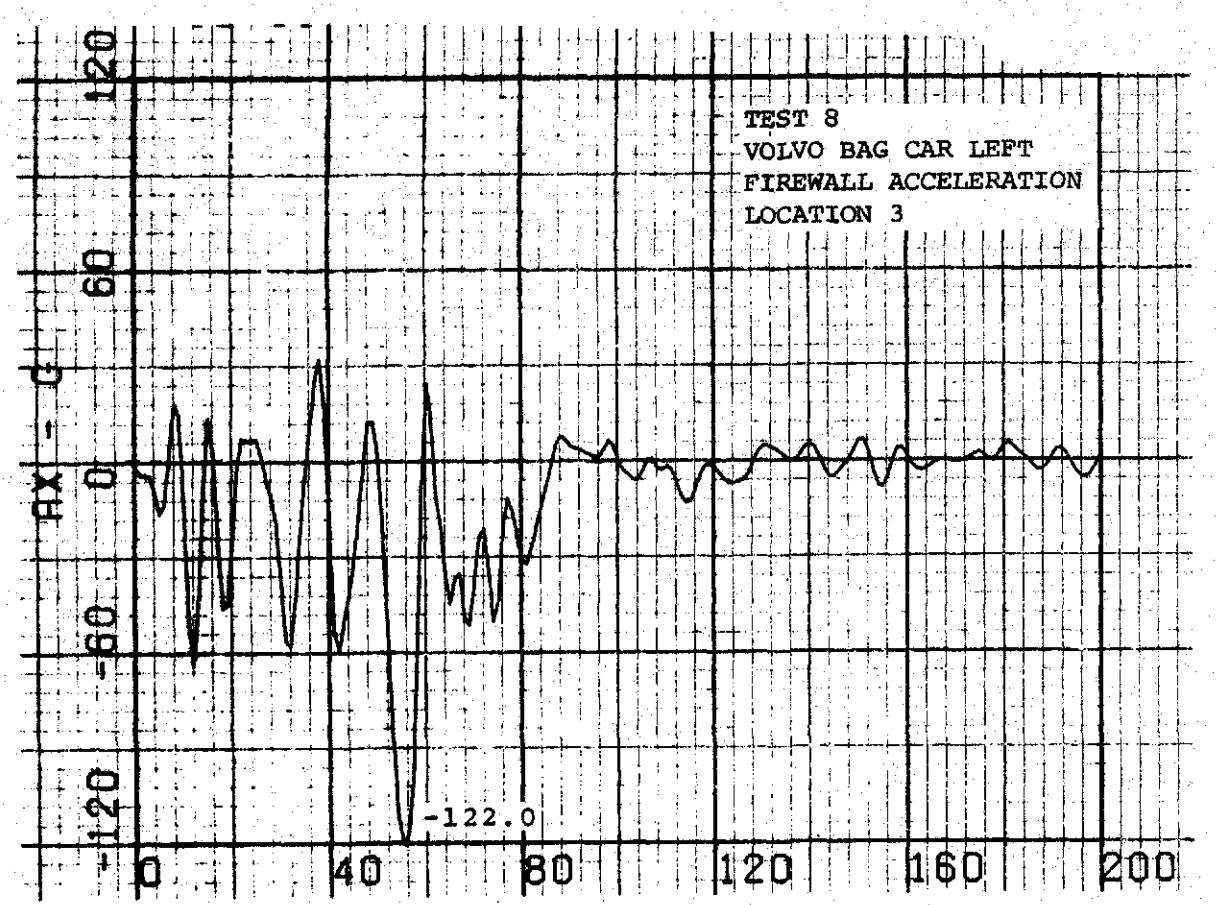

TEST 8
VOLVO BAG CAR
LEFT FRONT OCCUPANT
BAG PRESSURE
POUNDS/SQ INCH
45
30
15
0
-15
0
40
80
120
160
200

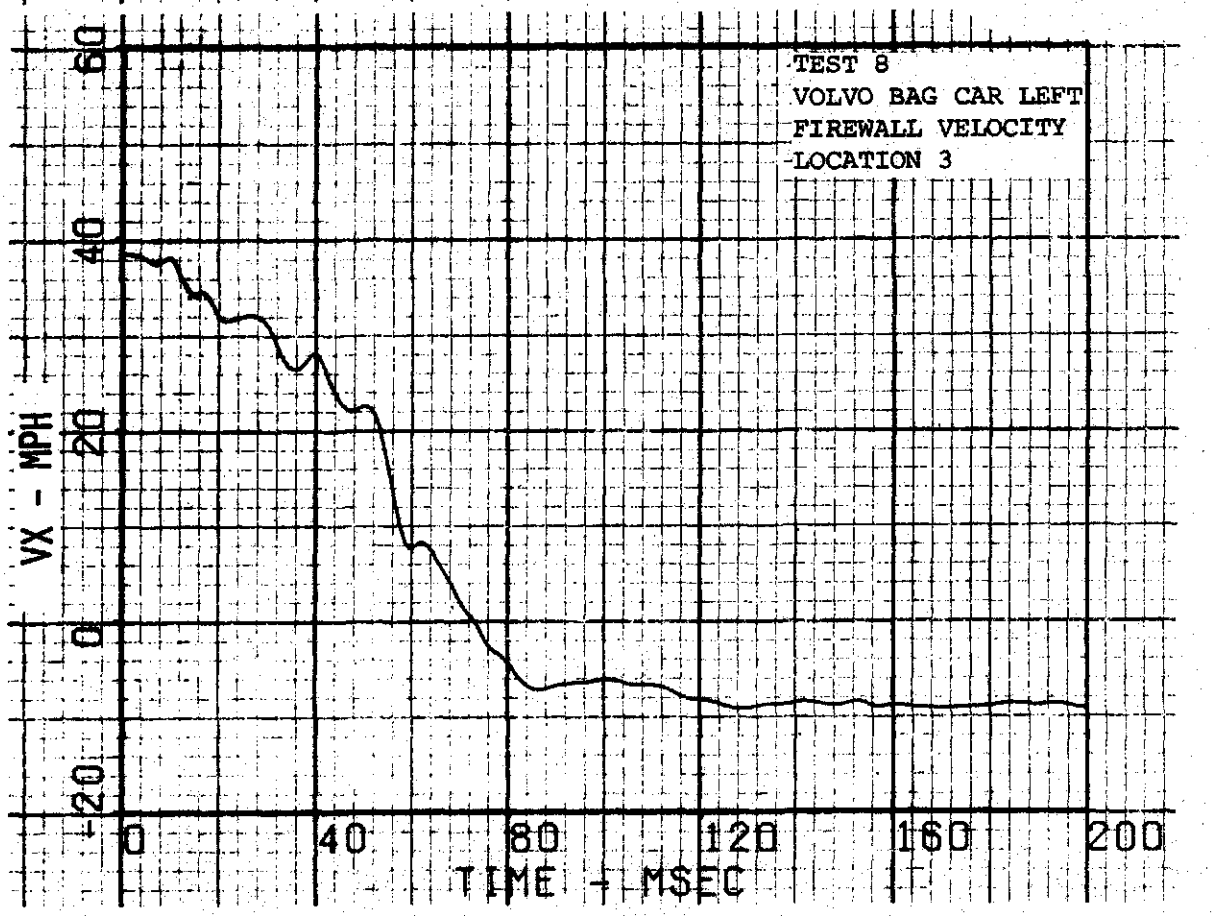

TEST 8
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
BAG PRESSURE
POUNDS/SQ INCH
24
16
8
0
-8
0
40
80
120
160
200
TIME - MSEC

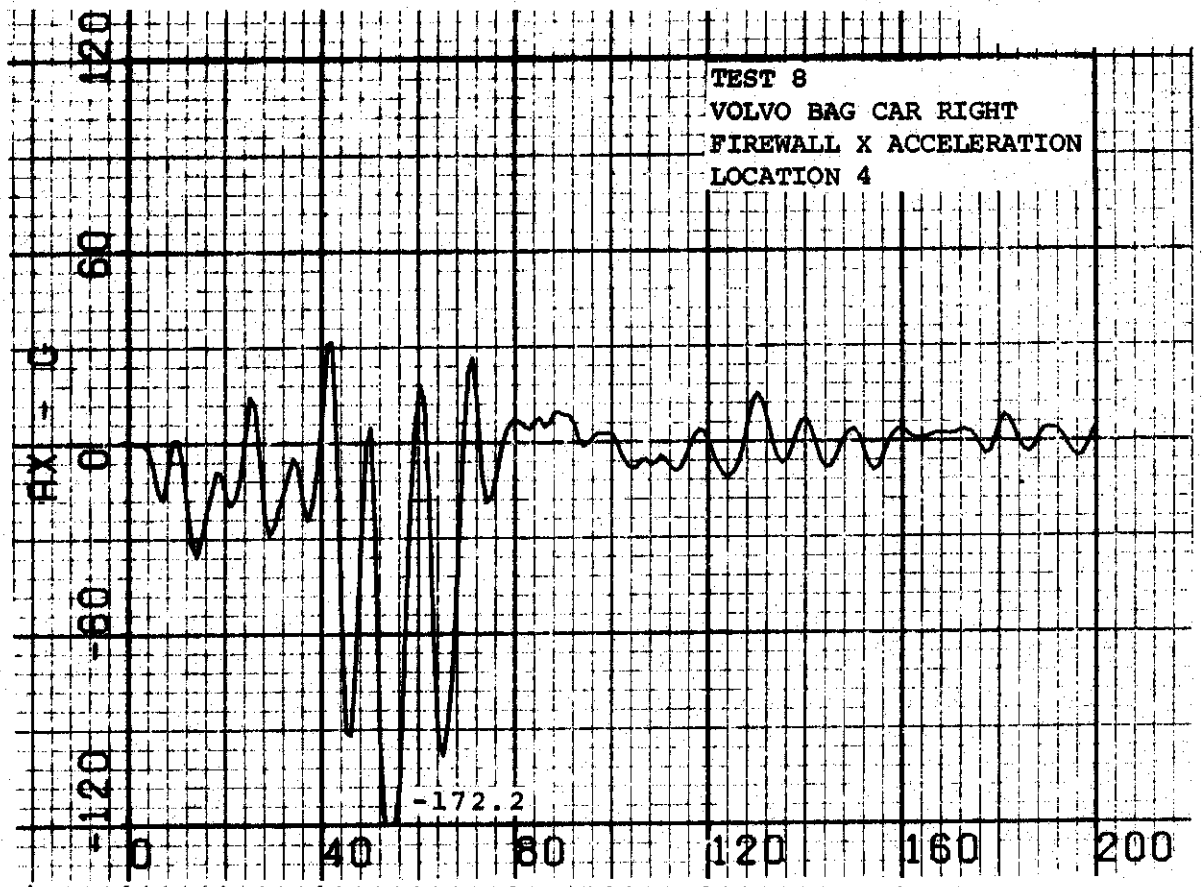

○ = AX
△ = AY
TEST 8
VOLVO BAG CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 8
VOLVO BAG CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
INTEGRATED VELOCITY DATA INVALID.
VELOCITY CHANGE TOO HIGH.
VX - MPH
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

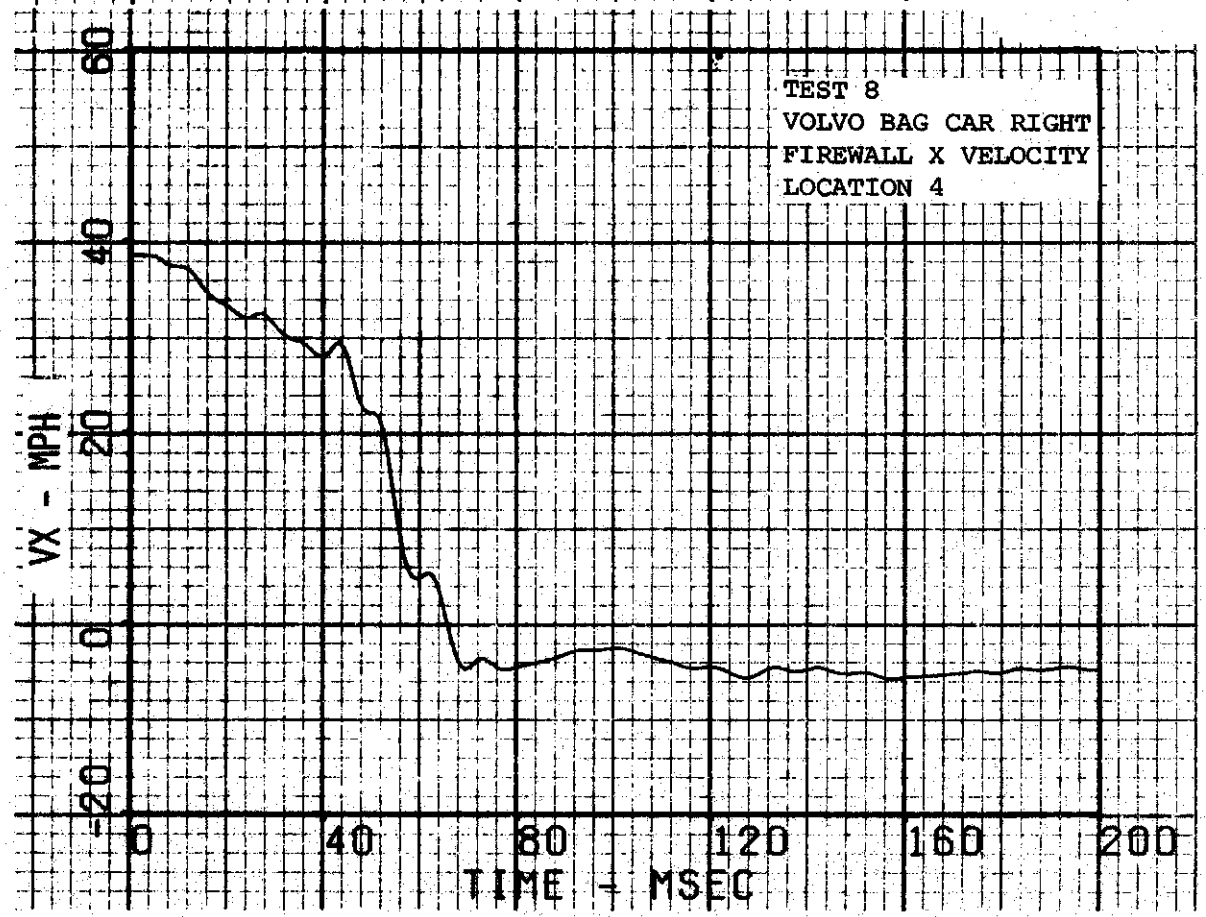

□ = AX ▲ = AY
TEST 8
VOLVO BAG CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

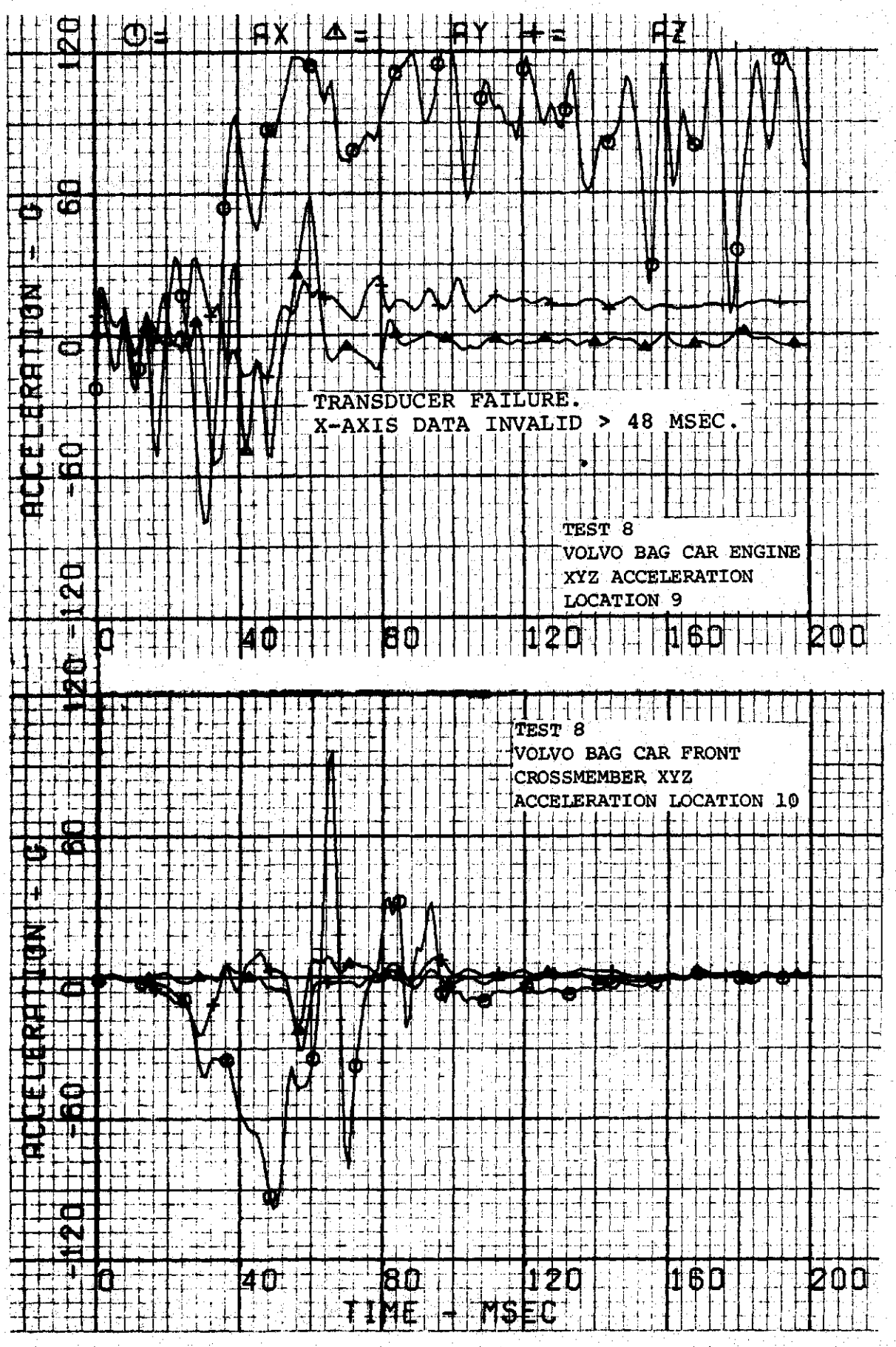

TEST 8
VOLVO BAG CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
INTEGRATED VELOCITY DATA INVALID.
VELOCITY CHANGE TOO HIGH.
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

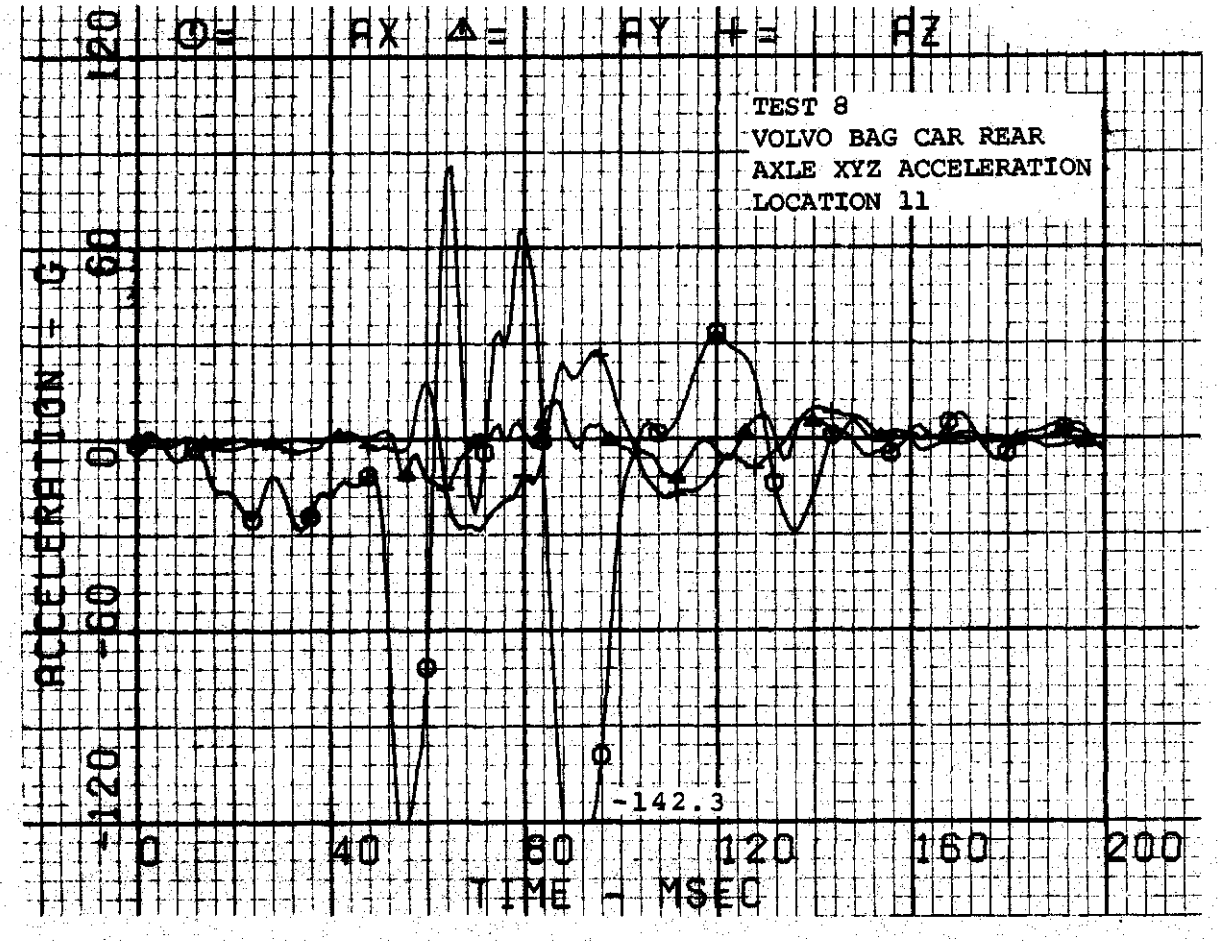

TEST 8
VOLVO BAG CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
AX - G
120
60
0
-60
-120
-122.0
0
40
80
120
160
200

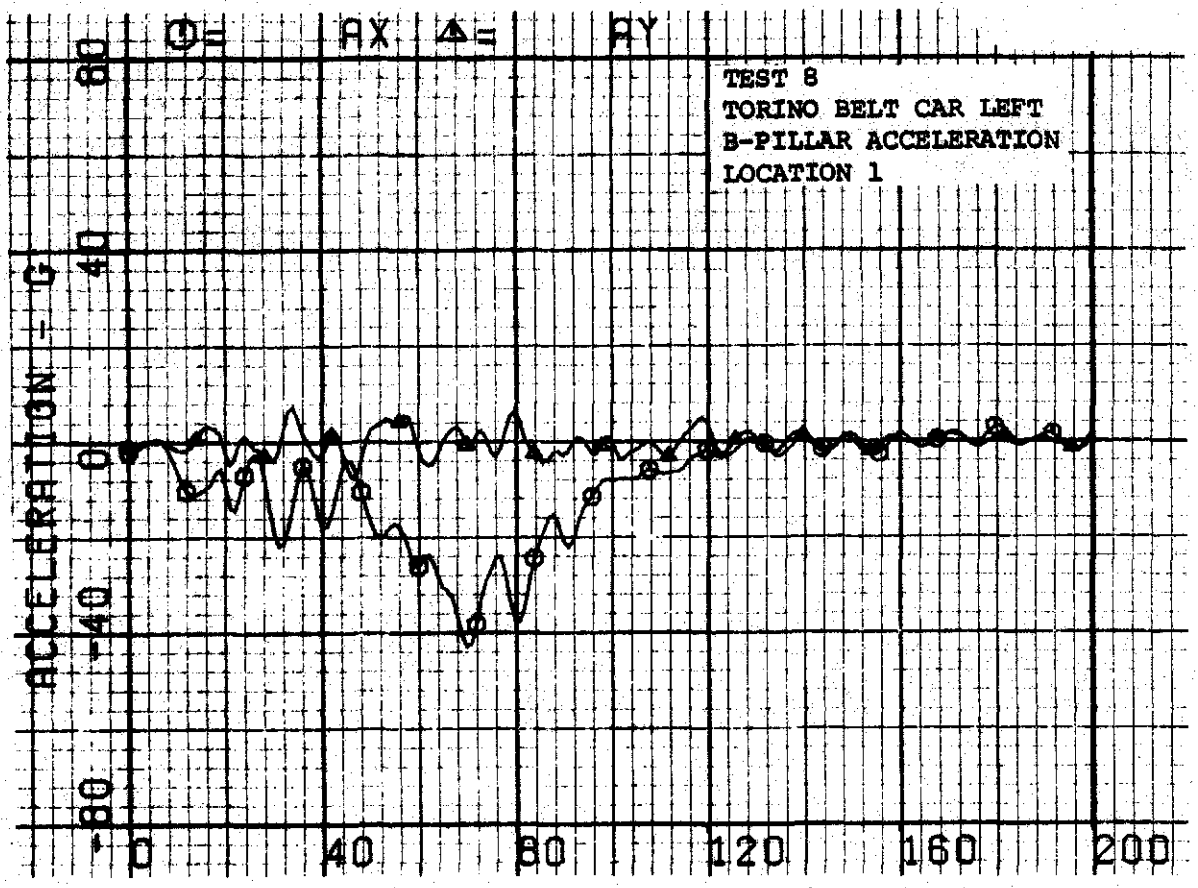

TEST 8
VOLVO BAG CAR LEFT
FIREWALL VELOCITY
LOCATION 3
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

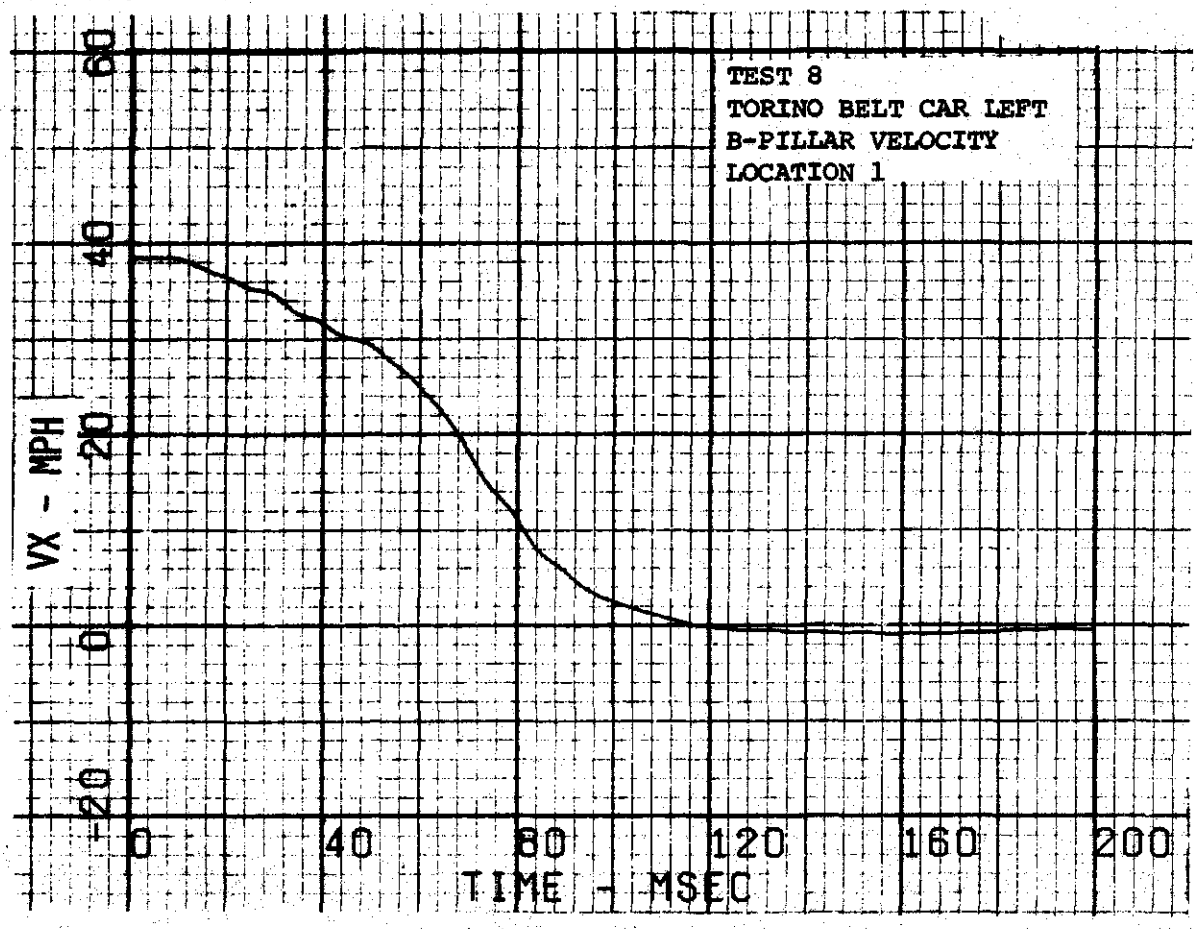

TEST 8
VOLVO BAG CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
AX - G
120
60
0
-60
-120
-172.2
0
40
80
120
160
200

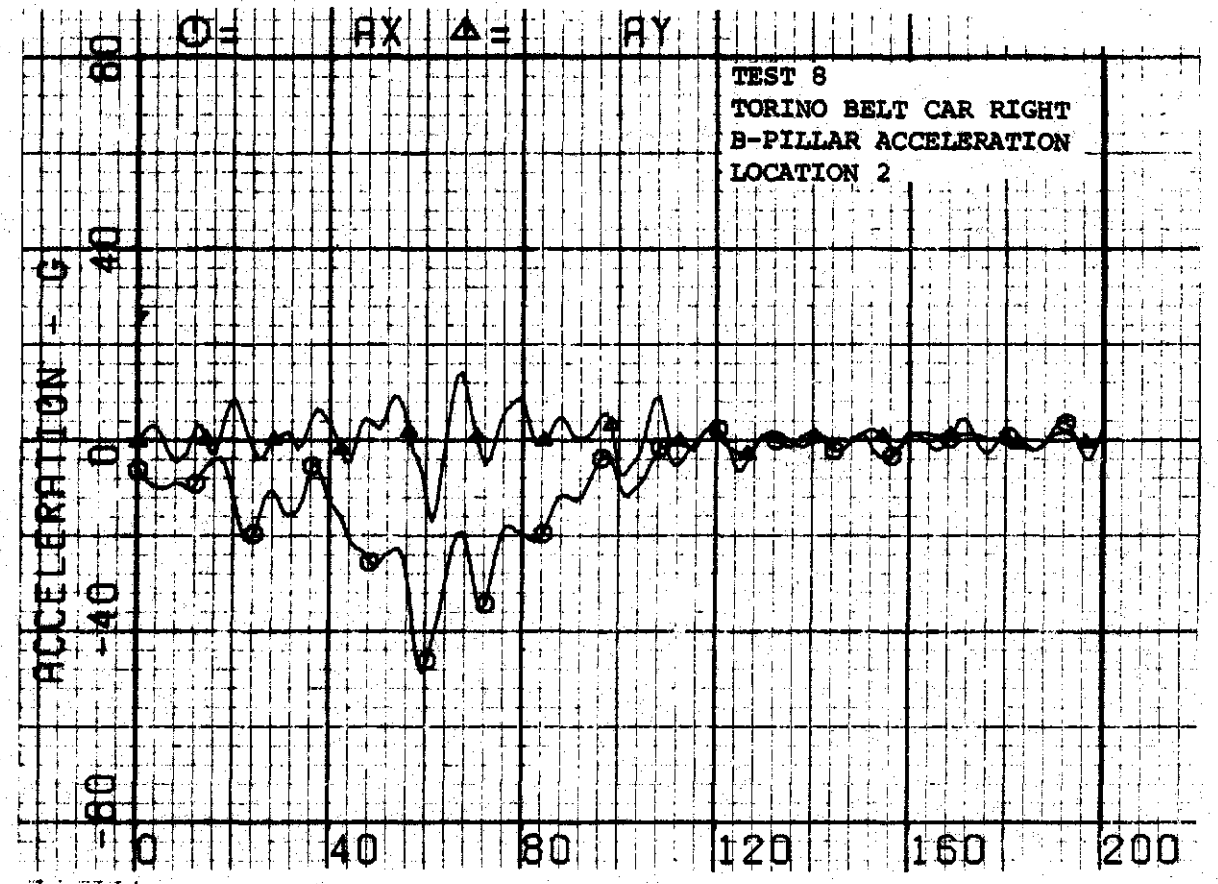

TEST 8
VOLVO BAG CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

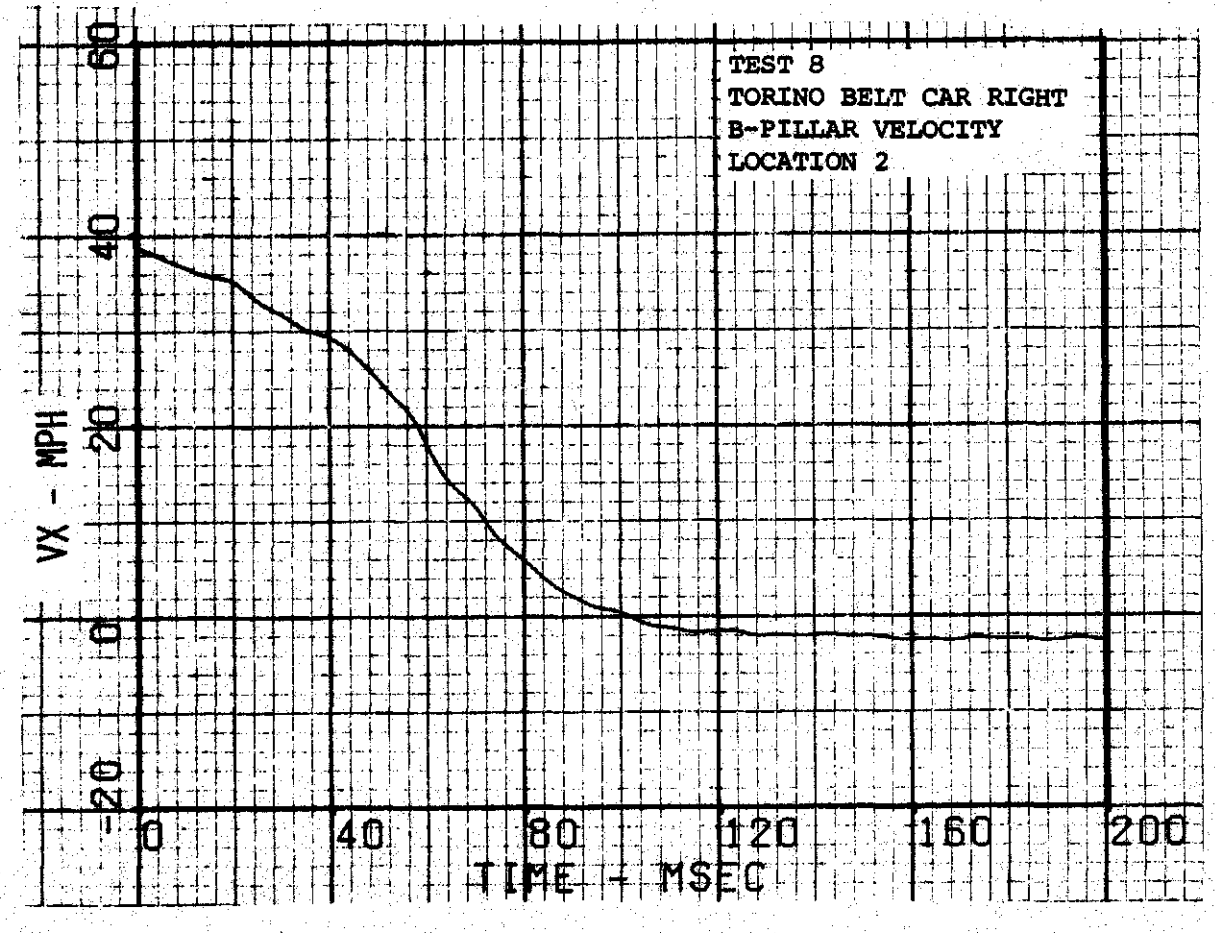

AX
AY
AZ
ACCELERATION - G
120
60
0
-60
-120
TRANSDUCER FAILURE.
X-AXIS DATA INVALID > 48 MSEC.
TEST 8
VOLVO BAG CAR ENGINE
XYZ ACCELERATION
LOCATION 9
0
40
80
120
160
200
TEST 8
VOLVO BAG CAR FRONT
CROSSMEMBER XYZ
ACCELERATION LOCATION 10
TIME - MSEC

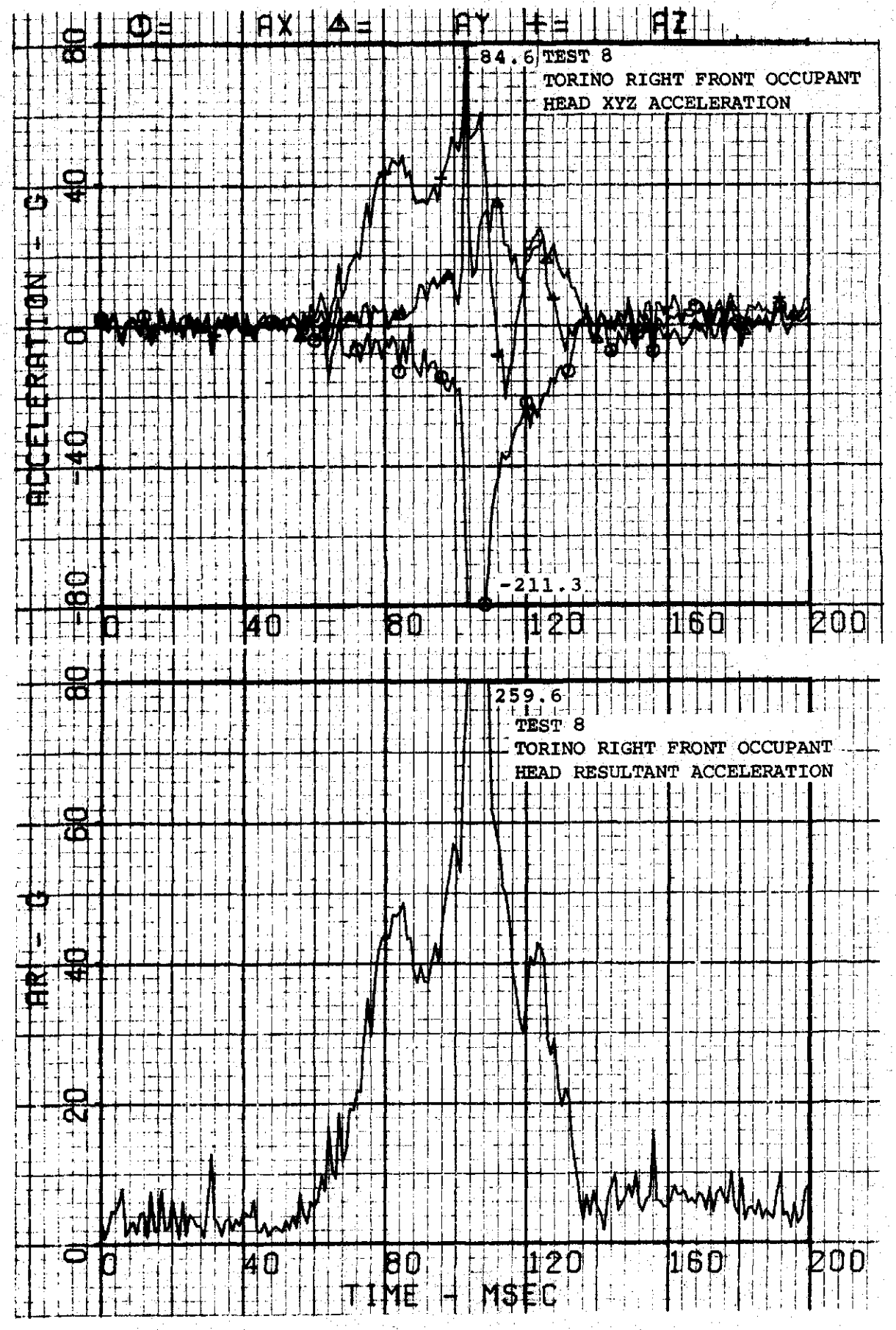

⊙= AX
△= AY
+= AZ
TEST 8
VOLVO BAG CAR REAR
AXLE XYZ ACCELERATION
LOCATION 11
ACCELERATION - G
+120
+60
0
-60
-120
-142.3
0
40
80
120
160
200
TIME - MSEC

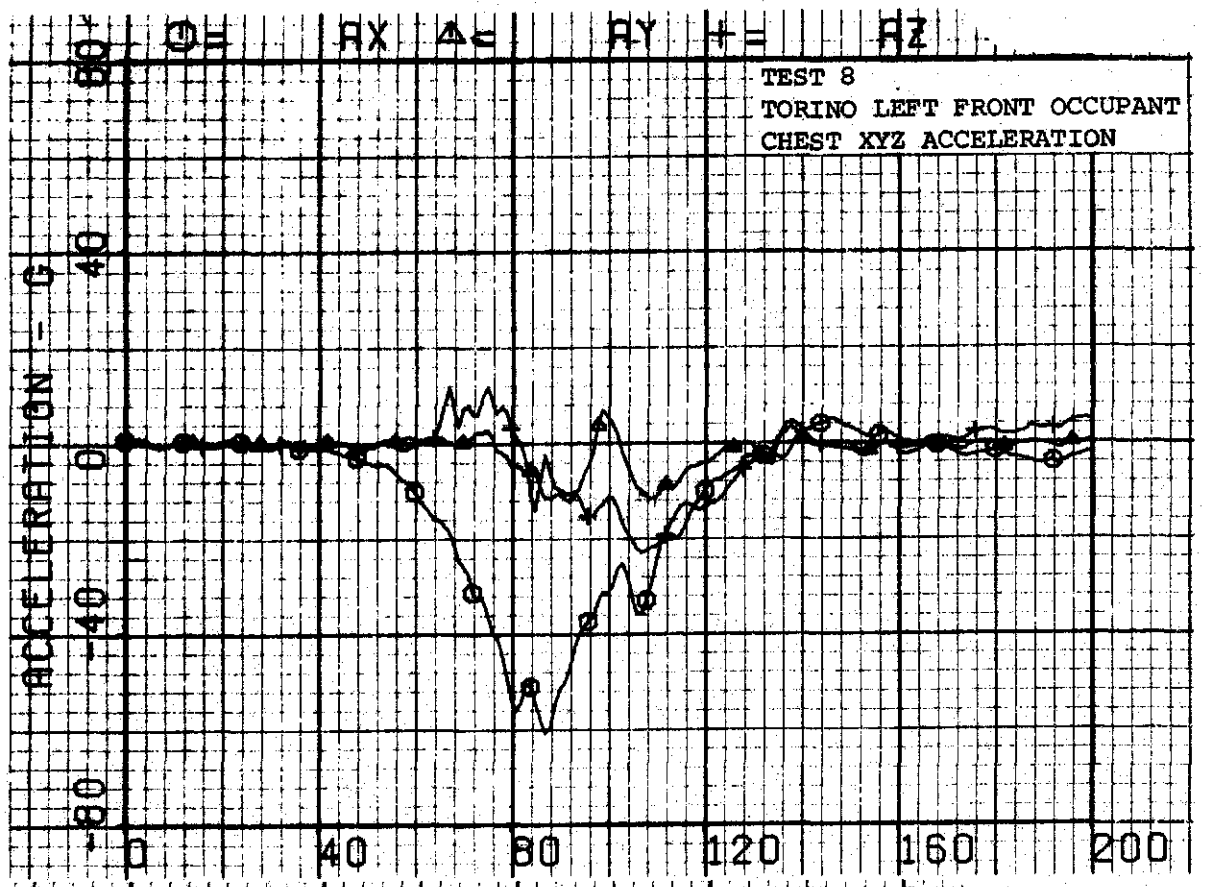

AX
AY
TEST 8
TORINO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

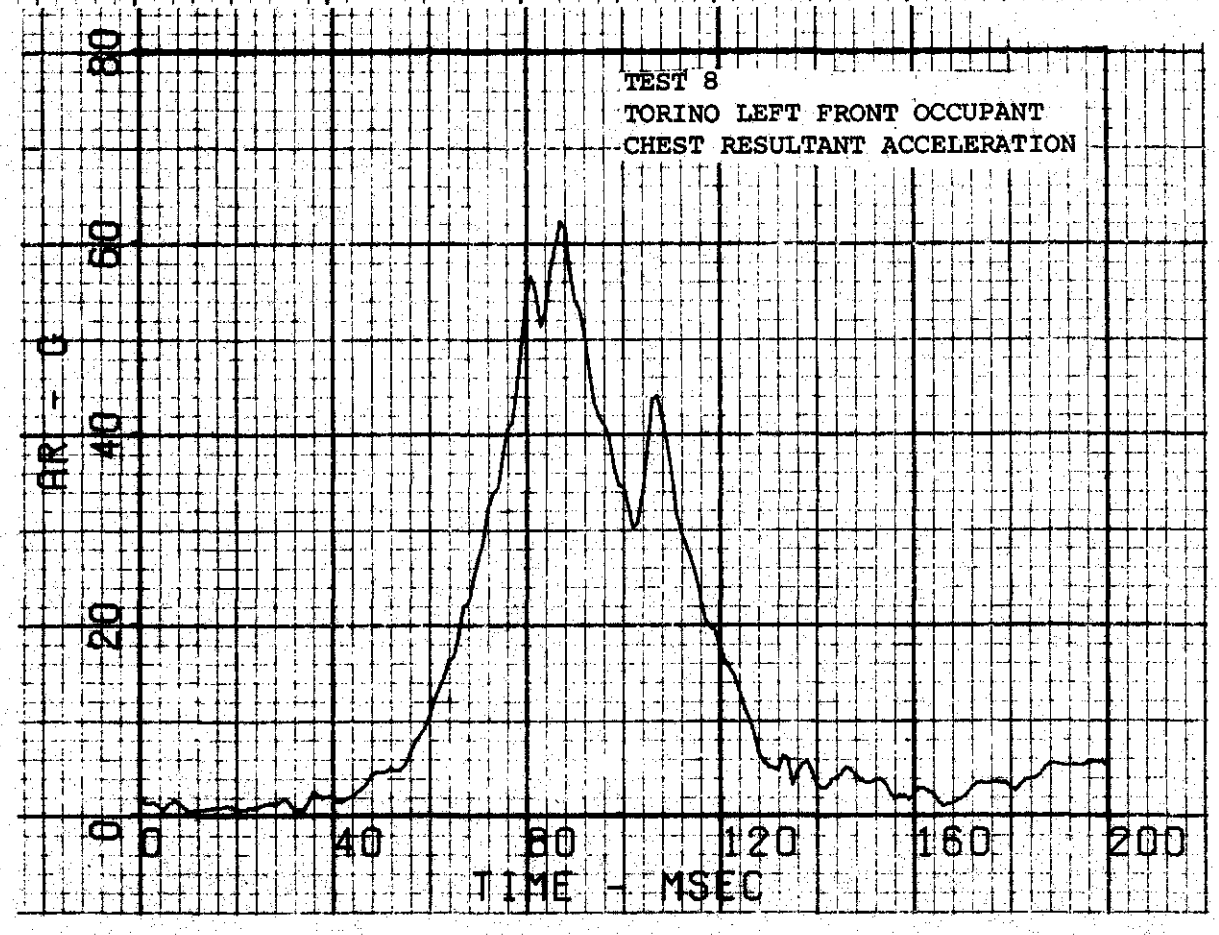

TEST 8
TORINO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

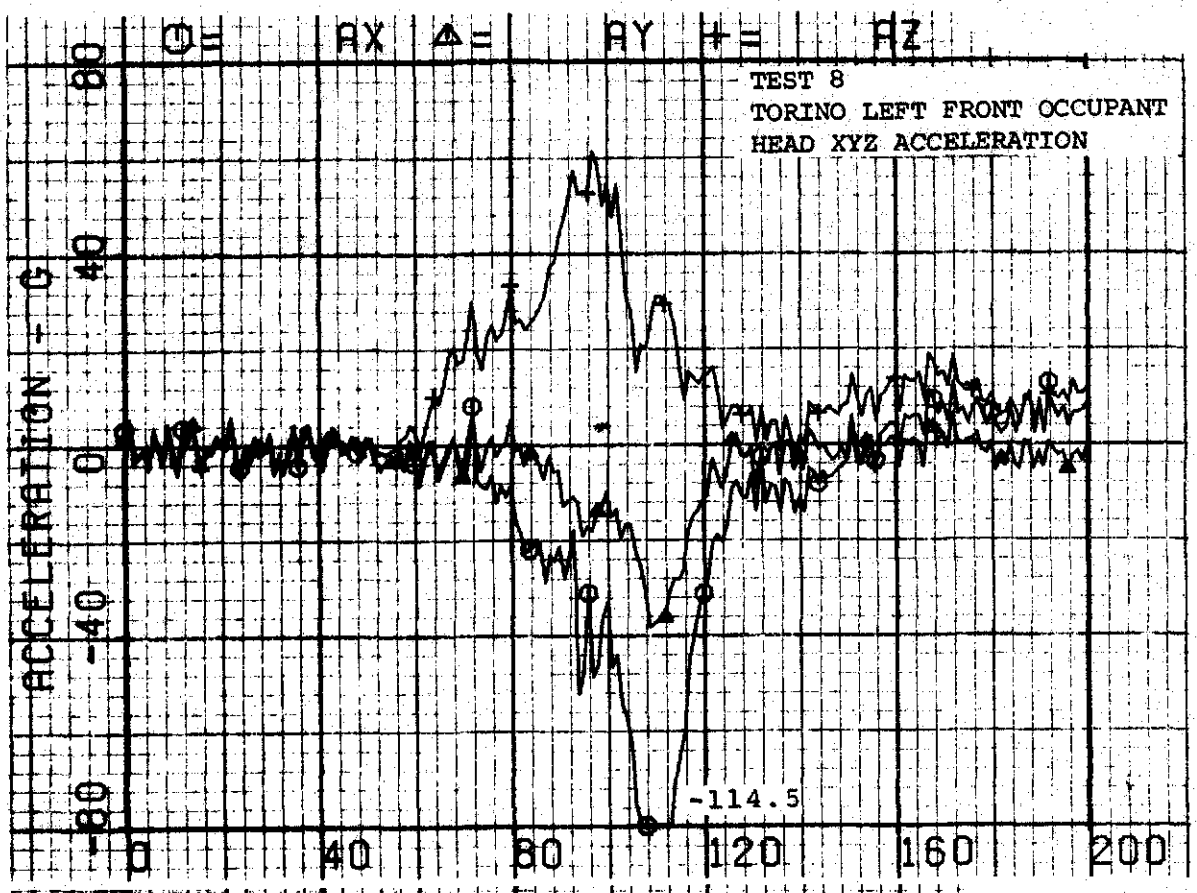

O= AX Δ= AY
TEST 8
TORINO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

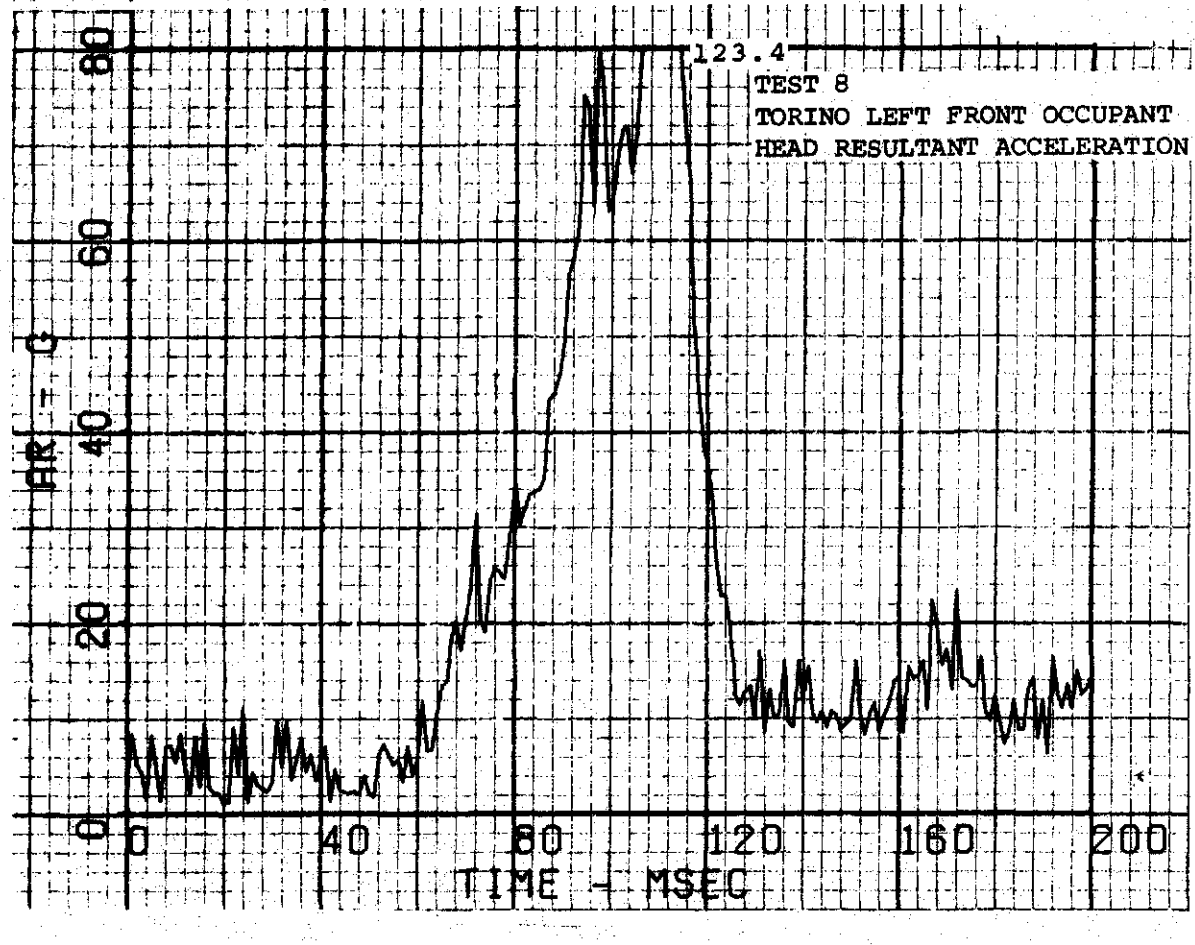

TEST 8
TORINO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

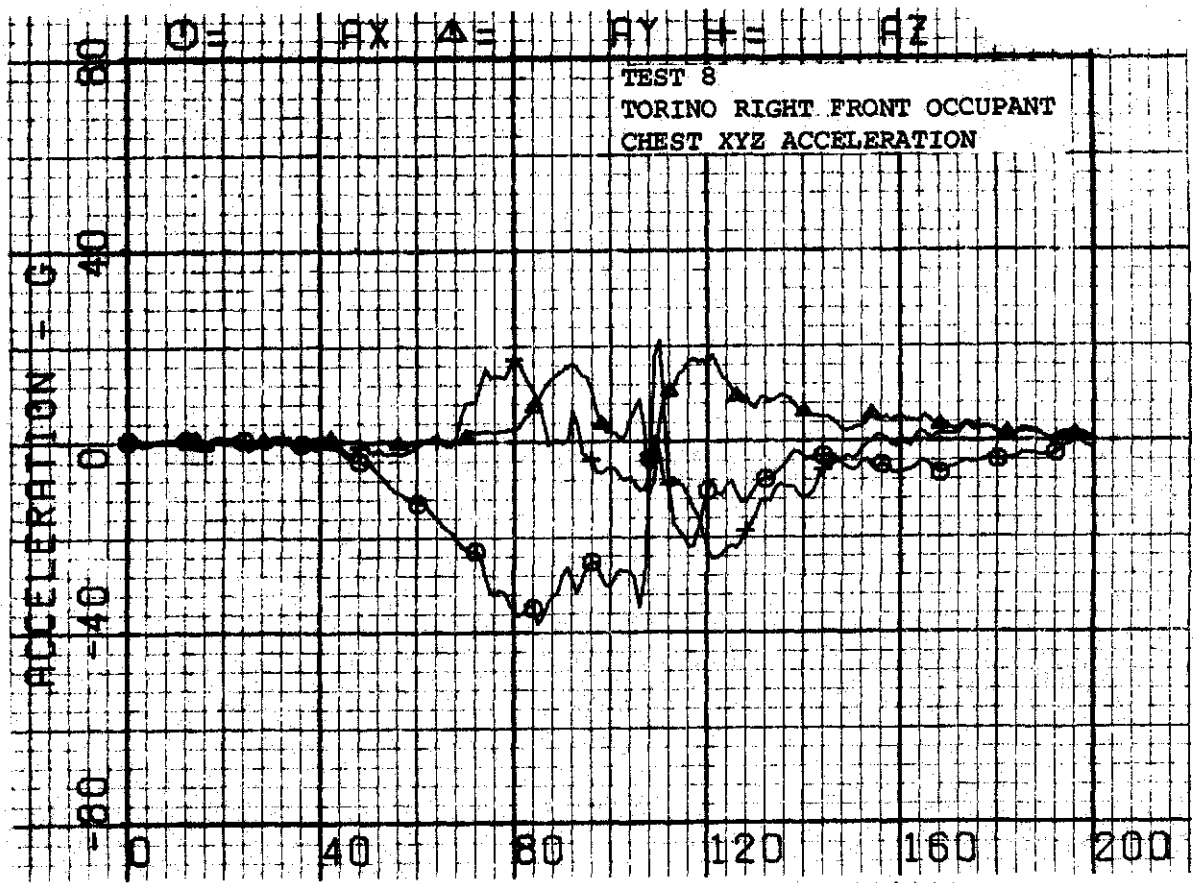

AX
AY
AZ
84.6
TEST 8
TORINO RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
-211.3
0
40
80
120
160
200
259.6
TEST 8
TORINO RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
TIME - MSEC

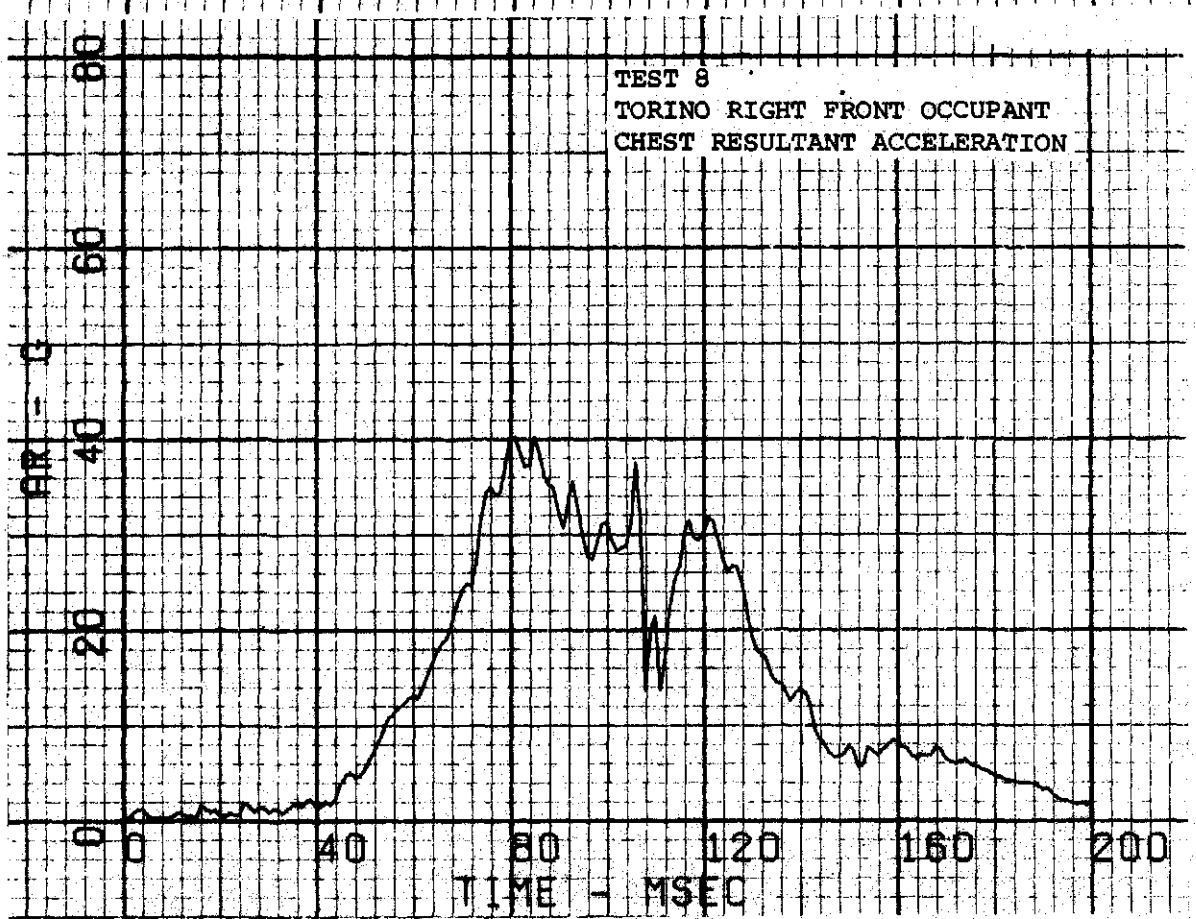

⊖= AX
△= AY
+= AZ
TEST 8
TORINO LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
60
40
0
-40
-80
0
40
80
120
160
200


TEST 8
TORINO LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC


□= AX △= AY += AZ
TEST 8
TORINO LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
-114.5
0
40
80
120
160
200


123.4
TEST 8
TORINO LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC


TEST 8
TORINO RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 8
TORINO RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

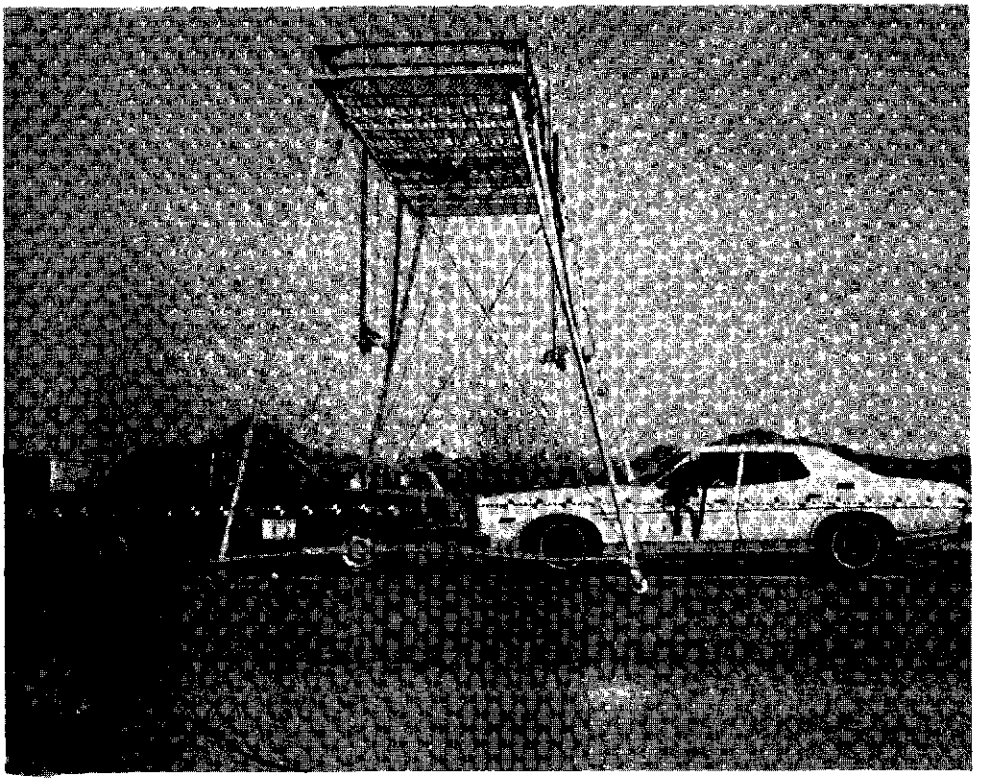


Figure 3-2. Pre-test Vehicle Configuration - Test 8.

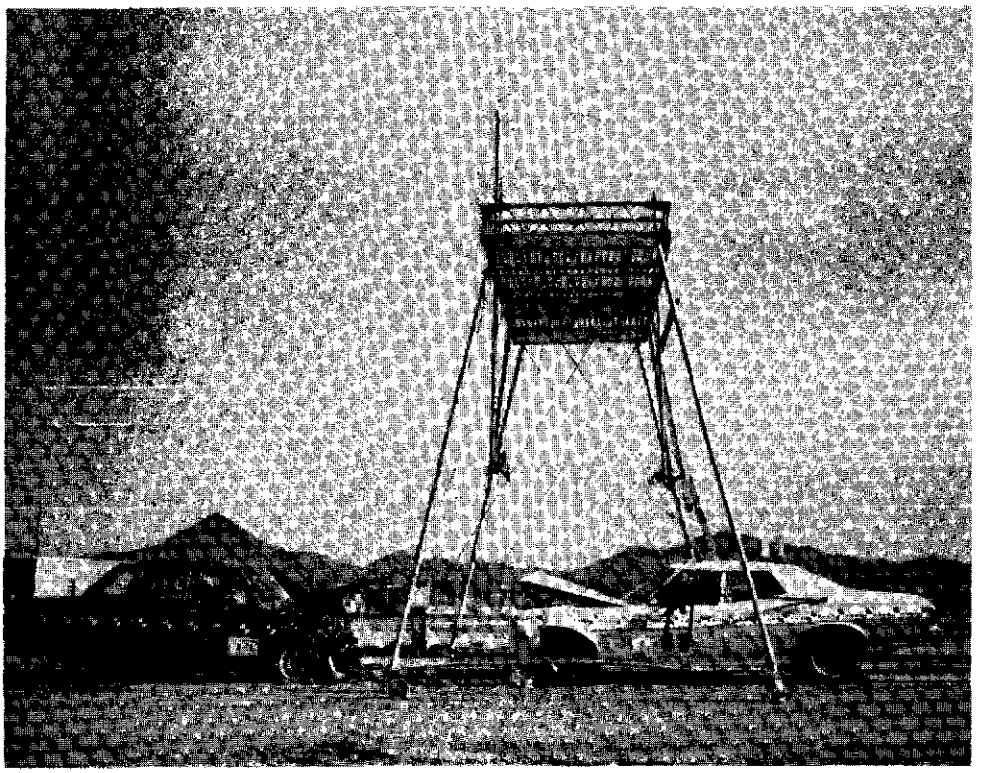


Figure 3-3. Post-test Vehicle Configuration - Test 8.

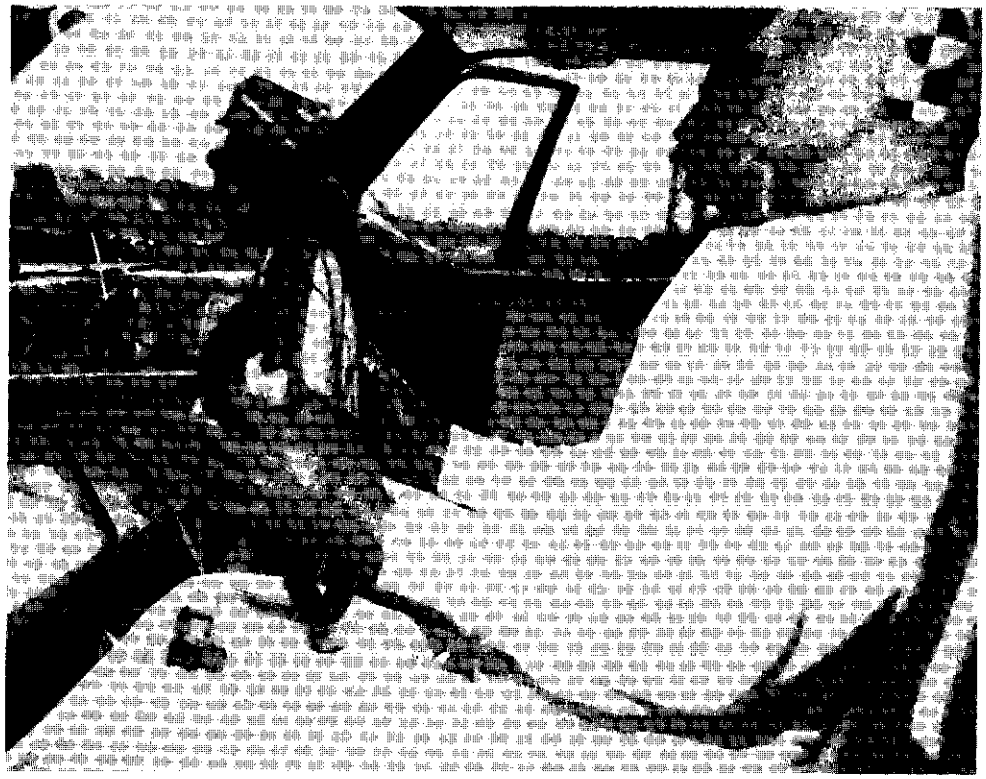


Figure 3-4. Pre-test RSV Driver Airbag - Test 8.

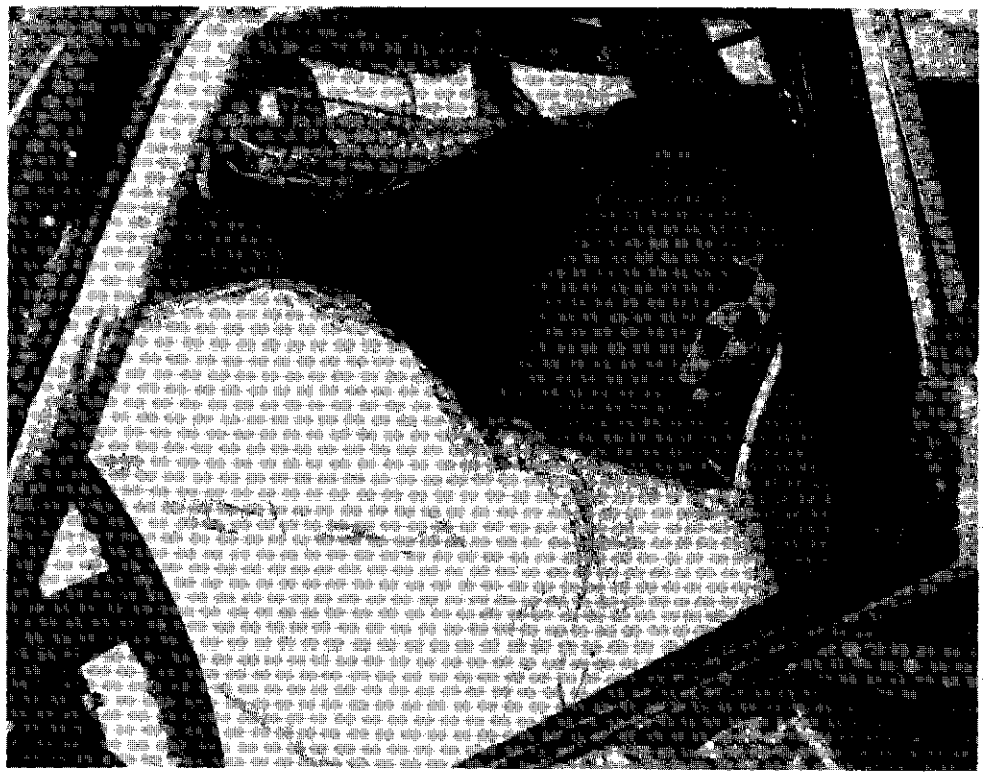


Figure 3-5. Post-test RSV Driver Airbag - Test 8.

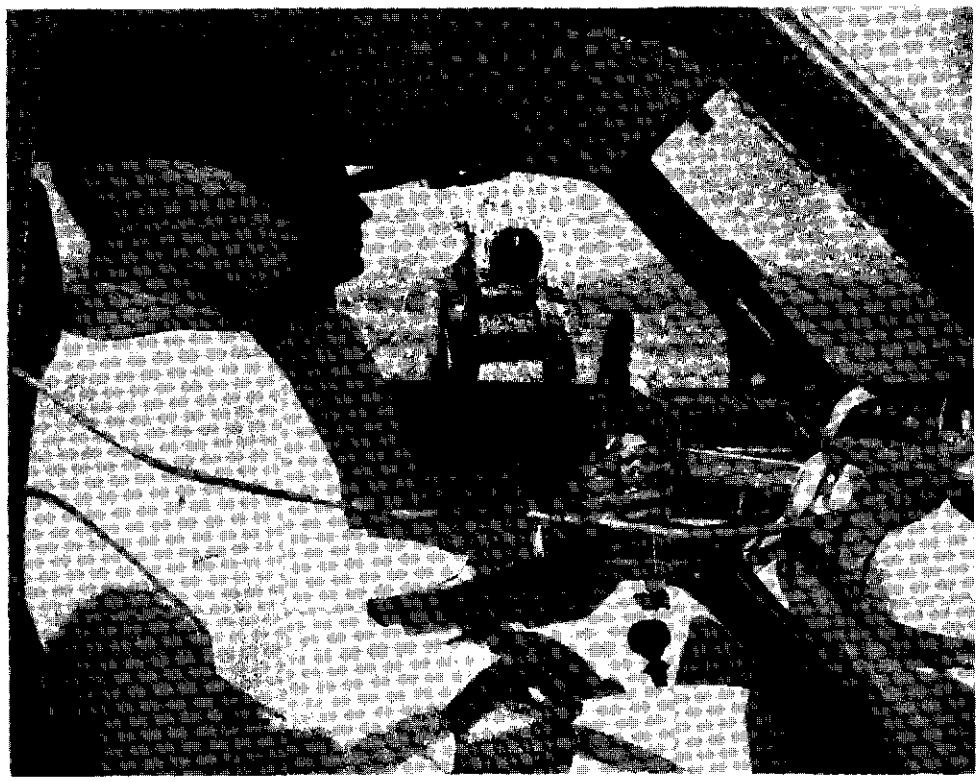


Figure 3-6. Pre-test RSV Passenger Airbag - Test 8.

Figure 3-7. Post-test RSV Passenger Airbag - Test 8.

3.2 TEST NUMBER 9

The impact conditions for Test 9 were:

Configuration	Closing Speed
Torino-to-Volvo Head-on	78.6 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Standard 3-Point Belt with Web Lockers	Force Limited Airbelt
Right Front	Standard 3-Point Belt with Web Lockers	Force Limited 2-Inch Belt

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was structurally modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity. The extent of these modifications is shown in Figure 1-2. The dash padding was reinstalled over the steel tubes in its original position.

The results of Test 9 are summarized in the following tables:

Table 3-5 - Summary of Vehicle Data (Test 9)

Table 3-6 - Injury Criteria Summary (Test 9)

Table 3-7 - Summary of Restraint System Data (Test 9)

Table 3-8 - Occupant Response Data (Test 9)

which are followed by Figure 3-8 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

TABLE 3-5. SUMMARY OF VEHICLE DATA (TEST 9)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 9/February 23, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		418	429
TEST WEIGHT (lb)		4570	3257
IMPACT VELOCITY (mph)		39.3	39.3
VELOCITY CHANGE (mph)		39.2	49.9
PEAK ACCELERATION (G @ msec)			
	LOCATION 1	47.7 @ 73	64.5 @ 57
	LOCATION 2	44.6 @ 65	72.8 @ 58
MAXIMUM STATIC CRUSH (in.)			
	LEFT	23.0	38.0
	CENTER	30.0	35.5
	RIGHT	17.0	35.0

TABLE 3-6. INJURY CRITERIA SUMMARY (TEST 9)

VEHICLE A - BELT CAR (TORINO)

OCCUPANT POSITION	LEFT FRONT		RIGHT FRONT	
RESTRAINT SYSTEM	STANDARD 3-POINT BELT W/WEB LOCKERS		STANDARD 3-POINT BELT W/WEB LOCKERS	
HIC	908		814	
HEAD G[1] @ msec	75.8 @ 109		56.4 @ 113	
CSI	421 @ 200		321 @ 200	
CHEST G[1] @ msec	44.4 @ 100		35.9 @ 79	
FEMUR LOAD (lb) [2]	LEFT NA	RIGHT NA	LEFT NA	RIGHT NA

VEHICLE B - BELT CAR (VOLVO)

OCCUPANT POSITION	LEFT FRONT		RIGHT FRONT	
RESTRAINT SYSTEM	FORCE LIMITED AIRBELT		FORCE LIMITED 2-INCH BELT	
HIC	1061		1064	
HEAD G[1] @ msec	84.1 @ 165		81.3 @ 102	
CSI	632 @ 200		555 @ 200	
CHEST G[1] @ msec	51.6 @ 96		55.4 @ 94	
FEMUR LOAD (lb)	LEFT 1918	RIGHT 1379	LEFT 526	RIGHT 1703

(1) 3 msec clip.
(2) No femur loads measured.

TABLE 3-7. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 9)

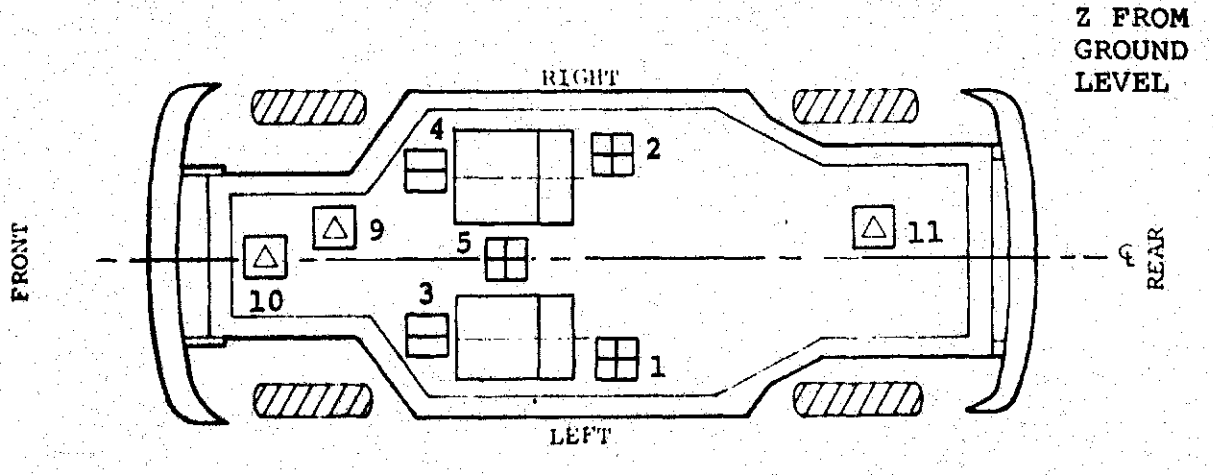
VEHICLE B - BELT CAR (VOLVO)		
FORCE LIMITED AIRBELT		
Peak Airbelt Pressure	psi @ msec	27 @ 75
Peak Lap Belt Load	lb @ msec	(1)
FORCE LIMITED 2-INCH BELT		
Peak Shoulder Belt Load	lb @ msec	1511 @ 67
Peak Lap Belt Load	lb @ msec	1474 @ 78

(1) Transducer failure.

TABLE 3-8. OCCUPANT RESPONSE DATA SUMMARY (TEST 9)

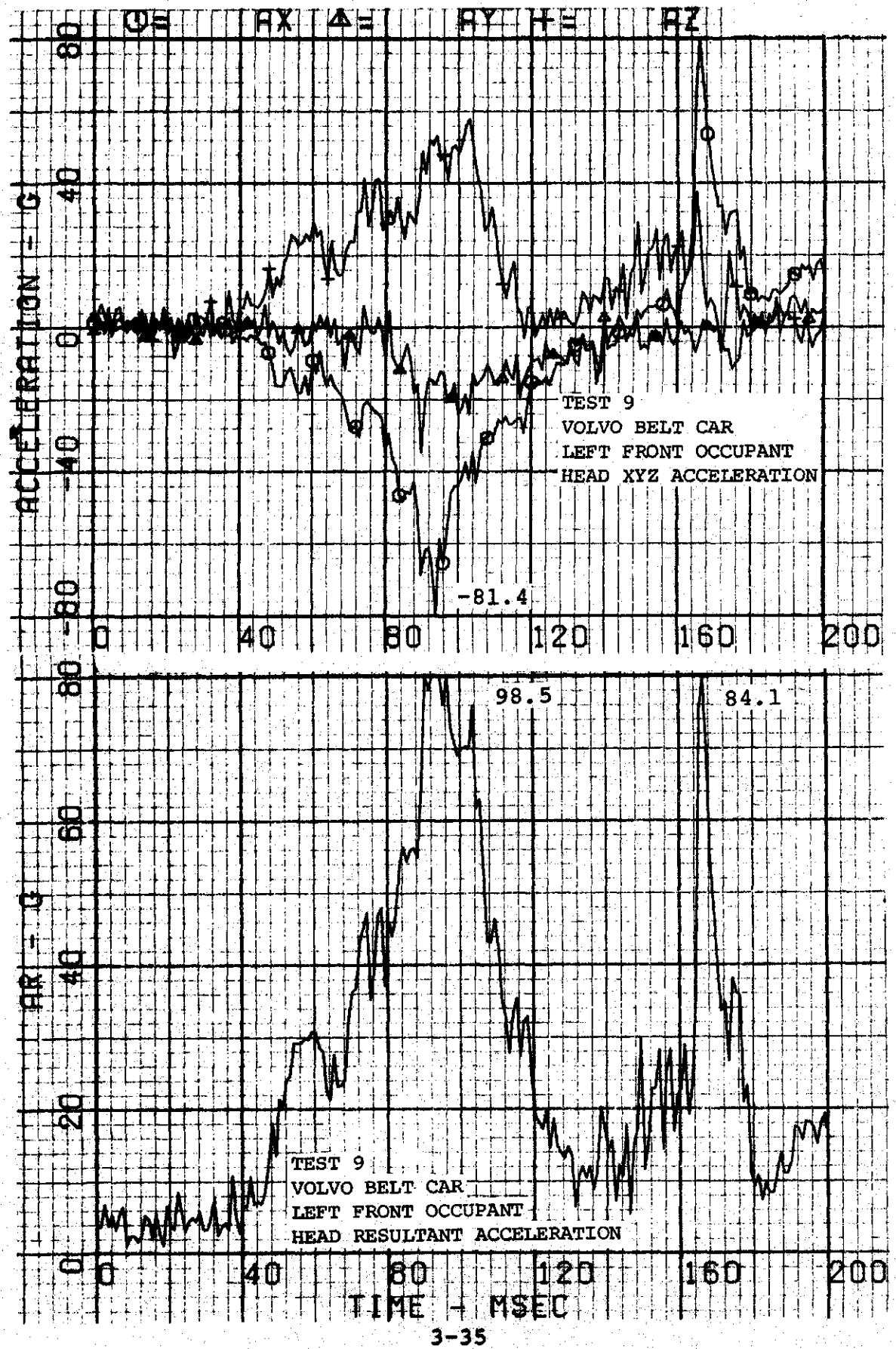
		VEHICLE A - BELT CAR (TORINO)				VEHICLE B - BELT CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT		LEFT FRONT PASSENGER		RIGHT FRONT PASSENGER	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD									
	X	66.7	109	28.0	126	81.4	94	111.5	99
	Y	33.5	110	31.8	116	34.8	90	15.7	99
	Z	79.1	96	50.9	94	57.9	103	62.6	102
	R(1)	75.8	109	56.4	113	84.1	165	81.3	102
	HIC	908 @ 79-124		814 @ 79-138		1061 @ 70-111		1064 @ 83-116	
CHEST									
	X	18.1	92	35.3	80	27.3	92	61.5	92
	Y	40.2	97	28.1	109	50.3	97	28.2	91
	Z	26.7	106	20.1	115	20.9	106	27.1	92
	R(1)	44.4	100	35.9	79	51.6	96	55.4	94
	SI	421 @ 200		321 @ 200		632 @ 200		555 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS									
	LF	NA		NA		1918	89	527	78
	RT	NA		NA		1379	77	1703	81

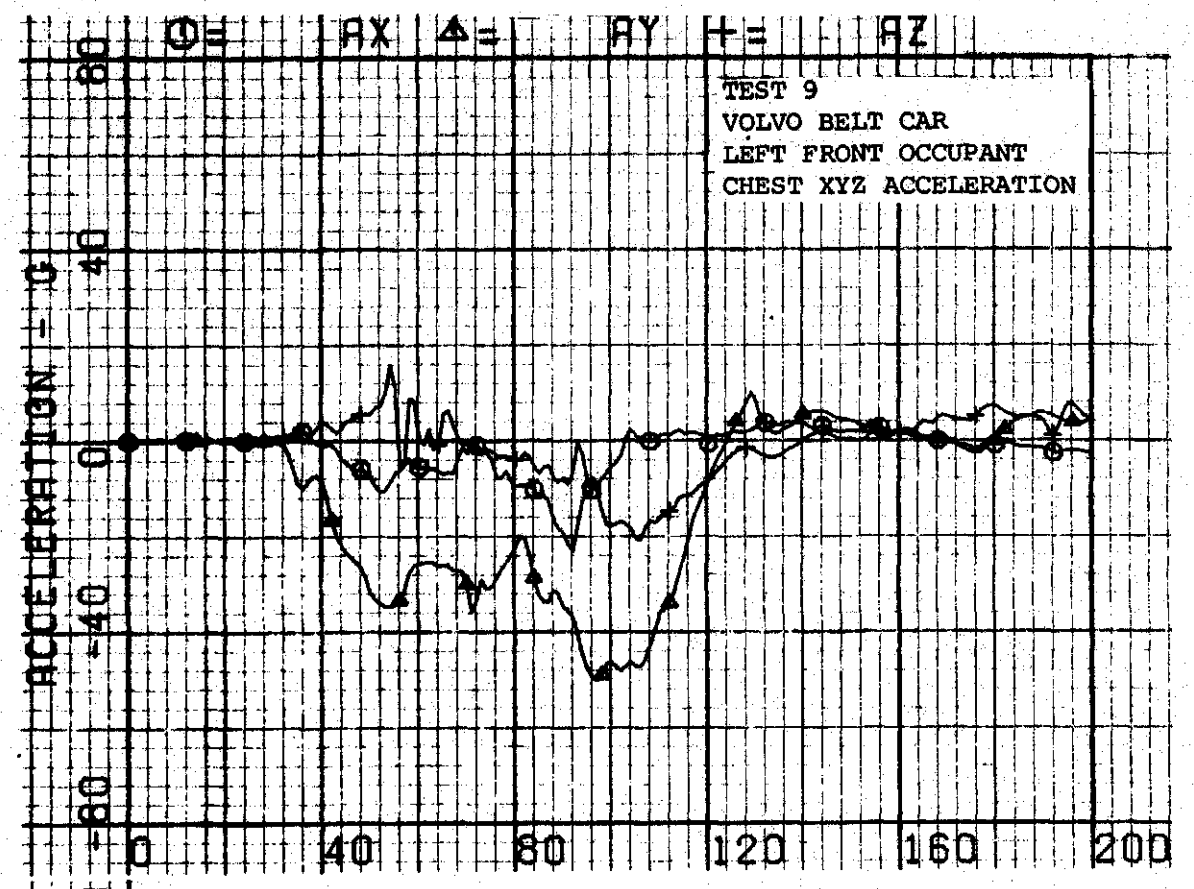
(1) 3 msec clip, components not clipped.

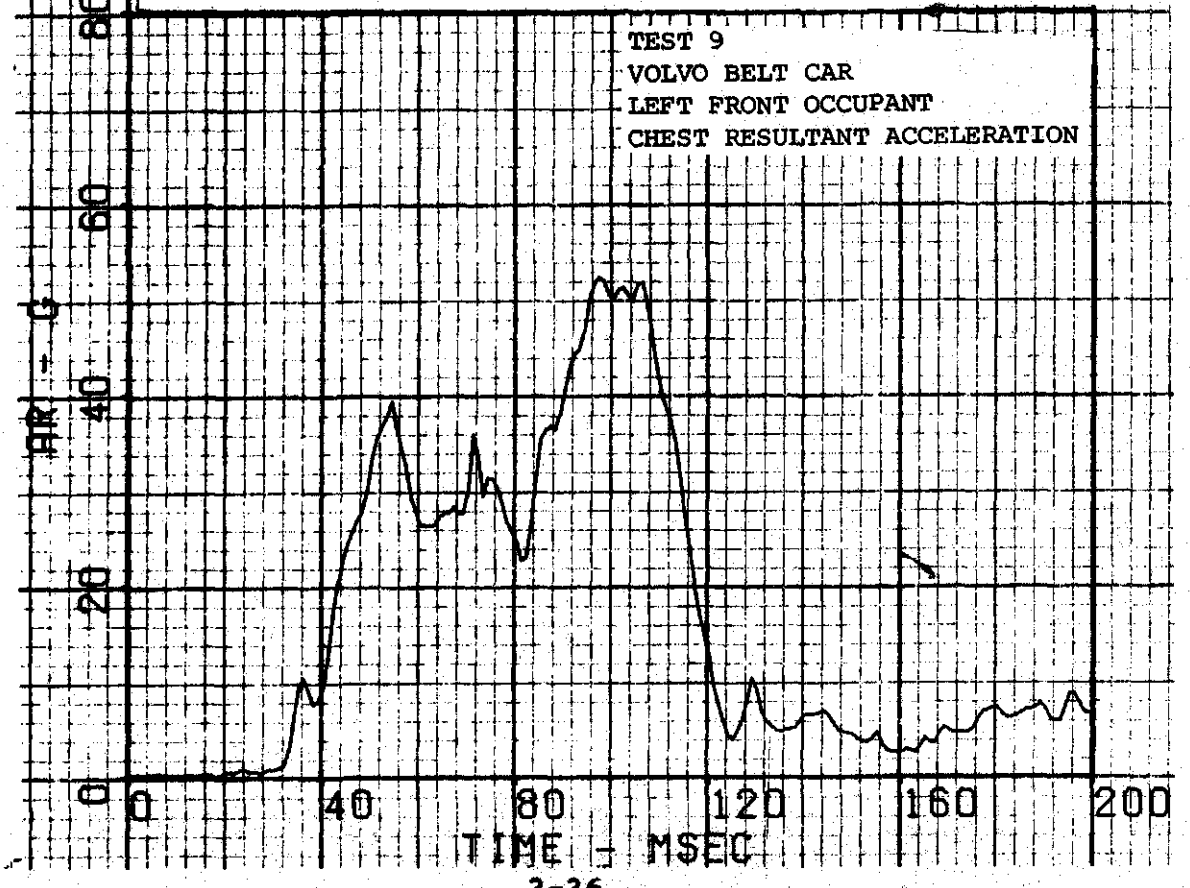


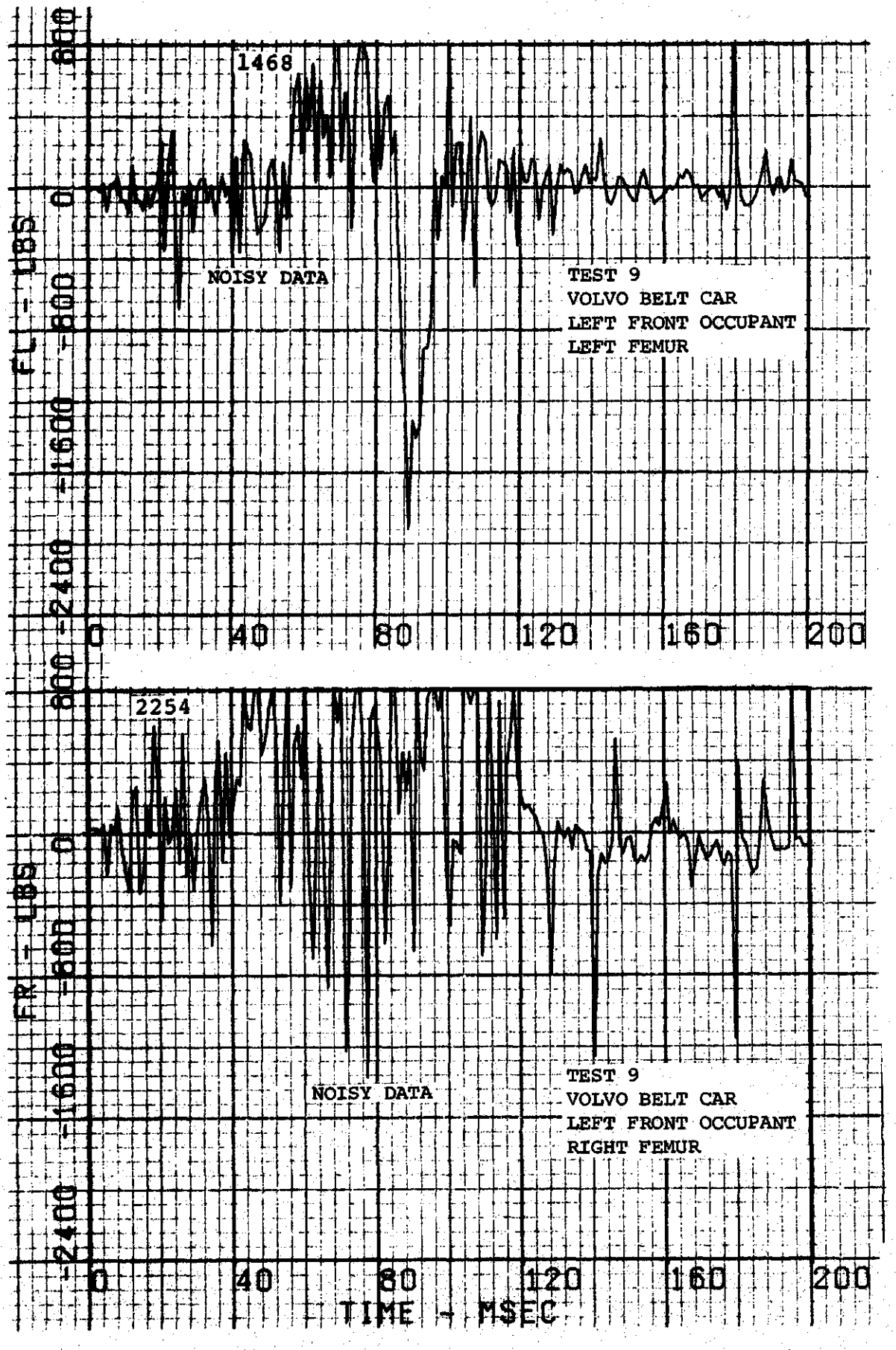
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
5	Drive Shaft Tunnel	X	X	
9	Front Crossmember	X	X	X
10	Engine In-take Manifold	X	X	X
11	Rear Axle	X	X	X

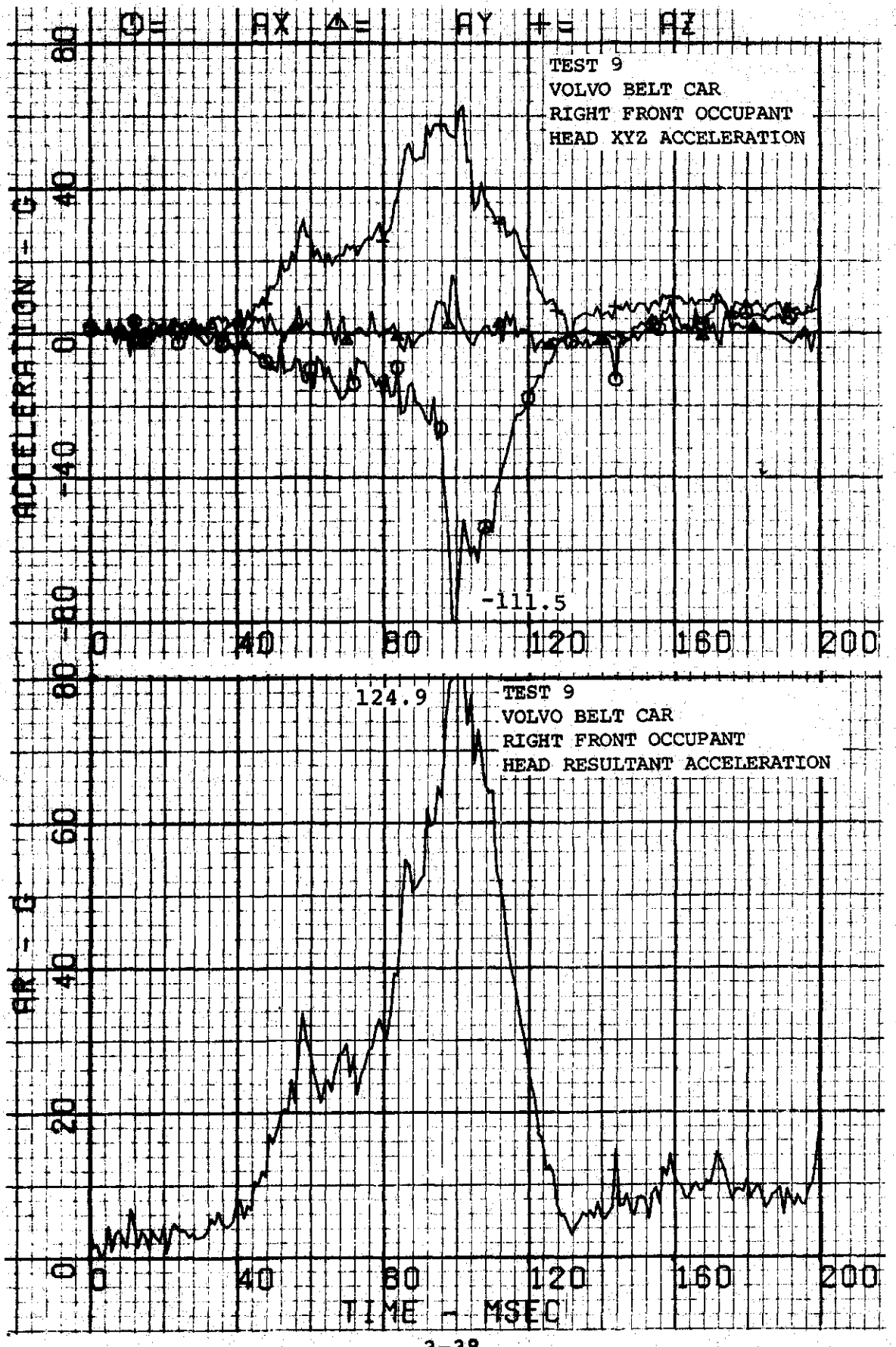
Figure 3-8. Vehicle Accelerometer Locations - Test 9.

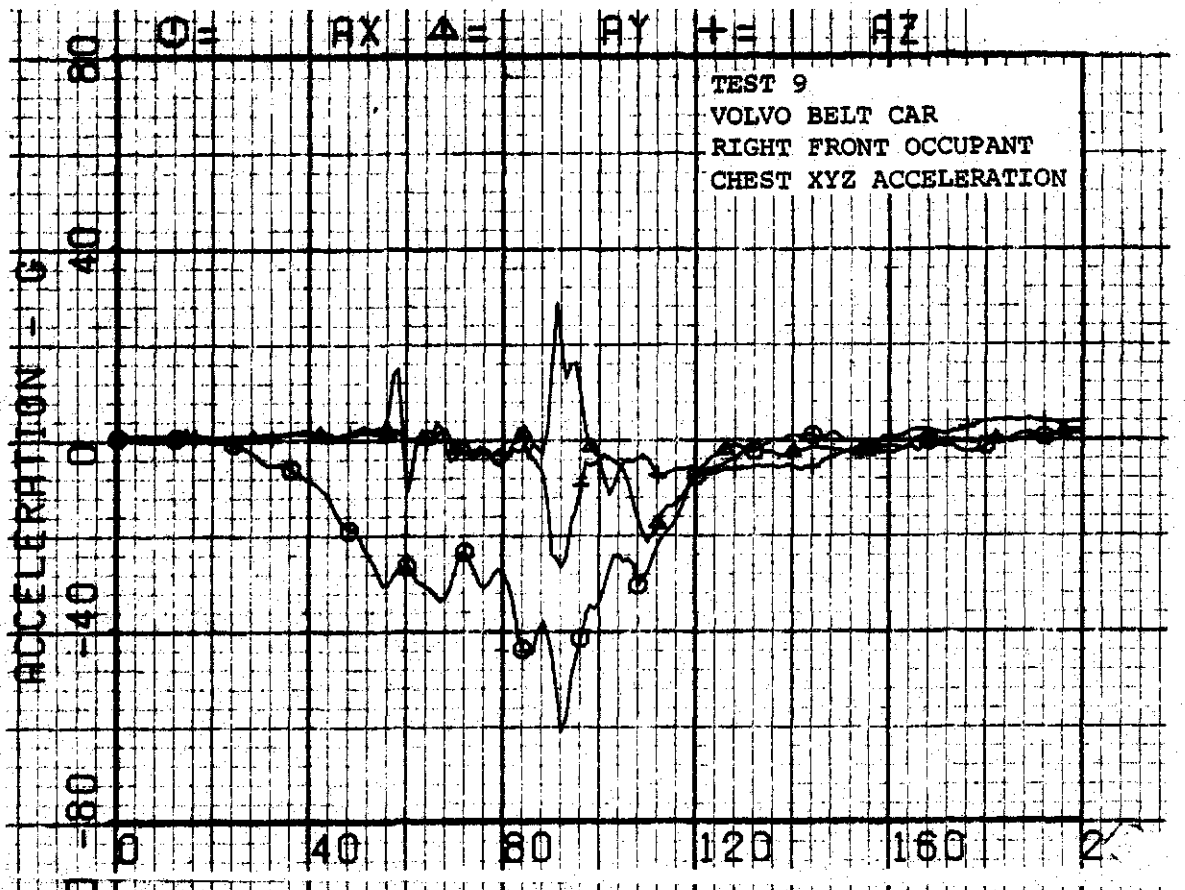

AX
AY
AZ
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
-81.4
TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
AR - G
80
60
40
20
0
98.5
84.1
TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
TIME - MSEC

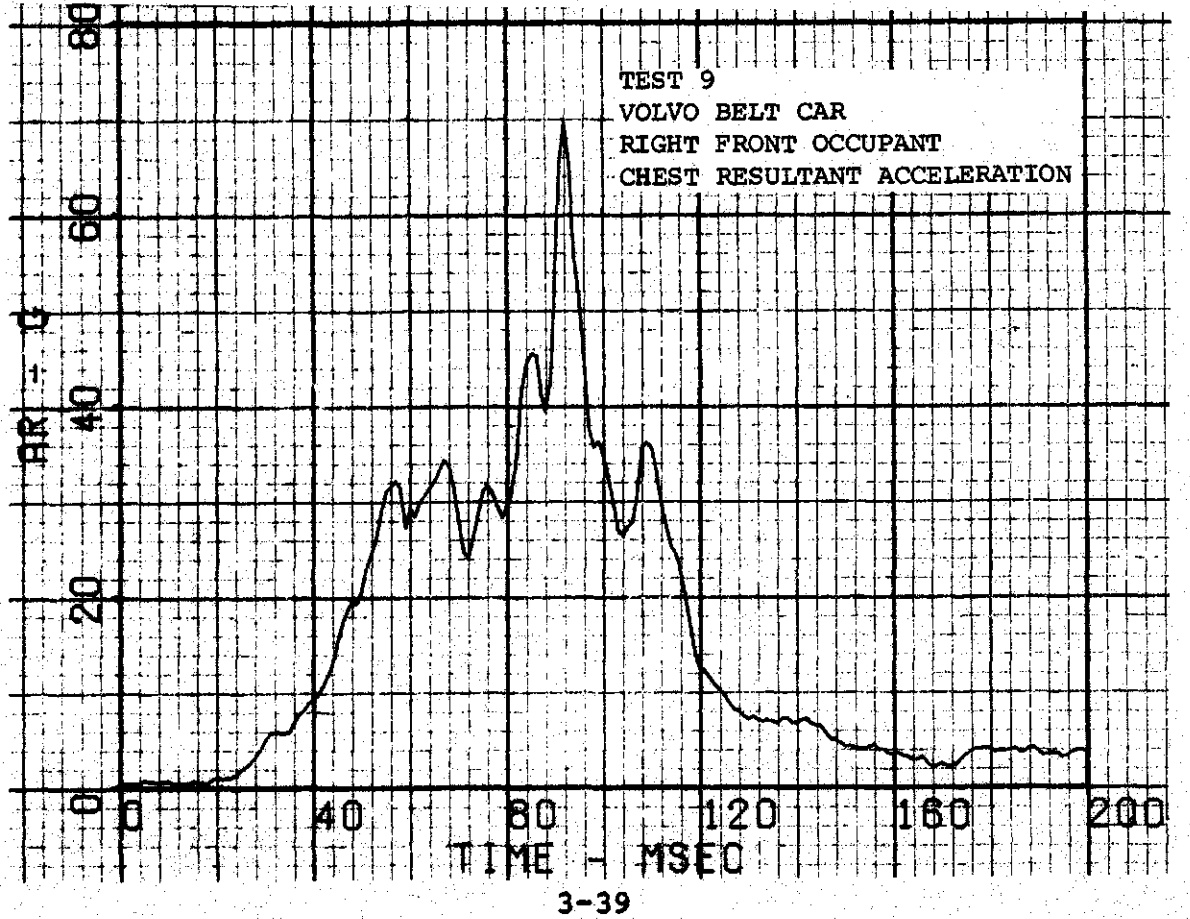

⊙= AX Δ= AY += AZ
TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

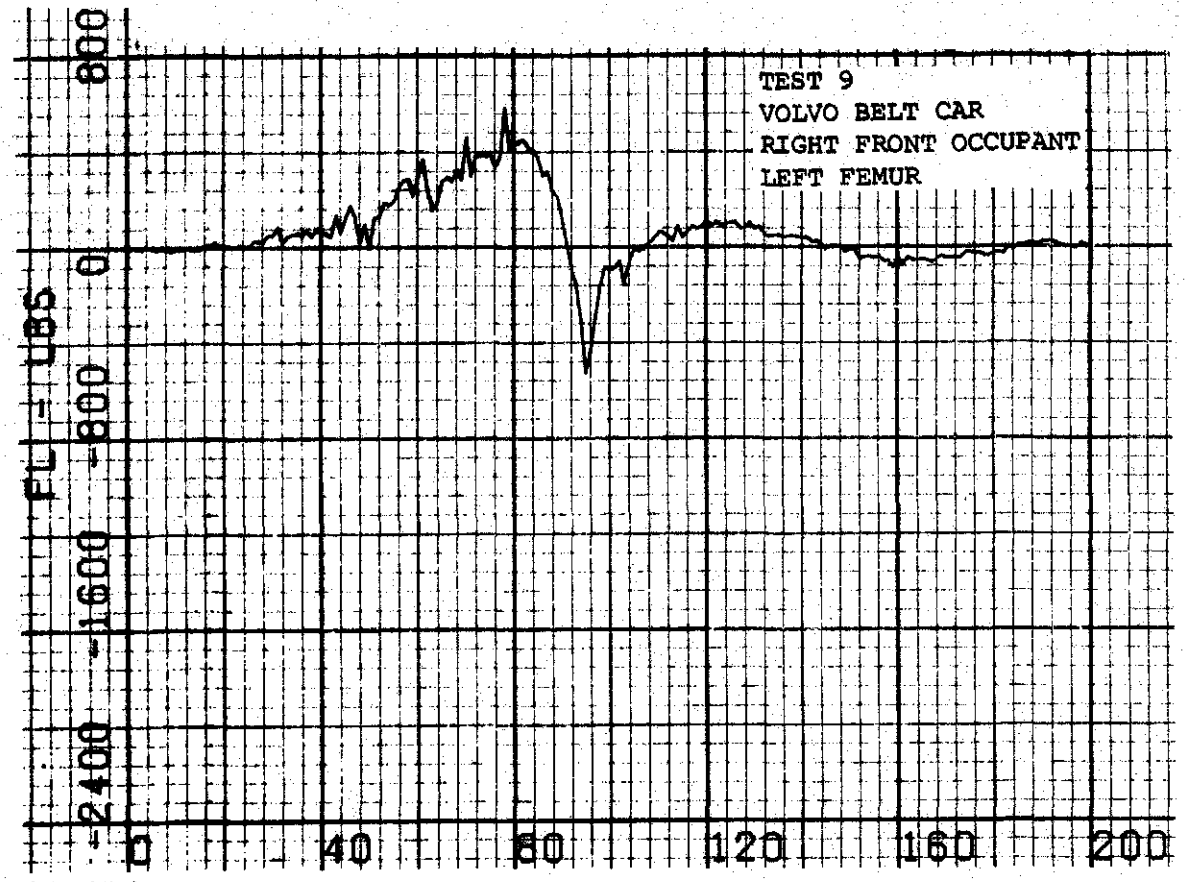

TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
RR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

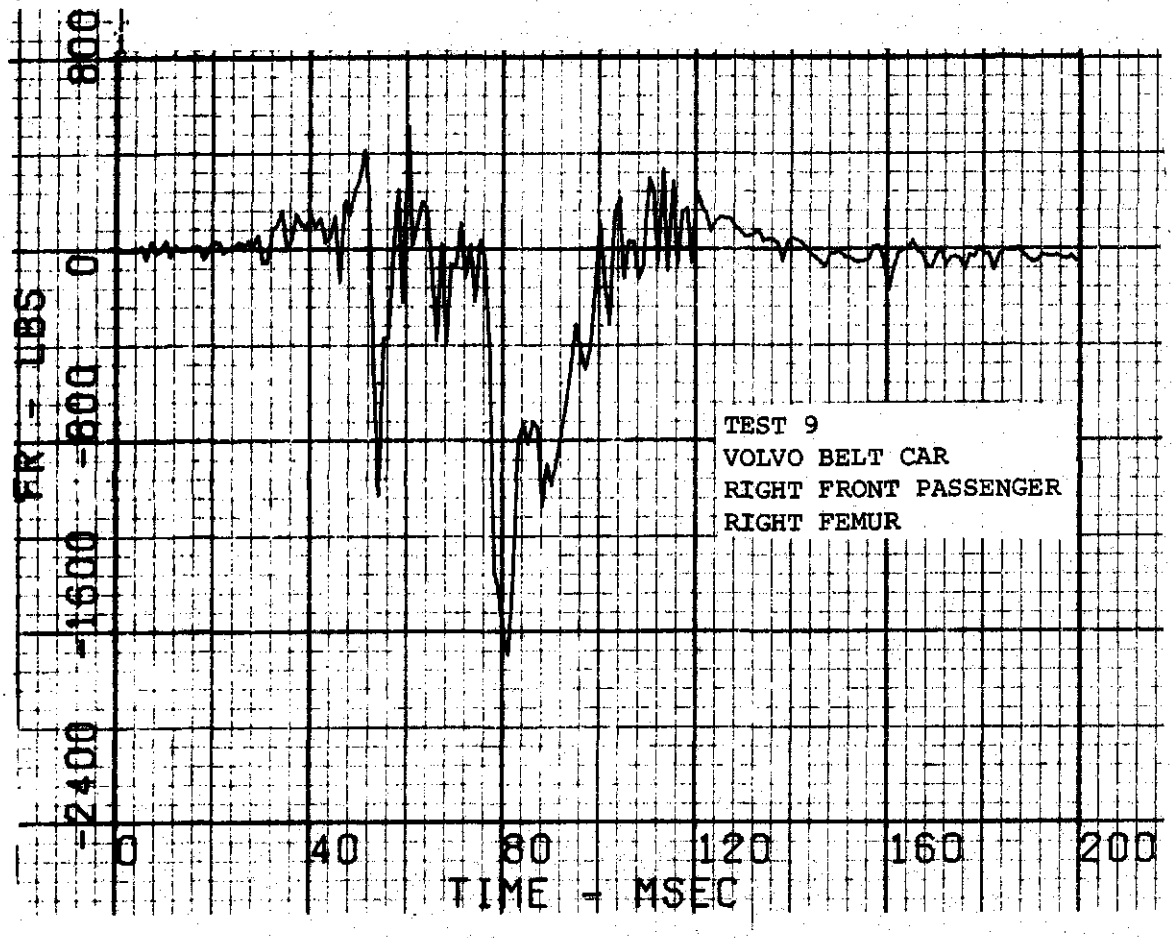

1468
NOISY DATA
TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
LEFT FEMUR
FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
2254
NOISY DATA
TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC

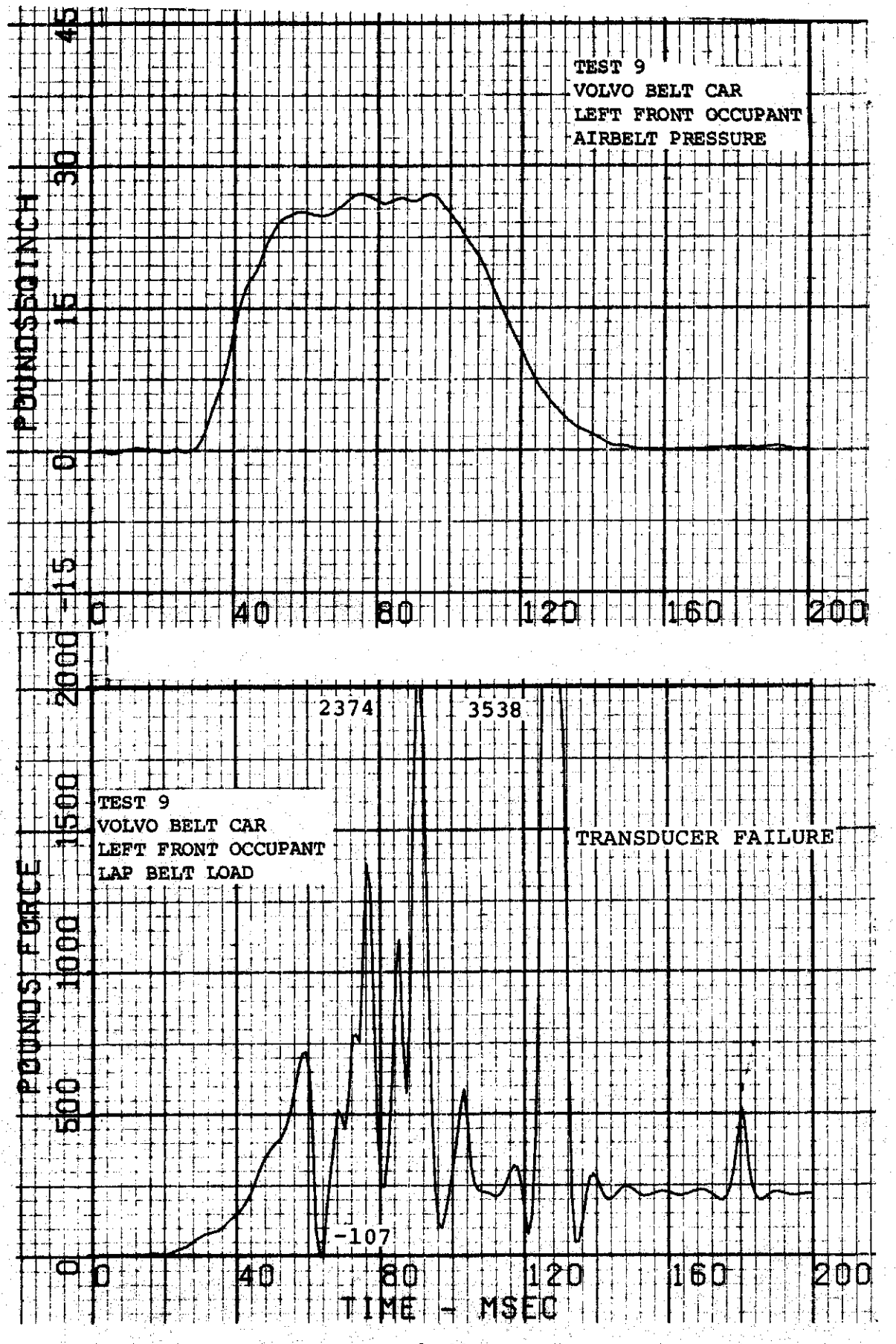

O= AX Δ= AY += AZ
TEST 9
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
-111.5
0
40
80
120
160
200
TEST 9
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
124.9
AR - G
80
60
40
20
0
TIME - MSEC

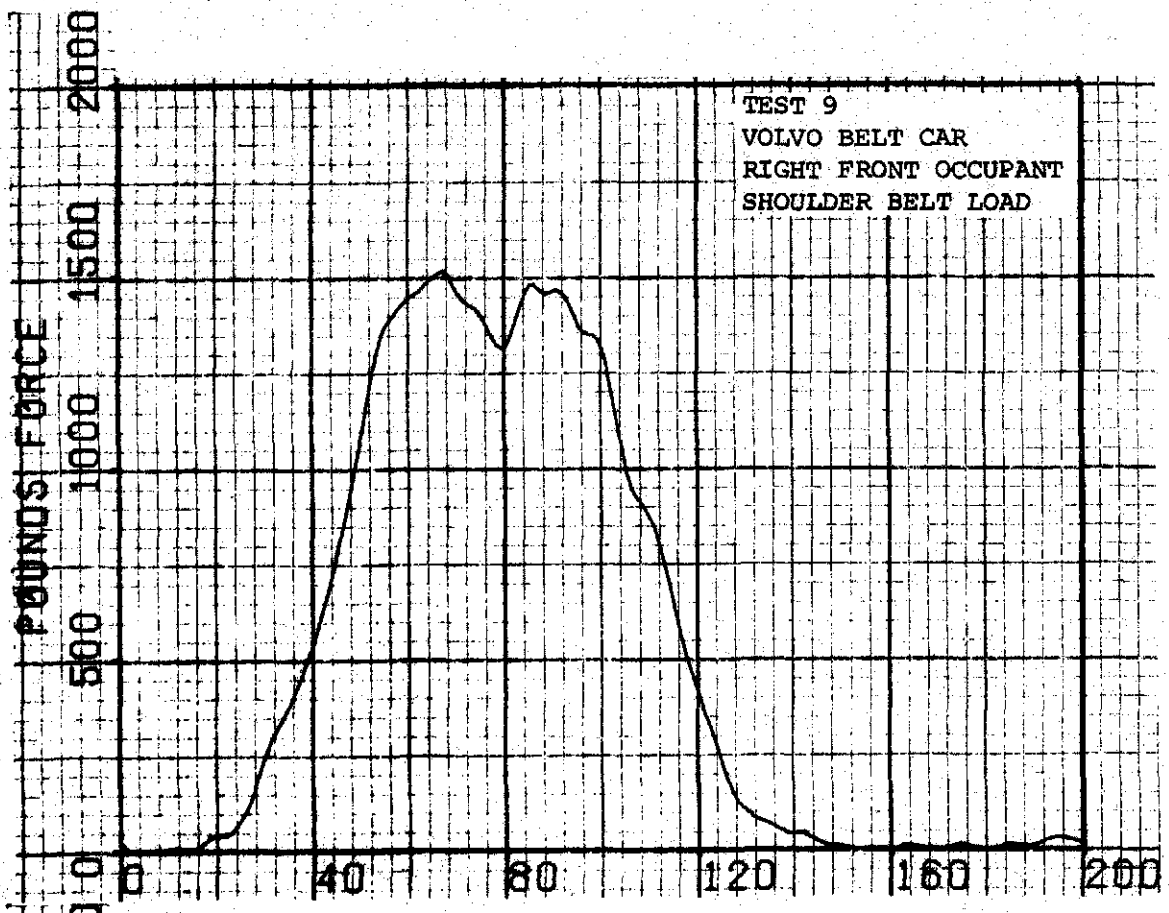

O= AX Δ= AY += AZ
TEST 9
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
2

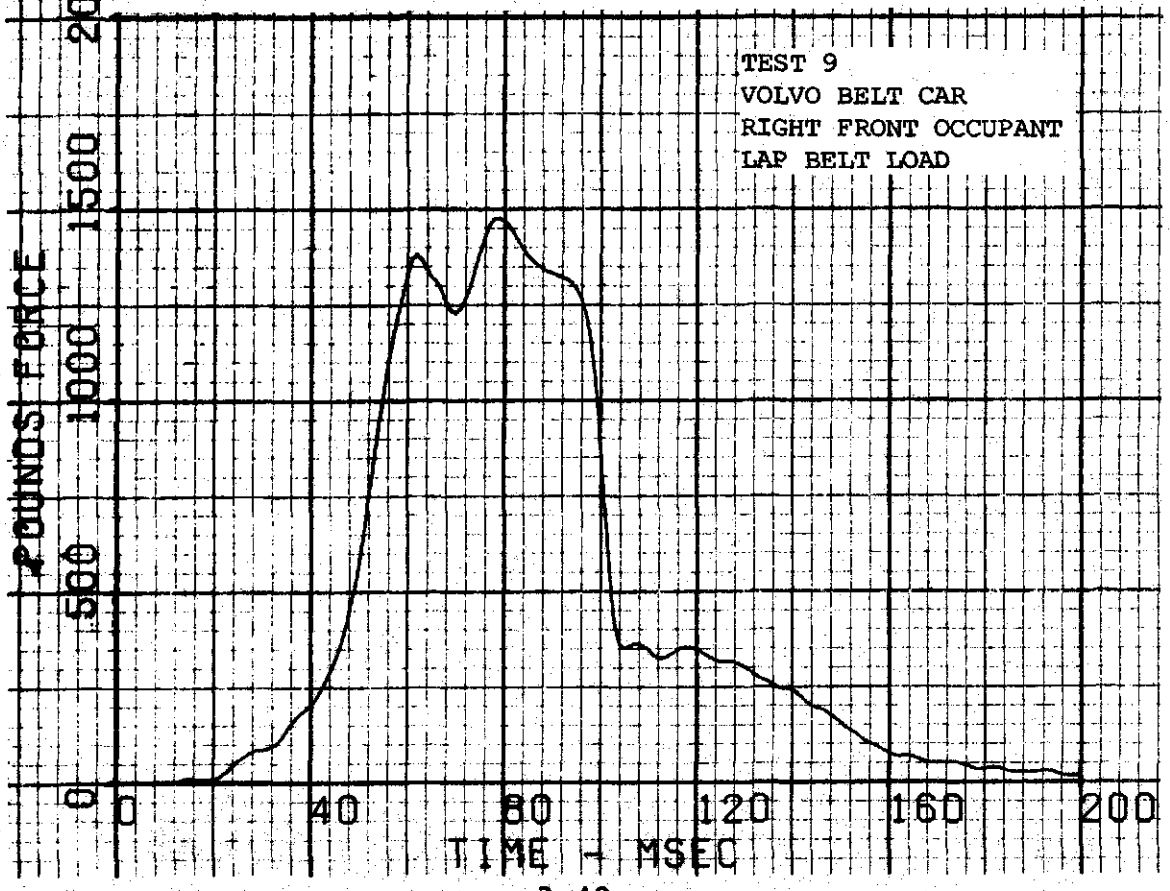

TEST 9
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

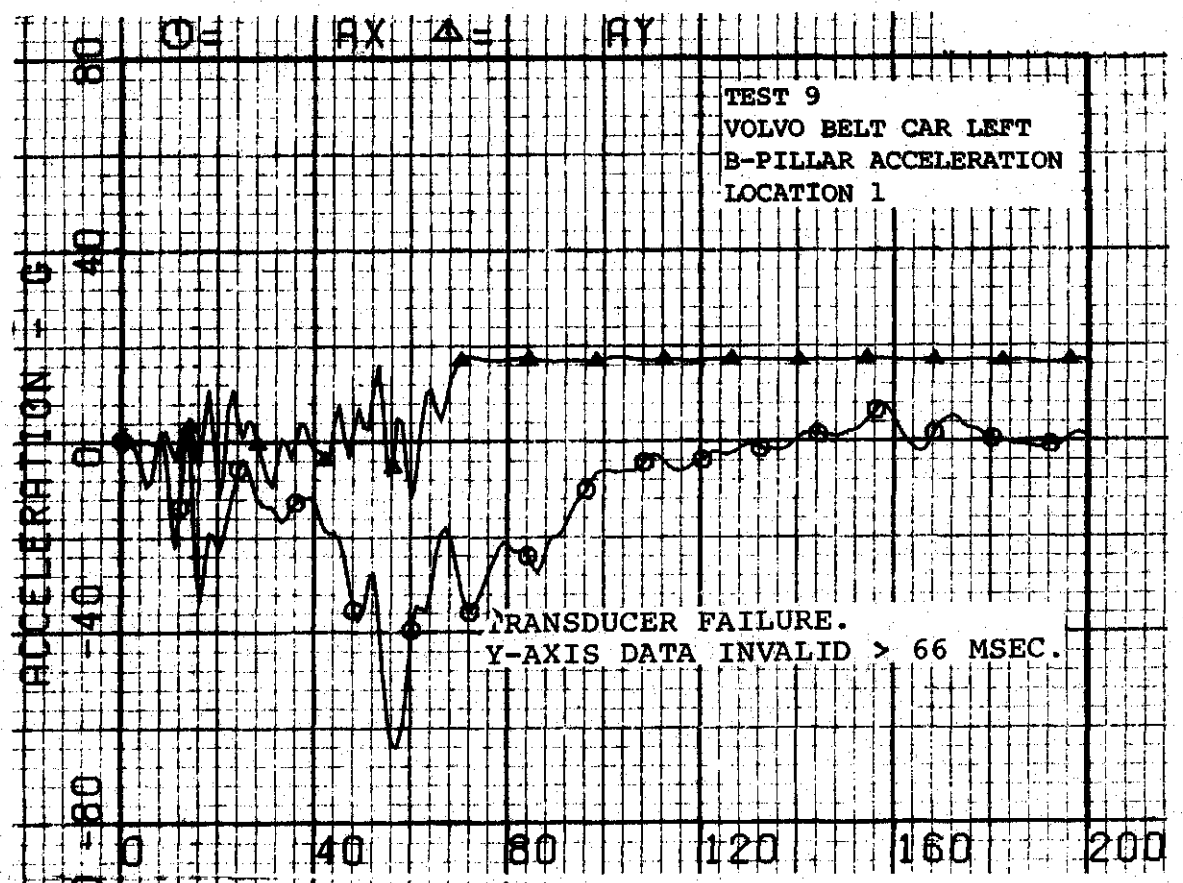

TEST 9
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR
FL = LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200

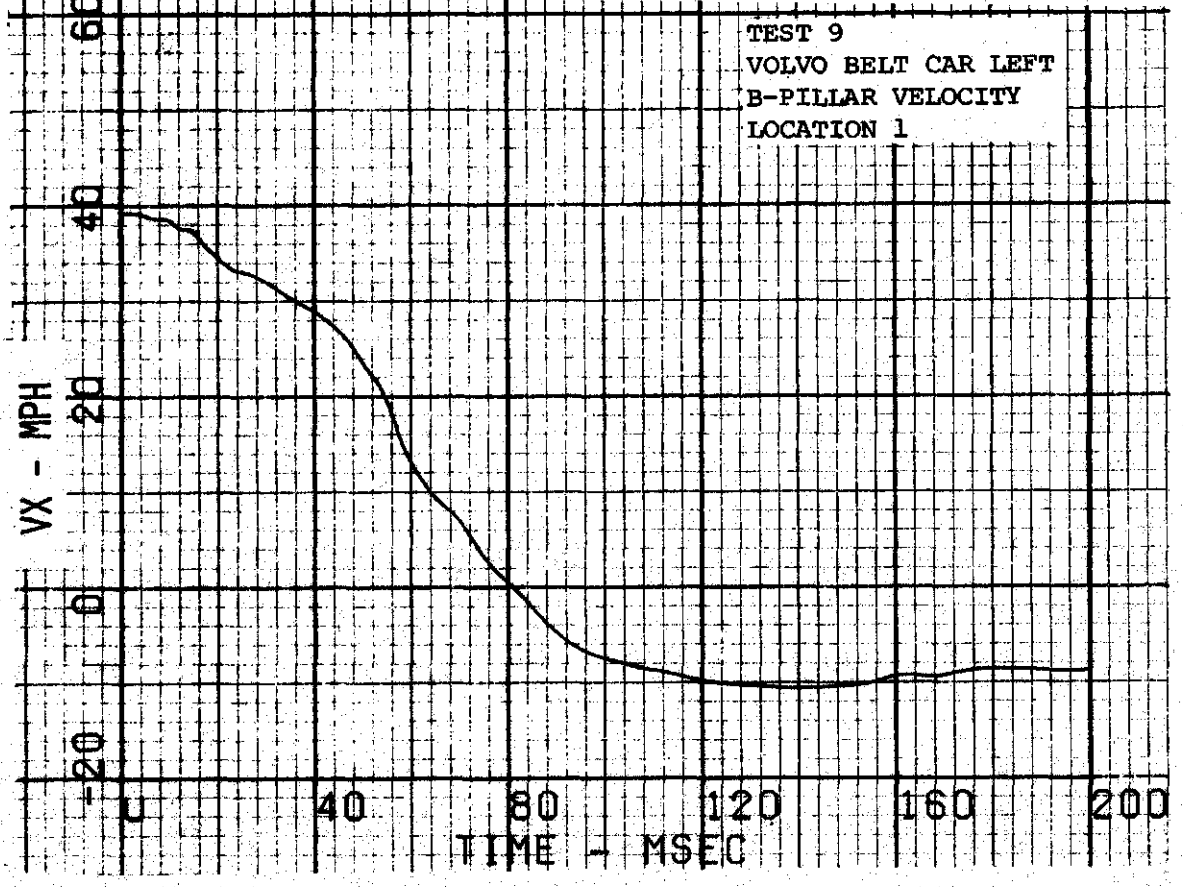

TEST 9
VOLVO BELT CAR
RIGHT FRONT PASSENGER
RIGHT FEMUR
FR = LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC

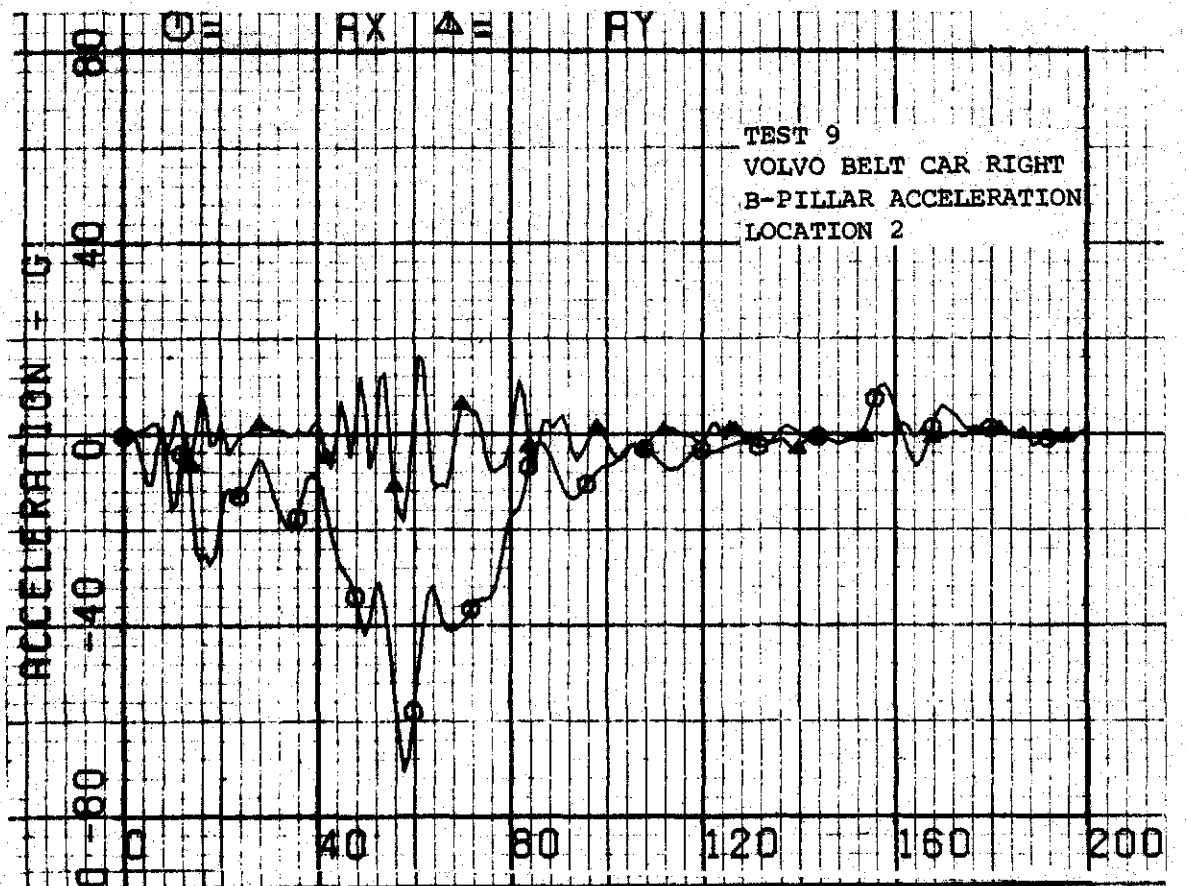

TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
AIRBELT PRESSURE
POUNDS/SQ INCH
45
30
15
0
-15
0
40
80
120
160
200
TEST 9
VOLVO BELT CAR
LEFT FRONT OCCUPANT
LAP BELT LOAD
2374
3538
TRANSDUCER FAILURE
-107
POUNDS FORCE
2000
1500
1000
500
0
TIME - MSEC

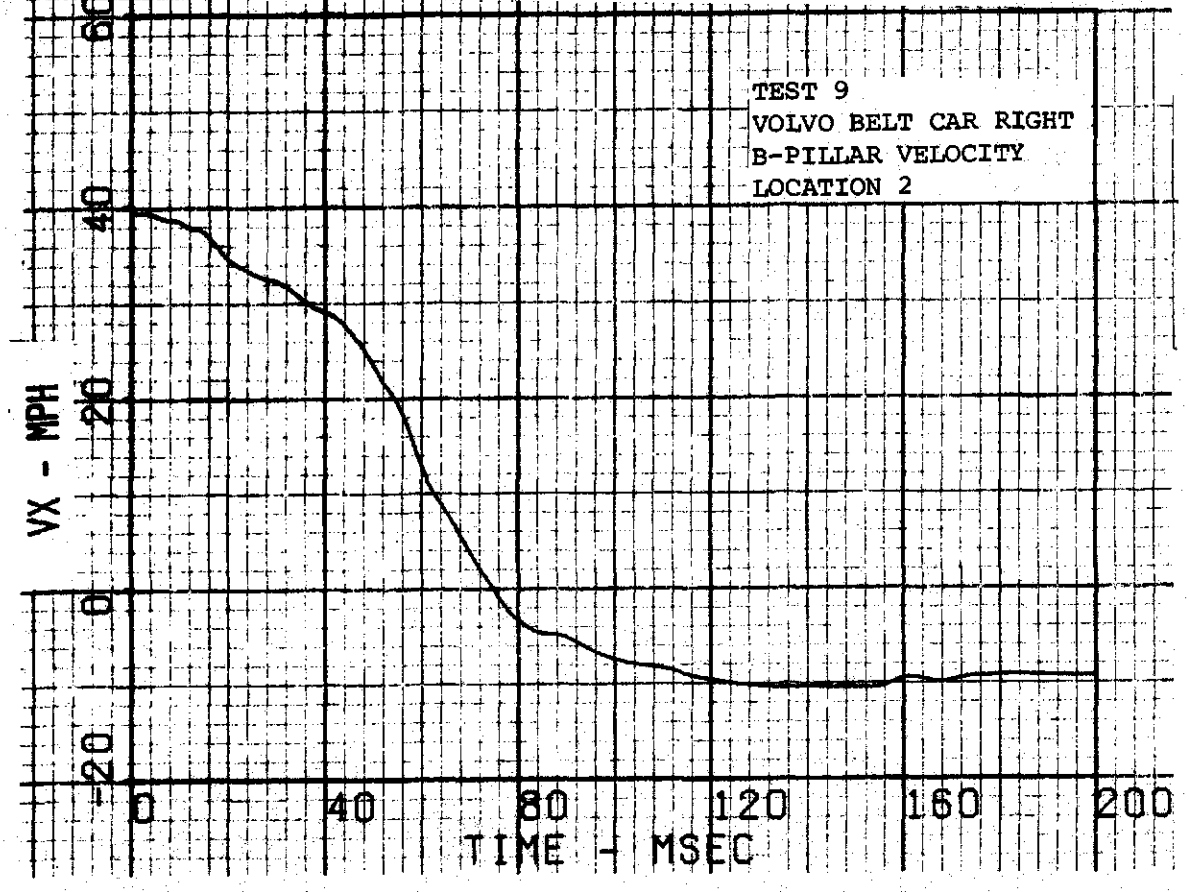

TEST 9
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
SHOULDER BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200

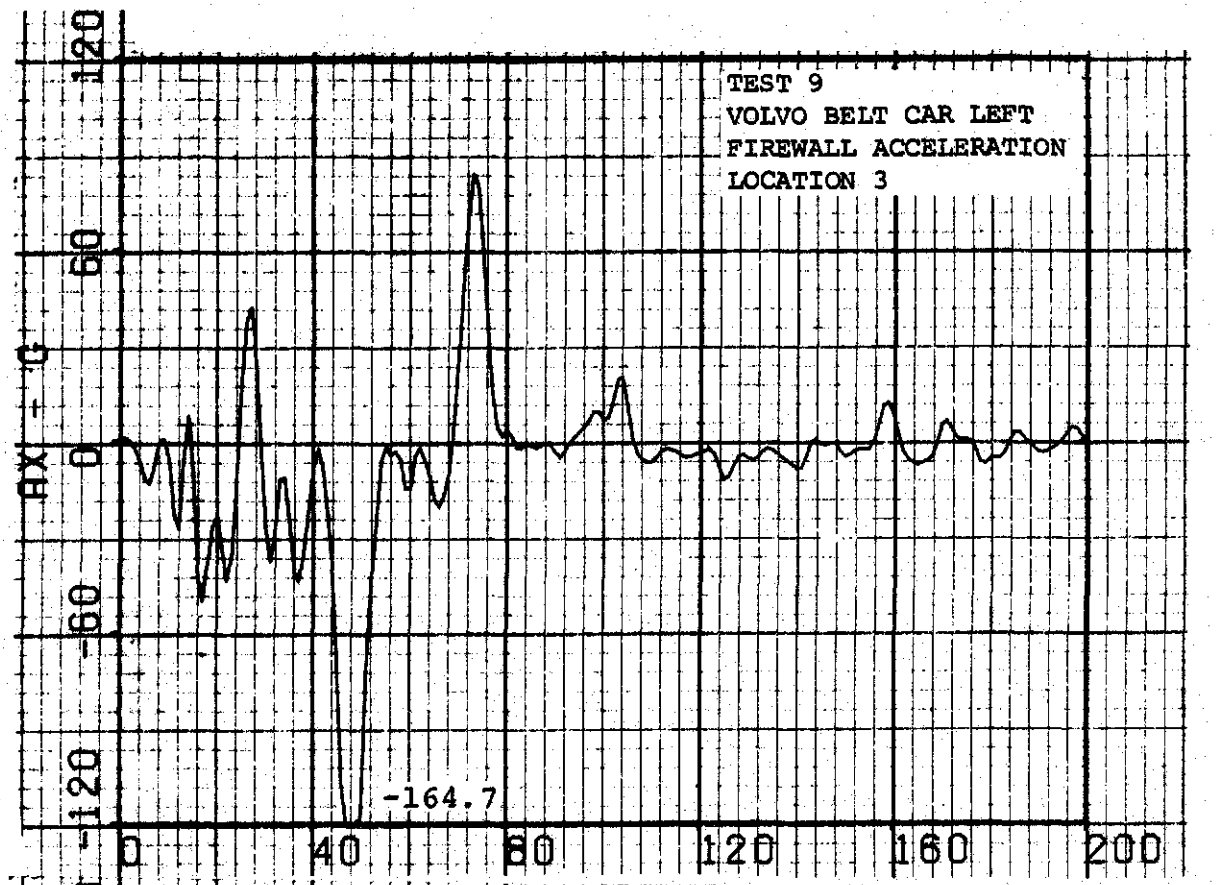

TEST 9
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
LAP BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200
TIME - MSEC

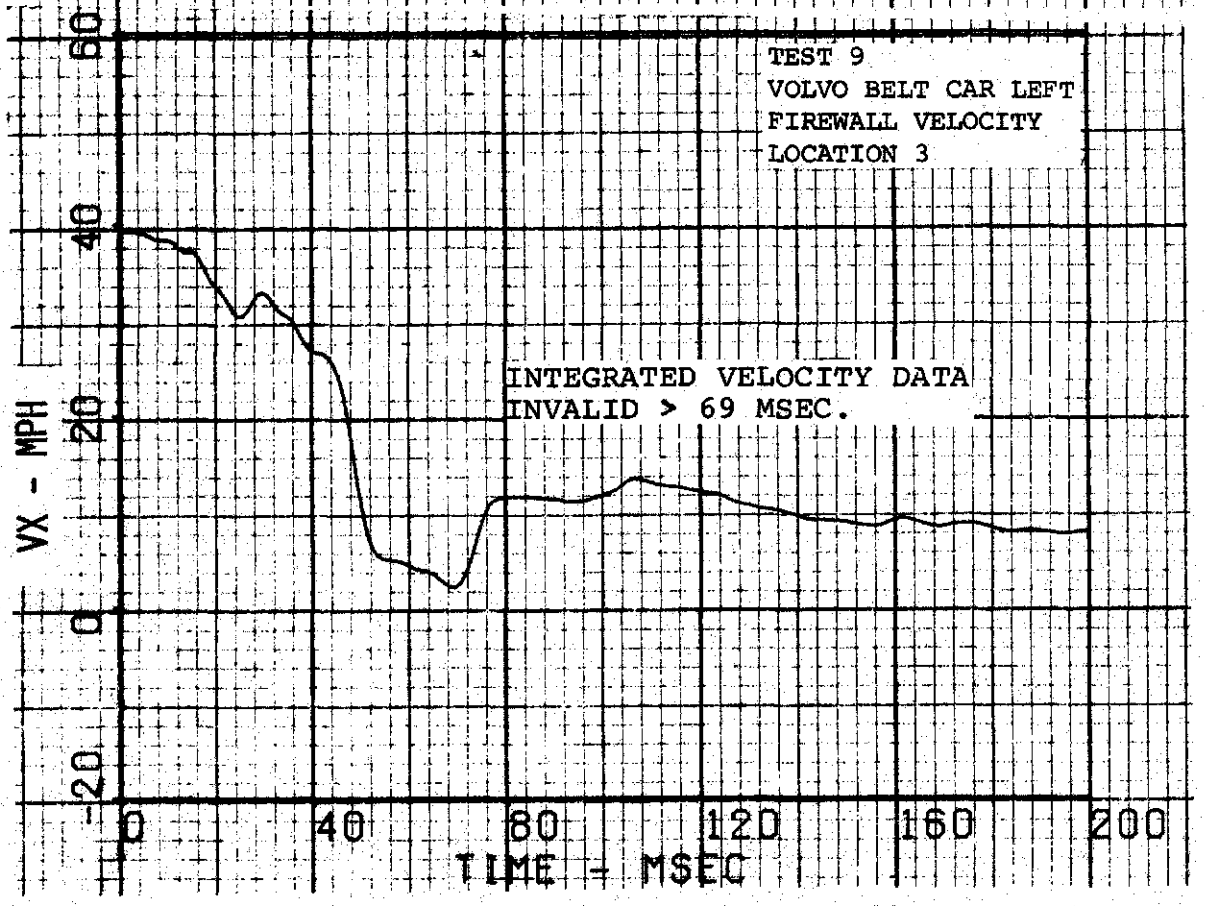

□= AX Δ= AY
TEST 9
VOLVO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
TRANSDUCER FAILURE.
Y-AXIS DATA INVALID > 66 MSEC.
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

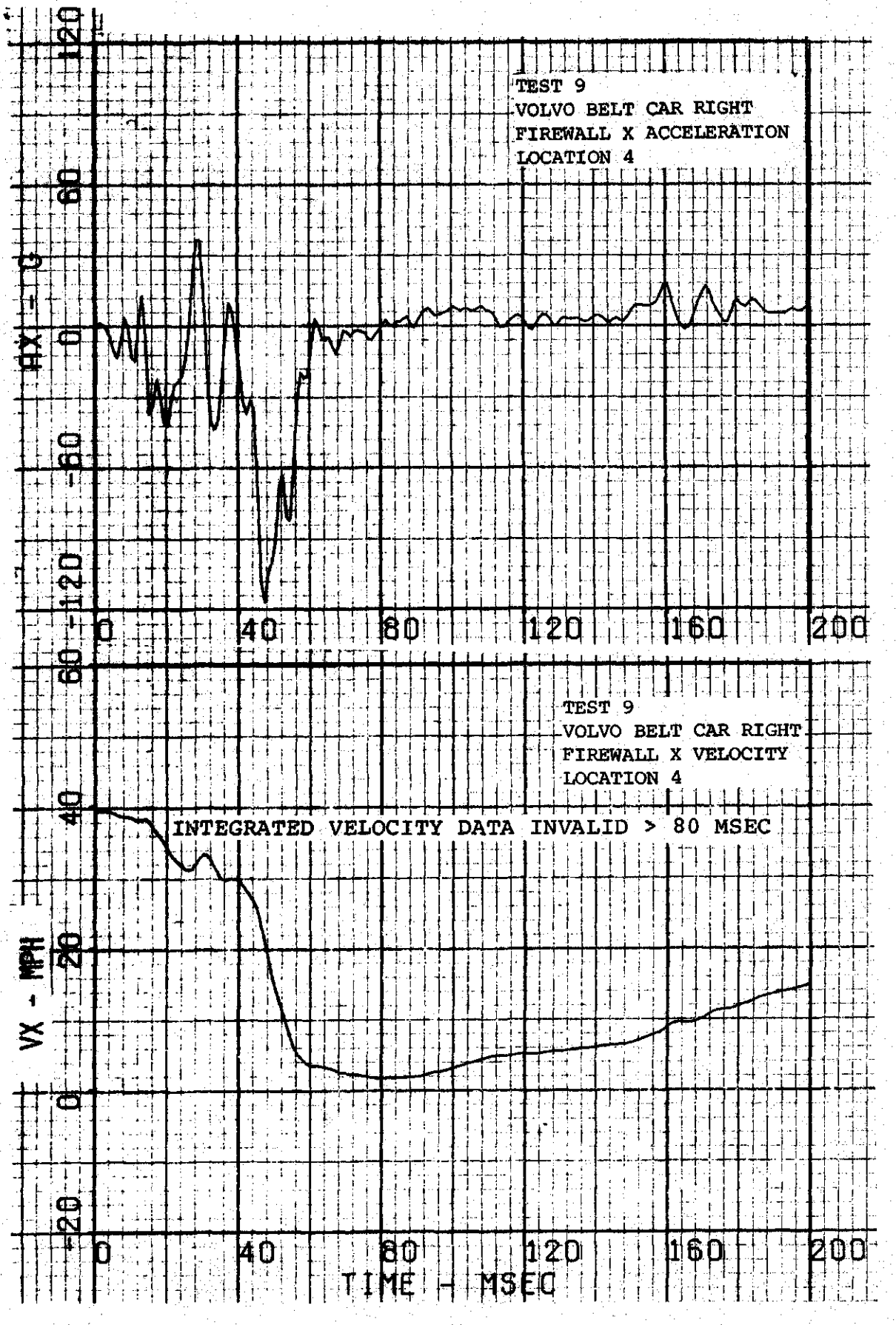

TEST 9
VOLVO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

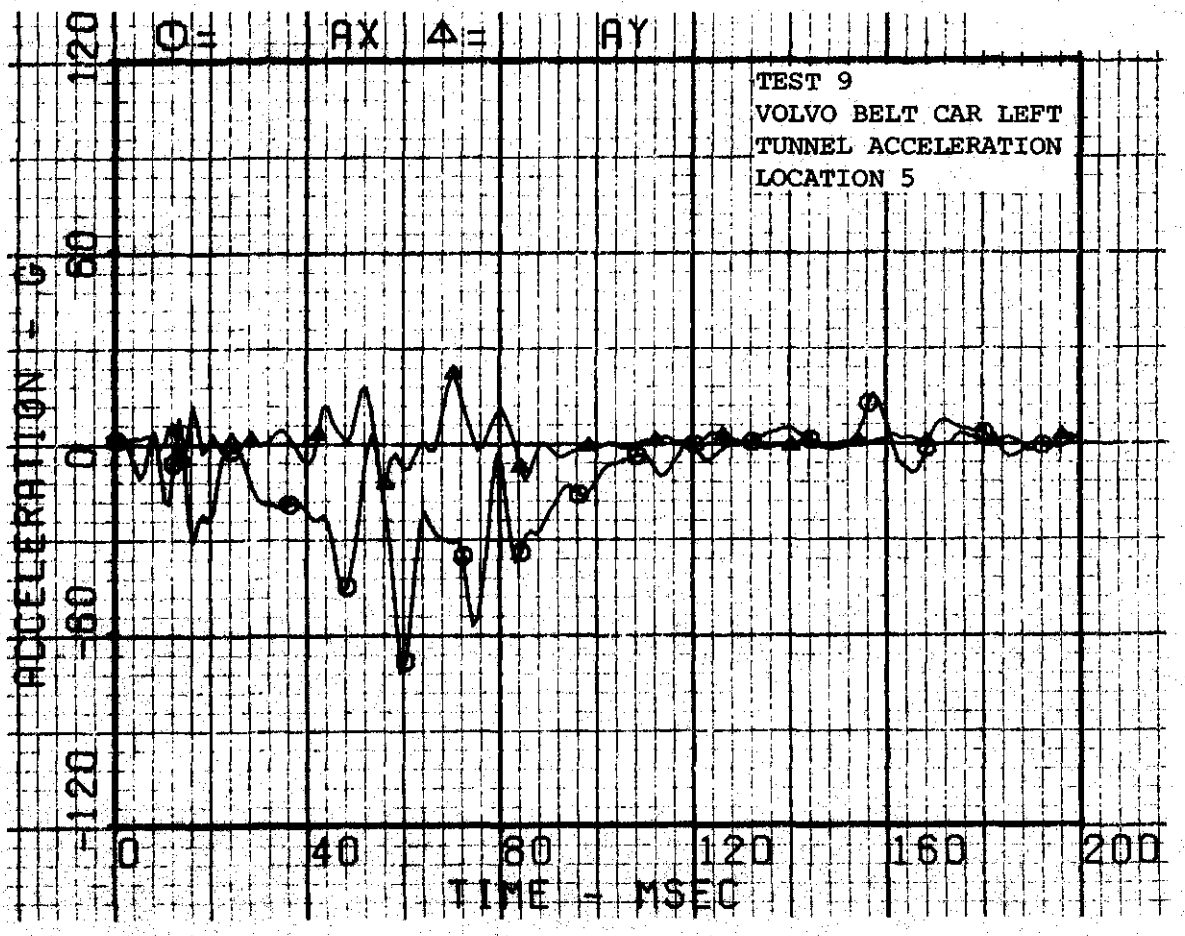

□= RX △= RY
TEST 9
VOLVO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

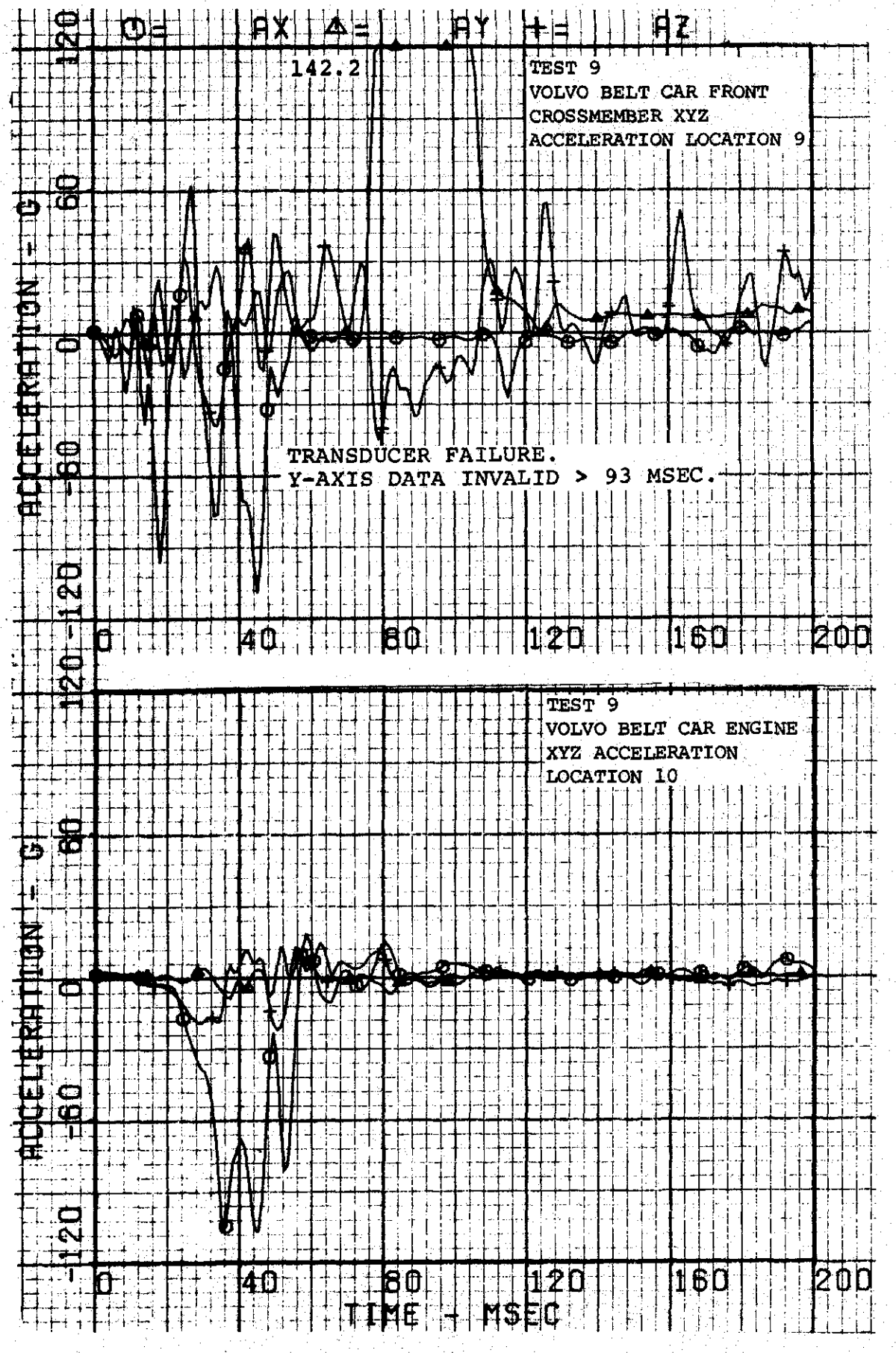

TEST 9
VOLVO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

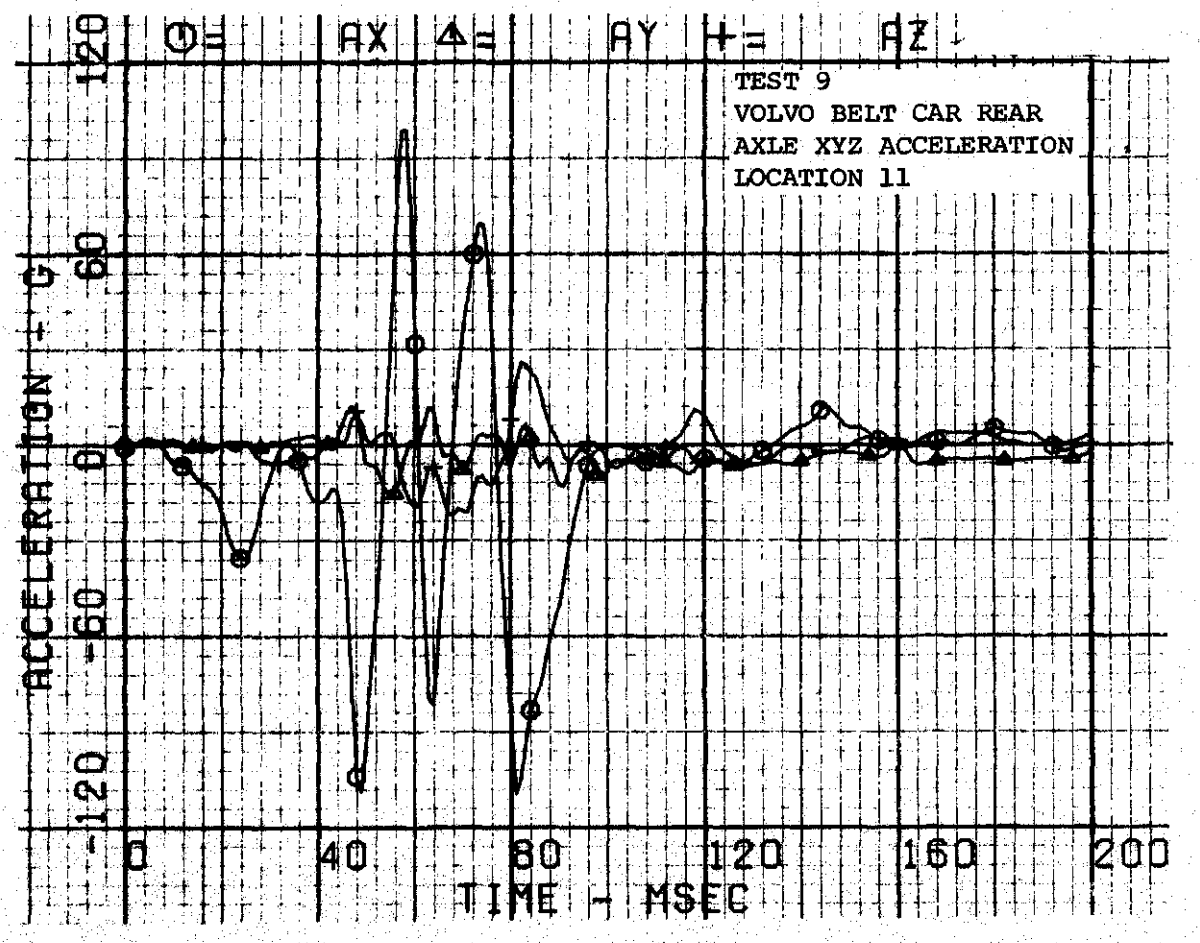

TEST 9
VOLVO BELT CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
AX - G
120
60
0
-60
-120
-164.7
0
40
80
120
160
200

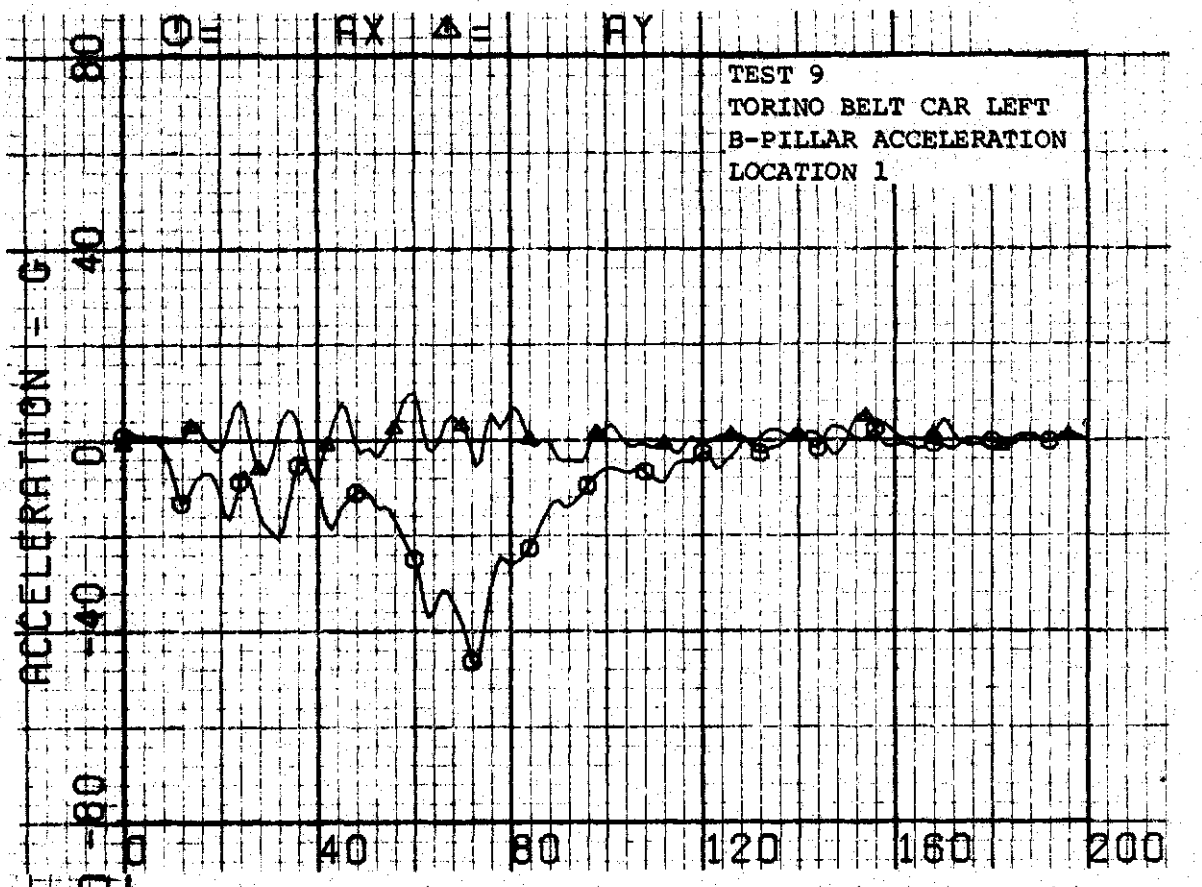

TEST 9
VOLVO BELT CAR LEFT
FIREWALL VELOCITY
LOCATION 3
INTEGRATED VELOCITY DATA
INVALID > 69 MSEC.
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

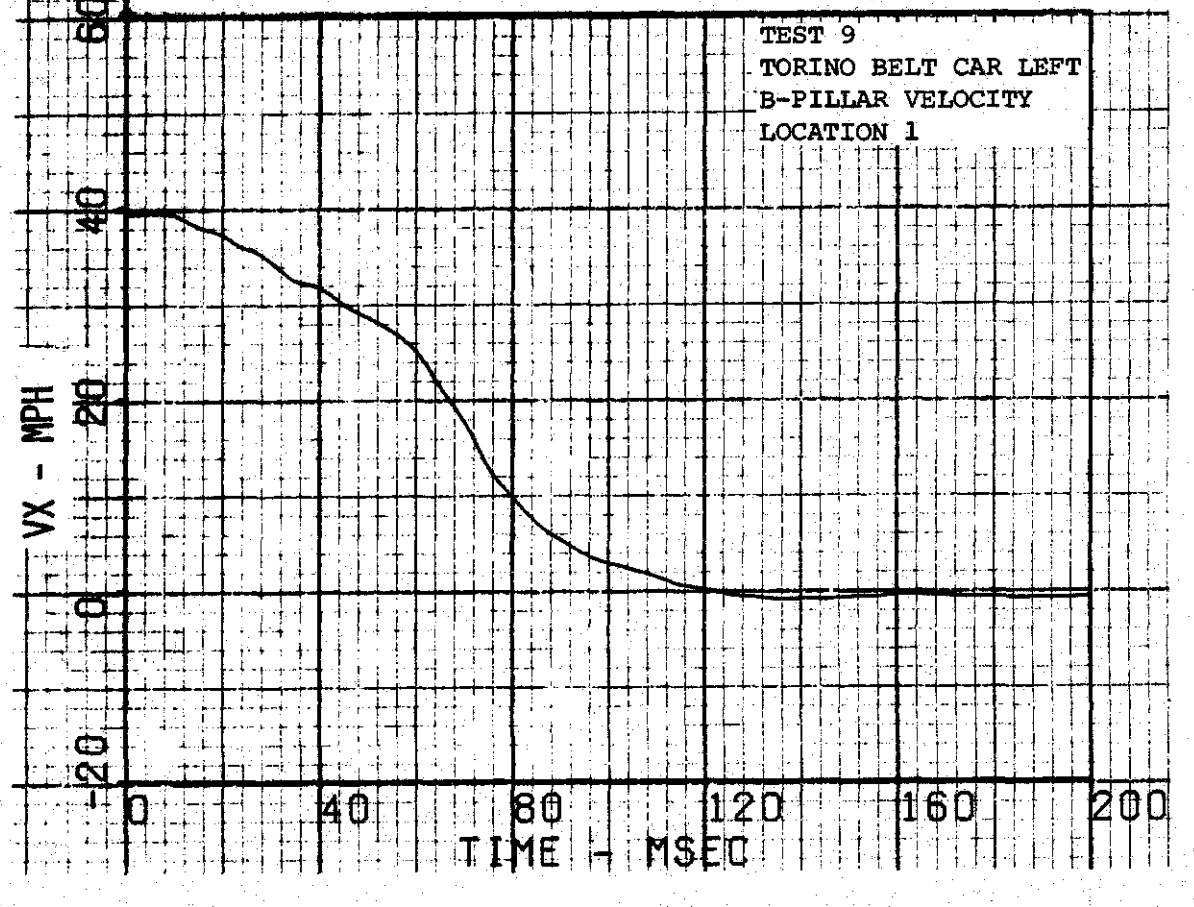

TEST 9
VOLVO BELT CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 9
VOLVO BELT CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
INTEGRATED VELOCITY DATA INVALID > 80 MSEC
VX - MPH
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

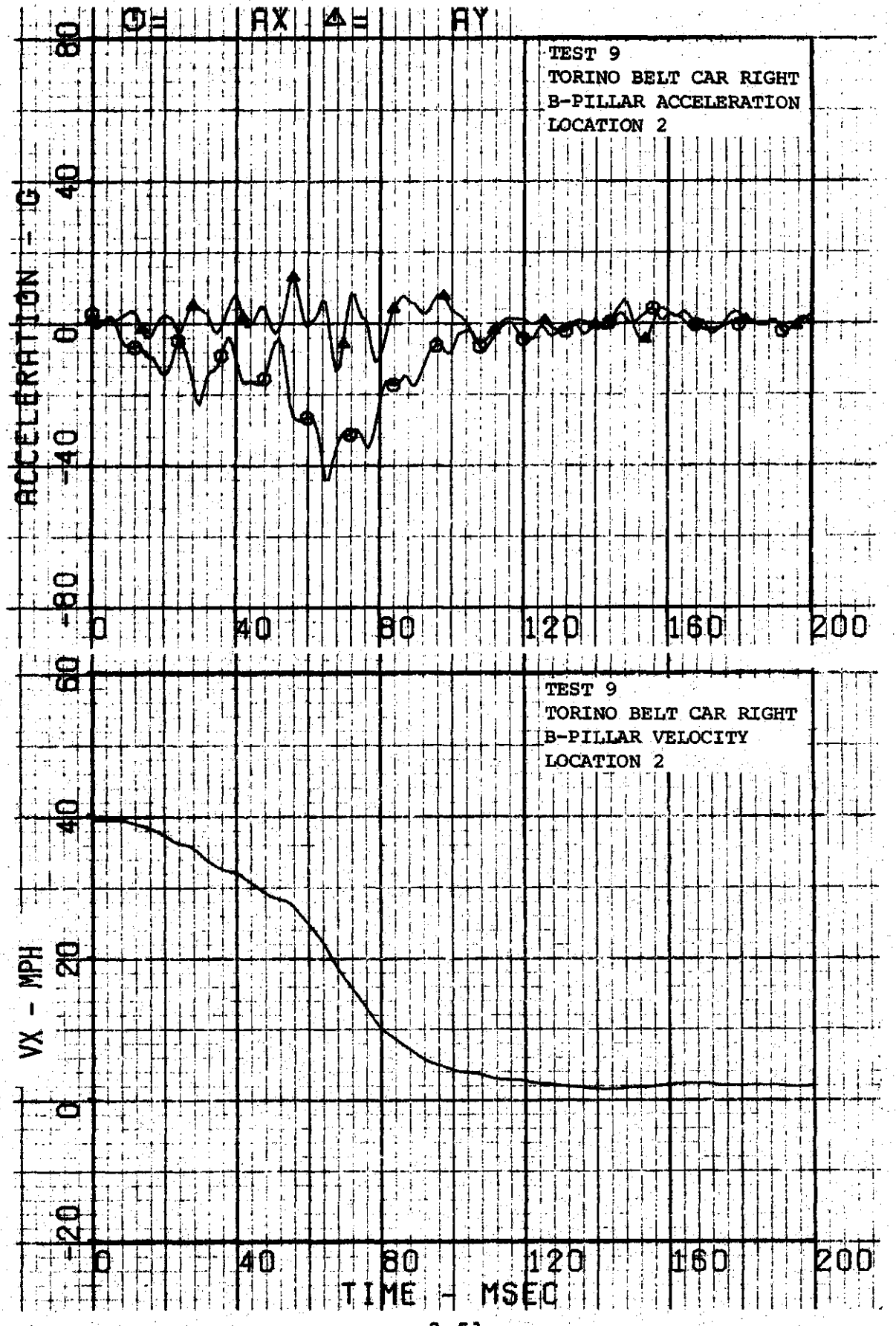

O = AX
Δ = AY
TEST 9
VOLVO BELT CAR LEFT
TUNNEL ACCELERATION
LOCATION 5
ACCELERATION - G
120
80
0
-80
-120
0
40
80
120
160
200
TIME - MSEC

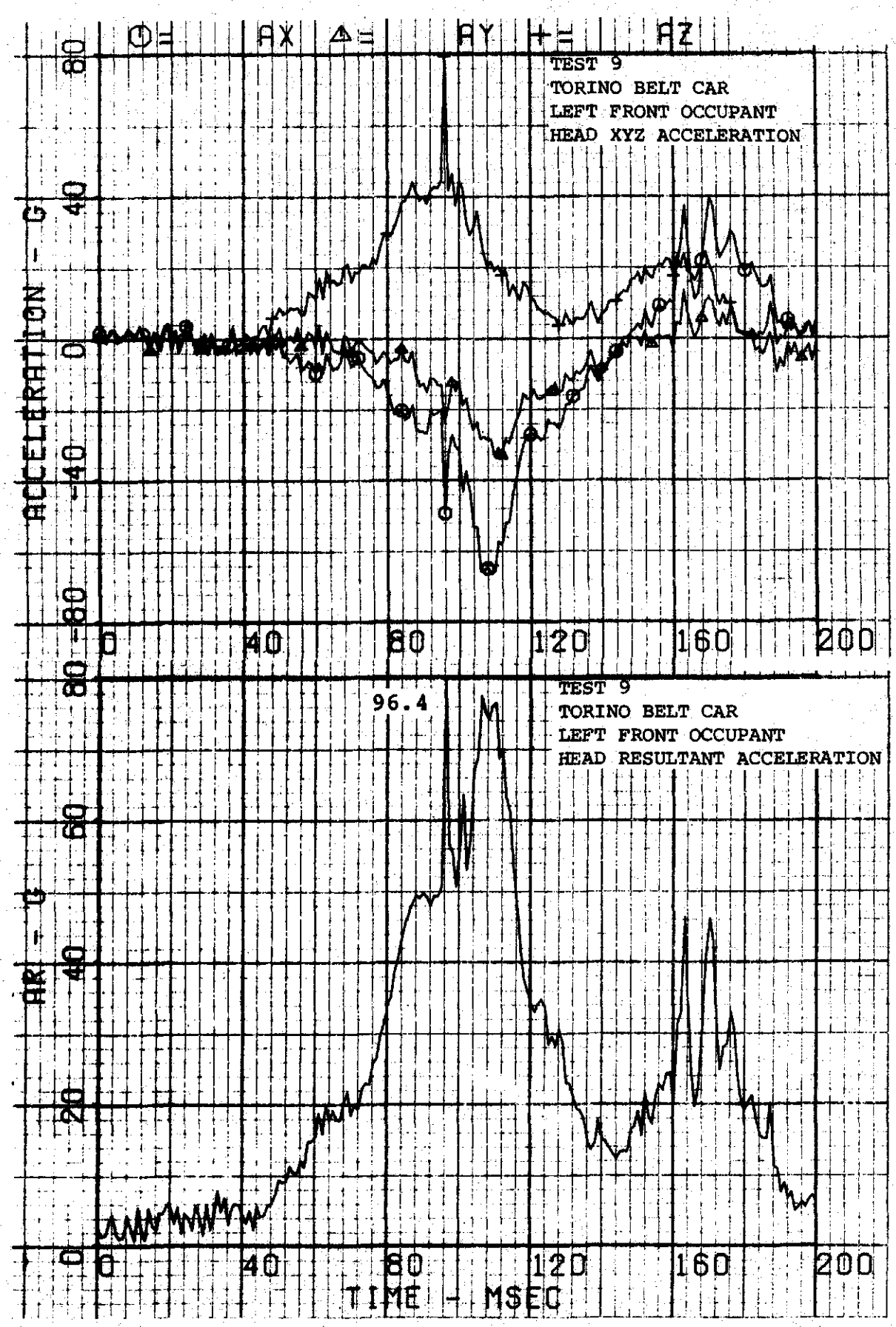

○= AX △= AY += AZ
142.2
TEST 9
VOLVO BELT CAR FRONT
CROSSMEMBER XYZ
ACCELERATION LOCATION 9
TRANSDUCER FAILURE.
Y-AXIS DATA INVALID > 93 MSEC.
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 9
VOLVO BELT CAR ENGINE
XYZ ACCELERATION
LOCATION 10
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC

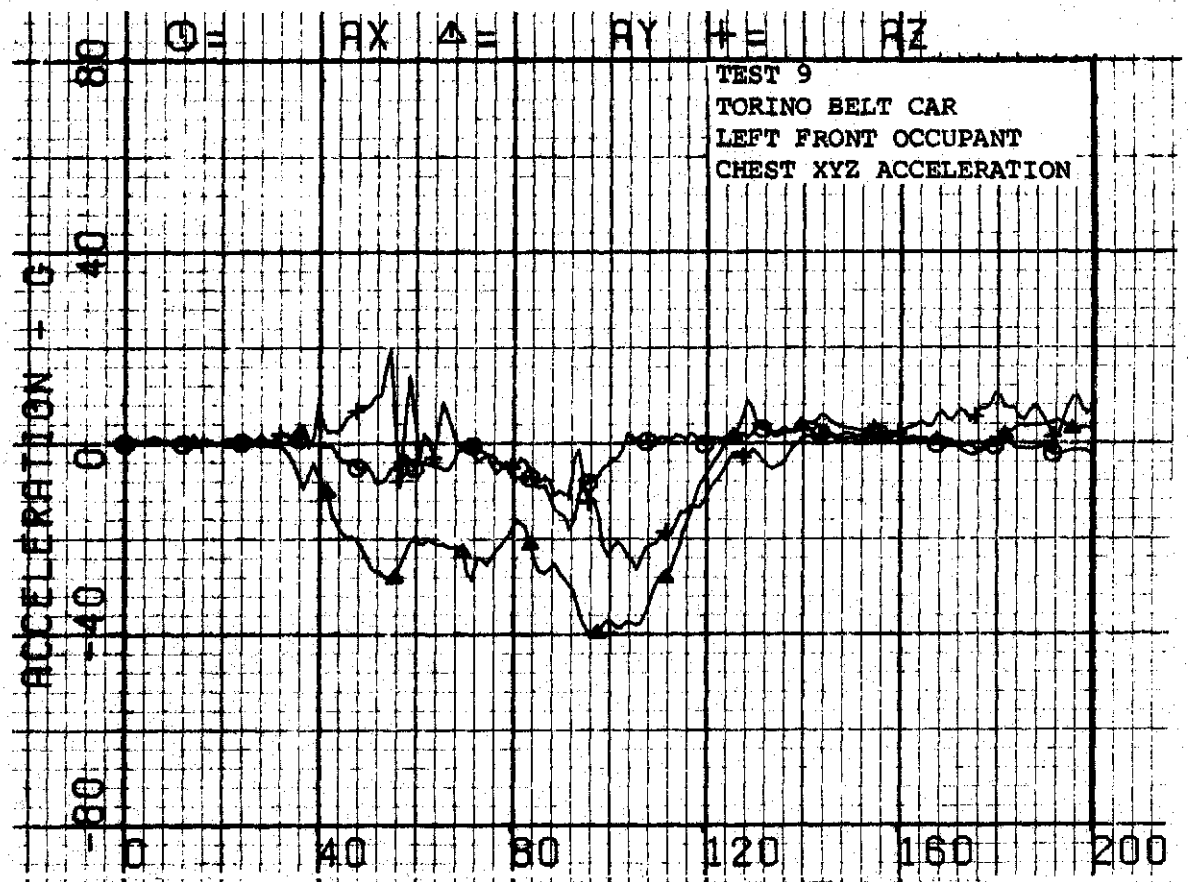

AX
AY
AZ
TEST 9
VOLVO BELT CAR REAR
AXLE XYZ ACCELERATION
LOCATION 11
ACCELERATION + G
120
60
0
-60
-120
0
40
80
120
160
200
TIME → MSEC

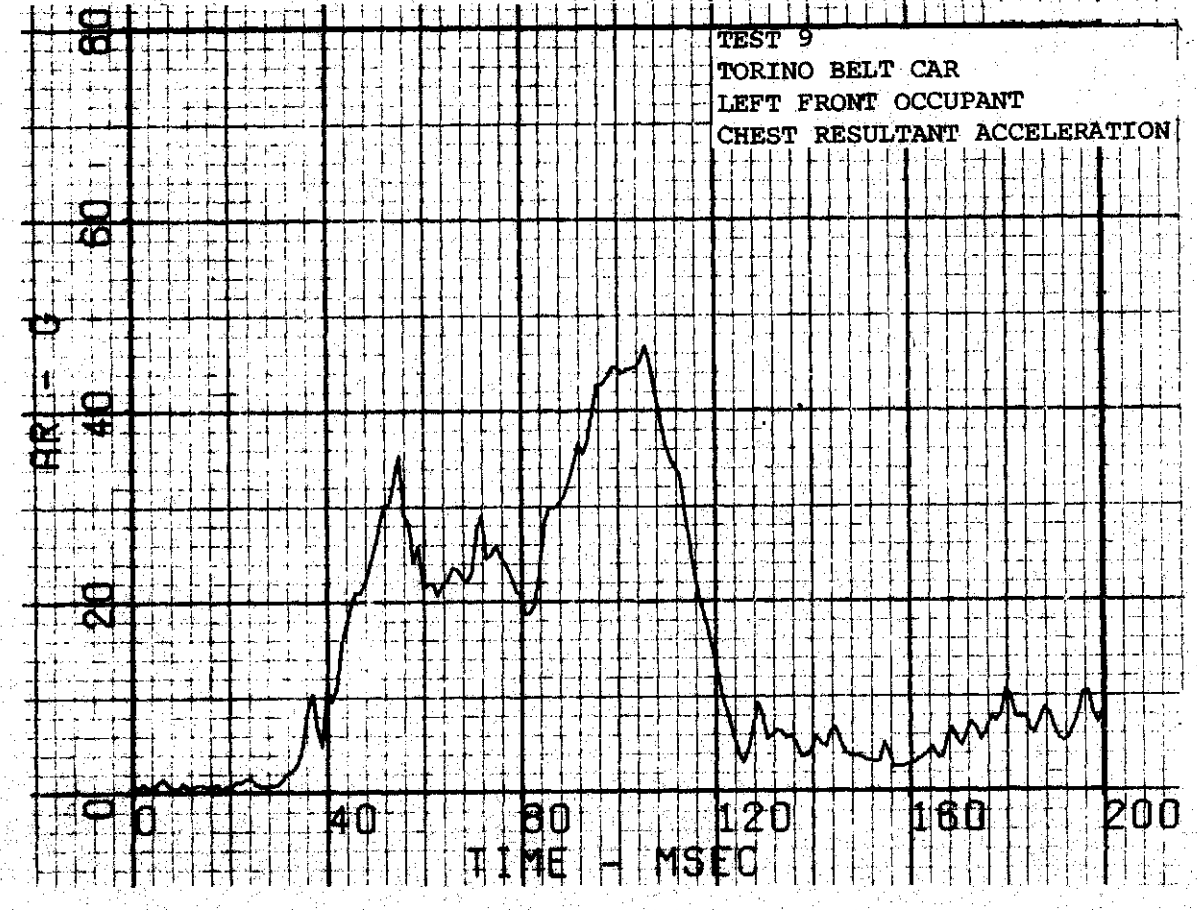

□ = AX △ = AY
TEST 9
TORINO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

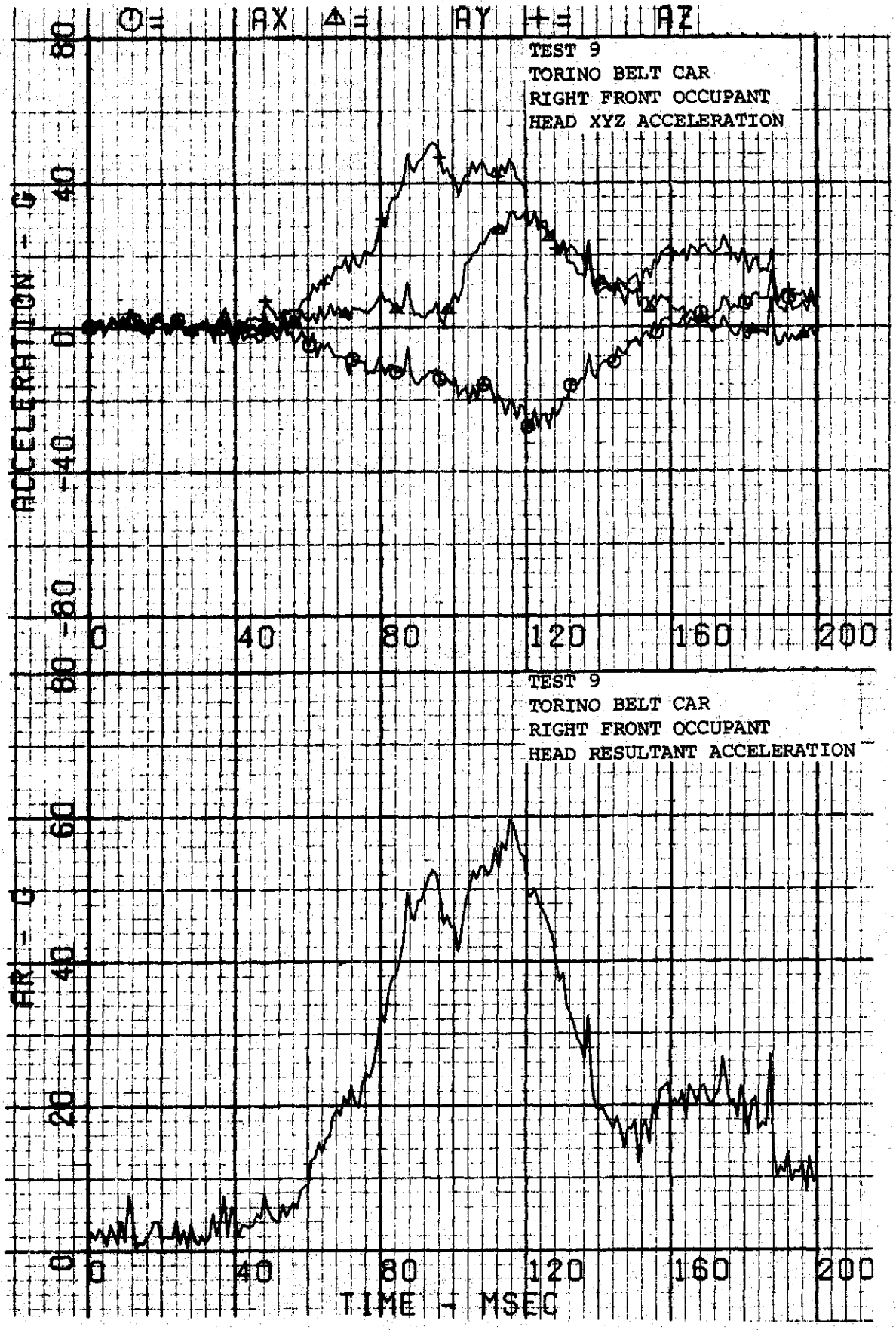

TEST 9
TORINO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

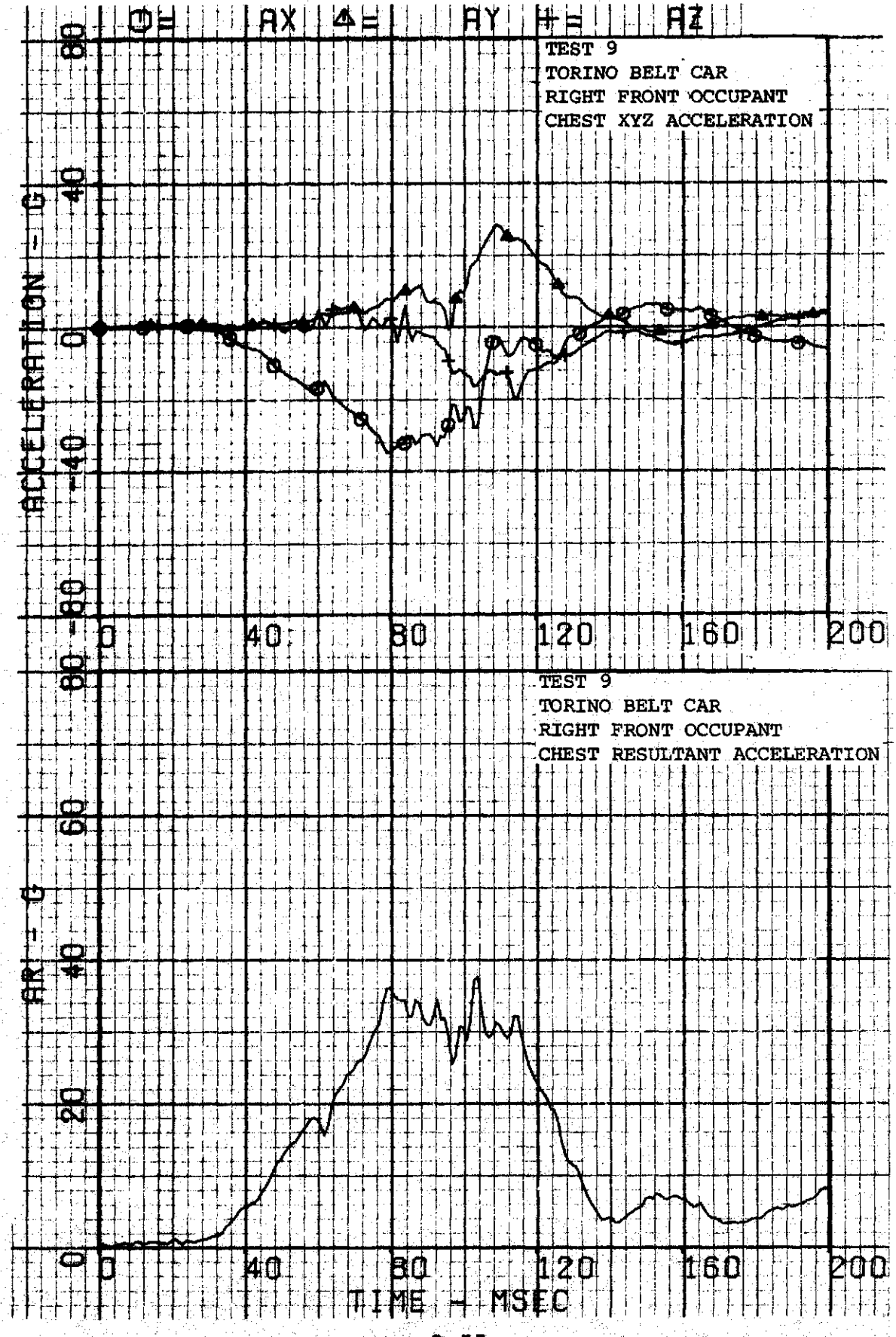

□= AX △= AY
TEST 9
TORINO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 9
TORINO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC


AX
AY
AZ
TEST 9
TORINO BELT CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
96.4
TEST 9
TORINO BELT CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
TIME - MSEC


○= AX △= AY +=
TEST 9
TORINO BELT CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION + G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 9
TORINO BELT CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC


○= AX △= AY += AZ
TEST 9
TORINO BELT CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 9
TORINO BELT CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
RR - G
60
40
20
0
0
40
80
120
160
200
TIME - MSEC


AX
AY
AZ
TEST 9
TORINO BELT CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 9
TORINO BELT CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
60
40
20
0
TIME - MSEC

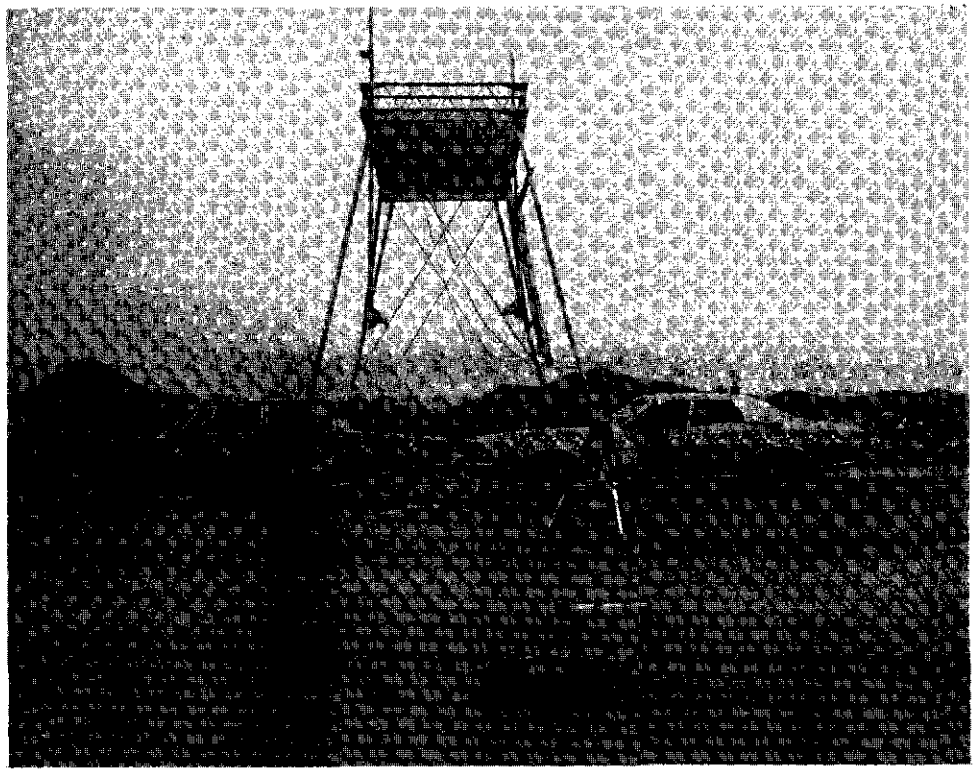


Figure 3-9. Pre-test Vehicle Configuration - Test 9.

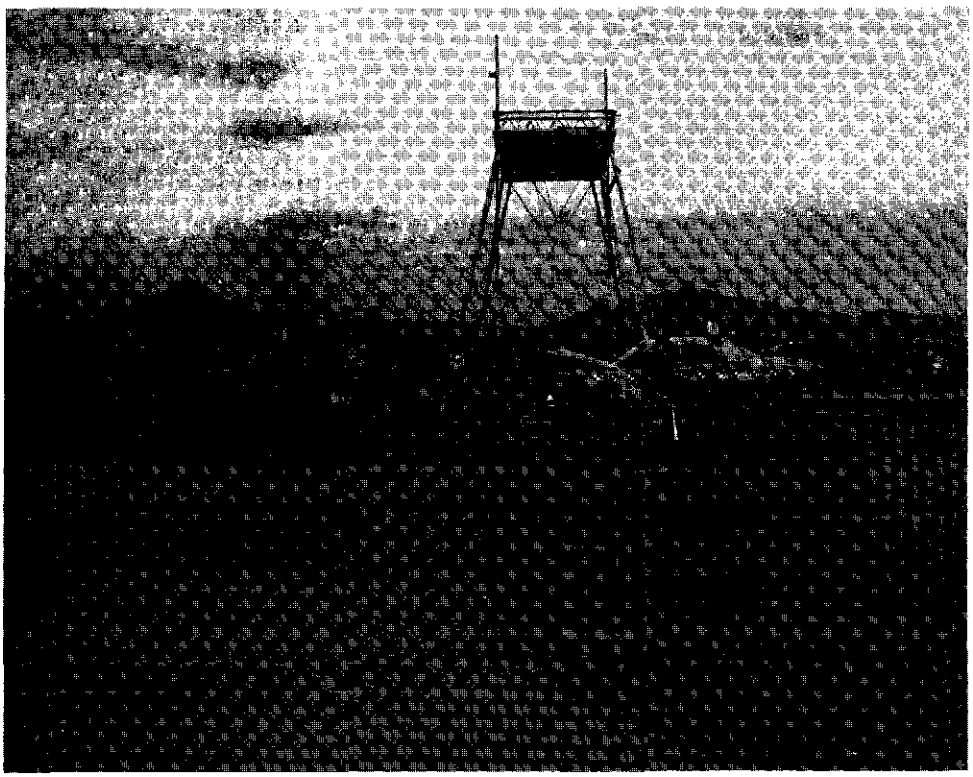


Figure 3-10. Post-test Vehicle Configuration - Test 9.

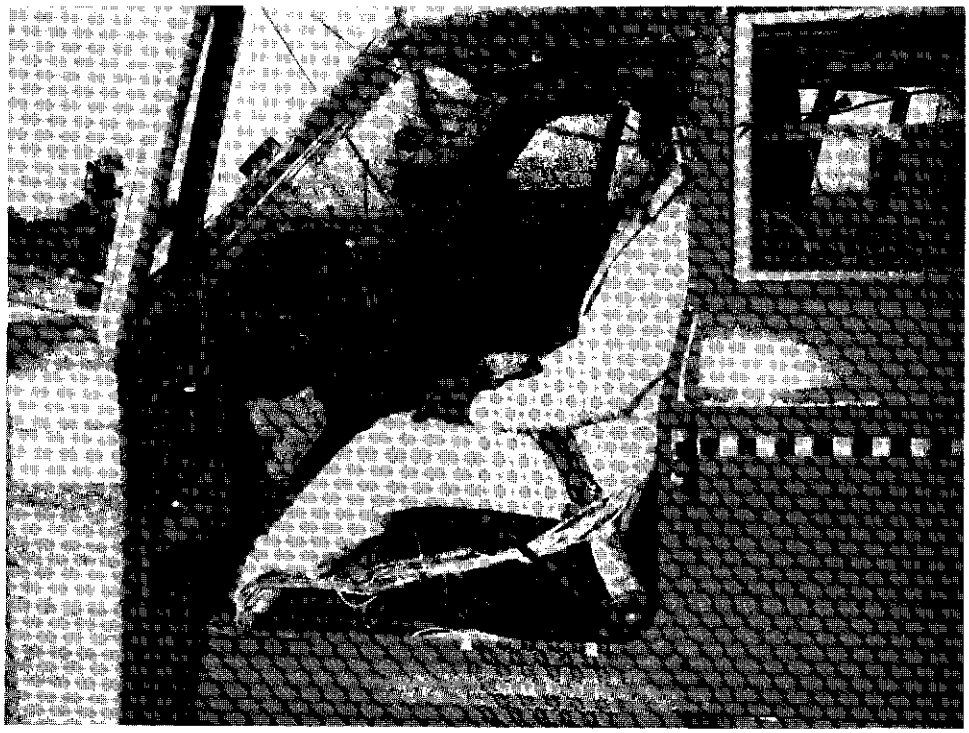


Figure 3-11. Pre-test Force Limited Airbelt - Test 9.

Figure 3-12. Post-test Force Limited Airbelt - Test 9.

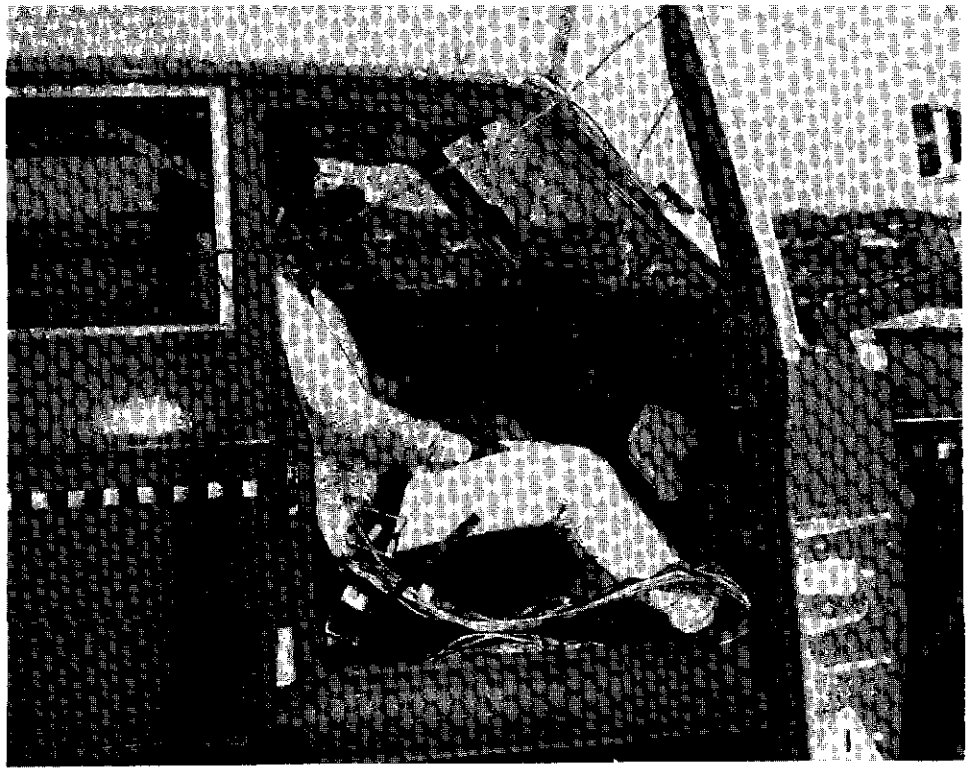


Figure 3-13. Pre-test Force Limited 2-Inch Belt - Test 9.

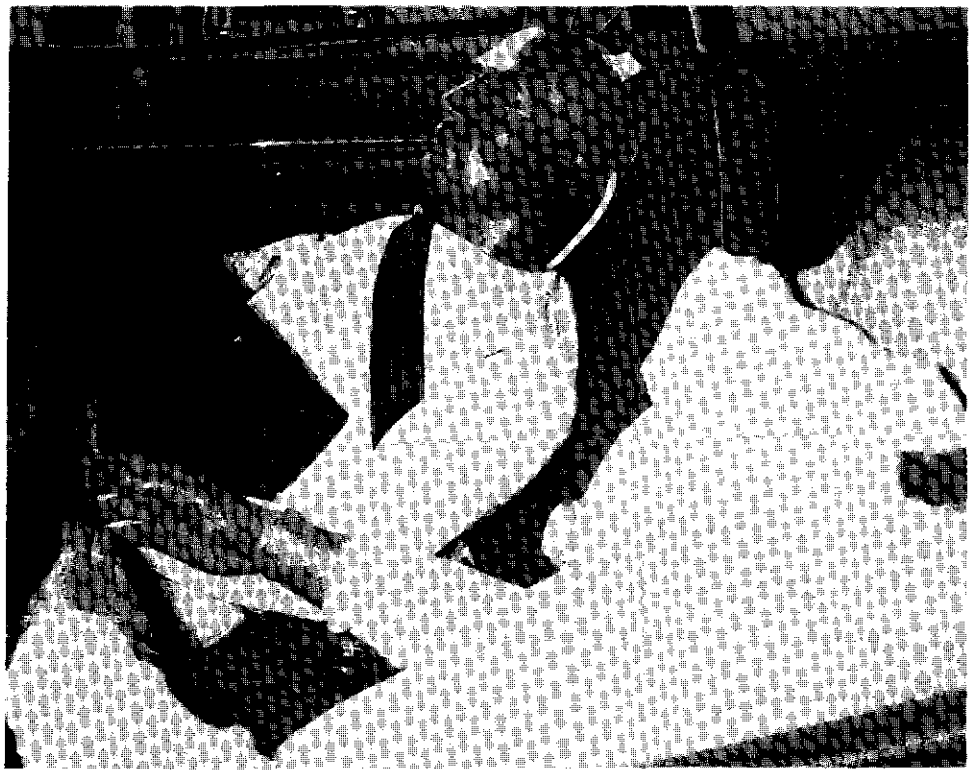


Figure 3-14. Post-test Force Limited 2-Inch Belt - Test 9.

3.3 TEST NUMBER 10

The impact conditions for Test 10 were:

Configuration	Closing Speed
Torino-to-Volvo Right Oblique (30°)	60.5 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Standard 3-Point Belt	RSV Driver Airbag
Right Front	Standard 3-Point Belt	RSV Passenger Airbag

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was structurally modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity and to accept the restraint systems that were installed in it. The extent of these modifications is shown in Figure 1-2.

The results of Test 10 are summarized in the following tables:

Table 3-9 - Summary of Vehicle Data (Test 10)

Table 3-10 - Injury Criteria Summary (Test 10)

Table 3-11 - Summary of Restraint System Data (Test 10)

Table 3-12 - Occupant Response Data (Test 10)

which are followed by Figure 3-15 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

TABLE 3-9. SUMMARY OF VEHICLE DATA (TEST 10)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 10/March 3, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		479	438
TEST WEIGHT (lb)		4725	3244
IMPACT VELOCITY (mph)		60.5	0
VELOCITY CHANGE (mph)		25.6	34.9 (1)
PEAK RESULTANT ACCELERATION (G @ msec)			
	LOCATION 1	(2)	39.0 @ 74
	LOCATION 2	20.2 @ 43	27.4 @ 20
MAXIMUM STATIC CRUSH (in.)			
	LEFT	18.0	11.0
	CENTER	21.0	12.5
	RIGHT	3.0	13.0

(1) Velocity change calculated using average of resultant velocity vector (V_R) data for compartment accelerometer locations.
(2) Transducer failure, y-axis accelerometer data not valid.

TABLE 3-10. INJURY CRITERIA SUMMARY (TEST 10)

VEHICLE B - AIRBAG CAR (VOLVO)				
	RSV DRIVER AIRBAG		RSV PASSENGER AIRBAG	
HIC	333		365	
HEAD G(1) @ msec	41.3 @ 190		63.3 @ 124	
CSI	184 @ 200		293 @ 200	
CHEST G(1) @ msec	38.0 @ 91		57.6 @ 120	
FEMUR LOAD (lb)	LEFT 1795	RIGHT 1250	LEFT 1092	RIGHT 601

(1) 3 msec clip.

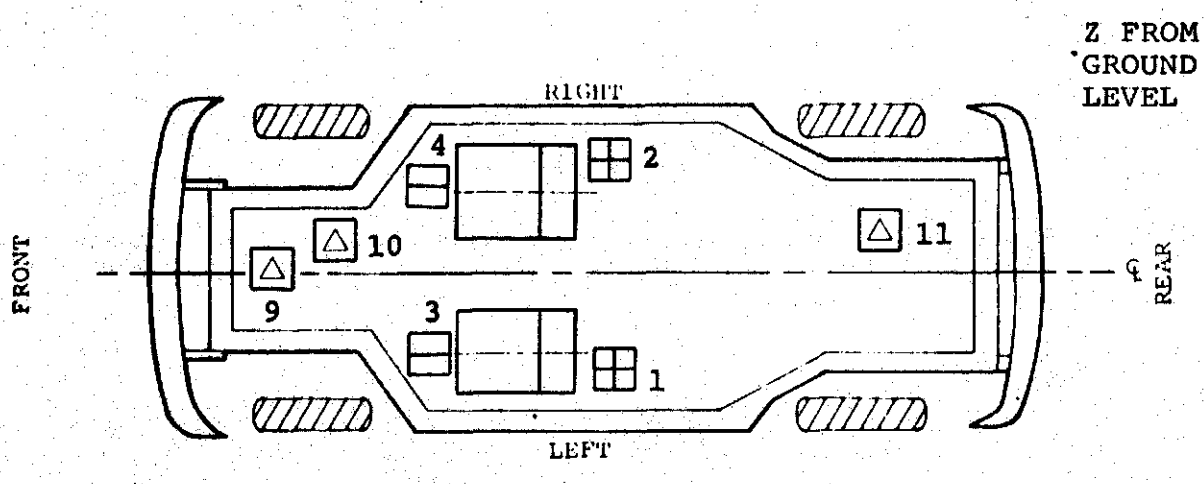
TABLE 3-11. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 10)

VEHICLE B - AIRBAG CAR (VOLVO)	
RSV DRIVER AIRBAG No Measurement Taken	
RSV PASSENGER AIRBAG Peak Bag Pressure psi @ msec	13.4 @ 15

TABLE 3-12. OCCUPANT RESPONSE DATA SUMMARY (TEST 10)

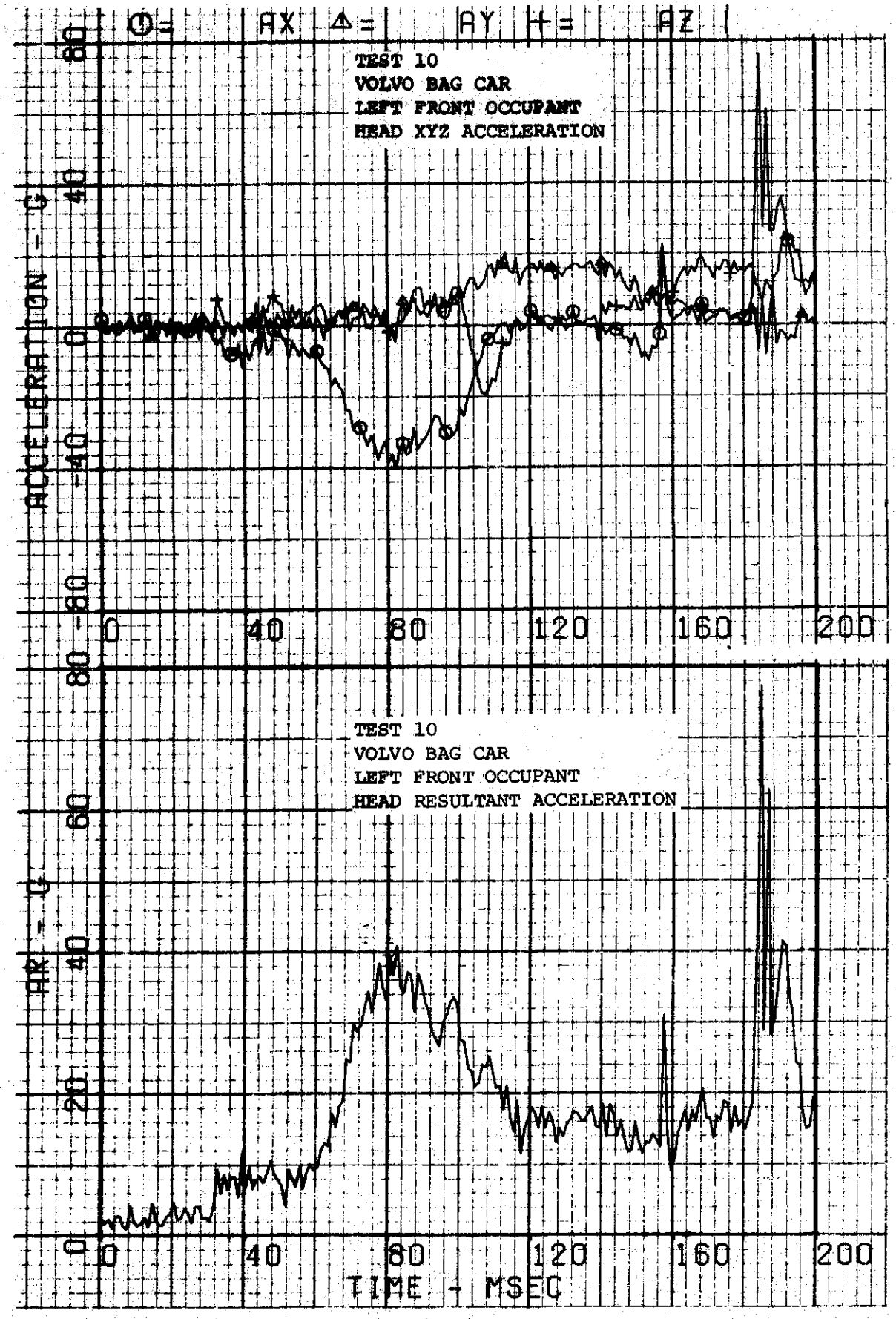
		VEHICLE B - AIRBAG CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD					
	X	76.2	184	86.5	123
	Y	22.5	147	70.4	123
	Z	25.8	191	68.8	122
	R(1)	41.3	190	63.3	124
	HIC	333 @ 63-200		365 @ 120-129	
CHEST					
	X	42.6	93	36.4	124
	Y	9.8	94	60.1	121
	Z	14.3	99	13.8	126
	R(1)	38.0	91	57.6	120
	SI	184 @ 200		293 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS					
	LF	1795	69	1092	76
	RT	1250	83	601	104

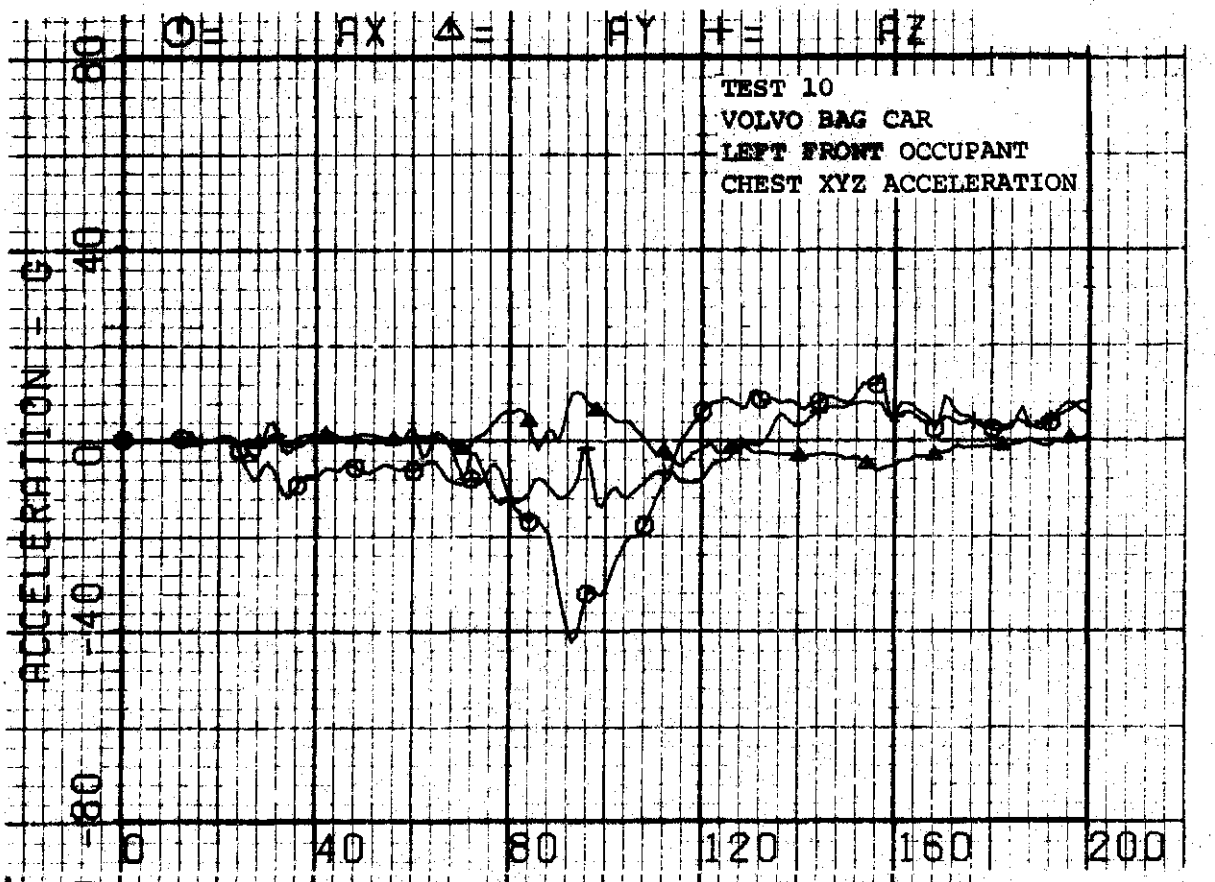
(1) 3 msec clip, components not clipped.

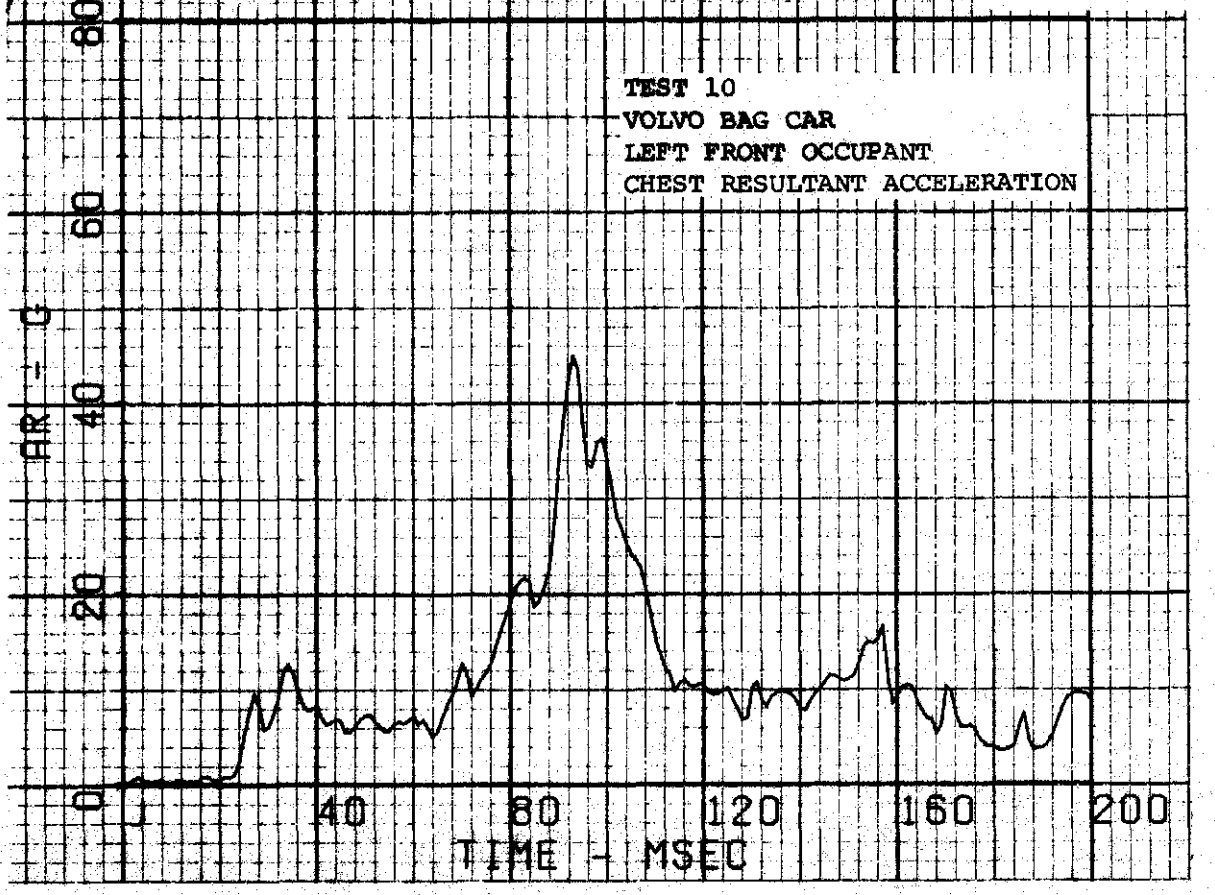


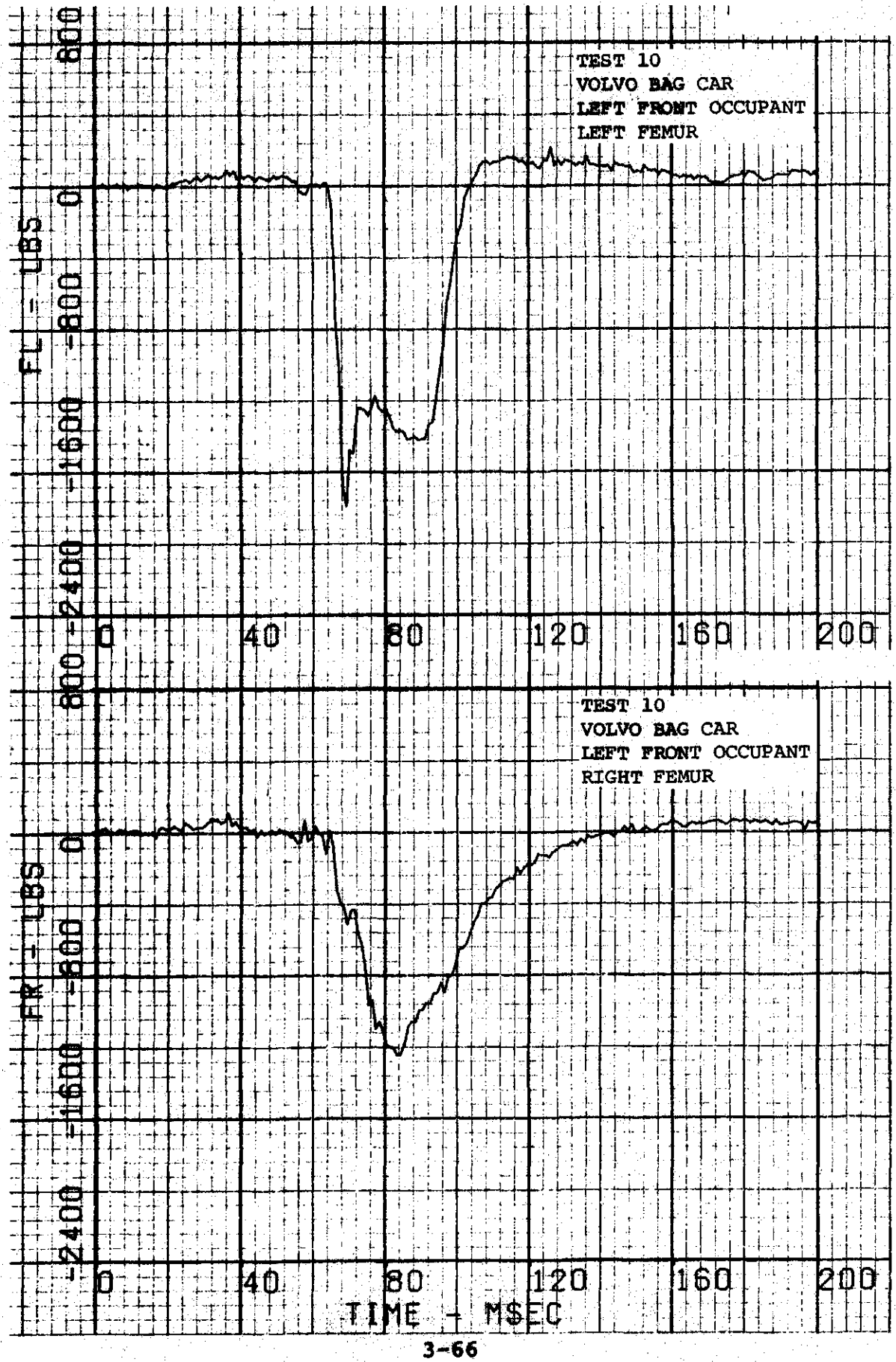
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
9	Engine Block	X	X	X
10	Front Crossmember	X	X	X
11	Rear Axle	X	X	X

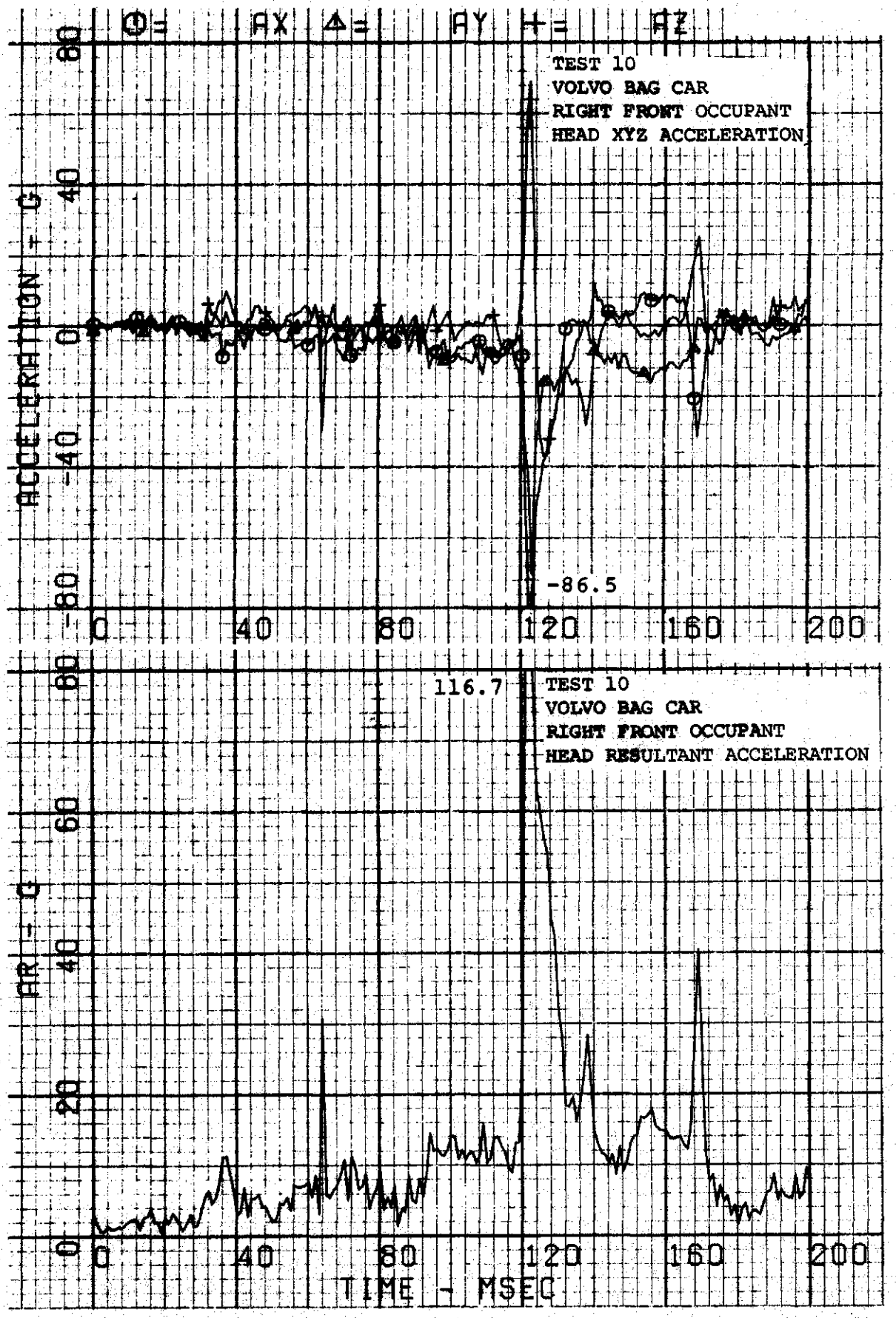
Figure 3-15. Vehicle Accelerometer Locations - Test 10.

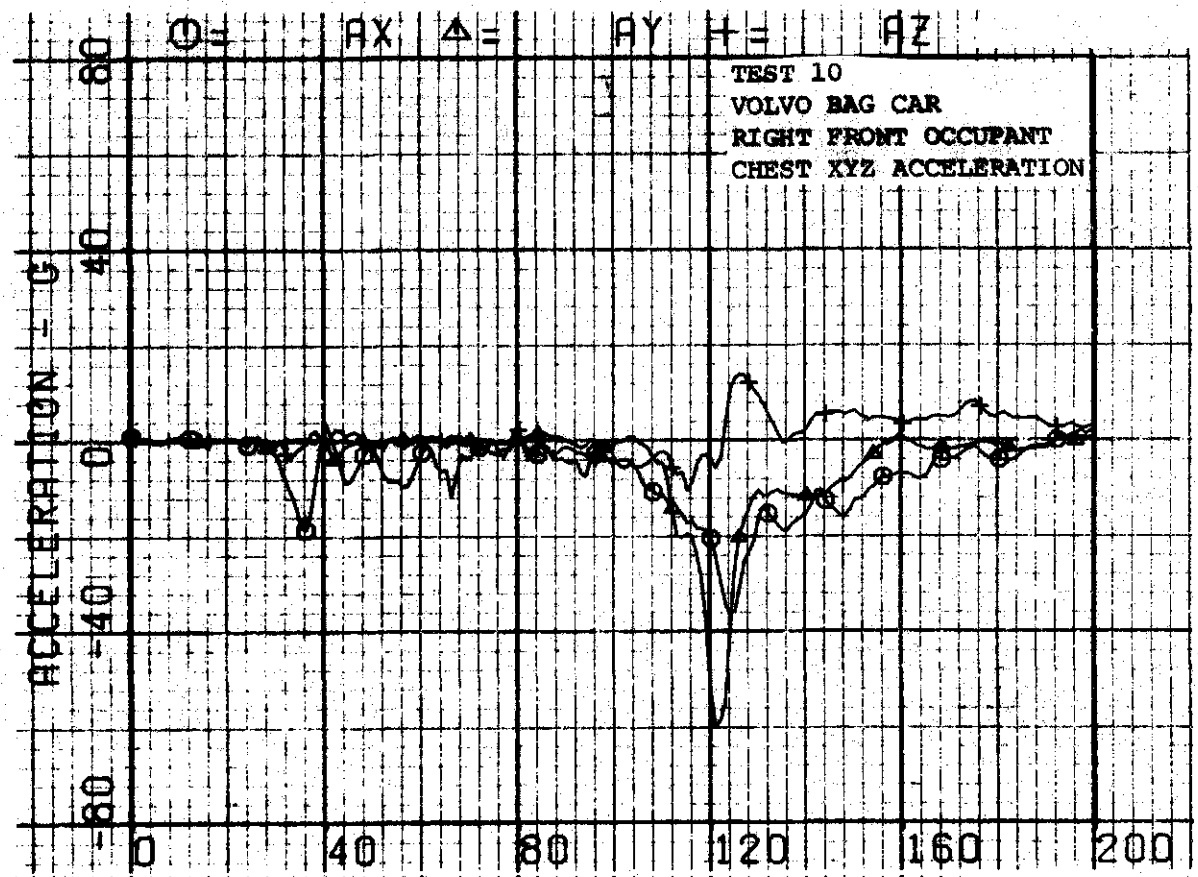

○= AX △= AY □= AZ
TEST 10
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 10
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

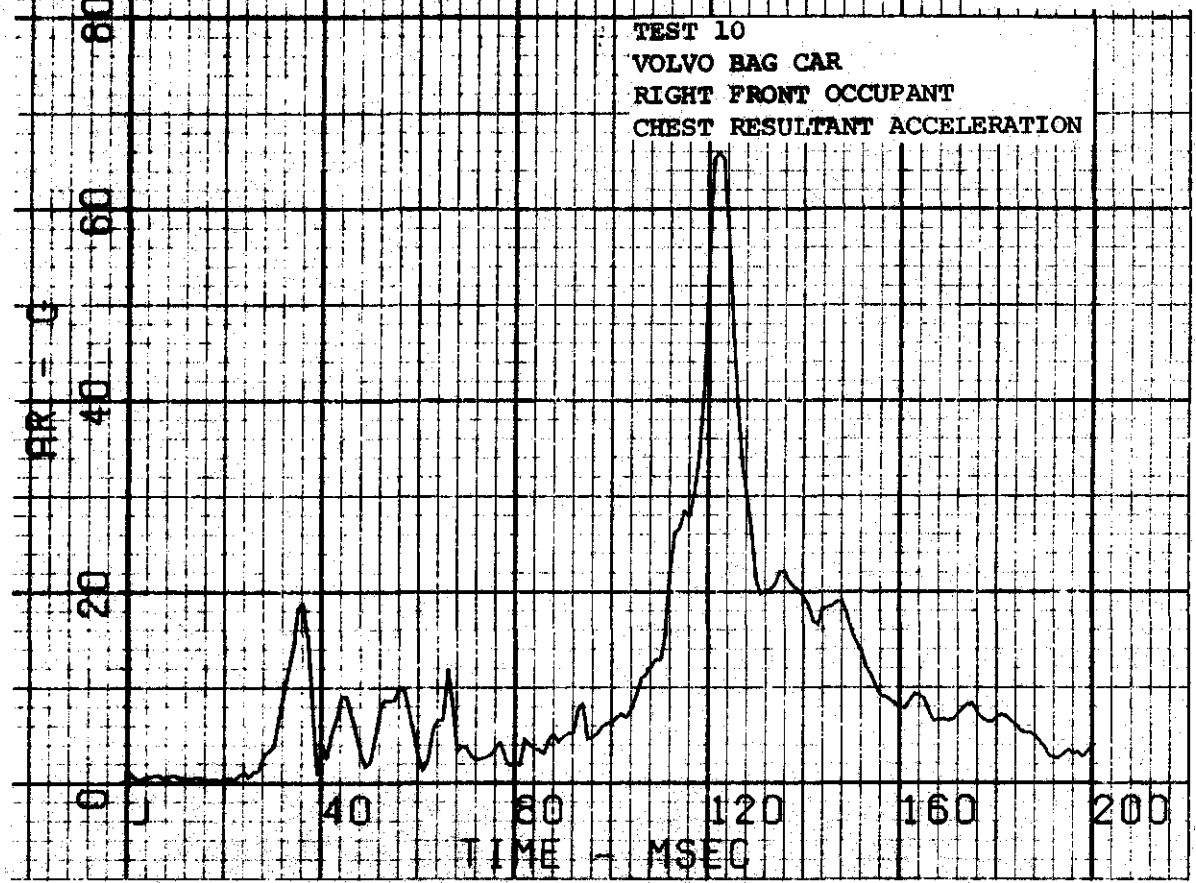

AX
AY
AZ
TEST 10
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

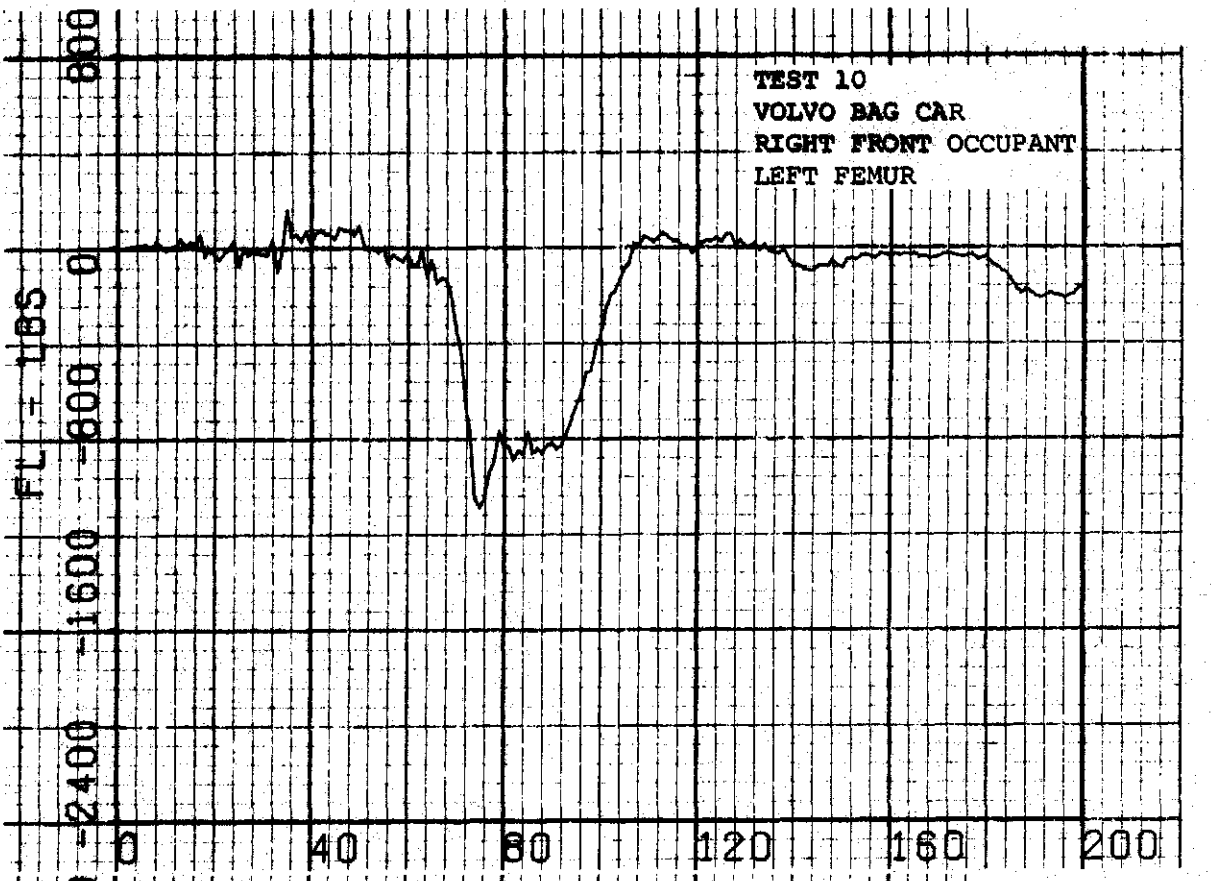

TEST 10
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
40
80
120
160
200
TIME - MSEC

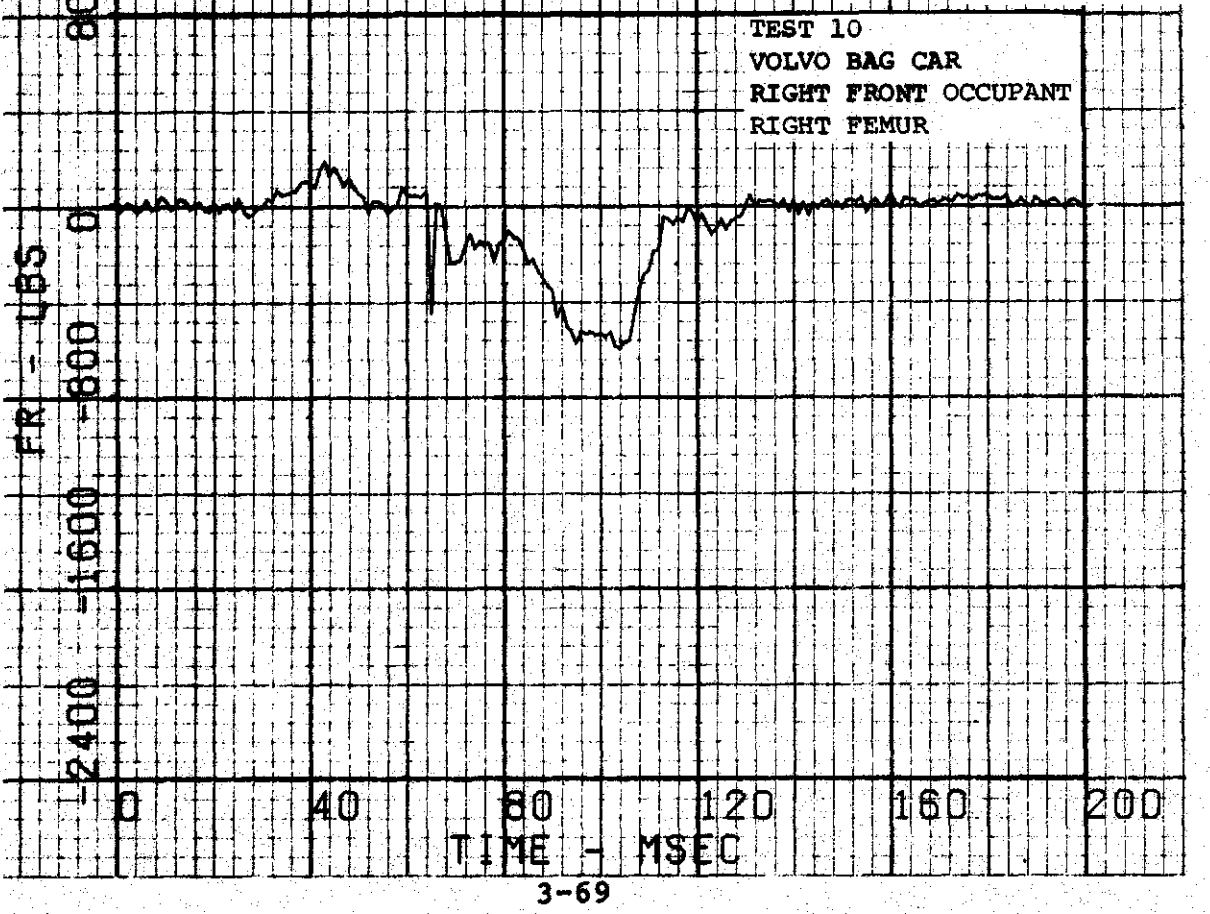

TEST 10
VOLVO BAG CAR
LEFT FRONT OCCUPANT
LEFT FEMUR
FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 10
VOLVO BAG CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC

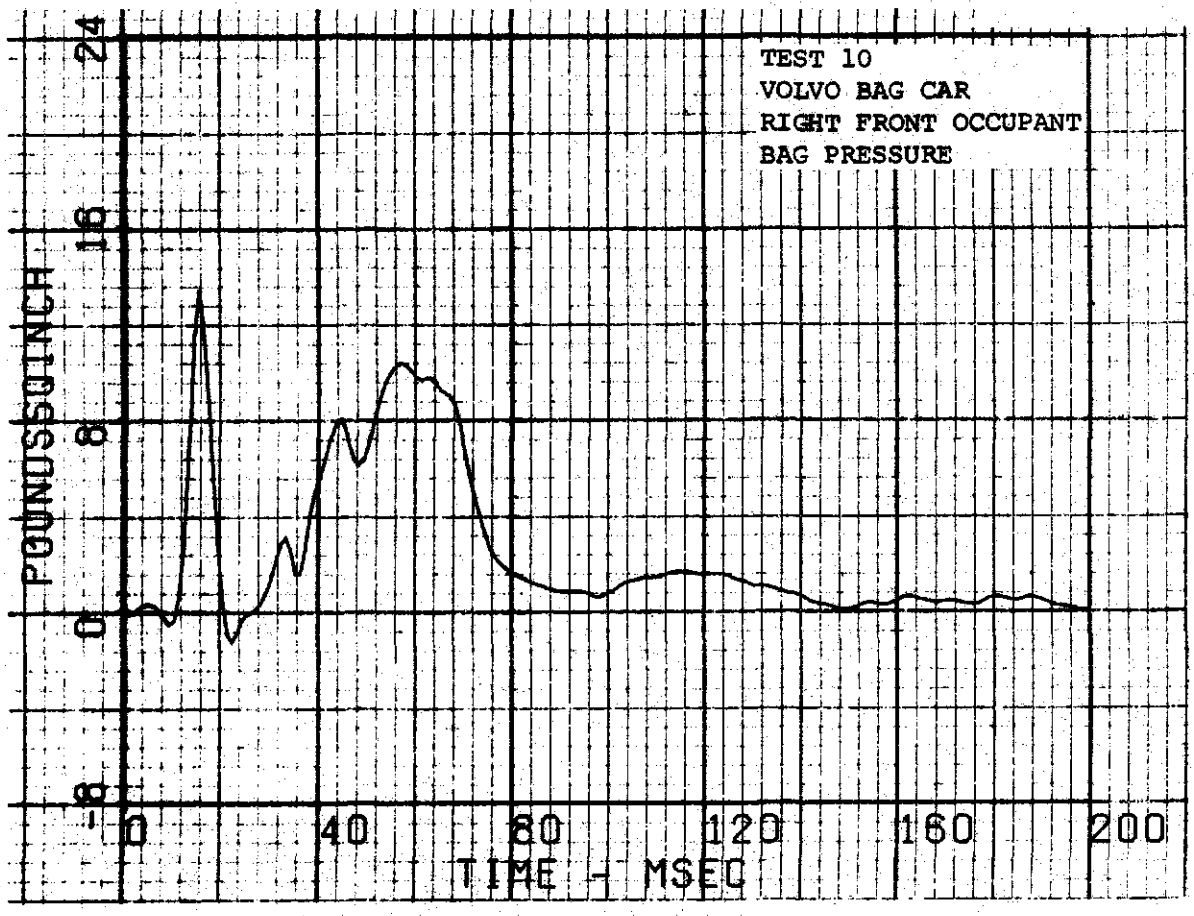

O= AX Δ= AY += AZ
TEST 10
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
-86.5
0
40
80
120
160
200
116.7
TEST 10
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
TIME - MSEC

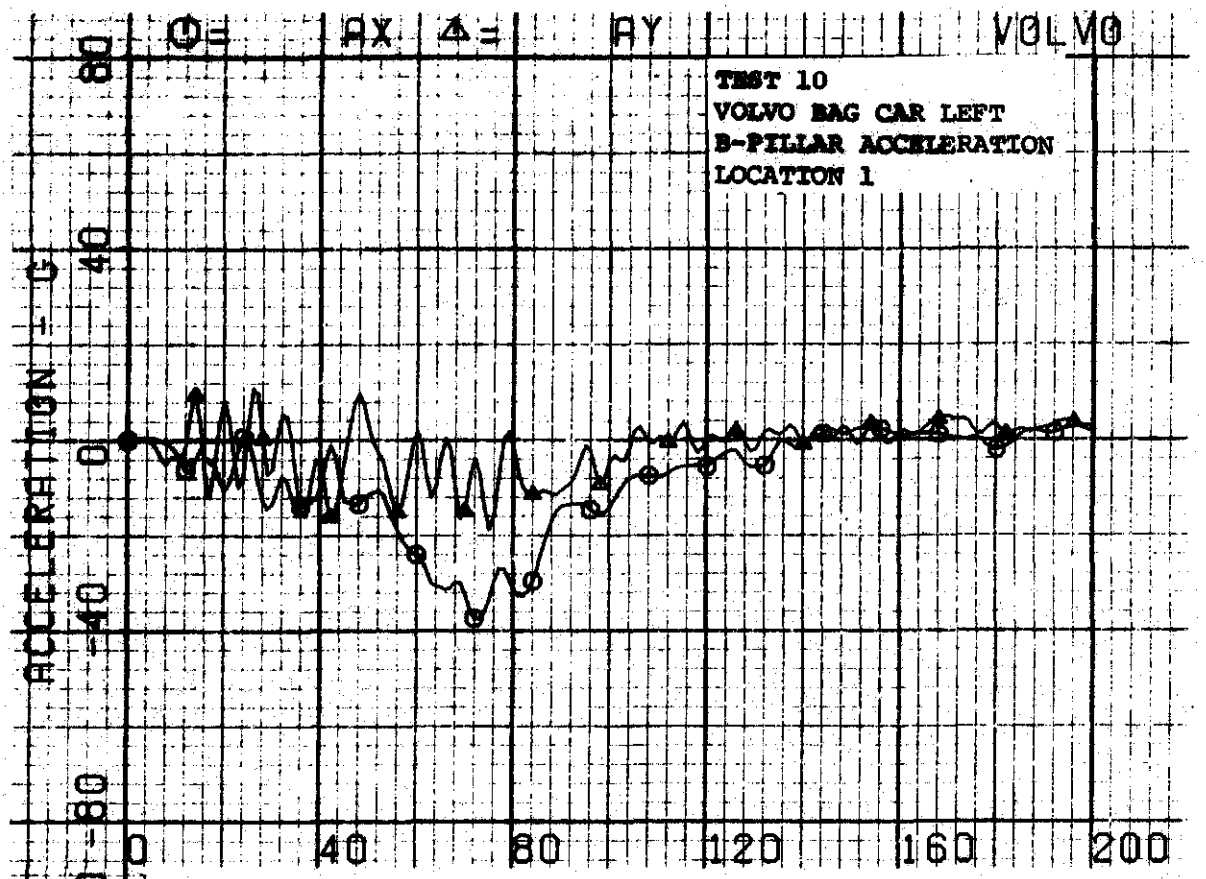

○= AX △= AY +=
TEST 10
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

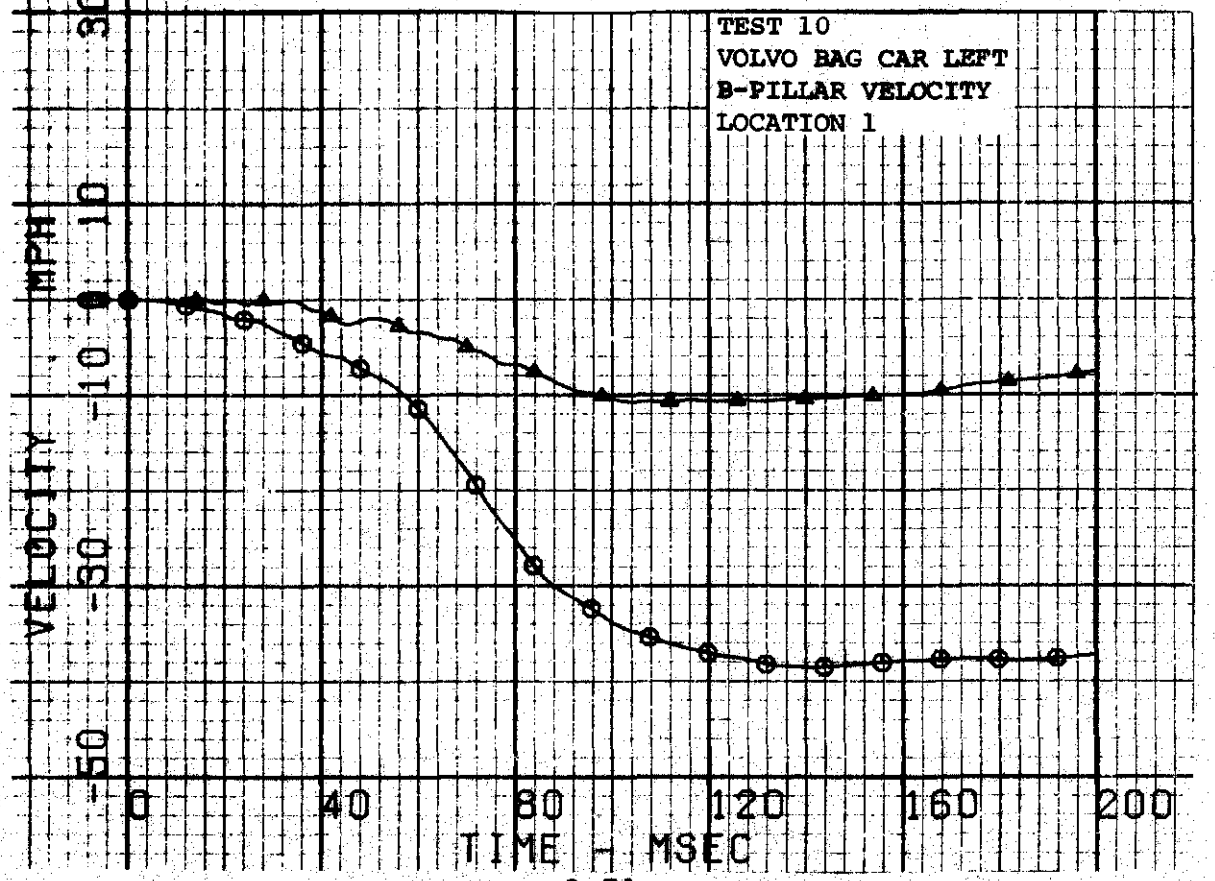

TEST 10
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
40
80
120
160
200
TIME - MSEC

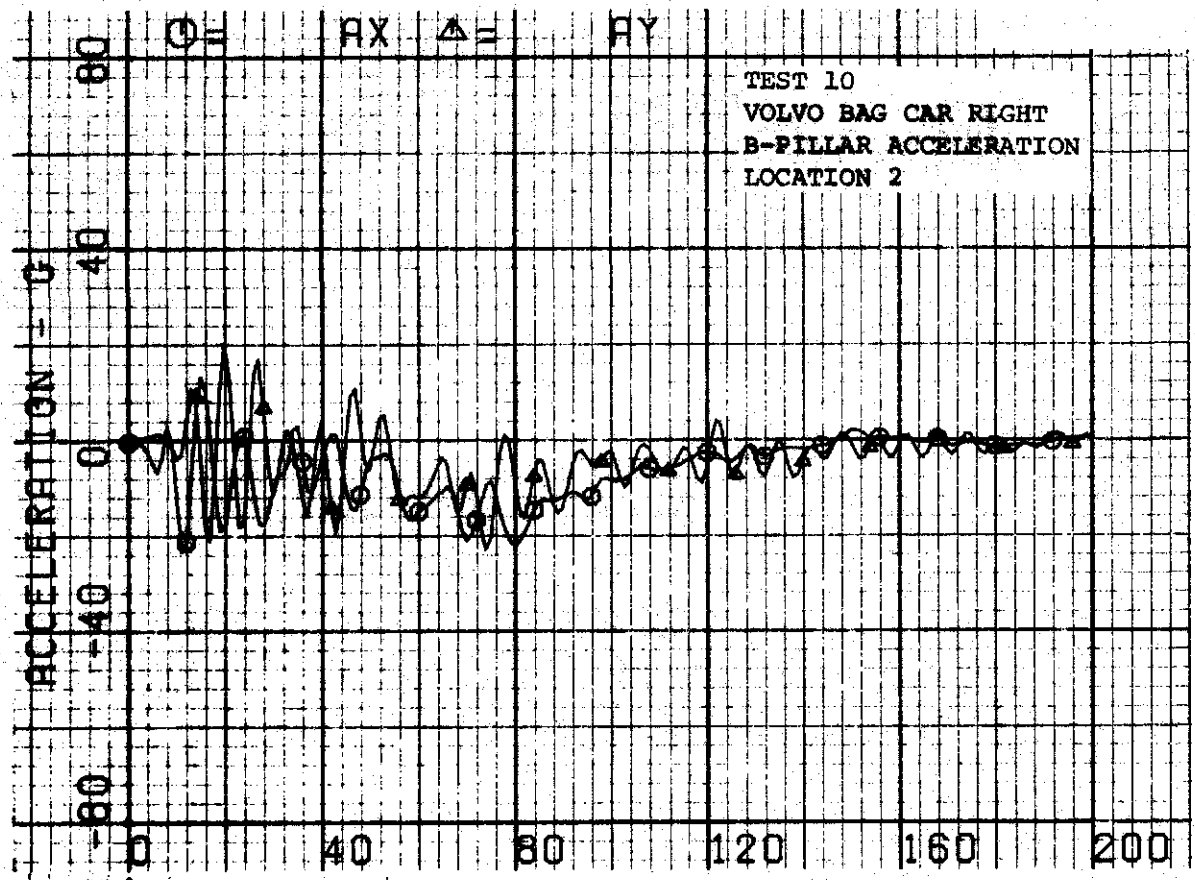

TEST 10
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR
FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200

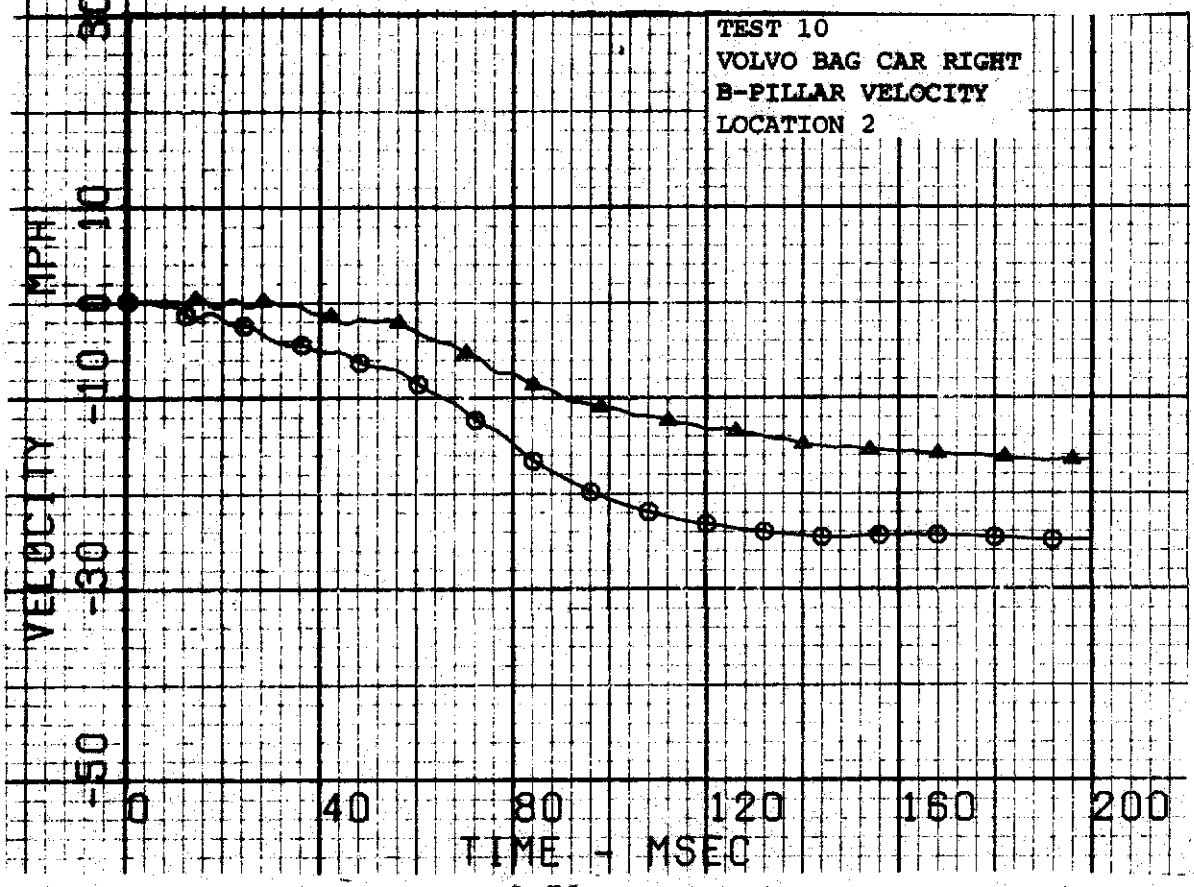

TEST 10
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
RIGHT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC

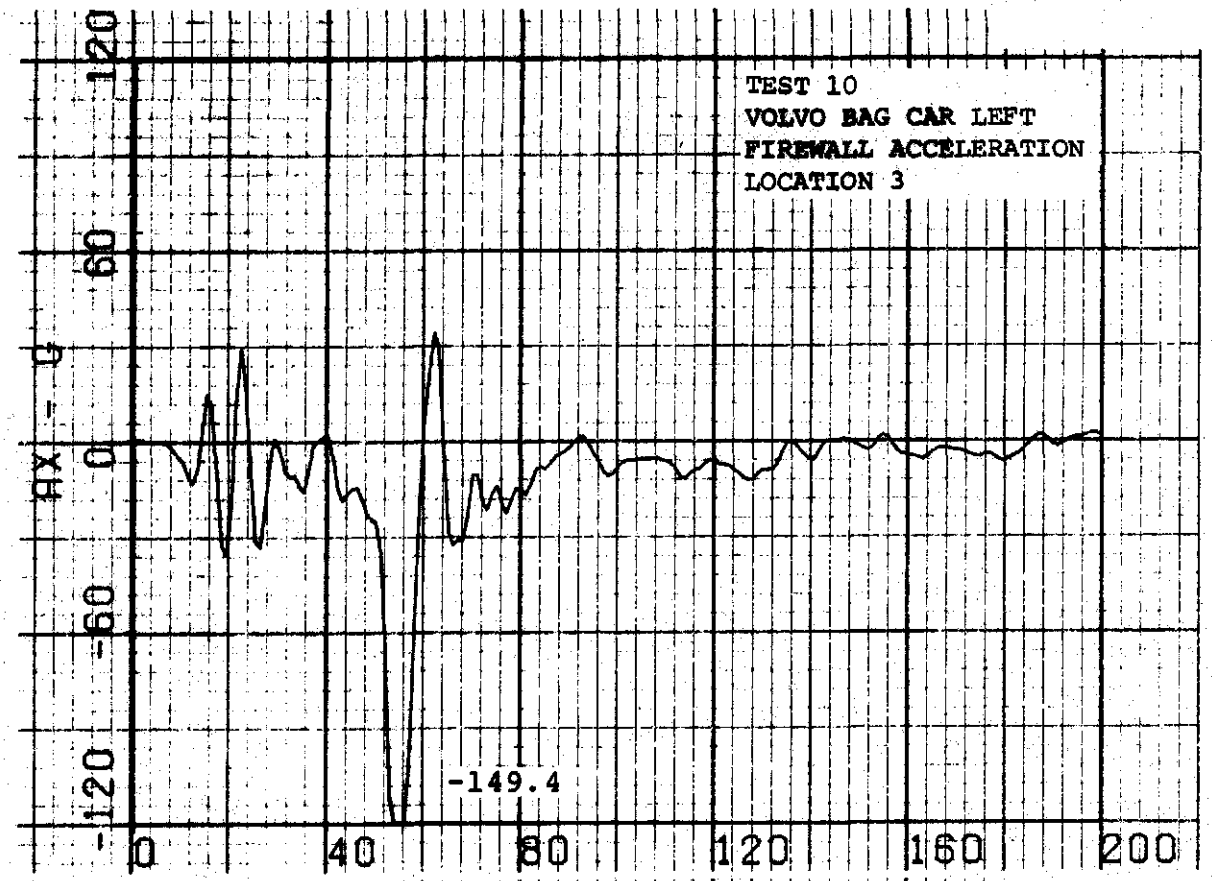

TEST 10
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
BAG PRESSURE
POUNDS/SQ INCH
24
16
8
0
-8
0
40
80
120
160
200
TIME - MSEC

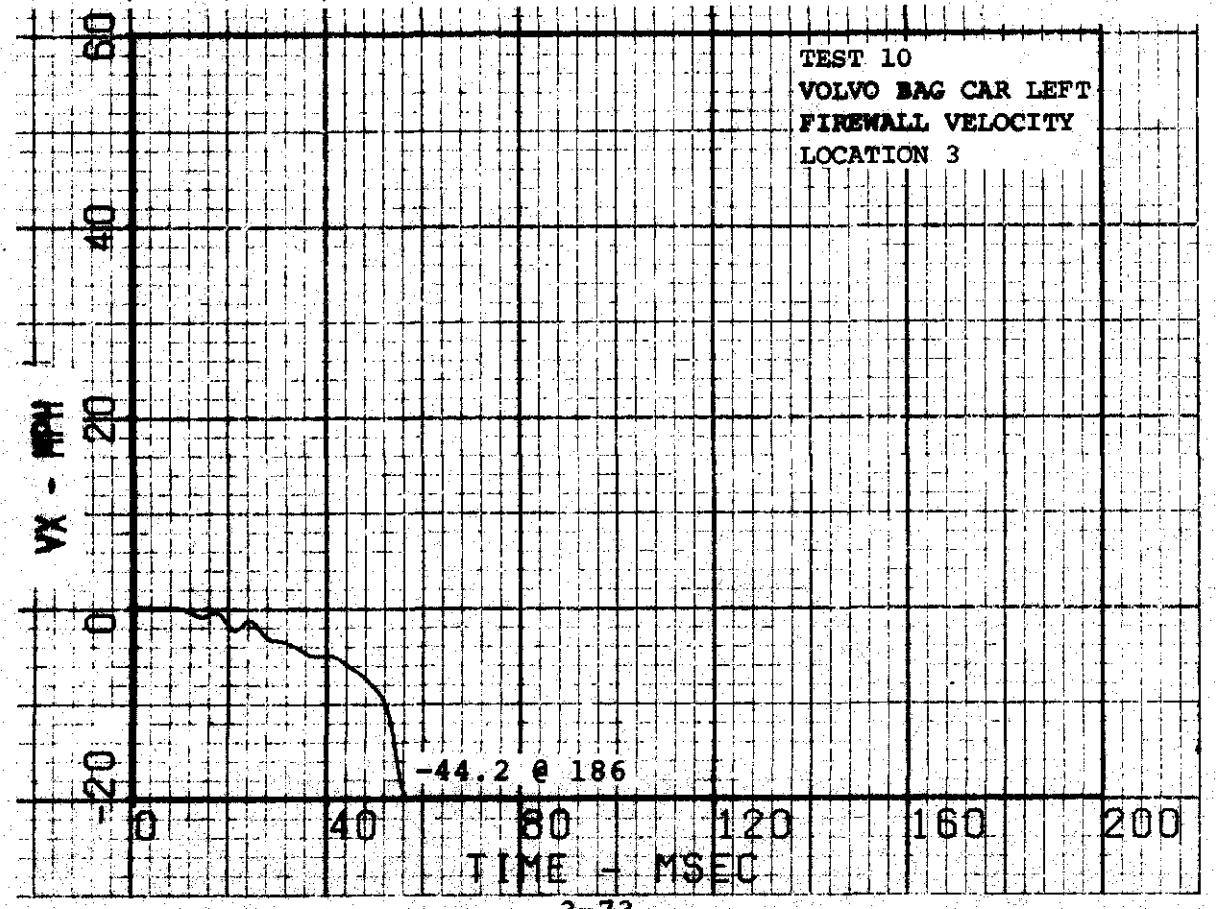

AX
AY
VOLVO
TEST 10
VOLVO BAG CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

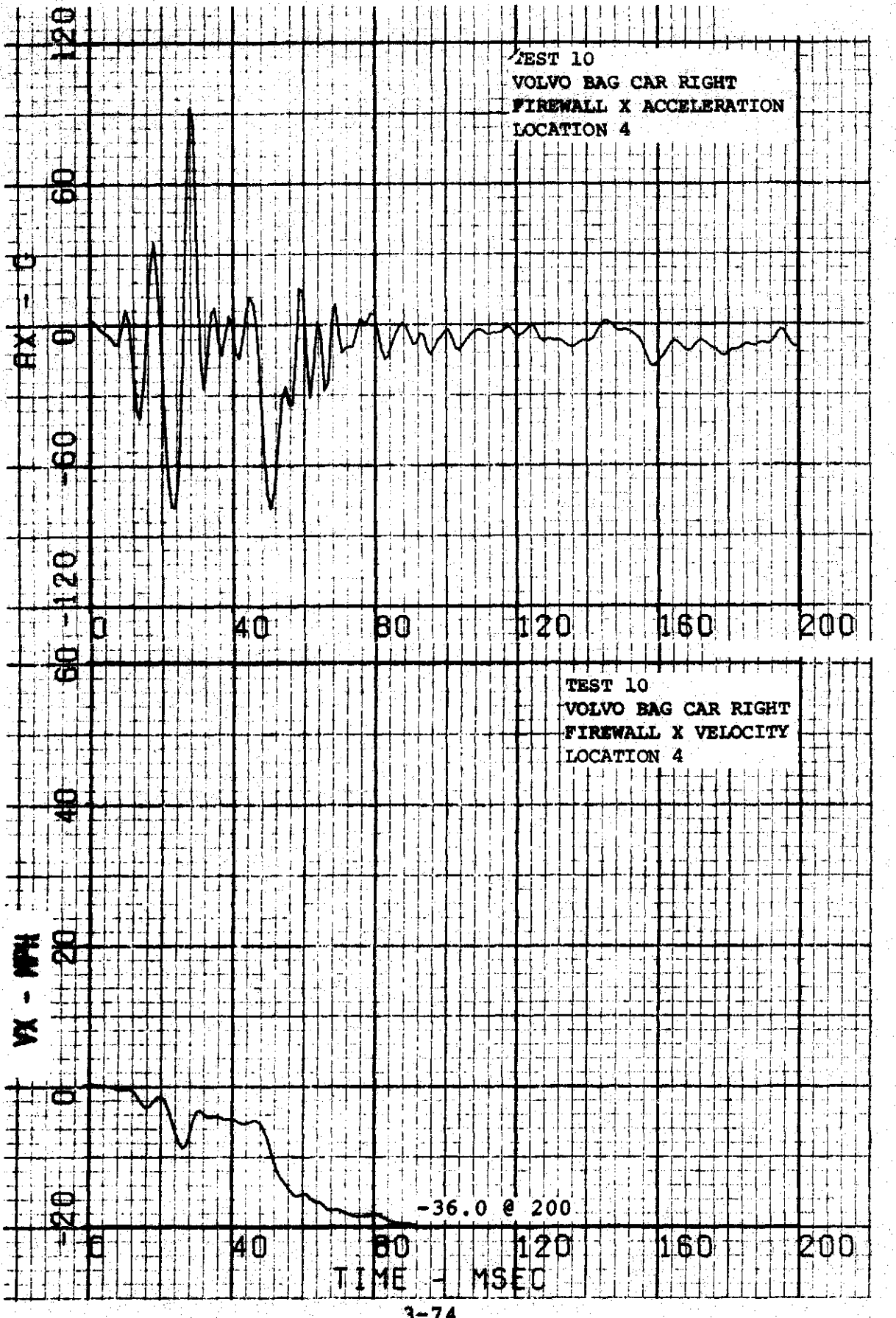

TEST 10
VOLVO BAG CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY - MPH
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

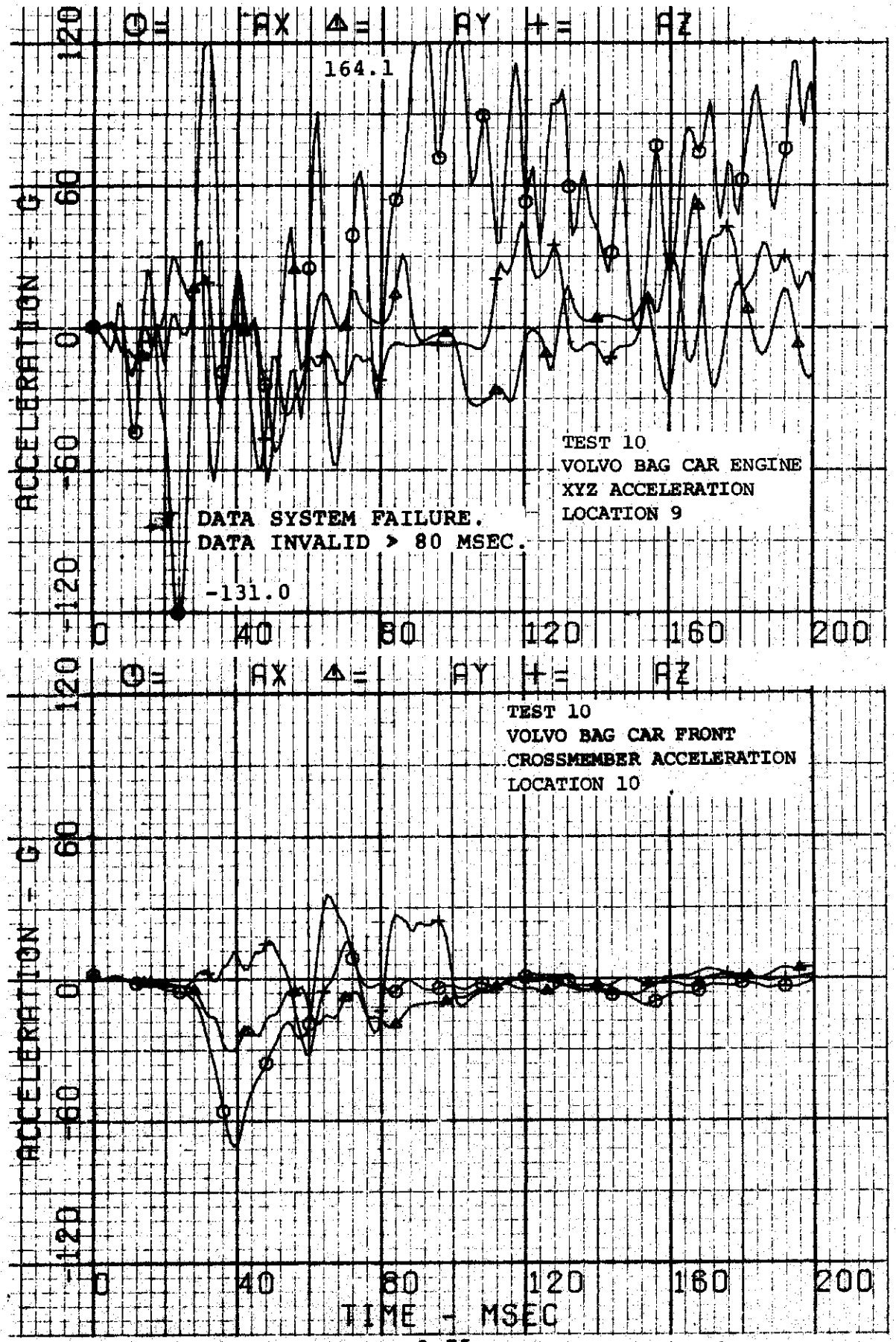

AX
AY
TEST 10
VOLVO BAG CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

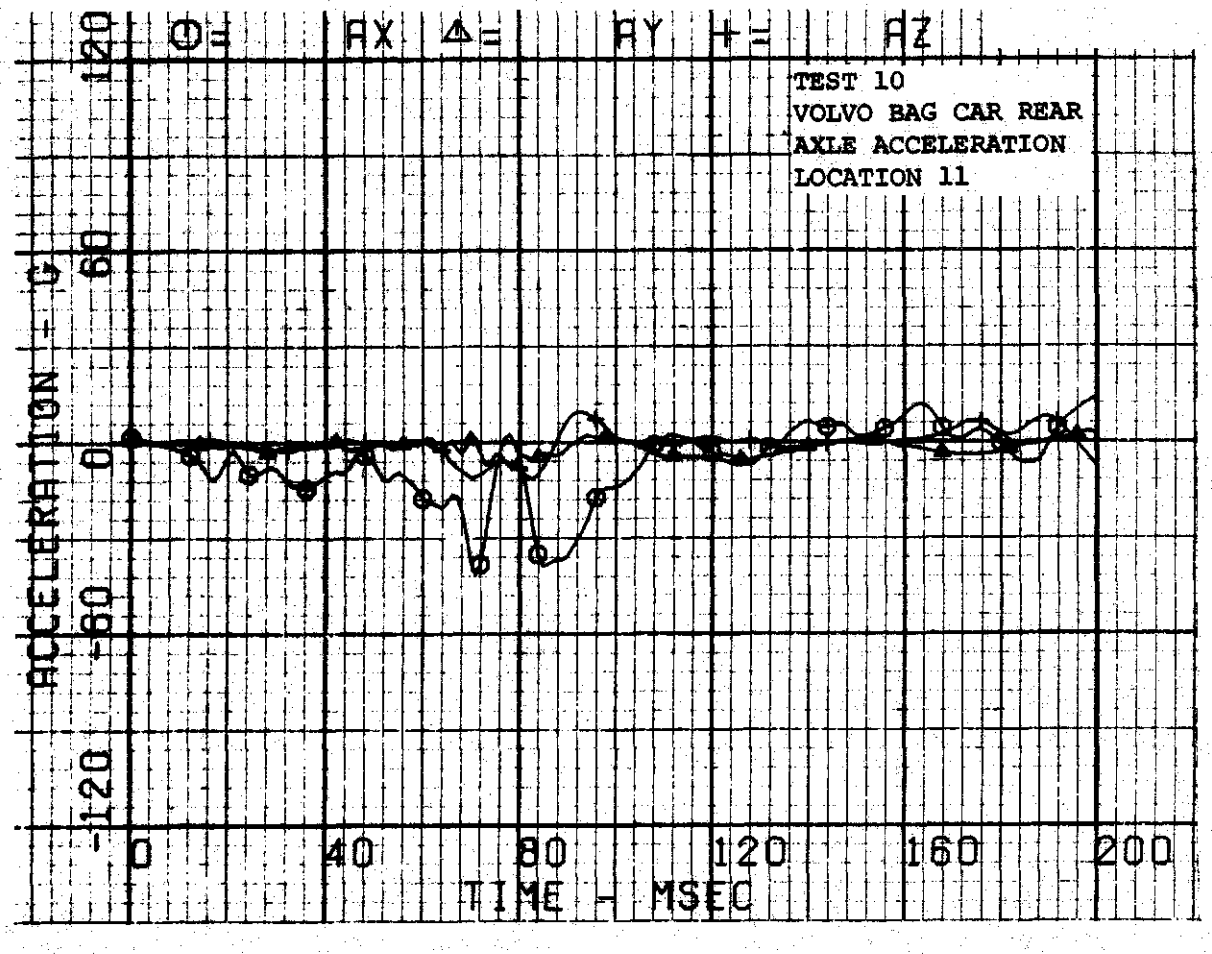

TEST 10
VOLVO BAG CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
MPH
VELOCITY
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

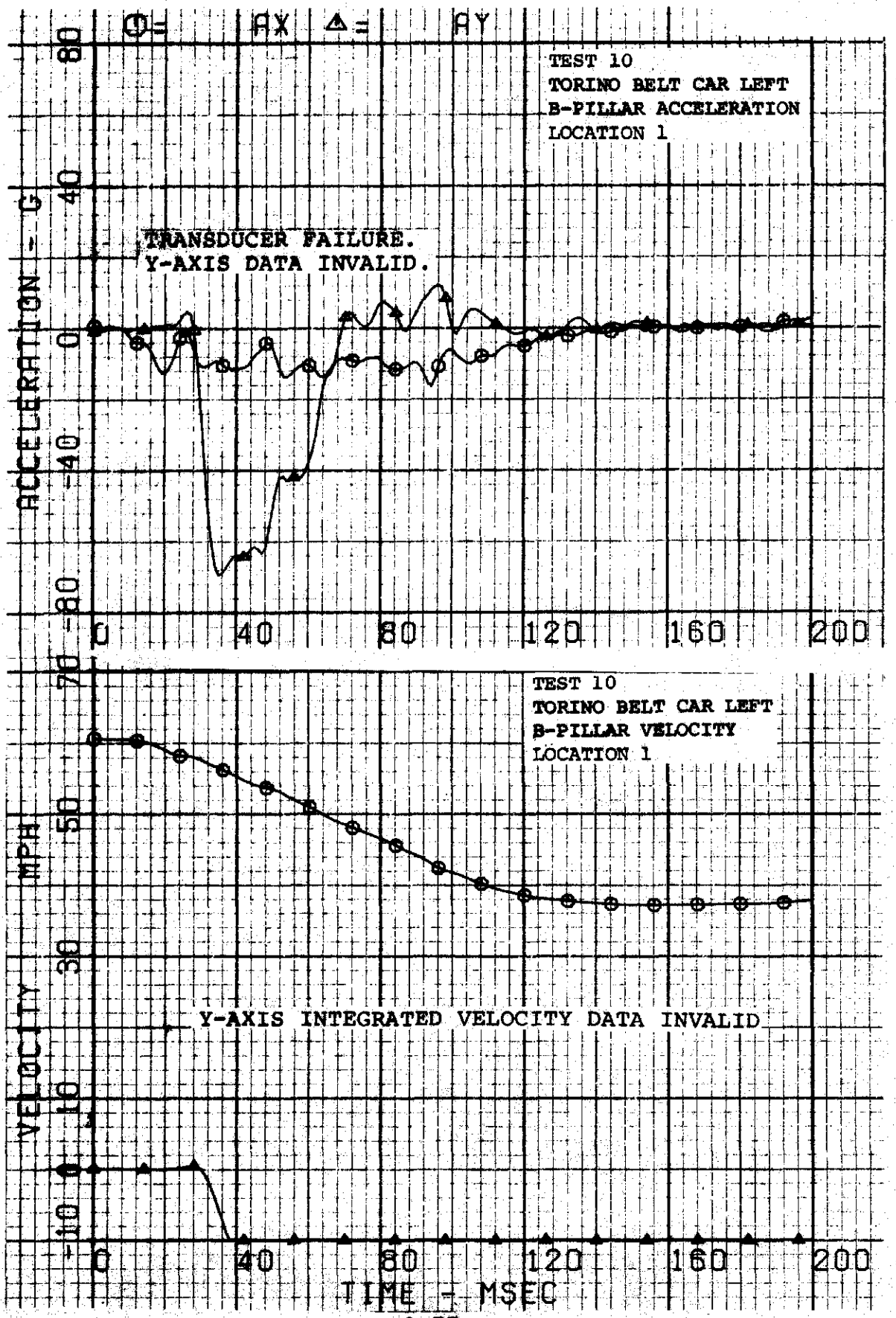

TEST 10
VOLVO BAG CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
-149.4
-120
-60
0
60
120
0
40
80
120
160
200

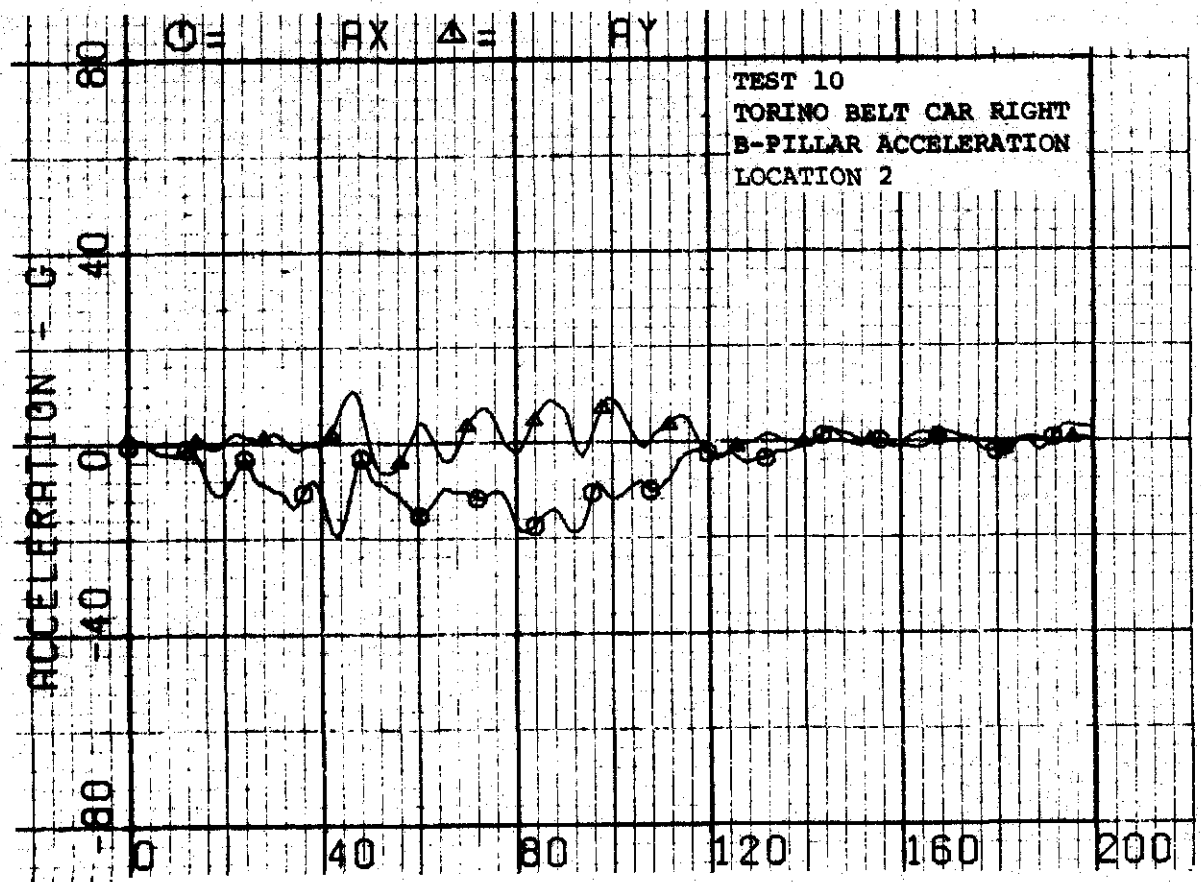

TEST 10
VOLVO BAG CAR LEFT
FIREWALL VELOCITY
LOCATION 3
-44.2 @ 186
-20
0
20
40
60
0
40
80
120
160
200
TIME - MSEC

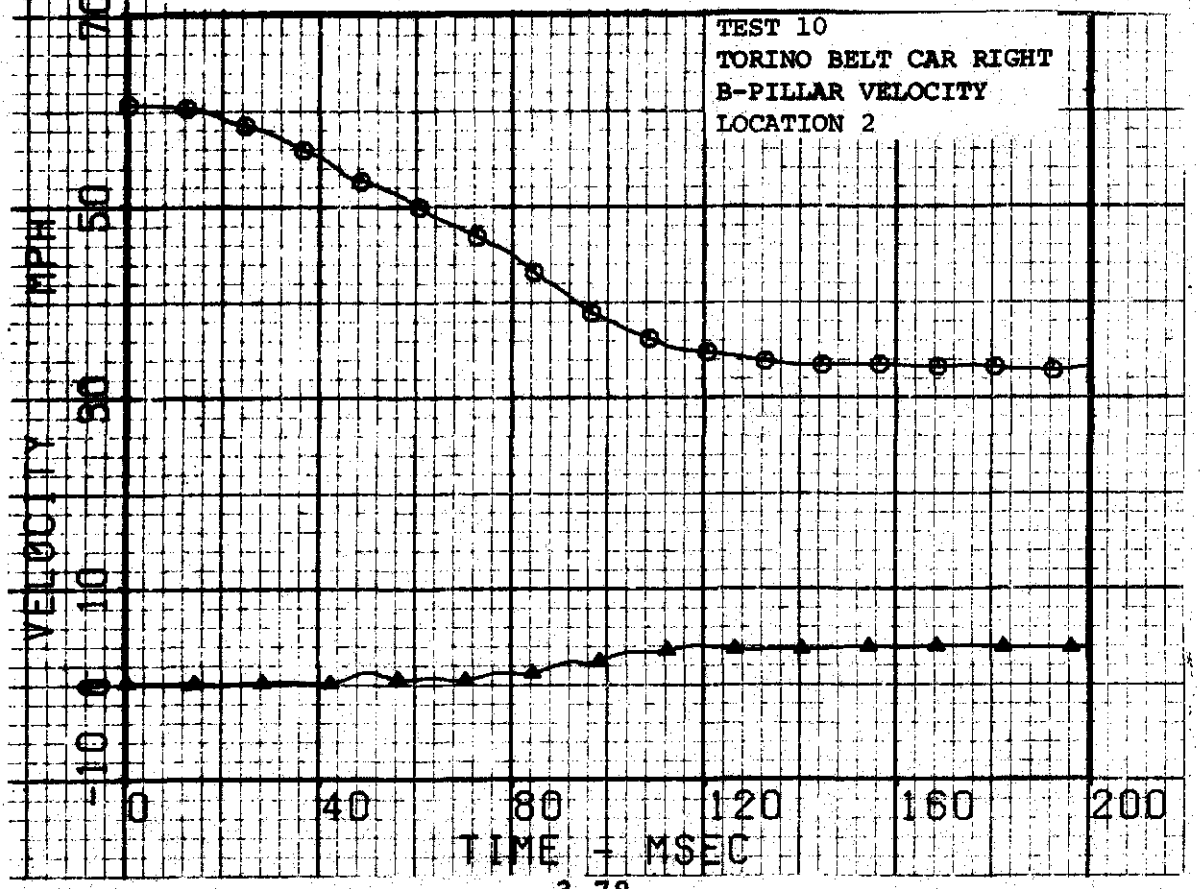

TEST 10
VOLVO BAG CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 10
VOLVO BAG CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
VX - MPH
40
20
0
-20
-36.0 @ 200
0
40
80
120
160
200
TIME - MSEC


○ = AX △ = AY + = AZ
164.1
-131.0
DATA SYSTEM FAILURE.
DATA INVALID > 80 MSEC.
TEST 10
VOLVO BAG CAR ENGINE
XYZ ACCELERATION
LOCATION 9
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
○ = AX △ = AY + = AZ
TEST 10
VOLVO BAG CAR FRONT
CROSSMEMBER ACCELERATION
LOCATION 10
ACCELERATION - G
TIME - MSEC


AX
AY
AZ
TEST 10
VOLVO BAG CAR REAR
AXLE ACCELERATION
LOCATION 11
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


□= AX △= AY
TEST 10
TORINO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
TRANSDUCER FAILURE.
Y-AXIS DATA INVALID.
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 10
TORINO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
Y-AXIS INTEGRATED VELOCITY DATA INVALID
VELOCITY - MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC


Θ = AX Δ = AY
TEST 10
TORINO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 10
TORINO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC

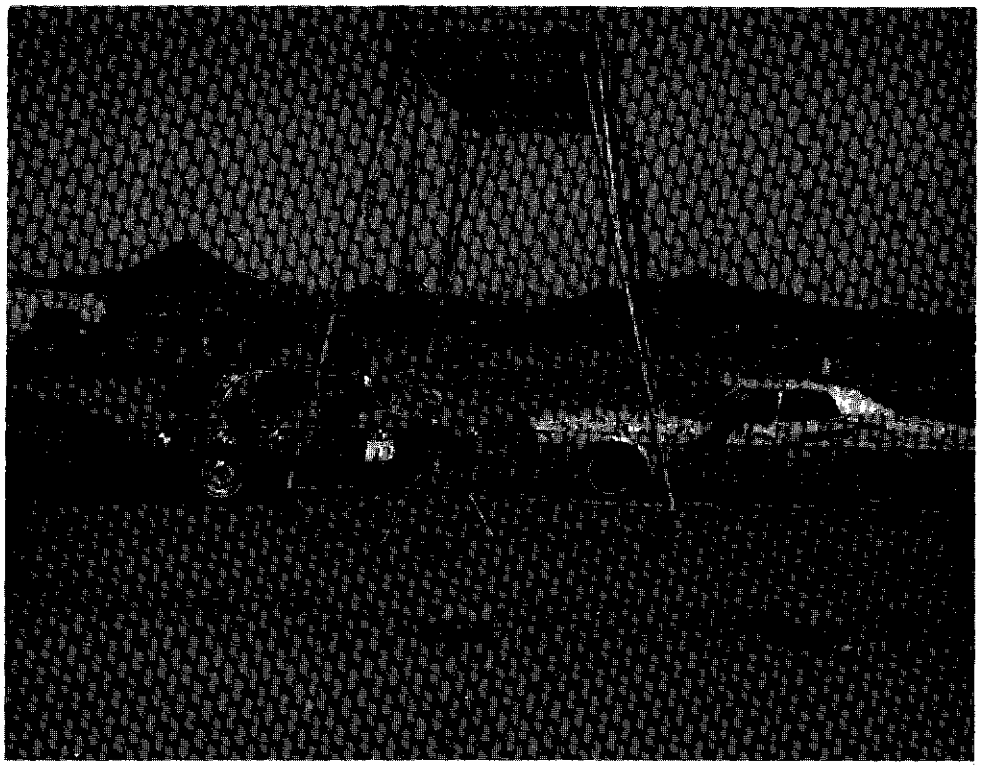


Figure 3-16. Pre-test Vehicle Configuration - Test 10.

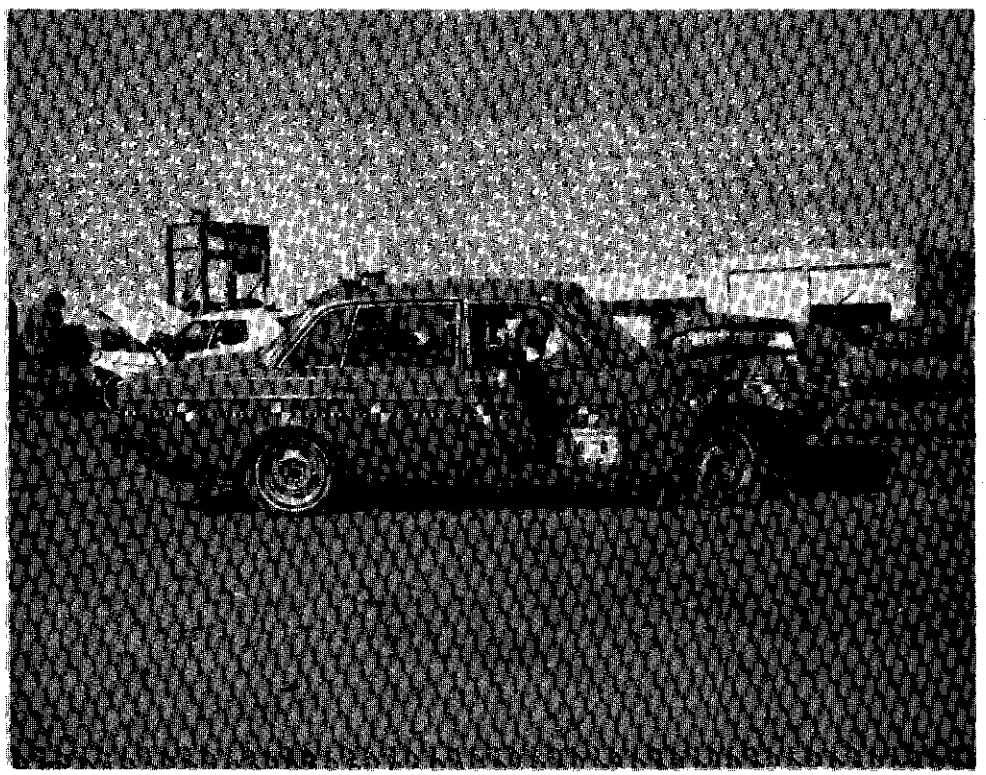


Figure 3-17. Post-test Vehicle Configuration - Test 10.

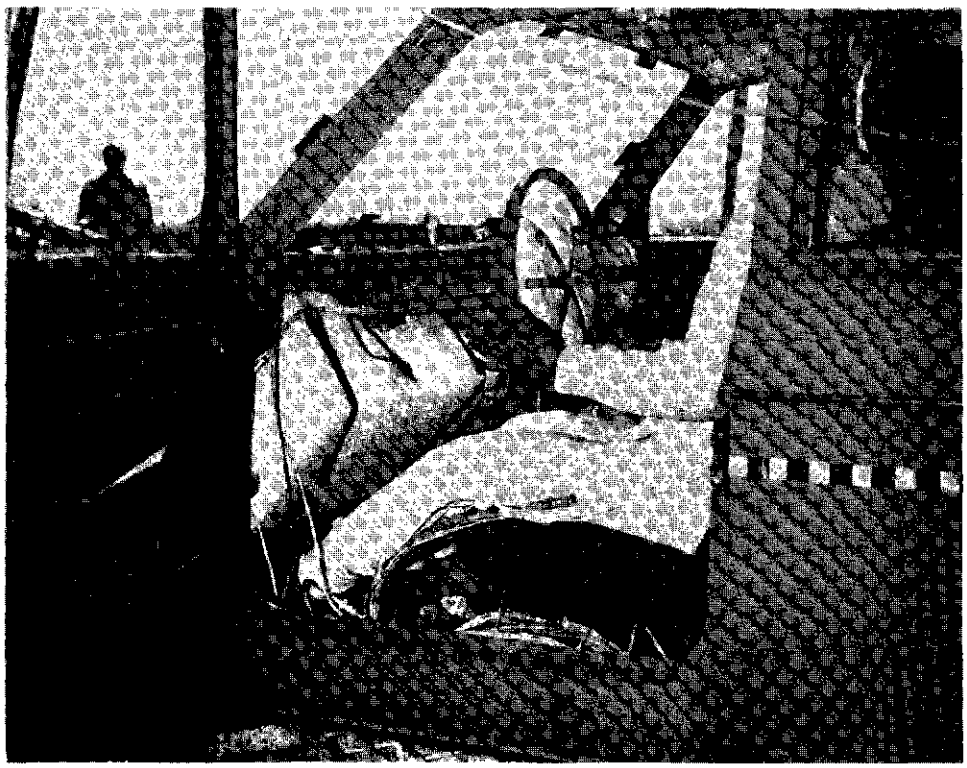


Figure 3-18. Pre-test RSV Driver Airbag - Test 10.

Figure 3-19. Post-test RSV Driver Airbag - Test 10.

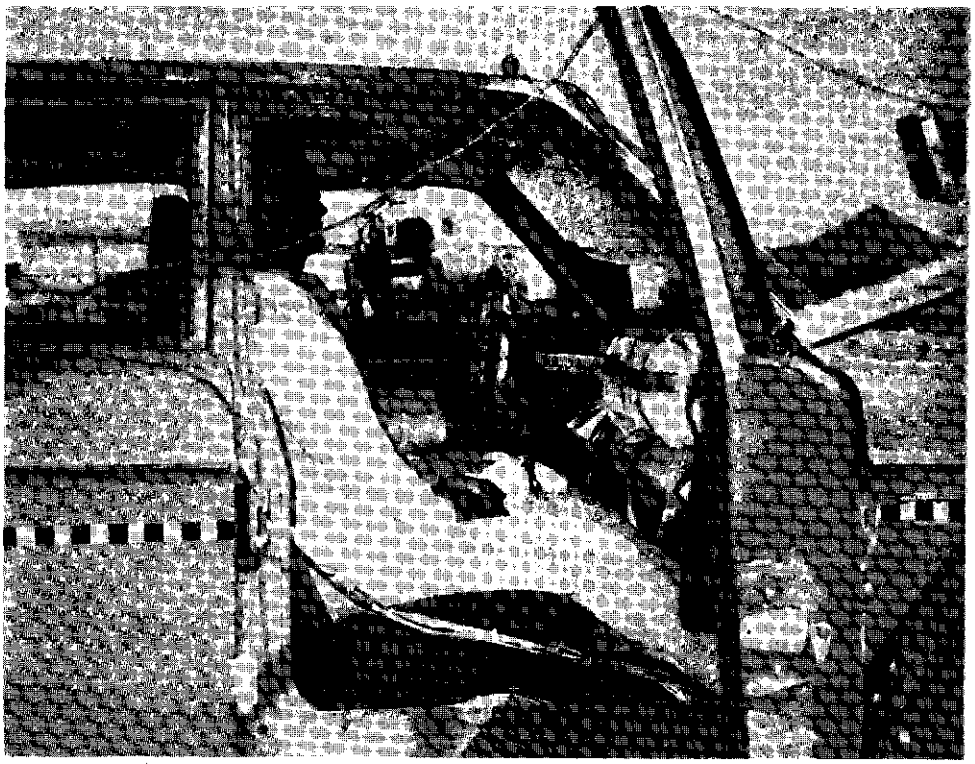


Figure 3-20. Pre-test RSV Passenger Airbag - Test 10.

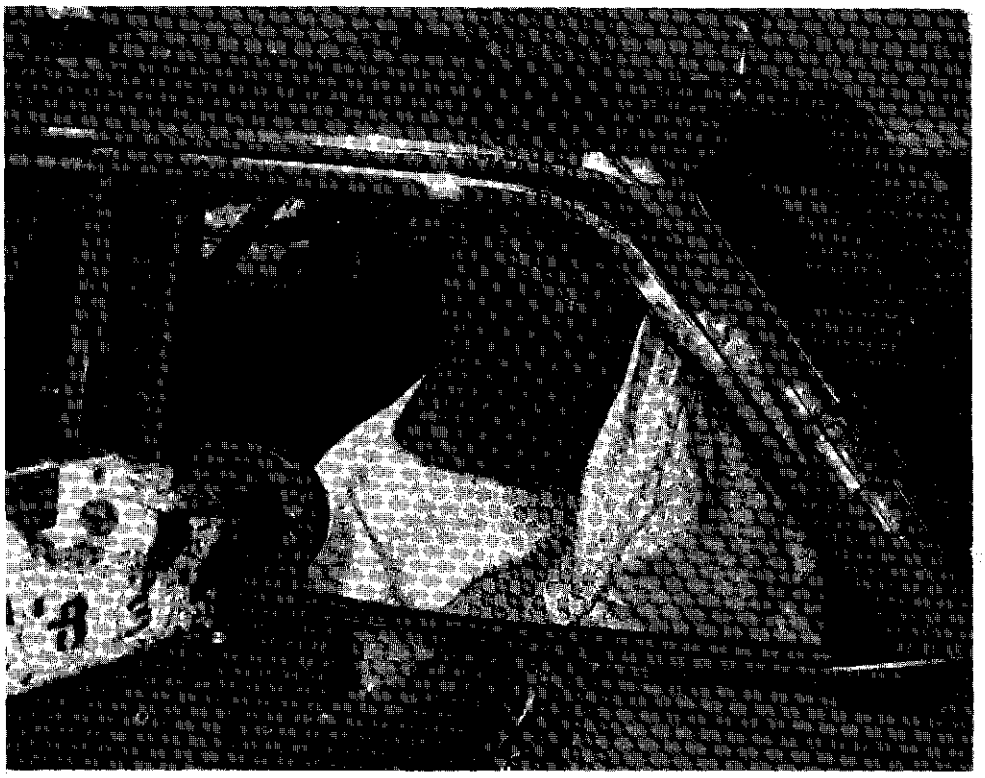


Figure 3-21. Post-test RSV Passenger Airbag - Test 10.

3.4 TEST NUMBER 11

The impact conditions for Test 11 were:

Configuration	Closing Speed
Torino-to-Volvo Left Oblique (30°)*	59.5 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Standard 3-Point Belt with Web Lockers	Force Limited Airbelt
Right Front	Standard 3-Point Belt with Web Lockers	Force Limited 2-Inch Belt

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity. The extent of these modifications is shown in Figure 1-2. The dash padding was reinstalled over the steel tubes in its original position.

The results of Test 11 are summarized in the following tables:

Table 3-13 - Summary of Vehicle Data (Test 11)

Table 3-14 - Injury Criteria Summary (Test 11)

Table 3-15 - Summary of Restraint System Data (Test 11)

Table 3-16 - Occupant Response Data (Test 11)

which are followed by Figure 3-22 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

*Major resultant acceleration vector 30° to centerline of target vehicle.

TABLE 3-13. SUMMARY OF VEHICLE DATA (TEST 11)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 11/March 11, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		486	428
TEST WEIGHT (lb)		4698	3214
IMPACT VELOCITY (mph)		59.5	0
VELOCITY CHANGE (mph)		26.7	35.1 (1)
PEAK RESULTANT ACCELERATION (G @ msec)			
	LOCATION 1	25.9 @ 103	41.0 @ 65
	LOCATION 2	23.1 @ 194	41.8 @ 76
MAXIMUM STATIC CRUSH (in.)			
	LEFT	11.0	49.0
	CENTER	27.0	21.5
	RIGHT	18.0	9.0

(1) Velocity change found by using average of resultant velocity vector (V_R) data for compartment accelerometer locations.

TABLE 3-14. INJURY CRITERIA SUMMARY (TEST 11)

VEHICLE B - BELT CAR (VOLVO)				
	FORCE LIMITED AIRBELT		FORCE LIMITED 2-INCH BELT	
HIC	247		236	
HEAD G(1) @ msec	34.9 @ 94		33.7 @ 123	
CSI	225 @ 200		166 @ 200	
CHEST G(1) @ msec	33.5 @ 114		29.6 @ 76	
FEMUR LOAD (lb)	LEFT 325	RIGHT 138	LEFT 656	RIGHT 972

(1) 3 msec clip.

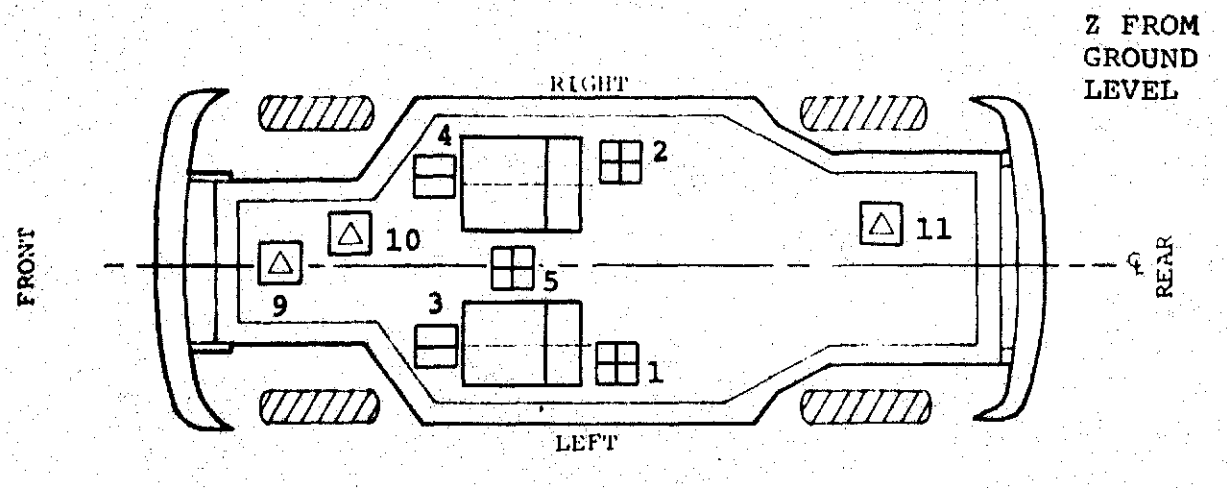
TABLE 3-15. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 11)

VEHICLE B - BELT CAR (VOLVO)		
FORCE LIMITED AIRBELT		
Peak Airbelt Pressure	psi @ msec	22.9 @ 62
Peak Lap Belt Load	lb @ msec	1780 @ 112
FORCE LIMITED 2-INCH BELT		
Peak Shoulder Belt Load	lb @ msec	1556 @ 77
Peak Lap Belt Load	lb @ msec	1429 @ 85

TABLE 3-16. OCCUPANT RESPONSE DATA SUMMARY (TEST 11)

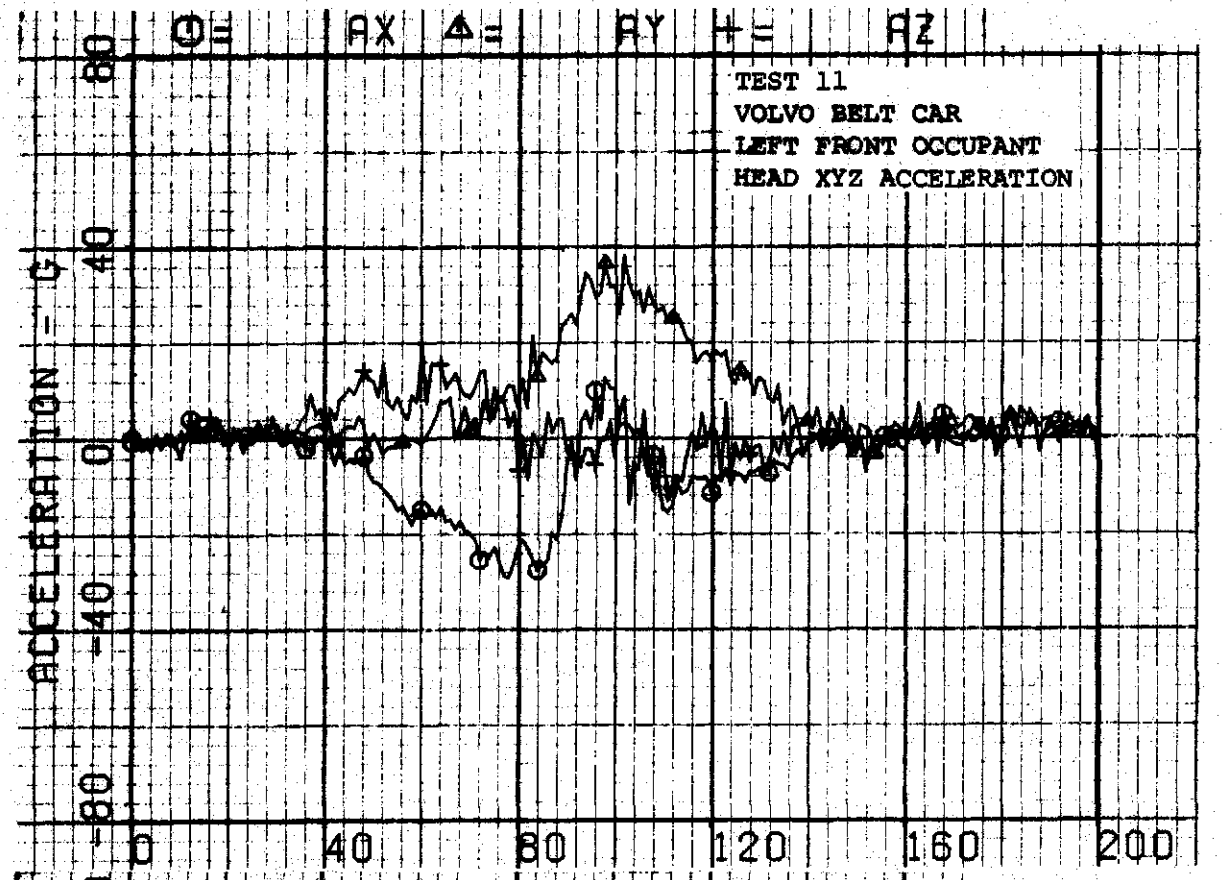
		VEHICLE B - BELT CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD					
	X	29.3	78	19.1	74
	Y	38.1	102	21.7	143
	Z	19.4	60	33.4	121
	R(1)	34.9	94	33.7	123
	HIC	247 @ 51-128		236 @ 72-166	
CHEST					
	X	24.3	52	31.4	78
	Y	29.4	113	13.1	130
	Z	20.1	93	12.0	108
	R(1)	33.5	114	29.6	76
	SI	225 @ 200		166 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS					
	LF	325	102	656	78
	RT	138	165	972	69

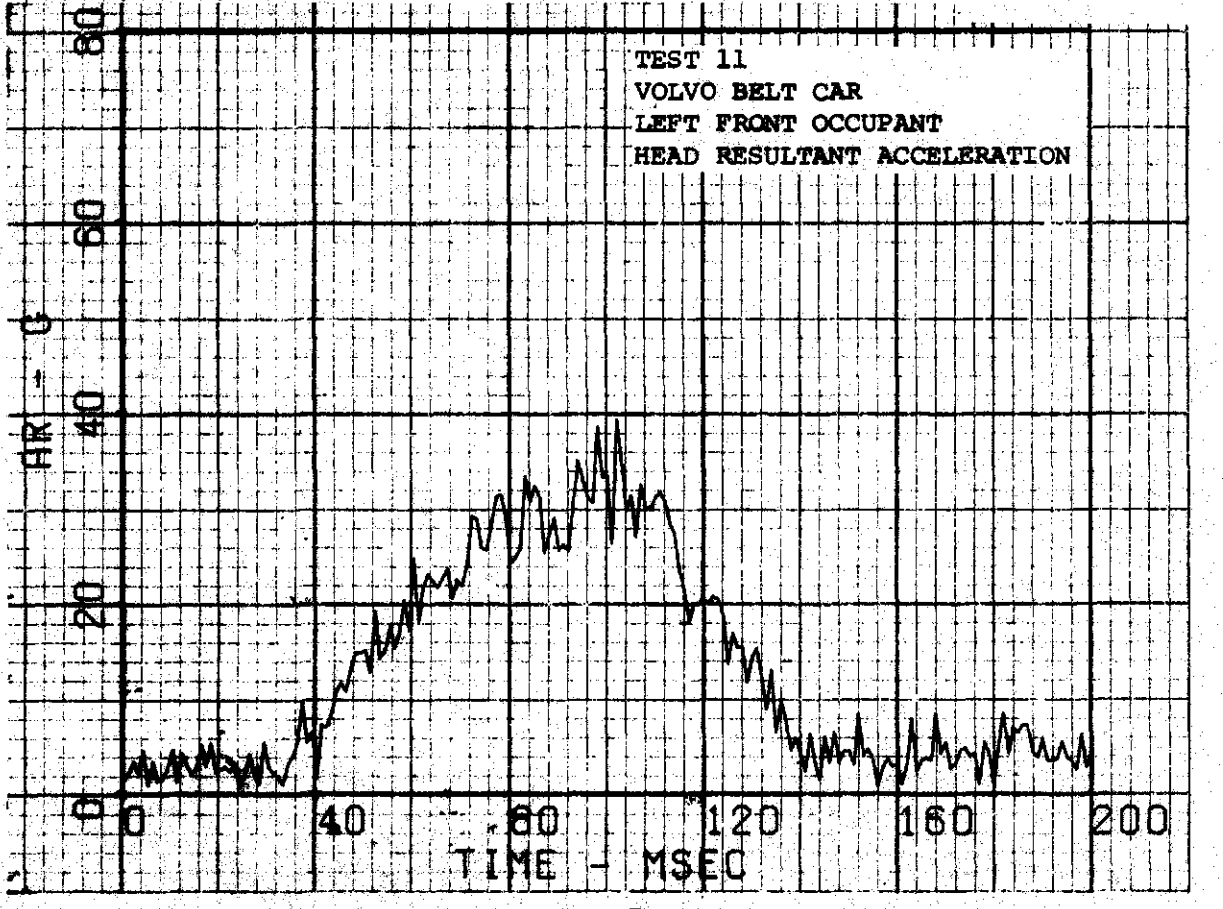
(1) 3 msec clip, components not clipped.

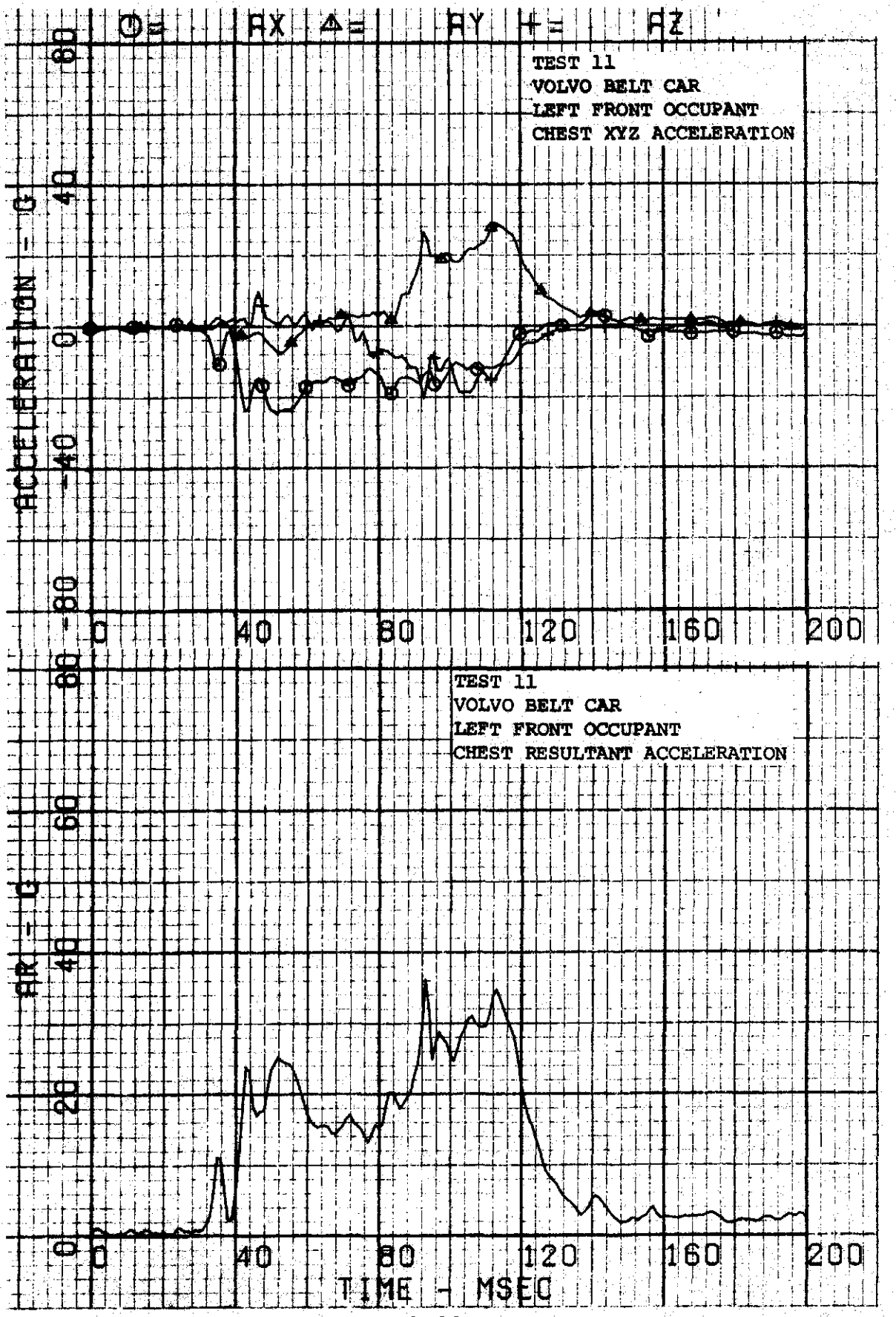


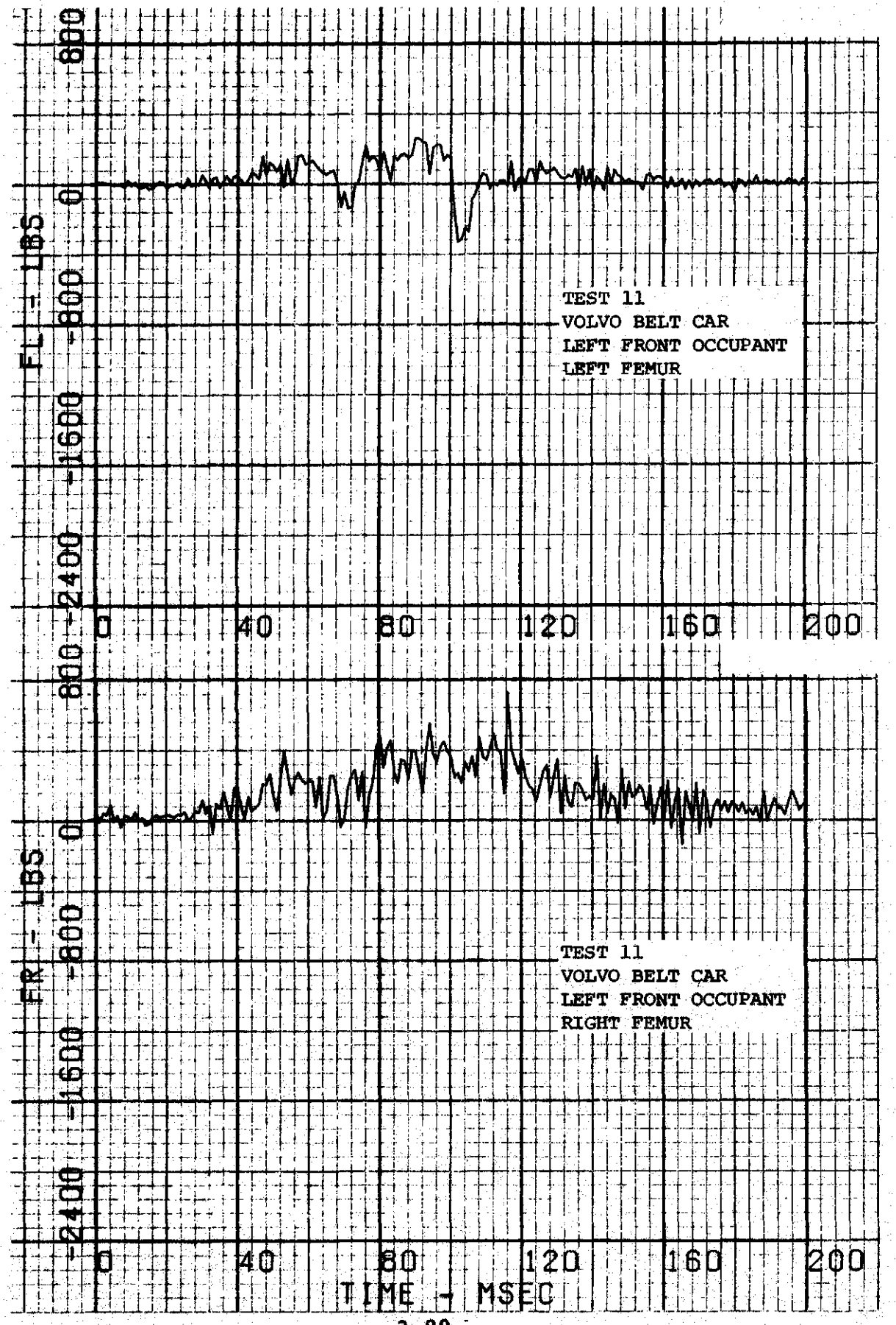
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
5	Drive Tunnel	X	X	
9	Engine Block	X	X	X
10	Front Crossmember	X	X	X
11	Rear Axle	X	X	X

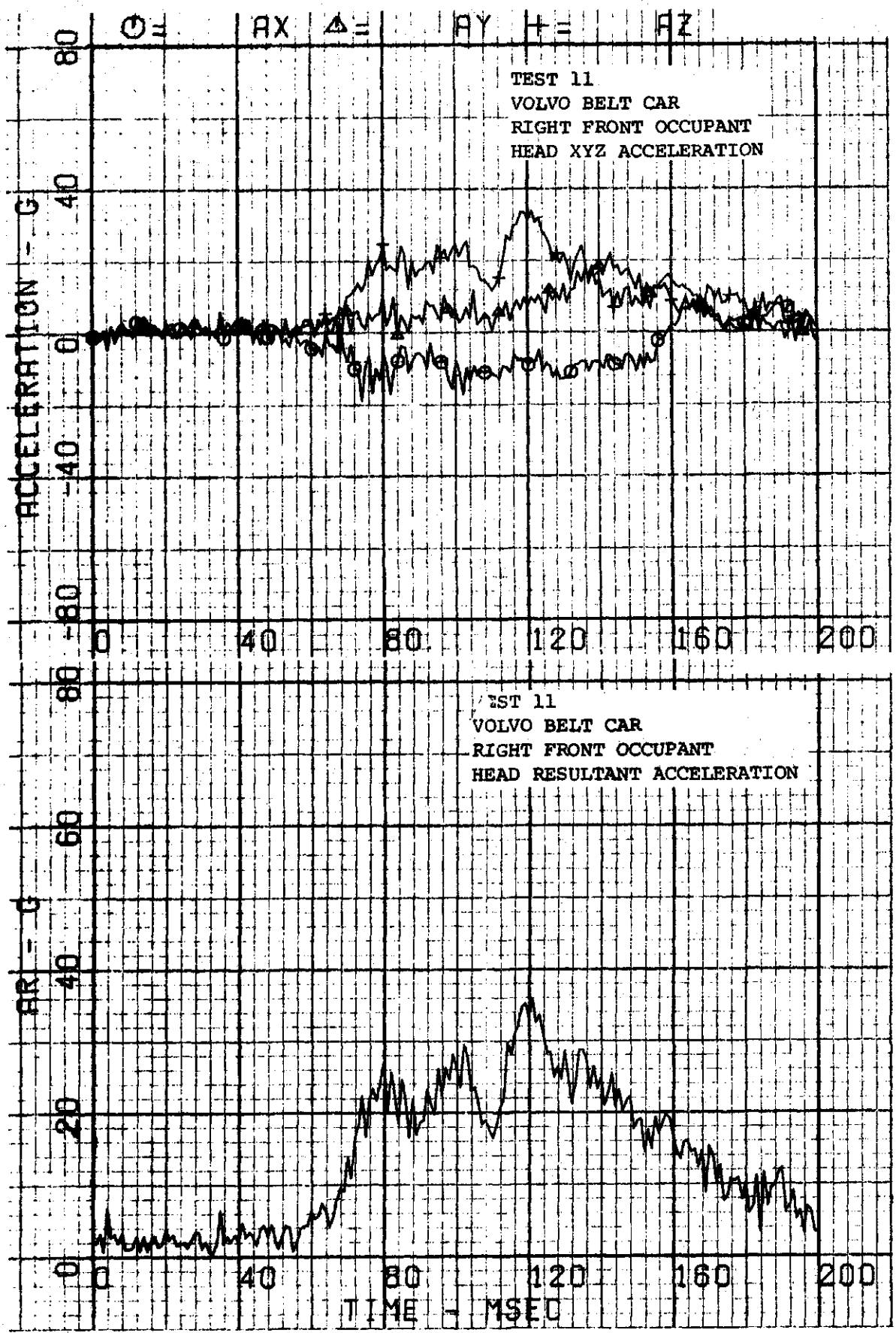
Figure 3-22. Vehicle Accelerometer Locations - Test 11.

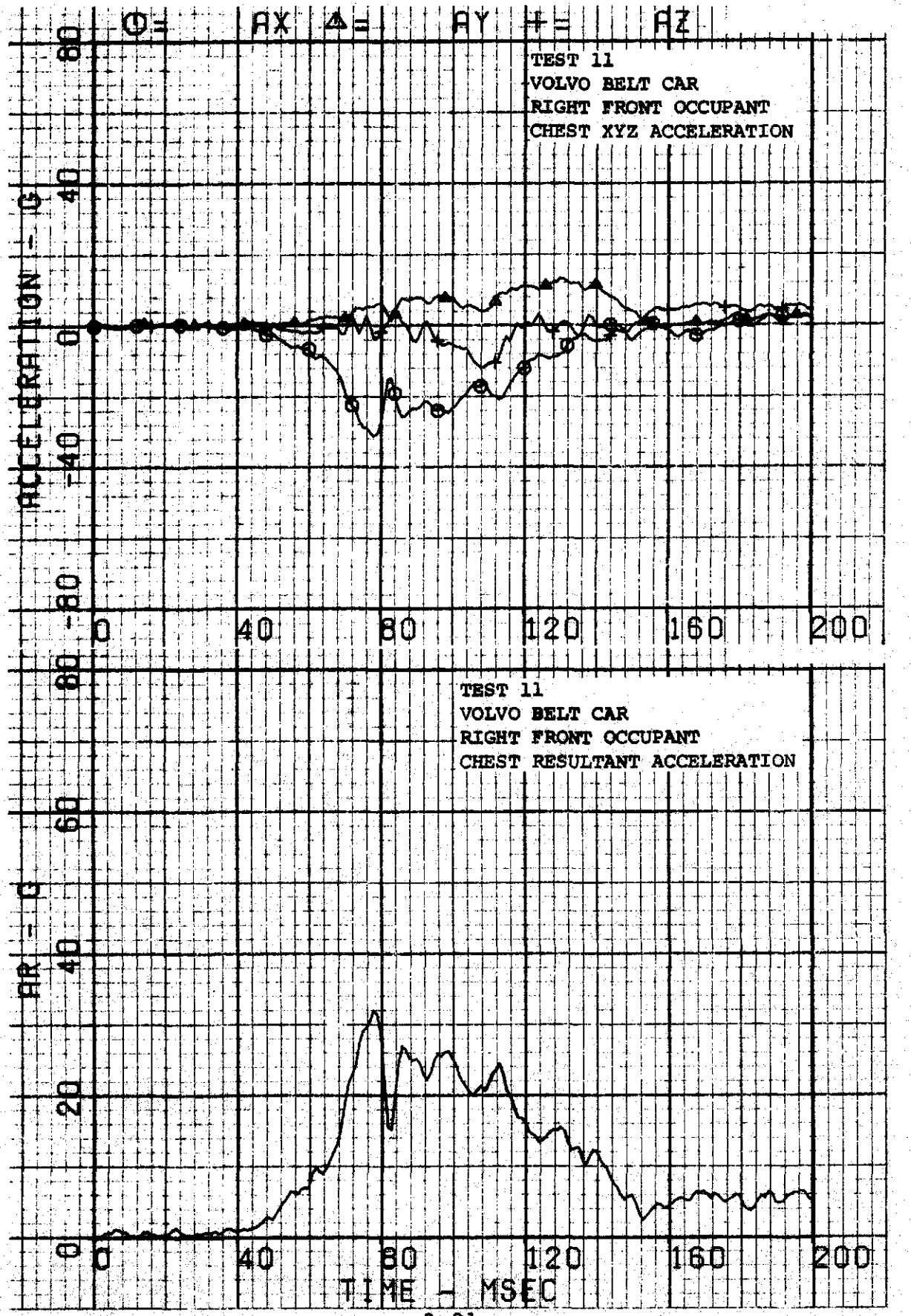

O = AX Δ = AY + = AZ
TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

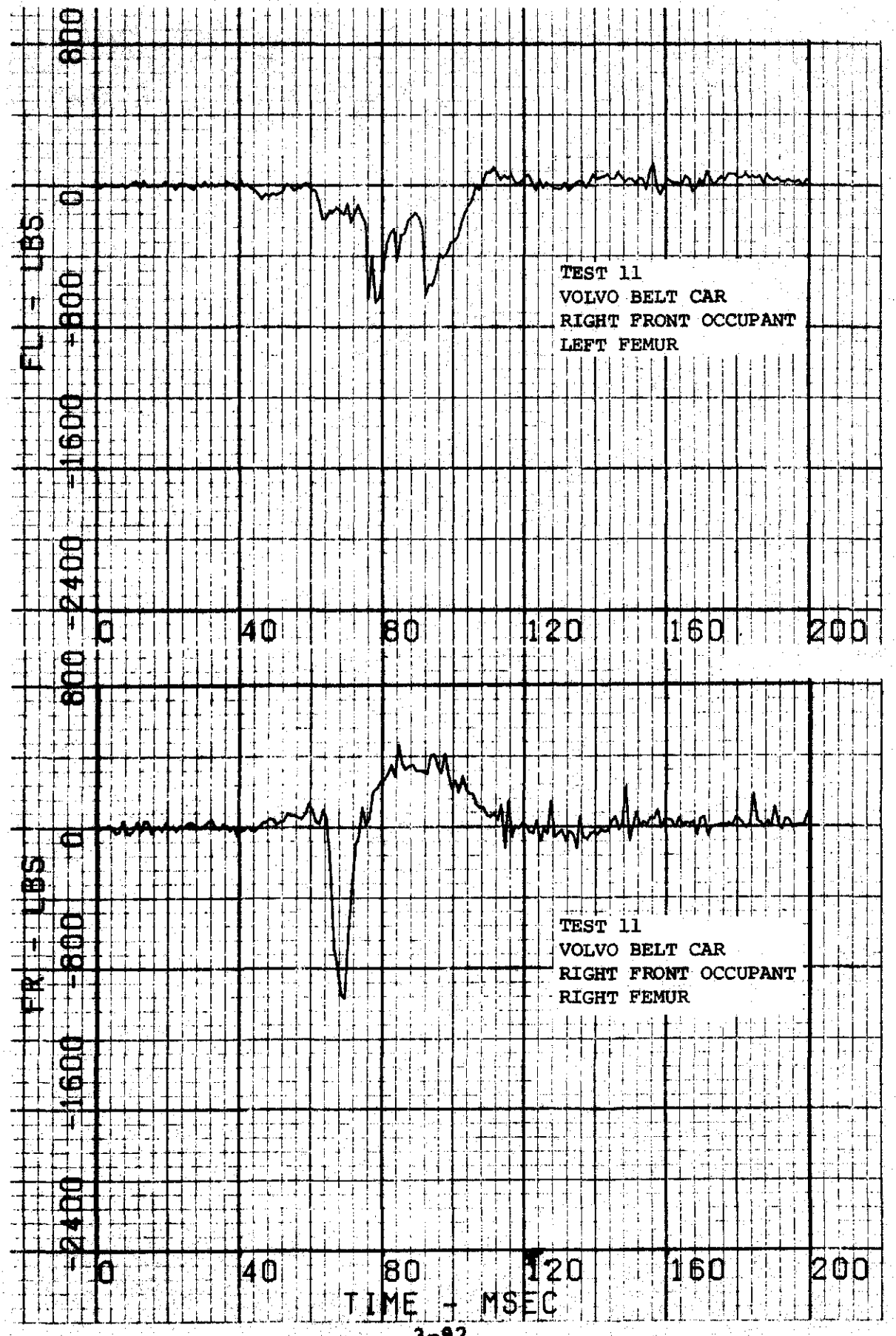

TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

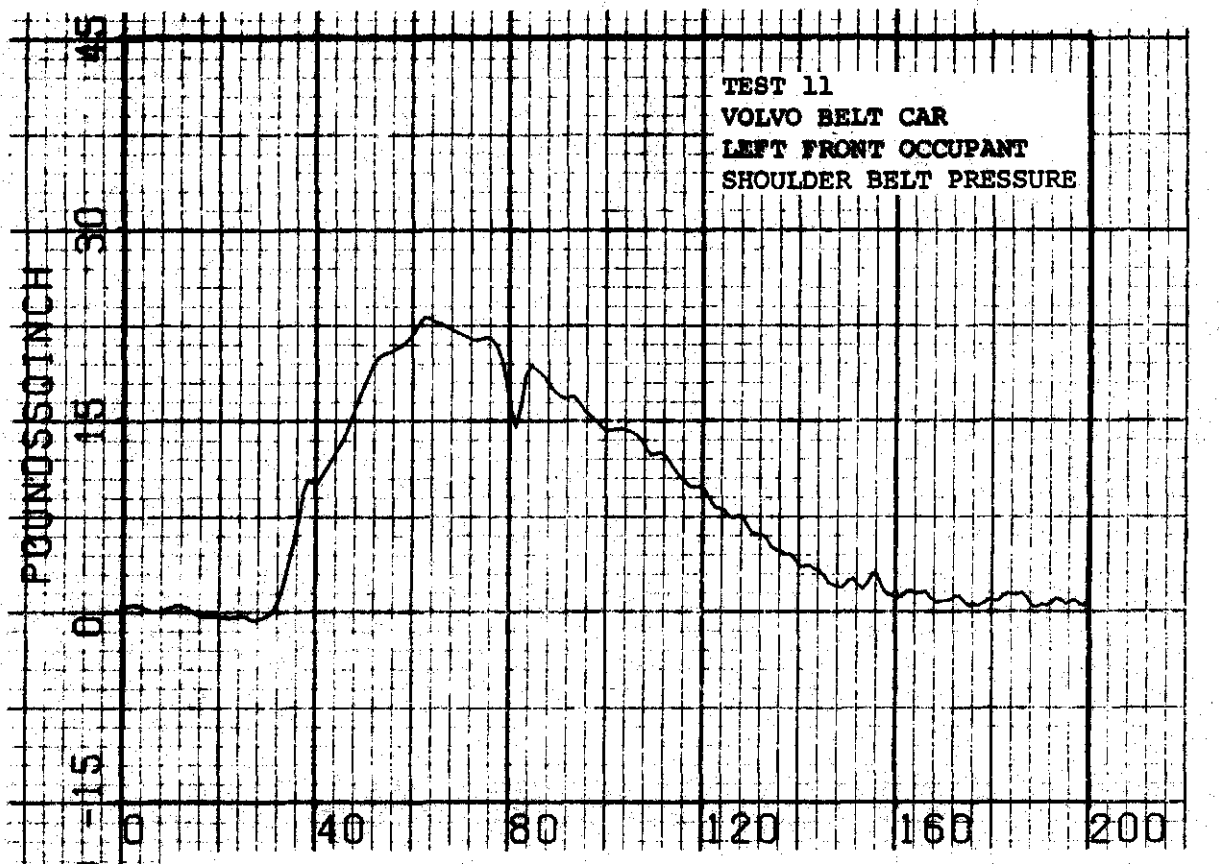

○ = AX △ = AY + = AZ
TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
TIME - MSEC

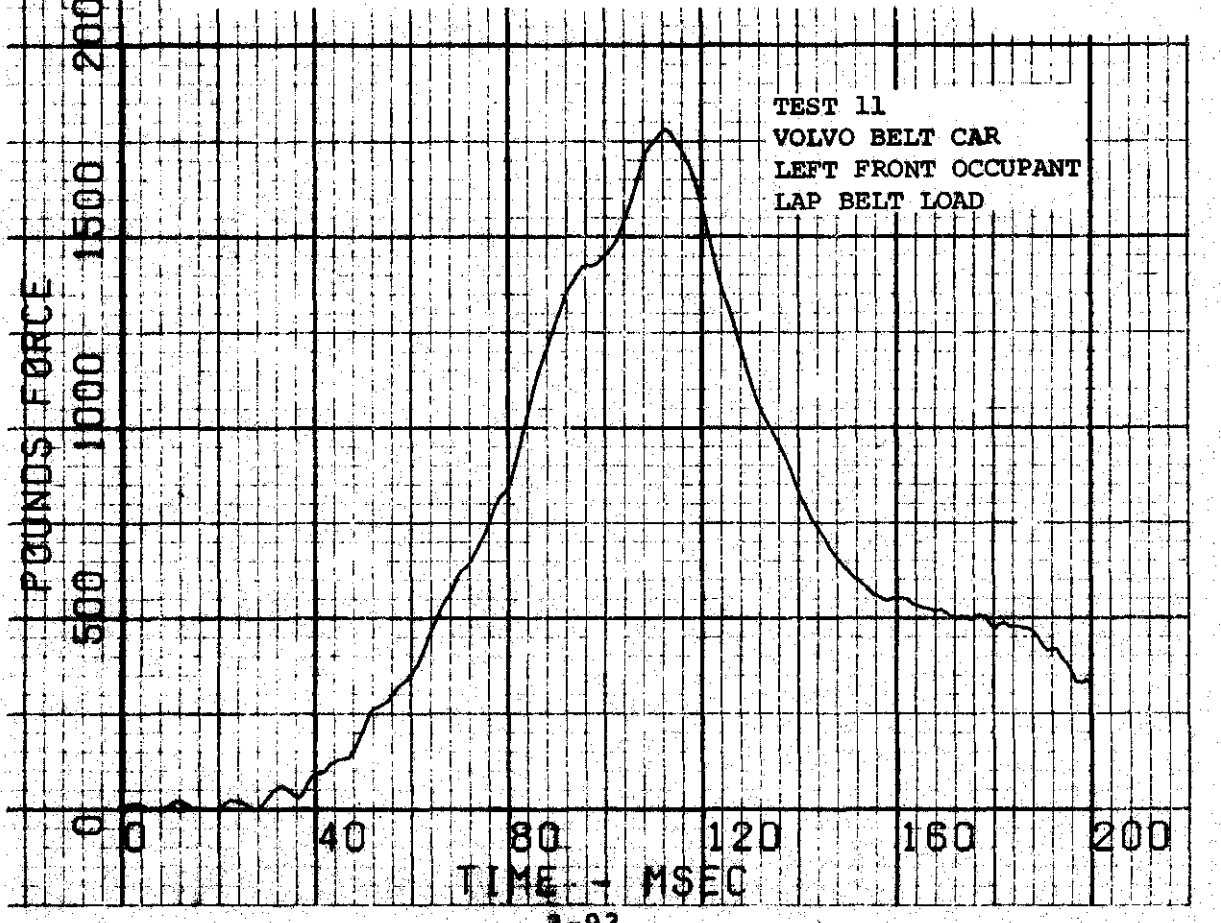

FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
LEFT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC
TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR

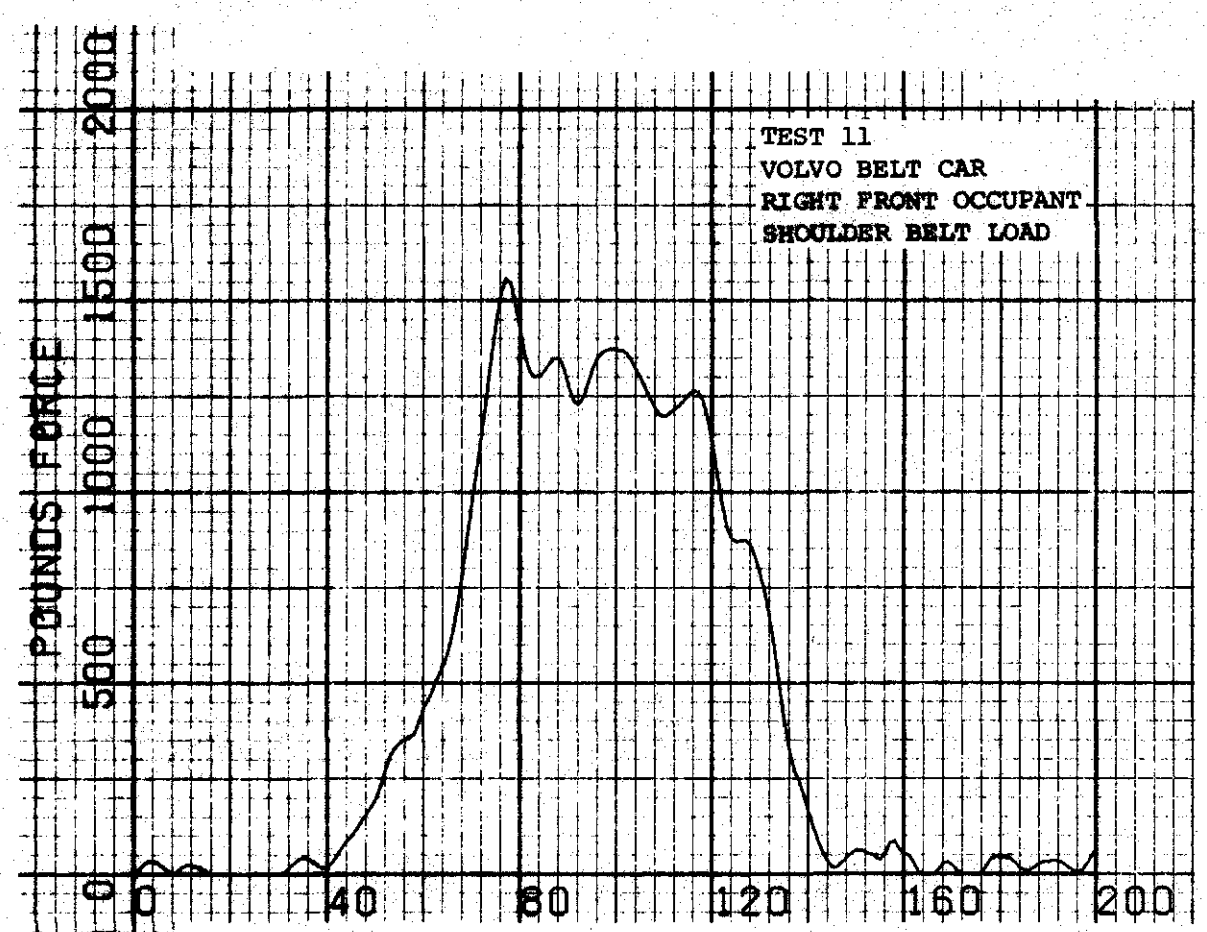

AX
AY
AZ
TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
TIME - MSEC

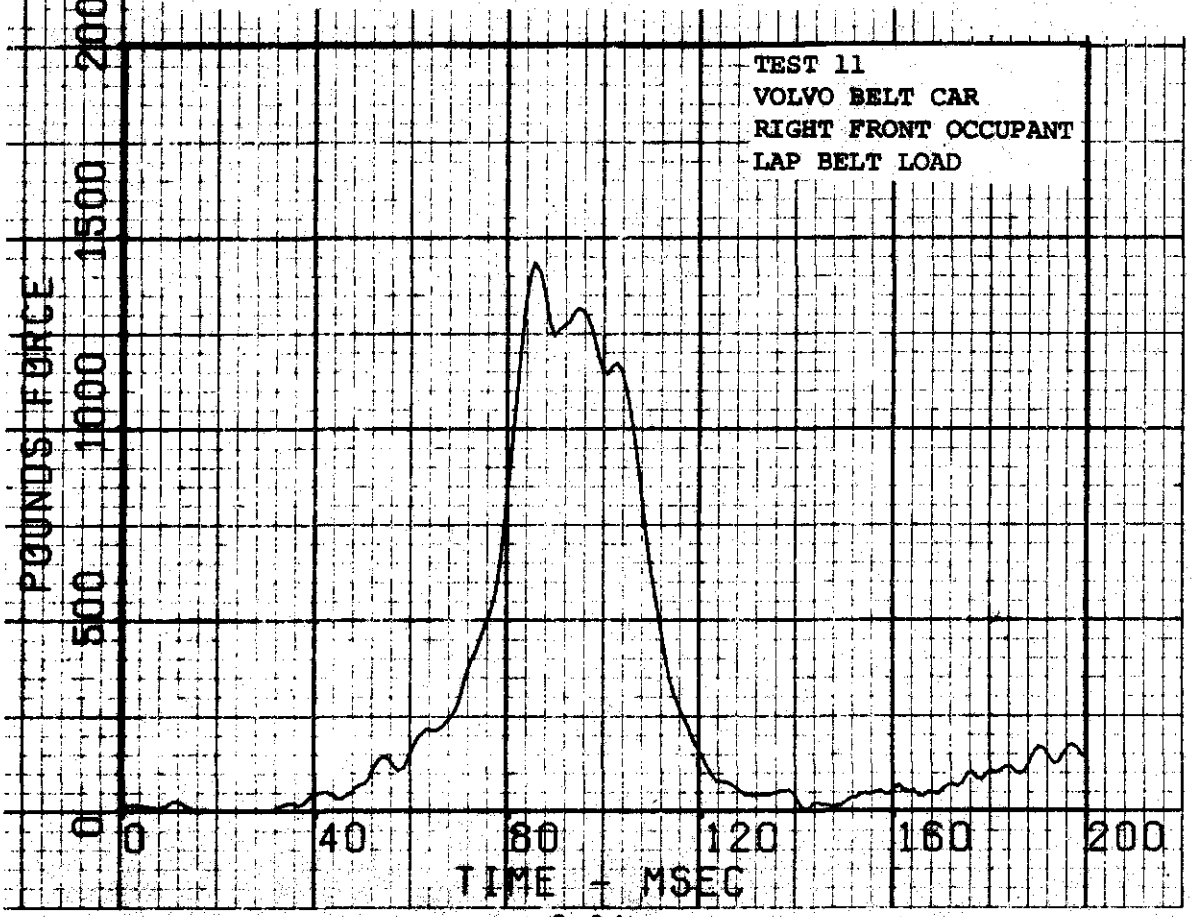

O= AX Δ= AY + = AZ
TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
60
40
20
0
TIME - MSEC

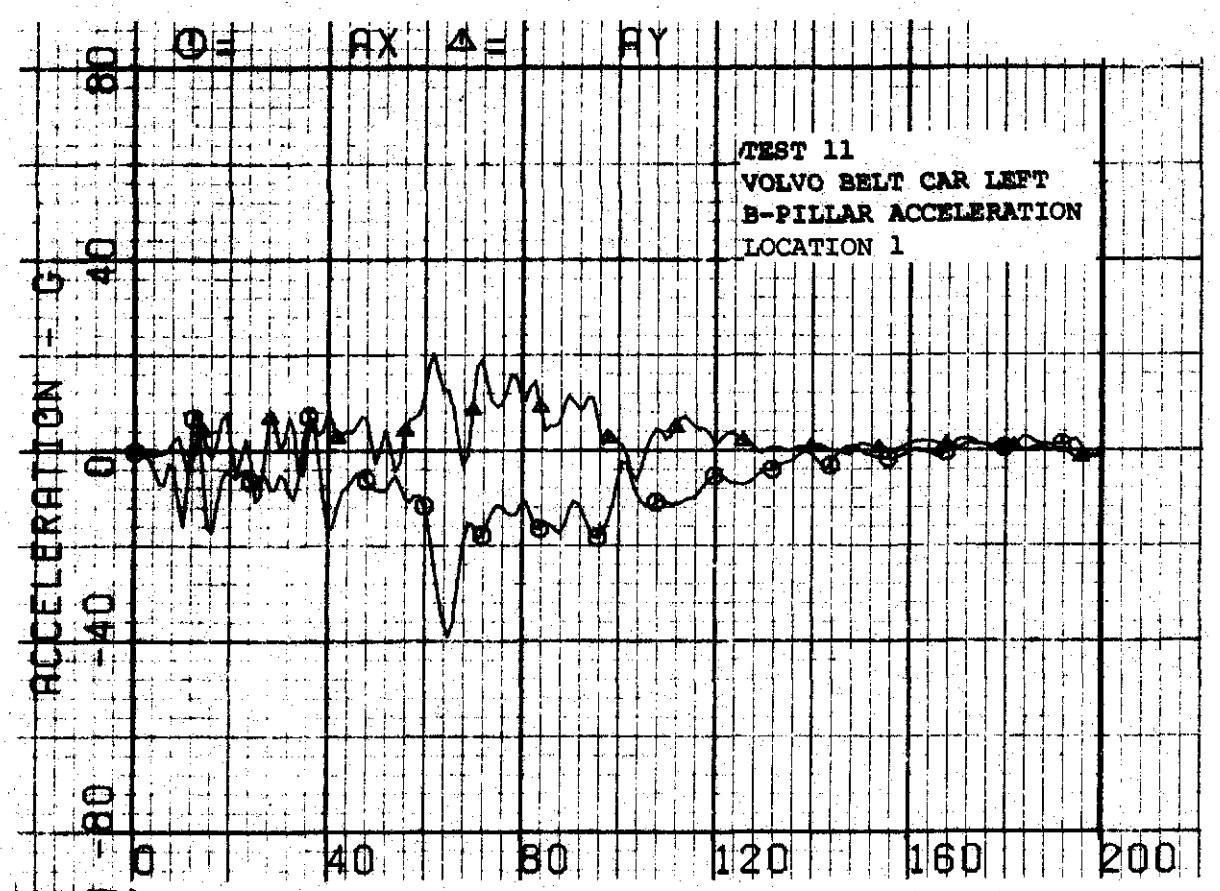

FL + LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR
FR + LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
RIGHT FEMUR
TIME + MSEC

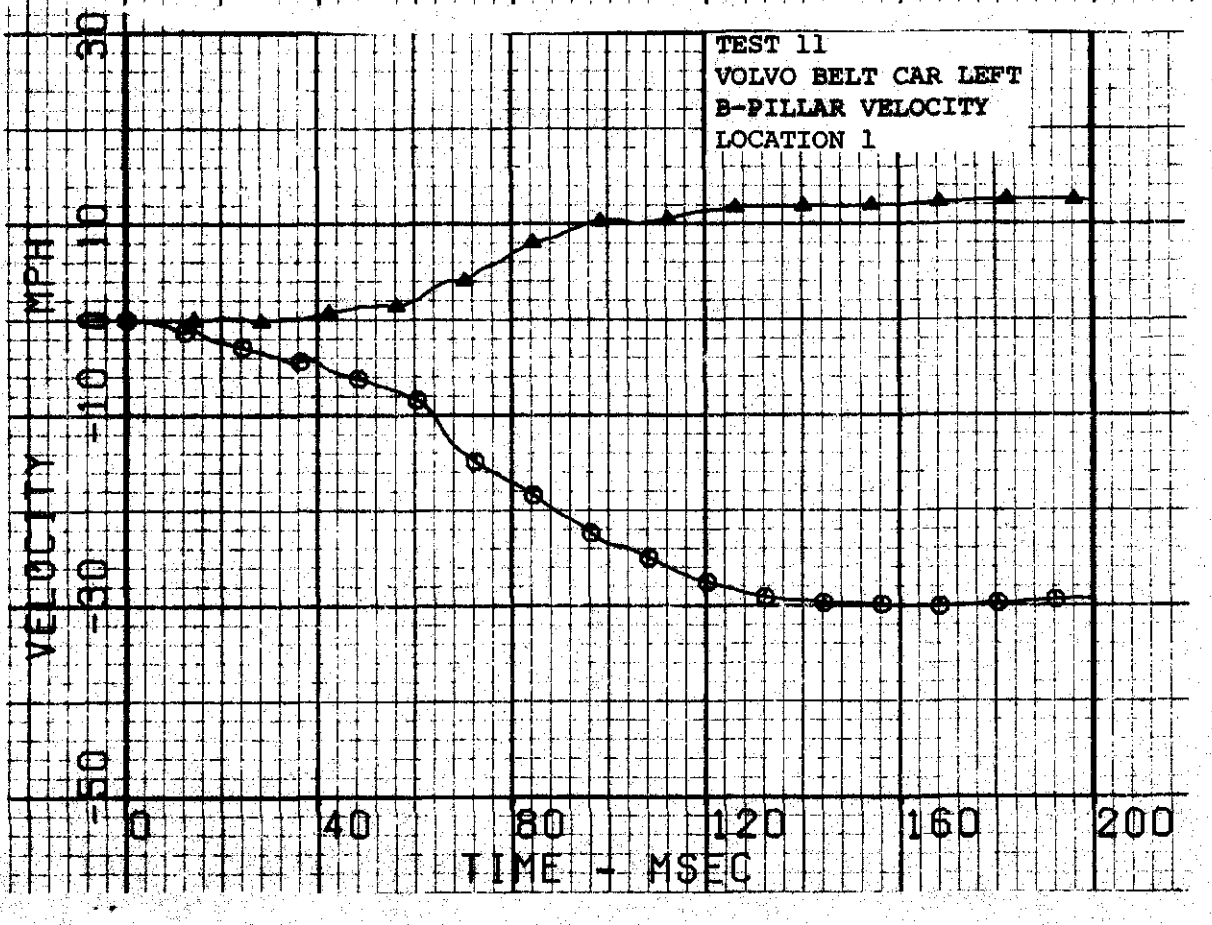

TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
SHOULDER BELT PRESSURE
POUNDS/SQ INCH
45
30
15
0
-15
0
40
80
120
160
200

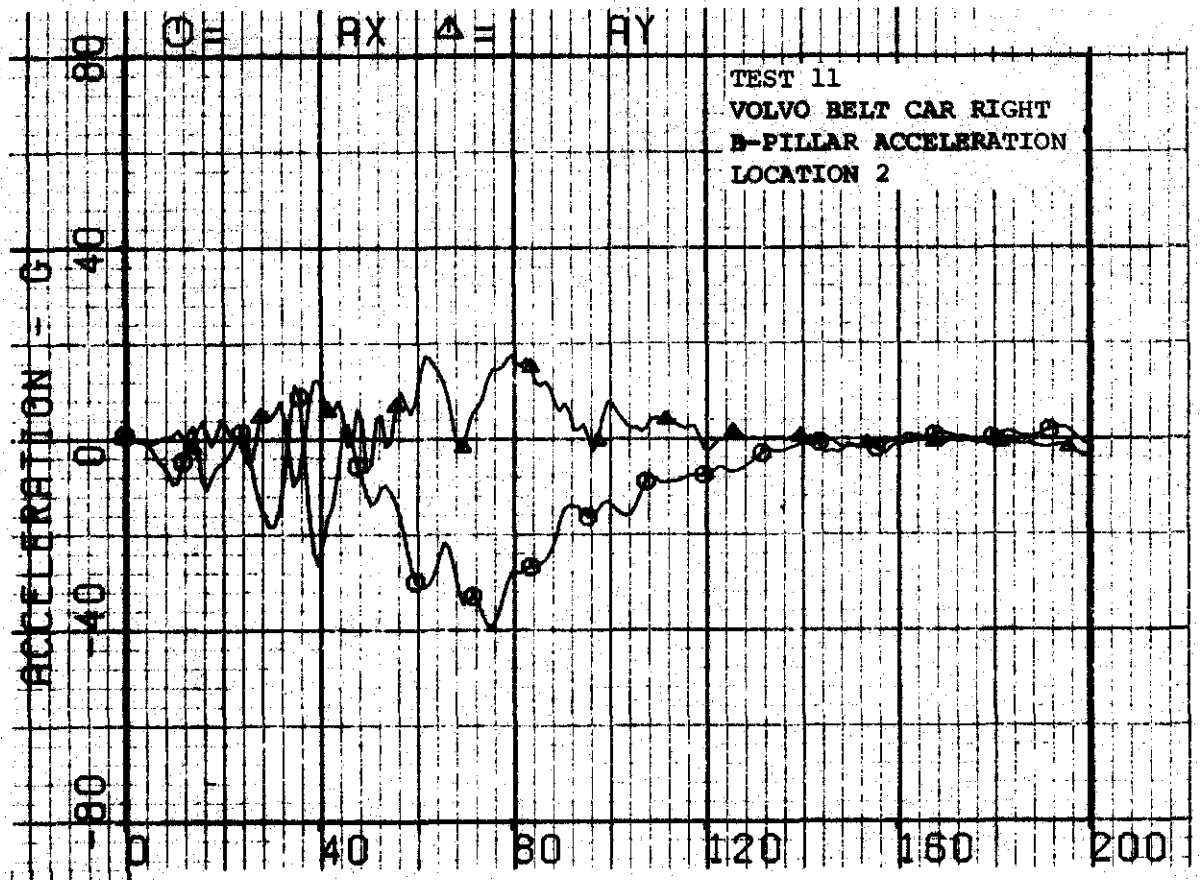

TEST 11
VOLVO BELT CAR
LEFT FRONT OCCUPANT
LAP BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200
TIME - MSEC

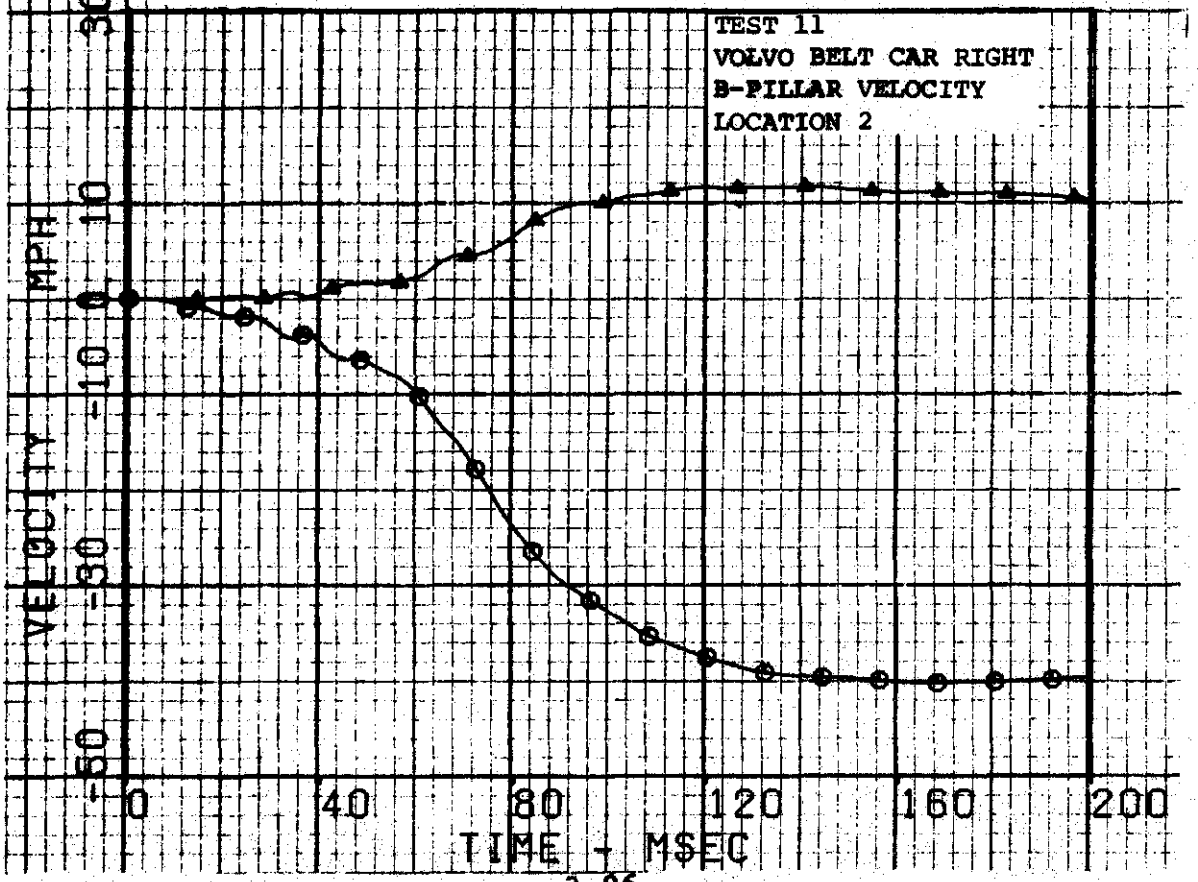

TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
SHOULDER BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200

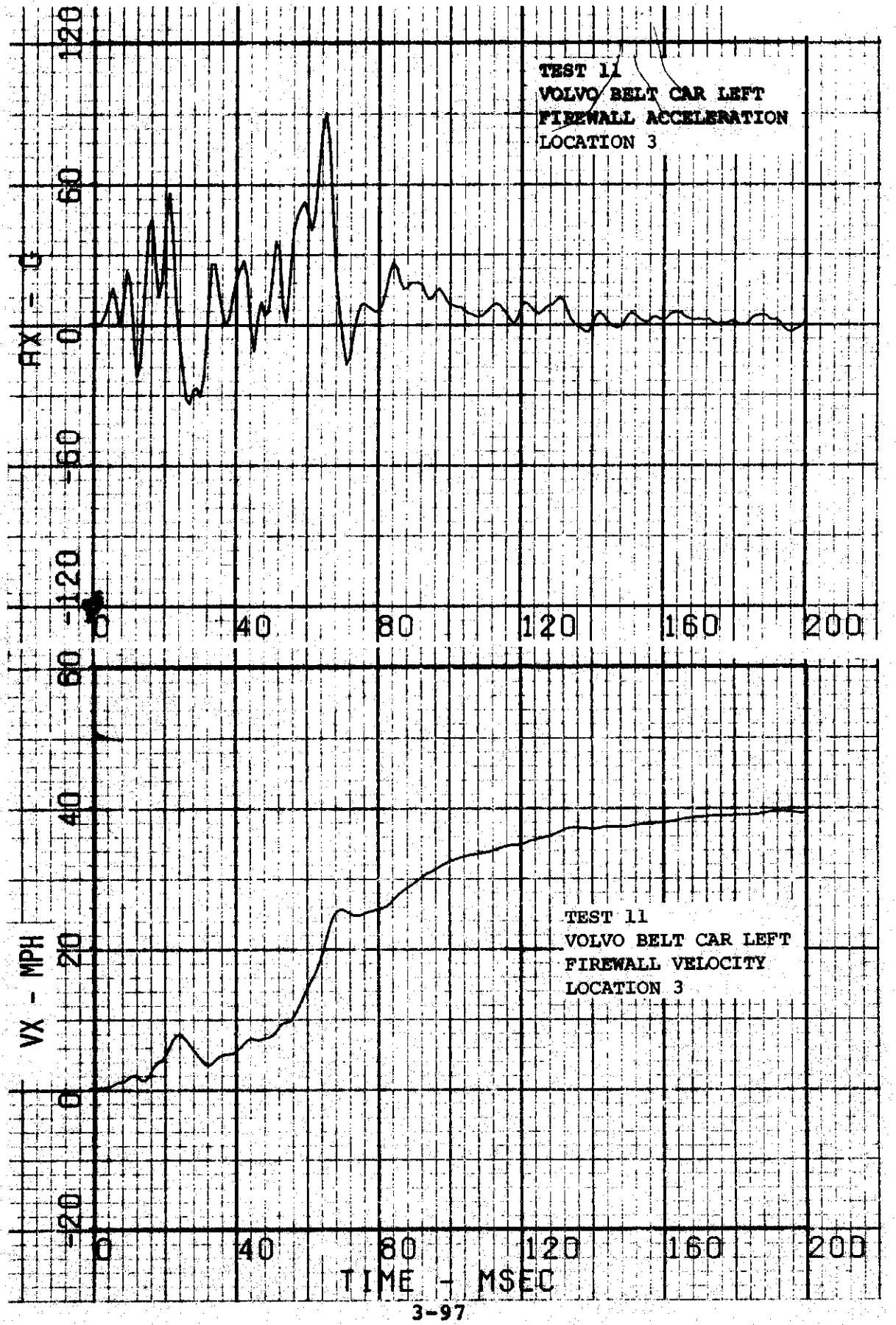

TEST 11
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
LAP BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200
TIME - MSEC

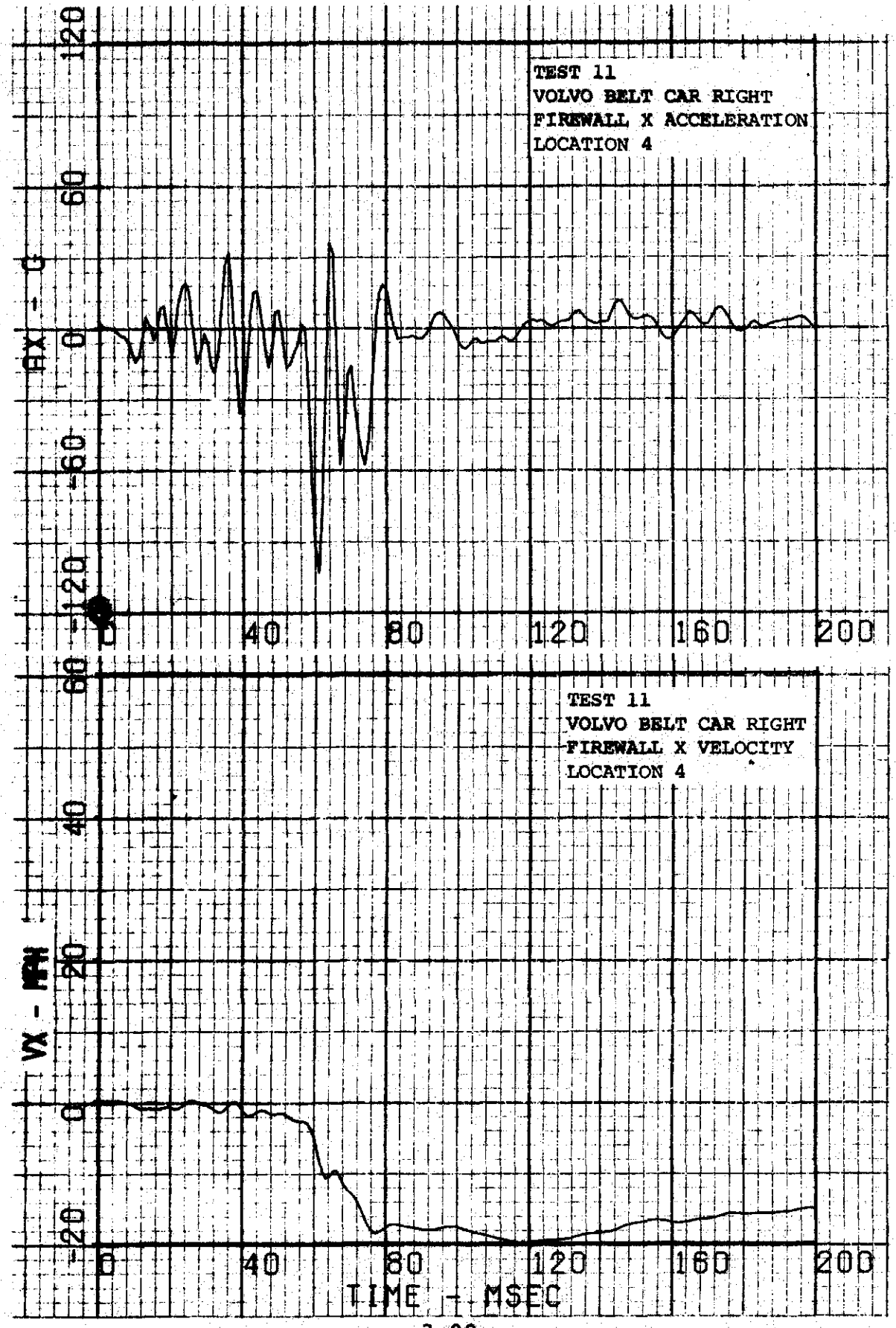

○ = AX △ = AY
TEST 11
VOLVO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

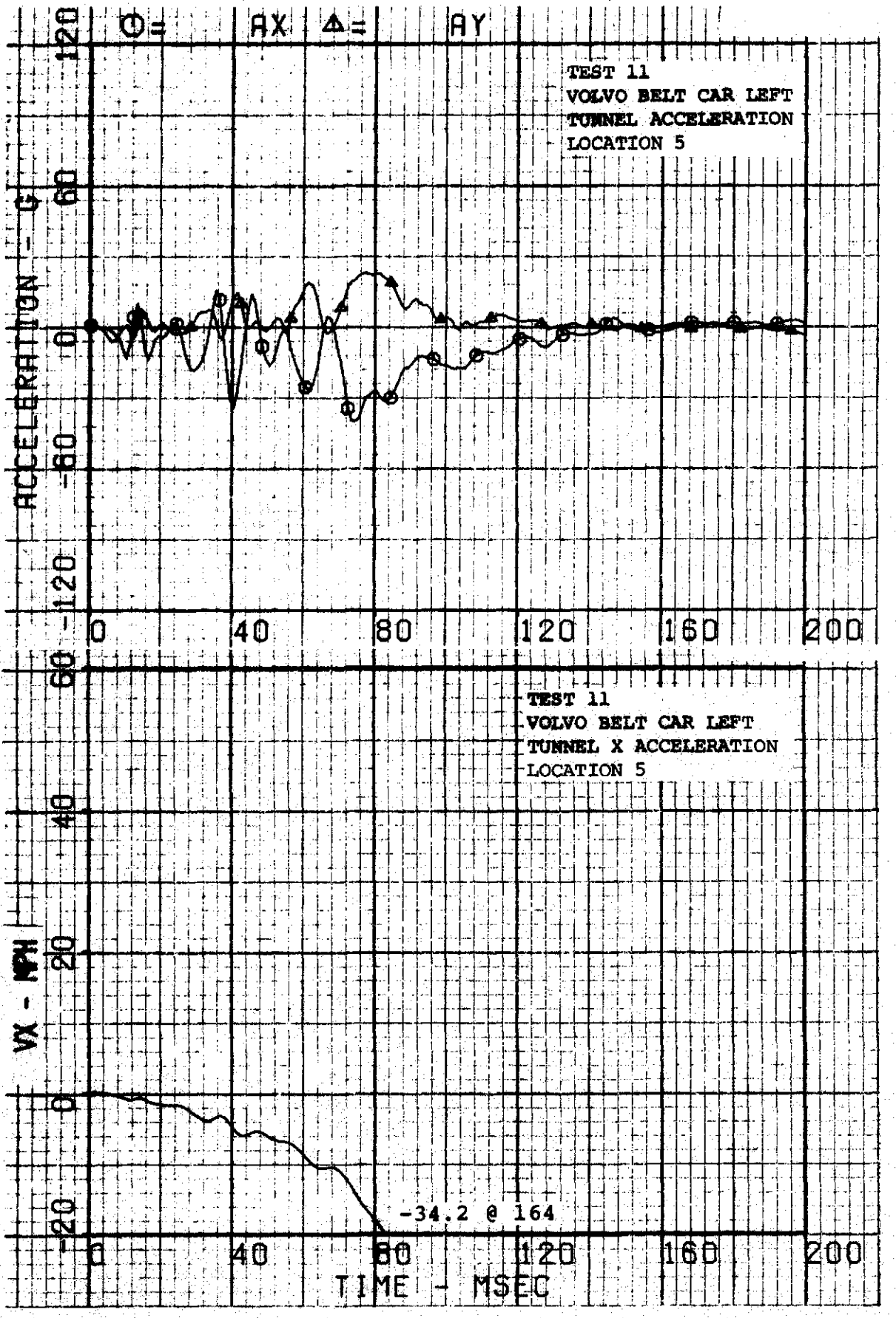

TEST 11
VOLVO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY MPH
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

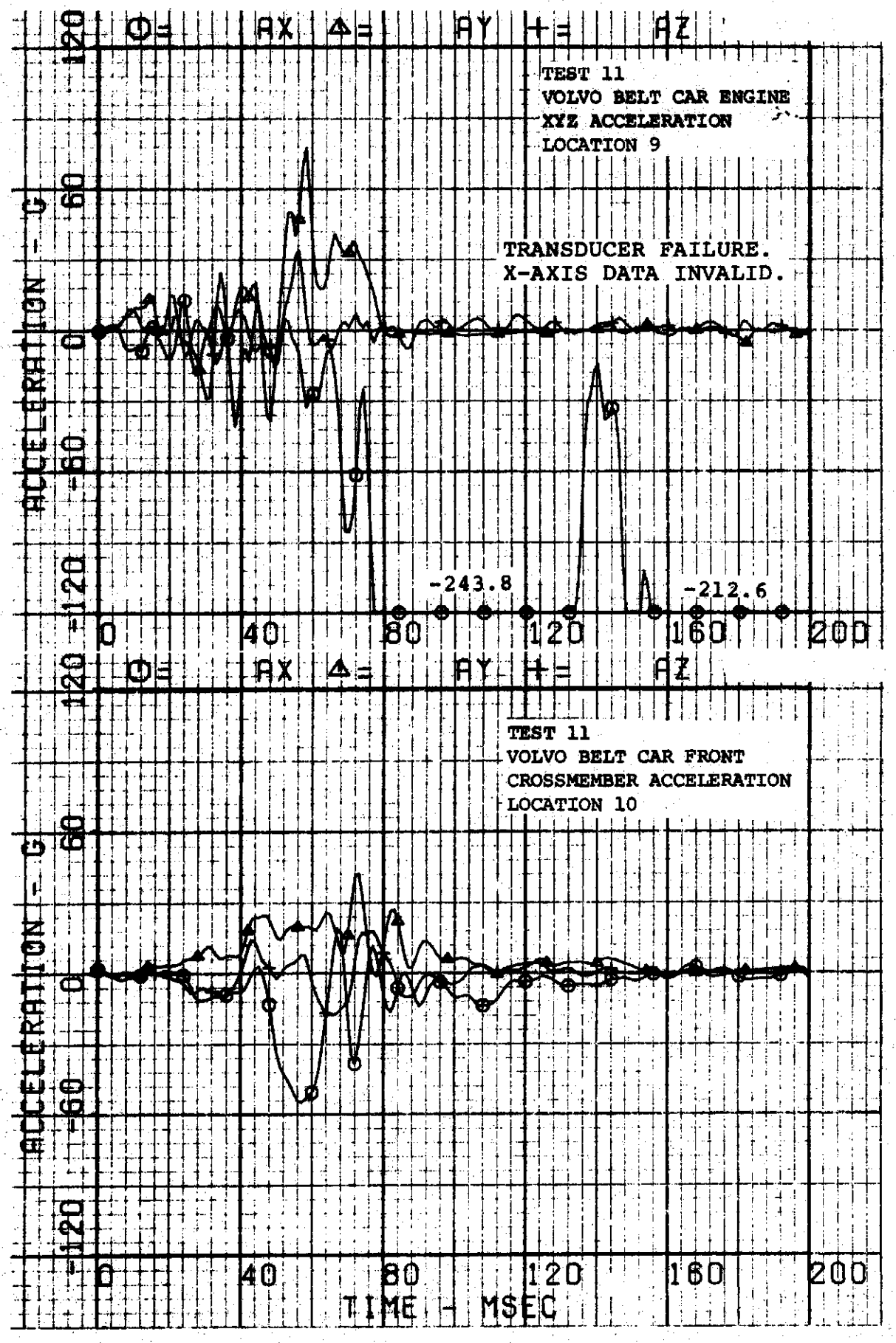

TEST 11
VOLVO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

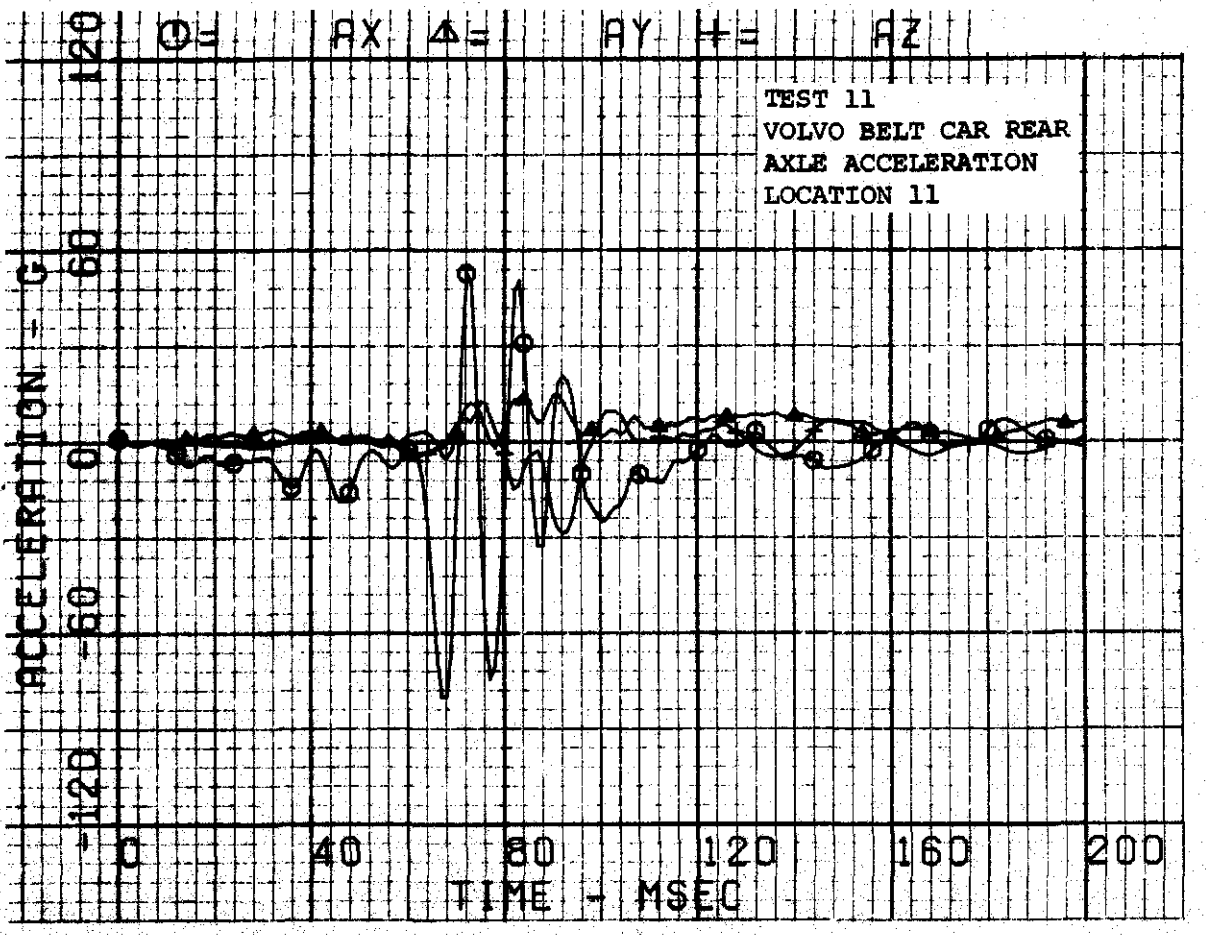

TEST 11
VOLVO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

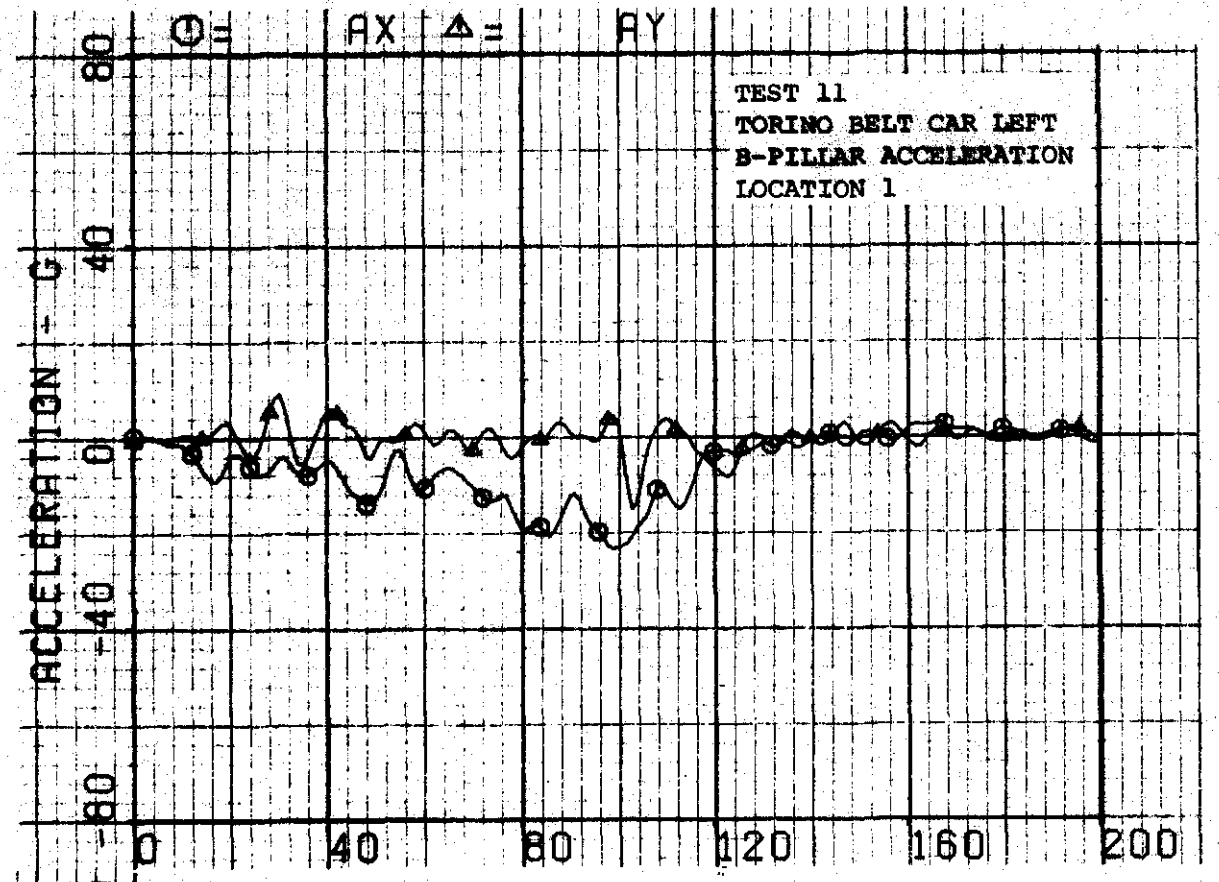

TEST 11
VOLVO BELT CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR LEFT
FIREWALL VELOCITY
LOCATION 3
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

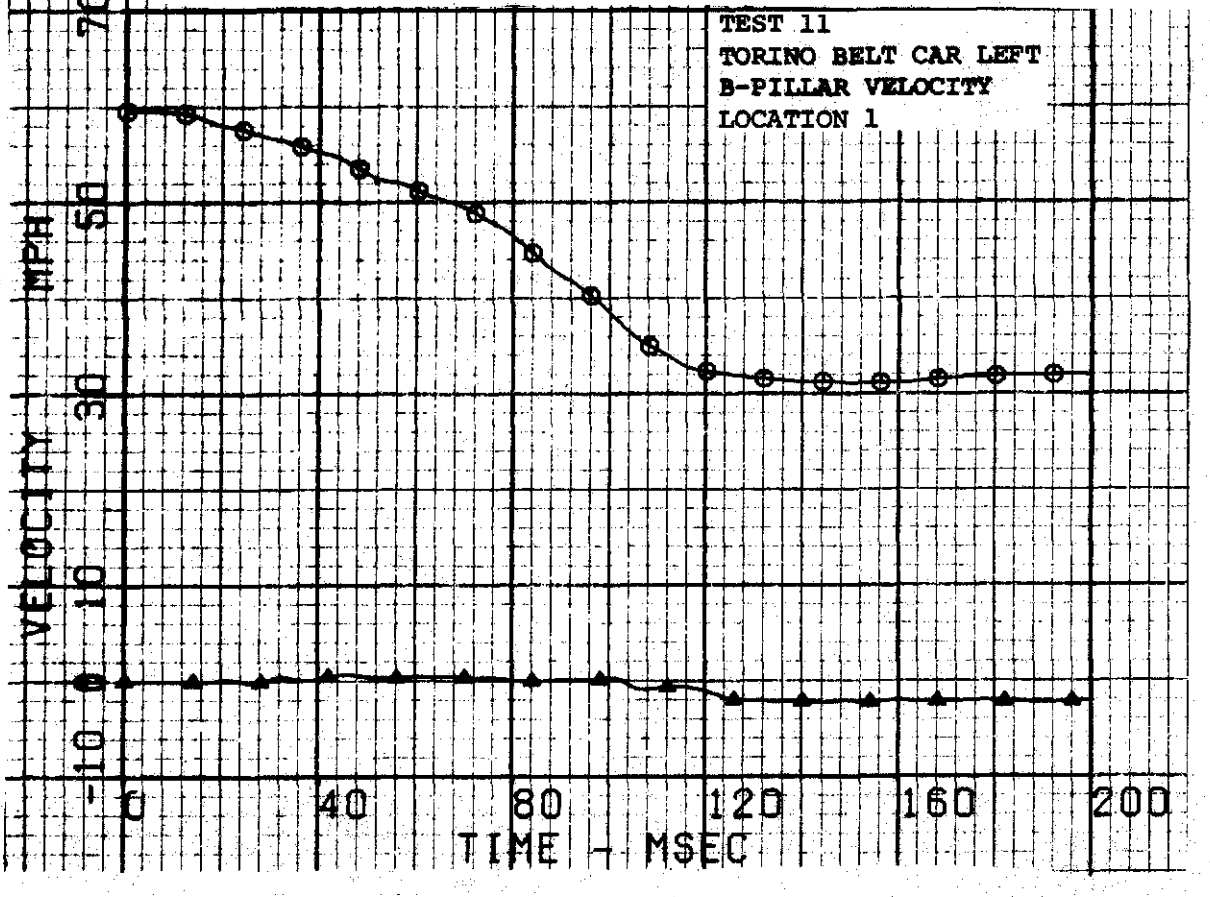

TEST 11
VOLVO BELT CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
VX - MPH
60
40
20
0
-20
0
40
80
120
160
200
TIME - MSEC

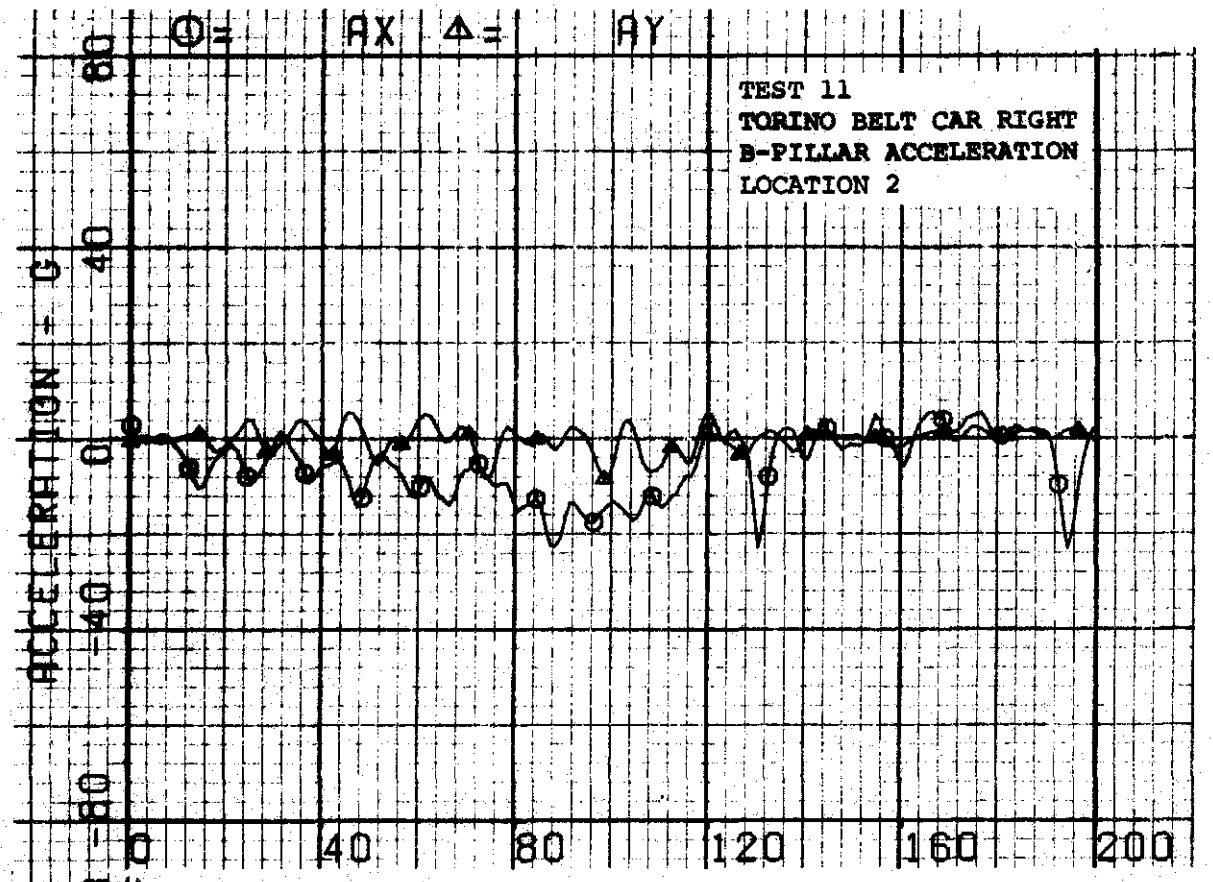

Θ=
AX
Δ=
AY
TEST 11
VOLVO BELT CAR LEFT
TUNNEL ACCELERATION
LOCATION 5
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR LEFT
TUNNEL X ACCELERATION
LOCATION 5
VX - MPH
60
40
20
0
-20
-34.2 @ 164
0
40
80
120
160
200
TIME - MSEC

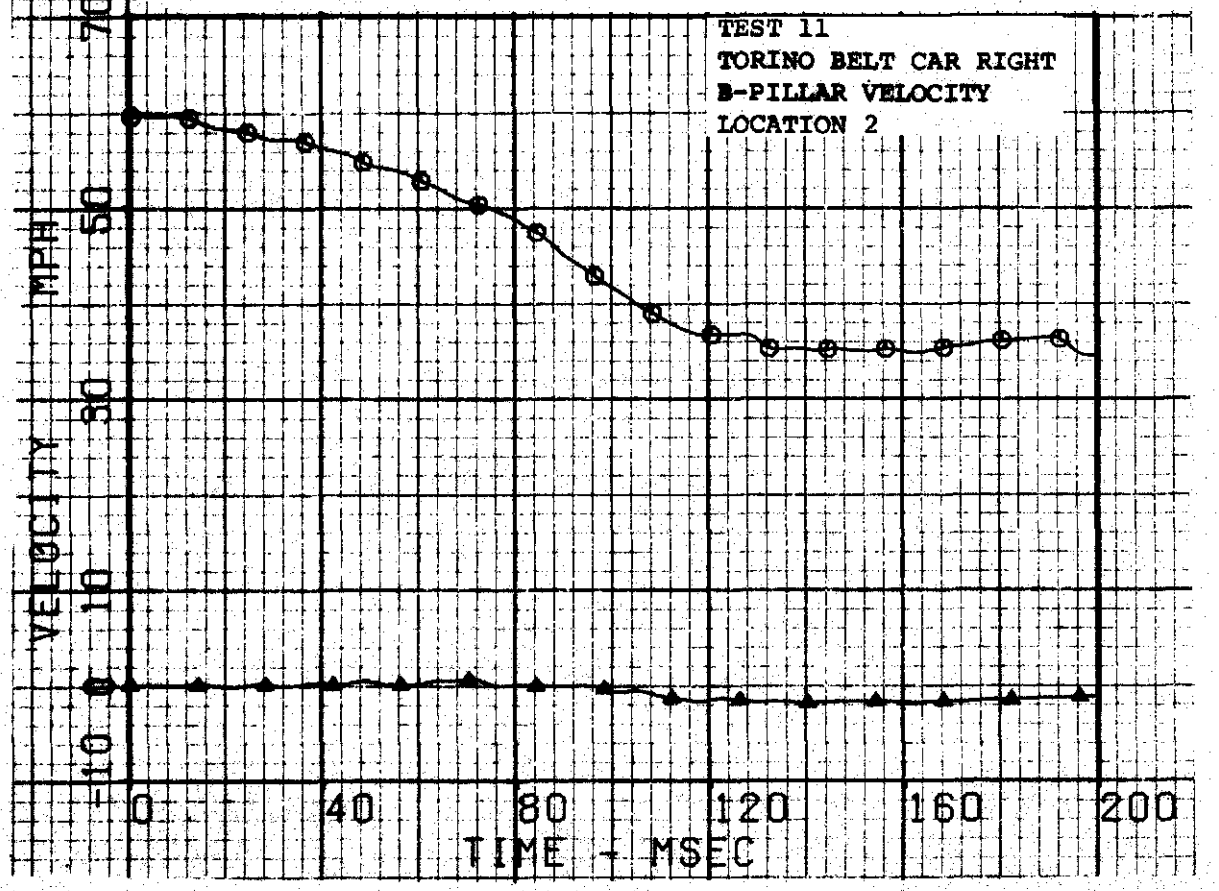

TEST 11
VOLVO BELT CAR ENGINE
XYZ ACCELERATION
LOCATION 9
TRANSDUCER FAILURE.
X-AXIS DATA INVALID.
-243.8
-212.6
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 11
VOLVO BELT CAR FRONT
CROSSMEMBER ACCELERATION
LOCATION 10
TIME - MSEC


Θ=
AX
Δ=
AY
+=
AZ
TEST 11
VOLVO BELT CAR REAR
AXLE ACCELERATION
LOCATION 11
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


Θ = AX Δ = AY
TEST 11
TORINO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 11
TORINO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY - MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC


○= AX △= AY
TEST 11
TORINO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 11
TORINO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC

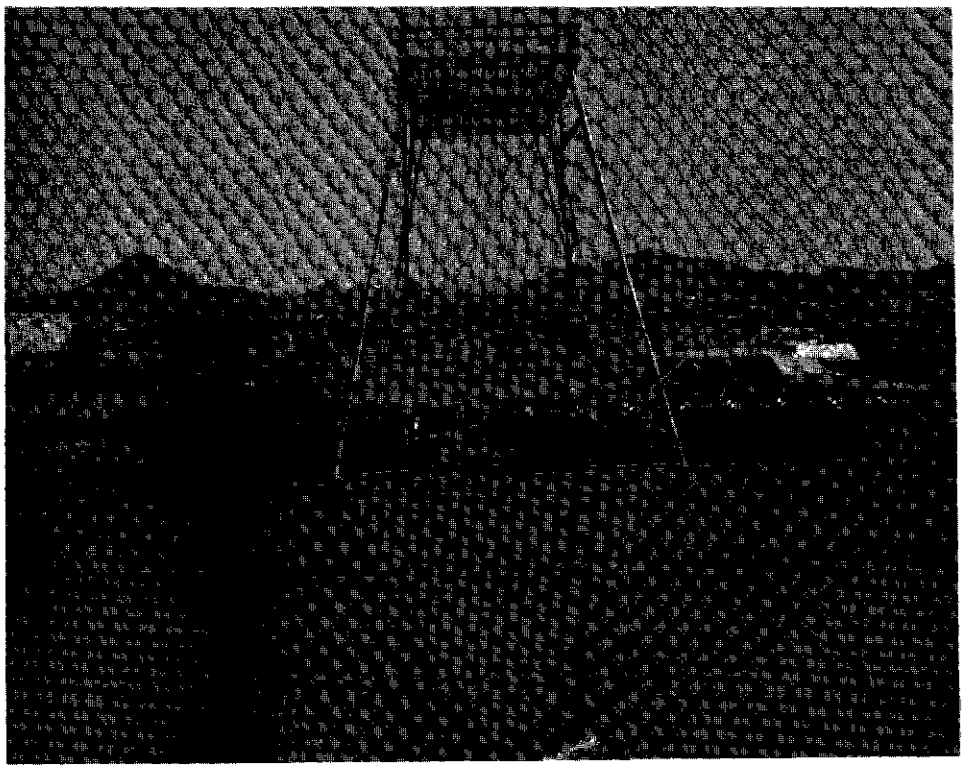


Figure 3-23. Pre-test Vehicle Configuration - Test 11.

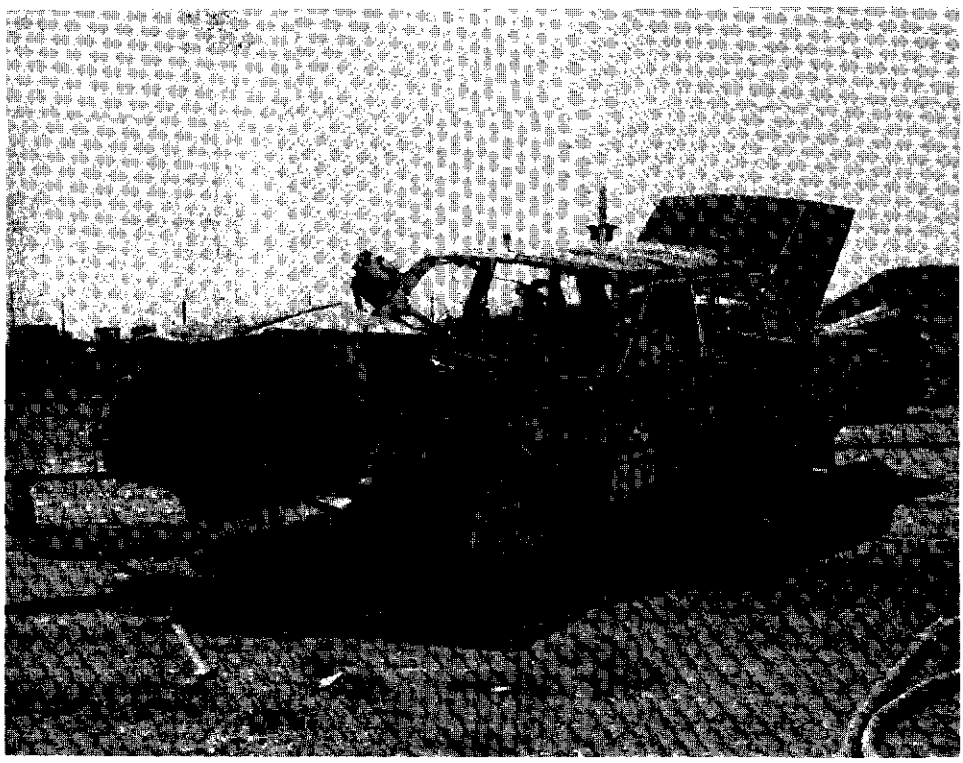


Figure 3-24. Post-test Vehicle Configuration - Test 11.

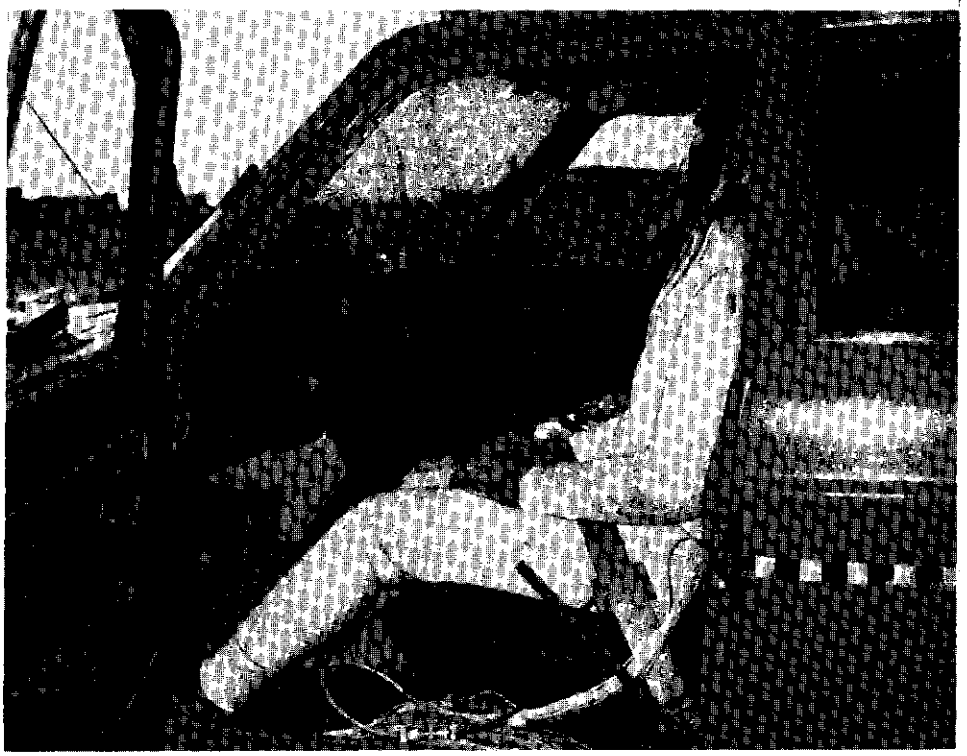


Figure 3-25. Pre-test Force Limited Airbelt - Test 11.

Figure 3-26. Post-test Force Limited Airbelt - Test 11.

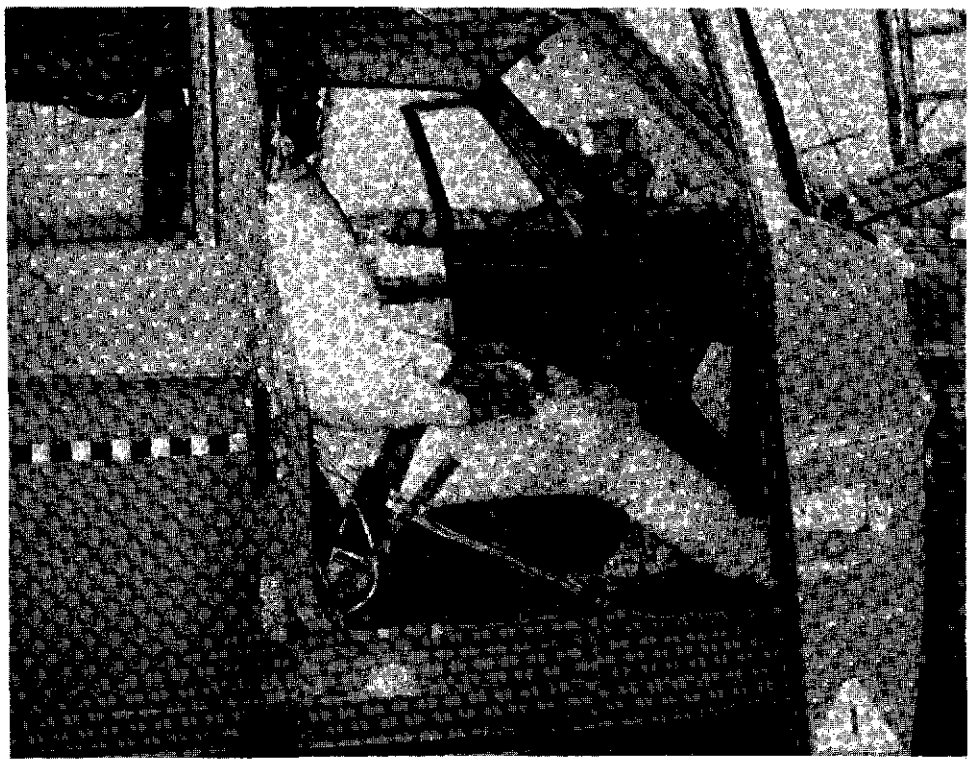


Figure 3-27. Pre-test Force Limited 2-Inch Belt - Test 11.

Figure 3-28. Post-test Force Limited 2-Inch Belt - Test 11.

3.5 TEST NUMBER 12

The impact conditions for Test 12 were:

Configuration	Closing Speed
Torino-to-Volvo Right Oblique (30°)*	63.3 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Standard 3-Point Belt with Web Lockers	RSV Driver airbag
Right Front	Standard 3-Point Belt with Web Lockers	RSV Passenger Airbag

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was structurally modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity and to accept the restraint systems that were installed in it. The extent of these modifications is shown in Figure 1-1.

The results of Test 12 are summarized in the following tables:

Table 3-17 - Summary of Vehicle Data (Test 12)

Table 3-18 - Injury Criteria Summary (Test 12)

Table 3-19 - Summary of Restraint System Data (Test 12)

Table 3-20 - Occupant Response Data (Test 12)

which are followed by Figure 3-29 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

*Major resultant acceleration vector 30° to centerline of target vehicle.

TABLE 3-17. SUMMARY OF VEHICLE DATA (TEST 12)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 12/March 17, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		487	436
TEST WEIGHT (lb)		4690	3230
IMPACT VELOCITY (mph)		63.3	0
VELOCITY CHANGE (mph)		29.5	40.2 (1)
PEAK RESULTANT ACCELERATION (G @ msec)			
	LOCATION 1	21.3 @ 90	42.1 @ 70
	LOCATION 2	25.3 @ 95	36.4 @ 70
MAXIMUM STATIC CRUSH (in.)			
	LEFT	16.0	8.0
	CENTER	24.0	15.5
	RIGHT	13.0	46.0

(1) Velocity change found by using average of resultant velocity vector (V_R) data for compartment accelerometer locations.

TABLE 3-18. INJURY CRITERIA SUMMARY (TEST 12)

VEHICLE B - AIRBAG CAR (VOLVO)				
	RSV DRIVER AIRBAG		RSV PASSENGER AIRBAG	
HIC	233		219	
HEAD G(1) @ msec	33.6 @ 81		39.5 @ 94	
CSI	212		204	
CHEST G(1) @ msec	37.9 @ 102		30.5 @ 128	
FEMUR LOAD (lb)	LEFT 1103	RIGHT 1440	LEFT 672	RIGHT 744

(1) 3 msec clip.

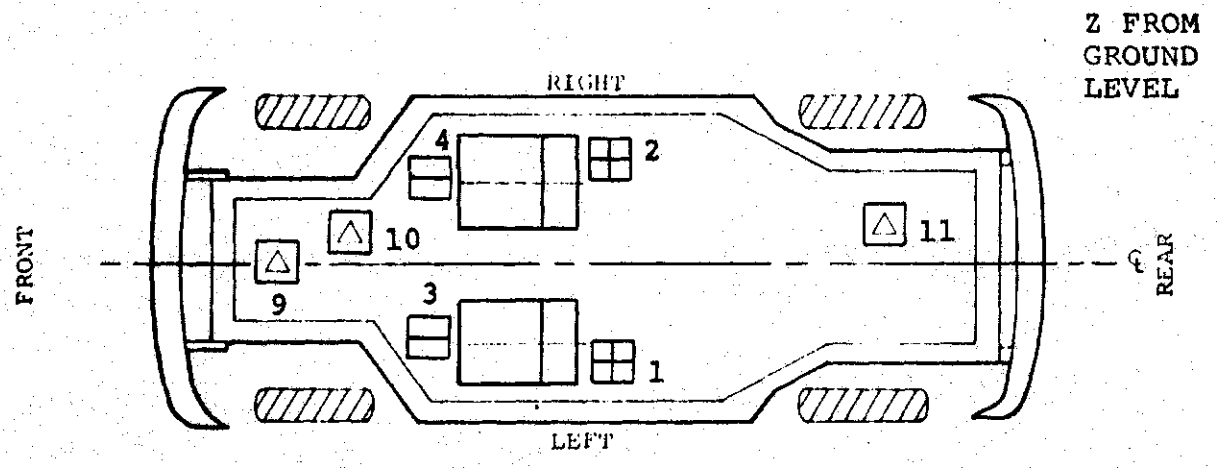
TABLE 3-19. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 12)

VEHICLE B - AIRBAG CAR (VOLVO)	
RSV DRIVER AIRBAG Peak Bag Pressure psi @ msec	15.7 @ 38
RSV PASSENGER AIRBAG Peak Bag Pressure psi @ msec	8.7 @ 51

TABLE 3-20. OCCUPANT RESPONSE DATA SUMMARY (TEST 12)

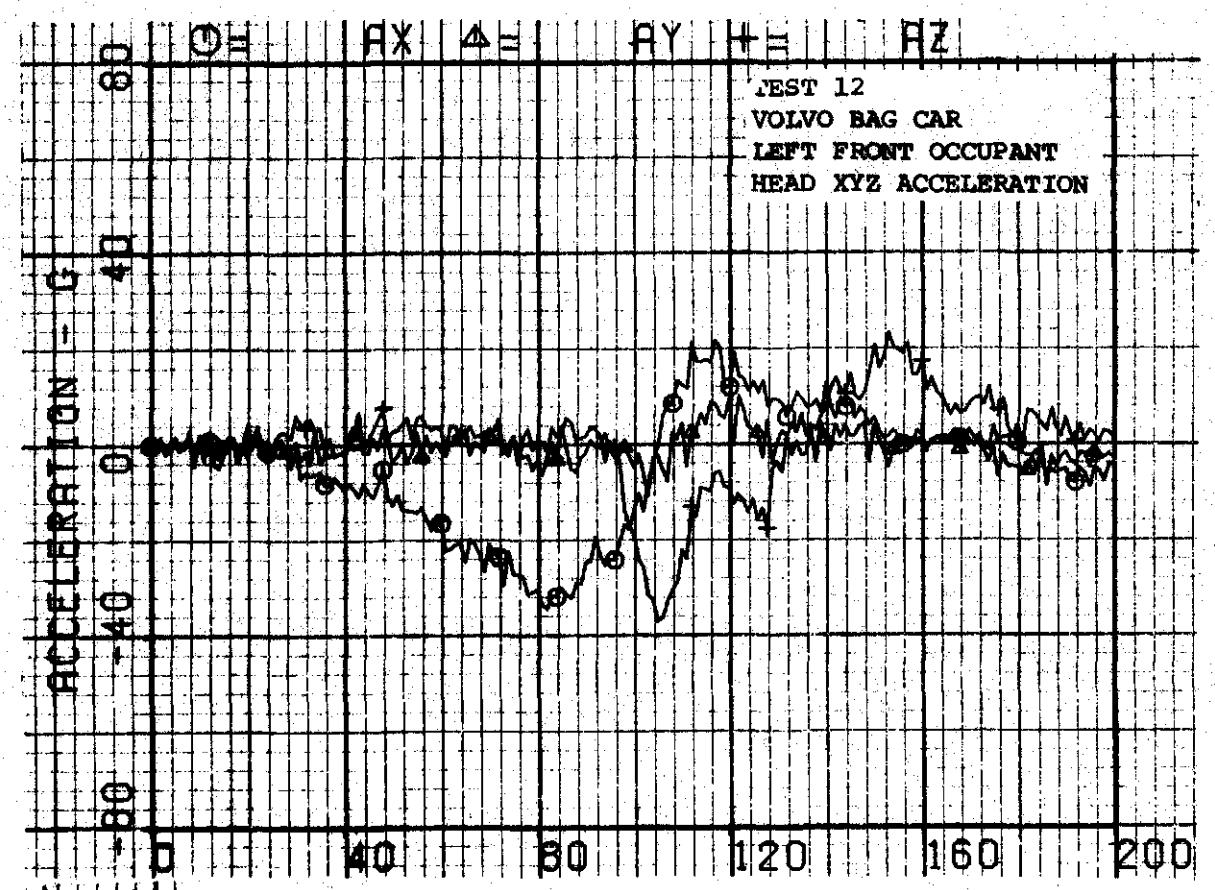
		VEHICLE B - AIRBAG CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD					
	X	34.0	82	33.9	94
	Y	10.6	122	39.0	43
	Z	36.6	105	83.3	43
	R(1)	33.6	81	39.5	94
	HIC	233 @ 52-163		219 @ 39-143	
CHEST					
	X	30.6	97	24.5	105
	Y	16.4	130	30.8	127
	Z	28.0	98	12.2	45
	R(1)	37.9	102	30.5	128
	SI	212 @ 200		204 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS					
	LF	1103	52	672	30
	RT	1440	57	744	67

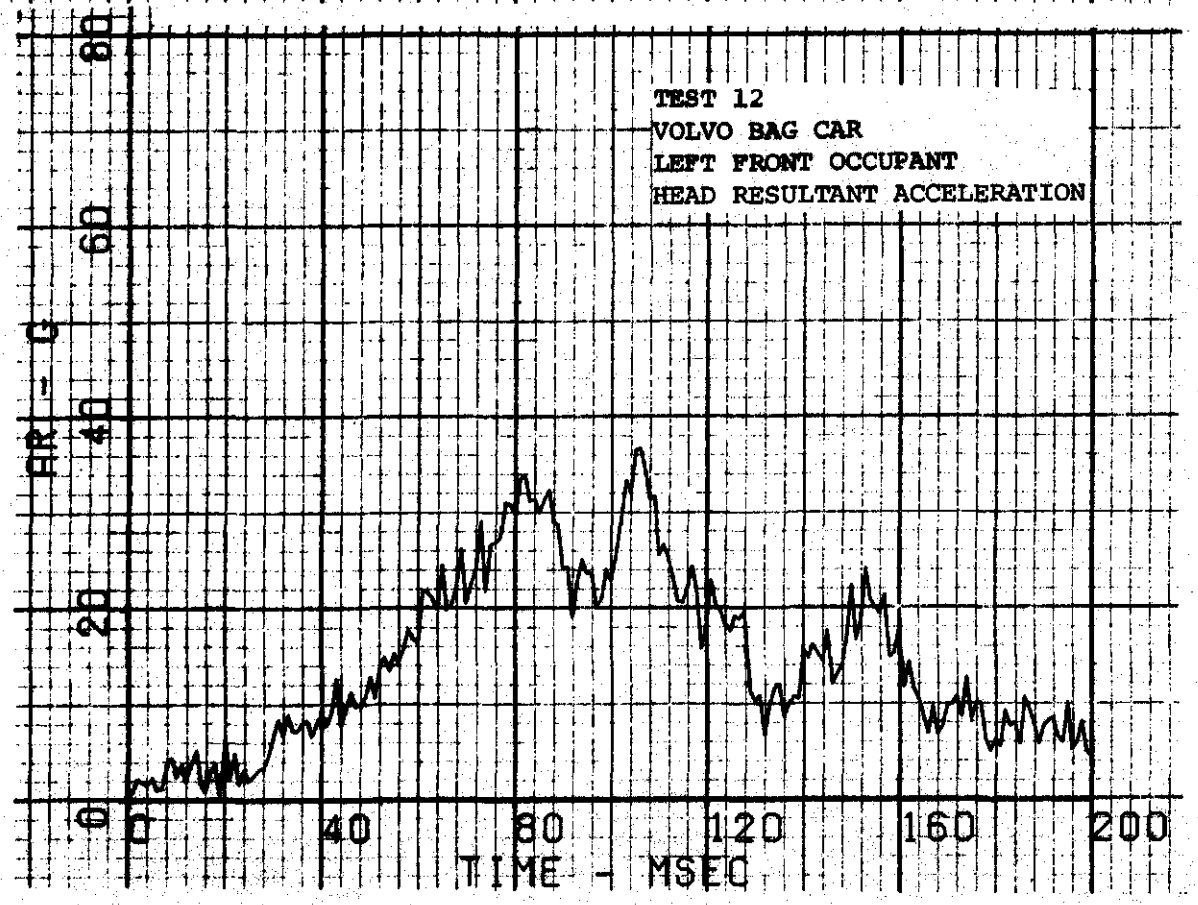
(1) 3 msec clip, components not clipped.

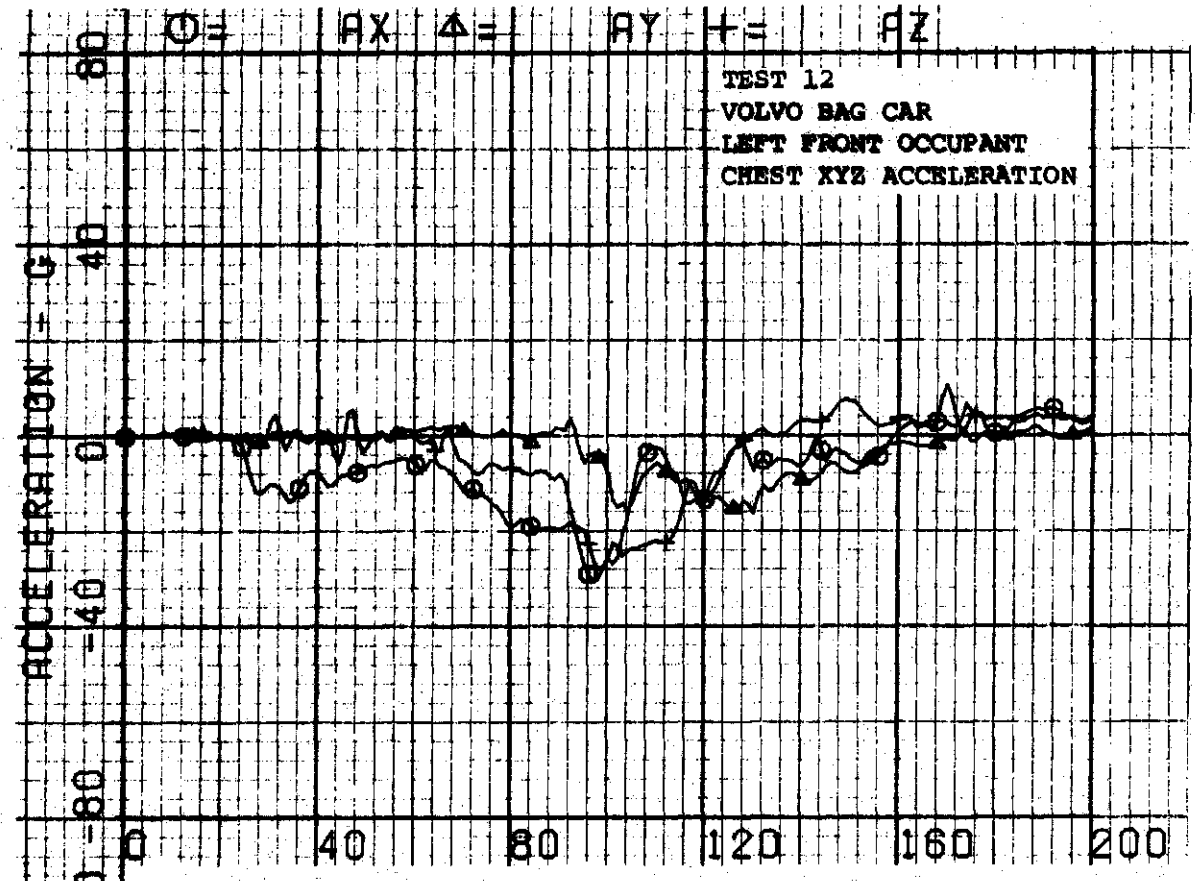


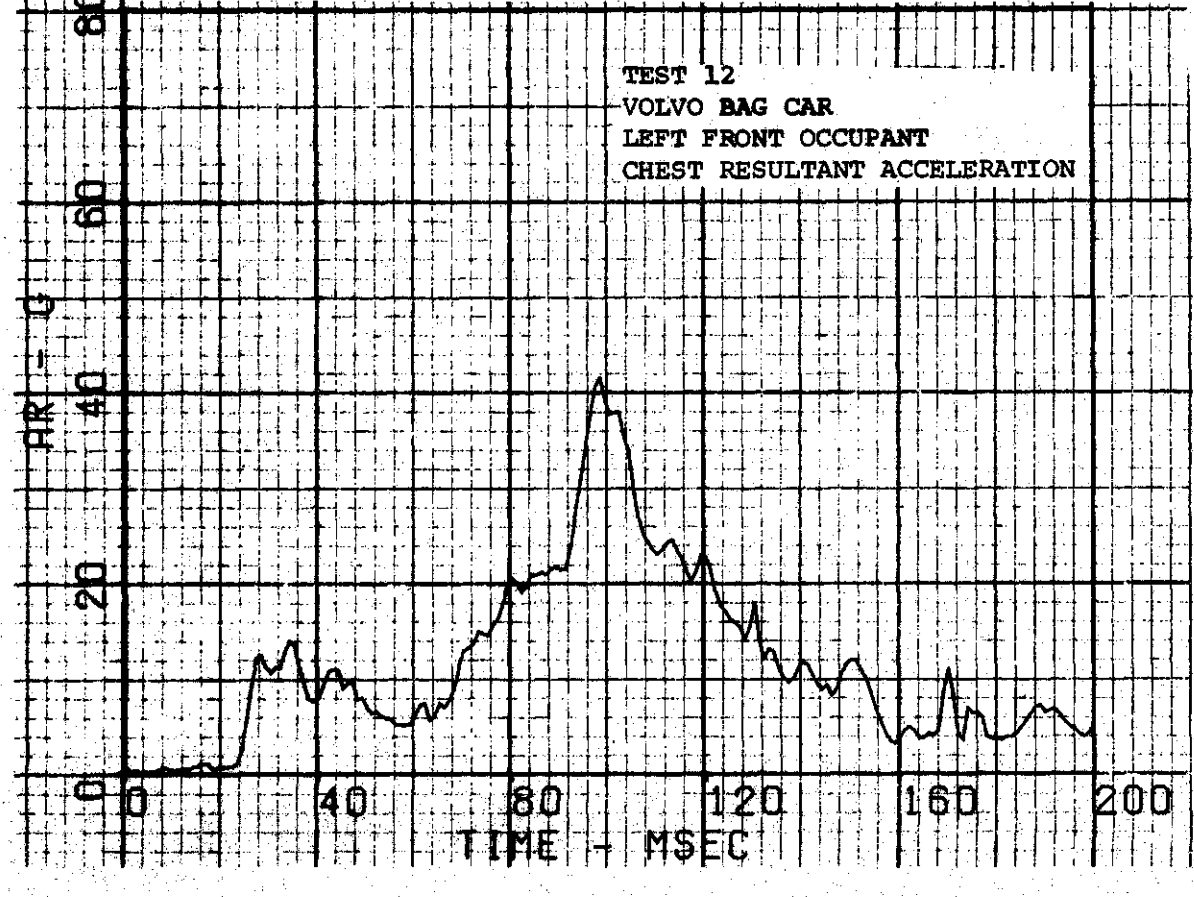
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
9	Engine Block	X	X	X
10	Front Crossmember	X	X	X
11	Rear Axle	X	X	X

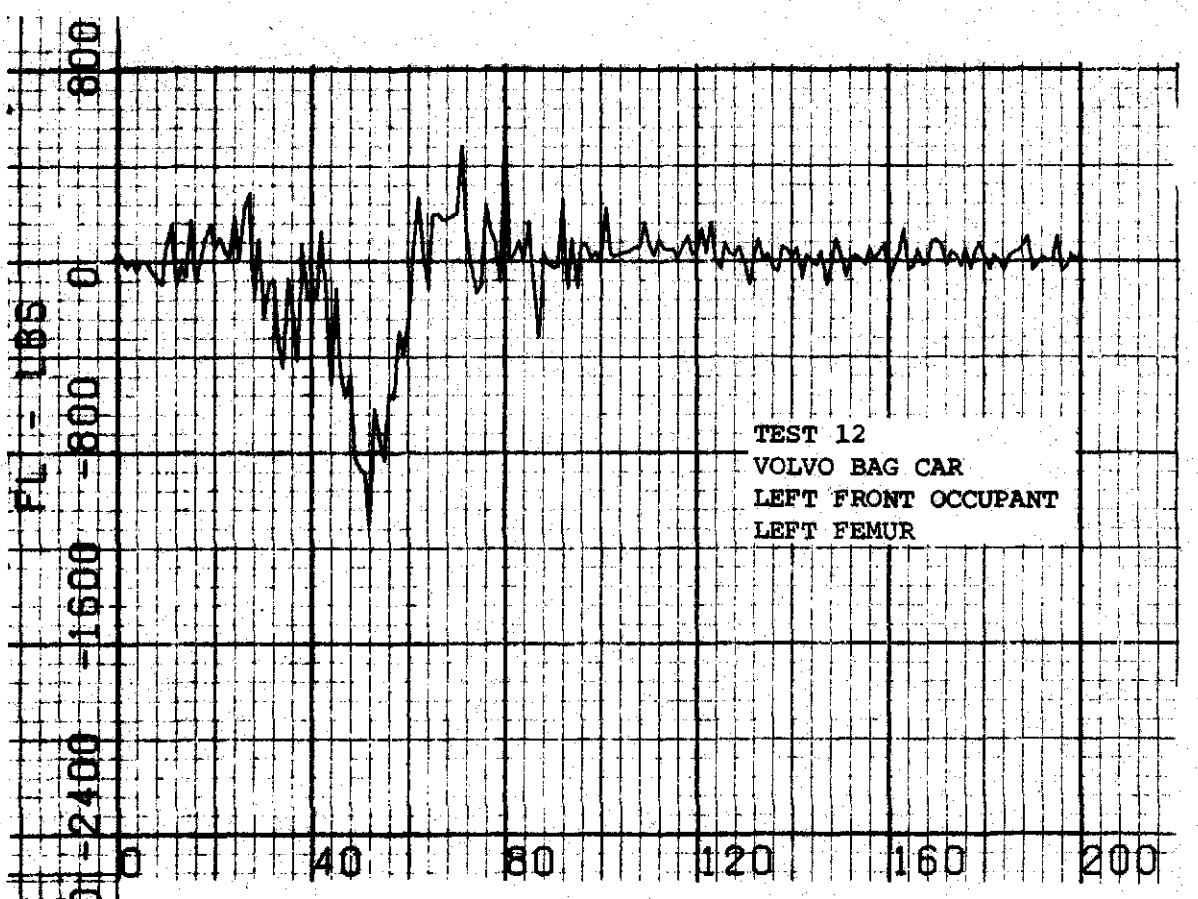
Figure 3-29. Vehicle Accelerometer Locations - Test 12.

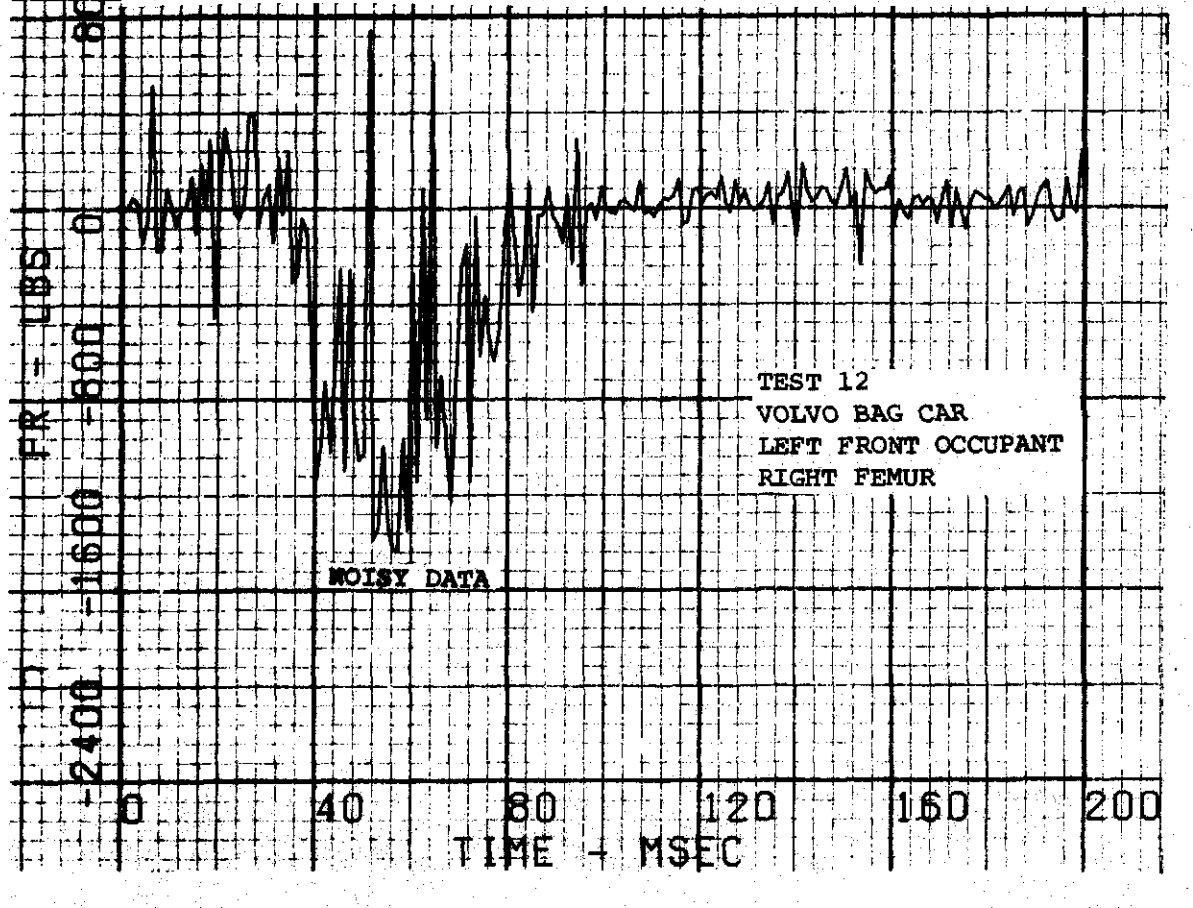

AX
AY
AZ
TEST 12
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

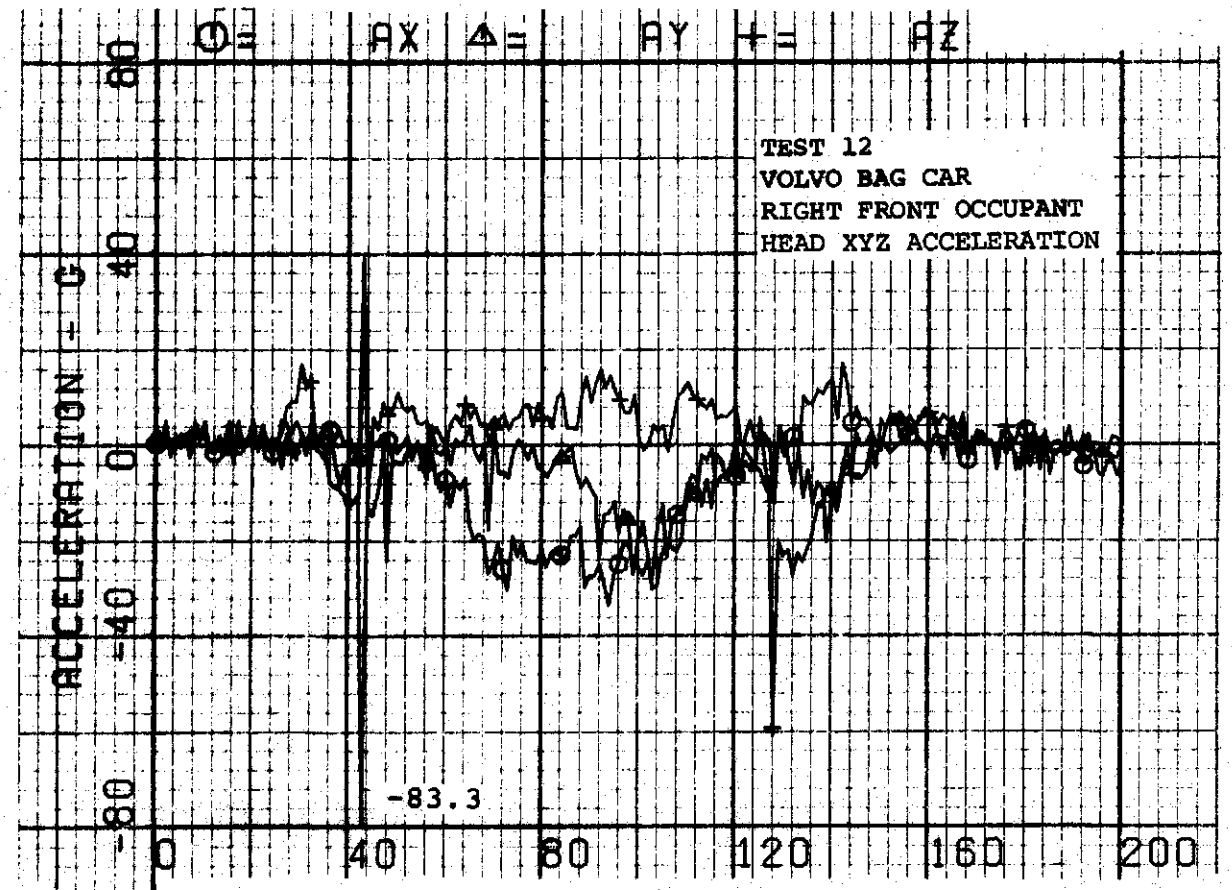

TEST 12
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

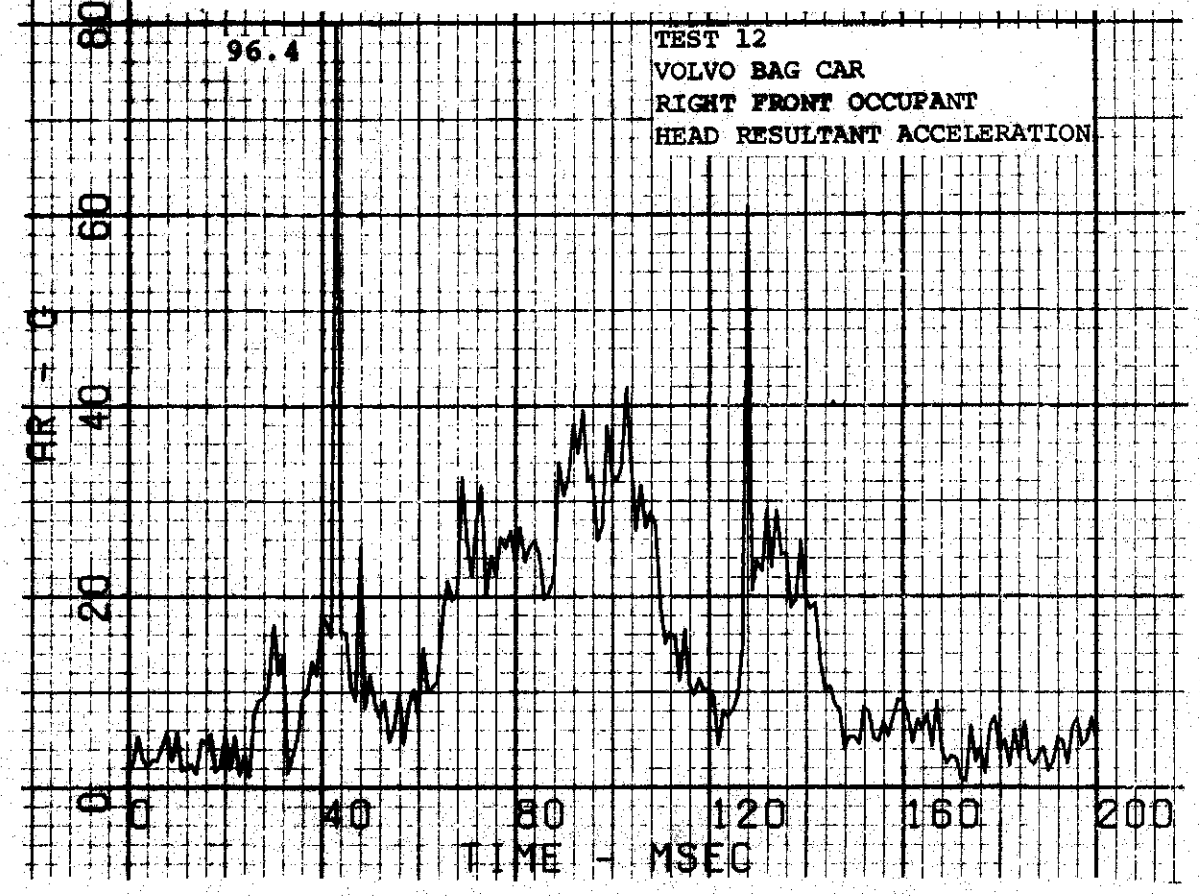

O= AX Δ= AY += AZ
TEST 12
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

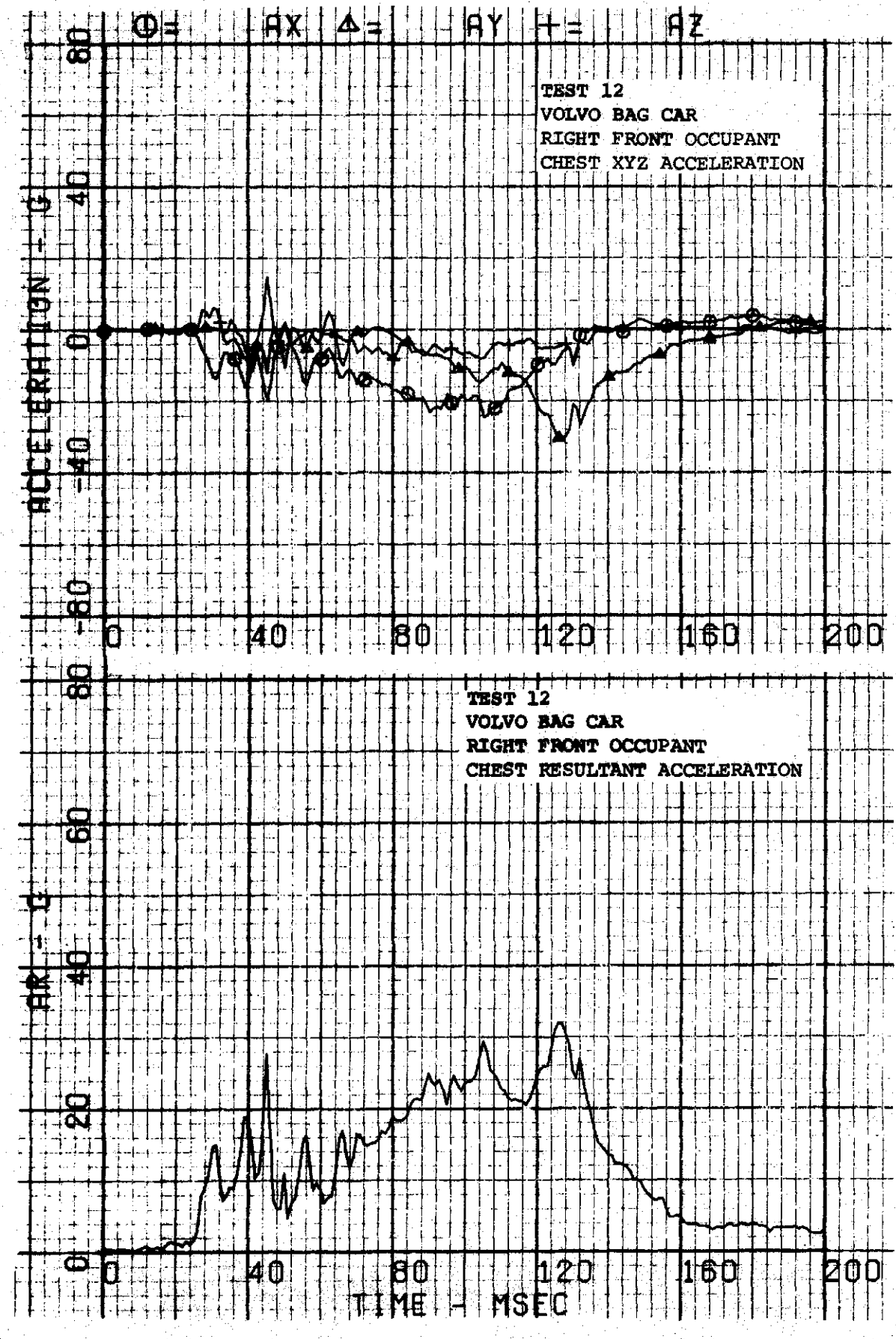

TEST 12
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

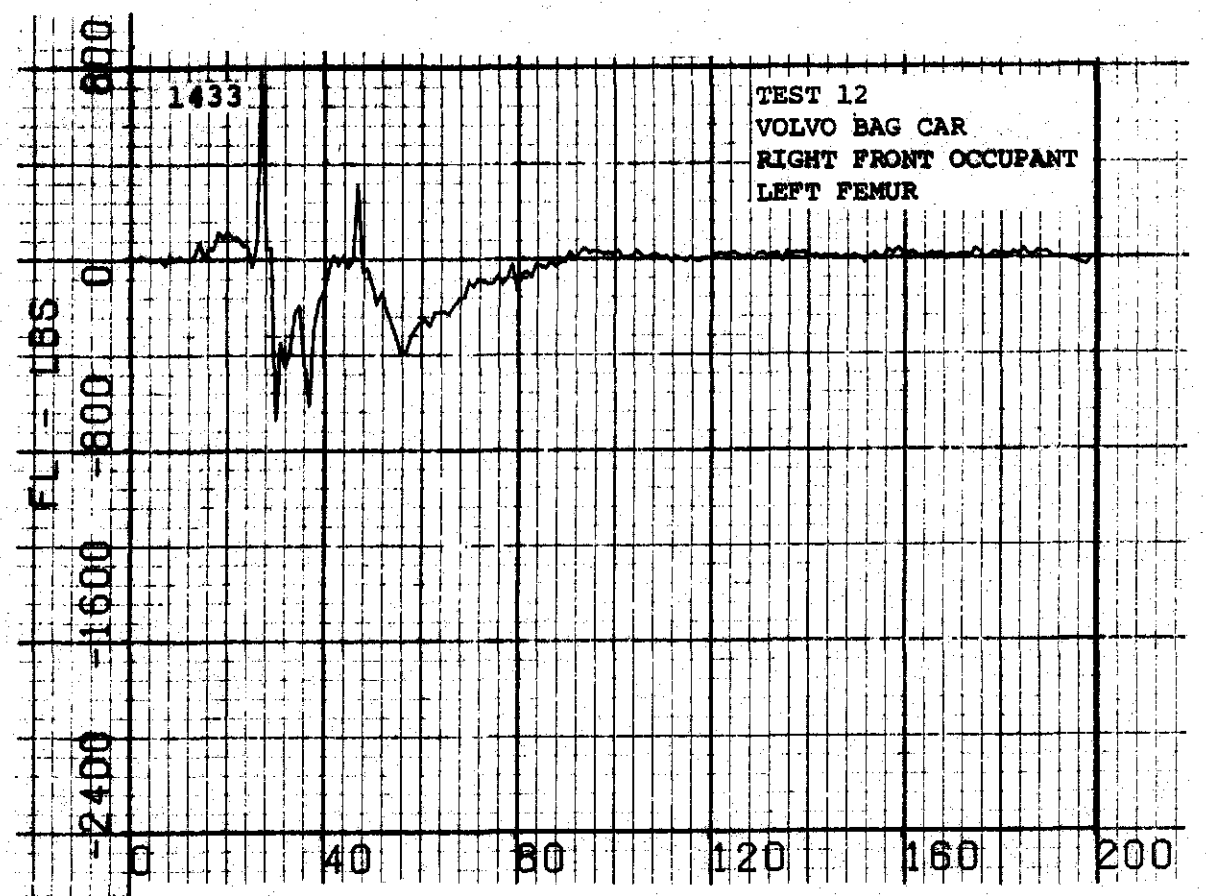

FL = LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 12
VOLVO BAG CAR
LEFT FRONT OCCUPANT
LEFT FEMUR

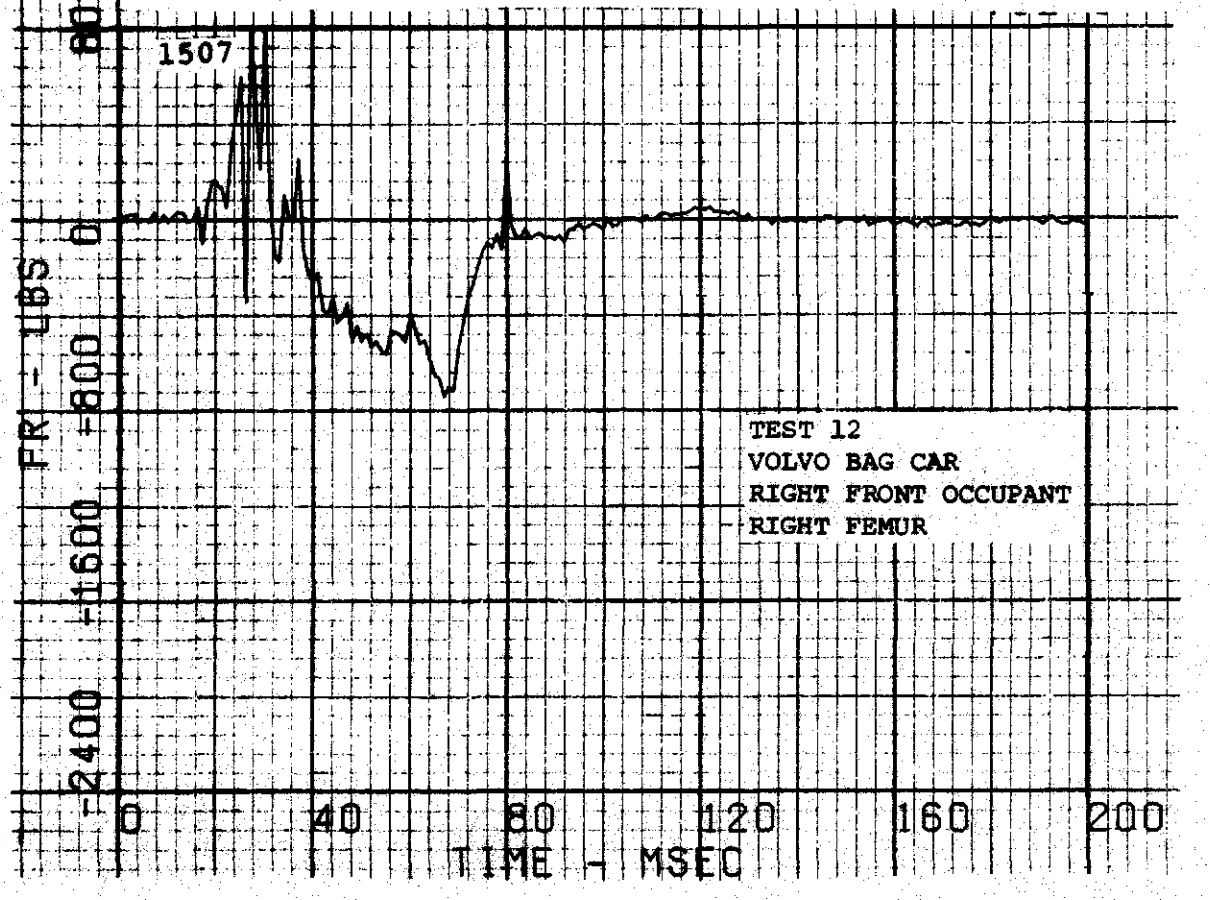

FR = LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC
TEST 12
VOLVO BAG CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR
NOISY DATA

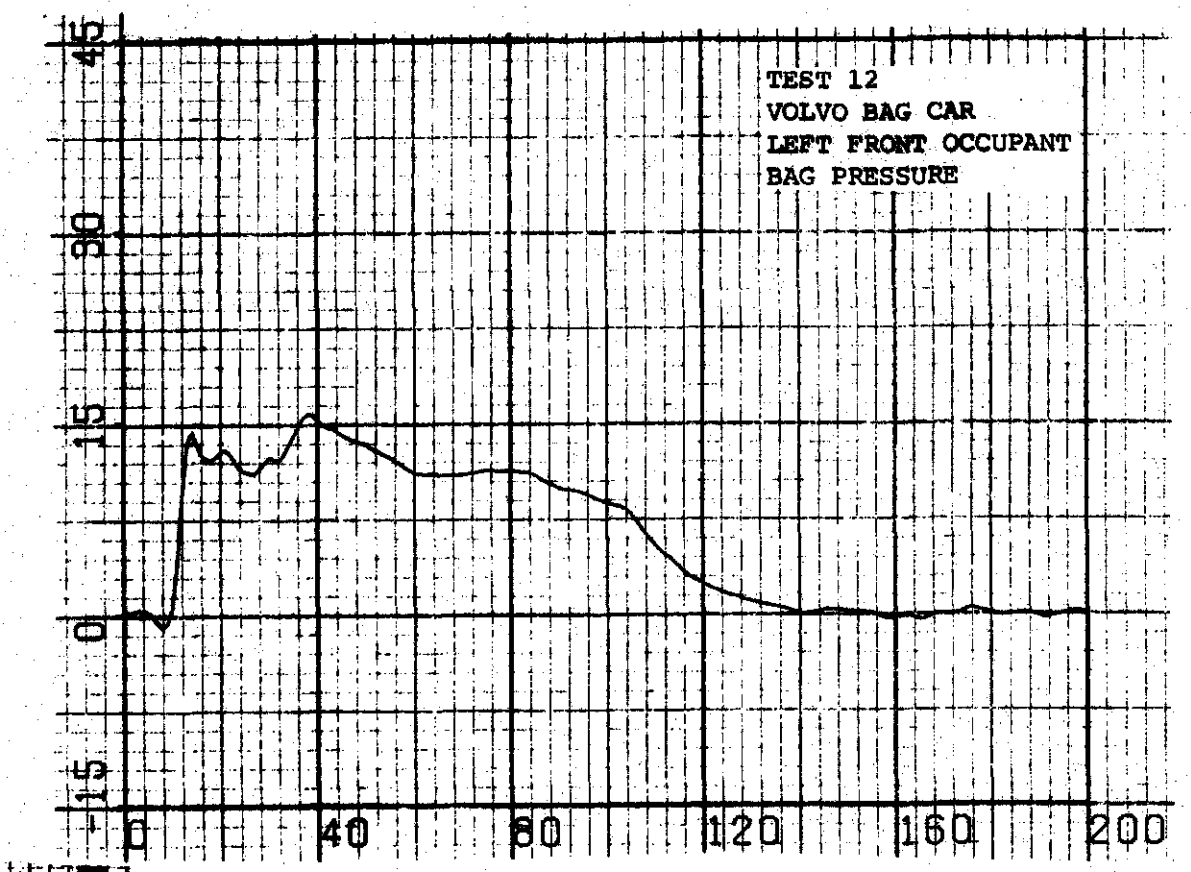

⊙ = AX
△ = AY
+ = AZ
TEST 12
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
-83.3
0
40
80
120
160
200

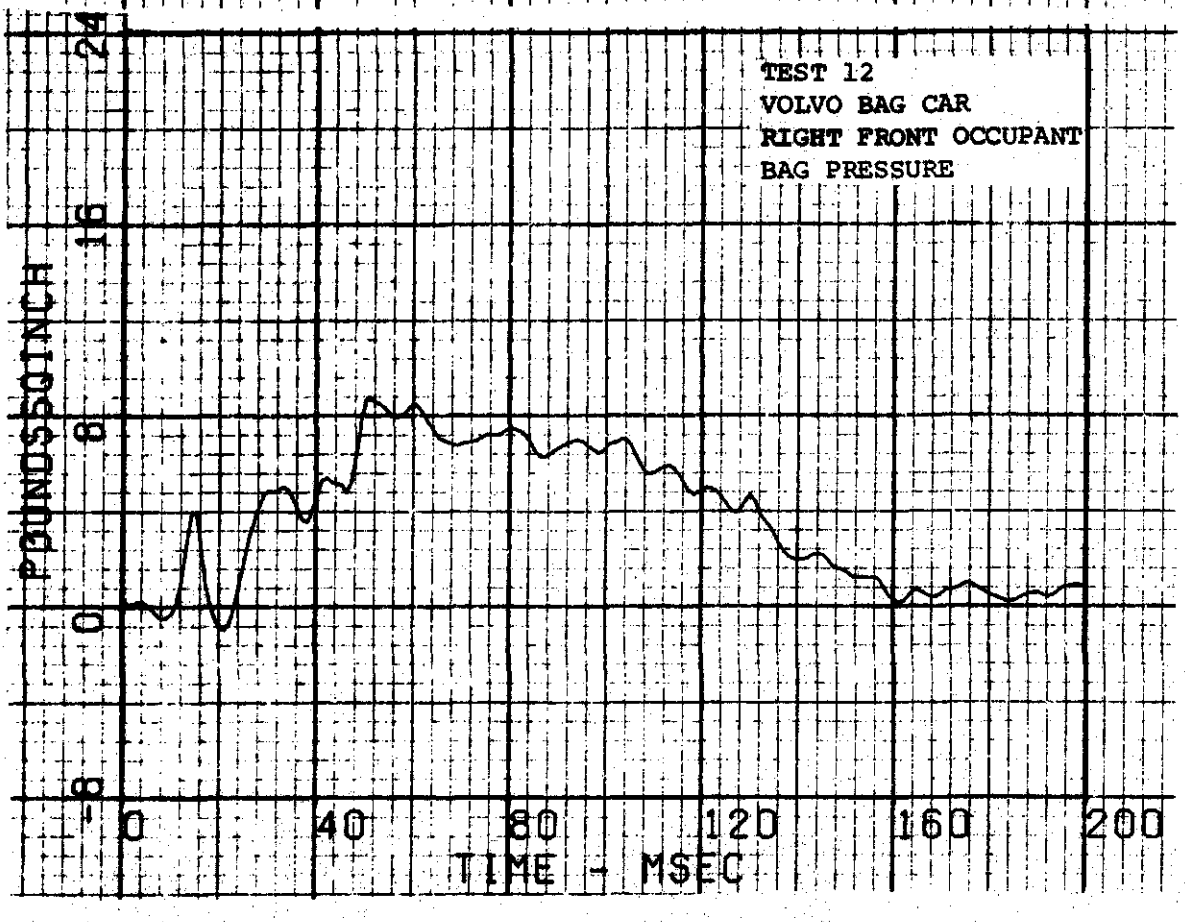

TEST 12
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
96.4
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

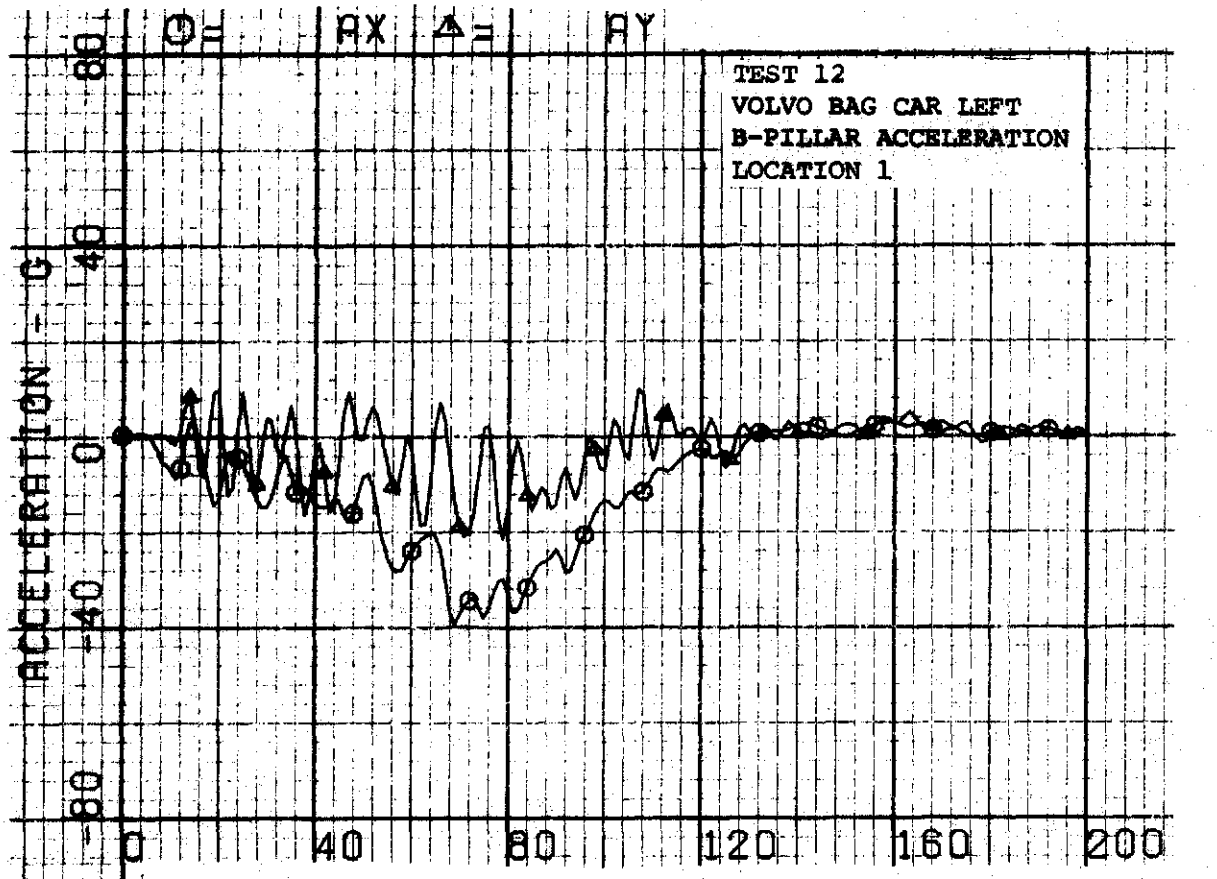

Φ= AX Δ= AY += AZ
TEST 12
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 12
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
TIME - MSEC

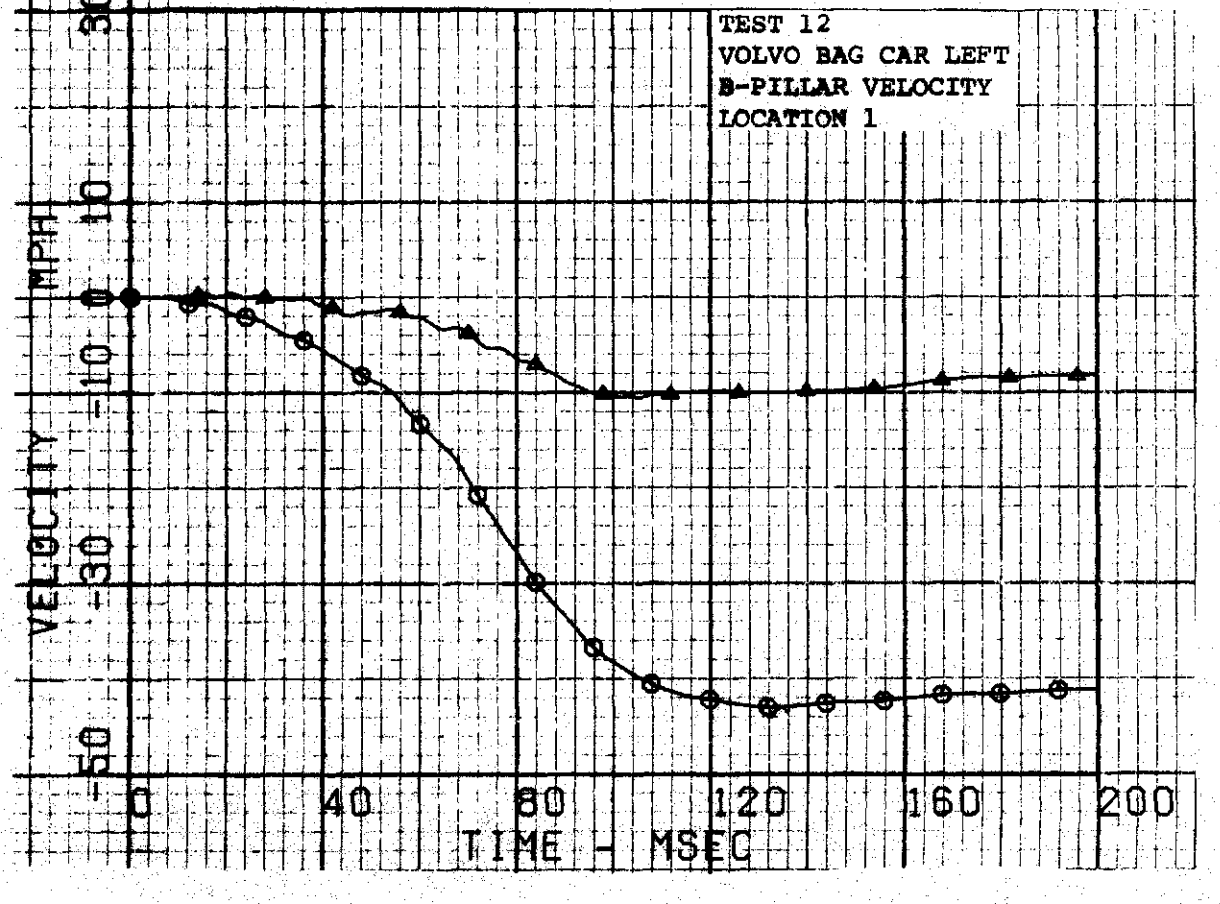

1433
TEST 12
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR
FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200

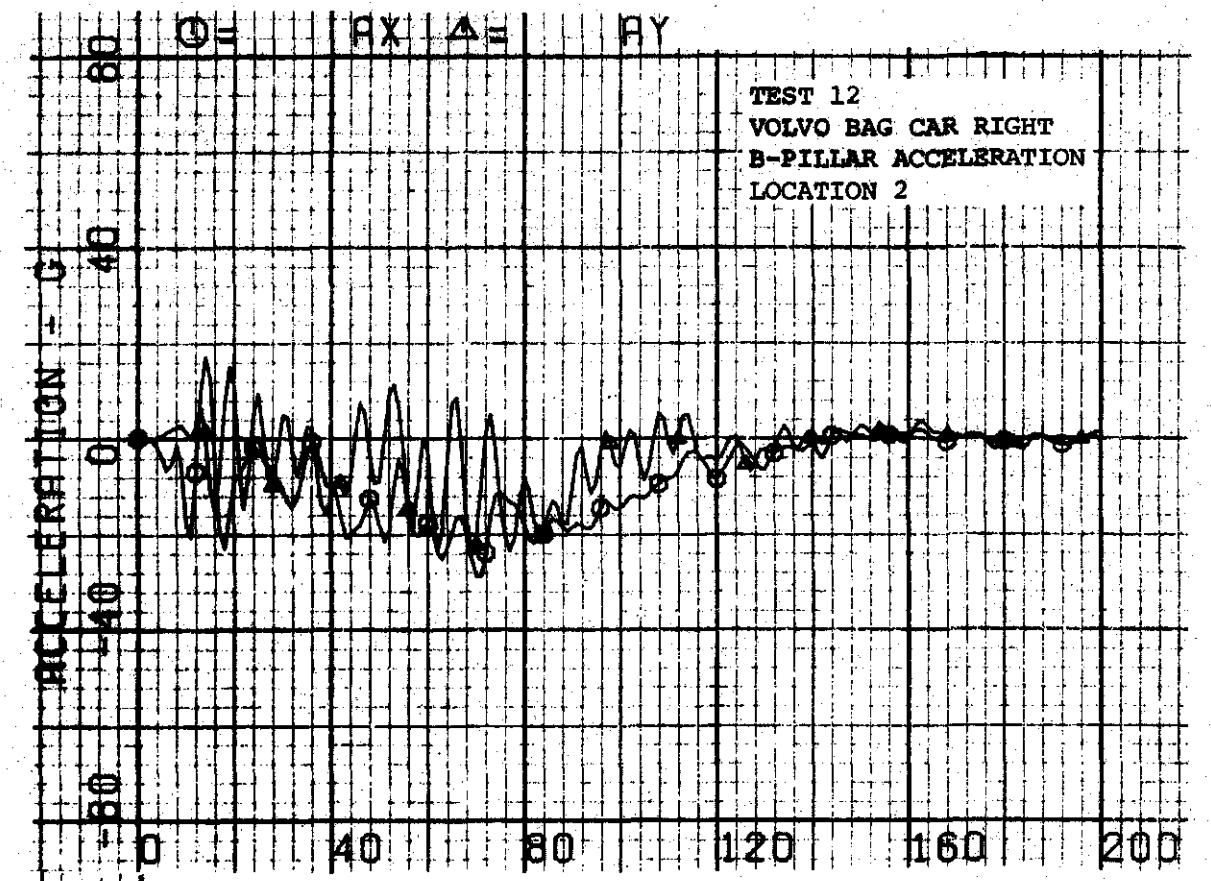

1507
TEST 12
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
RIGHT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC

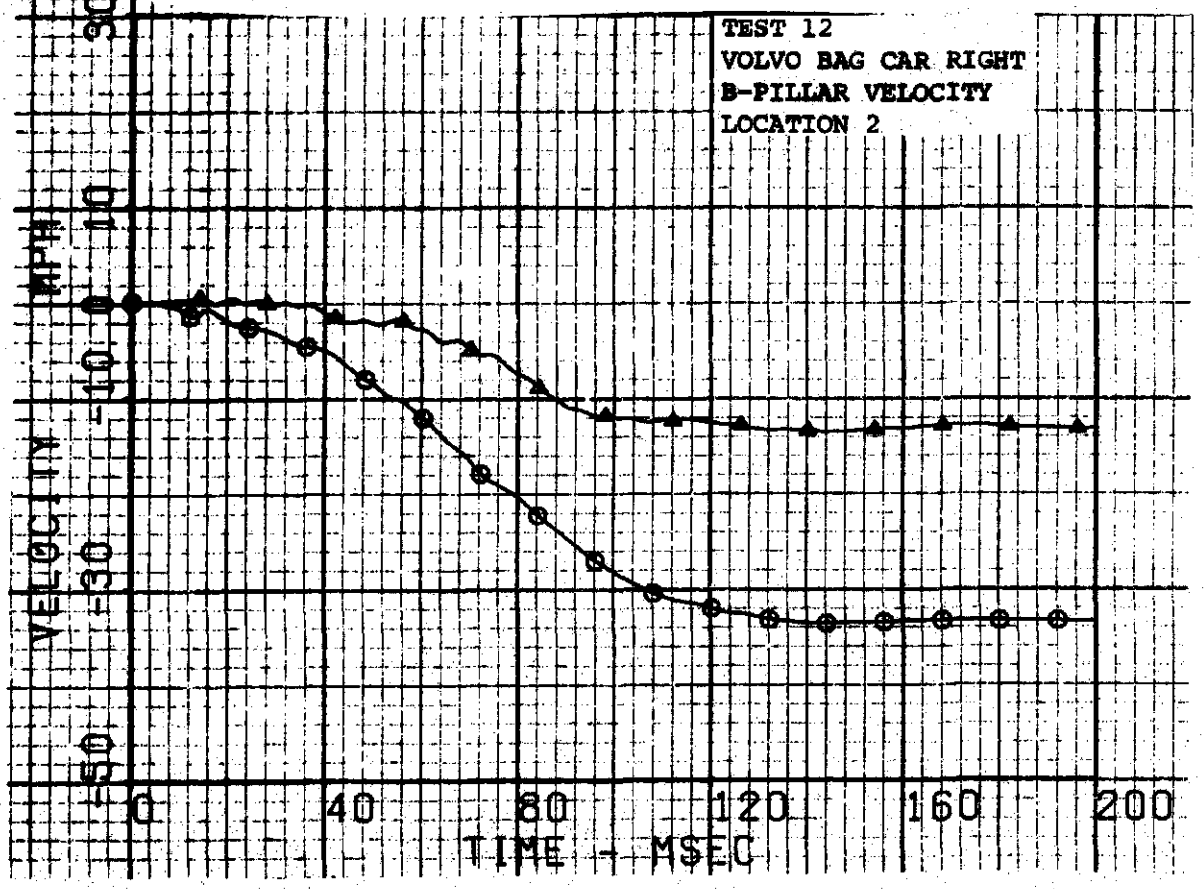

TEST 12
VOLVO BAG CAR
LEFT FRONT OCCUPANT
BAG PRESSURE
45
30
15
0
-15
0
40
80
120
160
200

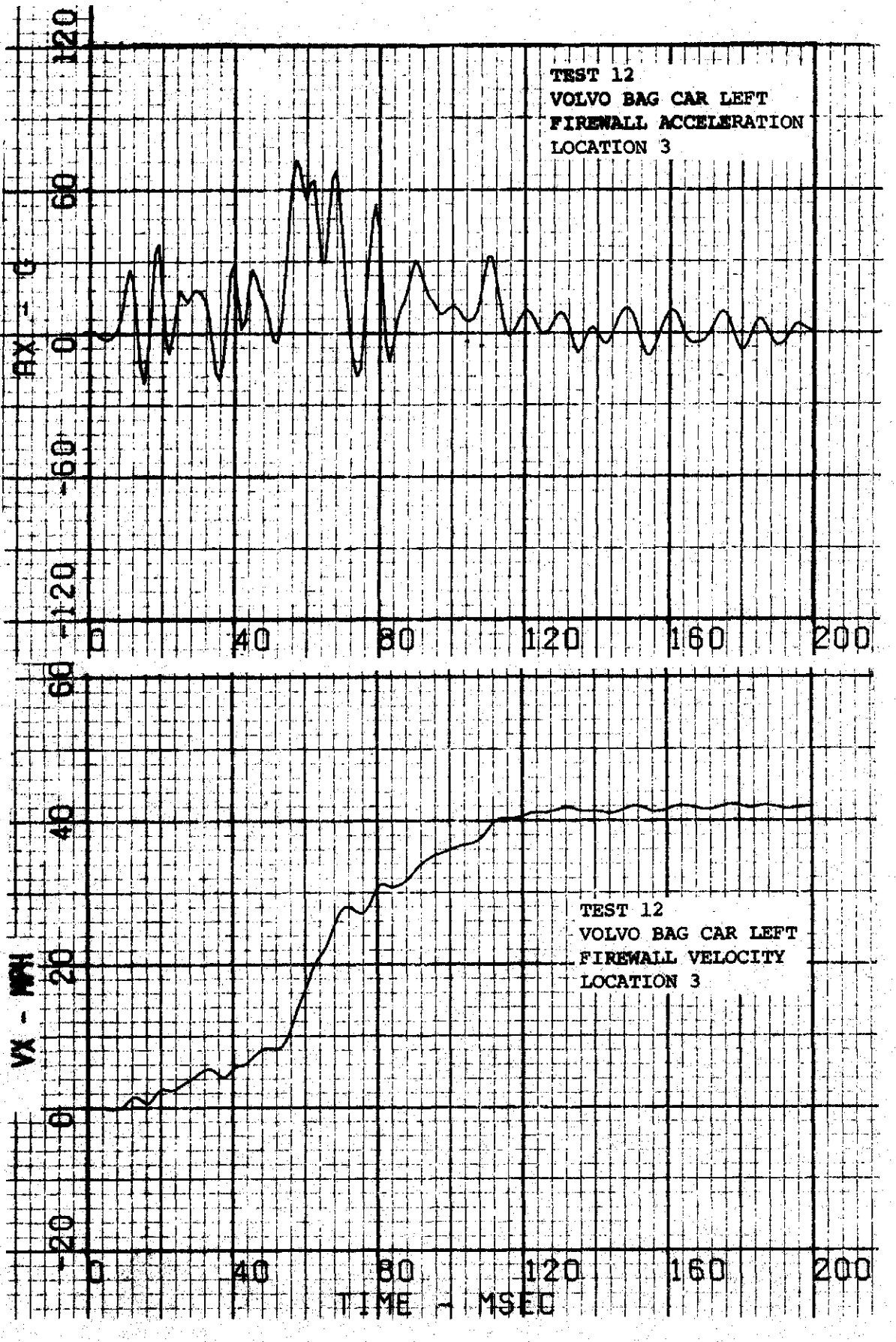

TEST 12
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
BAG PRESSURE
24
16
8
0
-8
POUNDS/INCH
0
40
80
120
160
200
TIME - MSEC

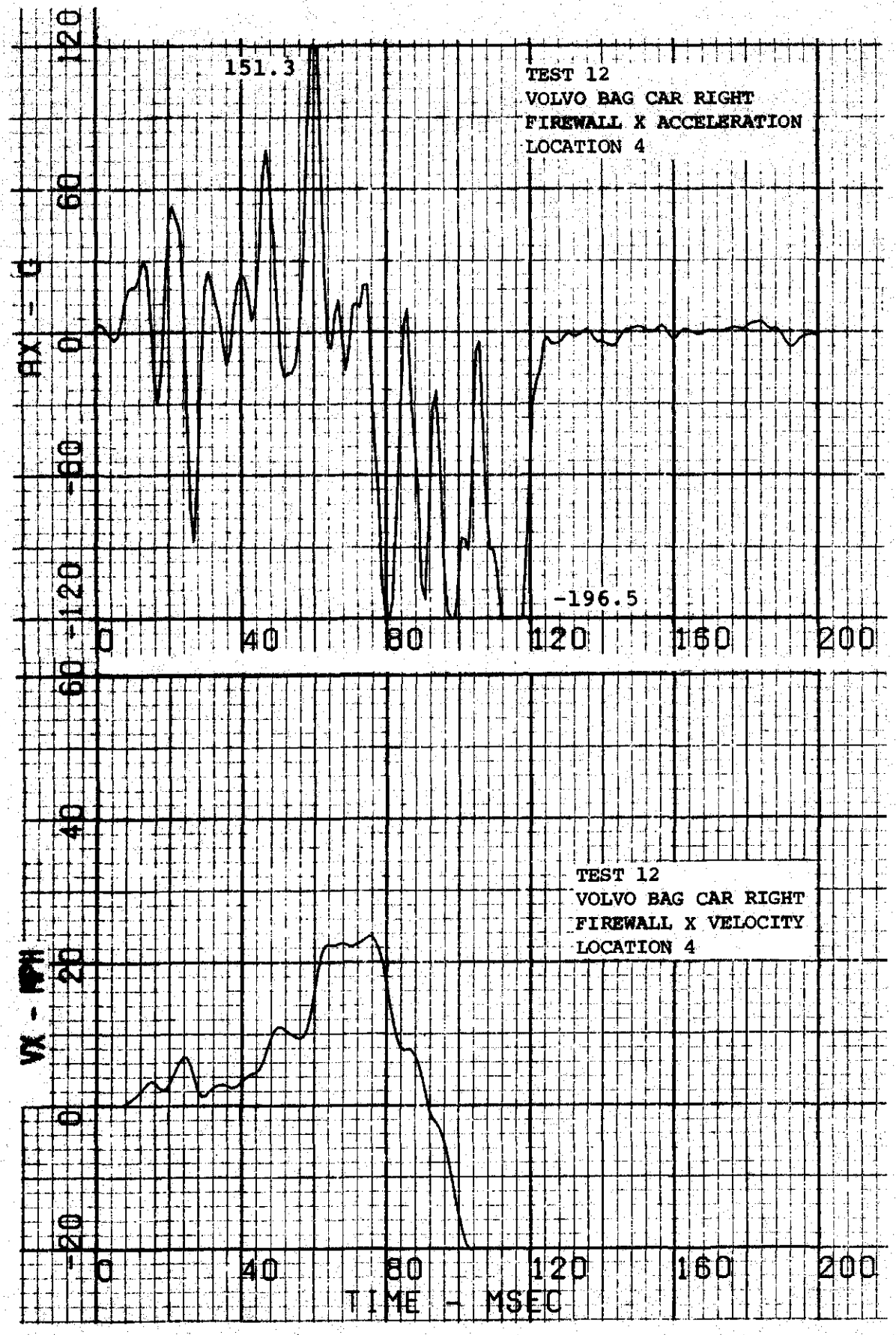

TEST 12
VOLVO BAG CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

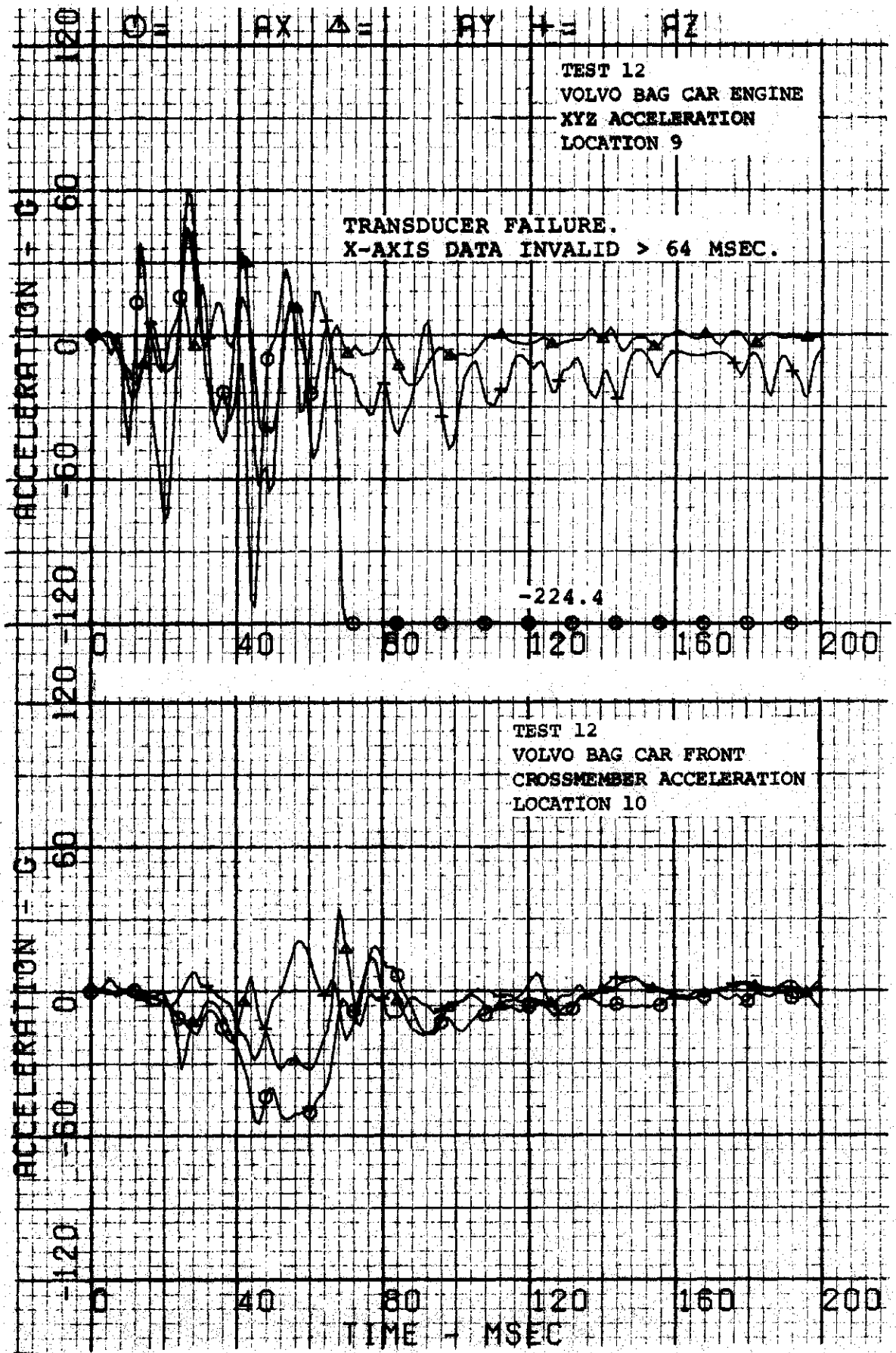

TEST 12
VOLVO BAG CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY - MPH
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

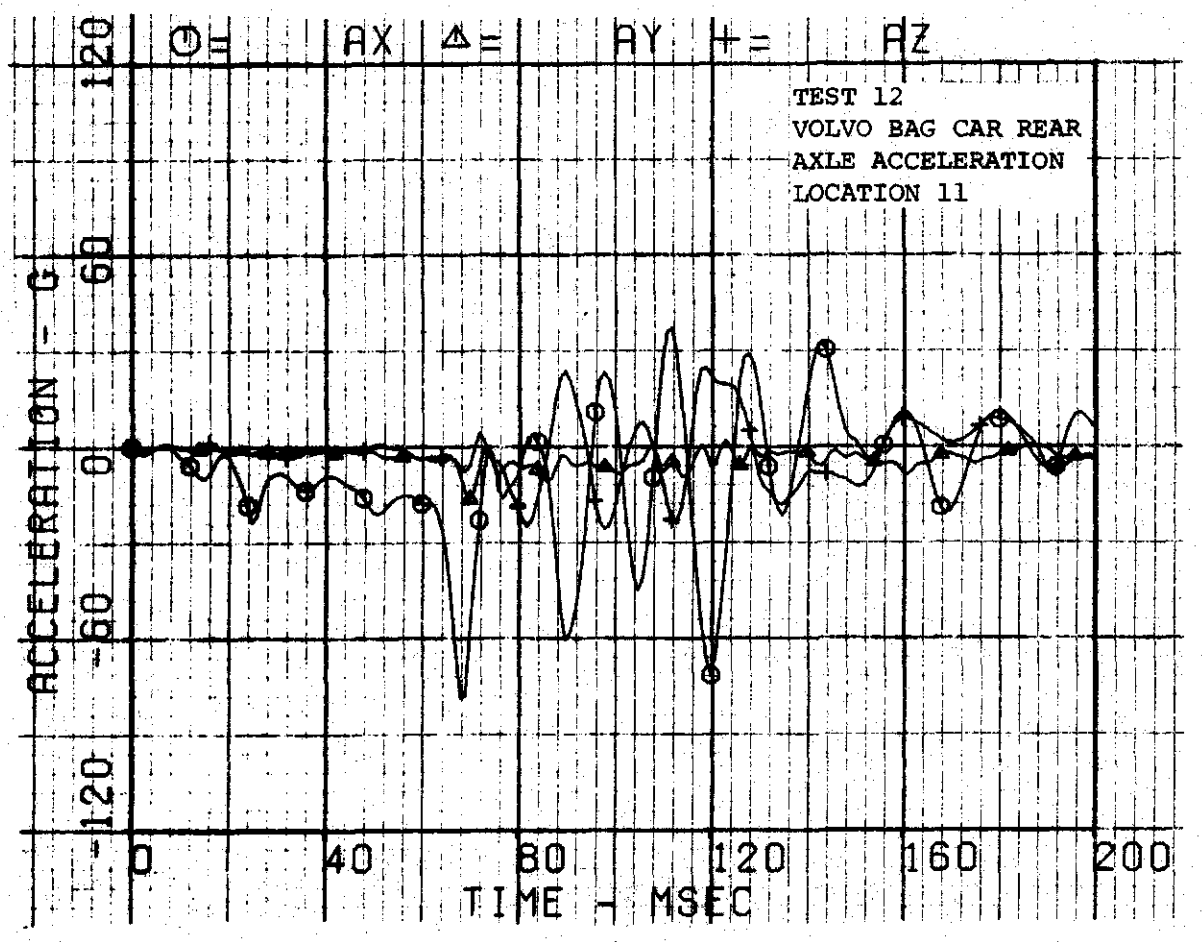

O= AX Δ= AY
TEST 12
VOLVO BAG CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

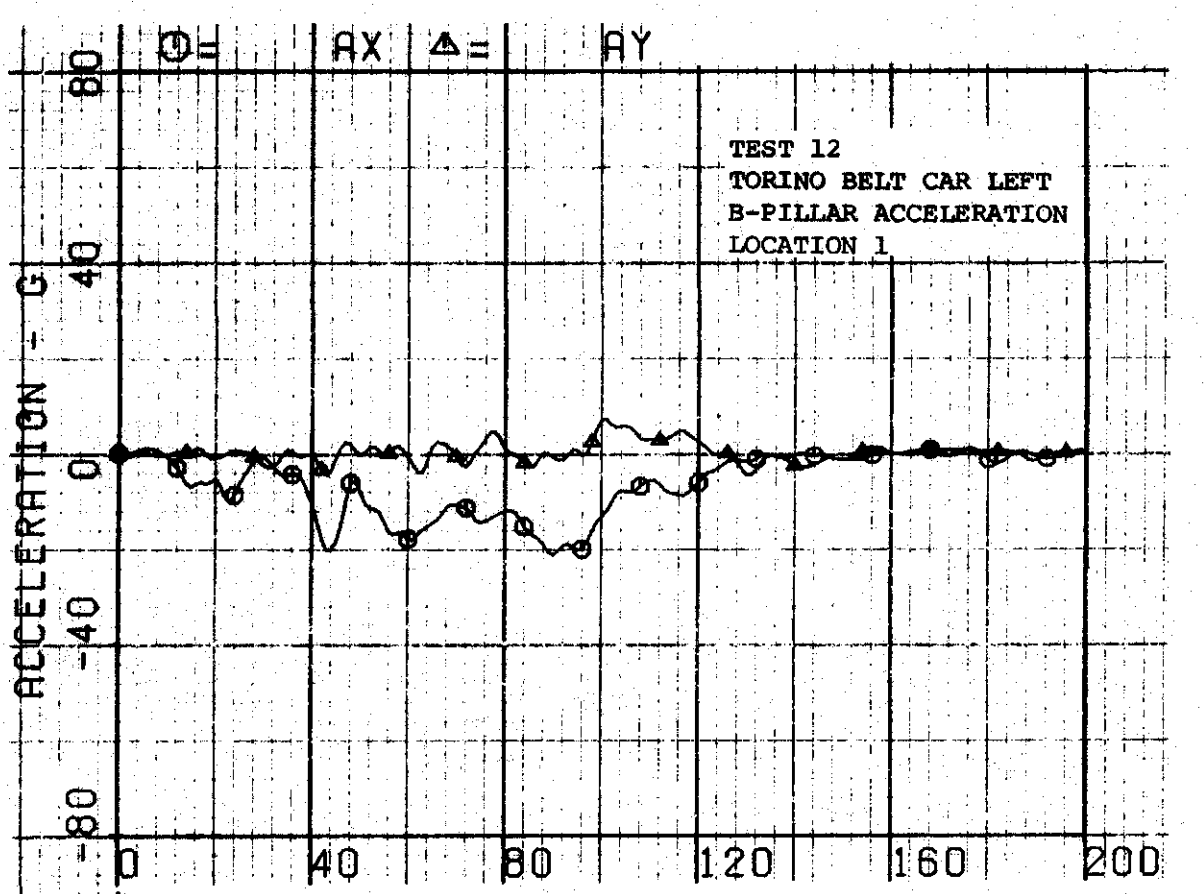

TEST 12
VOLVO BAG CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

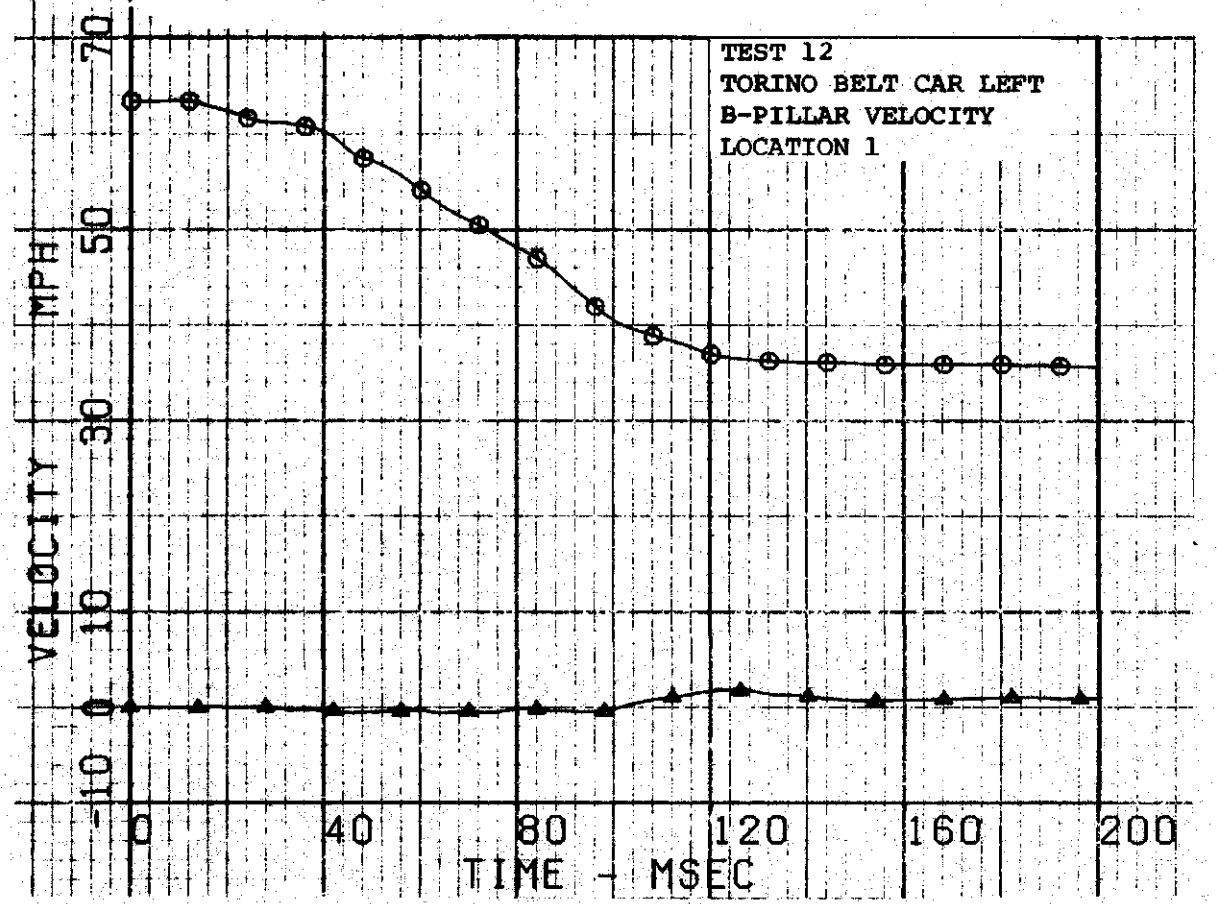

TEST 12
VOLVO BAG CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 12
VOLVO BAG CAR LEFT
FIREWALL VELOCITY
LOCATION 3
VX - MPH
60
40
20
0
-20
TIME - MSEC

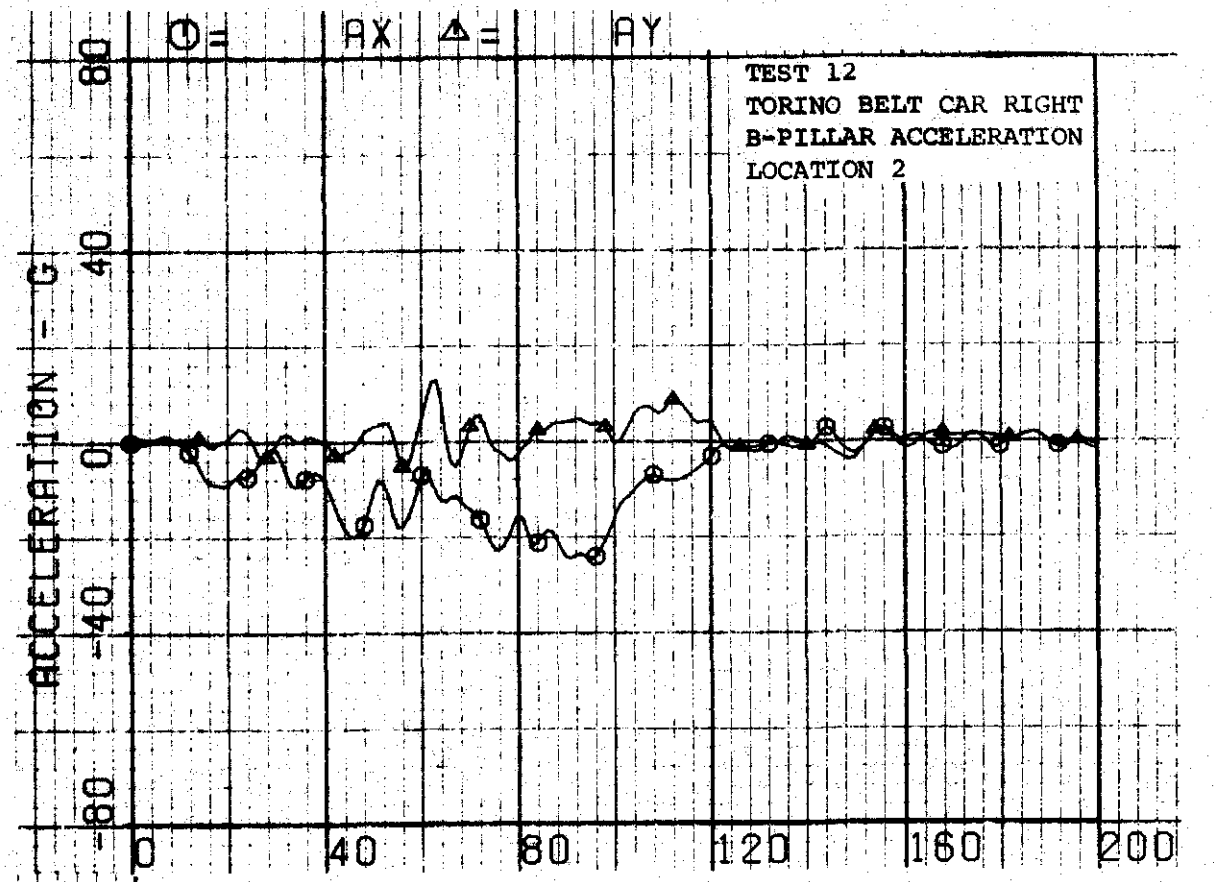

151.3
TEST 12
VOLVO BAG CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
-196.5
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 12
VOLVO BAG CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
VX - MPH
60
40
20
0
-20
TIME - MSEC


○= AX △= AY += AZ
TEST 12
VOLVO BAG CAR ENGINE
XYZ ACCELERATION
LOCATION 9
TRANSDUCER FAILURE.
X-AXIS DATA INVALID > 64 MSEC.
-224.4
ACCELERATION ± G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 12
VOLVO BAG CAR FRONT
CROSSMEMBER ACCELERATION
LOCATION 10
ACCELERATION ± G
TIME → MSEC


⊙ =
AX
Δ =
AY
+ =
AZ
TEST 12
VOLVO BAG CAR REAR
AXLE ACCELERATION
LOCATION 11
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


⊖= AX ⊿= AY
TEST 12
TORINO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 12
TORINO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC


Θ = AX
Δ = AY
TEST 12
TORINO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

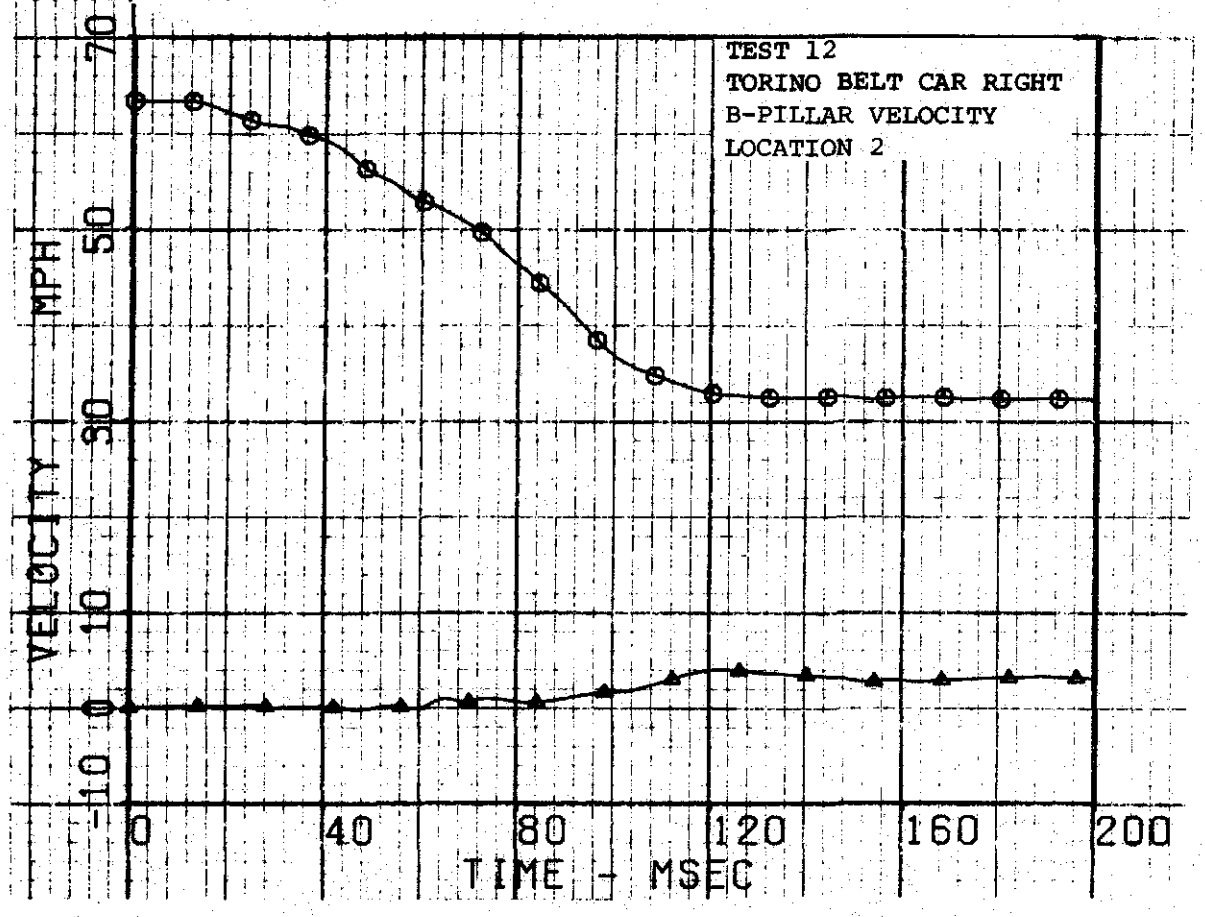

TEST 12
TORINO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC

Figure 3-30. Pre-test Vehicle Configuration - Test 12.

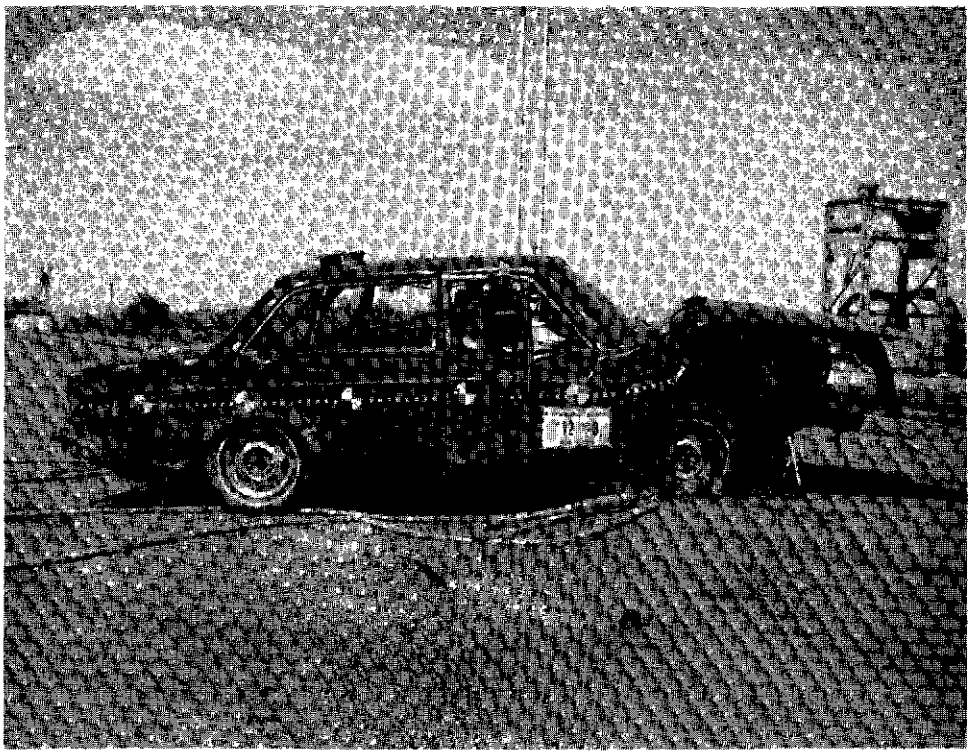


Figure 3-31. Post-test Vehicle Configuration - Test 12.

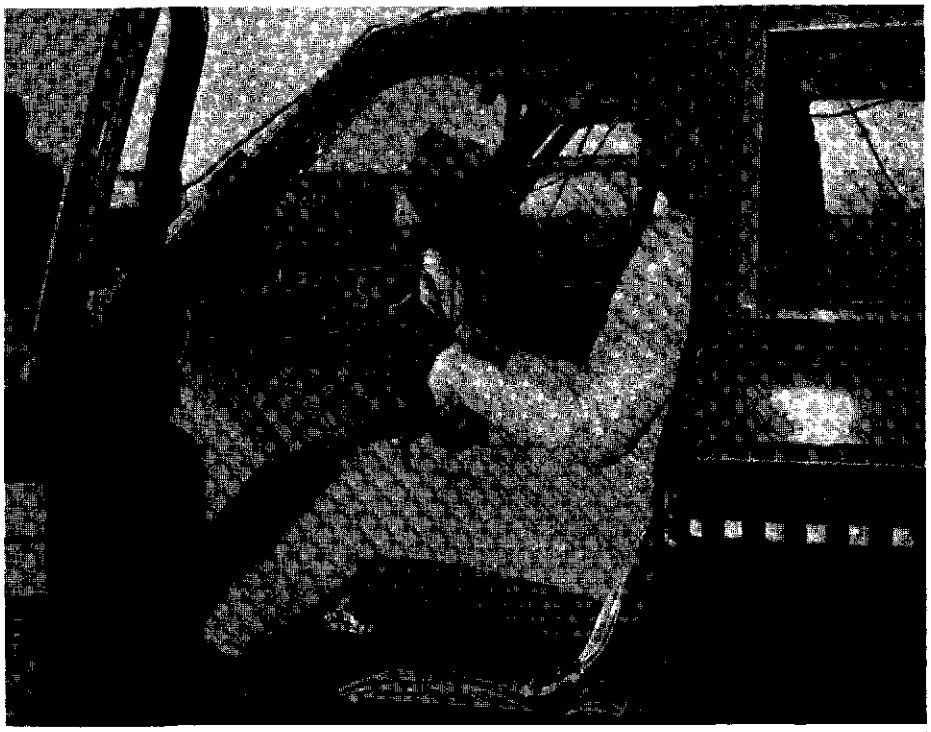


Figure 3-32. Pre-test RSV Driver Airbag - Test 12.

Figure 3-33. Post-test RSV Driver Airbag - Test 12.

Figure 3-34. Pre-test RSV Passenger Airbag - Test 12.

Figure 3-35. Post-test RSV Passenger Airbag - Test 12.

3.6 TEST NUMBER 13

The impact conditions for Test 13 were:

Configuration	Closing Speed
Torino-to-Volvo Left Oblique (30°)*	65.7 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Standard 3-Point Belt	RSV Driver Airbag
Right Front	Standard 3-Point Belt	RSV Passenger Airbag

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was structurally modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity and to accept the restraint systems that were installed in it. The extent of these modifications is shown in Figure 1-1.

The results of Test 13 are summarized in the following tables:

Table 3-21 - Summary of Vehicle Data (Test 13)

Table 3-22 - Injury Criteria Summary (Test 13)

Table 3-23 - Summary of Restraint System Data (Test 13)

Table 3-24 - Occupant Response Data (Test 13)

which are followed by Figure 3-36 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

*Major resultant acceleration vector 30° to centerline of target vehicle.

TABLE 3-21. SUMMARY OF VEHICLE DATA (TEST 13)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 13/April 1, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		494	437
TEST WEIGHT (lb)		4579	3238
IMPACT VELOCITY (mph)		65.7	0
VELOCITY CHANGE (mph)		33.4	42.5 (1)
PEAK RESULTANT ACCELERATION (G @ msec)			
	LOCATION 1	36.9 @ 88	48.3 @ 63
	LOCATION 2	31.6 @ 81	55.5 @ 76
MAXIMUM STATIC CRUSH (in.)			
	LEFT	11.0	29.0
	CENTER	22.0	21.5
	RIGHT	18.0	6.0

(1) Velocity change found by using average of resultant velocity vector (V_R) data for compartment accelerometer locations.

TABLE 3-22. INJURY CRITERIA SUMMARY (TEST 13)

VEHICLE B - AIRBAG CAR (VOLVO)				
	RSV DRIVER AIRBAG		RSV PASSENGER AIRBAG	
HIC	206		195	
HEAD G(1) @ msec	40.0 @ 94		38.3 @ 91	
CSI	234 @ 200		264 @ 200	
CHEST G(1) @ msec	38.3 @ 111		42.3 @ 111	
FEMUR LOAD (lb)	LEFT 1699	RIGHT 1278	LEFT (2)	RIGHT 523

(1) 3 msec clip.
(2) Transducer failure.

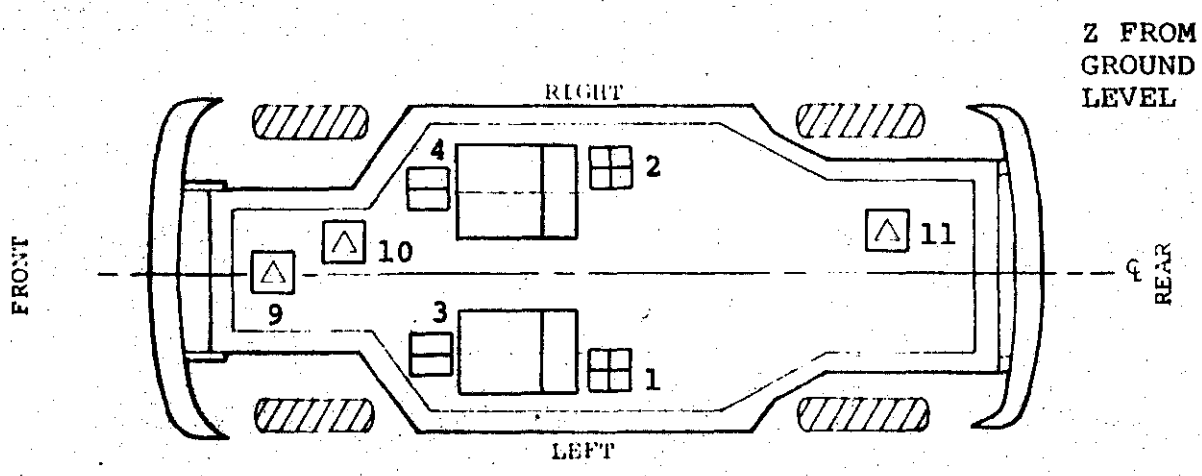
TABLE 3-23. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 13)

VEHICLE B - AIRBAG CAR (VOLVO)	
RSV DRIVER AIRBAG Peak Bag Pressure psi @ msec	18.6 @ 19
RSV PASSENGER AIRBAG Peak Bag Pressure psi @ msec	10.0 @ 50

TABLE 3-24. OCCUPANT RESPONSE DATA SUMMARY (TEST 13)

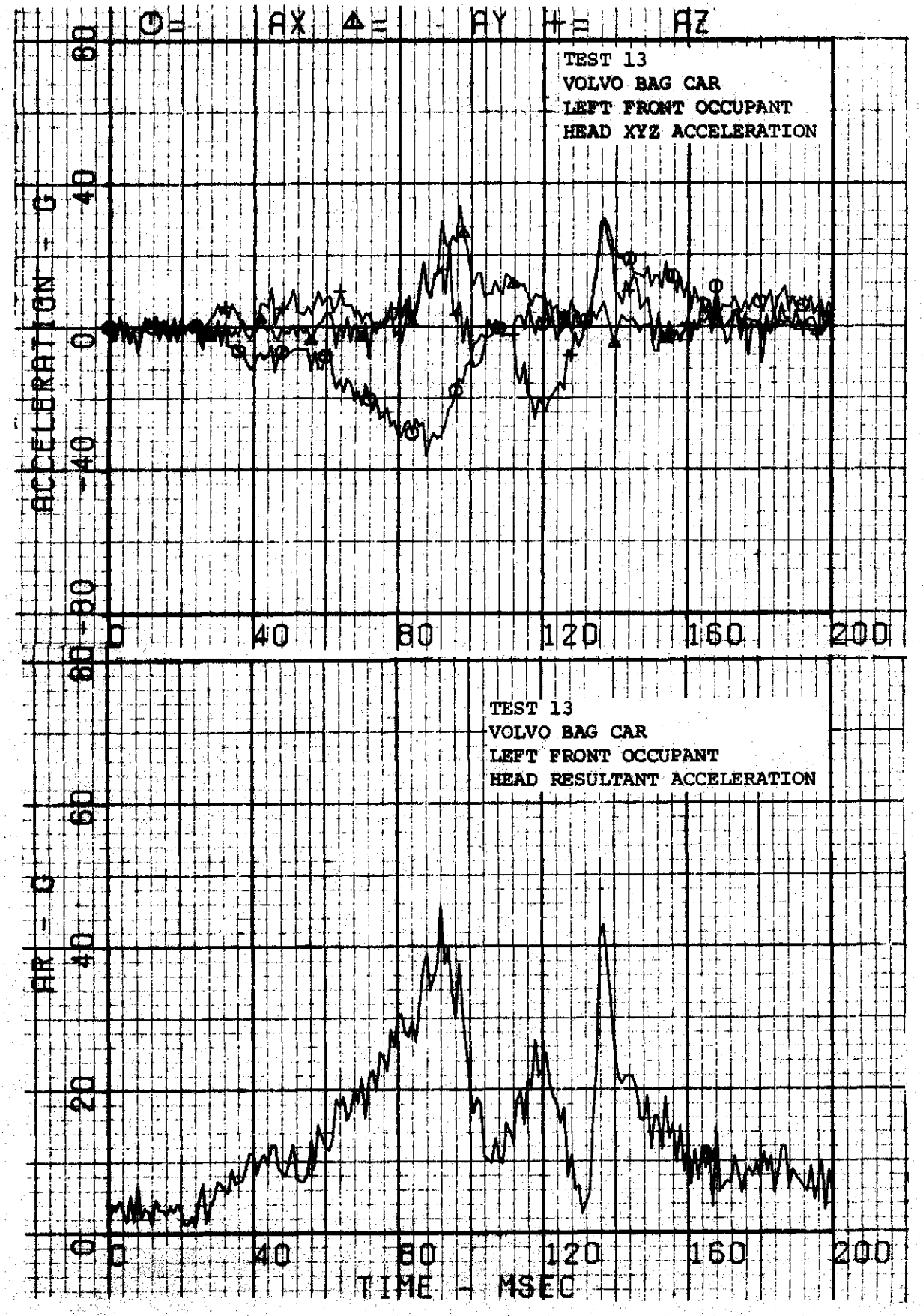
		VEHICLE B - AIRBAG CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD					
	X	35.9	88	36.9	87
	Y	34.2	97	28.6	116
	Z	30.6	137	18.3	136
	R(1)	40.0	94	38.3	91
	HIC	206 @ 58-156		195 @ 68-147	
CHEST					
	X	18.8	90	39.7	109
	Y	37.2	116	19.9	102
	Z	20.8	109	16.8	82
	R(1)	38.3	111	42.3	111
	SI	234 @ 200		264 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS					
	LF	1699	96	(2)	
	RT	1278	90	523	63

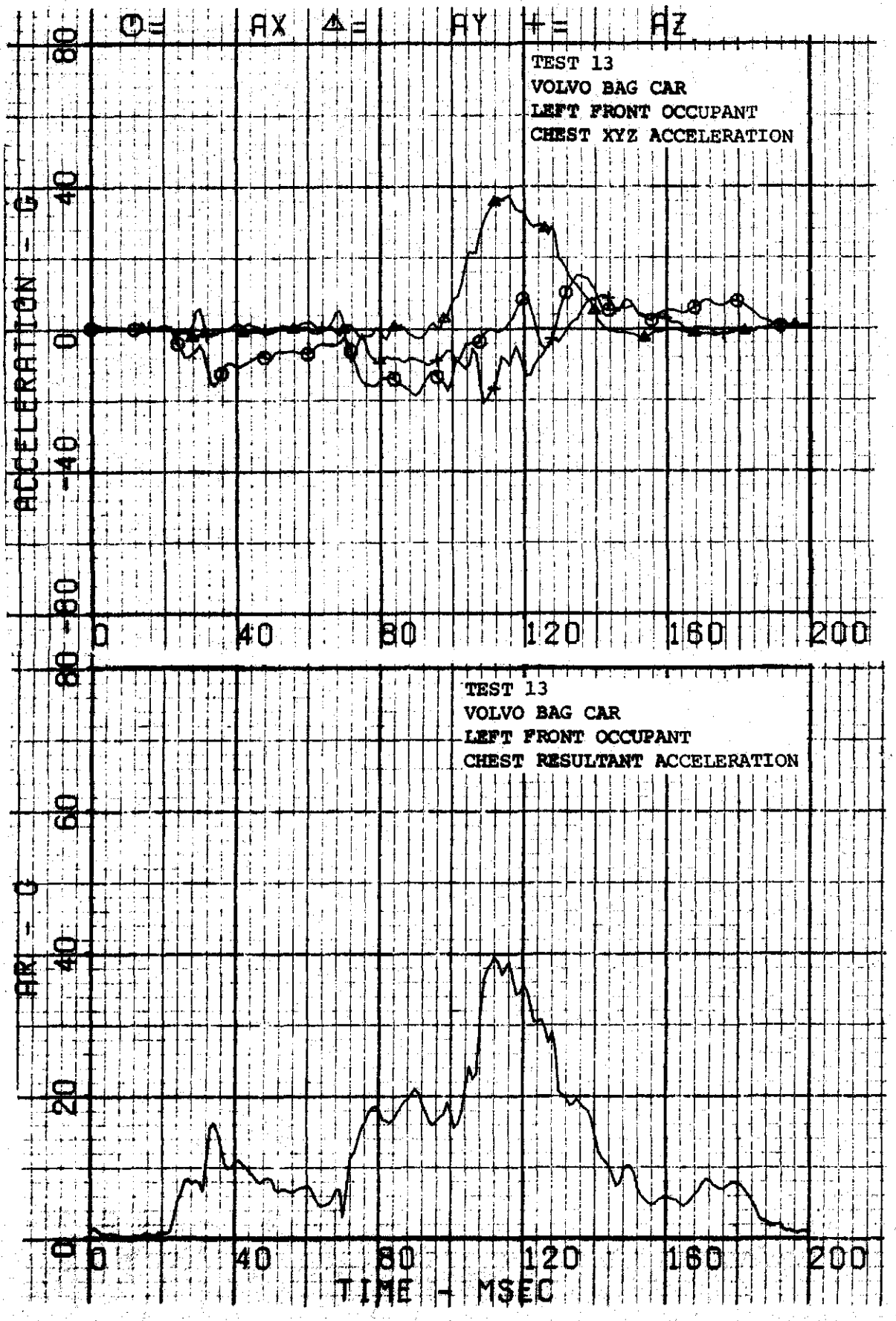
(1) 3 msec clip, components not clipped.
(2) Transducer failure.

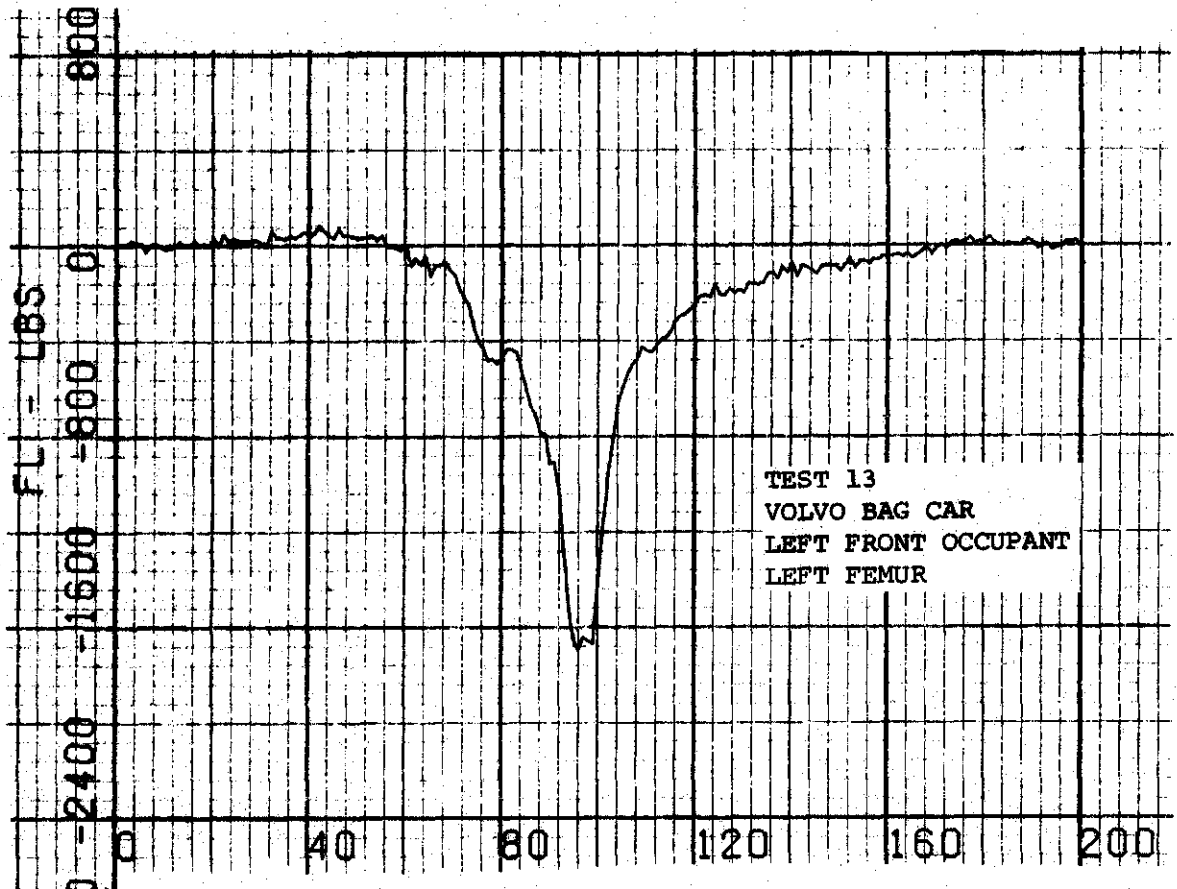


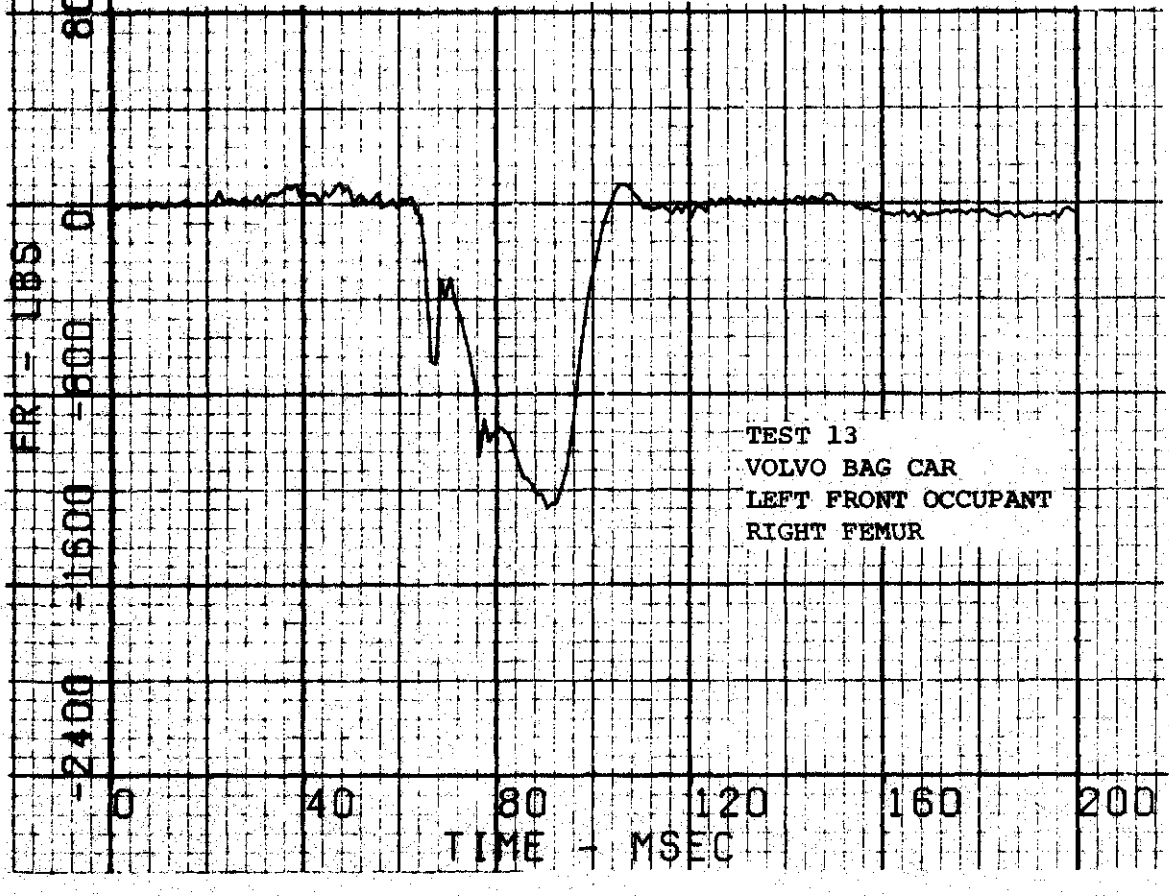
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
9	Engine Block	X	X	X
10	Front Crossmember	X	X	X
11	Rear Axle	X	X	X

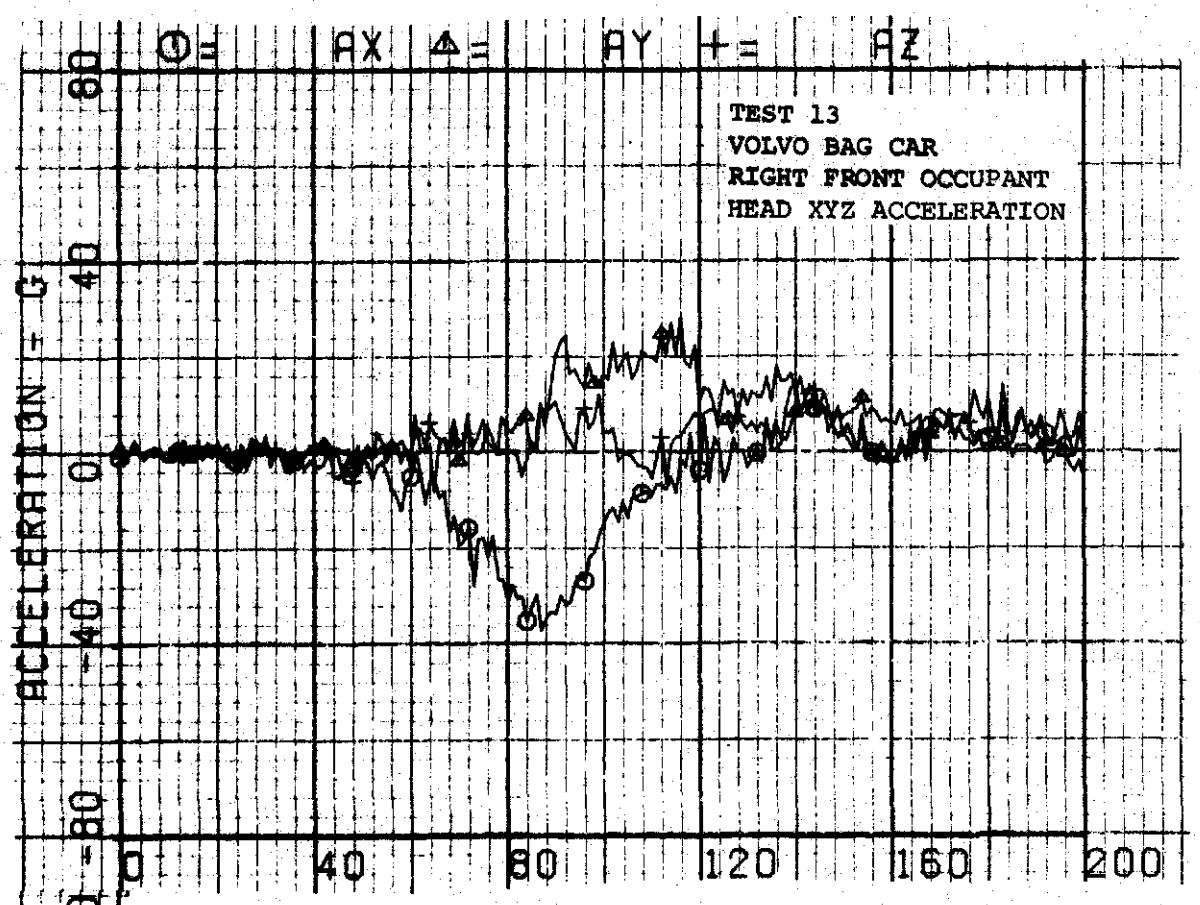
Figure 3-36. Vehicle Accelerometer Locations - Test 13.

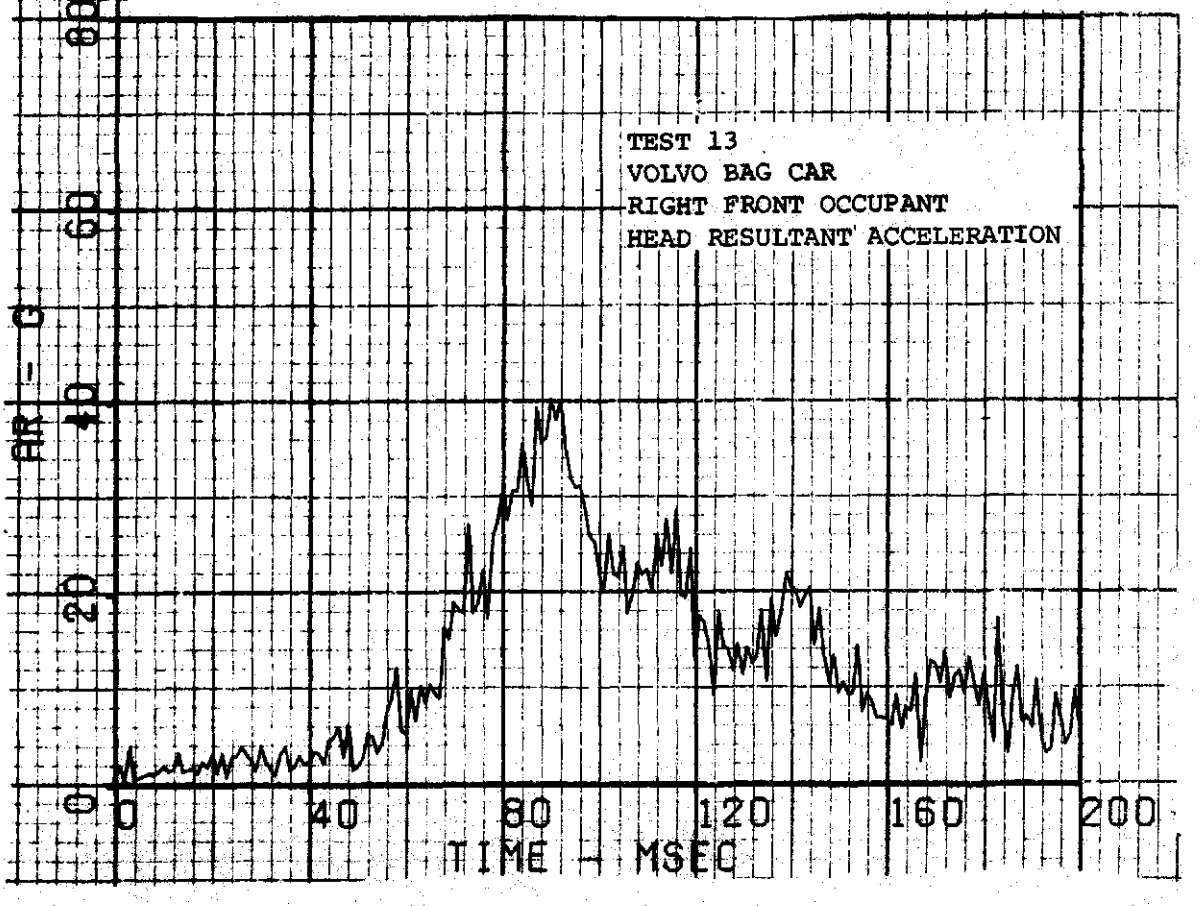

O= AX Δ= AY + = AZ
TEST 13
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 13
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

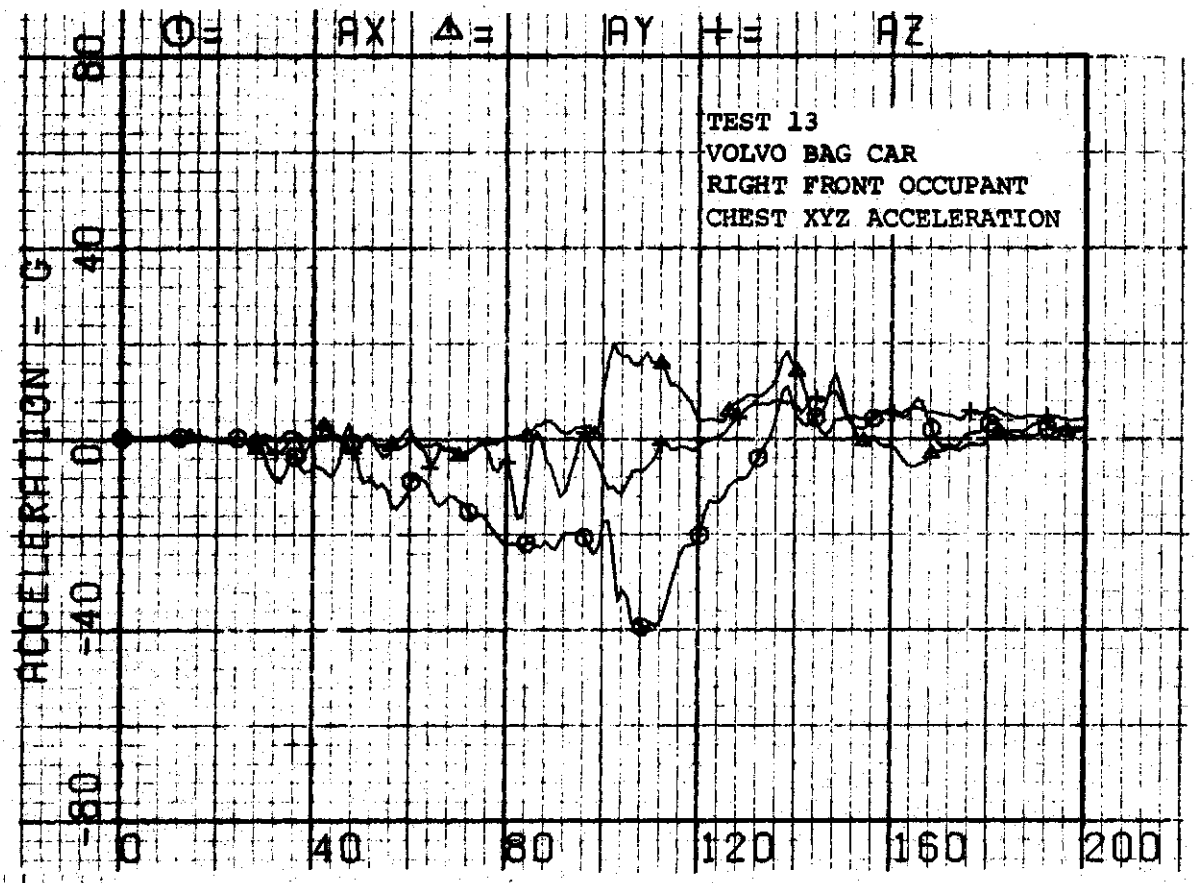

○= AX △= AY += AZ
TEST 13
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 13
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

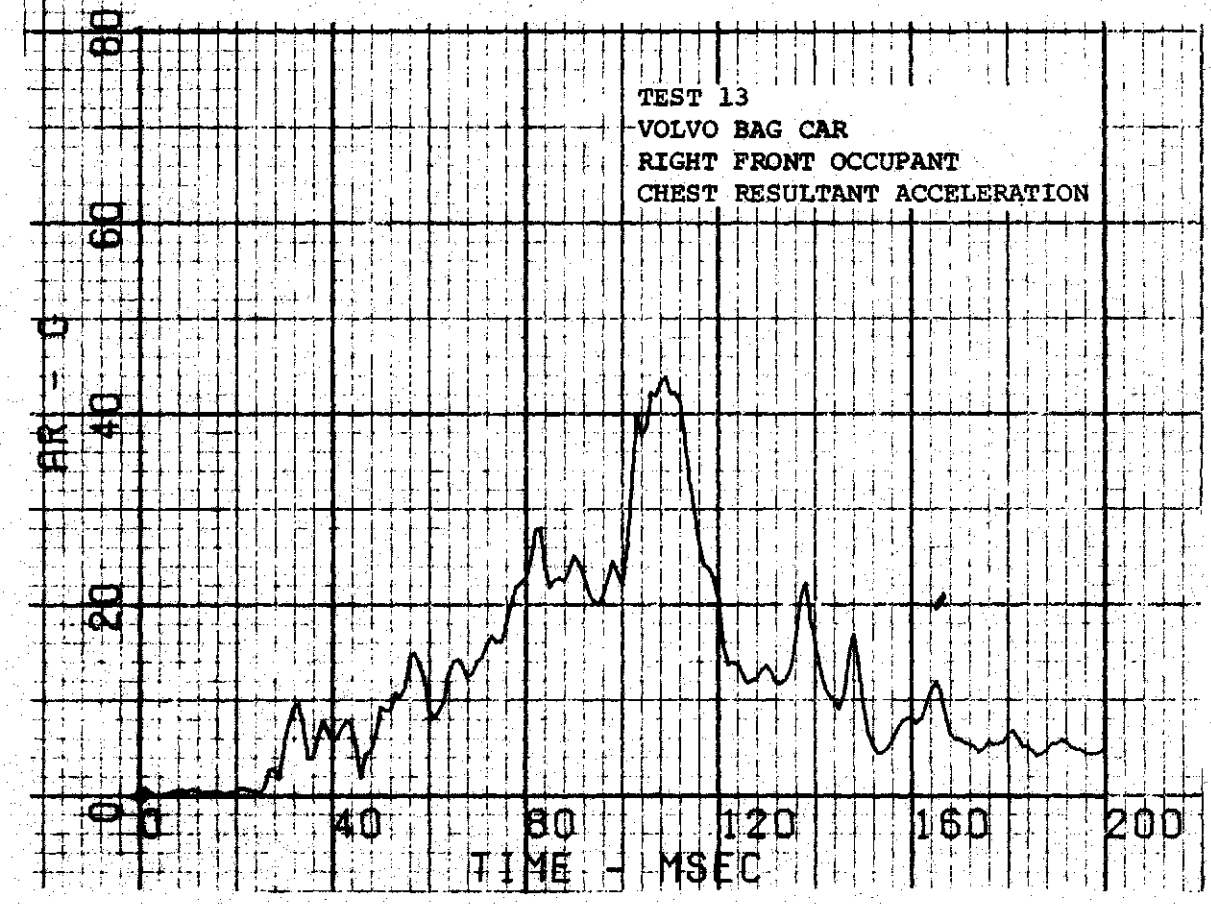

FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 13
VOLVO BAG CAR
LEFT FRONT OCCUPANT
LEFT FEMUR

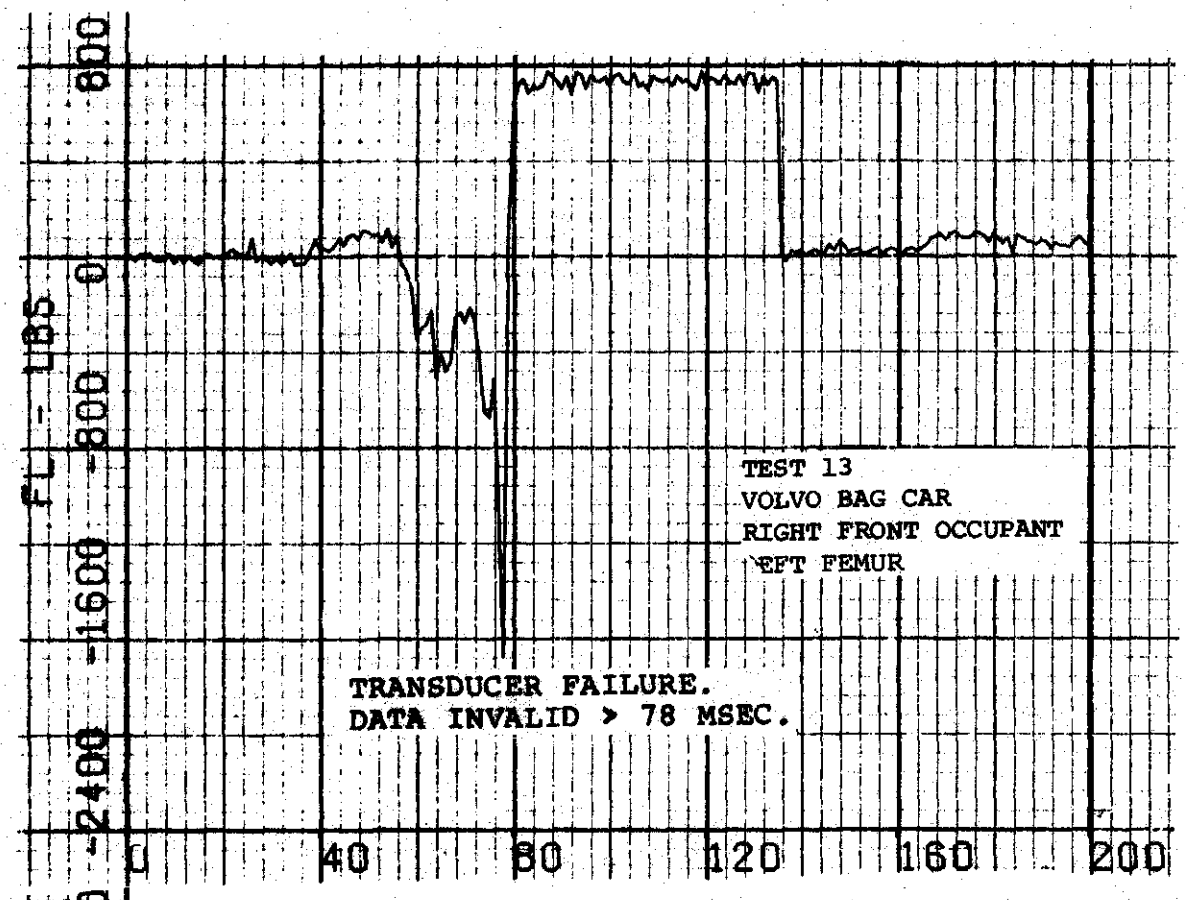

FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC
TEST 13
VOLVO BAG CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR

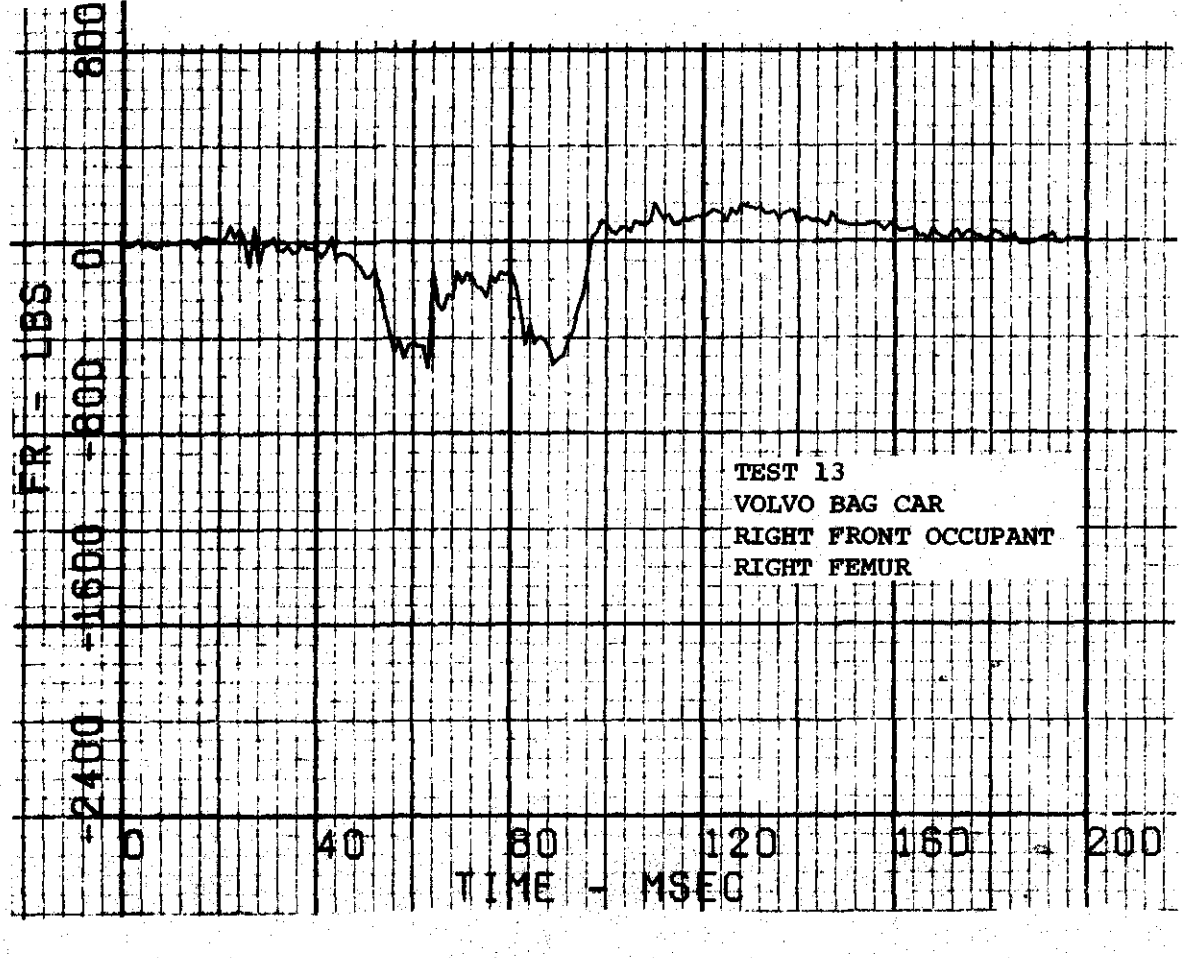

○= AX △= AY += AZ
TEST 13
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

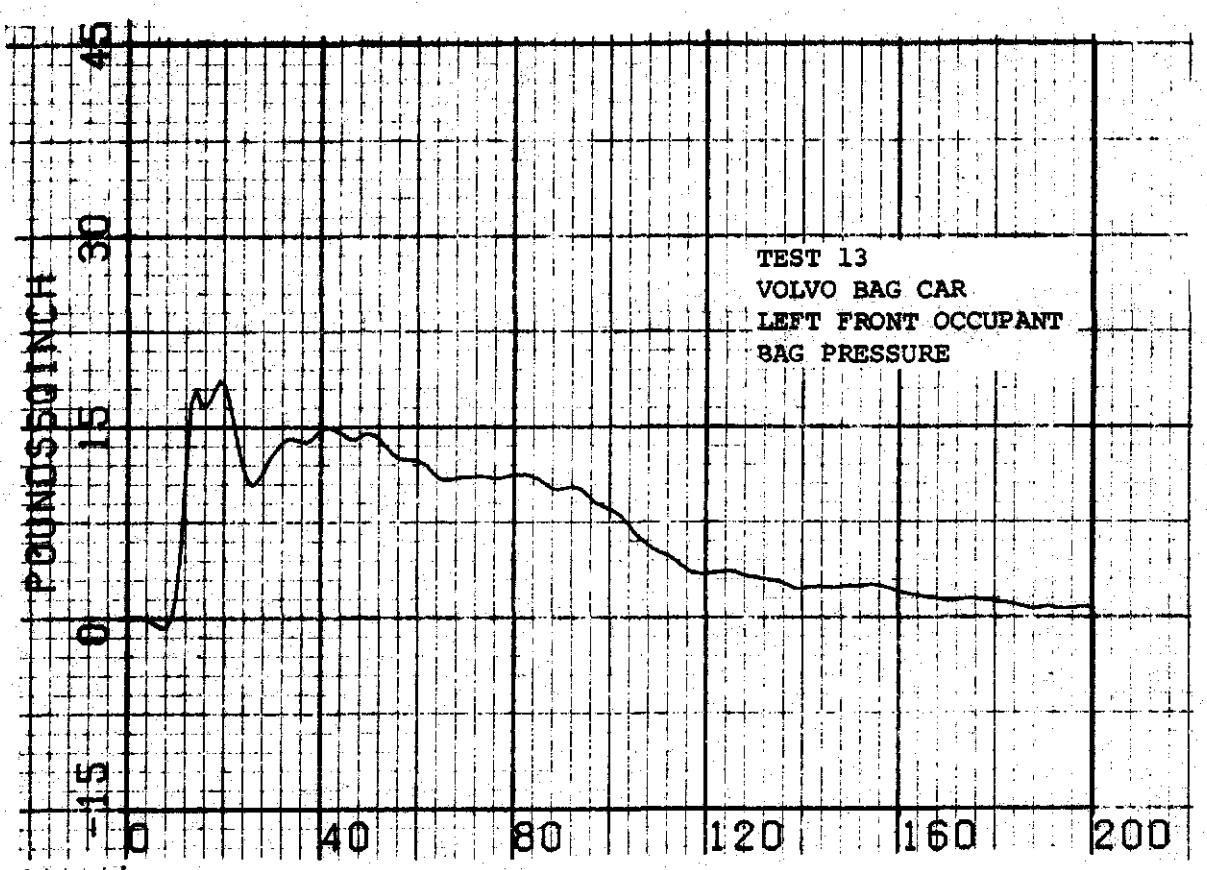

TEST 13
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

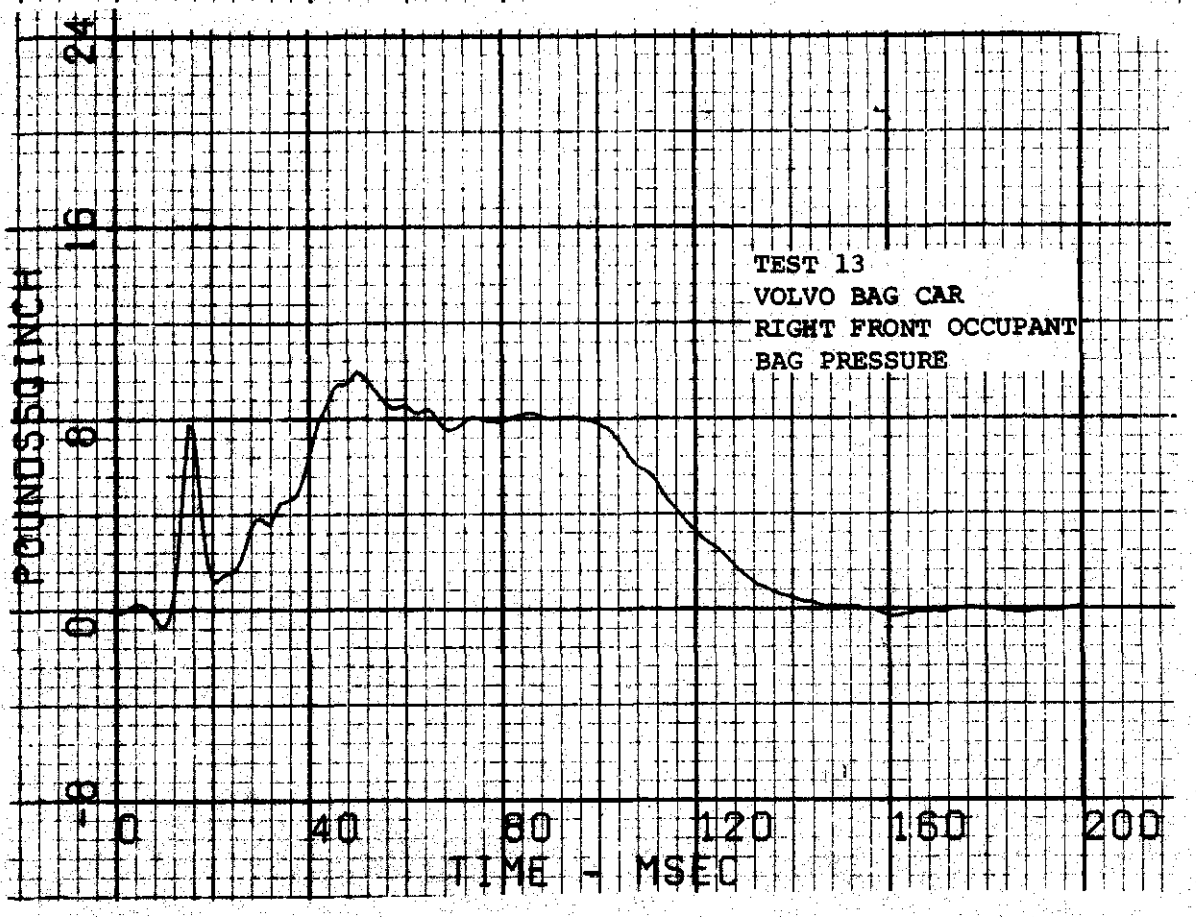

○= AX △= AY += AZ
TEST 13
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

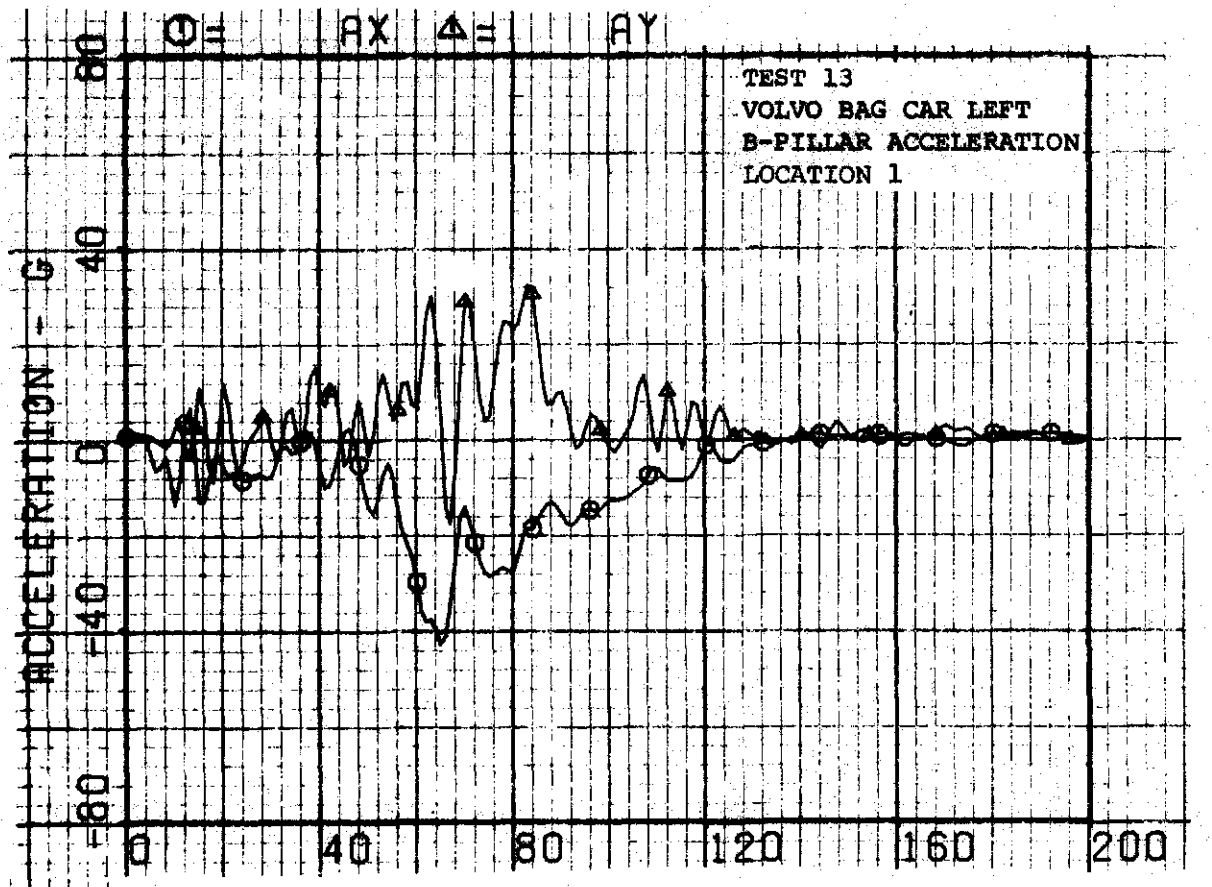

TEST 13
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

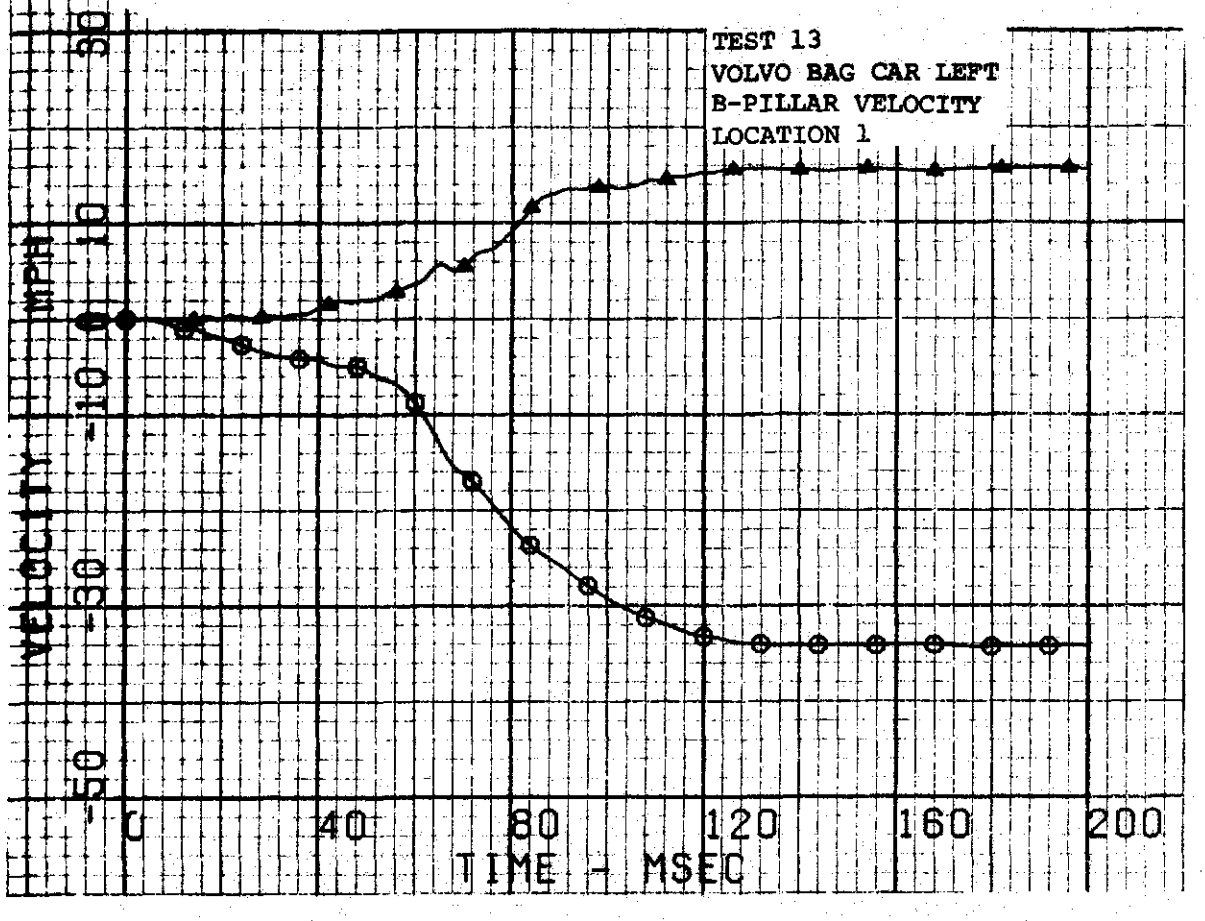

FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 13
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR
TRANSDUCER FAILURE.
DATA INVALID > 78 MSEC.

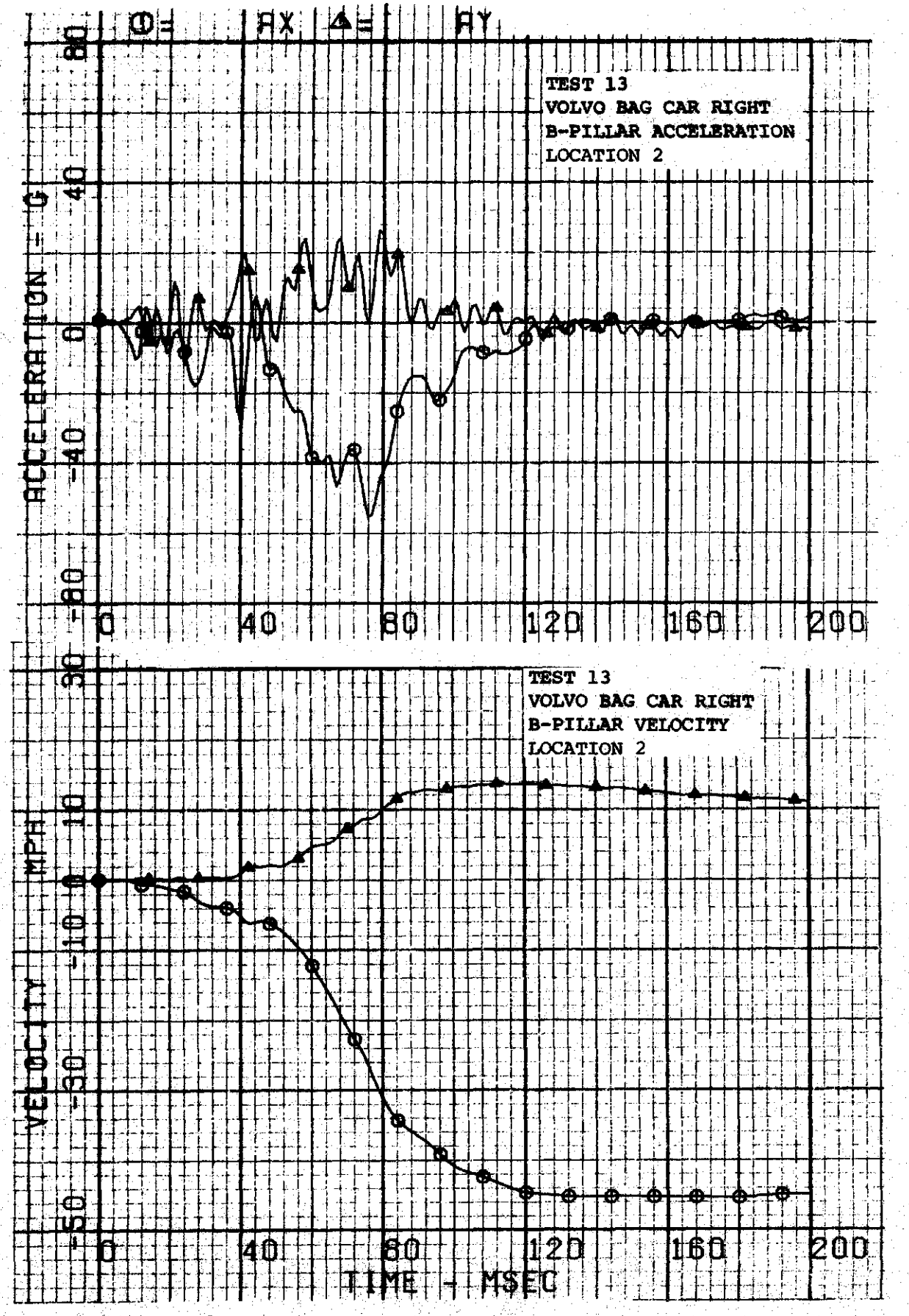

FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC
TEST 13
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
RIGHT FEMUR

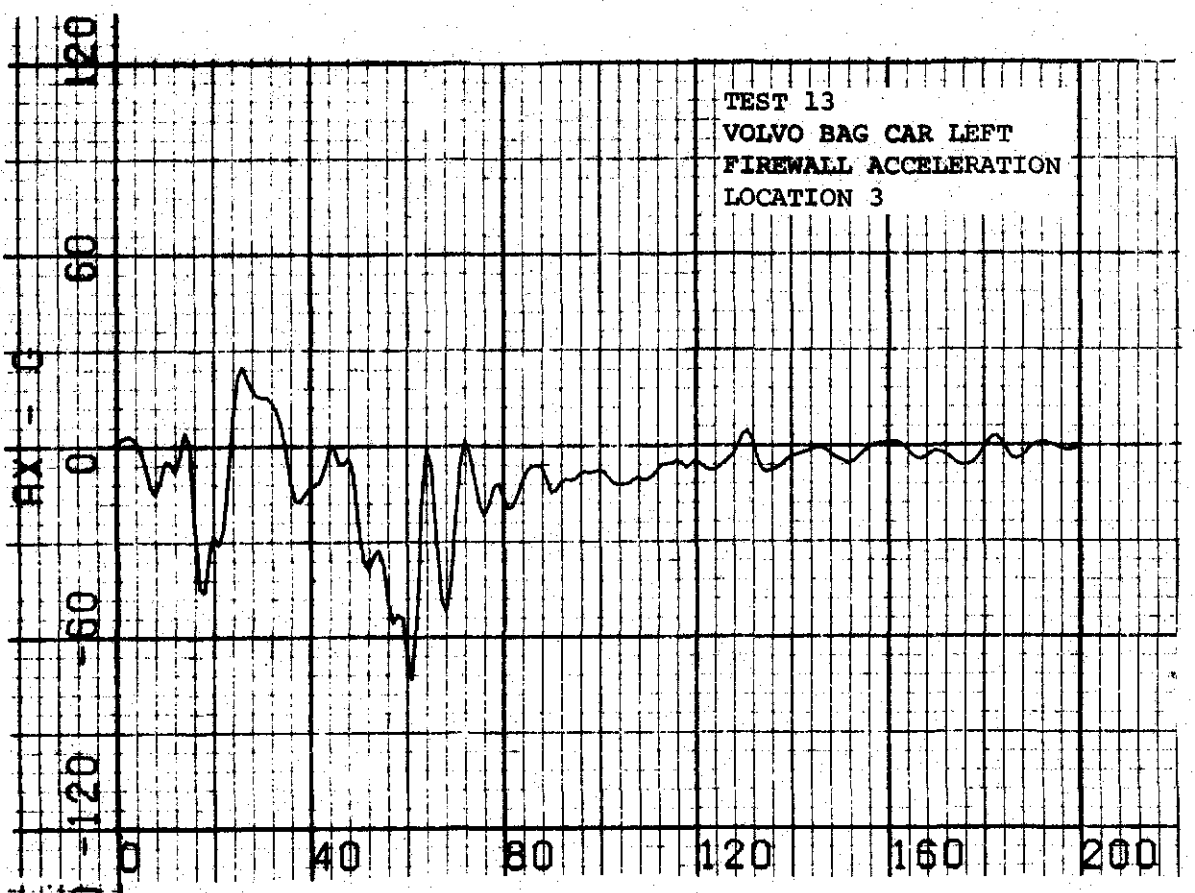

TEST 13
VOLVO BAG CAR
LEFT FRONT OCCUPANT
BAG PRESSURE
POUNDS/SQ INCH
45
30
15
0
-15
0
40
80
120
160
200

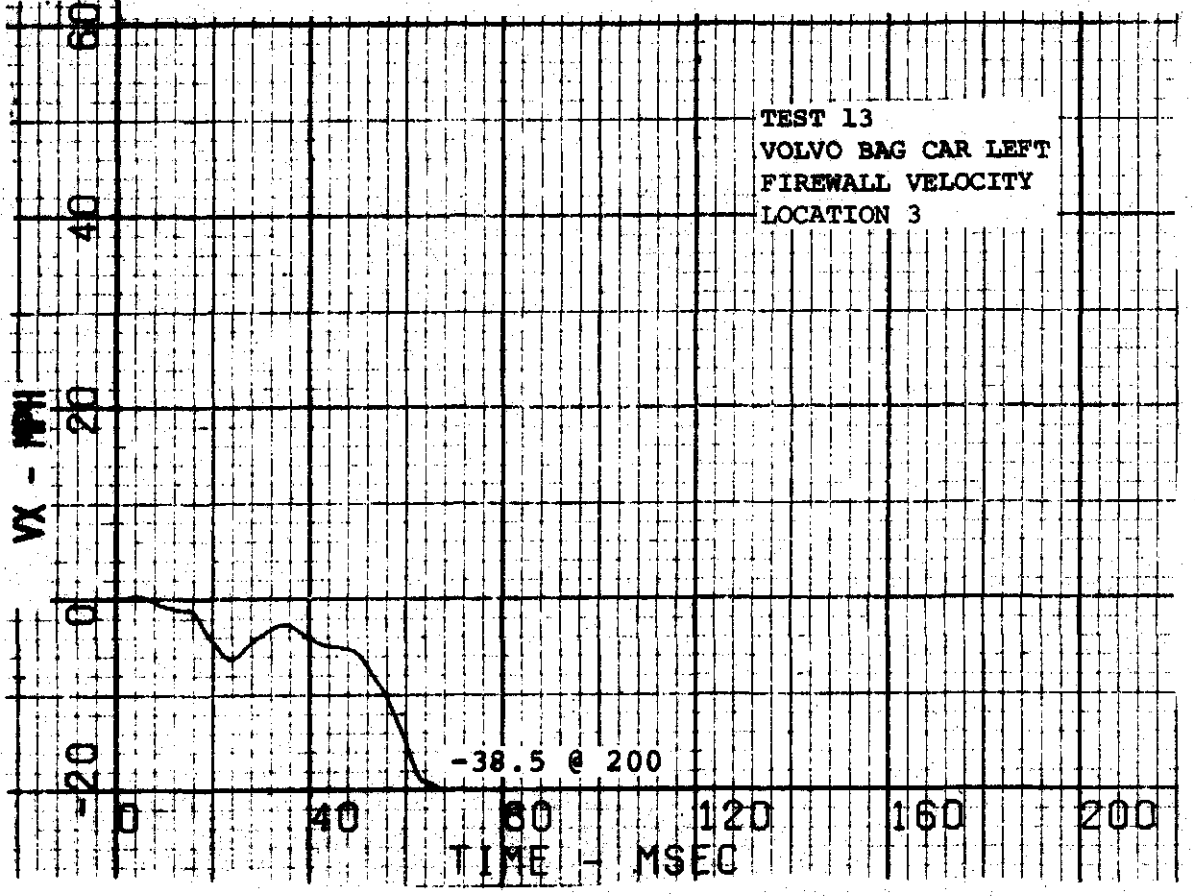

TEST 13
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
BAG PRESSURE
POUNDS/SQ INCH
24
16
8
0
-8
0
40
80
120
160
200
TIME - MSEC

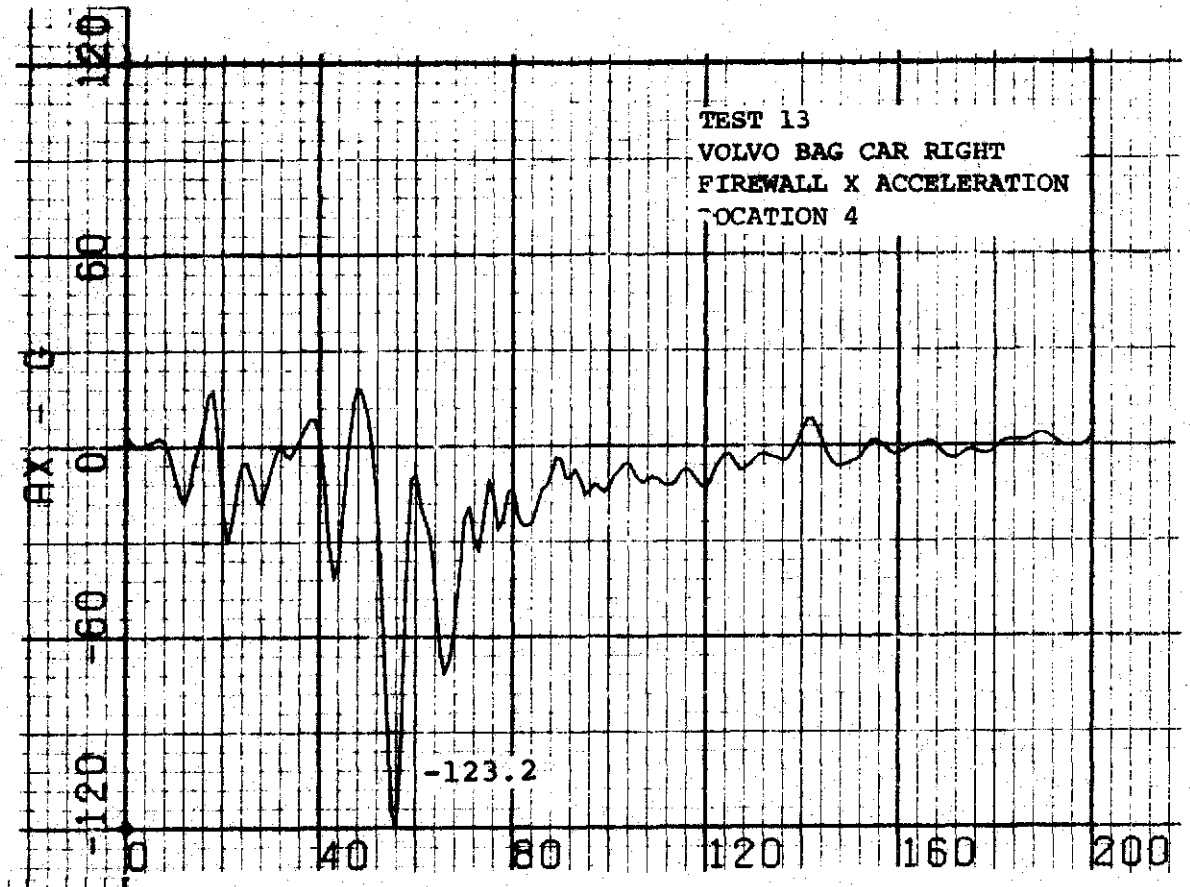

O= AX Δ= AY
TEST 13
VOLVO BAG CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

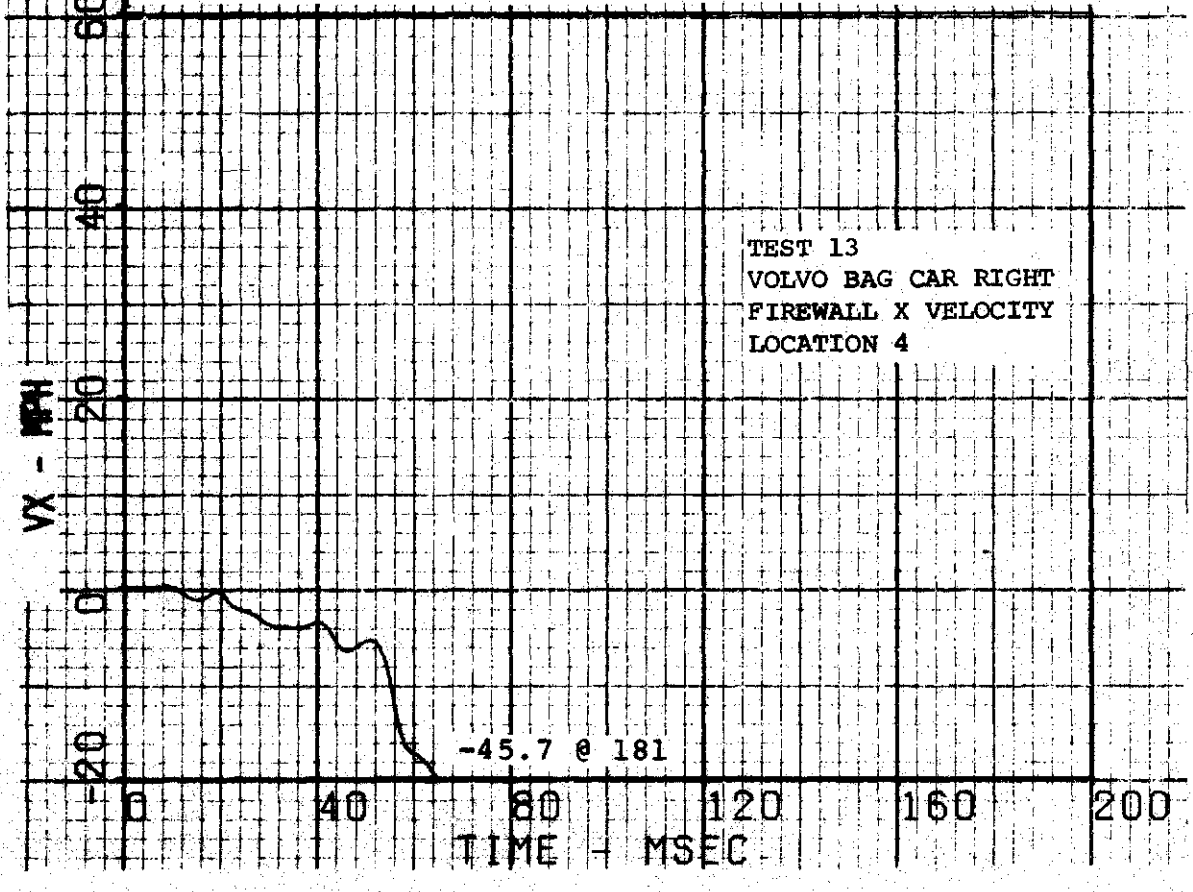

TEST 13
VOLVO BAG CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY - MPH
50
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

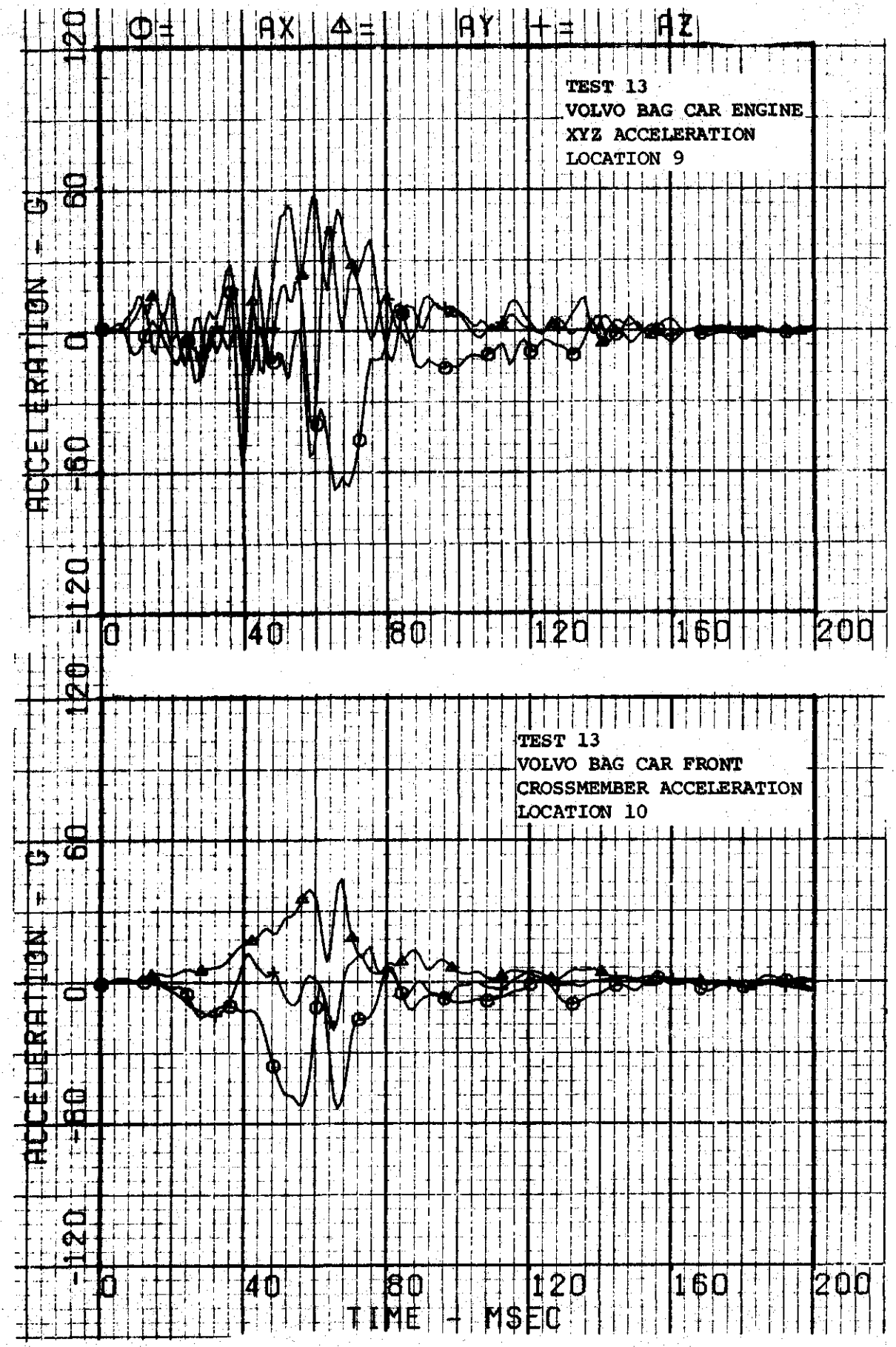

TEST 13
VOLVO BAG CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION = G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 13
VOLVO BAG CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
30
10
-10
-30
-50
TIME - MSEC

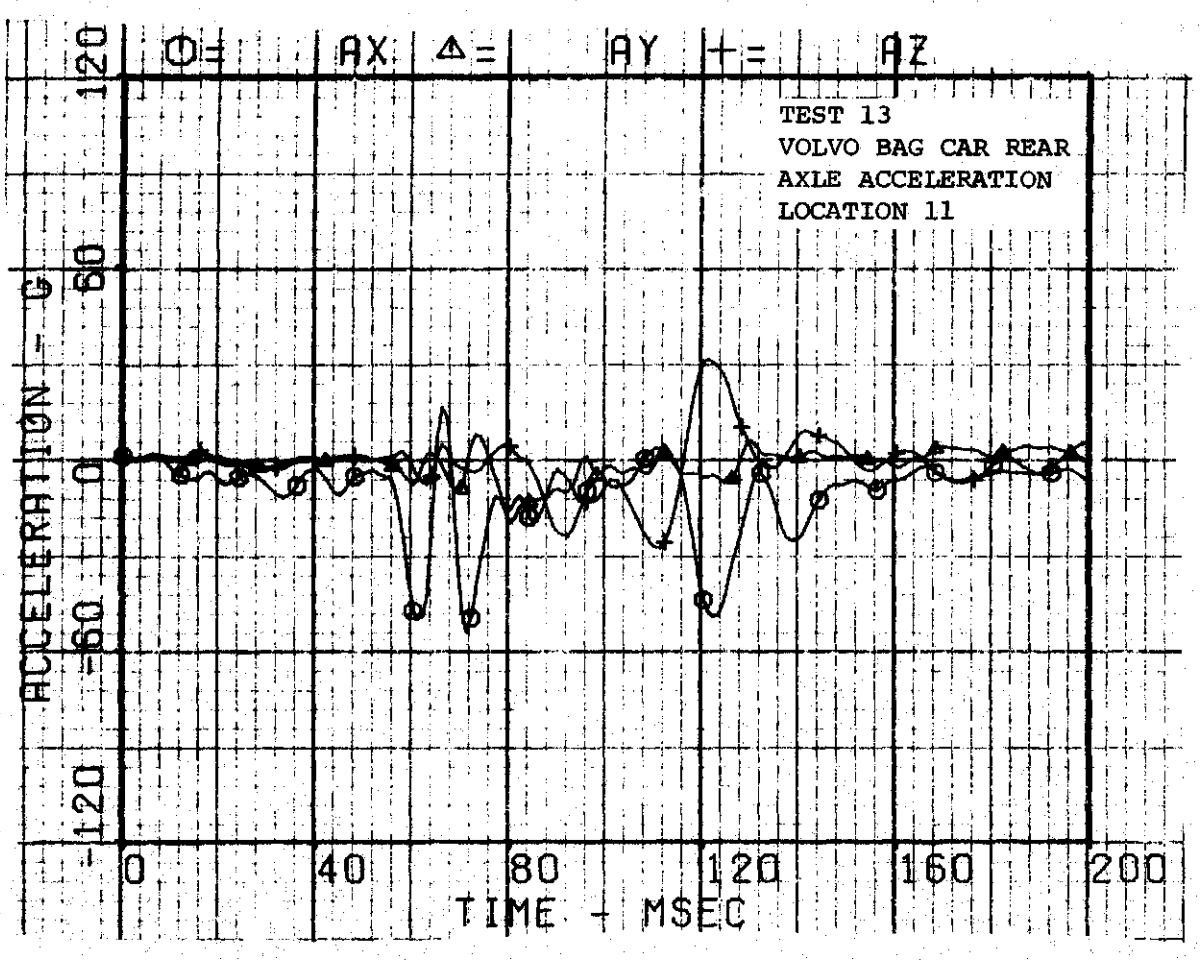

TEST 13
VOLVO BAG CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
AX - G
120
60
0
-60
-120
0
40
80
120
160
200

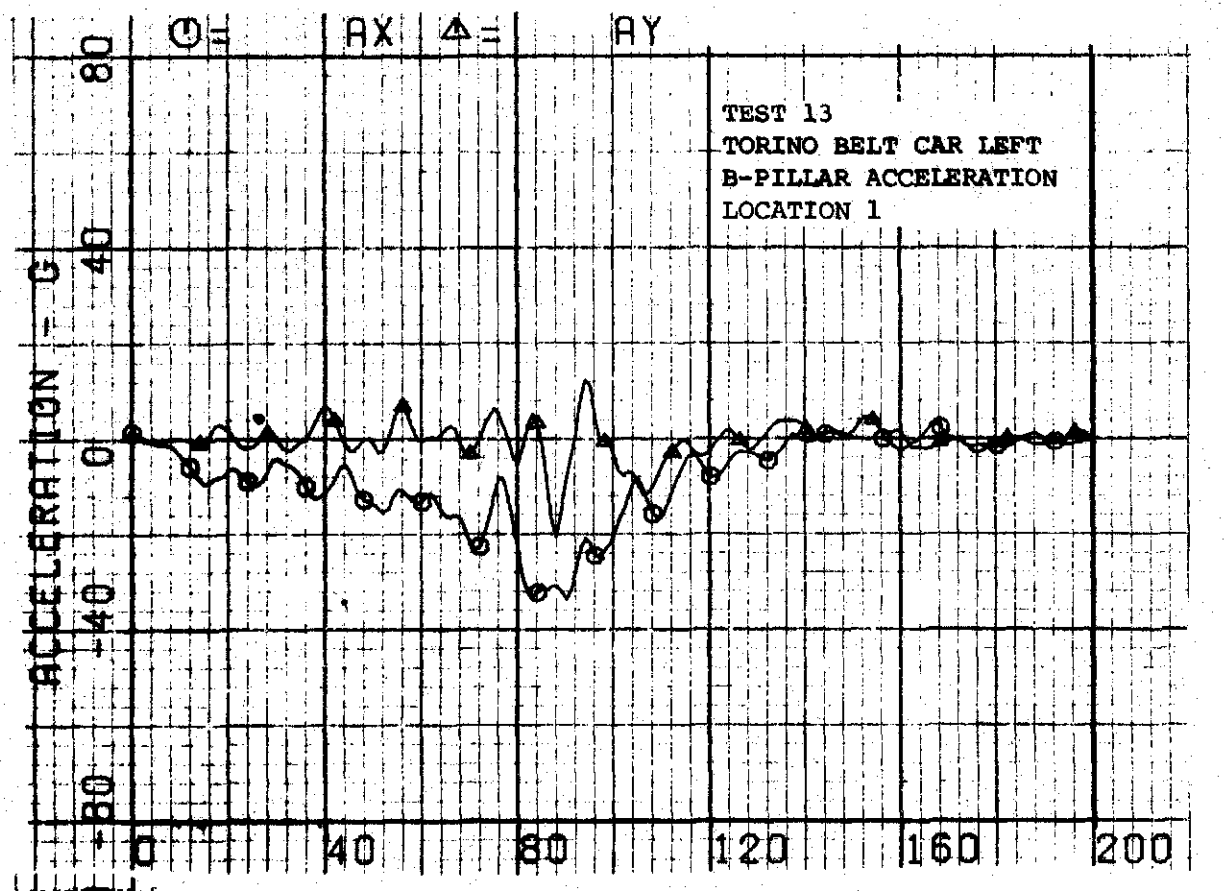

TEST 13
VOLVO BAG CAR LEFT
FIREWALL VELOCITY
LOCATION 3
VX - MPH
60
40
20
0
-20
-38.5 @ 200
0
40
80
120
160
200
TIME - MSEC

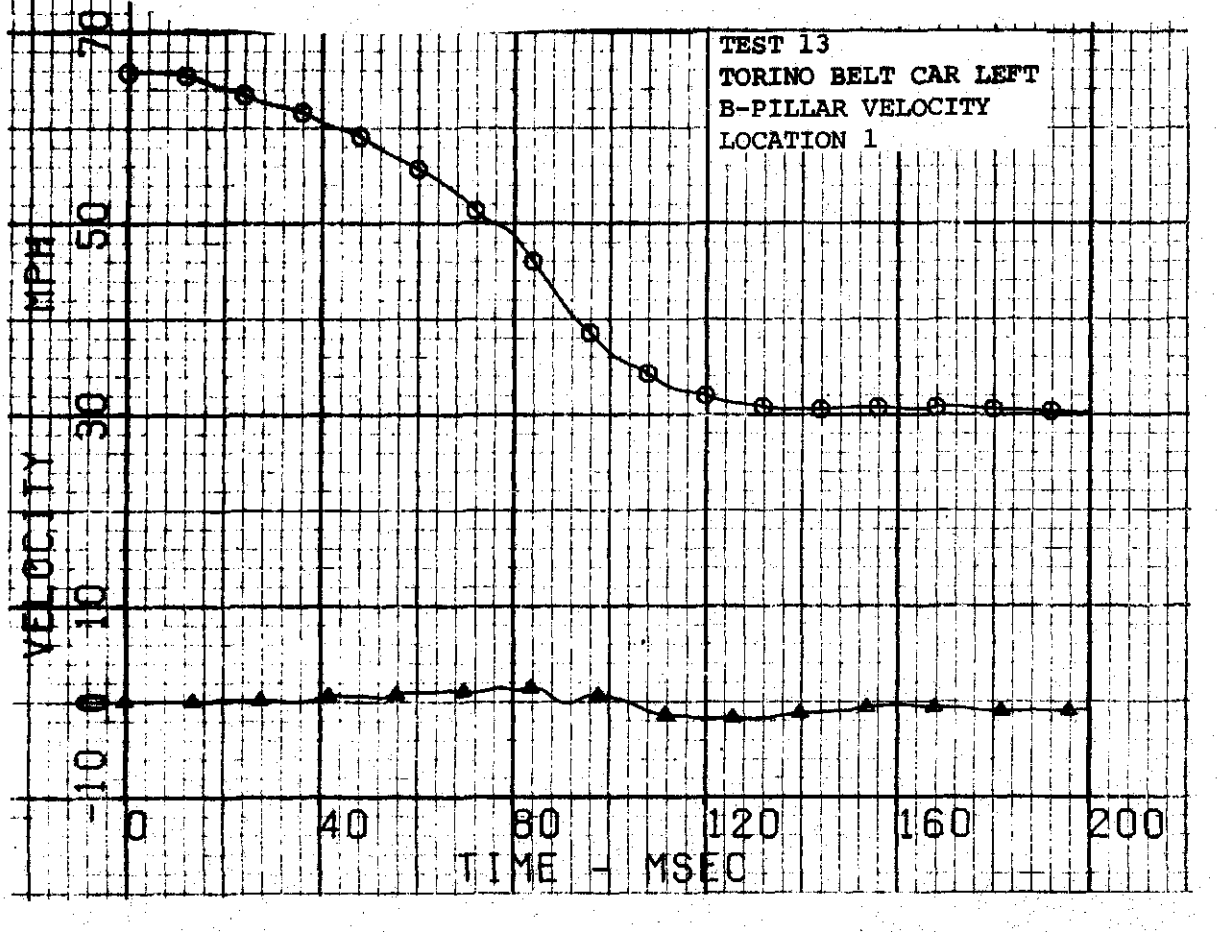

TEST 13
VOLVO BAG CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
AX - G
120
60
0
-60
-120
-123.2
0
40
80
120
160
200

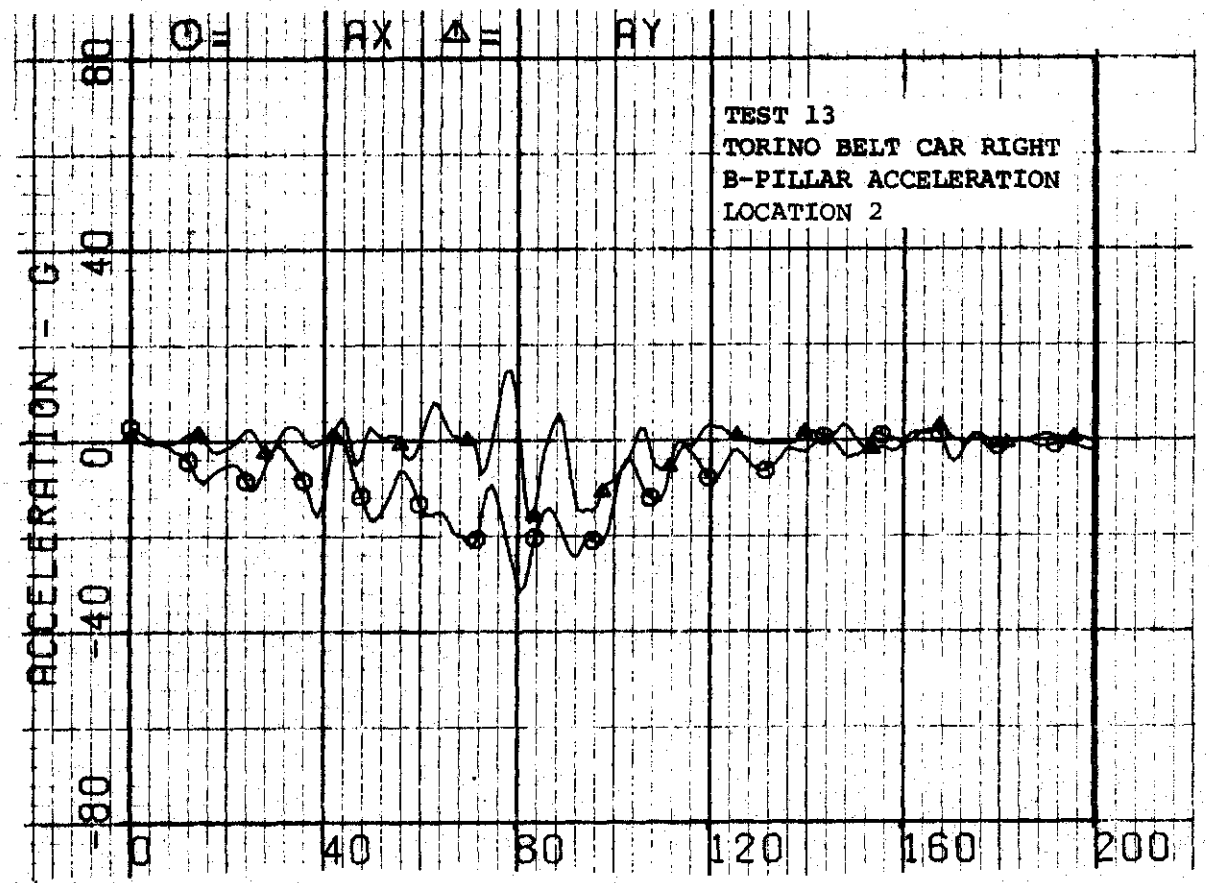

TEST 13
VOLVO BAG CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
VX - MPH
60
40
20
0
-20
-45.7 @ 181
0
40
80
120
160
200
TIME - MSEC

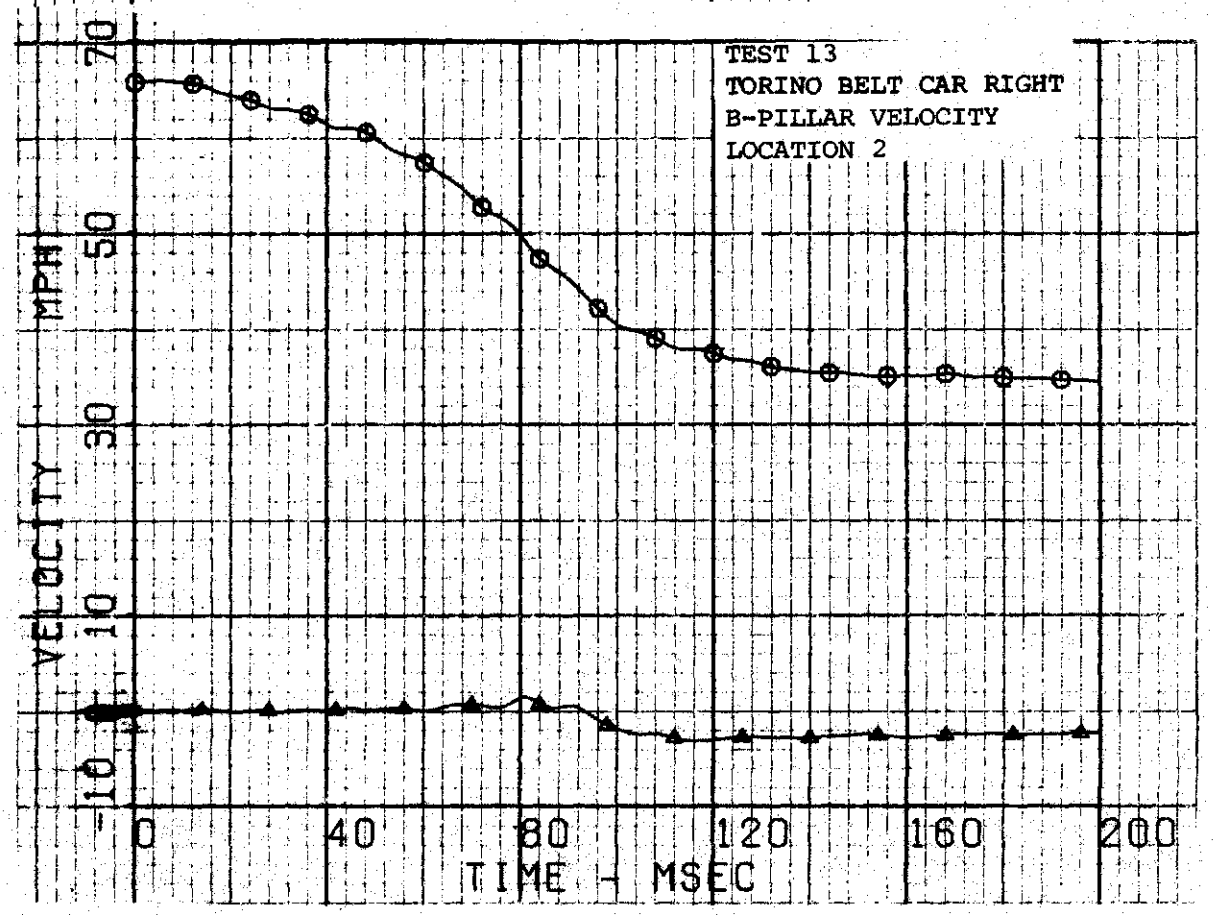

⊙ = AX
△ = AY
+ = AZ
TEST 13
VOLVO BAG CAR ENGINE
XYZ ACCELERATION
LOCATION 9
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 13
VOLVO BAG CAR FRONT
CROSSMEMBER ACCELERATION
LOCATION 10
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


Φ=
AX
Δ=
AY
+=
AZ
TEST 13
VOLVO BAG CAR REAR
AXLE ACCELERATION
LOCATION 11
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


○ = AX △ = AY
TEST 13
TORINO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 13
TORINO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC


○= AX △= AY
TEST 13
TORINO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 13
TORINO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC

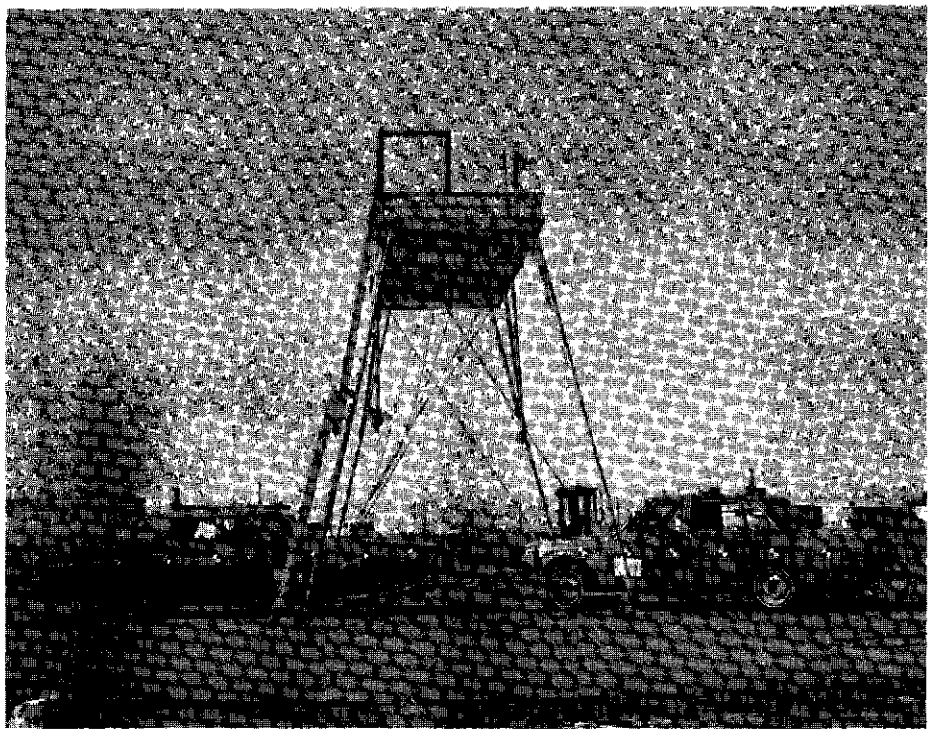


Figure 3-37. Pre-test Vehicle Configuration - Test 13.

Figure 3-38. Post-test Vehicle Configuration - Test 13.

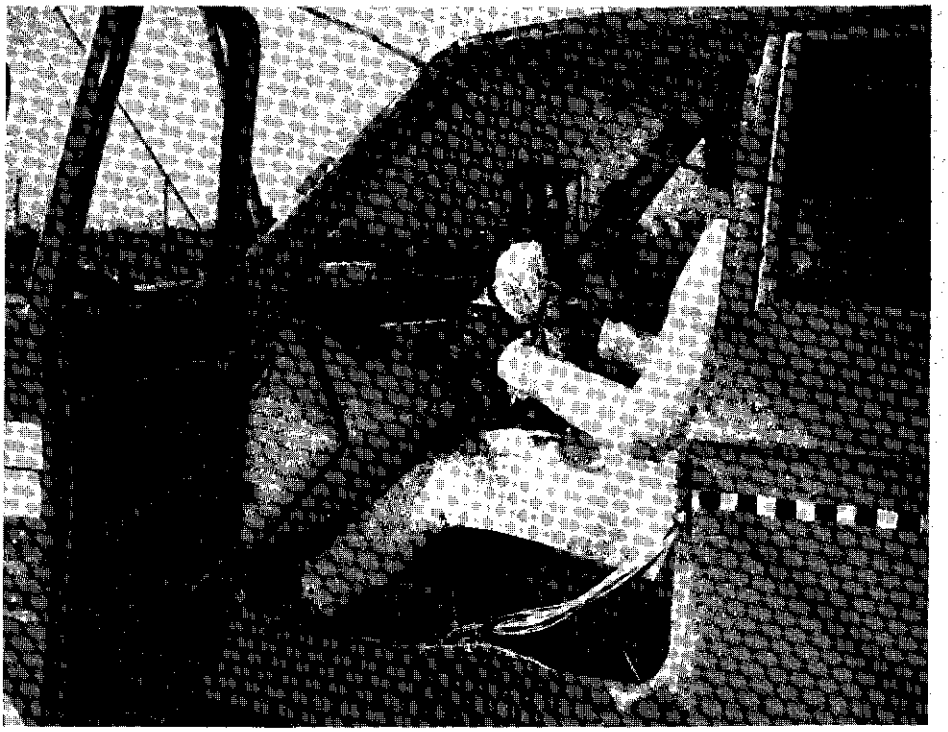


Figure 3-39. Pre-test RSV Driver Airbag - Test 13.

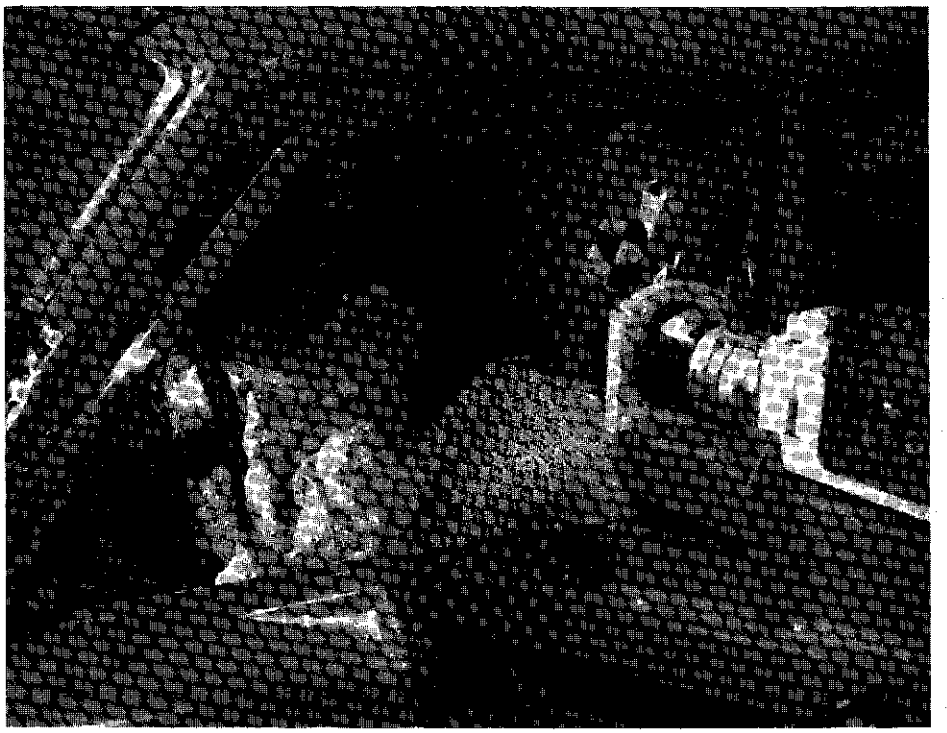


Figure 3-40. Post-test RSV Driver Airbag - Test 13.

Figure 3-41. Pre-test RSV Passenger Airbag - Test 13.

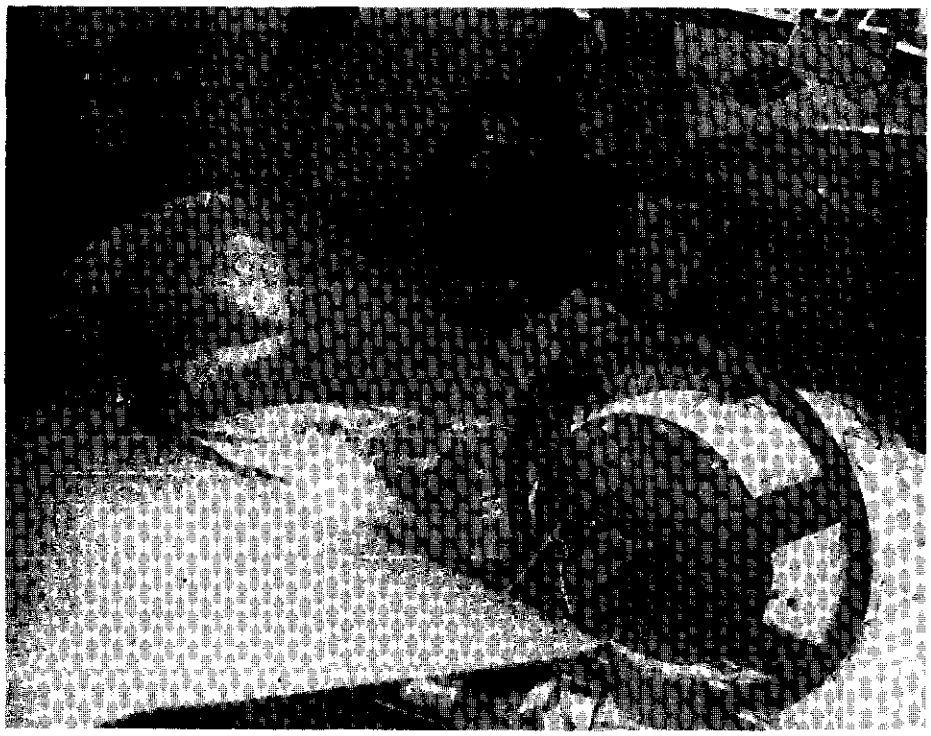


Figure 3-42. Post-test RSV Passenger Airbag - Test 13.

3.7 TEST NUMBER 14

The impact conditions for Test 14 were:

Configuration	Closing Speed
Torino-to-Volvo Right Oblique (30°)*	66.6 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Standard 3-Point Belt with Web Lockers and Force Limiters	Force Limited Airbelt
Right Front	Standard 3-Point Belt with Web Lockers and Force Limiters	Force Limited 2-Inch Belt

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was structurally modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity. The extent of these modifications is shown in Figure 1-2. The dash padding was reinstalled over the steel tubes in its original position.

The results of Test 14 are summarized in the following tables:

Table 3-25 - Summary of Vehicle Data (Test 14)

Table 3-26 - Injury Criteria Summary (Test 14)

Table 3-27 - Summary of Restraint System Data (Test 14)

Table 3-28 - Occupant Response Data (Test 14)

*Major resultant acceleration vector 30° to centerline of target vehicle.

which are followed by Figure 3-43 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

TABLE 3-25. SUMMARY OF VEHICLE DATA (TEST 14)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 14/April 7, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		491	427
TEST WEIGHT (lb)		4675	3216
IMPACT VELOCITY (mph)		66.6	0
VELOCITY CHANGE (mph)		31.9	40.5 (1)
PEAK RESULTANT ACCELERATION (G @ msec)			
	LOCATION 1	22.5 @ 87	39.5 @ 85
	LOCATION 2	39.3 @ 87	35.6 @ 63
MAXIMUM STATIC CRUSH (in.)			
	LEFT	17.0	10.0
	CENTER	26.0	30.5
	RIGHT	18.0	53.0

(1) Velocity change found by using average of resultant velocity vector (V_R) data for compartment accelerometer locations.

TABLE 3-26. INJURY CRITERIA SUMMARY (TEST 14)

VEHICLE B - BELT CAR (VOLVO)				
	FORCE LIMITED AIRBELT		FORCE LIMITED 2-INCH BELT	
HIC	313		396	
HEAD G(1) @ msec	41.7 @ 118		48.5 @ 115	
CSI	355		394	
CHEST G(1) @ msec	45.1 @ 118		50.9 @ 112	
FEMUR LOAD (lb)	LEFT 577	RIGHT 681	LEFT 571	RIGHT 957

(1) 3 msec clip.

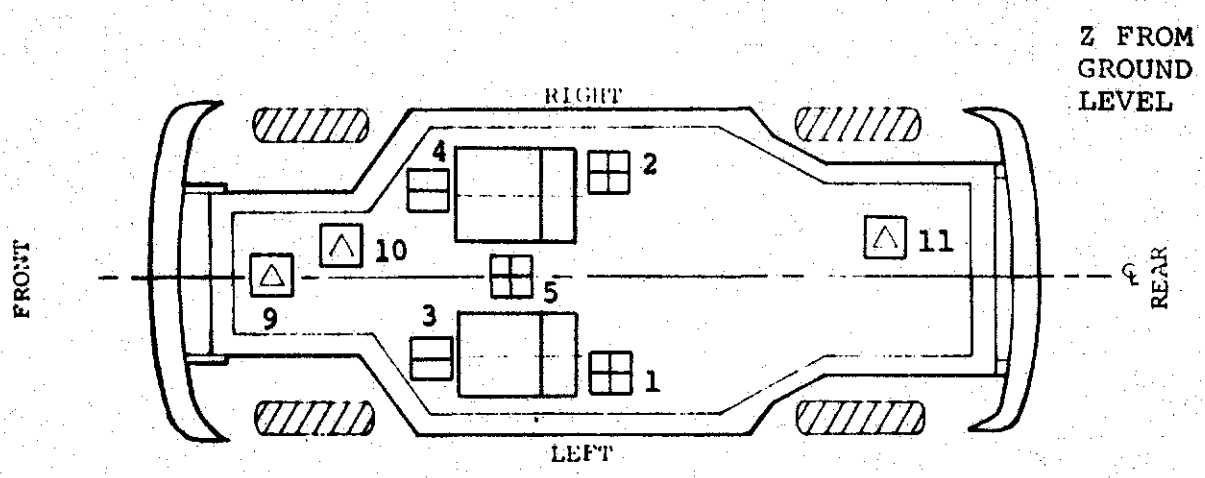
TABLE 3-27. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 14)

VEHICLE B - BELT CAR (VOLVO)		
FORCE LIMITED AIRBELT		
Peak Airbelt Pressure	psi @ msec	26.1 @ 74
Peak Lap Belt Load	lb @ msec	959 @ 86
FORCE LIMITED 2-INCH BELT		
Peak Shoulder Belt Load	lb @ msec	1404 @ 84
Peak Lap Belt Load	lb @ msec	743 @ 105

TABLE 3-28. OCCUPANT RESPONSE DATA SUMMARY (TEST 14)

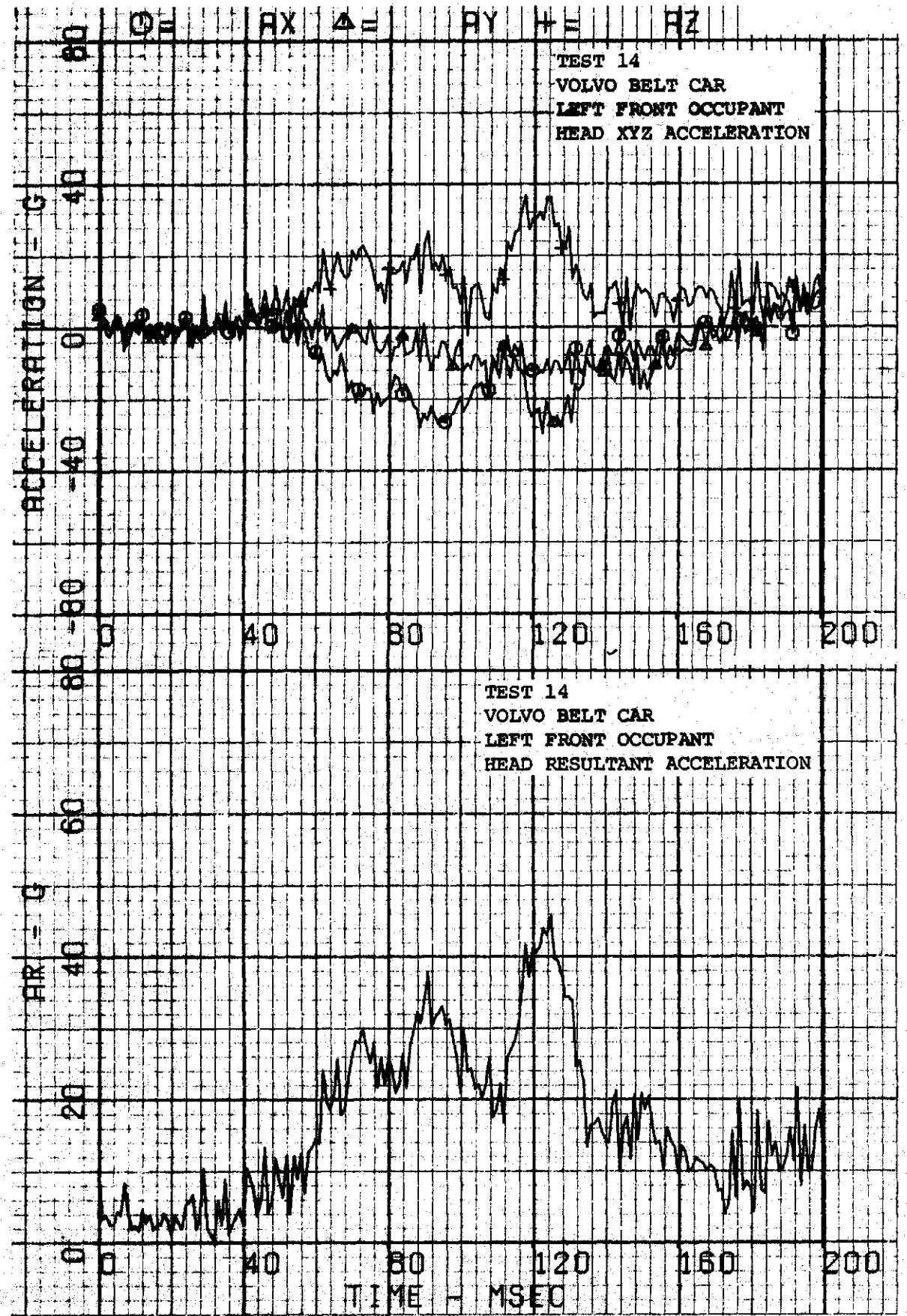
		VEHICLE B - BELT CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD					
	X	27.6	89	35.9	86
	Y	29.5	123	15.7	81
	Z	37.0	118	46.0	117
	R(1)	41.7	118	48.5	115
	HIC	313 @ 61-153		396 @ 78-155	
CHEST					
	X	33.6	65	51.1	110
	Y	36.1	116	13.3	103
	Z	16.5	108	21.2	69
	R(1)	45.1	118	50.9	112
	SI	355 @ 200		394 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS					
	LF	577	71	571	66
	RT	681	76	957	66

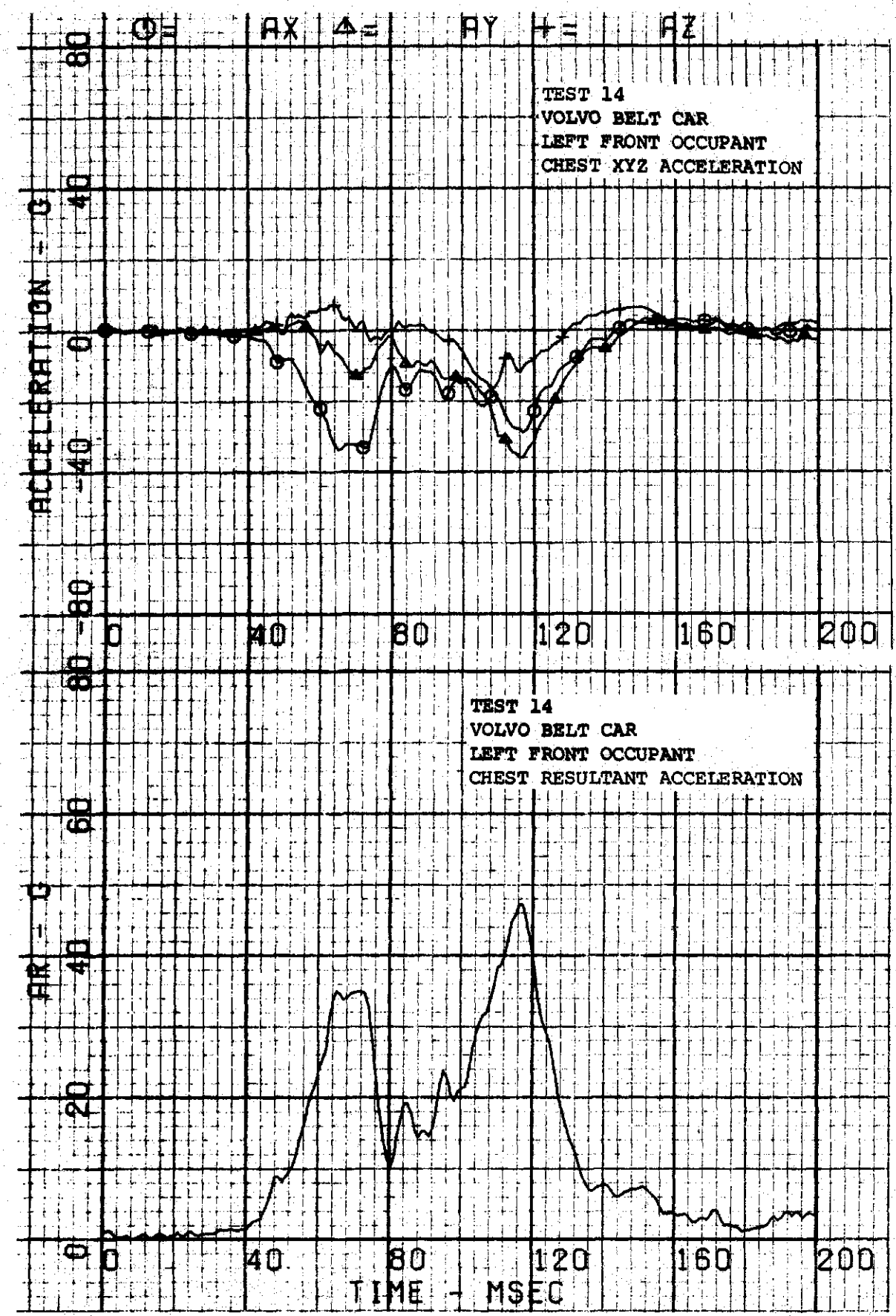
(1) 3 msec clip, components not clipped.

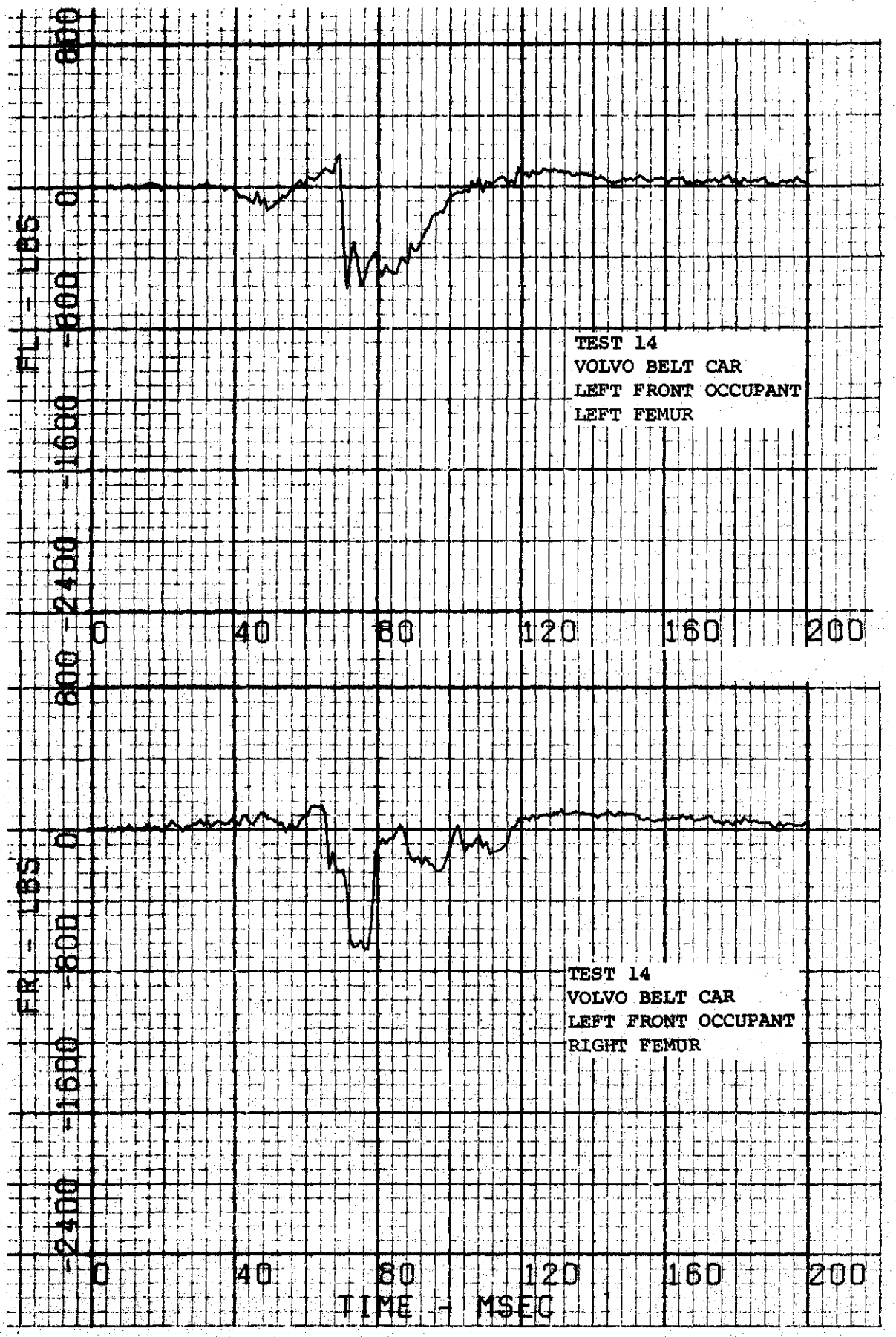


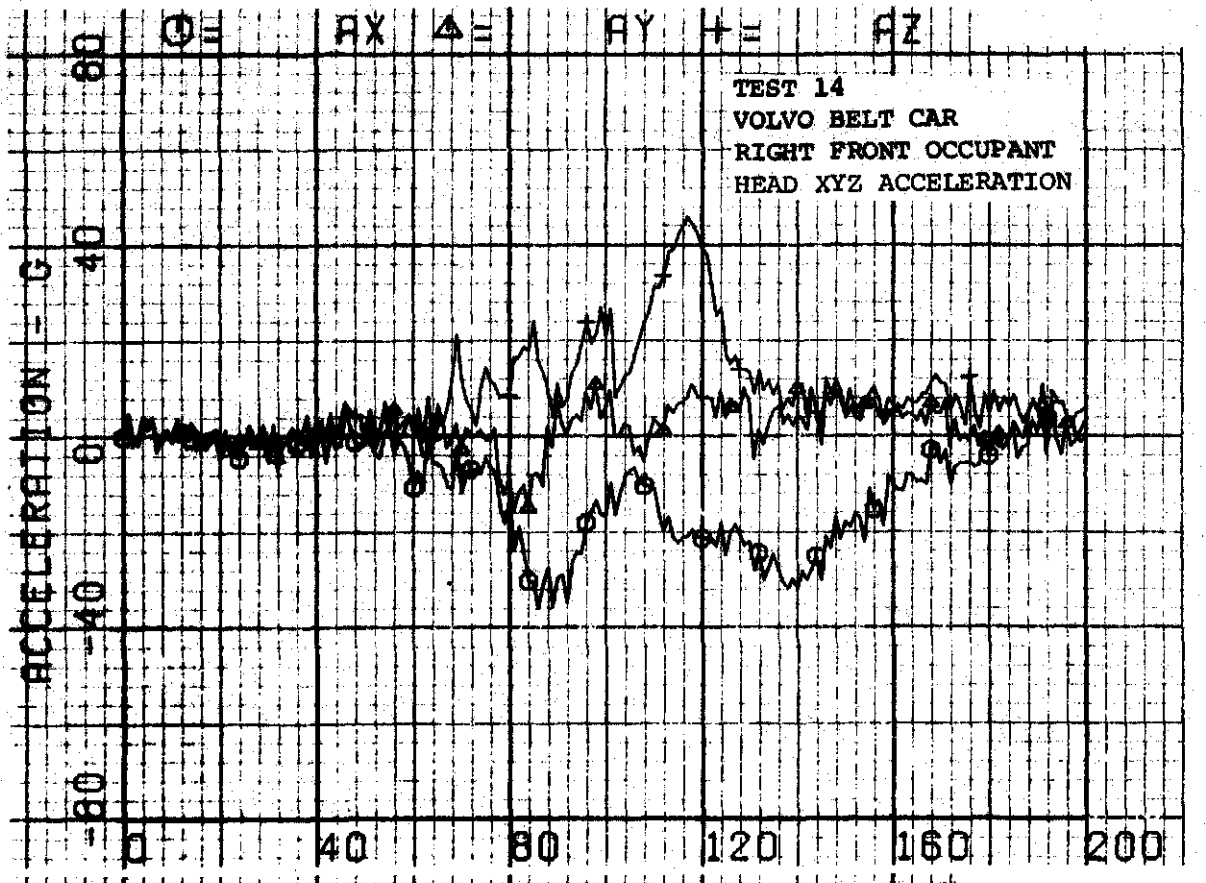
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
5	Drive Tunnel	X	X	
9	Engine Block	X	X	X
10	Front Crossmember	X	X	X
11	Rear Axle	X	X	X

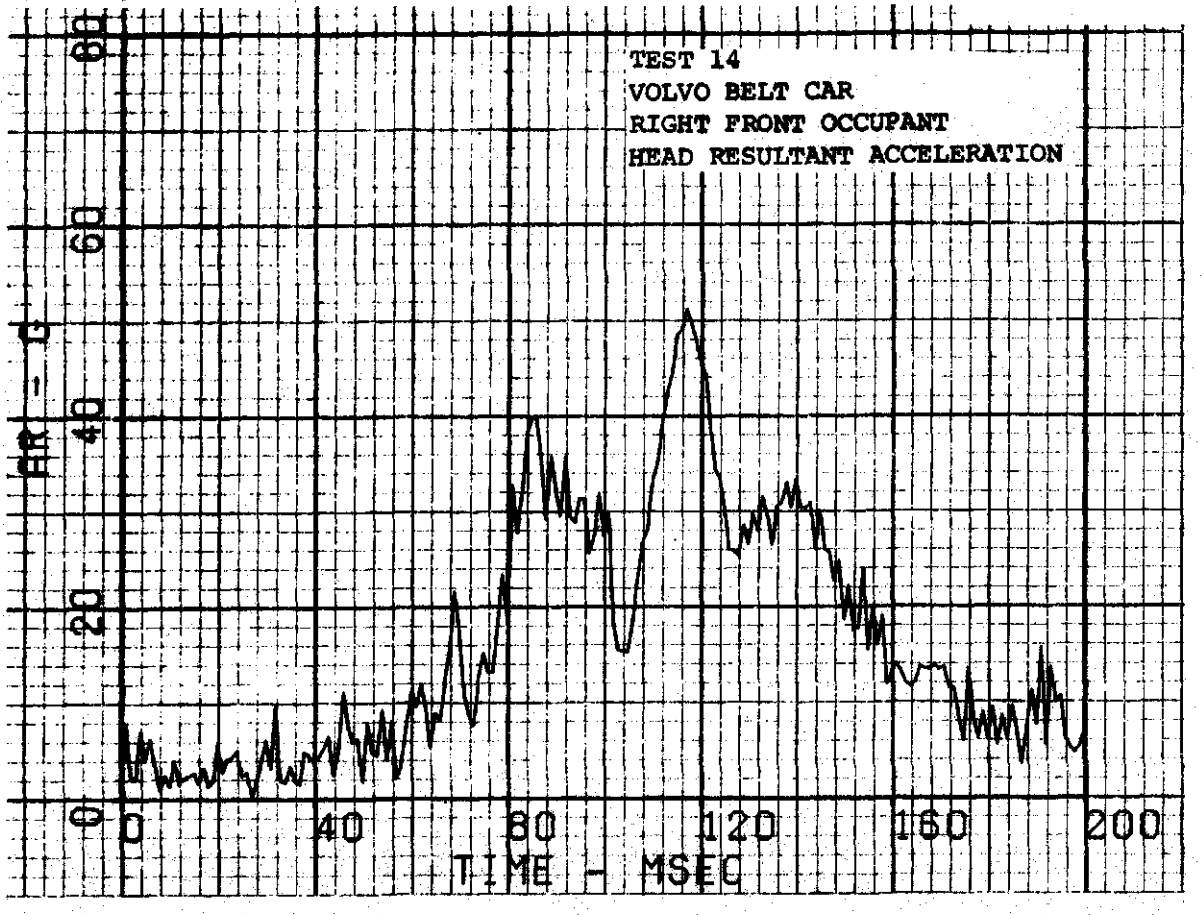
Figure 3-43. Vehicle Accelerometer Locations - Test 14.

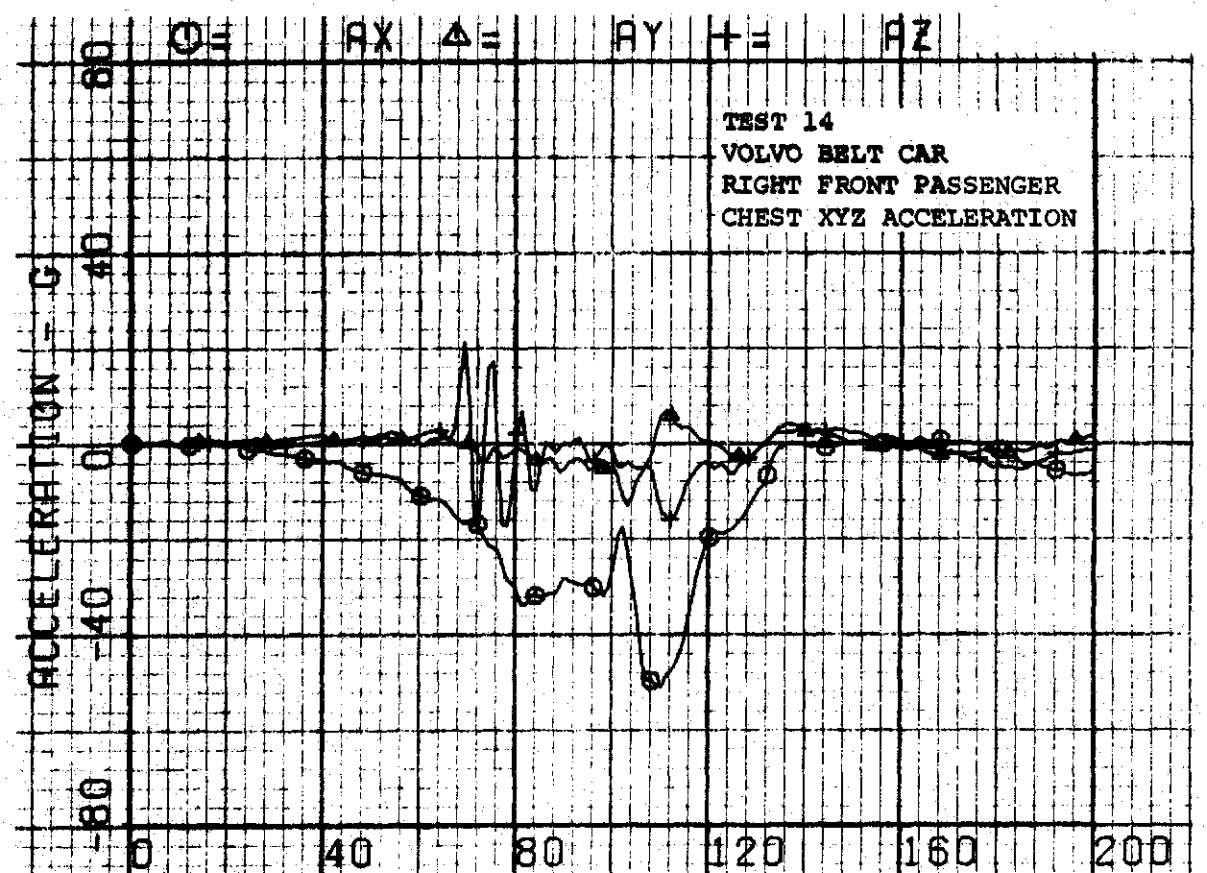

AX
AY
AZ
TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

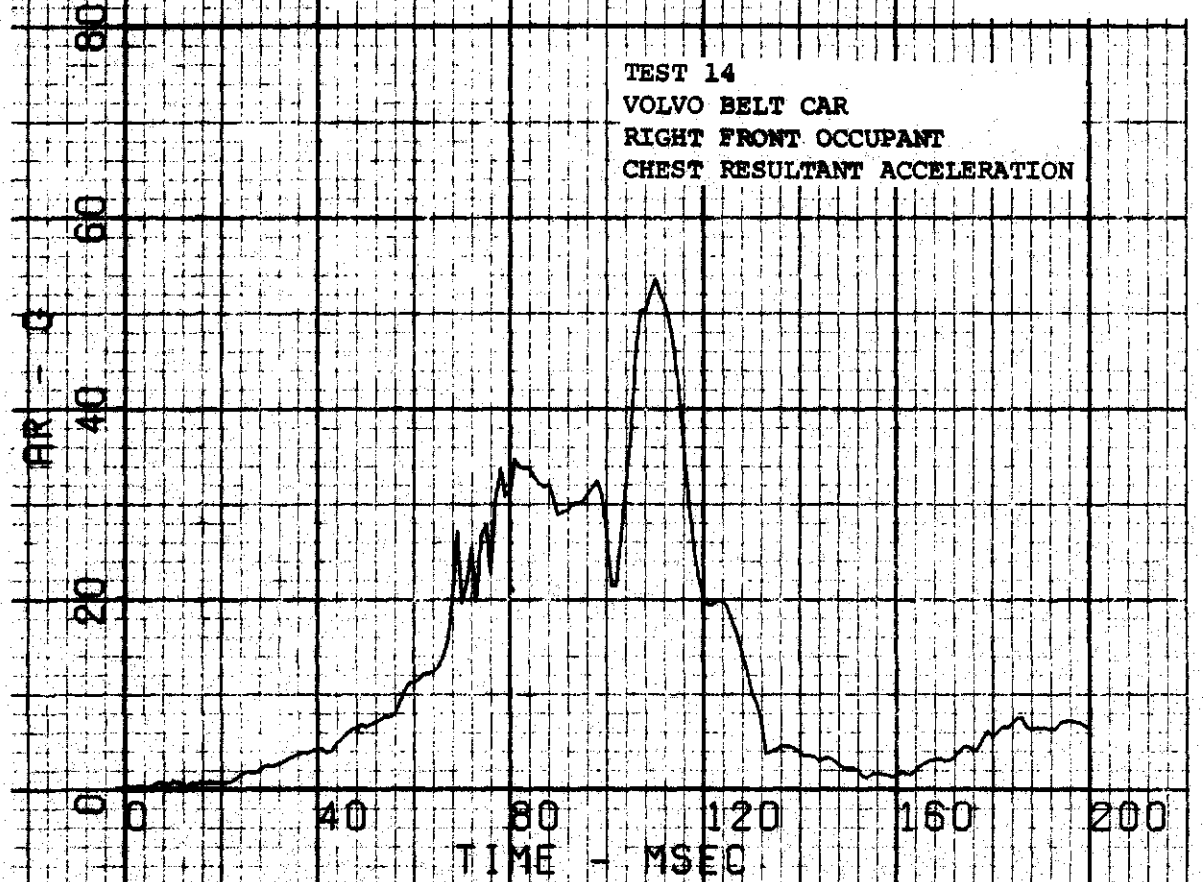

TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
TIME - MSEC

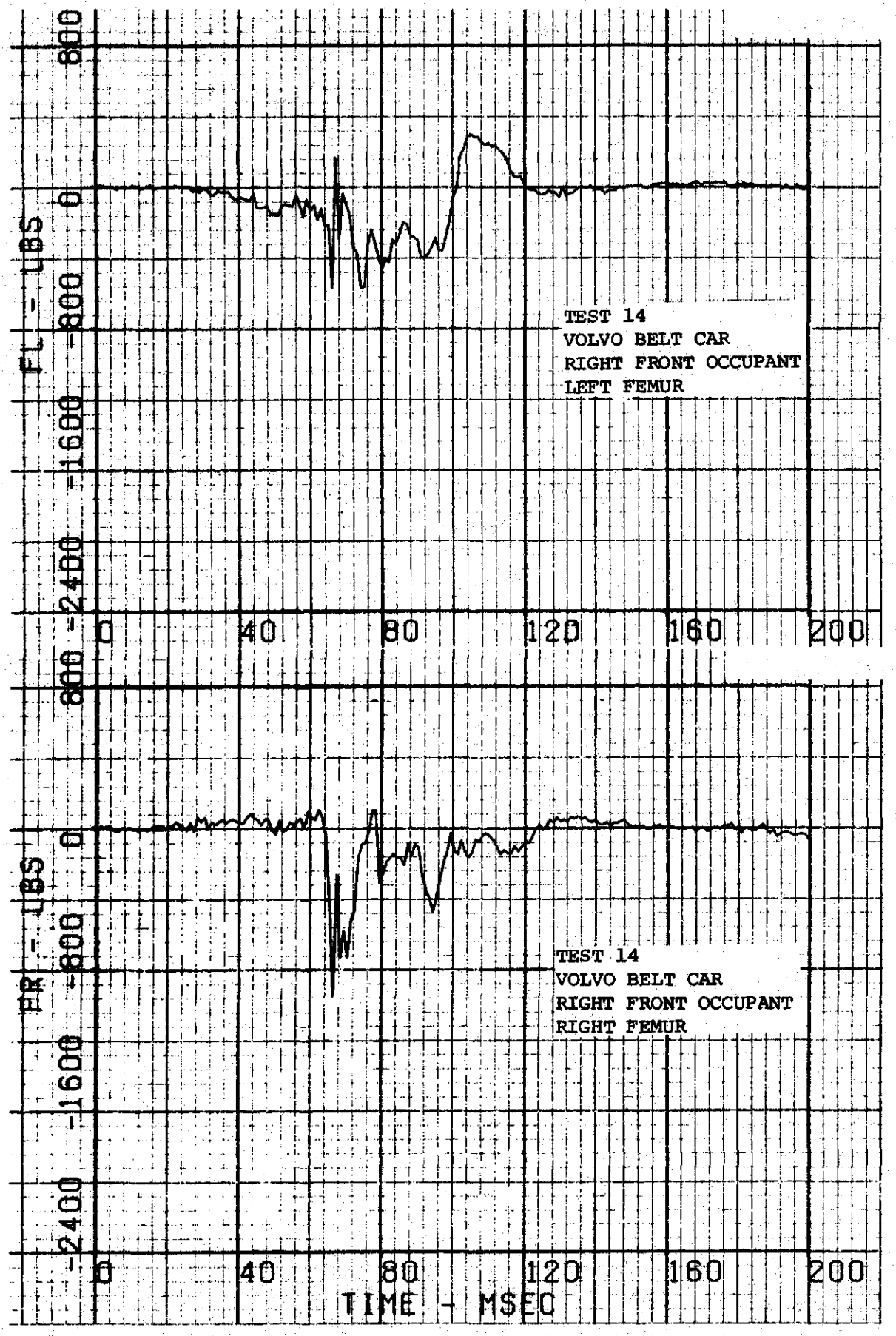

FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
LEFT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC
TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR

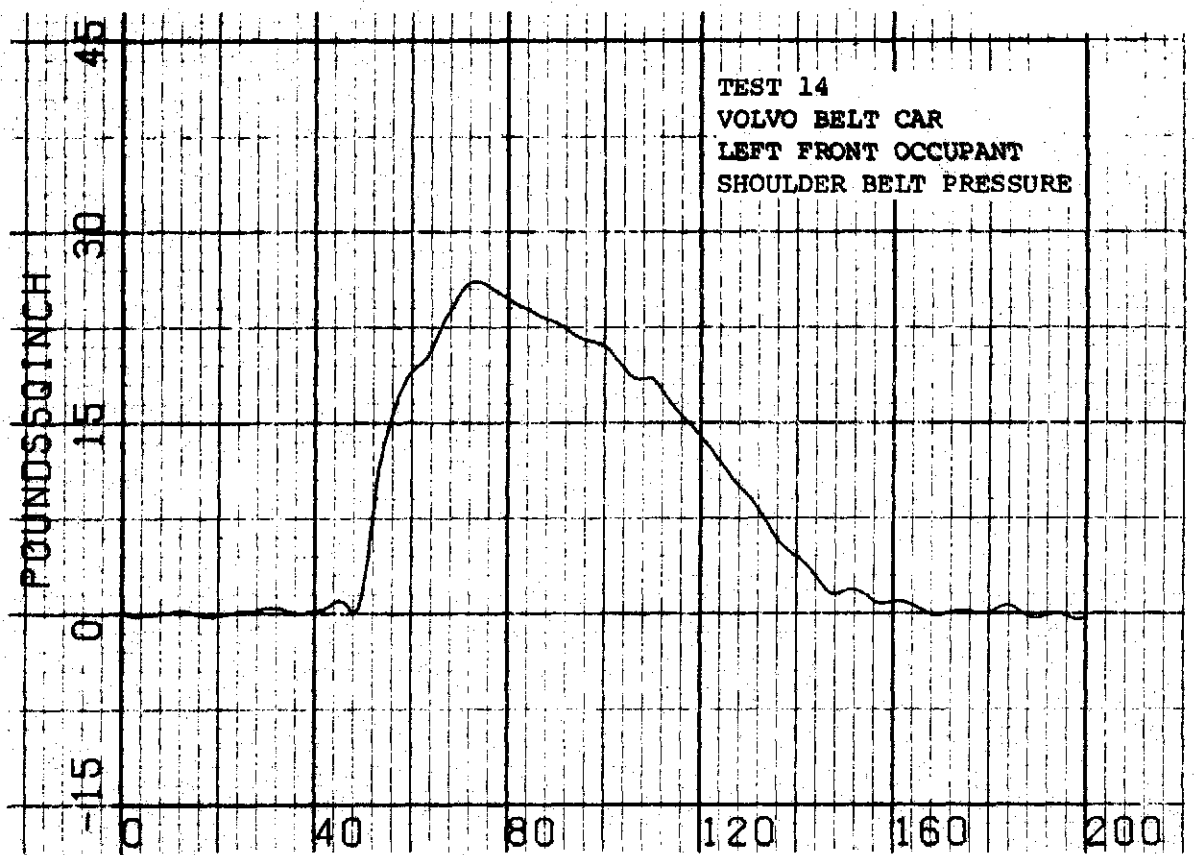

O= AX Δ= AY += AZ
TEST 14
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

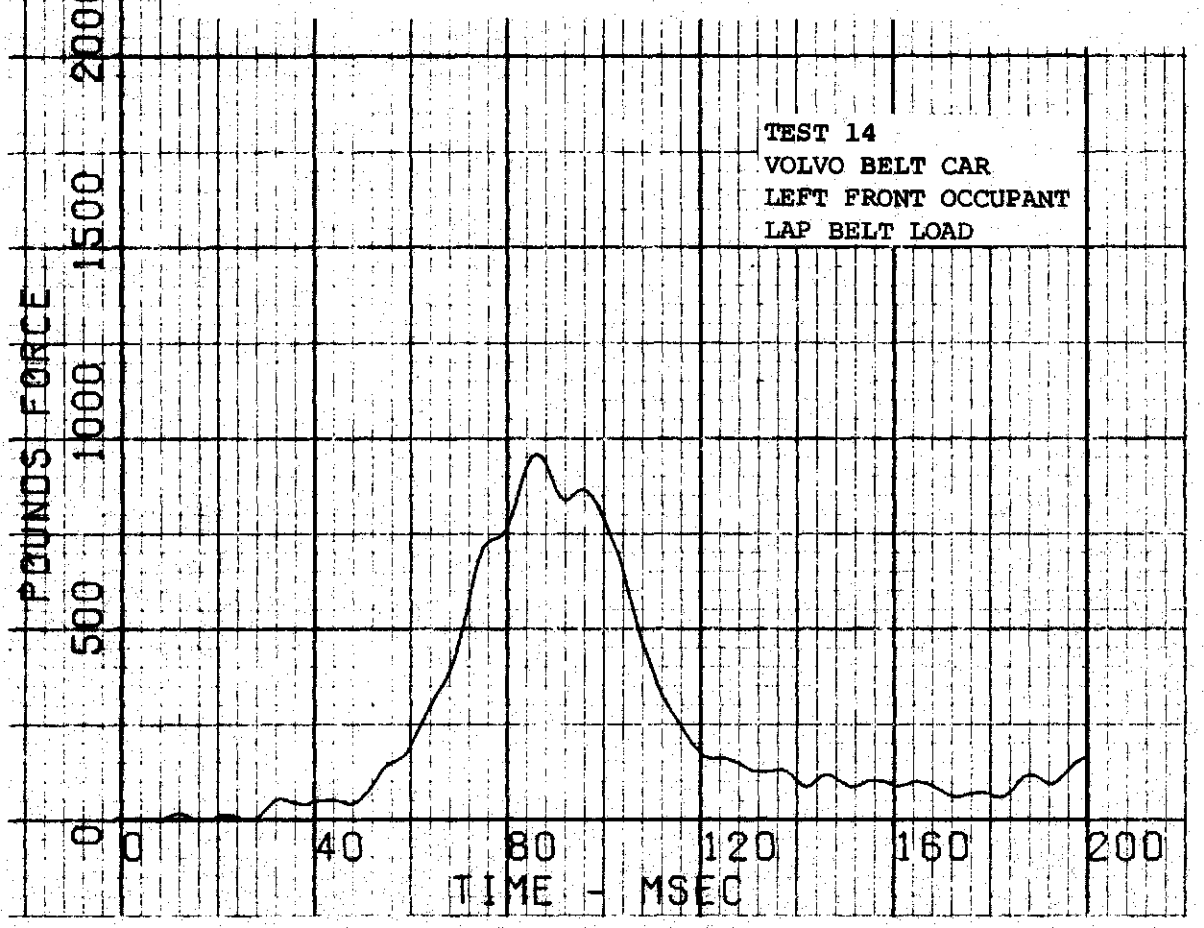

TEST 14
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

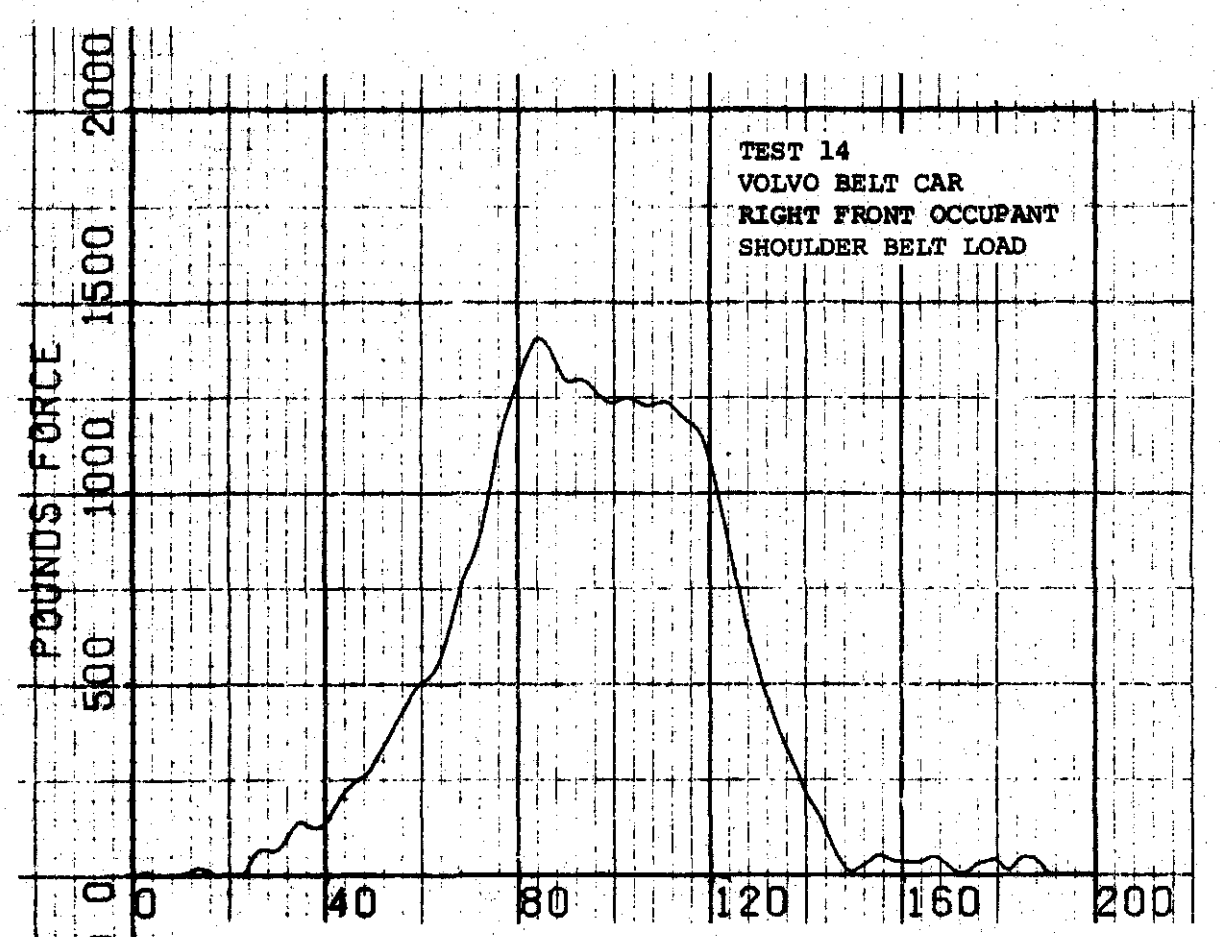

O= AX Δ= AY += AZ
TEST 14
VOLVO BELT CAR
RIGHT FRONT PASSENGER
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

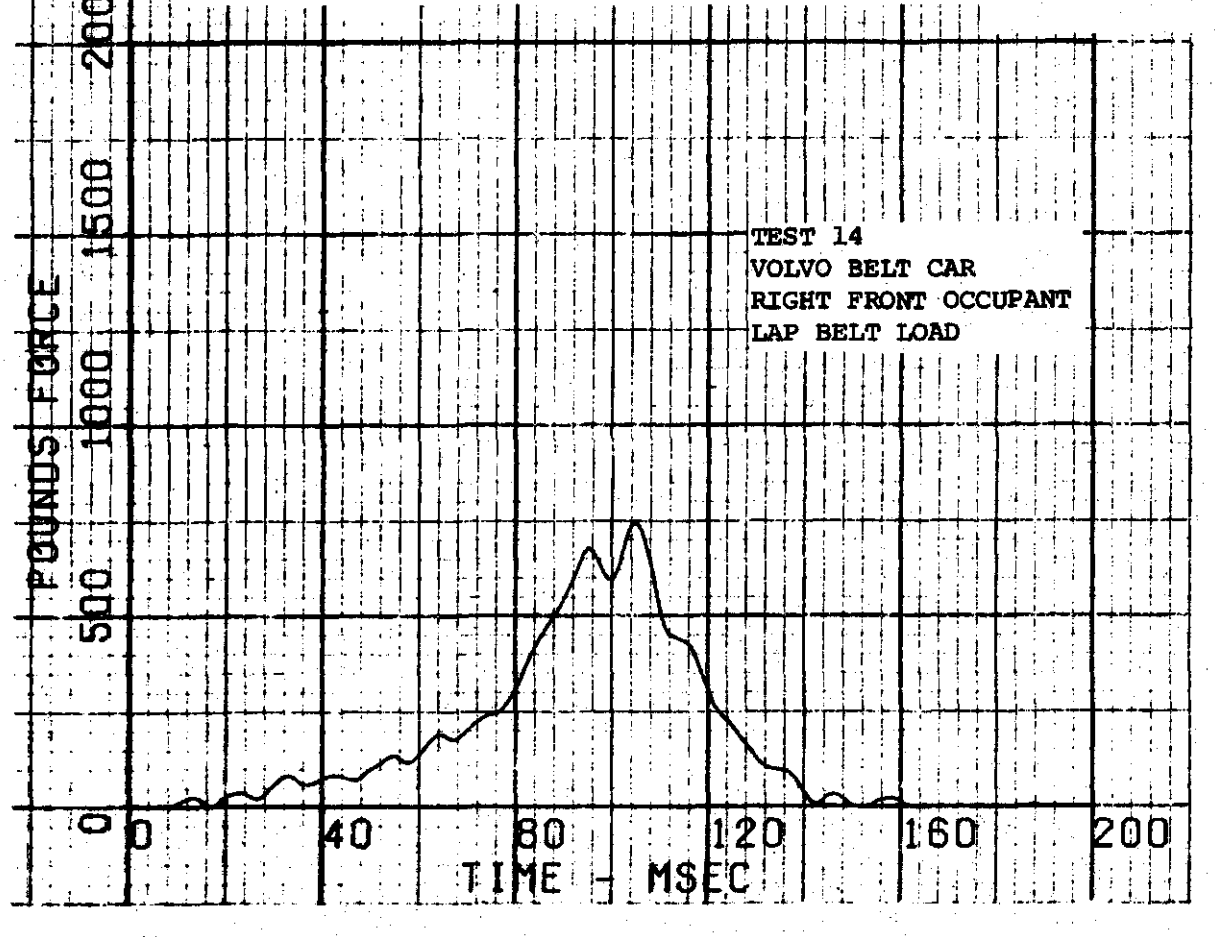

TEST 14
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
80
60
40
20
0
0
40
80
120
160
200
TIME - MSEC

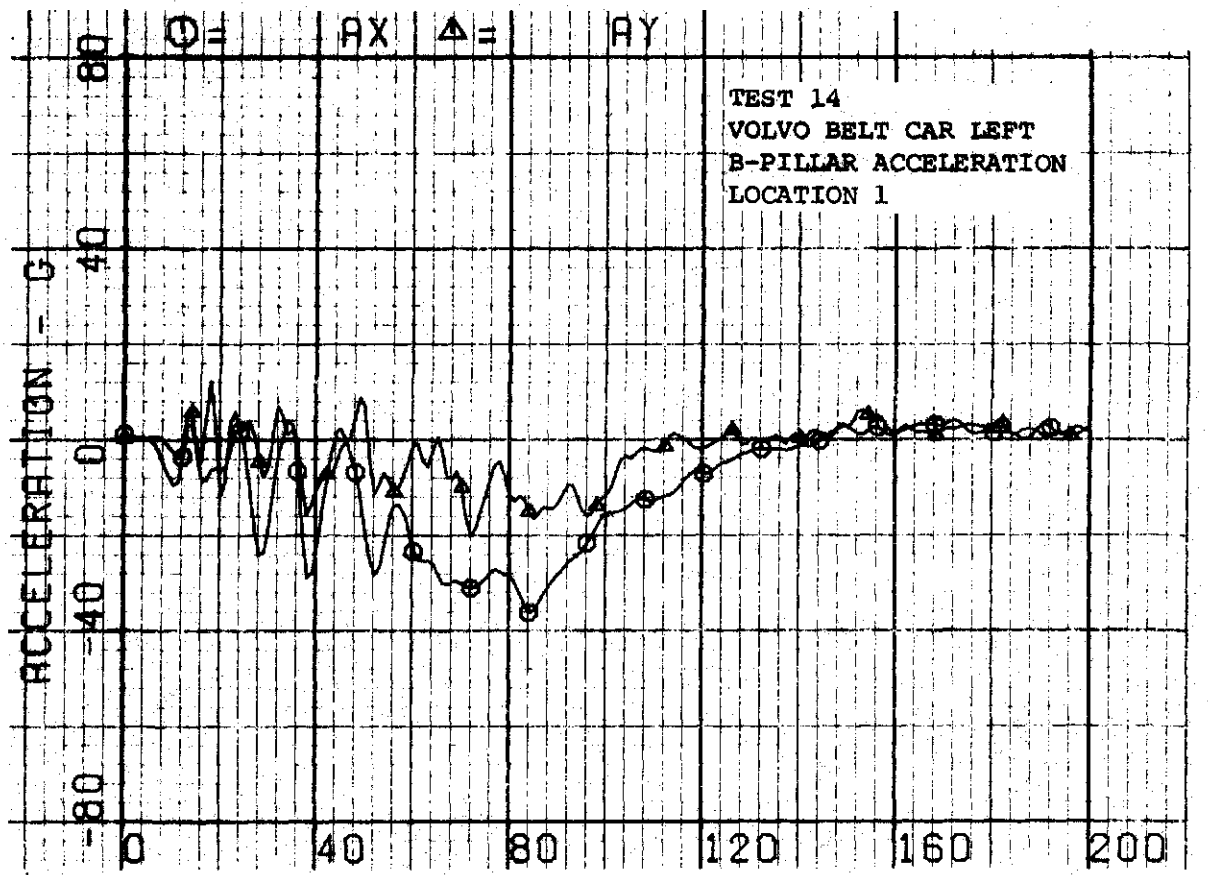

FL - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TEST 14
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR
FR - LBS
800
0
-800
-1600
-2400
0
40
80
120
160
200
TIME - MSEC
TEST 14
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
RIGHT FEMUR

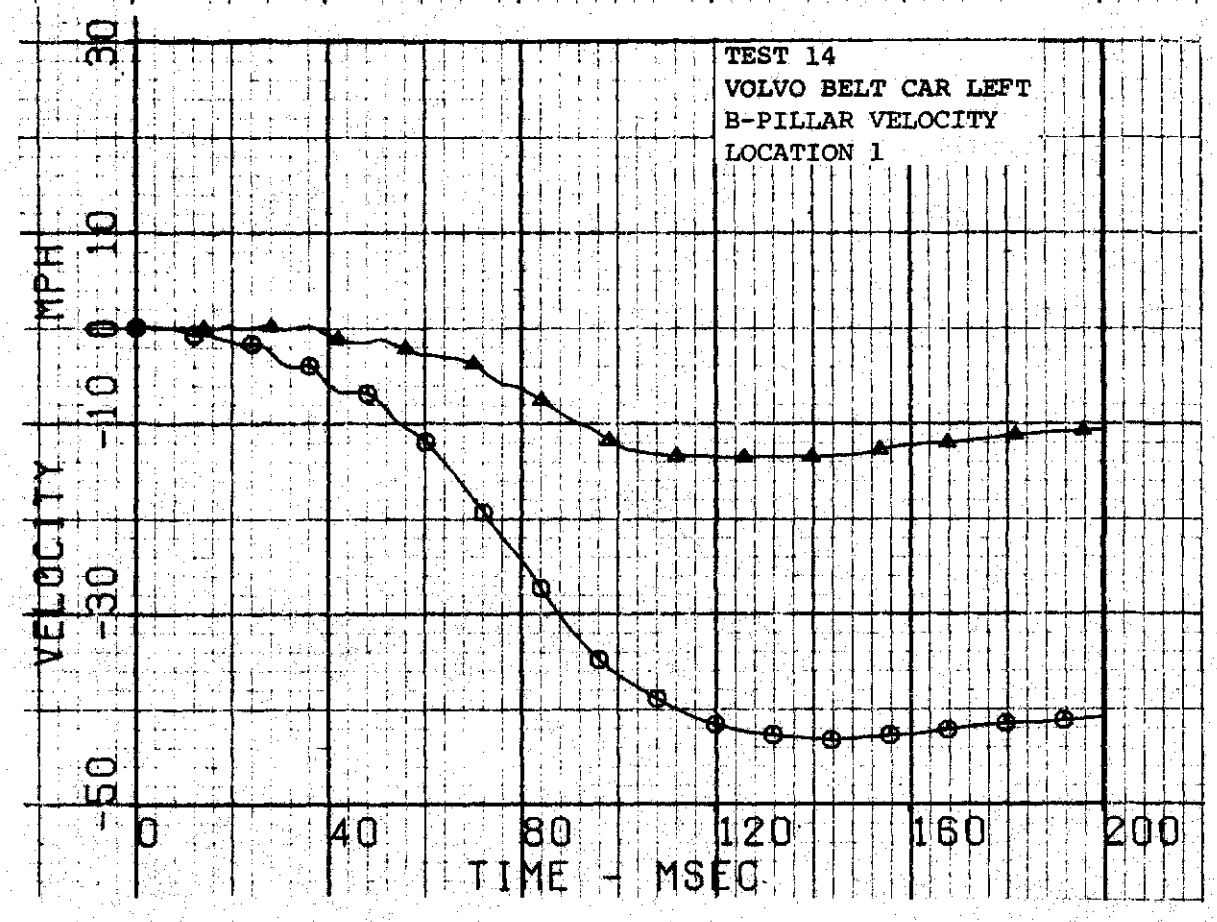

TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
SHOULDER BELT PRESSURE
POUNDS/INCH
45
30
15
0
-15
0
40
80
120
160
200

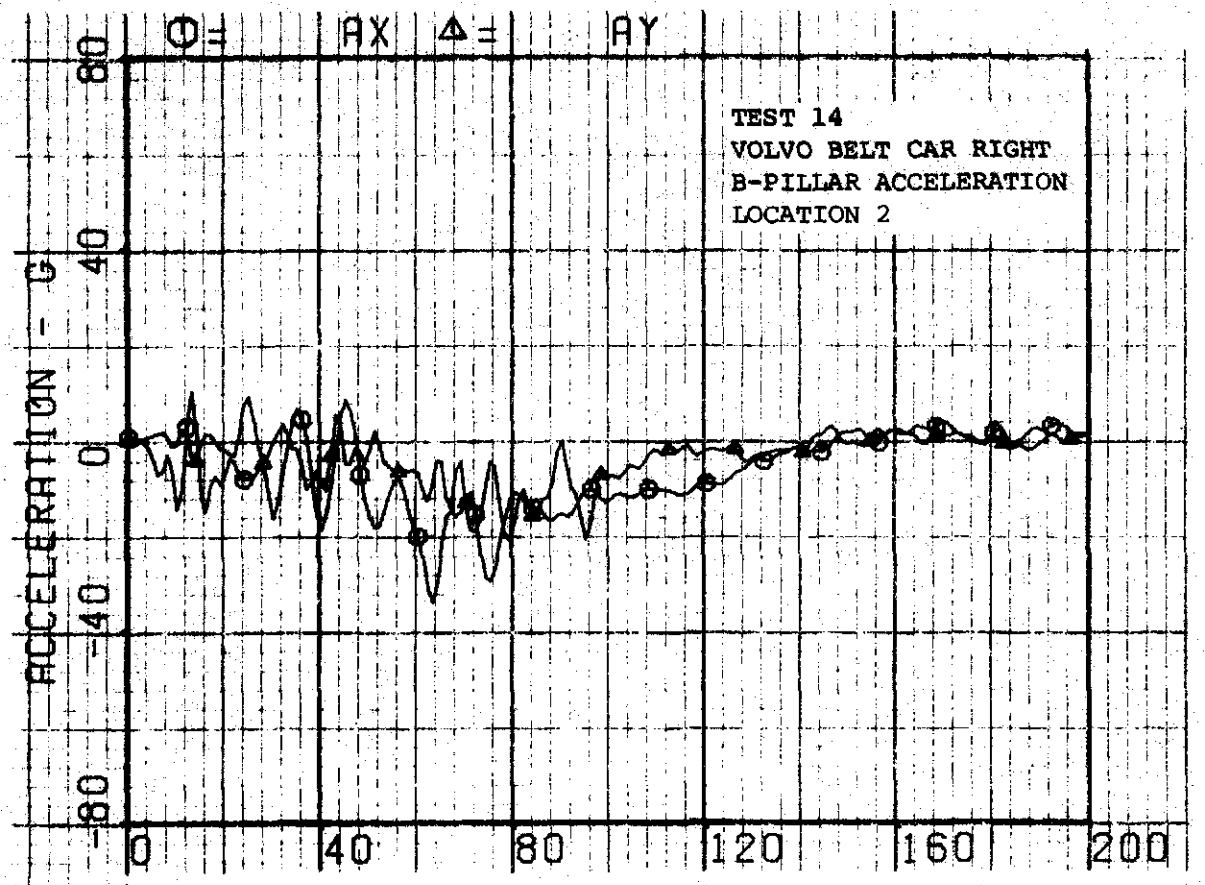

TEST 14
VOLVO BELT CAR
LEFT FRONT OCCUPANT
LAP BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200
TIME - MSEC

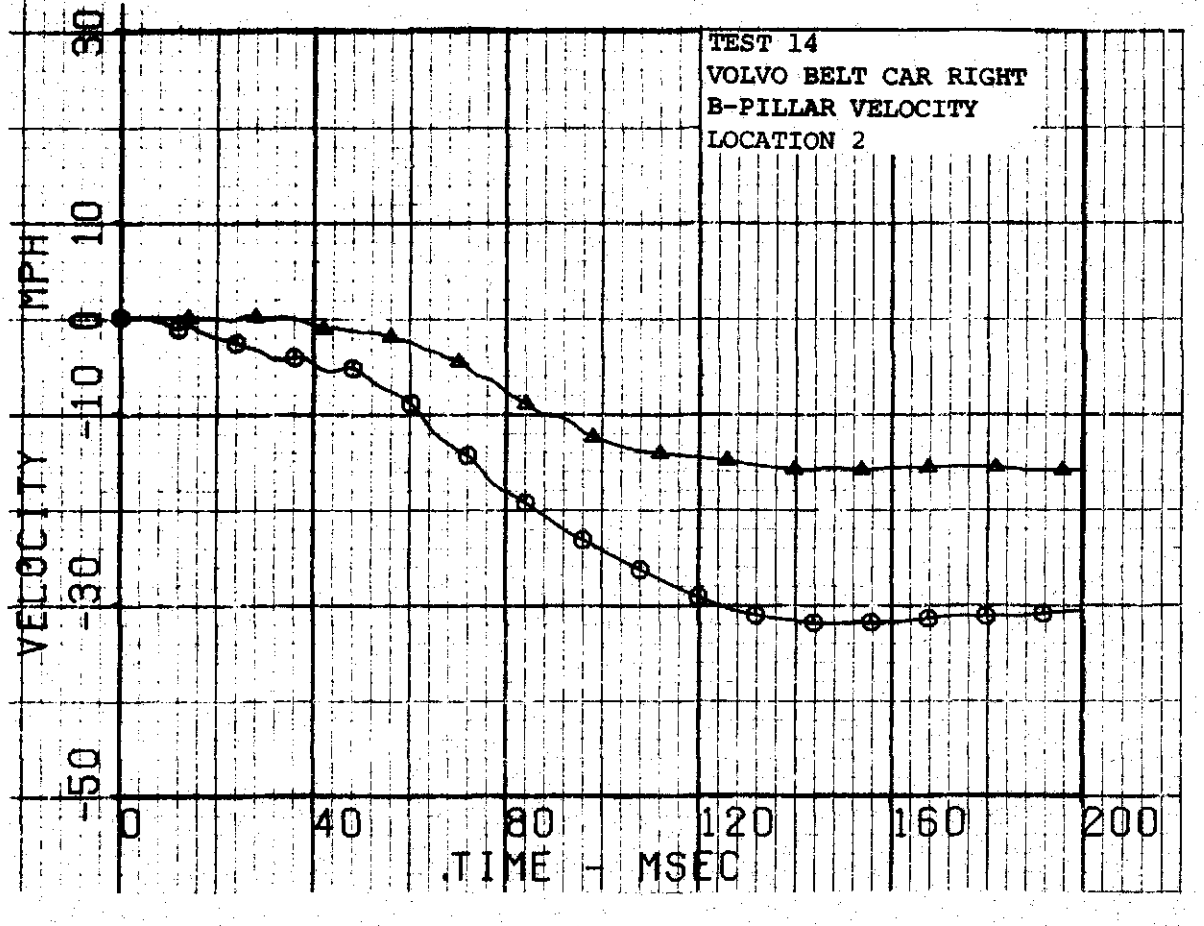

TEST 14
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
SHOULDER BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200

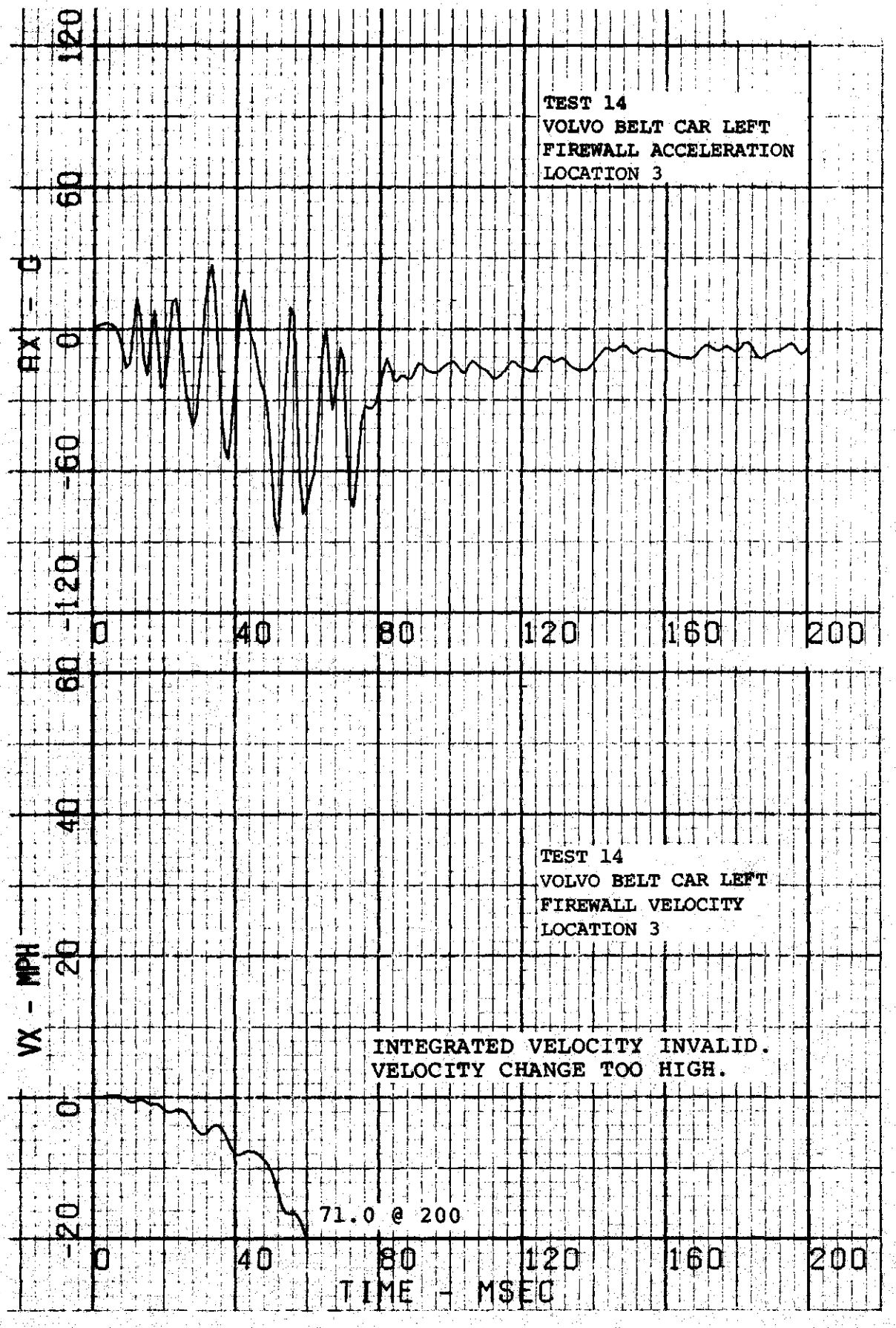

TEST 14
VOLVO BELT CAR
RIGHT FRONT OCCUPANT
LAP BELT LOAD
POUNDS FORCE
2000
1500
1000
500
0
0
40
80
120
160
200
TIME - MSEC

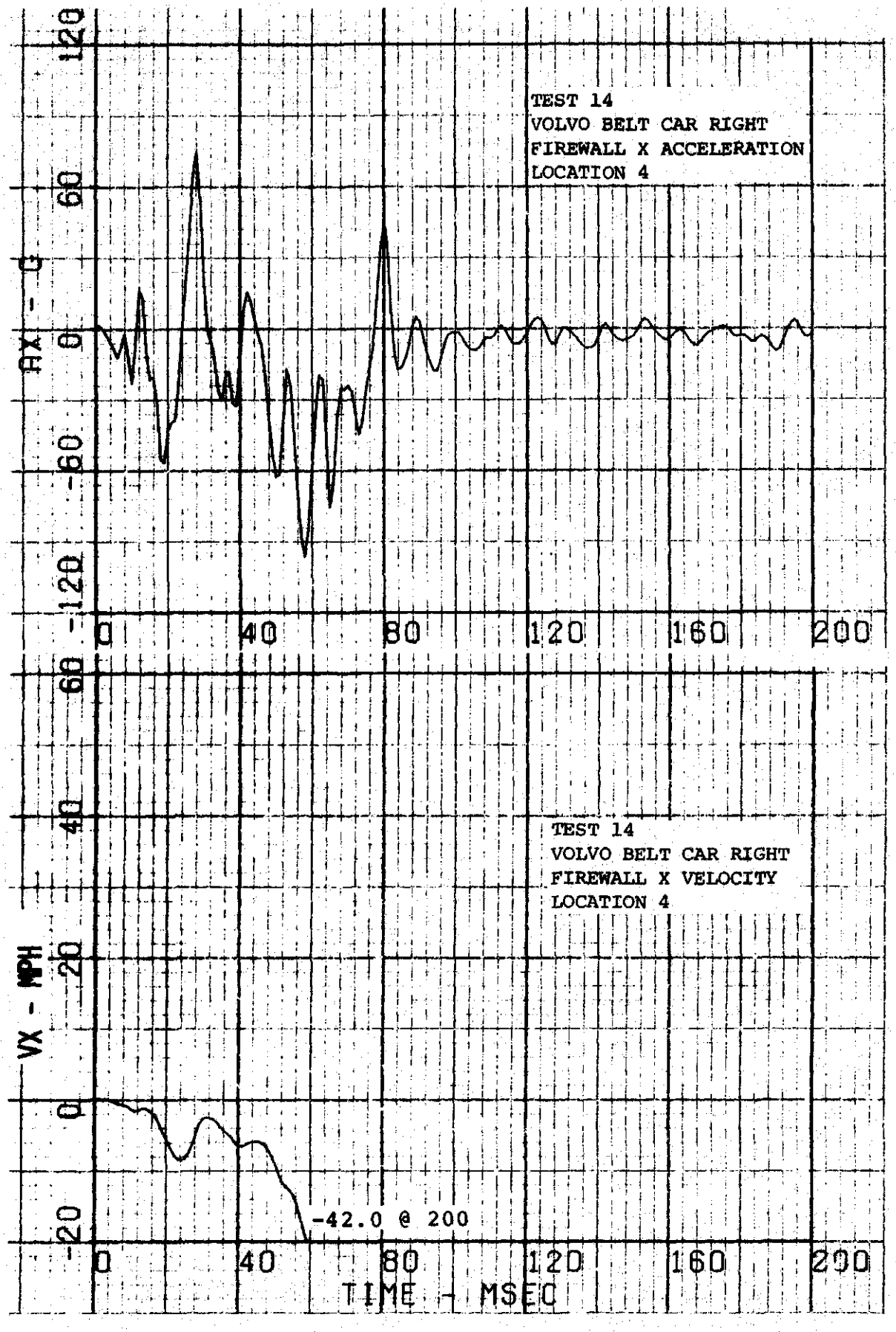

○= AX △= AY
TEST 14
VOLVO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

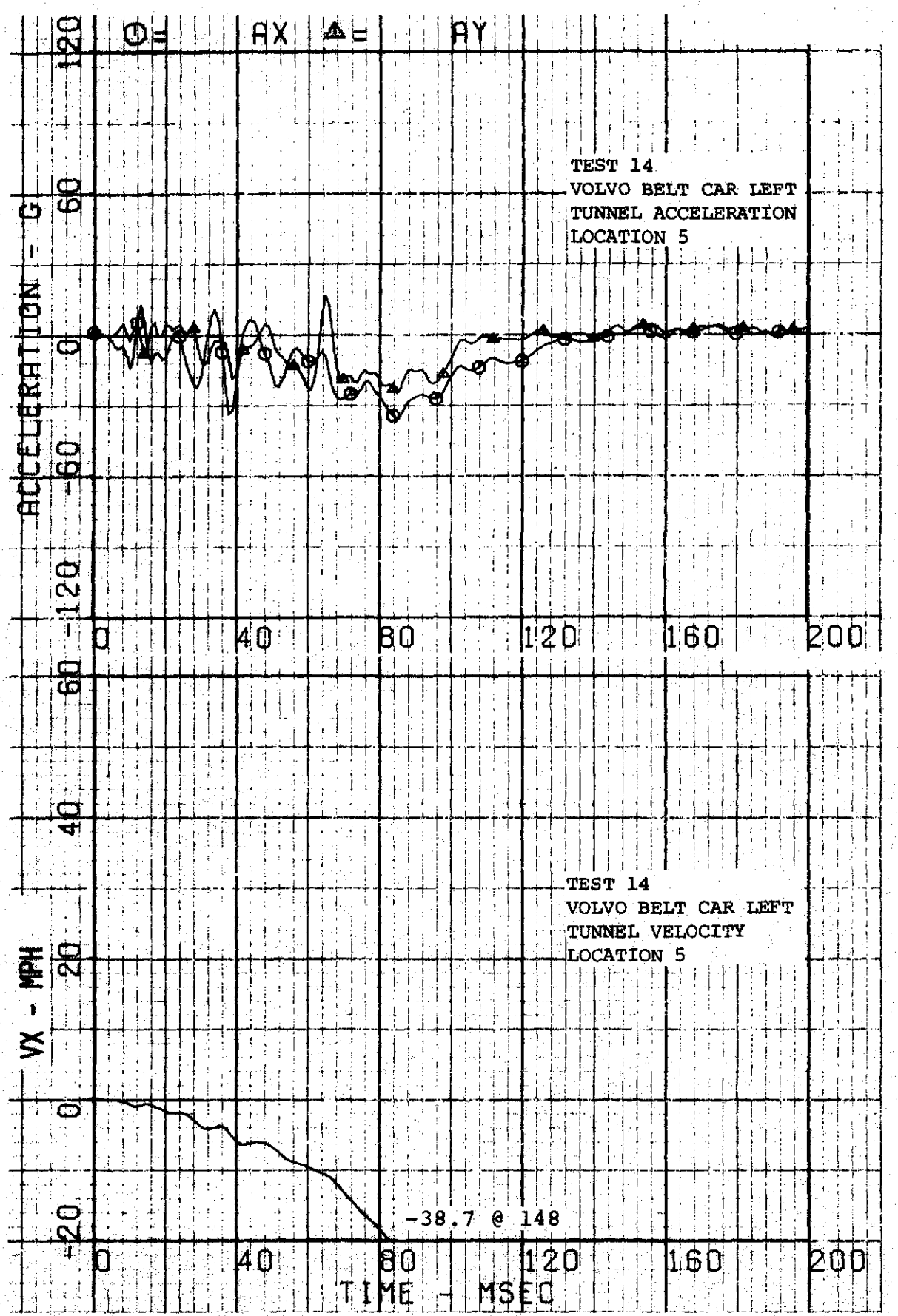

TEST 14
VOLVO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY - MPH
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

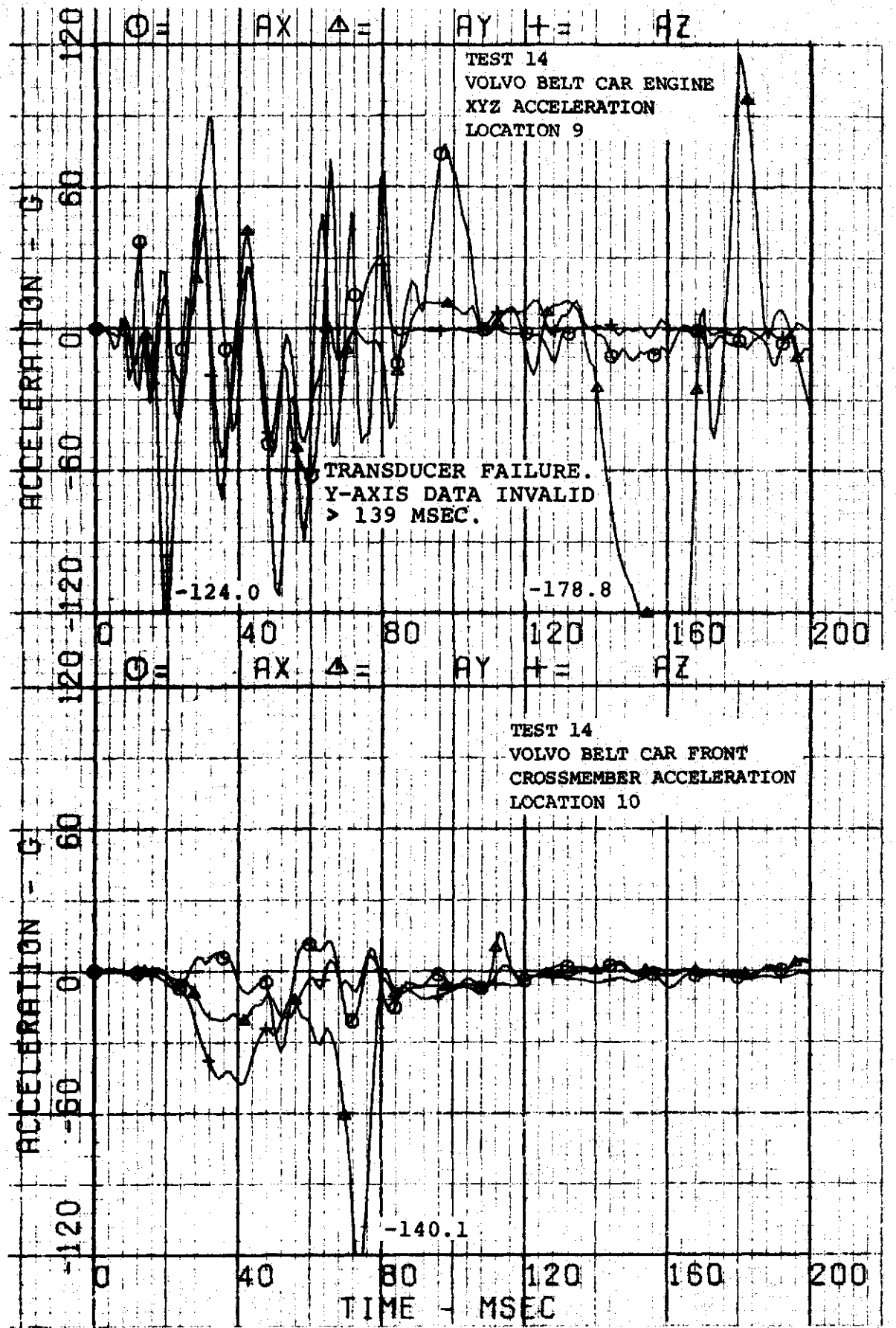

○= AX △= AY
TEST 14
VOLVO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

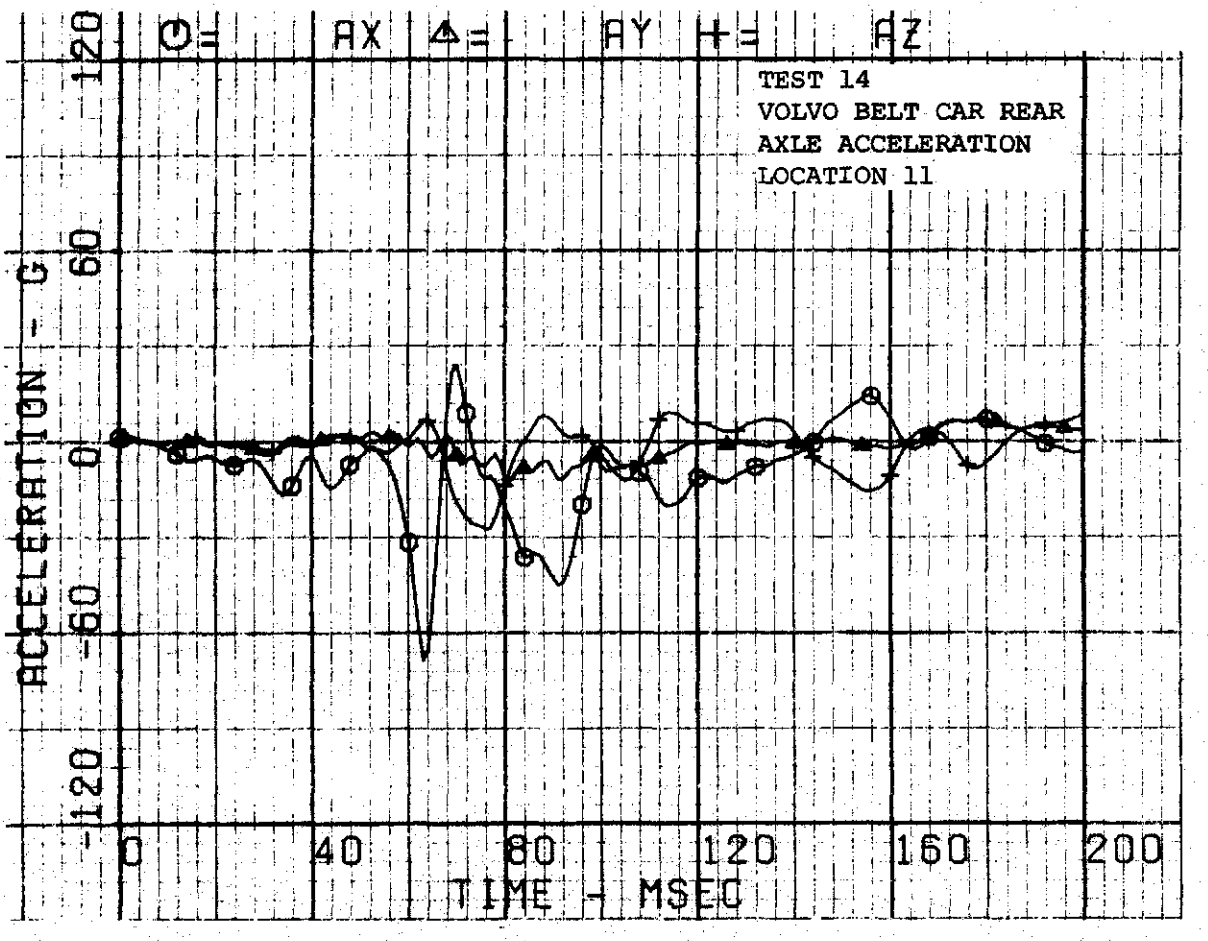

TEST 14
VOLVO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY MPH
30
10
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

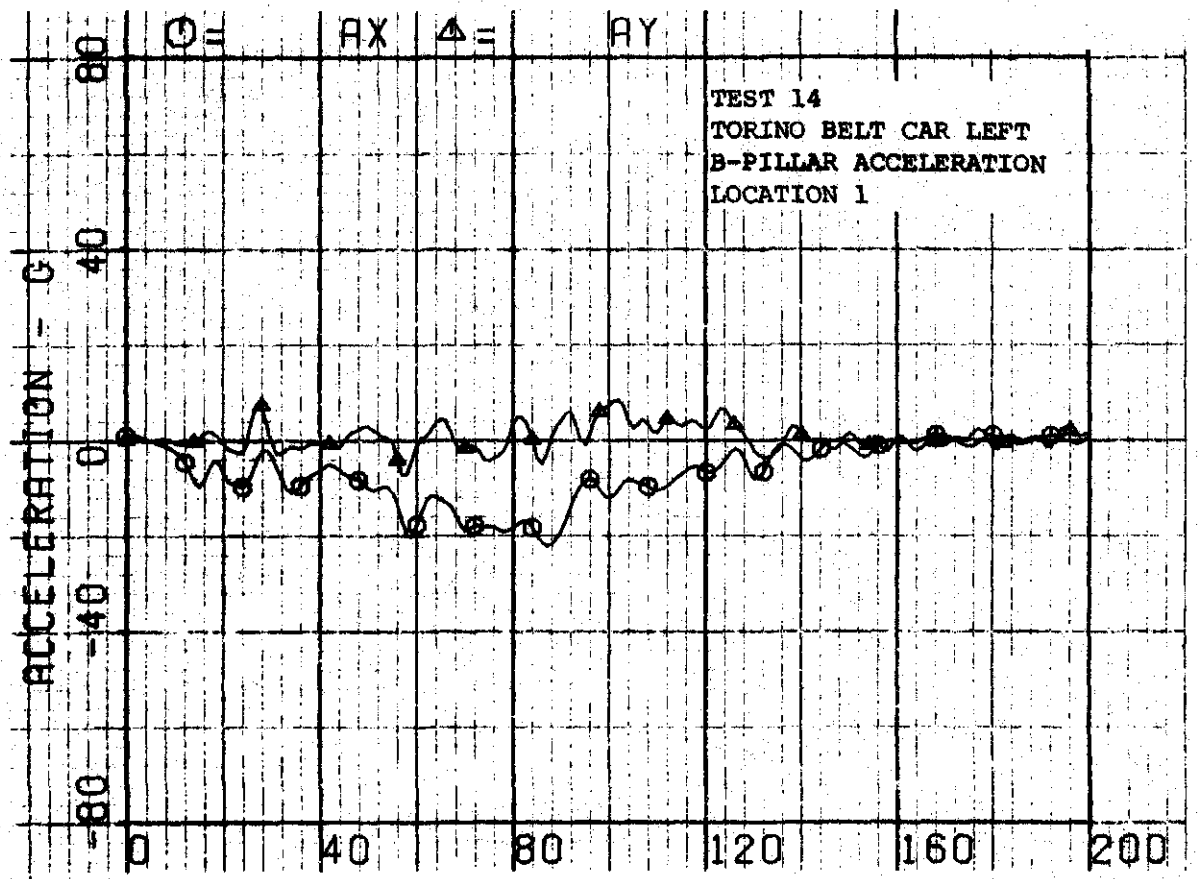

TEST 14
VOLVO BELT CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 14
VOLVO BELT CAR LEFT
FIREWALL VELOCITY
LOCATION 3
INTEGRATED VELOCITY INVALID.
VELOCITY CHANGE TOO HIGH.
VX - MPH
60
40
20
0
-20
71.0 @ 200
0
40
80
120
160
200
TIME - MSEC

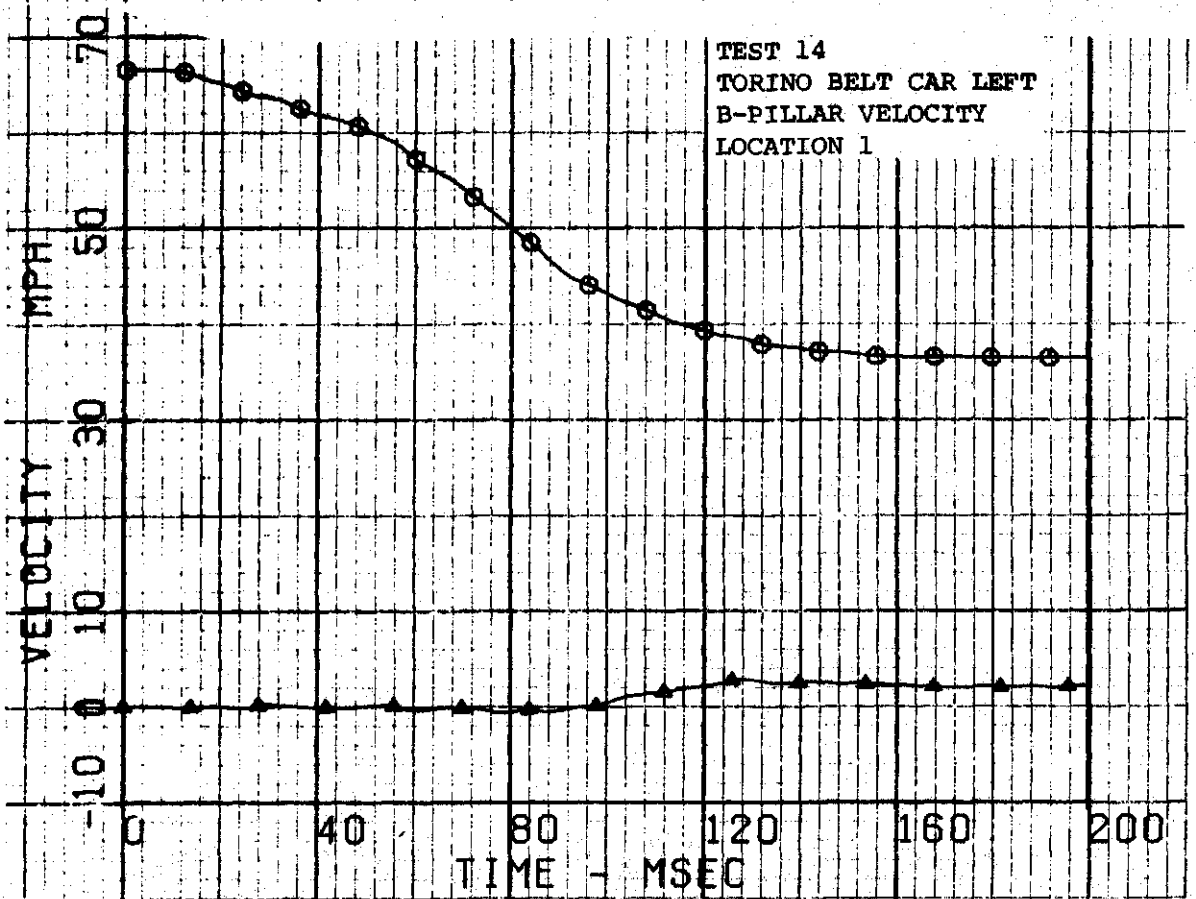

TEST 14
VOLVO BELT CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
AX - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 14
VOLVO BELT CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
VX - MPH
60
40
20
0
-20
-42.0 @ 200
0
40
80
120
160
200
TIME - MSEC

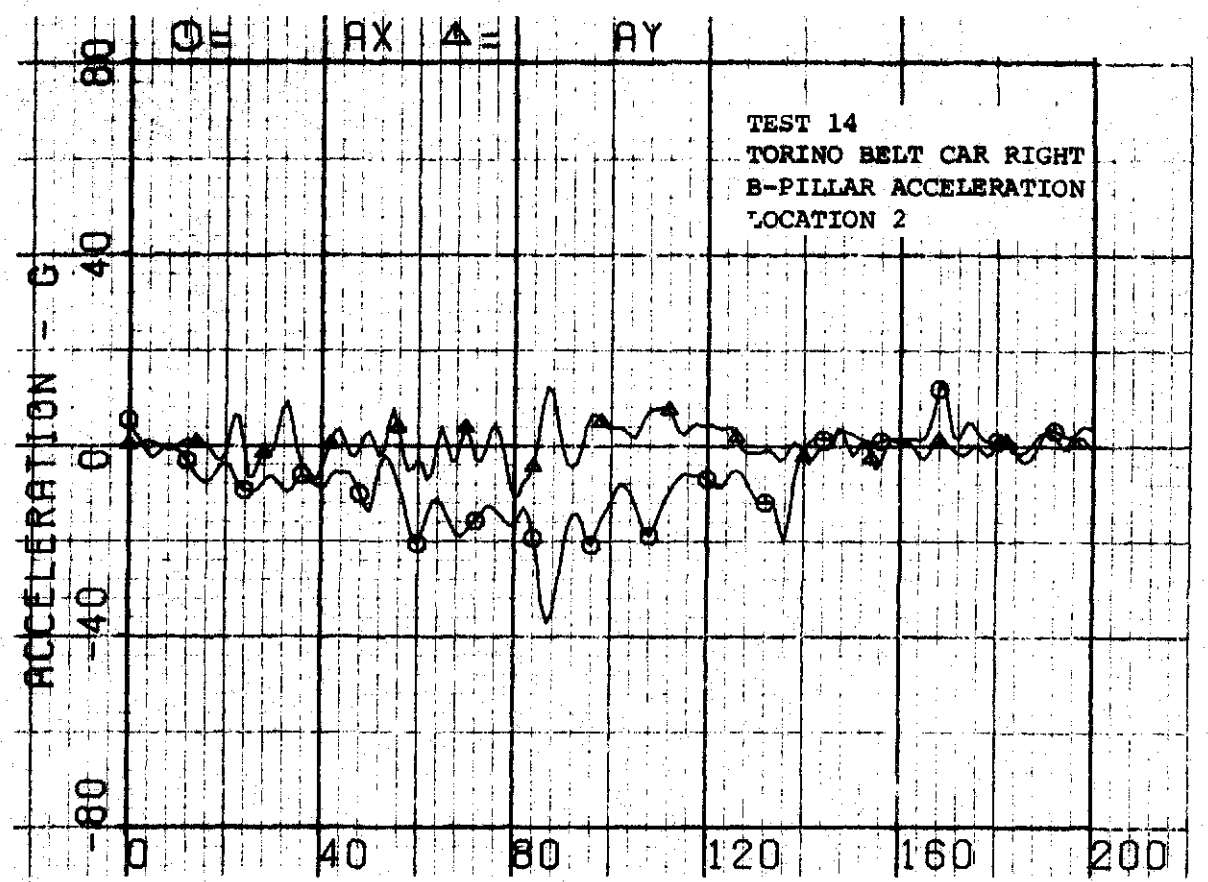

AX
AY
TEST 14
VOLVO BELT CAR LEFT
TUNNEL ACCELERATION
LOCATION 5
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TEST 14
VOLVO BELT CAR LEFT
TUNNEL VELOCITY
LOCATION 5
VX - MPH
60
40
20
0
-20
-38.7 @ 148
TIME - MSEC

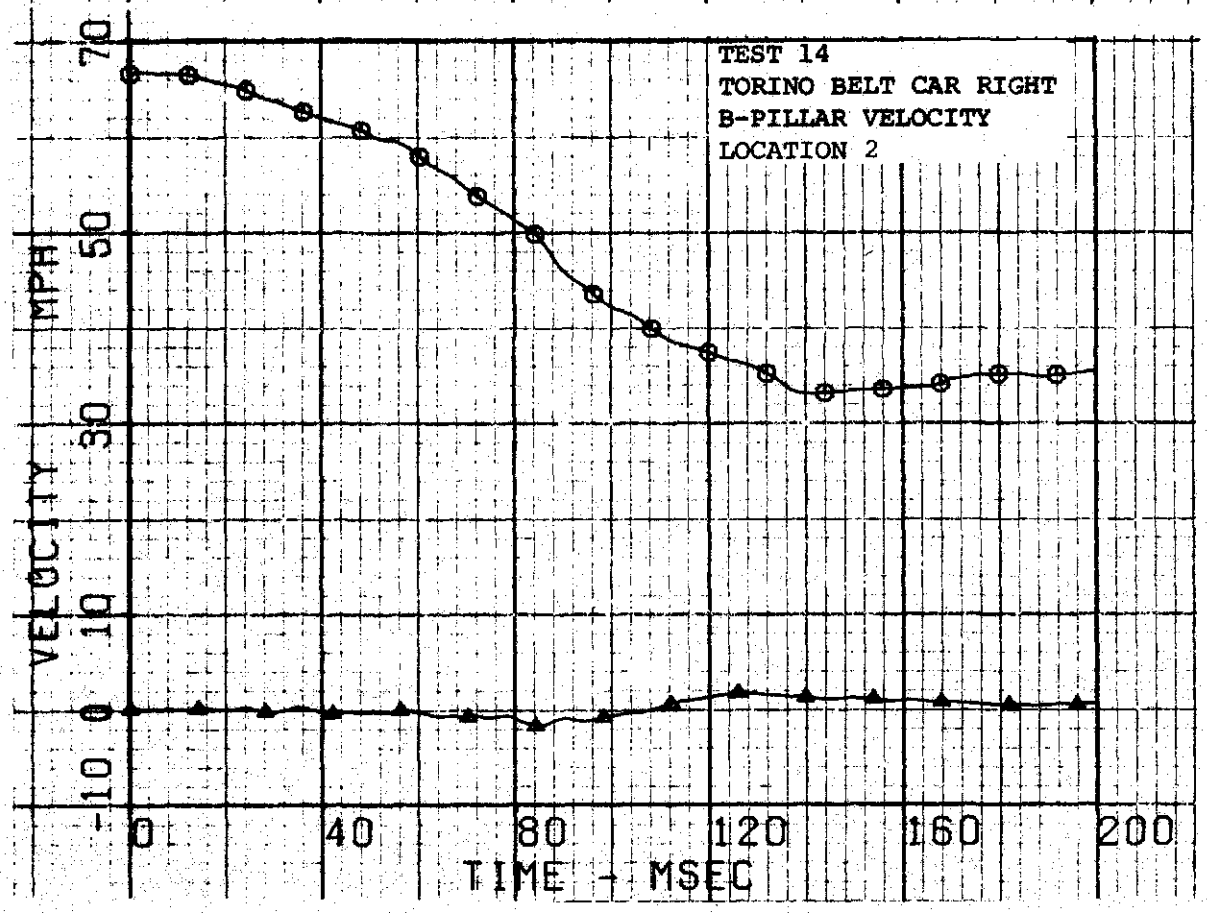

○= AX △= AY += AZ
TEST 14
VOLVO BELT CAR ENGINE
XYZ ACCELERATION
LOCATION 9
TRANSDUCER FAILURE.
Y-AXIS DATA INVALID
> 139 MSEC.
-124.0
-178.8
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
○= AX △= AY += AZ
TEST 14
VOLVO BELT CAR FRONT
CROSSMEMBER ACCELERATION
LOCATION 10
-140.1
TIME - MSEC


AX
AY
AZ
TEST 14
VOLVO BELT CAR REAR
AXLE ACCELERATION
LOCATION 11
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


□ = AX △ = AY
TEST 14
TORINO BELT CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 14
TORINO BELT CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC


AX
AY
TEST 14
TORINO BELT CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 14
TORINO BELT CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC

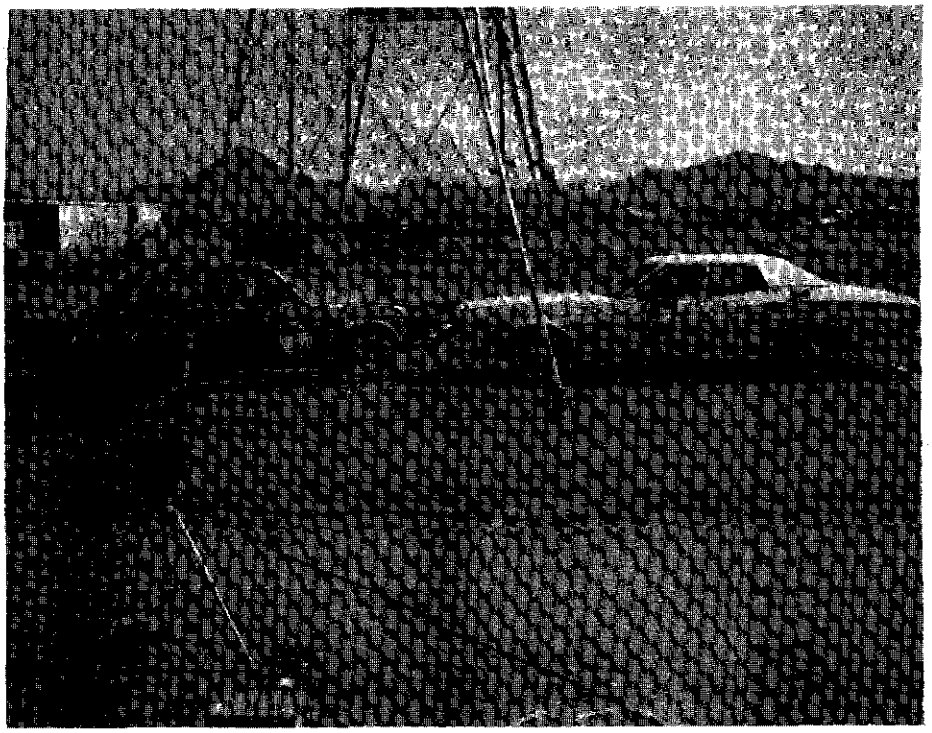


Figure 3-44. Pre-test Vehicle Configuration - Test 14.

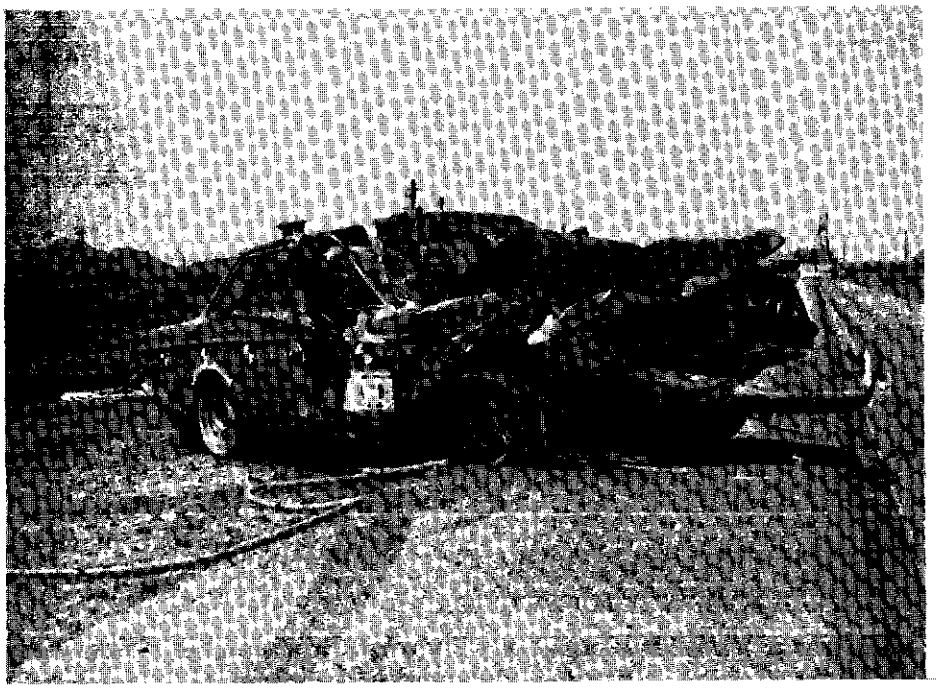


Figure 3-45. Post-test Vehicle Configuration - Test 14.

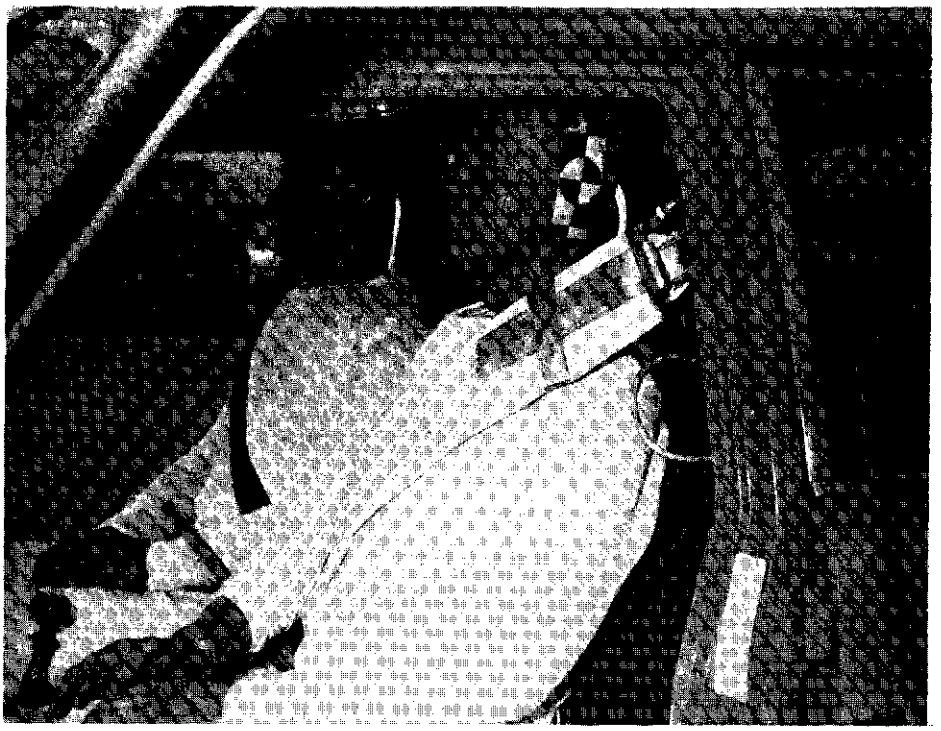


Figure 3-46. Pre-test Force Limited Airbelt - Test 14.

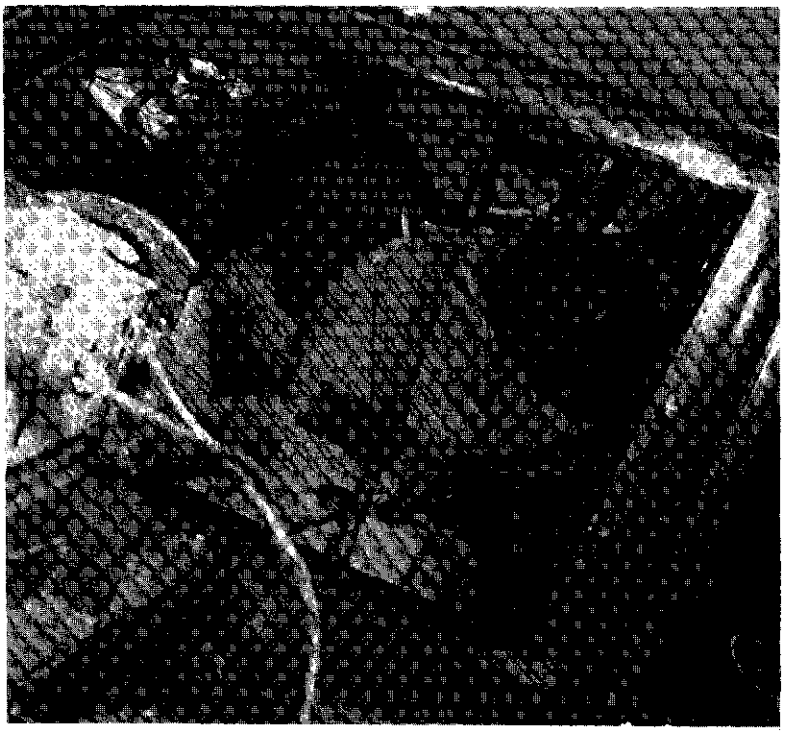


Figure 3-47. Post-test Force Limited Airbelt - Test 14.

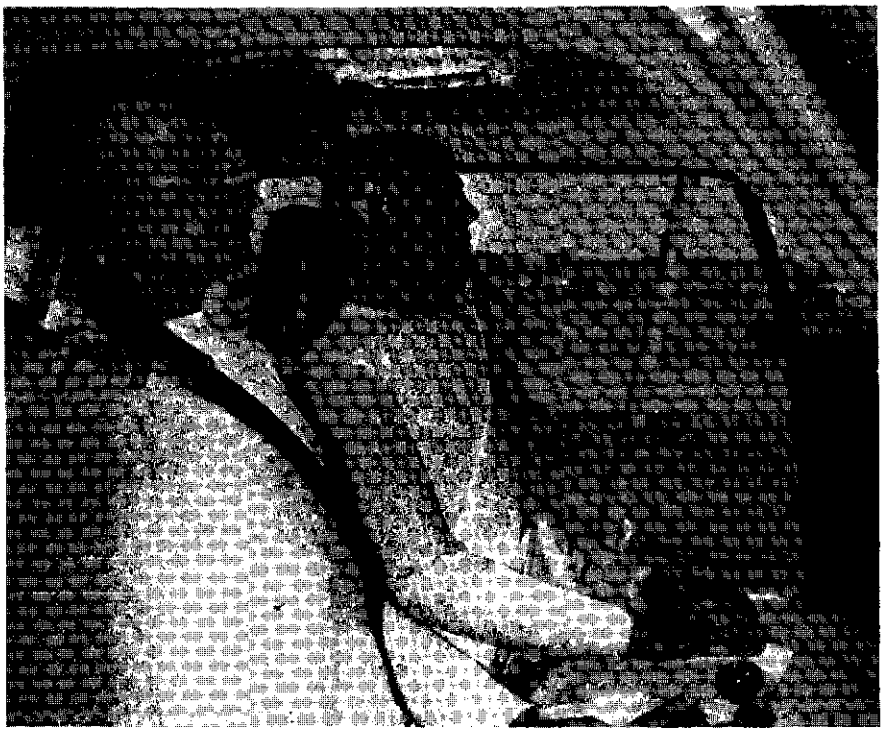


Figure 3-48. Pre-test Force Limited 2-Inch Belt - Test 14.

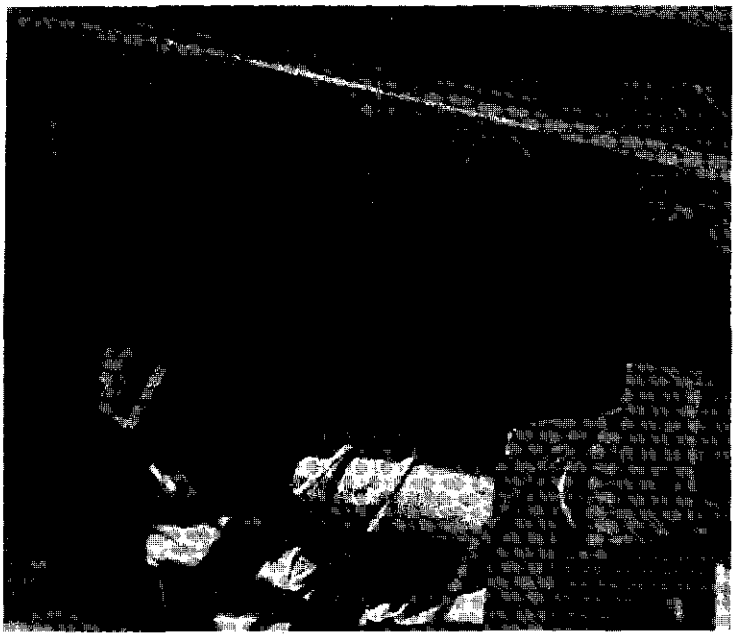


Figure 3-49. Post-test Force Limited 2-Inch Belt - Test 14.

3.8 TEST NUMBER 16

The impact conditions for Test 16 were:

Configuration	Closing Speed
Torino-to-Volvo Left Oblique (45°)	60.3 mph

and the restraint system configuration was:

Occupant	Vehicle A	Vehicle B
Left Front	Unrestrained	RSV Driver Airbag
Right Front	Unrestrained	RSV Passenger Airbag

For this test, Vehicle A was a 1975 Ford Torino and Vehicle B was a 1976 Volvo 244. No structural modifications were made to Vehicle A, while Vehicle B was structurally modified in the dash, A pillar, and B pillar areas to preserve occupant compartment integrity and to accept the restraint systems that were installed in it. The extent of these modifications is shown in Figure 1-1.

The results of Test 16 are summarized in the following tables:

Table 3-29 - Summary of Vehicle Data (Test 16)

Table 3-30 - Injury Criteria Summary (Test 16)

Table 3-31 - Summary of Restraint System Data (Test 16)

Table 3-32 - Occupant Response Data (Test 16)

which are followed by Figure 3-50 defining vehicle accelerometer locations. The plotted data from the test are presented after this figure, and following the data plots are photos showing the before and after conditions of the vehicles and restraint systems.

TABLE 3-29. SUMMARY OF VEHICLE DATA (TEST 16)

PARAMETER		VEHICLE A	VEHICLE B
TEST NUMBER AND DATE		Test 16/July 19, 1977	
TEST VEHICLE		Torino	Volvo
DYNAMIC SCIENCE NUMBER		506	426
TEST WEIGHT (lb)		4634	3263
IMPACT VELOCITY (mph)		60.3	0
VELOCITY CHANGE (mph)		25.9	31.6 (1)
PEAK RESULTANT ACCELERATION (G @ msec)			
	LOCATION 1	26.7 @ 93	29.5 @ 63
	LOCATION 2	19.8 @ 95	31.2 @ 64
MAXIMUM STATIC CRUSH (in.)			
	LEFT	4.0	49.0
	CENTER	25.0	17.5
	RIGHT	25.0	8.0

(1) Velocity change found by using average of resultant velocity vector (V_R) data for compartment accelerometer locations.

TABLE 3-30. INJURY CRITERIA SUMMARY (TEST 16)

VEHICLE B - AIRBAG CAR (VOLVO)				
	RSV DRIVER AIRBAG		RSV PASSENGER AIRBAG	
HIC	207		1246	
HEAD G(1) @ msec	60.7 @ 107		117.3 @ 172	
CSI	130		120	
CHEST G(1) @ msec	32.1 @ 75		31.5 @ 138	
FEMUR LOAD (lb)	LEFT 423	RIGHT 592	LEFT 365	RIGHT 937

(1) 3 msec clip.

TABLE 3-31. SUMMARY OF RESTRAINT SYSTEM DATA (TEST 16)

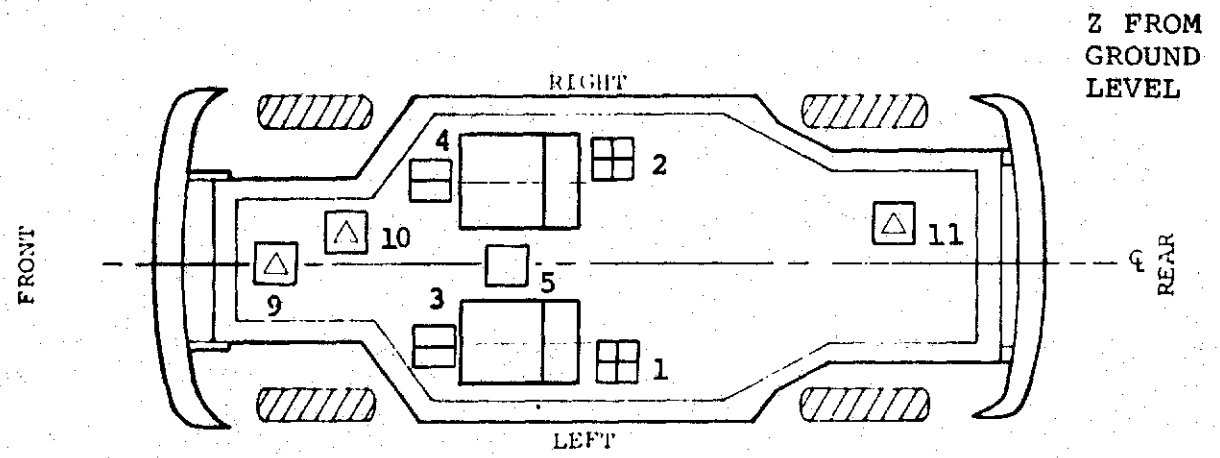
VEHICLE B - AIRBAG CAR (VOLVO)	
RSV DRIVER AIRBAG Peak Bag Pressure psi @ msec	16.8 @ 18(1)
RSV PASSENGER AIRBAG Peak Bag Pressure psi @ msec	4.4 @ 15

(1) Transducer failure. Bag pressure data invalid > 30 msec.

TABLE 3-32. OCCUPANT RESPONSE DATA SUMMARY (TEST 16)

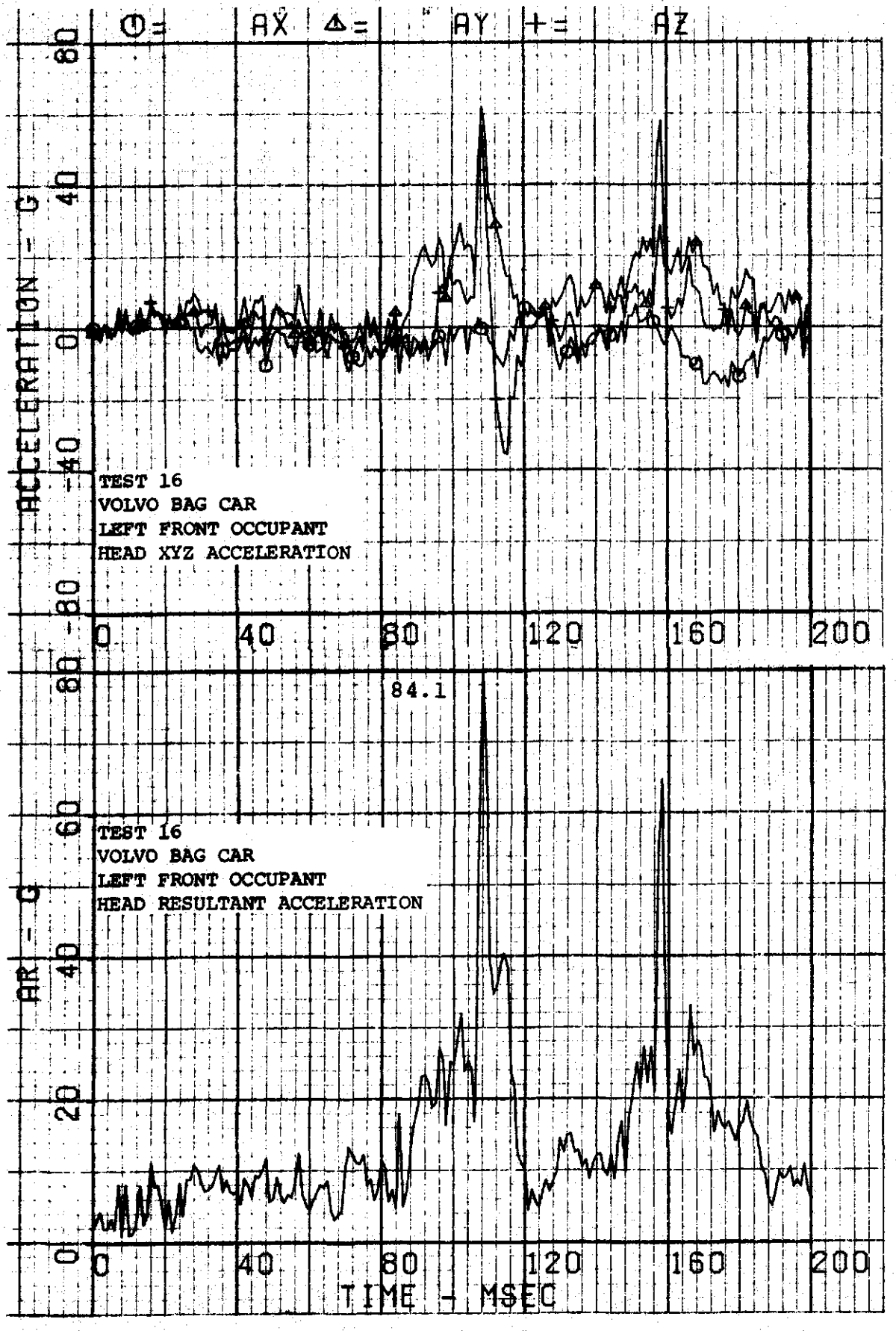
		VEHICLE B - AIRBAG CAR (VOLVO)			
		LEFT FRONT OCCUPANT		RIGHT FRONT OCCUPANT	
		MAX VALUE (g)	T MSEC	MAX VALUE (g)	T MSEC
HEAD					
	X	16.7	177	89.1	169
	Y	62.1	108	122.1	169
	Z	58.2	158	125.4	170
	R(1)	60.7	107	117.3	172
	HIC	207 @ 88-185		1246 @ 168-173(2)	
CHEST					
	X	20.1	102	23.8	85
	Y	39.3	72	27.6	139
	Z	10.8	98	29.3	141
	R(1)	32.1	75	31.5	138
	SI	130 @ 200		120 @ 200	
		MAX VALUE (lb)	T MSEC	MAX VALUE (lb)	T MSEC
FEMURS					
	LF	423	93	365	99
	RT	592	95	937	89

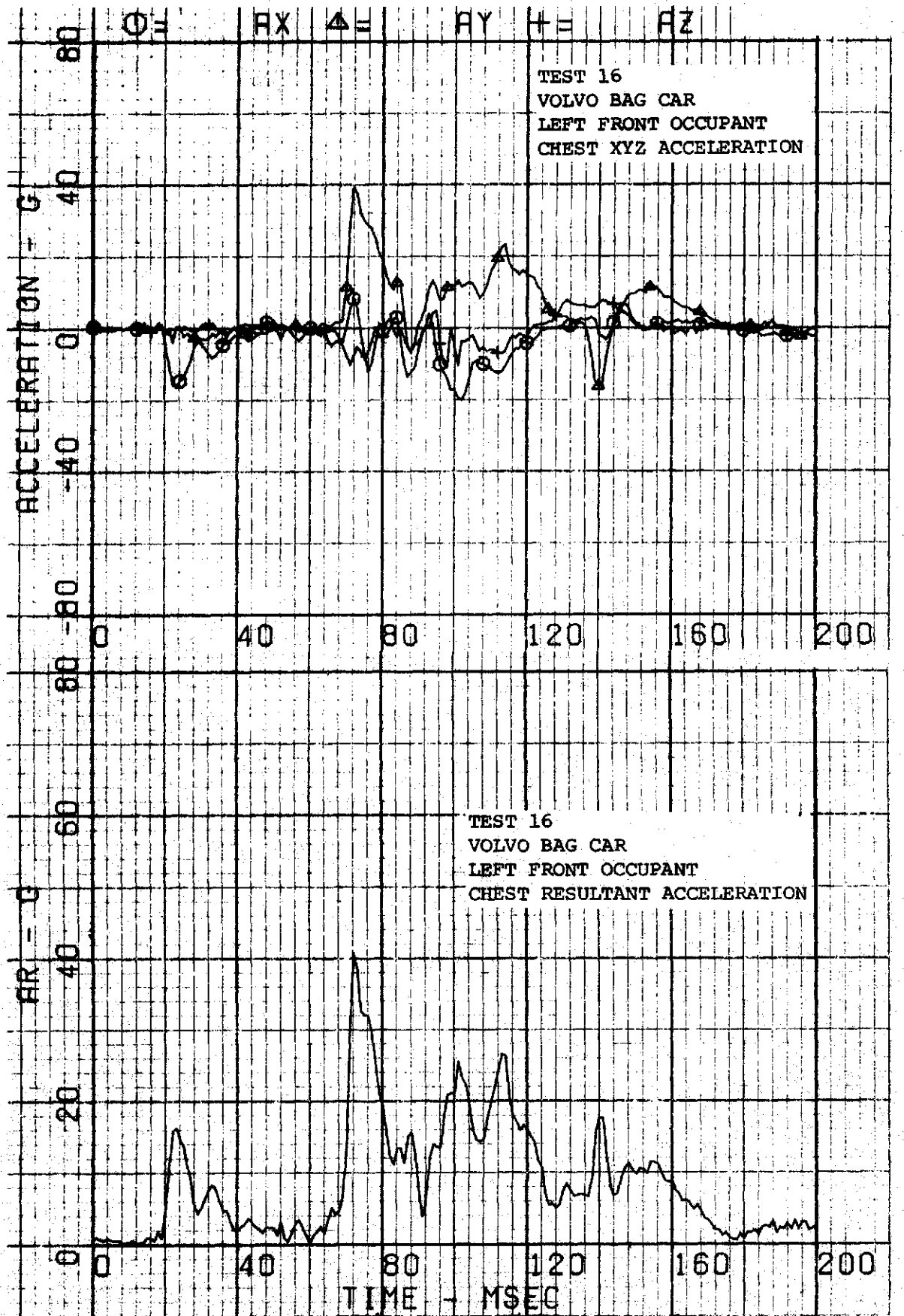
(1) 3 msec clip, components not clipped.
(2) Second HIC of 27.2 calculated between 18-150 msec; head strike on steering column at 172 msec.

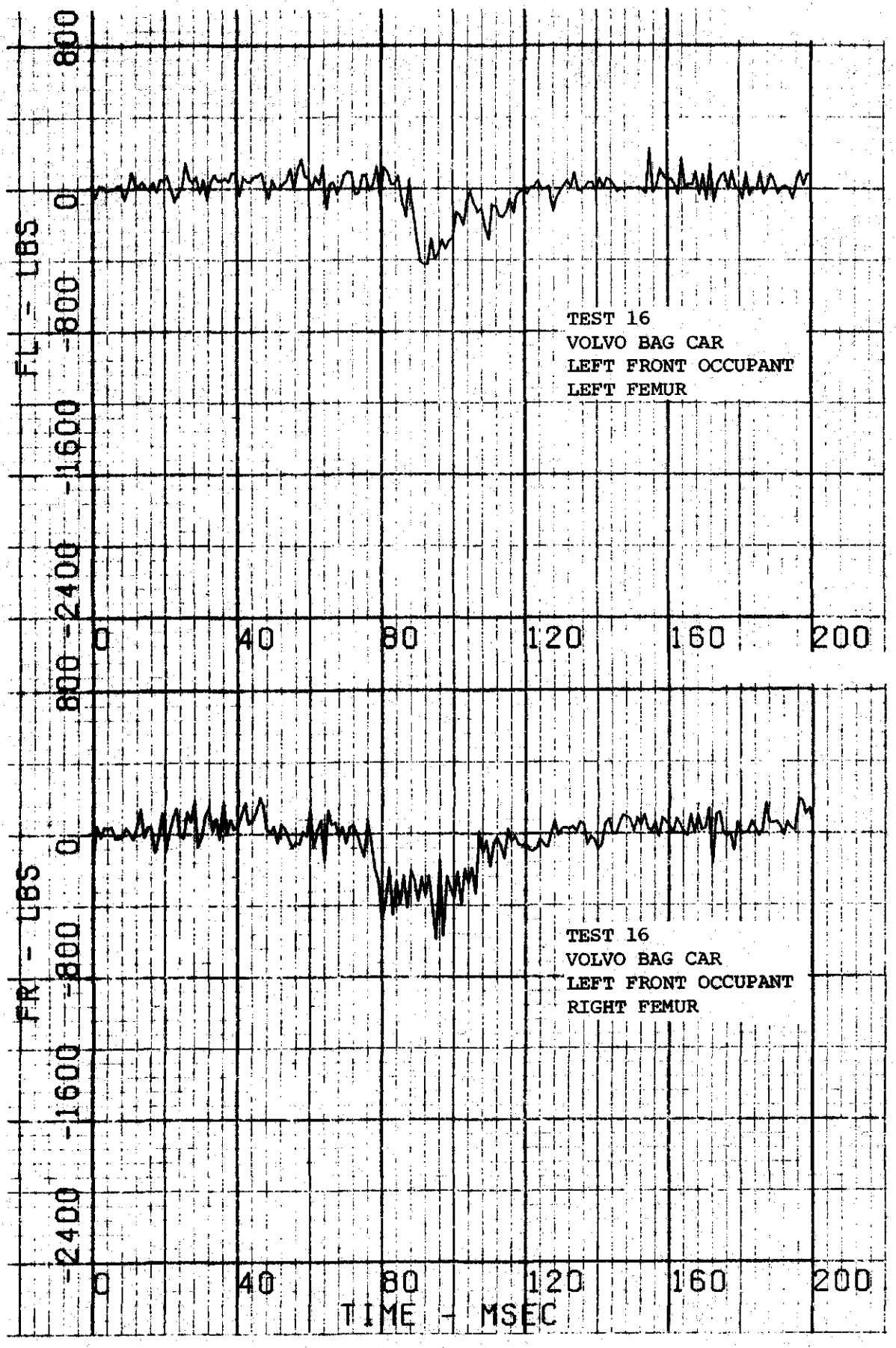


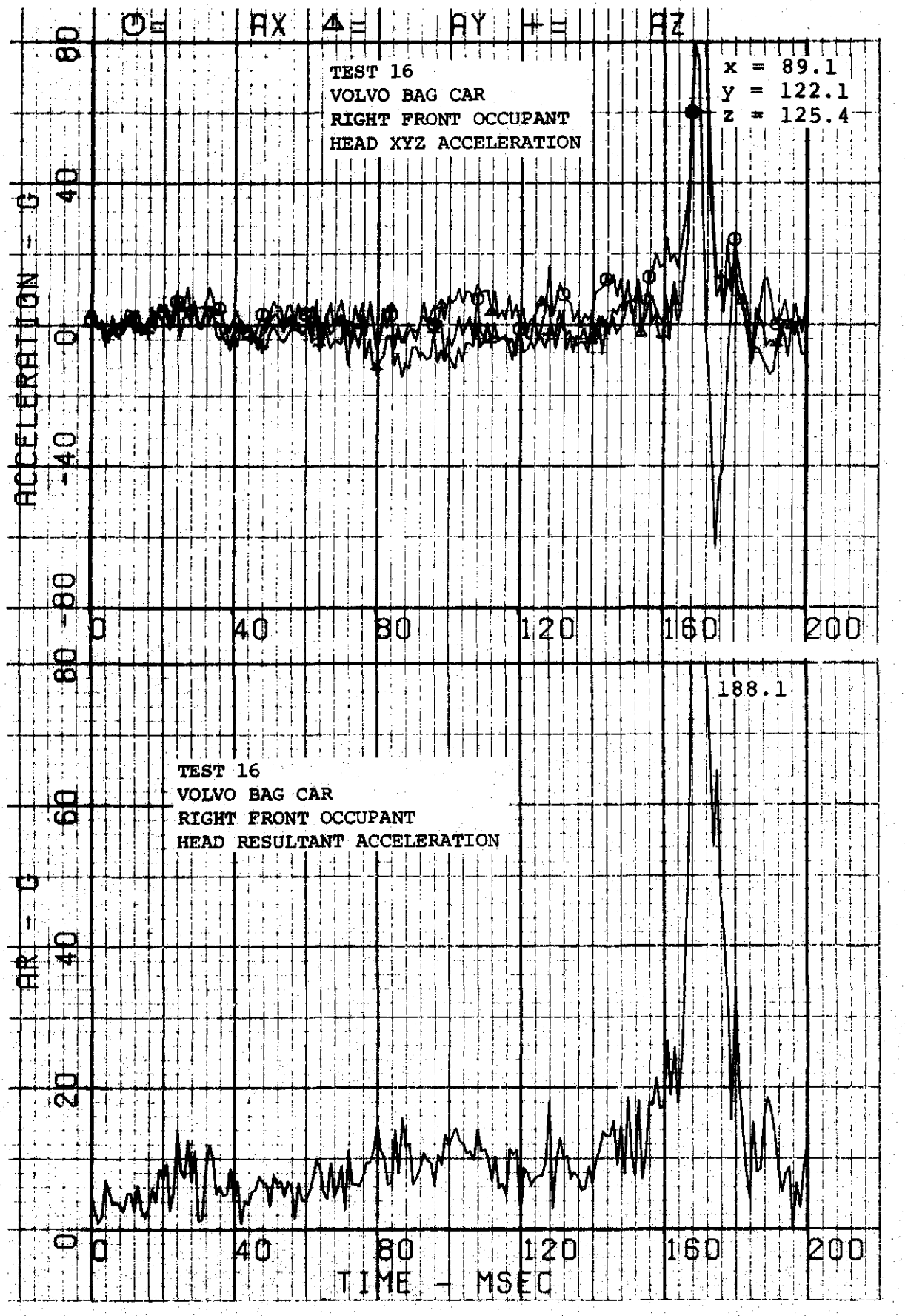
VEHICLE B ACCELEROMETER LOCATIONS AND COORDINATES				
NO.	DESCRIPTION OF LOCATION	X	Y	Z
1	Left Floor Pan near B-Pillar	X	X	
2	Right Floor Pan near B-Pillar	X	X	
3	Left Firewall on CL of Driver's Seat	X		
4	Right Firewall on CL of Passenger's Seat	X		
9	Engine Block	X	X	X
10	Front Crossmember	X	X	X
11	Rear Axle	X	X	X

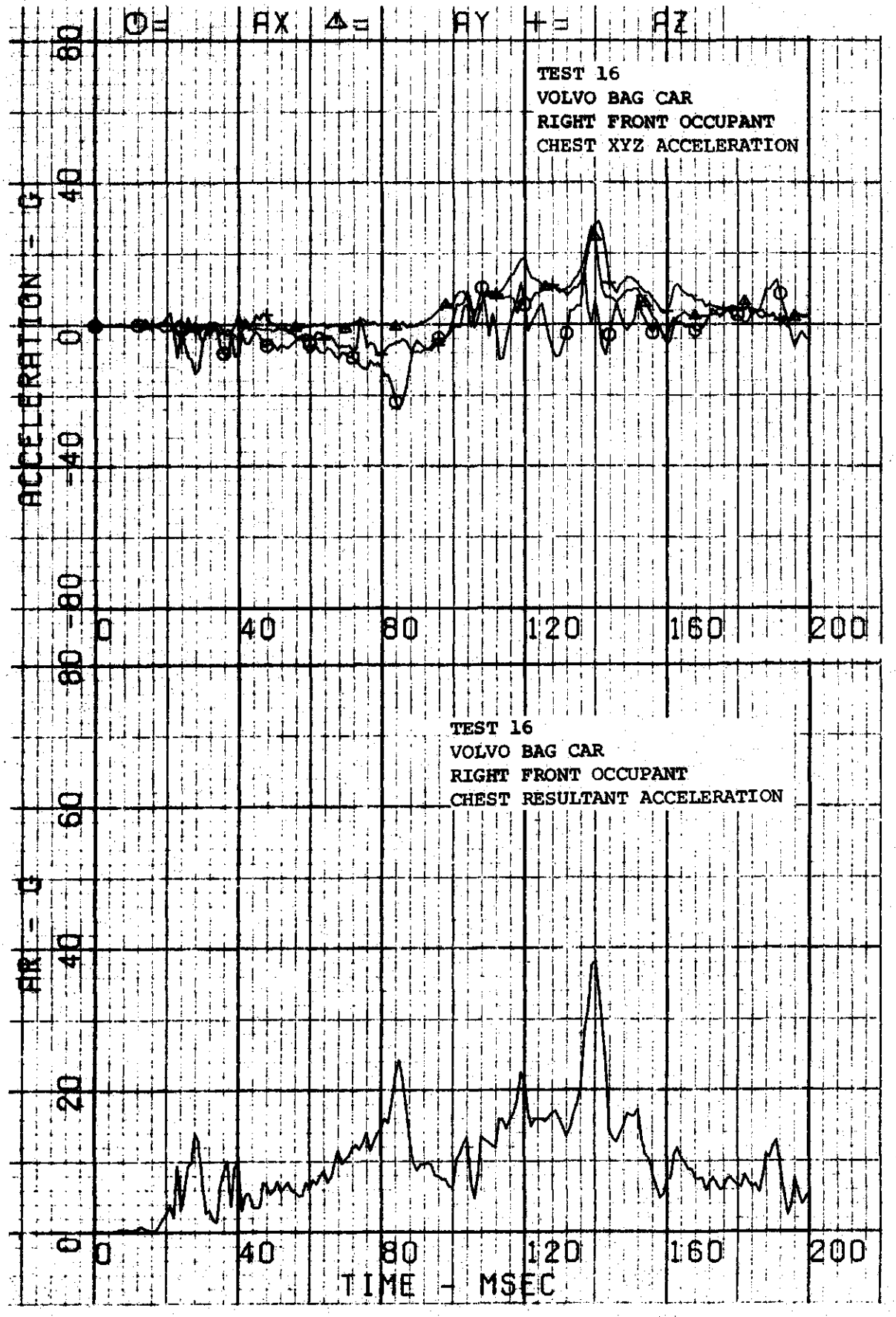
Figure 3-50. Vehicle Accelerometer Locations - Test 16.

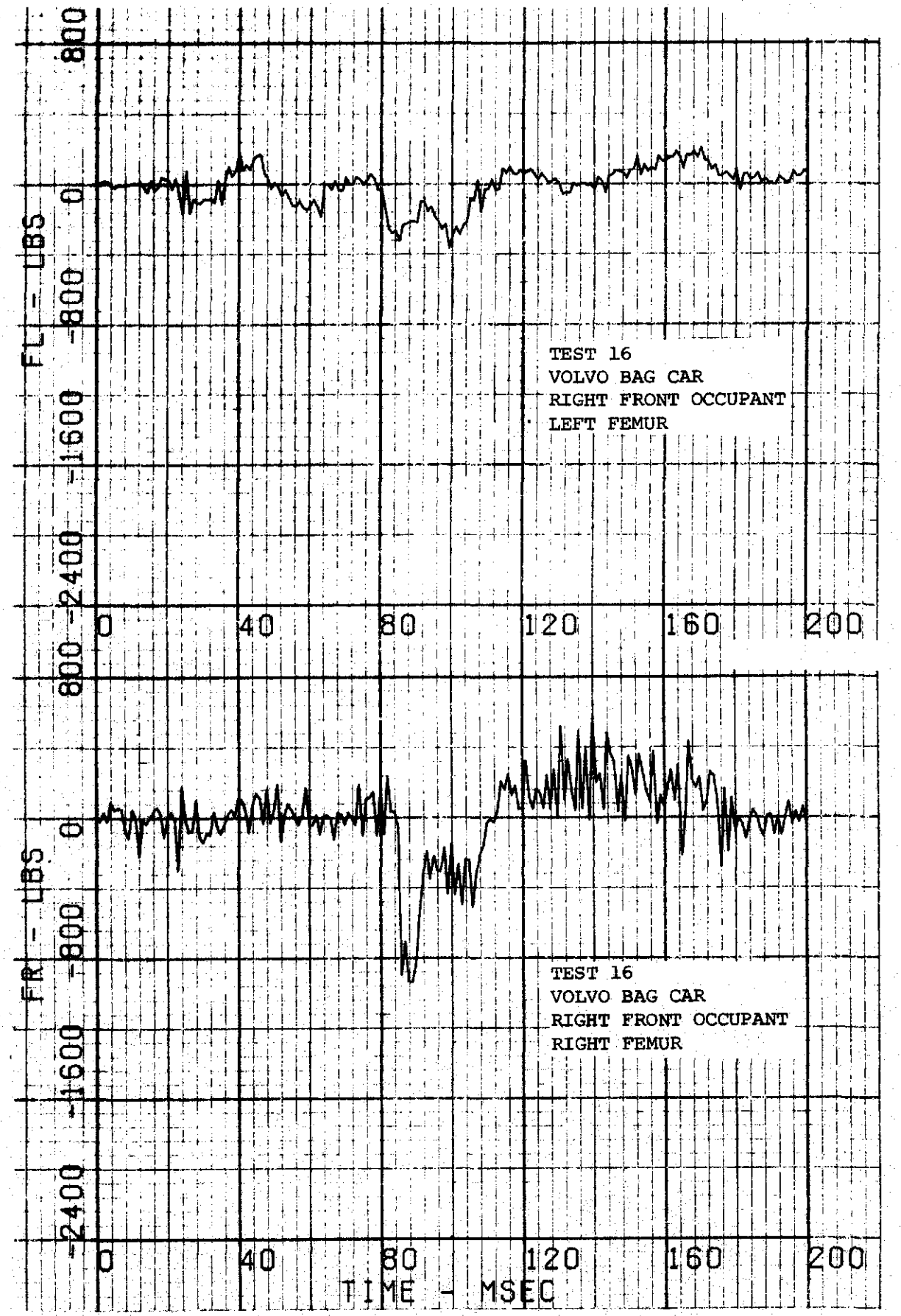

○= AX △= AY += AZ
ACCELERATION - G
80
40
0
-40
-80
TEST 16
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD XYZ ACCELERATION
0
40
80
120
160
200
84.1
AR - G
80
60
40
20
0
TEST 16
VOLVO BAG CAR
LEFT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
0
40
80
120
160
200
TIME - MSEC

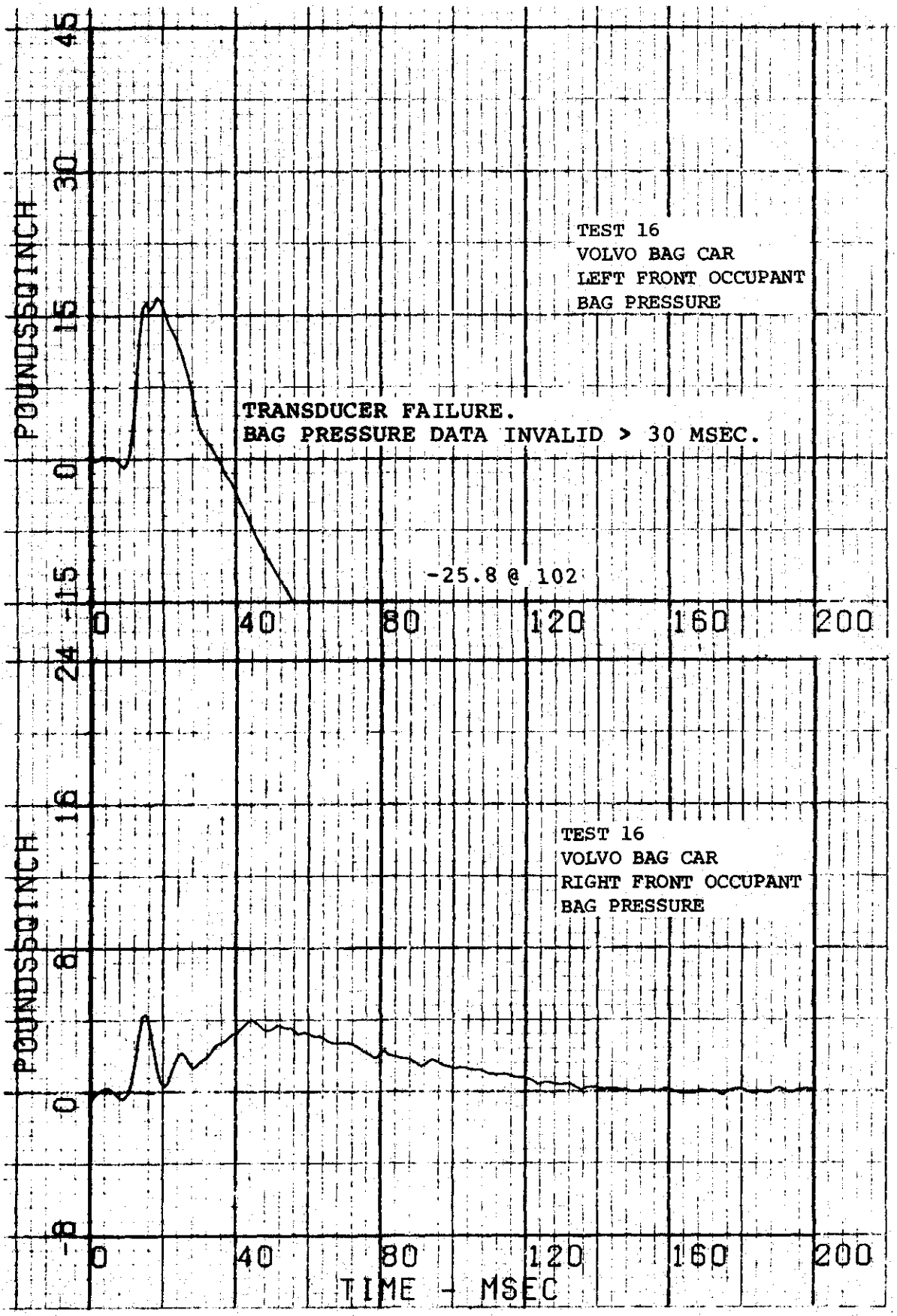

Φ=
AX
Θ=
AY
Ψ=
AZ
TEST 16
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 16
VOLVO BAG CAR
LEFT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR = G
60
40
20
0
TIME - MSEC

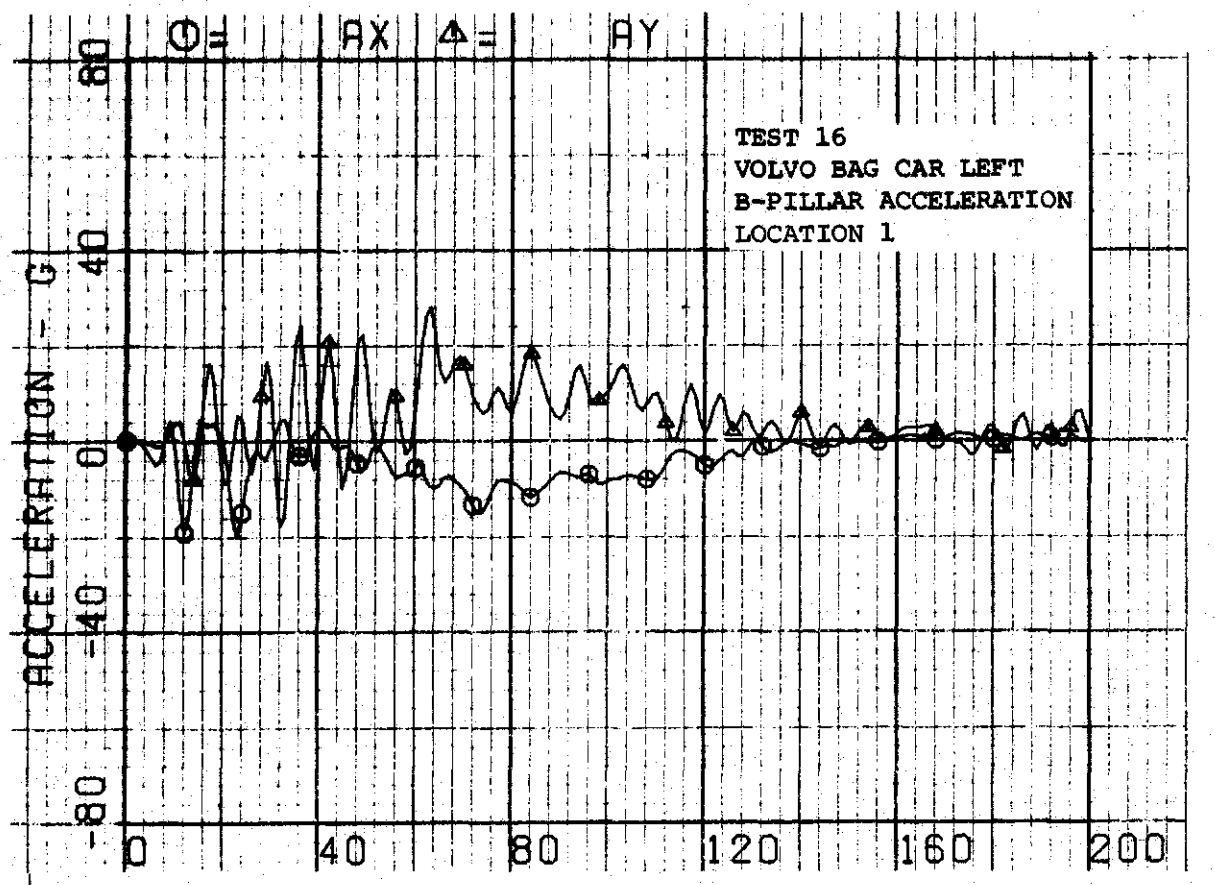

FL - LBS
800
0
-800
-1600
-2400
TEST 16
VOLVO BAG CAR
LEFT FRONT OCCUPANT
LEFT FEMUR
0
40
80
120
160
200
FR - LBS
800
0
-800
-1600
-2400
TEST 16
VOLVO BAG CAR
LEFT FRONT OCCUPANT
RIGHT FEMUR
0
40
80
120
160
200
TIME - MSEC

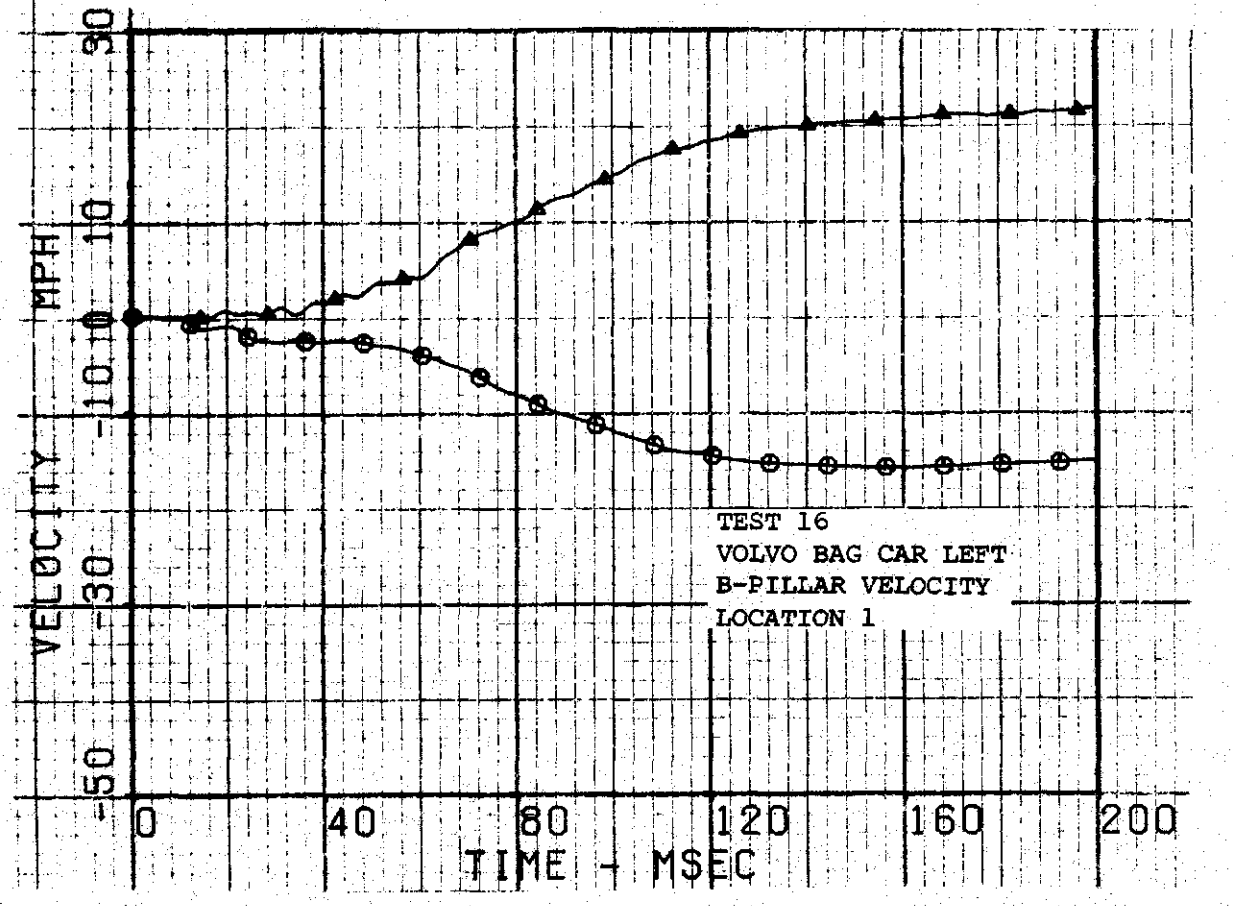

AX
AY
AZ
TEST 16
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD XYZ ACCELERATION
x = 89.1
y = 122.1
z = 125.4
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
188.1
TEST 16
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
HEAD RESULTANT ACCELERATION
AR - G
60
40
20
0
TIME - MSEC

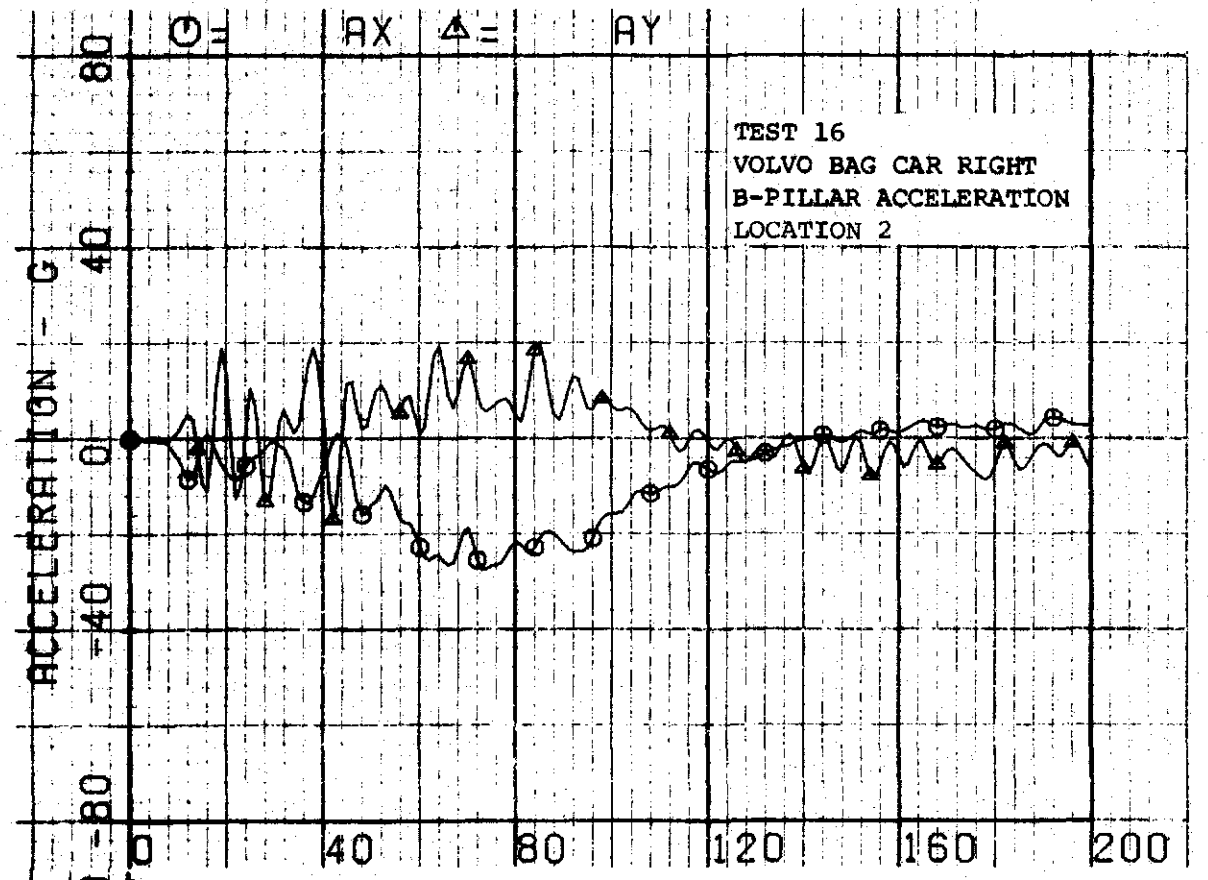

○= AX △= AY += AZ
TEST 16
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST XYZ ACCELERATION
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200
TEST 16
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
CHEST RESULTANT ACCELERATION
AR - G
60
40
20
0
TIME - MSEC

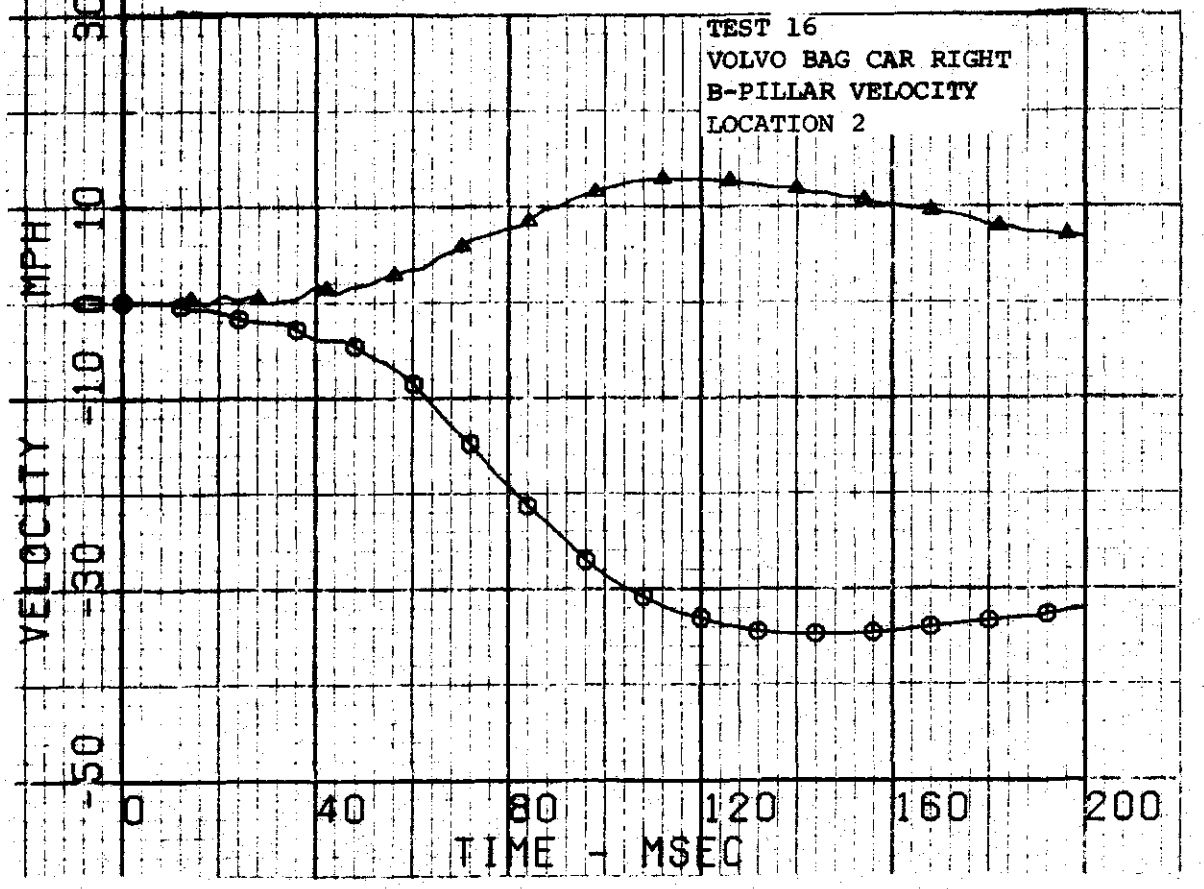

FL - LBS
800
0
-800
-1600
-2400
TEST 16
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
LEFT FEMUR
0
40
80
120
160
200
FR - LBS
800
0
-800
-1600
-2400
TEST 16
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
RIGHT FEMUR
0
40
80
120
160
200
TIME - MSEC

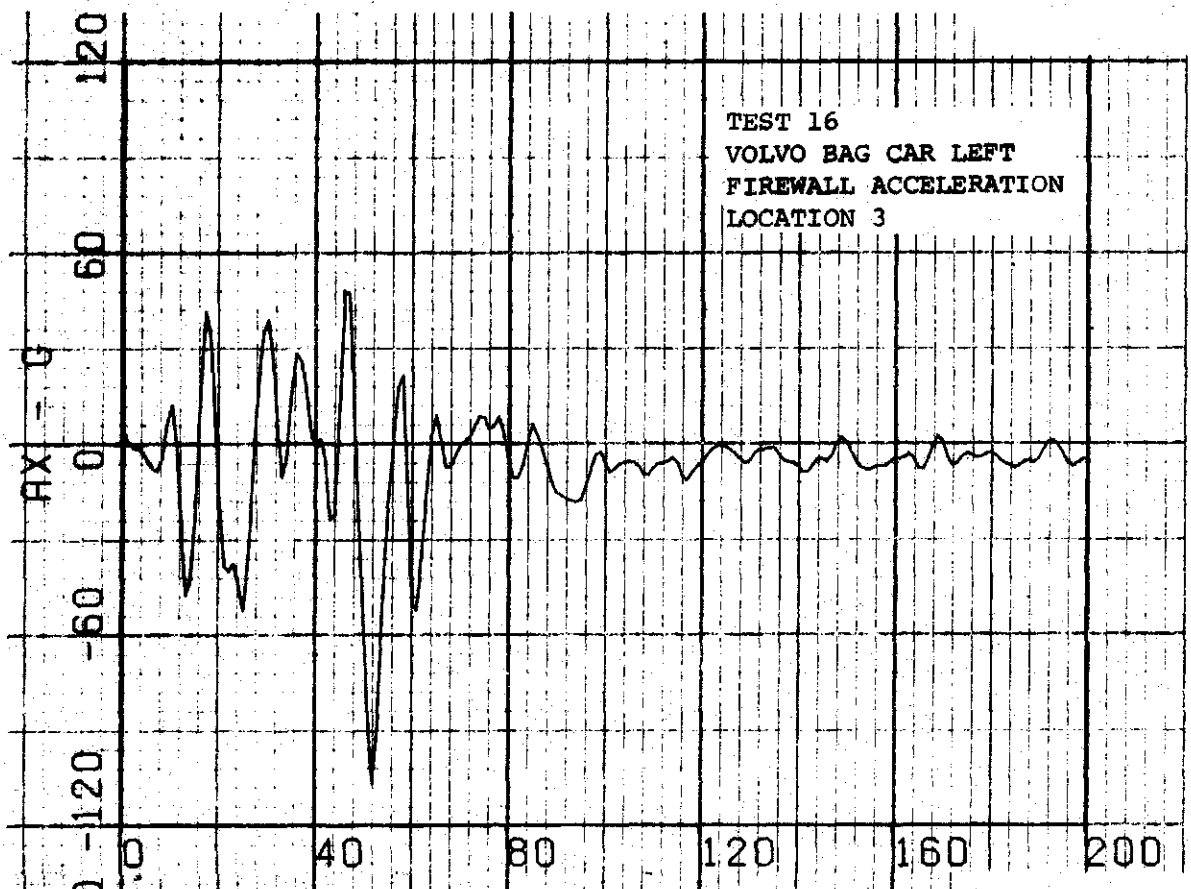

TEST 16
VOLVO BAG CAR
LEFT FRONT OCCUPANT
BAG PRESSURE
TRANSDUCER FAILURE.
BAG PRESSURE DATA INVALID > 30 MSEC.
-25.8 @ 102
POUNDS/INCH
45
30
15
0
-15
0
40
80
120
160
200
TEST 16
VOLVO BAG CAR
RIGHT FRONT OCCUPANT
BAG PRESSURE
POUNDS/INCH
24
16
8
0
-8
0
40
80
120
160
200
TIME - MSEC

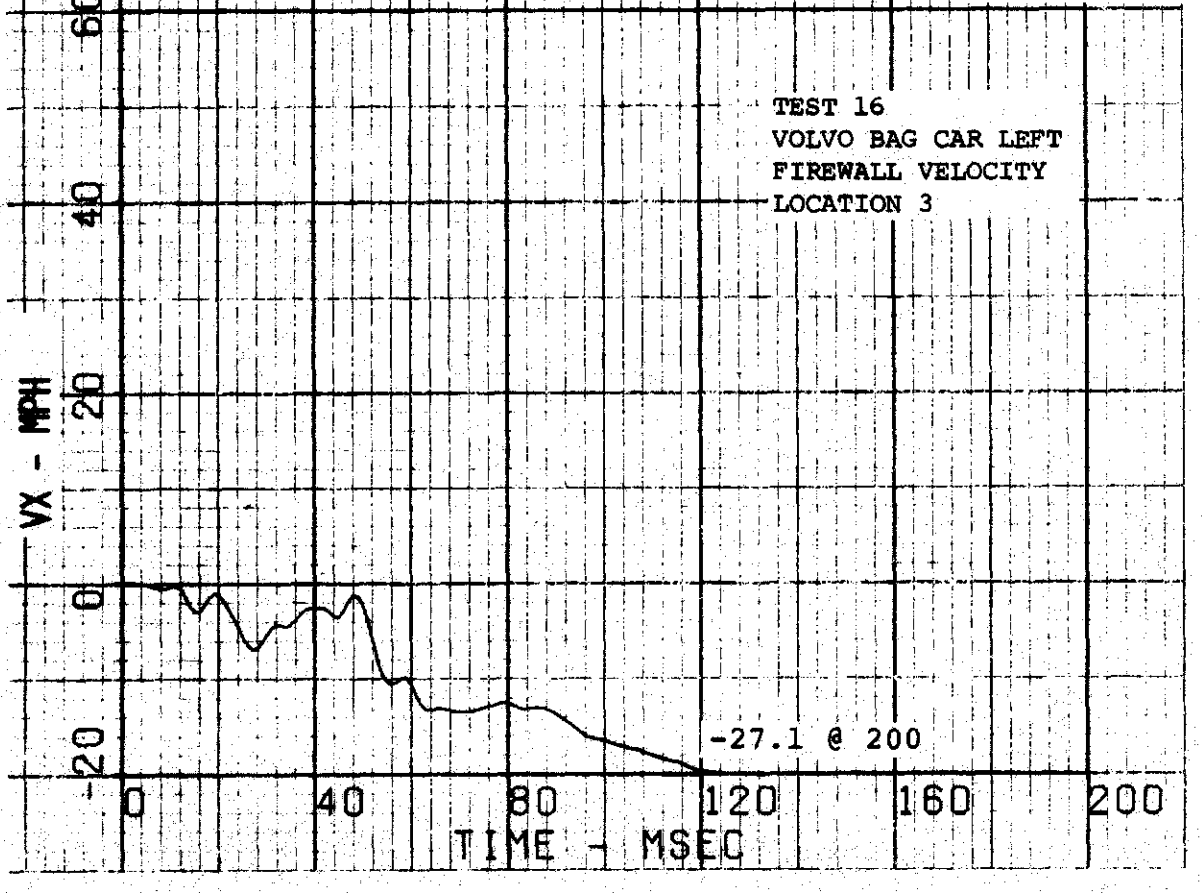

○ = AX △ = AY
TEST 16
VOLVO BAG CAR LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

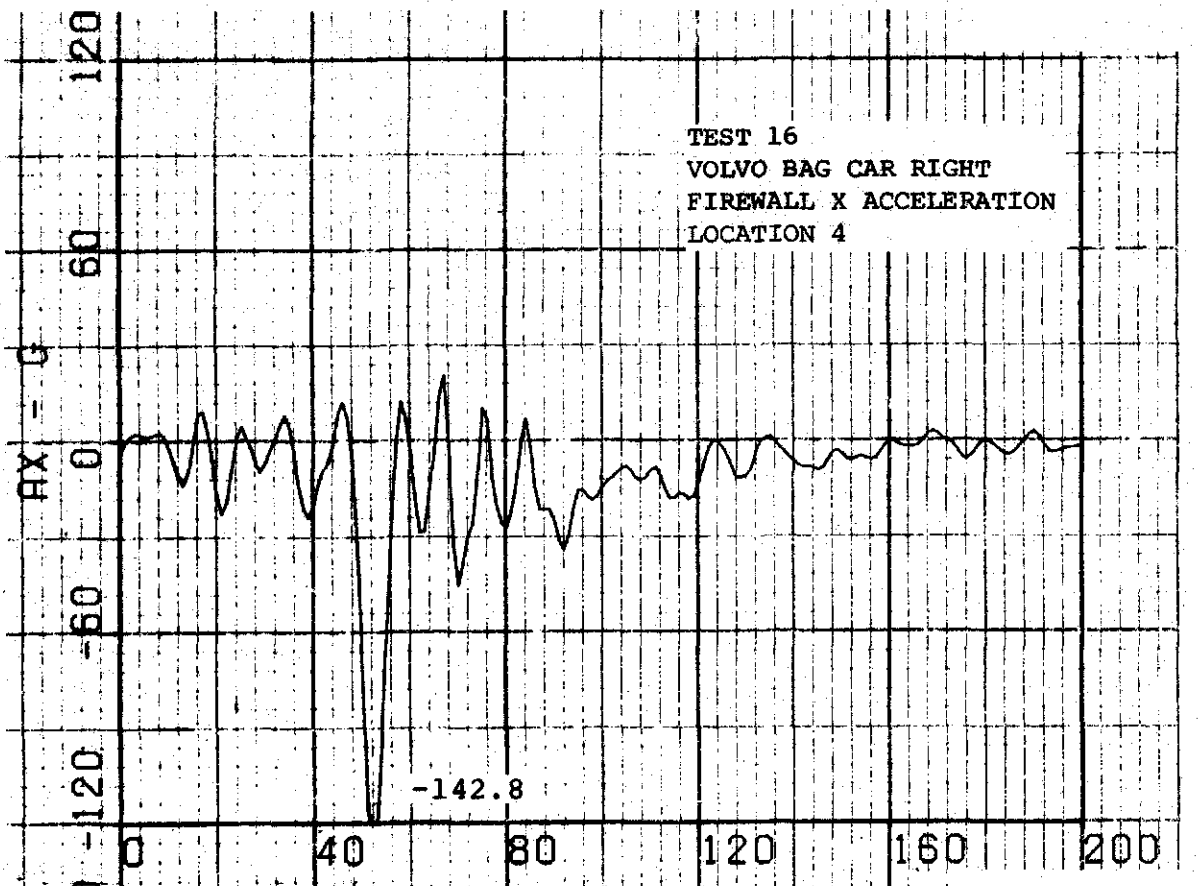

VELOCITY - MPH
30
10
-10
-30
-50
TEST 16
VOLVO BAG CAR LEFT
B-PILLAR VELOCITY
LOCATION 1
0
40
80
120
160
200
TIME - MSEC

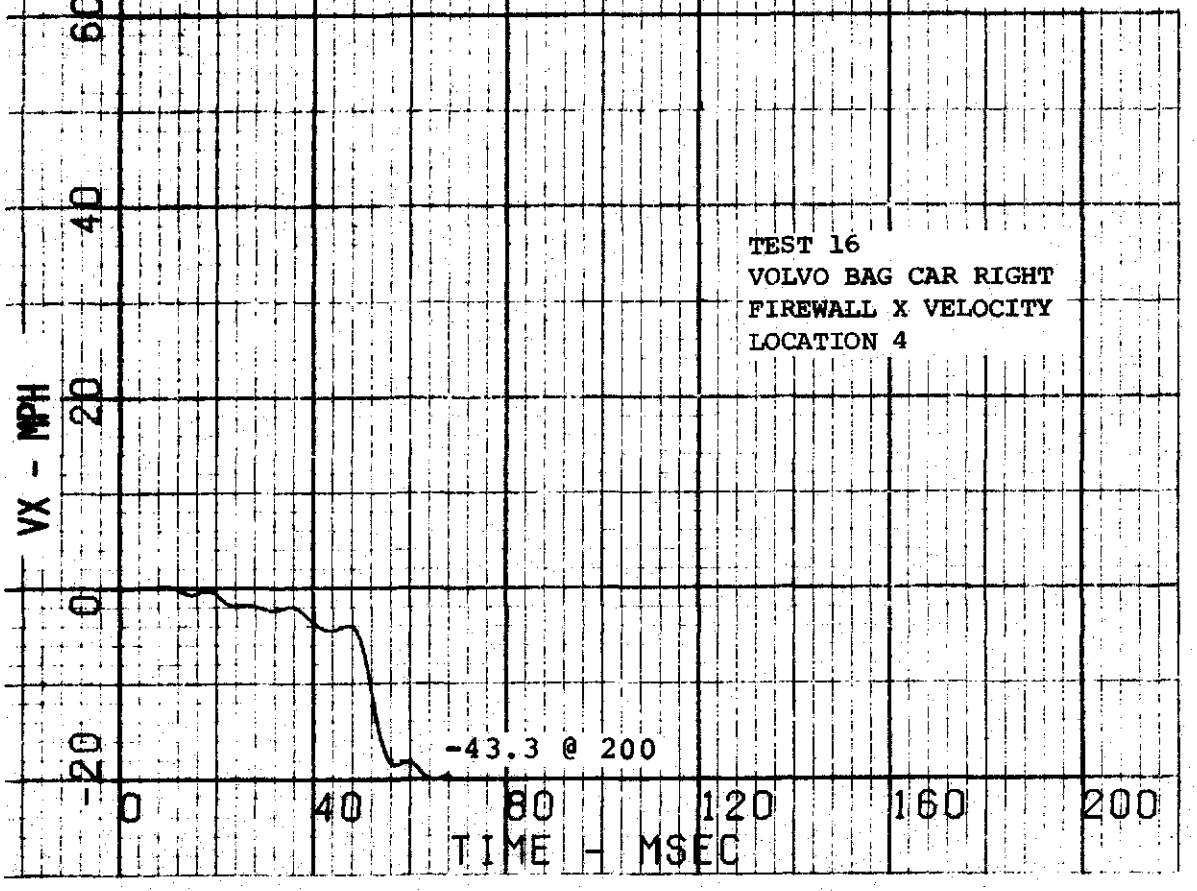

⊙= AX △= AY
TEST 16
VOLVO BAG CAR RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

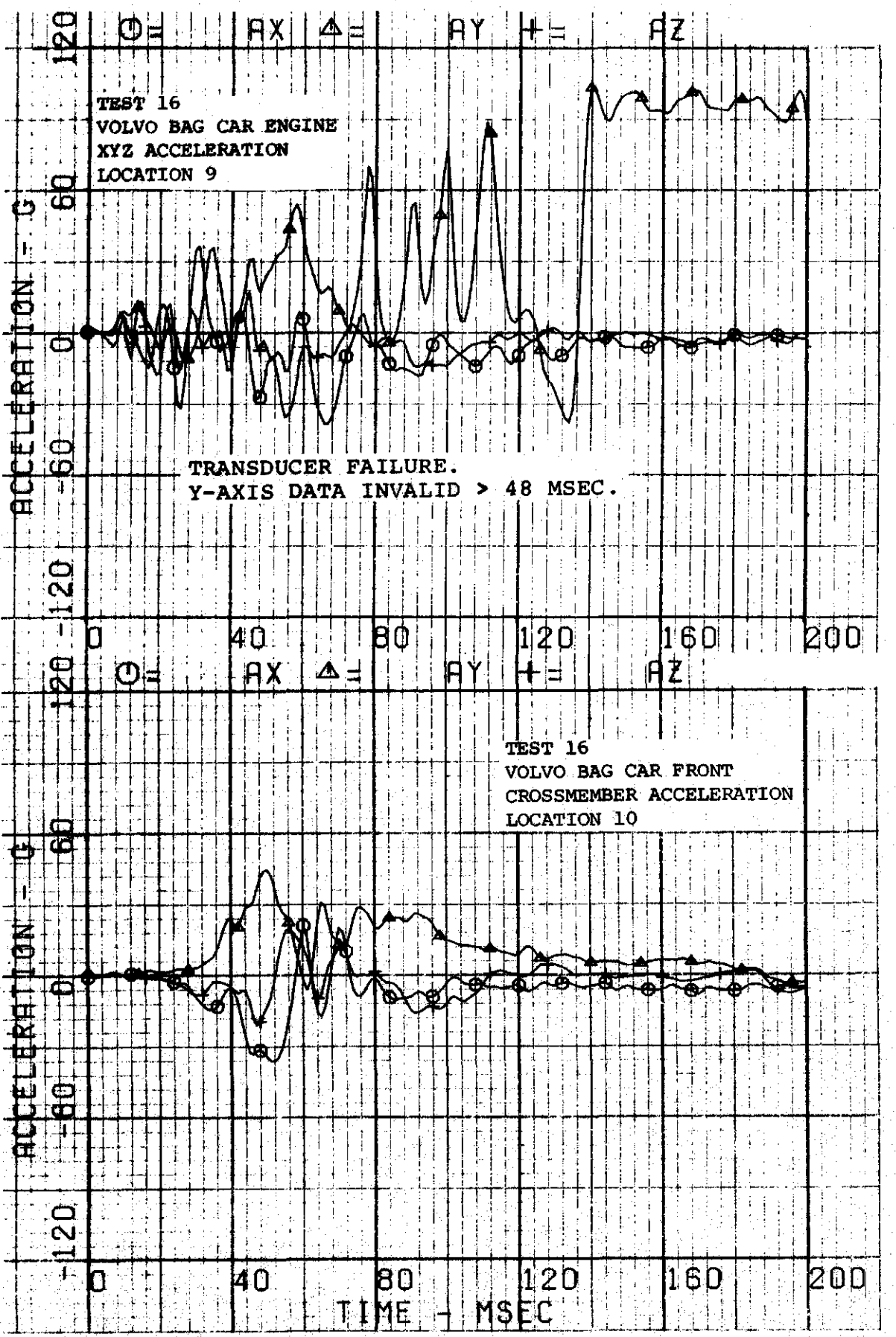

TEST 16
VOLVO BAG CAR RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY - MPH
30
10
0
-10
-30
-50
0
40
80
120
160
200
TIME - MSEC

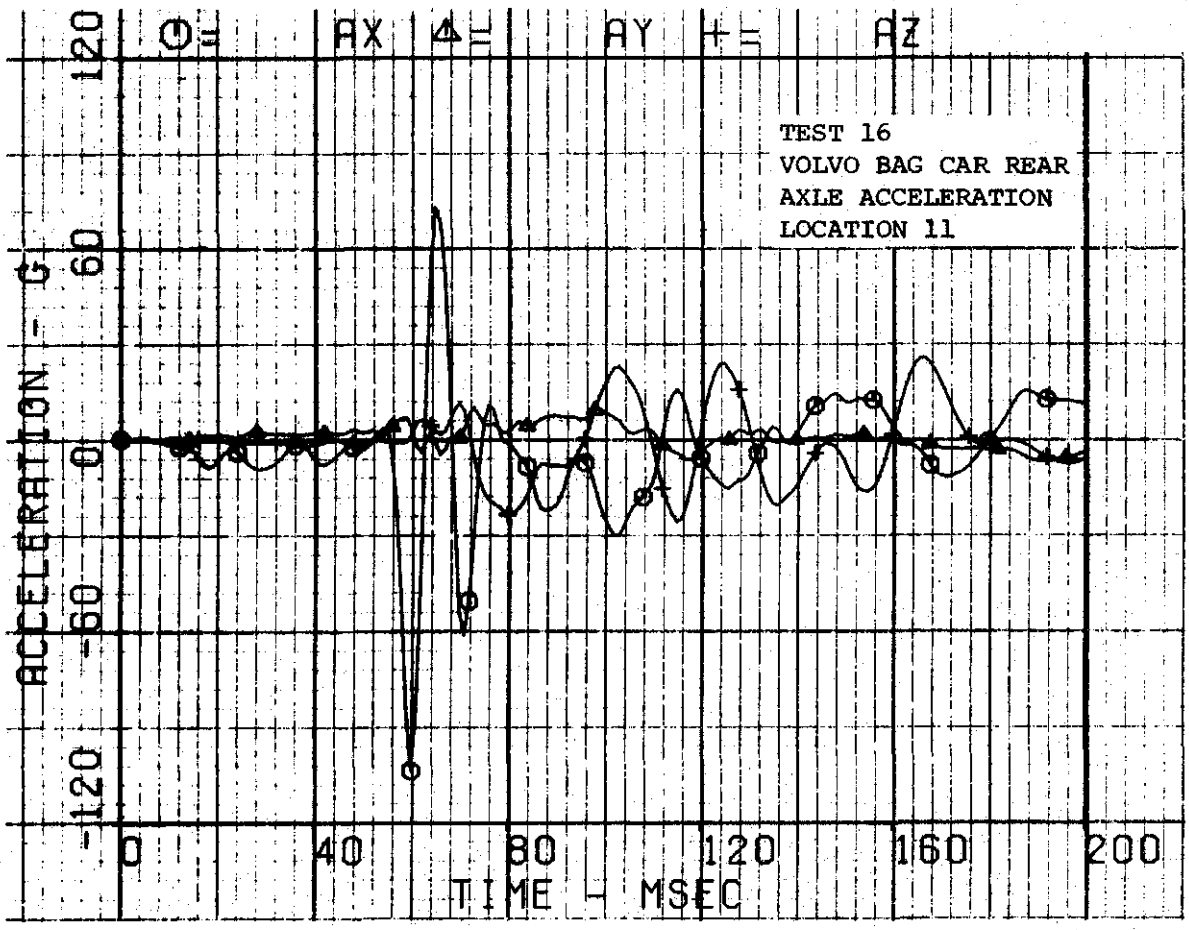

TEST 16
VOLVO BAG CAR LEFT
FIREWALL ACCELERATION
LOCATION 3
AX - G
120
60
0
-60
-120
0
40
80
120
160
200

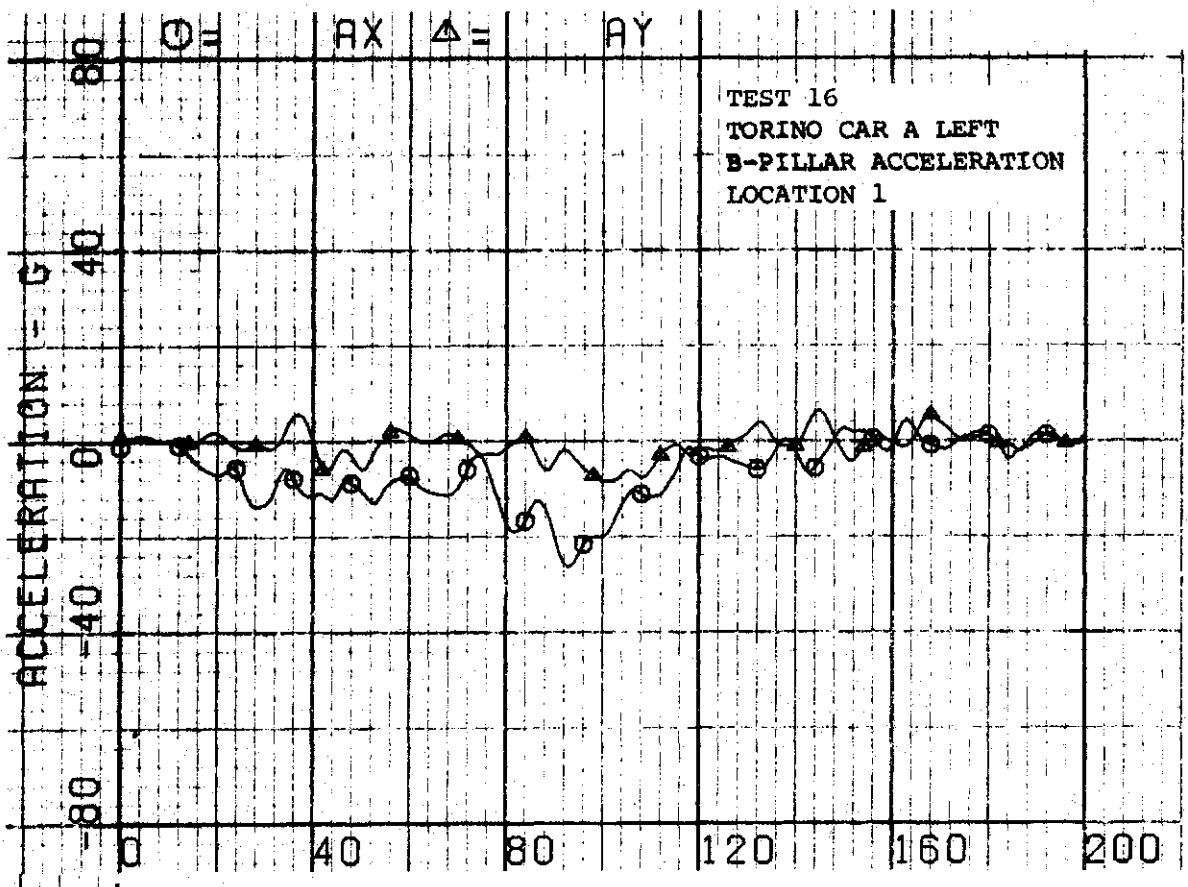

TEST 16
VOLVO BAG CAR LEFT
FIREWALL VELOCITY
LOCATION 3
VX - MPH
40
20
0
-20
-27.1 @ 200
0
40
80
120
160
200
TIME - MSEC

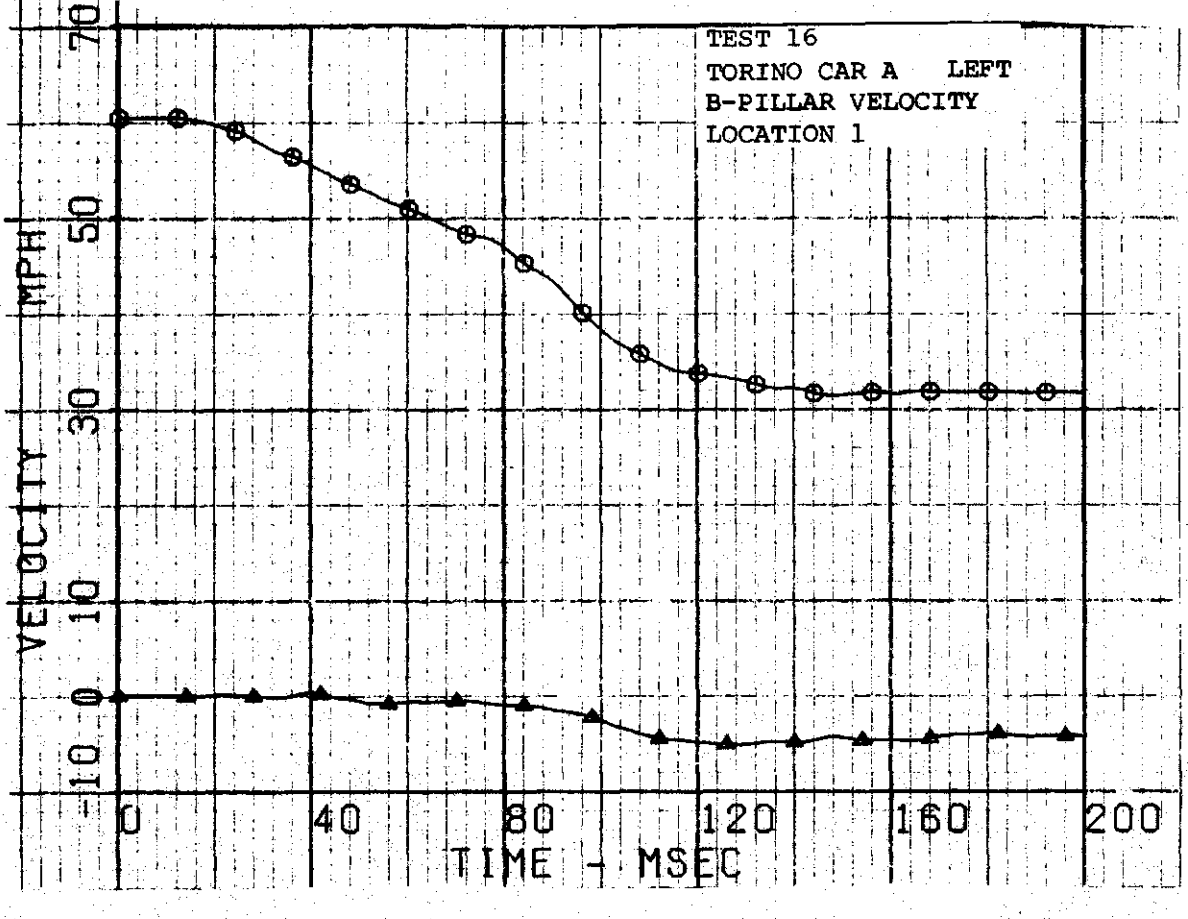

TEST 16
VOLVO BAG CAR RIGHT
FIREWALL X ACCELERATION
LOCATION 4
AX - G
120
60
0
-60
-120
-142.8
0
40
80
120
160
200

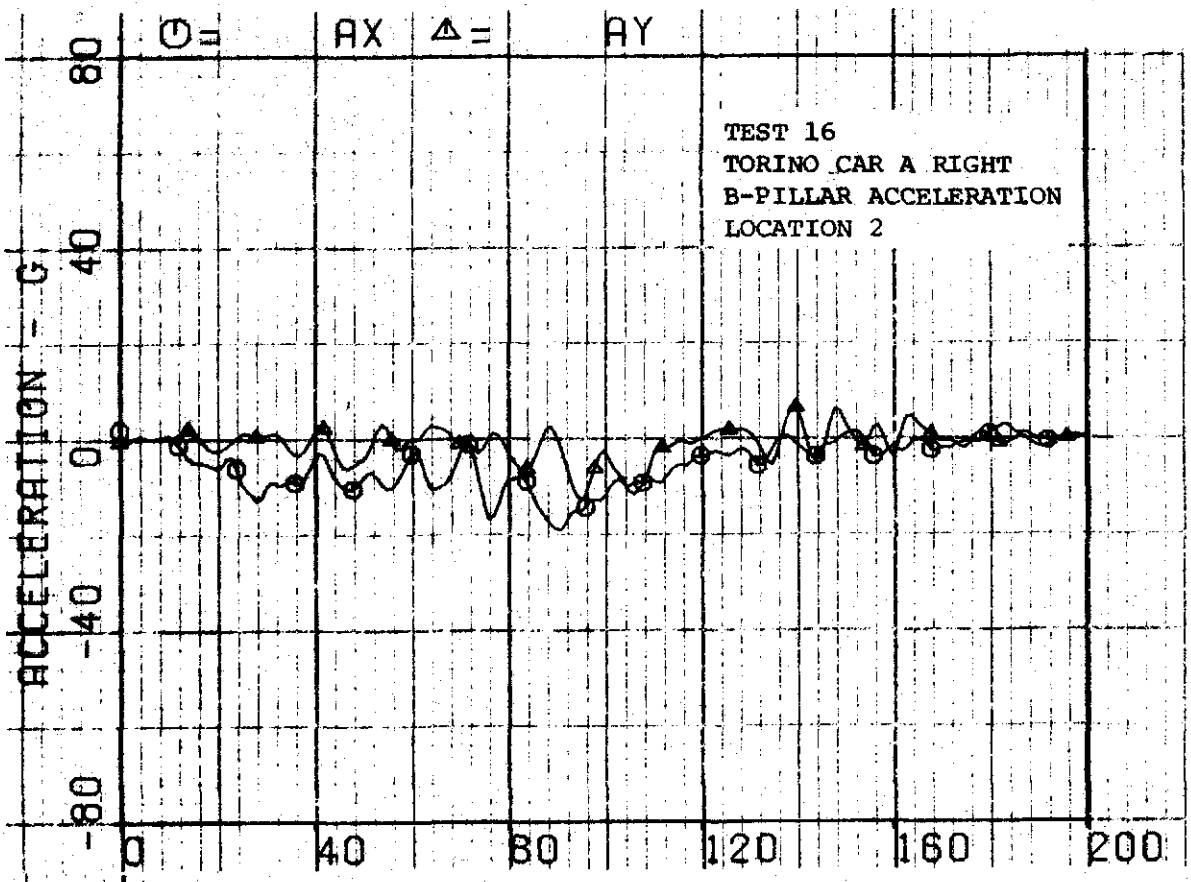

TEST 16
VOLVO BAG CAR RIGHT
FIREWALL X VELOCITY
LOCATION 4
VX - MPH
60
40
20
0
-20
-43.3 @ 200
0
40
80
120
160
200
TIME - MSEC


O = AX Δ = AY + = AZ
TEST 16
VOLVO BAG CAR ENGINE
XYZ ACCELERATION
LOCATION 9
TRANSDUCER FAILURE.
Y-AXIS DATA INVALID > 48 MSEC.
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
O = AX Δ = AY + = AZ
TEST 16
VOLVO BAG CAR FRONT
CROSSMEMBER ACCELERATION
LOCATION 10
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


AX
AY
AZ
TEST 16
VOLVO BAG CAR REAR
AXLE ACCELERATION
LOCATION 11
ACCELERATION - G
120
60
0
-60
-120
0
40
80
120
160
200
TIME - MSEC


○ = AX △ = AY
TEST 16
TORINO CAR A LEFT
B-PILLAR ACCELERATION
LOCATION 1
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200


TEST 16
TORINO CAR A LEFT
B-PILLAR VELOCITY
LOCATION 1
VELOCITY MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC


○= AX △= AY
TEST 16
TORINO CAR A RIGHT
B-PILLAR ACCELERATION
LOCATION 2
ACCELERATION - G
80
40
0
-40
-80
0
40
80
120
160
200

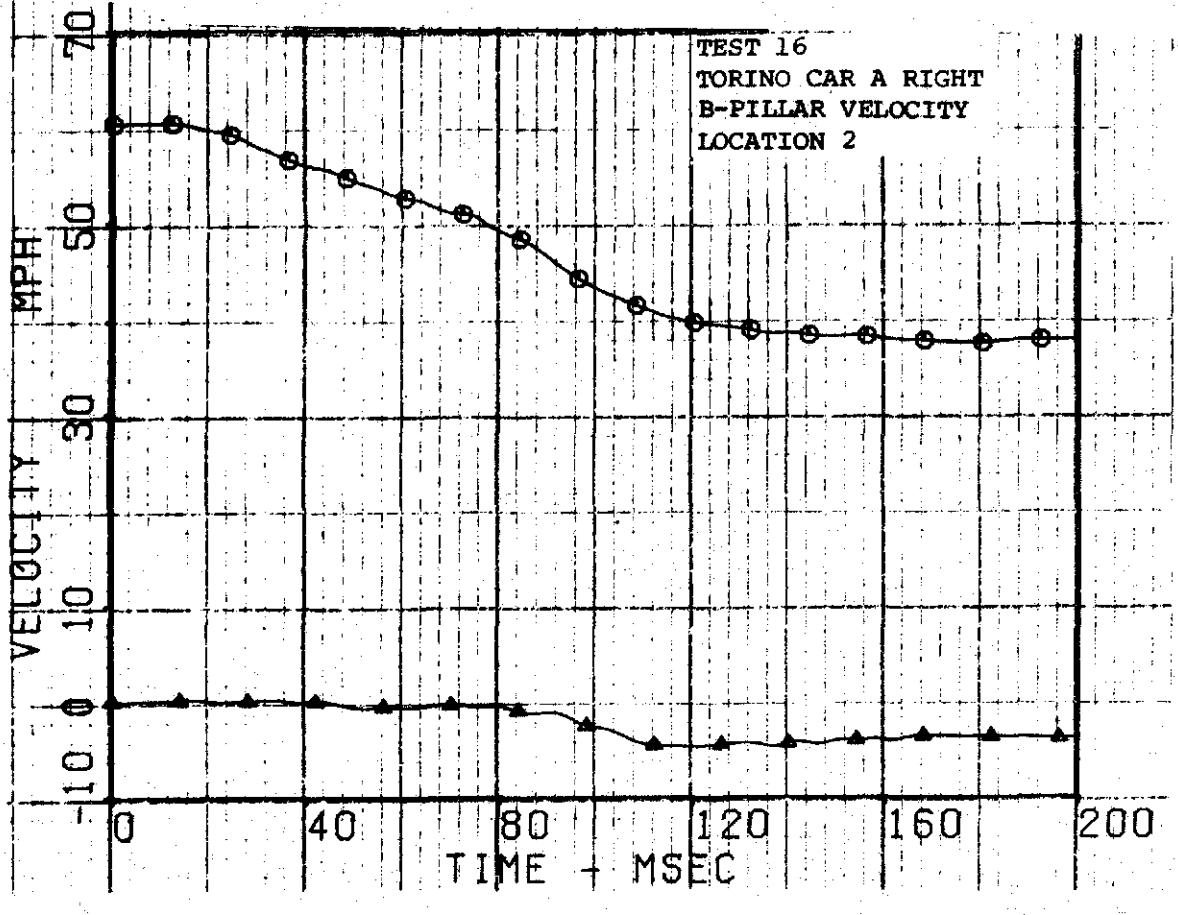

TEST 16
TORINO CAR A RIGHT
B-PILLAR VELOCITY
LOCATION 2
VELOCITY MPH
70
50
30
10
-10
0
40
80
120
160
200
TIME - MSEC

Figure 3-51. Pre-test Vehicle Configuration - Test 16.

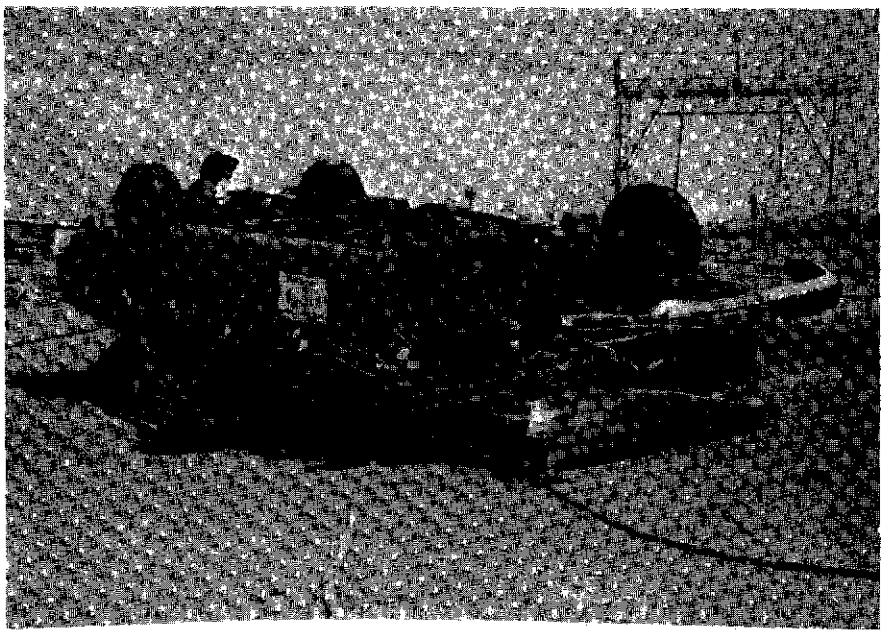


Figure 3-52. Post-test Vehicle Configuration - Test 16.

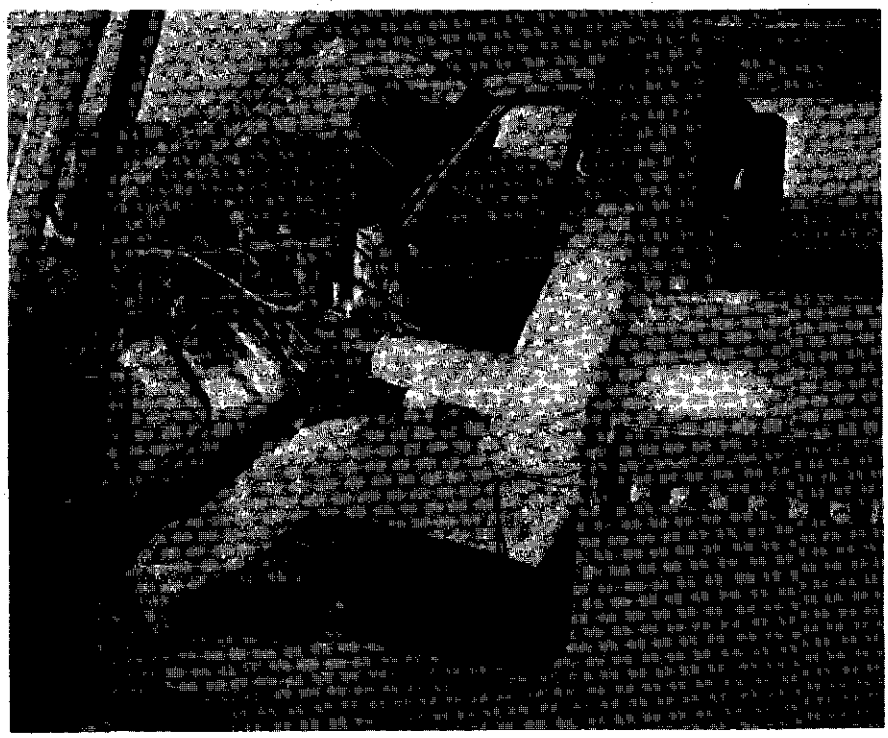


Figure 3-53. Pre-test RSV Driver Airbag - Test 16.

NO POST-TEST PHOTOS AVAILABLE

Figure 3-54. Post-test RSV Driver Airbag - Test 16.

Figure 3-55. Pre-test RSV Passenger Airbag - Test 16.

NO POST-TEST PHOTOS AVAILABLE

Figure 3-56. Post-test RSV Passenger Airbag - Test 16.