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U.S. Department  
Transportation  
**National Highway  
Traffic Safety  
Administration**



DOT HS 808 362

March 1996

Final Report

# Heavy Truck with Cab and Modified Bumper into 1988 Ford Taurus 4-Door Sedan

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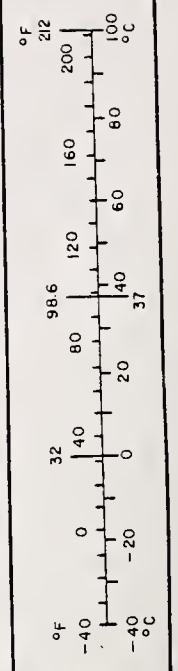
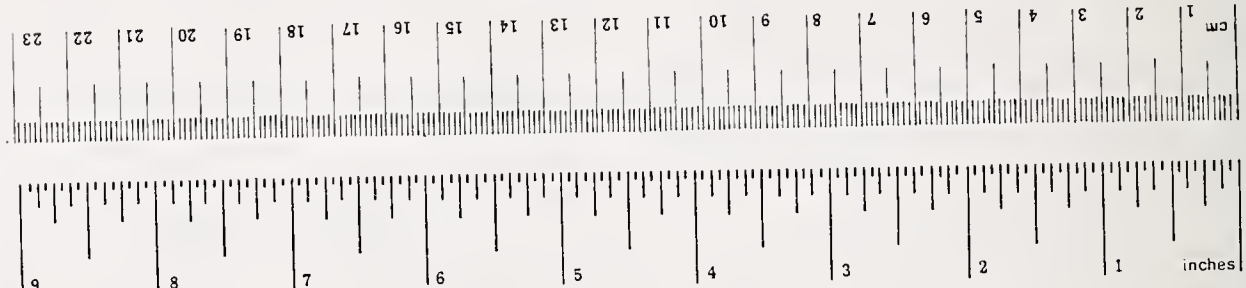
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1. Report No. DOT HS 808 362 <sup>C1</sup>		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Heavy Truck with Cab and Modified Bumper into 1988 Ford Taurus 4-door Sedan			5. Report Date October - November 1995		
			6. Performing Organization Code TRC		
7. Author(s) K. W. Looker, Project Engineer, TRC			8. Performing Organization Report No. 951023		
9. Performing Organization Name and Address National Highway Traffic Safety Administration Vehicle Research and Test Center P. O. Box 37, East Liberty, OH 43319			10. Work Unit No. (TRAIS)		
			11. Contract or Grant No. DTNH22-88-C-07292		
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration 400 Seventh Street, S.W. Washington, DC 20590			13. Type of Report and Period Covered Final Report October - November 1995		
			14. Sponsoring Agency Code		
15. Supplemental Notes					
16. Abstract  This report documents a crash test that was conducted for research and development in support of reducing heavy truck aggressiveness. This test was conducted with a 1988 Ford Taurus 4-door sedan, VIN 1FABP50D3JG137680, at Transportation Research Center Inc. on October 23, 1995. The left front 50% of the test vehicle was impacted by a heavy truck with cab and modified bumper. The vehicle contained seventeen (17) accelerometers, two (2) seat belt load cells, and one (1) instrumented Hybrid III driver dummy.					
17. Key Words  Heavy Truck Aggressiveness Occupant Response 1988 Ford Taurus 4-door Sedan Heavy Truck with Cab and Modified Bumper			18. Distribution Statement Copies of this report are available from: National Highway Traffic Safety Admin. Technical Reference Division Nassif Building, Room 5108 400 Seventh Street, S.W. Washington, DC 20590  DEPARTMENT OF TRANSPORTATION		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. Number of Pages 123	22. MAY 13 1998		

## METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures			Approximate Conversions from Metric Measures					
Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>								
in	inches	*2.5	centimeters	mm	millimeters	0.04	inches	in
ft	feet	30	centimeters	cm	centimeters	0.4	inches	in
yd	yards	0.9	meters	m	meters	3.3	feet	ft
mi	miles	1.6	kilometers	km	kilometers	1.1	yards	yd
						0.6	miles	mi
<b>AREA</b>								
in <sup>2</sup>	square inches	6.5	square centimeters	cm <sup>2</sup>	square centimeters	0.16	square inches	in <sup>2</sup>
ft <sup>2</sup>	square feet	0.09	square meters	m <sup>2</sup>	square meters	1.2	square yards	yd <sup>2</sup>
yd <sup>2</sup>	square yards	0.8	square meters	m <sup>2</sup>	square kilometers	0.4	square miles	mi <sup>2</sup>
mi <sup>2</sup>	square miles	2.6	square kilometers	km <sup>2</sup>	hectares (10,000 m <sup>2</sup> )	2.5	acres	ac
	acres	0.4	hectares	ha				
<b>MASS (weight)</b>								
oz	ounces	28	grams	g	grams	0.035	ounces	oz
lb	pounds	0.45	kilograms	kg	kilograms	2.2	pounds	lb
	short tons (2000 lb)	0.9	tonnes	t	tonnes (1000 kg)	1.1	short tons	st
<b>VOLUME</b>								
tsp	teaspoons	5	milliliters	ml	milliliters	0.03	fluid ounces	fl oz
Tbsp	tablespoons	15	milliliters	ml	liters	2.1	pints	pt
fl oz	fluid ounces	30	milliliters	ml	liters	1.06	quarts	qt
c	cups	0.24	liters	l	liters	0.26	gallons	gal
pt	pints	0.47	liters	l	cubic meters	35	cubic feet	ft <sup>3</sup>
qt	quarts	0.95	liters	l	cubic meters	1.3	cubic yards	yd <sup>3</sup>
gal	gallons	3.8	liters	l				
ft <sup>3</sup>	cubic feet	0.03	cubic meters	m <sup>3</sup>				
yd <sup>3</sup>	cubic yards	0.76	cubic meters	m <sup>3</sup>				
<b>TEMPERATURE (exact)</b>								
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



\*1 m = 2.54 (exact). 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.

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Section 1.0

Purpose and Test Summary

## Purpose and Test Summary

This test was conducted as research in support of reducing heavy truck aggressiveness. This test was conducted on October 23, 1995.

The test vehicle, a 1987 Ford Taurus 4-door sedan, was equipped with a 2.5-liter, 4-cylinder, transverse gasoline engine and a 3-speed automatic transmission. The test weight of the vehicle was 1583 kg. The vehicle was instrumented with seven (7) longitudinal axis accelerometers, five (5) lateral axis accelerometers, five (5) vertical axis accelerometer and two (2) seat belt force load cells. One (1) Part 572E dummy was seated in the left front outboard seating position according to the dummy placement procedure specified in Appendix B and Optional Appendix C of Laboratory Test Procedure TP-208-09. The dummy was instrumented in the head, chest, and pelvis with longitudinal, lateral, and vertical accelerometers. The dummy was also instrumented with two (2) femur load cells, and a chest deflection potentiometer.

The vehicle was impacted by a Peterbilt Model 352ST heavy truck with cab and modified deformable bumper at 89.2 kph. The intended impact engagement was the left front 50% of the car with the left front of the truck bumper. The Taurus sustained 552 mm of static crush.

The dummy's head injury criterion, HIC, was 176. The dummy's chest deceleration with 3 milliseconds minimum duration was 29.6 g. The dummy's maximum chest deflection was 24.8 mm. The dummy's maximum left femur force was 1869 N. The dummy's maximum right femur force was 7211 N.

The vehicle and dummy data were digitally sampled at 12,500 samples per second. The data was digitally filtered as per SAE J211 OCT88.

The test was filmed by one (1) real-time panning motion picture camera and seven (7) high-speed motion picture cameras operating at approximately 1000 frames per second.

Section 2.0 contains the vehicle, dummy, and test data. Appendix A contains the pre- and post-test still photographs. Appendix B contains the final test data plots. Appendix C contains miscellaneous test information.



Section 2.0

Vehicle, Dummy, and Test Data

Table 1 Crash Test Summary

Test type:	Heavy Truck with Cab and Modified Bumper into Vehicle
Test date:	10/23/95
Test time:	1723
Ambient temperature:	22° C
Vehicle:	1988 Ford Taurus 4-door sedan
Vehicle test weight:	1583 kg
Vehicle Maximum static crush:	552 mm
Offset:	Left front 50% of vehicle
Impact angle: <sup>1</sup>	0°
Impact velocity: <sup>2</sup>	Primary = 89.2 kph Secondary = 89.2 kph
Heavy Truck:	Peterbilt Model 352ST with Cab
Truck Bumper:	Modified
Truck Test Weight:	10099 kg
Dummies:	Driver #043
Type:	Part 572 E
Location:	Left front
Restraint:	3-point unibelt
Number of data channels:	37
Number of cameras:	
High-speed	7
Real-time	1

<sup>1</sup> With respect to two track centerline.

<sup>2</sup> Speed trap measurement ( $\pm .08$  kph accuracy)

Table 2 Test Vehicle Information

Vehicle manufacturer: Ford Motor Company  
 Make/model: Ford/Taurus  
 VIN: 1FABP50D3JG137680  
 Model year: 1988  
 Body style: 4-door sedan  
 Color: Red  
 Engine data:  
   Type: Transverse  
   Cylinders: 4  
   Displacement: 2.5-liter  
 Transmission data: 3 Speed,   Manual,   X Automatic,  
  X FWD,    RWD,    4WD  
 Date vehicle received: NA  
 Odometer reading: 87,951  
 Dealer's name and address: NA

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Yes	Automatic speed control	Yes
Power seats	No	Tilting steering wheel	No
Power windows	No	Telescoping steering wheel	No
Tinted glass	Yes	Air conditioning	Yes
Radio	Yes	Anti-skid brake	No
Clock	Yes	Rear window defroster	Yes
Other	None		

Certification data from vehicle's label:

Vehicle manufactured by: Ford Motor Company  
 Date of manufacture: 11/87  
 VIN: 1FABP50D3JG137680  
 GVWR: 4615 lbs.  
 GAWR: Front: 2594 lbs.  
       Rear: 2135 lbs.

Table 2 Test Vehicle Information. Cont'd.

Tires on vehicle (mfr., line, size): Sears, Superguard GT, P205/70R14 93S

Tire pressure with maximum capacity vehicle load: Front: 240 kPa  
Rear: 240 kPa

Spare tire (mfr., line, size): Michelin, T135/80R14

Type of seats: Front: Split bench  
Rear: Bench

Type of front seat backs: Manually adjustable

Maximum width: 1829 mm

Wheelbase: 2686 mm

Location of "Recommended Tire Pressure" label:

The label was located on the passenger's rear door.

Data from vehicle's "Recommended Tire Pressure" label:

Recommended tire size: P205/70R14

Recommended cold tire pressure: Front: 35 psi  
Rear: 35 psi

Seating capacity: Front: 3  
Rear: 3  
Total: 6

Vehicle capacity load: 1100 lbs.

Test vehicle attitude:

Delivered attitude: LF 693 mm; RF 700 mm; LR 625 mm; RR 629 mm  
Pre-test attitude: LF 669 mm; RF 681 mm; LR 578 mm; RR 588 mm  
Post-test attitude: LF 731 mm; RF 676 mm; LR 565 mm; RR 608 mm



Table 2 Test Vehicle Information, Cont'd.

Weight of test vehicle as received (with maximum fluids):

Right front	428 kg	Right rear	257 kg
Left front	449 kg	Left rear	254 kg
Total front weight	877 kg	(63.2% of total vehicle weight)	
Total rear weight	511 kg	(36.8% of total vehicle weight)	
Total test weight	1388 kg		
Target test weight <sup>1</sup>	1581 kg		

Weight of test vehicle with required dummies and 119 kg of cargo weight:

Right front	448 kg	Right rear	325 kg
Left front	478 kg	Left rear	332 kg
Total front weight	926 kg	(58.5% of total vehicle weight)	
Total rear weight	657 kg	(41.5% of total vehicle weight)	
Total test weight	1583 kg	(0.1% over target test weight)	
Weight of ballast secured in vehicle cargo area:	57 kg		
Components removed to meet target test weight:	None		
CG rearward of front wheel centerline:	1115 mm		

<sup>1</sup> Provided by Vehicle Research and Test Center.

Table 3 Heavy Truck Information

Vehicle manufacturer:	Peterbilt Motors Co.
Model:	352ST
Serial No.:	34256
Chassis/body type:	Cab-over with sleeper and modified bumper
Wheelbase:	3945 mm
Chassis weight:	6169 kg
Gross weight:	22,226 kg
Test weight:	
Front:	4094 kg
Rear:	6005 kg
Total:	10,099 kg

Table 4 Post-Impact Data

Test number:	951023
Date of test:	10/23/95
Time of test:	1723
Type of test:	Heavy Truck with Cab and Modified bumper into Vehicle
Impact angle: <sup>1</sup>	0°
Offset:	Left Front 50% of Vehicle
Ambient temperature at impact area:	22° C
Temperature in occupant compartment:	21° C
Impact velocity:	
Primary	89.2 kph
Secondary	89.2 kph
Distance from heavy truck to vehicle:	
Entering trap	381 mm
Exiting trap	51 mm

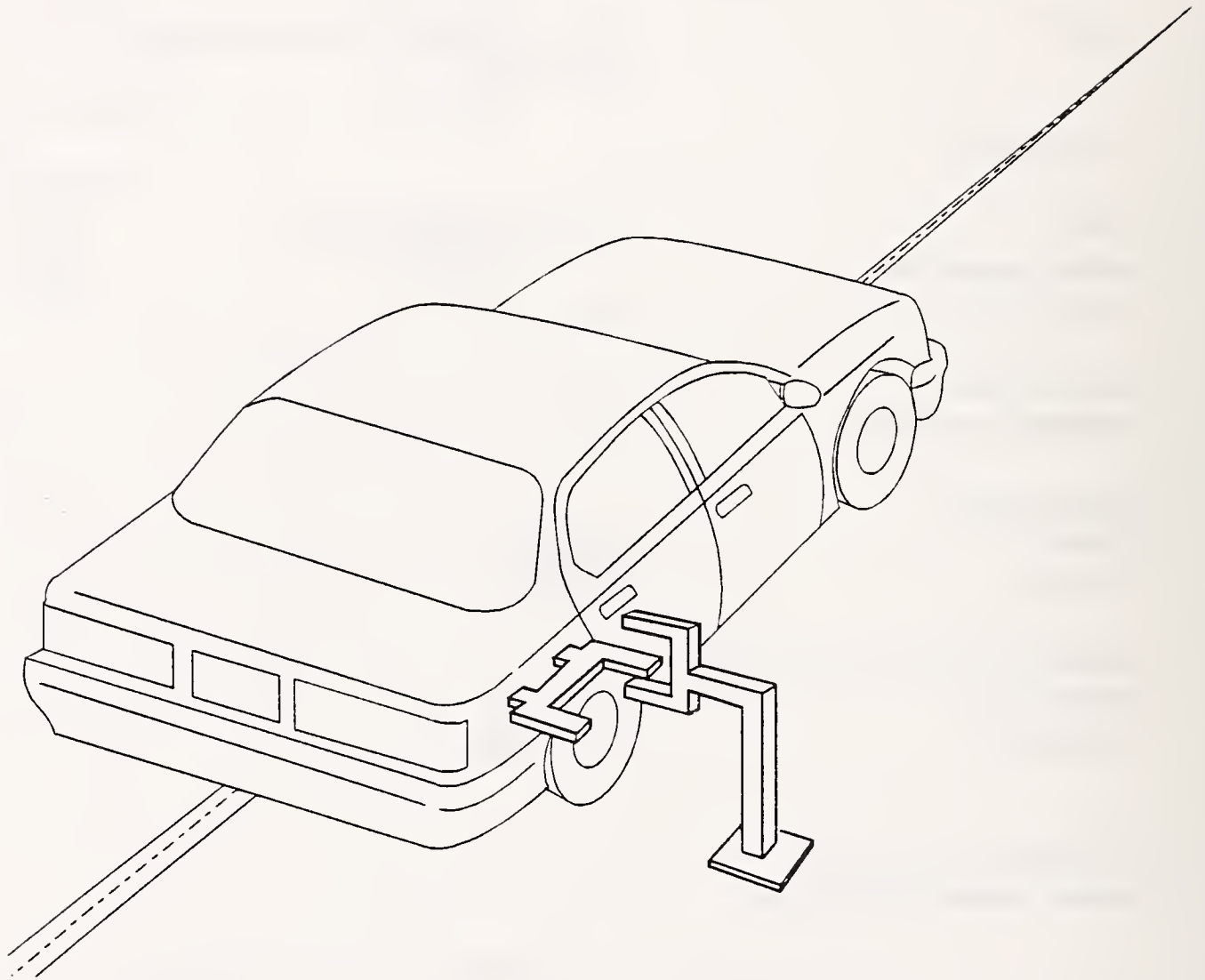
Test vehicle static crush:

Overall length of test vehicle:

Pre-test:	L	4642 mm;	C	4765 mm;	R	4650 mm
Post-test:	L	4090 mm;	C	4573 mm;	R	4842 mm
Total crush:	L	552 mm;	C	192 mm;	R	-192 mm
Average crush:		184 mm				

<sup>1</sup> As measured clockwise from the subject vehicle's front longitudinal centerline.

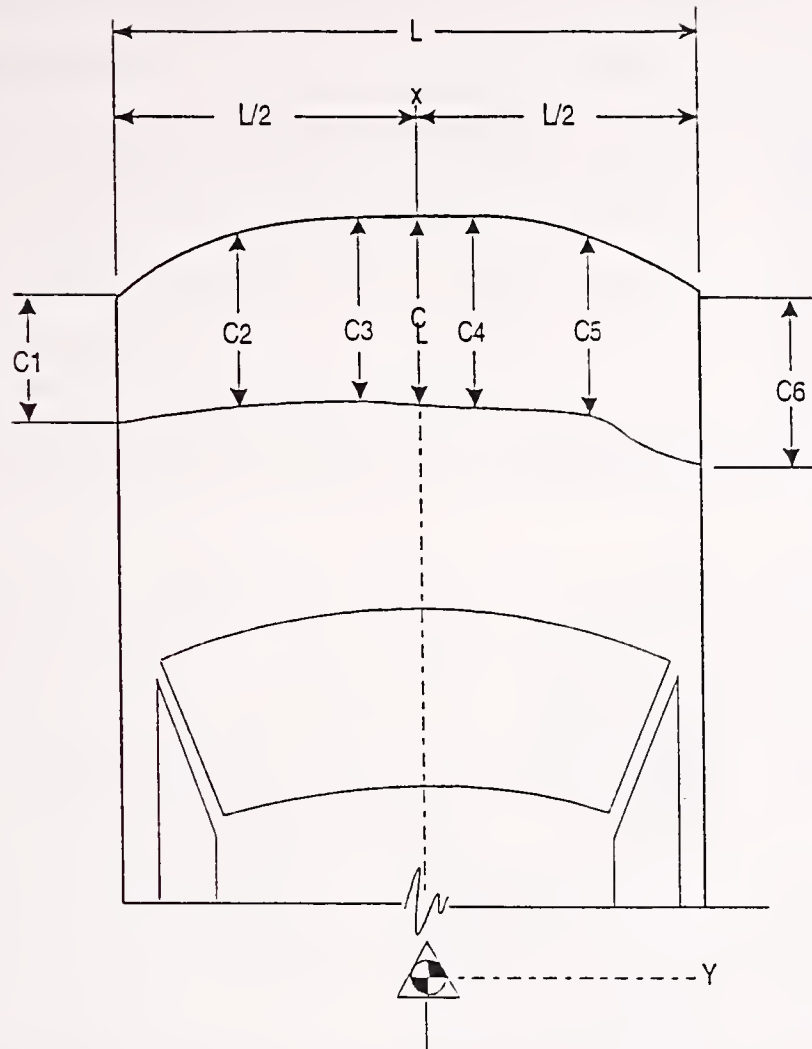
Figure 1 Impact Velocity Measurement System



The final vane clears emitter/receiver 51 millimeters before impact.

The vanes have 305-millimeter spacing.

Figure 2 Vehicle Crush



NOTES: L is pre-test length of contact surface.  
 C1 through C6 are spaced equally apart.  
 CL is vehicle centerline.

Vehicle: 1988 Ford Taurus

	Pre-test	Post-test <sup>1</sup>	Crush
L	1526 mm		
C1	4642 mm	4090 mm	552 mm
C2	4733 mm	4342 mm	391 mm
C3	4763 mm	4510 mm	253 mm
C4	4760 mm	4662 mm	98 mm
C5	4733 mm	4775 mm	-42 mm
C6	4650 mm	4842 mm	-192 mm
CL	4765 mm	4573 mm	192 mm

<sup>1</sup> Post-test measurements taken to plane of front bumper mounting flanges because the front bumper was destroyed during the impact event.

Figure 3 Pre-Test and Post-Test Measurement Points

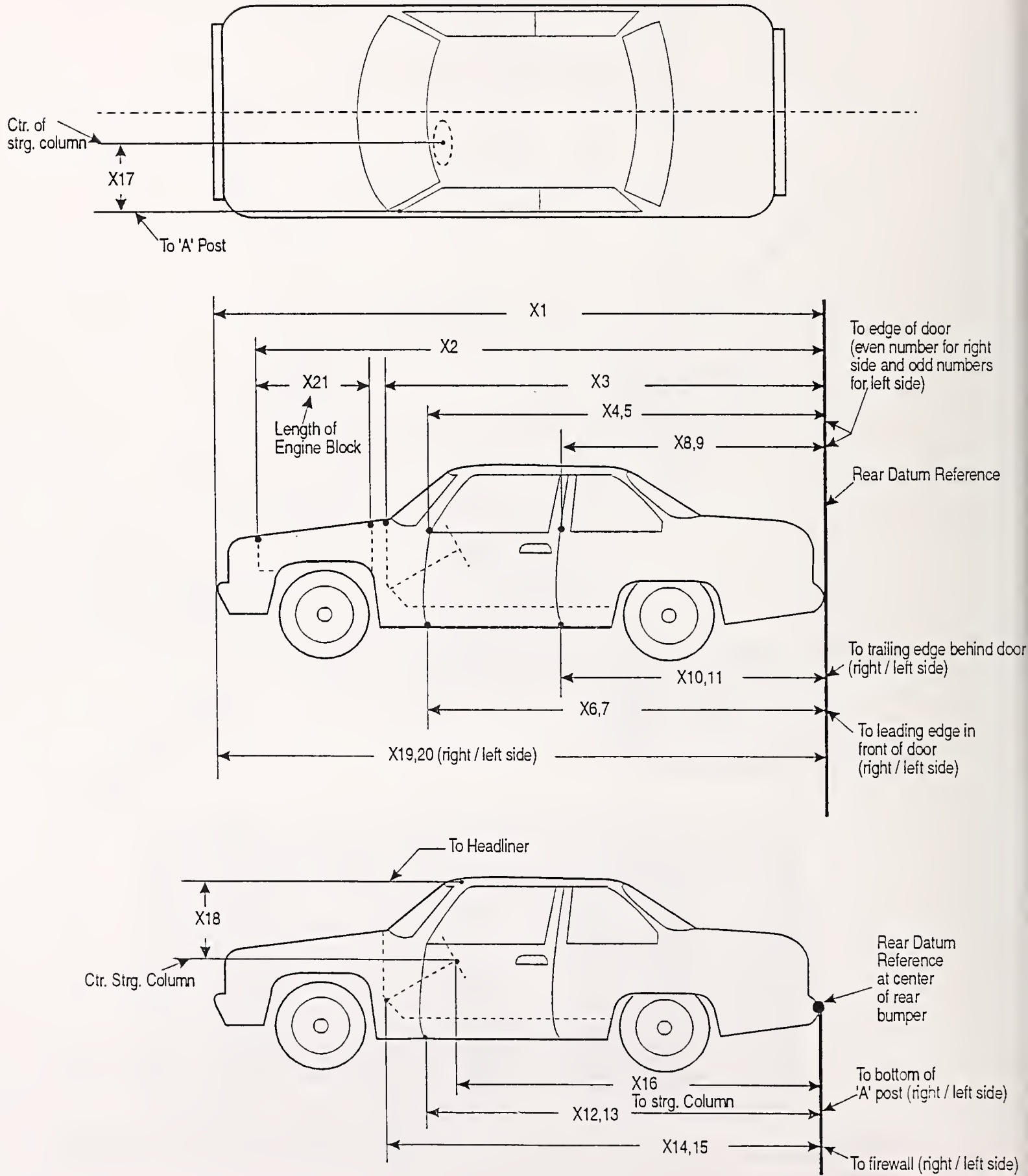


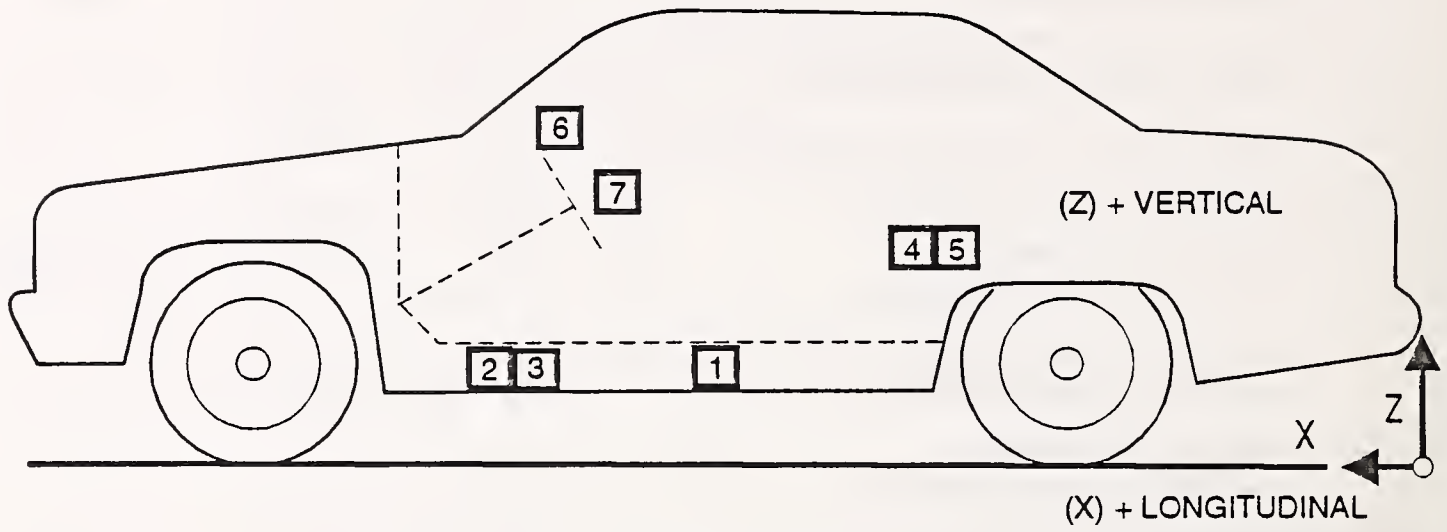
Table 5 Impacted Vehicle Measurements

Vehicle Make/Model: Ford/Taurus

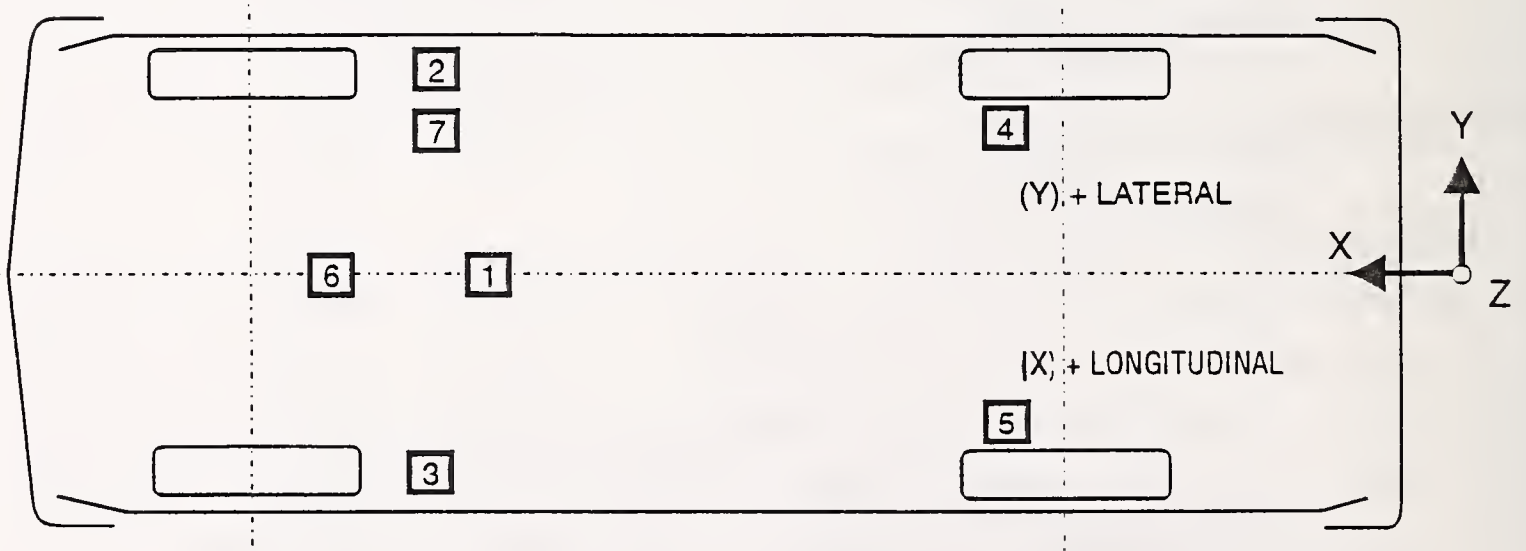
Test Number: 951023

No.	Type of measurement	Pre-test	Post-test	Diff.
X1	Total length of vehicle at centerline	4765 mm	4573 mm	192 mm
X2	Rear surface of vehicle to front of engine block	4040 mm	3998 mm	42 mm
X3	Rear surface of vehicle to firewall	3608 mm	3560 mm	48 mm
X4	Rear surface of vehicle to upper leading edge of right door	3324 mm	3310 mm	14 mm
X5	Rear surface of vehicle to upper leading edge of left door	3324 mm	3281 mm	43 mm
X6	Rear surface of vehicle to lower leading edge of right door	3276 mm	3254 mm	22 mm
X7	Rear surface of vehicle to lower leading edge of left door	3256 mm	3224 mm	32 mm
X8	Rear surface of vehicle to upper trailing edge of right door	2241 mm	2230 mm	11 mm
X9	Rear surface of vehicle to upper trailing edge of left door	2240 mm	2206 mm	34 mm
X10	Rear surface of vehicle to lower trailing edge of right door	2220 mm	2203 mm	17 mm
X11	Rear surface of vehicle to lower trailing edge of left door	2217 mm	2187 mm	30 mm
X12	Rear surface of vehicle to bottom of "A" post on right side	3231 mm	3219 mm	12 mm
X13	Rear surface of vehicle to bottom of "A" post on left side	3226 mm	3180 mm	46 mm
X14	Rear surface of vehicle to firewall - right side	3565 mm	3565 mm	0 mm
X15	Rear surface of vehicle to firewall - left side	3547 mm	3450 mm	97 mm
X16	Rear surface of vehicle to steering wheel center	2887 mm	2825 mm	62 mm
X17	Center of steering column to "A" post	280 mm	292 mm	-12 mm
X18	Center of steering column to headliner	450 mm	461 mm	-11 mm
X19	Rear surface of vehicle to right side of front bumper	4650 mm	4842 mm	-192 mm
X20	Rear surface of vehicle to left side of front bumper	4642 mm	4090 mm	552 mm
X21	Length of engine block	470 mm	470 mm	0 mm

Figure 4 Vehicle Accelerometer Placement



SIDE VIEW



BOTTOM VIEW



Table 6 Vehicle Accelerometer Locations and Data Summary

TEST NUMBER: 951023				POSITIVE		NEGATIVE	
No. LOCATION	X	Y	Z	DIRECTION		DIRECTION	
1 CENTER OF GRAVITY	2736 mm	0 mm	313 mm				
LONGITUDINAL				@ 132.2 ms	25.4 g	@ 78.5 ms	
LATERAL				@ 141.8 ms	17.7 g	@ 77.4 ms	
VERTICAL				@ 79.0 ms	37.2 g	@ 63.6 ms	
RESULTANT				@ 63.8 ms			
2 LEFT FRONT SILL	2918 mm	696 mm	276 mm				
LONGITUDINAL				@ 127.2 ms	20.0 g	@ 93.9 ms	
LATERAL				@ 1.4 ms	43.9 g	@ 77.3 ms	
VERTICAL				@ 107.0 ms	31.9 g	@ 88.6 ms	
RESULTANT				@ 77.2 ms			
3 RIGHT FRONT SILL	2907 mm	-685 mm	287 mm				
LONGITUDINAL				@ 132.9 ms	21.3 g	@ 70.7 ms	
LATERAL				@ 131.5 ms	30.9 g	@ 64.2 ms	
VERTICAL				@ 36.2 ms	14.3 g	@ 75.6 ms	
RESULTANT				@ 64.4 ms			
4 LEFT REAR SEAT	1804 mm	708 mm	351 mm				
CROSSMEMBER							
LONGITUDINAL				@ 128.4 ms	19.6 g	@ 95.2 ms	
LATERAL				@ 145.3 ms	10.0 g	@ 67.8 ms	
VERTICAL				@ 112.3 ms	7.7 g	@ 75.4 ms	
RESULTANT				@ 95.0 ms			

Table 6 Vehicle Accelerometer Locations and Data Summary, Cont'd.

TEST NUMBER: 951023 No. LOCATION	X	Y	Z	POSITIVE DIRECTION	NEGATIVE DIRECTION
5 RIGHT REAR SEAT CROSSMEMBER LONGITUDINAL LATERAL VERTICAL RESULTANT	1809 mm	-710 mm	360 mm	8.1 g @ 132.6 ms 5.7 g @ 139.6 ms 7.2 g @ 105.8 ms 23.0 g @ 65.4 ms	21.9 g @ 65.2 ms 7.1 g @ 67.2 ms 6.3 g @ 145.8 ms
6 INSTRUMENT PANEL CENTER LONGITUDINAL	3214 mm	0 mm	942 mm	15.2 g @ 119.6 ms	28.1 g @ 100.0 ms
7 STEERING WHEEL HUB LONGITUDINAL	2816 mm	365 mm	841 mm	15.3 g @ 119.4 ms	39.2 g @ 78.5 ms

REFERENCE: X: + FORWARD FROM REAR BUMPER  
 Y: + LEFTWARD FROM VEHICLE CENTERLINE  
 Z: + UPWARD FROM GROUND LEVEL

Figure 5 Heavy Truck Accelerometer Placement

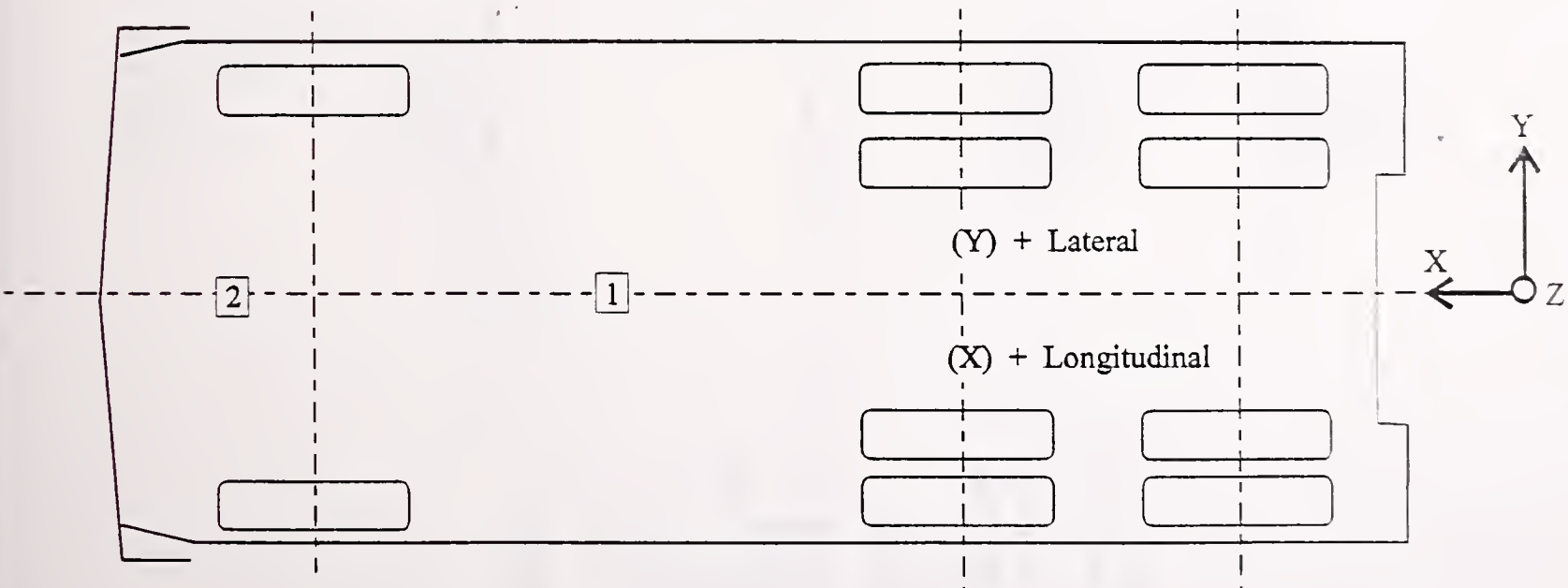
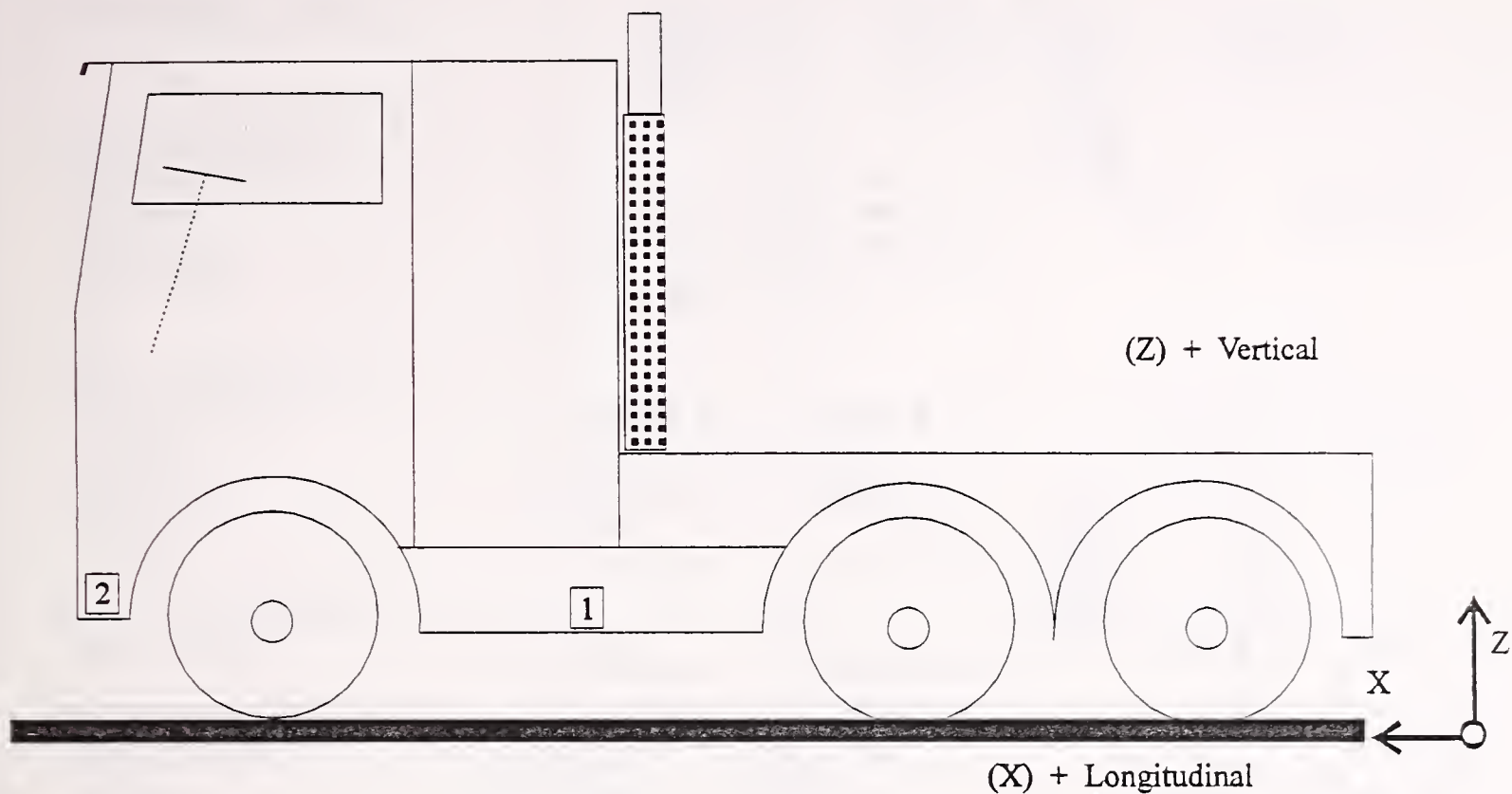


Table 7 Heavy Truck Accelerometer Locations and Data Summary

TEST NUMBER: 951023 No. LOCATION	X	Y	Z	POSITIVE DIRECTION		NEGATIVE DIRECTION	
1 CENTER OF GRAVITY	2743 mm	0 mm	927 mm				
LONGITUDINAL				1.4 g	@ 71.5 ms	4.0 g	@ 28.1 ms
LATERAL				2.5 g	@ 191.4 ms	4.6 g	@ 71.5 ms
VERTICAL				5.8 g	@ 39.4 ms	5.6 g	@ 86.5 ms
RESULTANT				6.1 g	@ 86.3 ms		
2 FRONT FRAME CROSSMEMBER	5969 mm	0 mm	679 mm				
LONGITUDINAL				3.0 g	@ 123.3 ms	10.0 g	@ 65.3 ms
LATERAL				8.6 g	@ 97.4 ms	20.4 g	@ 62.5 ms
VERTICAL				6.9 g	@ 73.5 ms	12.2 g	@ 65.5 ms
RESULTANT				22.6 g	@ 62.6 ms		

REFERENCE: X: + FORWARD FROM TRAILING EDGE OF TRUCK  
 Y: + LEFT FROM TRUCK CENTERLINE  
 Z: + UP FROM GROUND LEVEL

Table 8 Dummy Data Summary

TEST NUMBER: 951023

DRIVER DUMMY SERIAL NUMBER: 043

	POSITIVE DIRECTION		NEGATIVE DIRECTION	
<b>HEAD ACCELERATION</b>				
LONGITUDINAL	3.1 g	@ 246.6 ms	17.8 g	@ 99.6 ms
LATERAL	3.3 g	@ 202.6 ms	22.5 g	@ 132.6 ms
VERTICAL	3.1 g	@ 133.0 ms	28.9 g	@ 96.7 ms
RESULTANT	37.0 g	@ 101.9 ms		
HIC	176 from 86.0 to 122.0			
<b>CHEST ACCELERATION</b>				
LONGITUDINAL	6.6 g	@ 131.8 ms	18.9 g	@ 85.8 ms
LATERAL	3.6 g	@ 307.5 ms	26.3 g	@ 95.7 ms
VERTICAL	17.8 g	@ 130.2 ms	7.7 g	@ 109.0 ms
RESULTANT	30.4 g	@ 95.4 ms		
3 MSEC	29.6			
<b>CHEST DEFLECTION</b>				
LONGITUDINAL	0.0 mm	@ 20.5 ms	24.8 mm	@ 95.1 ms
<b>PELVIS ACCELERATION</b>				
LONGITUDINAL	12.1 g	@ 131.9 ms	37.2 g	@ 73.4 ms
LATERAL	13.4 g	@ 73.3 ms	27.1 g	@ 104.6 ms
VERTICAL	14.6 g	@ 127.8 ms	6.5 g	@ 105.4 ms
RESULTANT	40.4 g	@ 73.4 ms		
<b>FEMUR LOAD</b>				
LEFT	295.2 N	@ 74.8 ms	1868.9 N	@ 91.7 ms
RIGHT	561.2 N	@ 98.7 ms	7211.1 N	@ 73.4 ms
<b>POSITIVE DIRECTION</b>			<b>NEGATIVE DIRECTION</b>	
LONGITUDINAL:	FORWARD		LONGITUDINAL:	REARWARD
LATERAL:	LEFTWARD		LATERAL:	RIGHTWARD
VERTICAL:	UPWARD		VERTICAL:	DOWNWARD
FORCE:	TENSION		FORCE:	COMPRESSION

Table 9 Post-Impact Dummy/Vehicle Data

Visible Dummy Contact Points:

	<u>Driver #043</u>	<u>Passenger #NA</u>
Head	None	
Chest	None	
Abdomen	None	
Left knee	Instrument panel	
Right knee	Steering column cover	

Door Opening:

	<u>Left</u>	<u>Right</u>
Front	Tools required	Easy
Rear	Easy	Easy

Seat Movement:

	<u>Seat Back Failure</u>	<u>Seat Shift</u>
Front	None	None
Rear	NA	NA

Glazing Damage:

The windshield cracked from lower outside corners

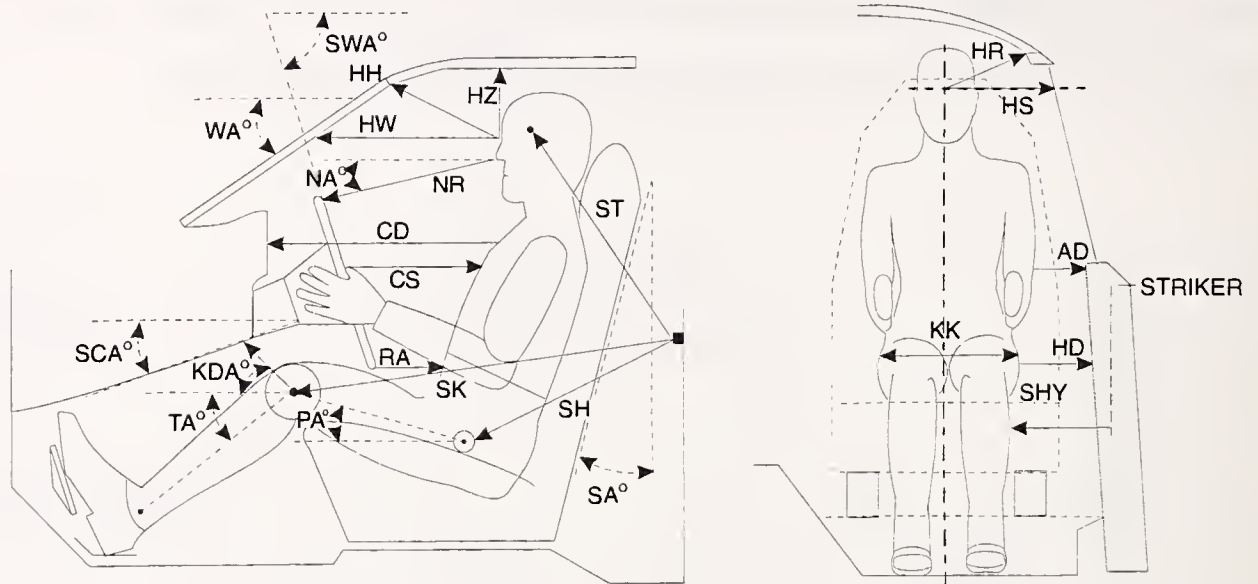
Other Notable Impact Effects:

The left front tire was flat.

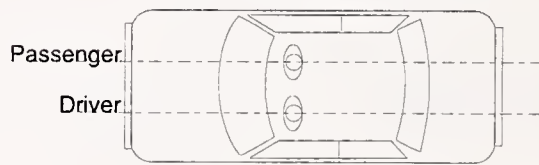
### Dummy Kinematic Summary

Upon impact the driver dummy translated forward and to the left across the seat. Both knees impacted the lower instrument panel. The dummy was restrained by the three-point unbelt. The dummy rebounded rearward and to the right. The dummy then came to rest facing forward and leaning toward the right in the driver's seating position.

Figure 6 Dummy Measurement Locations for Front Seat Occupants



VERTICAL LONGITUDINAL PLANE



VERTICAL TRANSVERSE PLANE

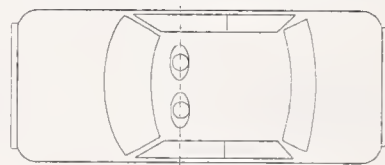




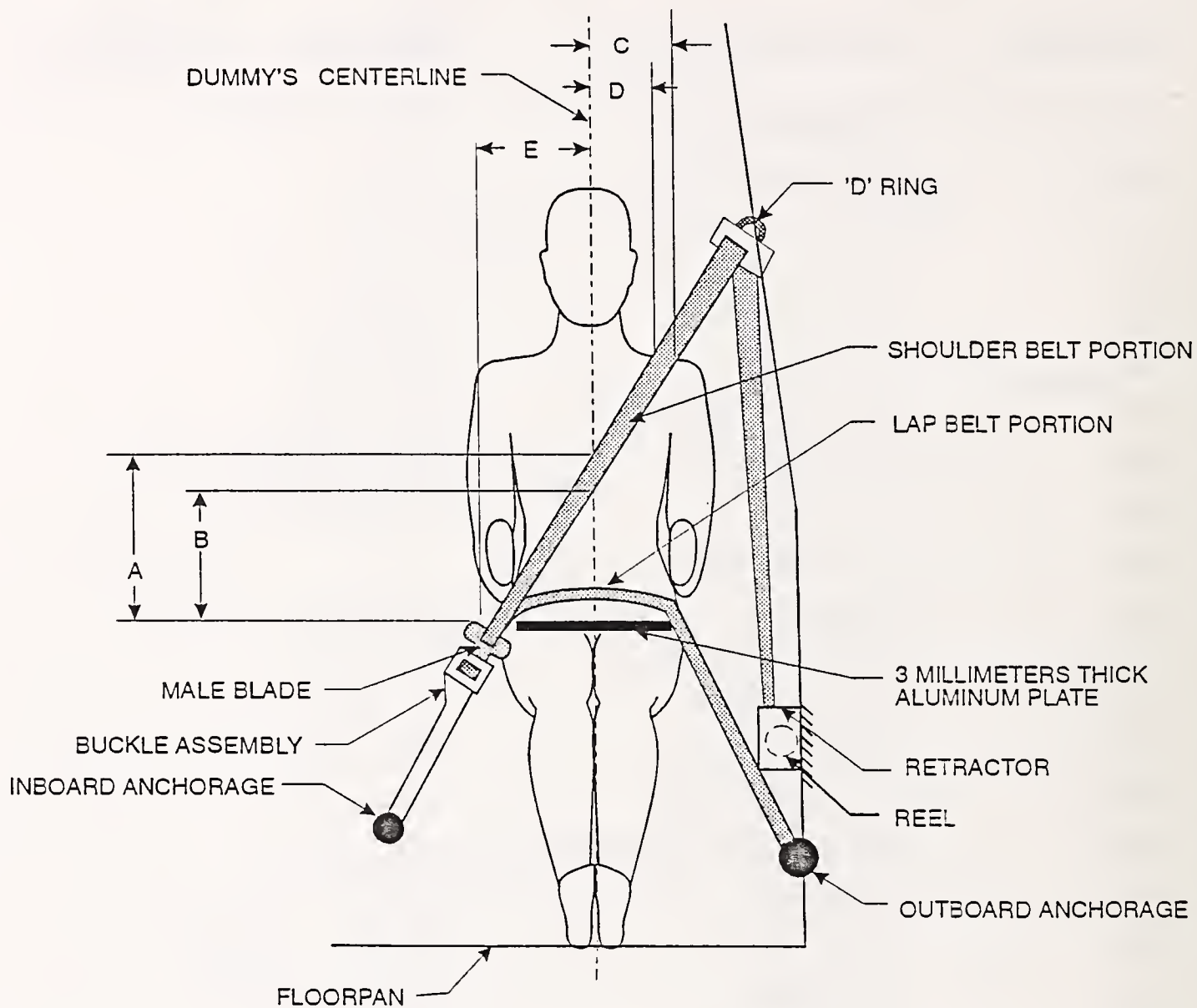
Table 10 Dummy Measurement Data For Front Seat Occupants

Designation	Type of Measurement	Driver (Serial #043)	Passenger (Serial #NA)
WA	Windshield angle	29°	
SWA	Steering wheel angle	67°	
SCA	Steering column angle	23°	
SA	Seat back angle	23°	
HZ	Head to roof	197 mm	
HH	Head to header	339 mm	
HW	Head to windshield	555 mm	
HR	Head to side header	216 mm	
NR	Nose to rim	413 mm	
NA	Nose to rim angle	9°	
CD	Chest to dash	558 mm	
CS	Steering wheel to chest	305 mm	
RA	Rim to abdomen	217 mm	
KDL	Left knee to dash	196 mm	
KDR	Right knee to dash	206 mm	
KDA	Outboard knee to dash angle	-26°	
PA	Pelvic angle	23.5°	
TA	Tibial angle	41°	
KK	Knee to knee	270 mm	
ST <sup>1</sup>	Striker to head	481 mm	
	Striker to head angle	-84°	
SK <sup>1</sup>	Striker to knee	593 mm	
	Striker to knee angle	7°	
SH <sup>1</sup>	Striker to H-point	266 mm	
	Striker to H-point angle	45°	
SHY	Striker to H-point (Y dir.)	235 mm	
HS	Head to side window	330 mm	
HD	H-point to door	185 mm	
AD	Arm to door	107 mm	

The seat back angle (SA°) is measured relative to vertical, all other angles are measured relative to horizontal.

<sup>1</sup> A negative angle indicates the measurement point was located above the striker.

Figure 7 Seat Belt Positioning Data

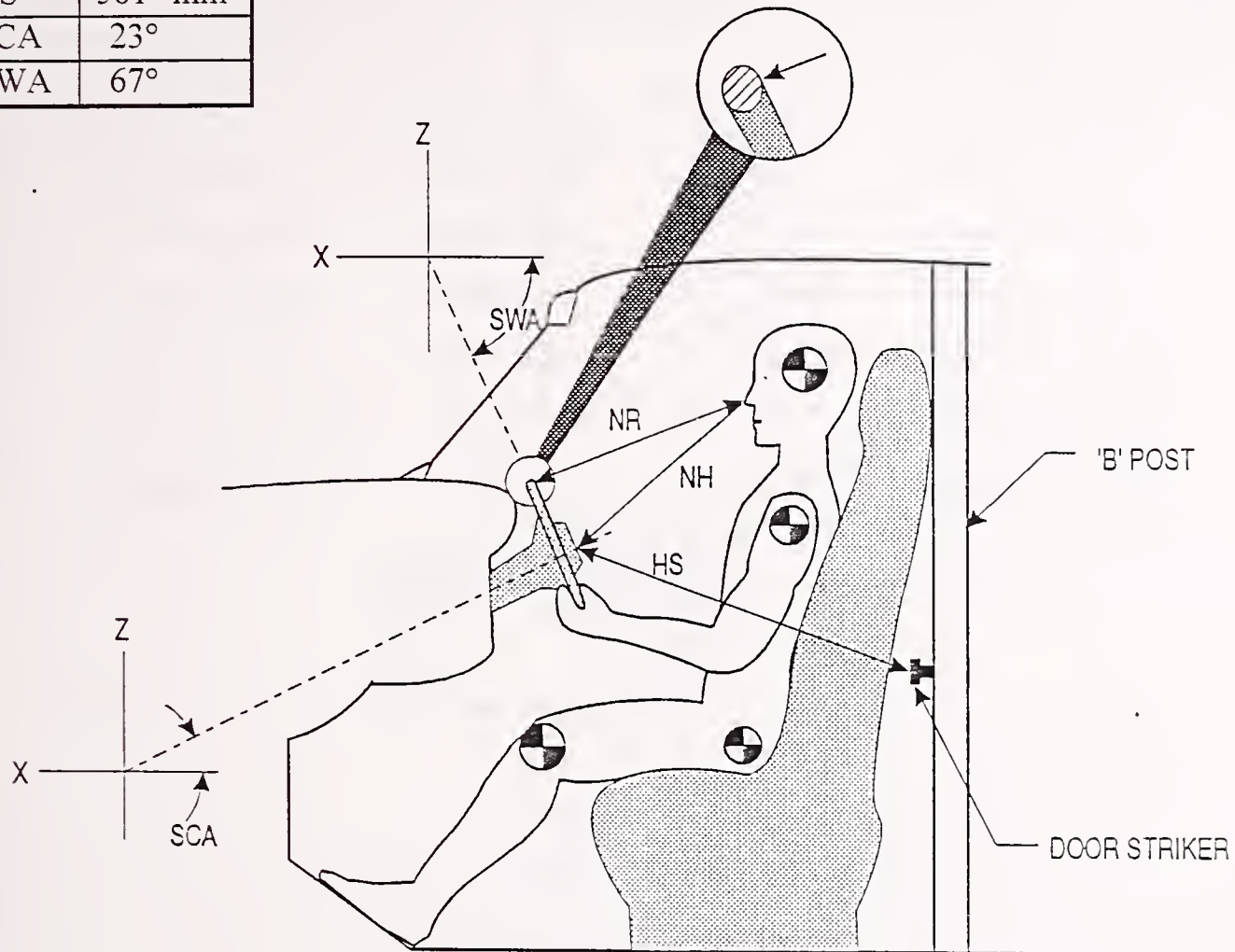


		Driver	Passenger
A	Top surface of aluminum plate to belt upper edge	335	NA
B	Top surface of aluminum plate to belt lower edge	250	NA
C	Dummy centerline to outer edge of belt at chest flesh top	118	NA
D	Dummy centerline to inner edge of belt at chest flesh top	65	NA
E	Dummy centerline to intersection of upper torso belt and lap belt	175	NA

All distance measurements are in millimeters.

Figure 8. Driver Dummy To Steering Column/Wheel Assembly Data

NR	413 mm
NH	416 mm
HS	561 mm
SCA	23°
SWA	67°



Position of steering column tilting and telescoping adjustments, if any:

The steering column was non-adjustable.

- NR = Distance from tip of dummy's nose to top rear surface of steering wheel rim.
- NH = Distance from tip of dummy's nose to center of steering column hub.
- HS = Distance from center of steering column hub to the forward surface of the door lock striker pin.
- SCA = Angle of steering column relative to horizontal.
- SWA = Angle of steering wheel relative to horizontal.

Figure 9 Camera Positions

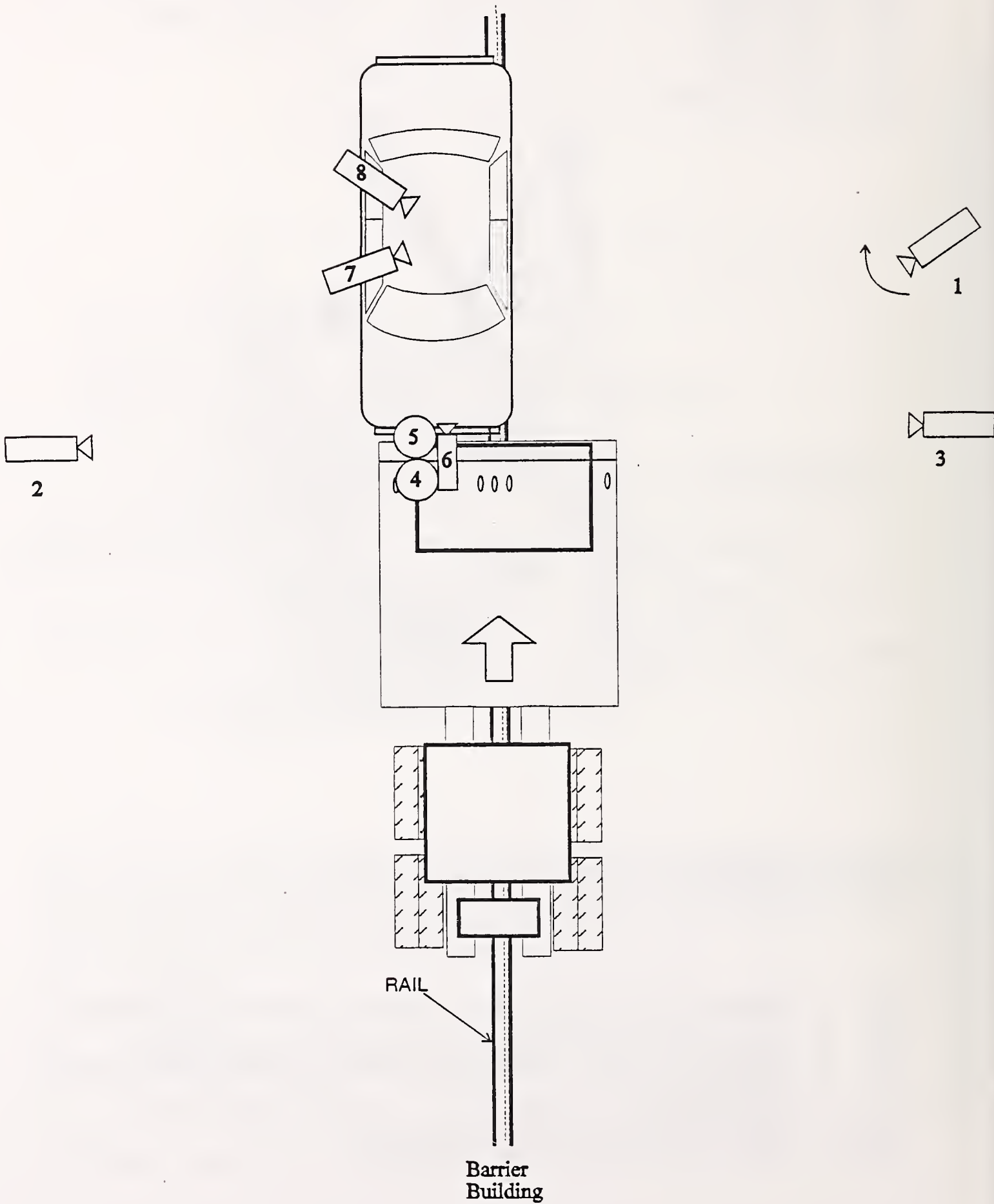


Table 11 Motion Picture Camera Information

Camera Number	Location	Type	Lens (mm)	Speed (Fps)	Purpose of Camera Data
1	Left panning	Bolex	16	24	Real-time documentation
2	Left wide	Photosonic	13	995	Vehicle dynamics
3	Right wide	Photosonic	13	1005	Vehicle dynamics
4	Overhead wide	Photosonic	8.5	1000	Vehicle dynamics
5	Overhead tight	Photosonic	25	995	Vehicle dynamics
6	Onboard truck	Photosonic	8	1000	Dummy kinematics
7	Onboard car front	Photosonic	8	650	Dummy kinematics
8	Onboard car rear	Photosonic	8	995	Dummy kinematics



Appendix A

Photographs







Figure A-1 Pre-Test Front View

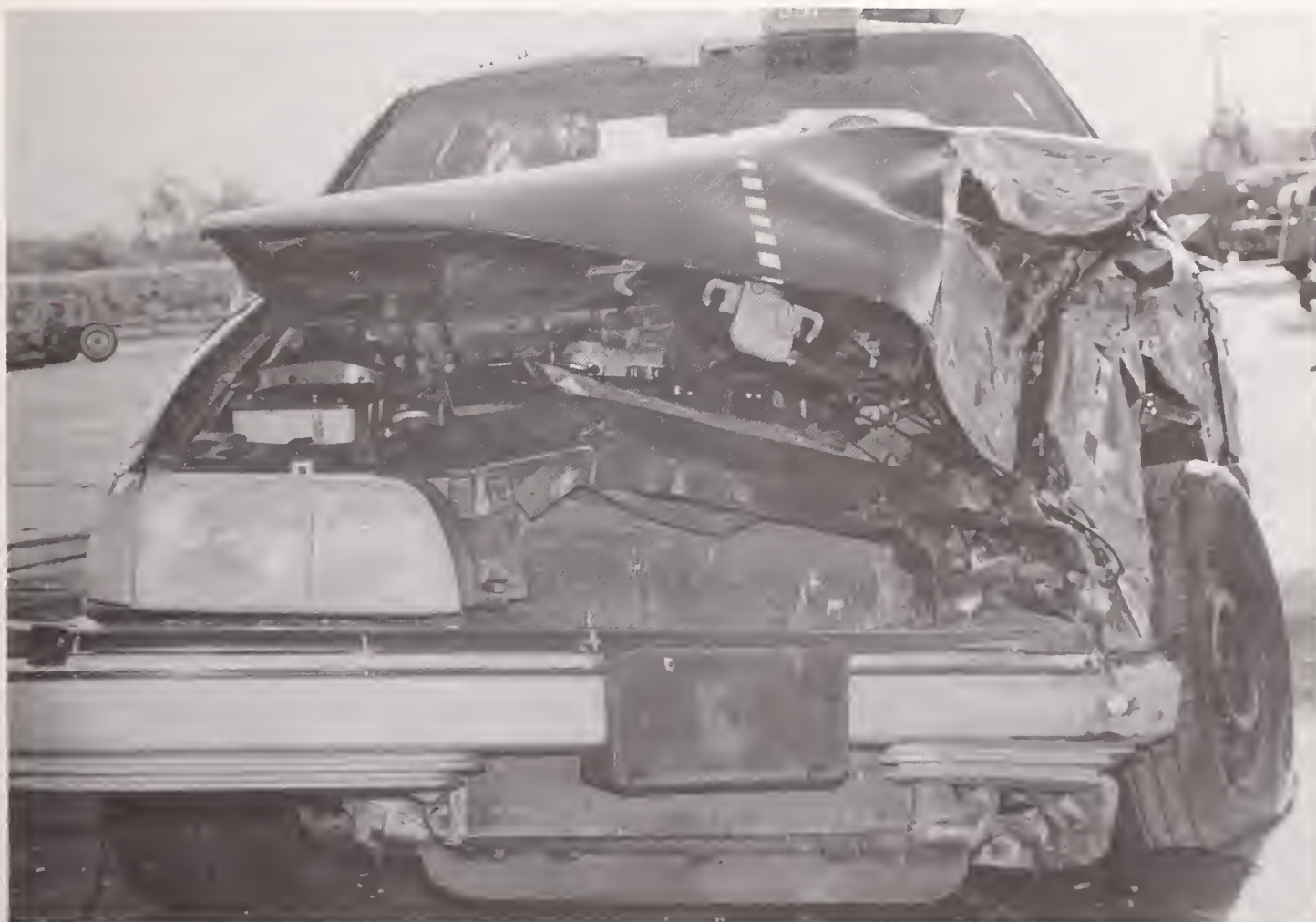


Figure A-2 Post-Test Front View

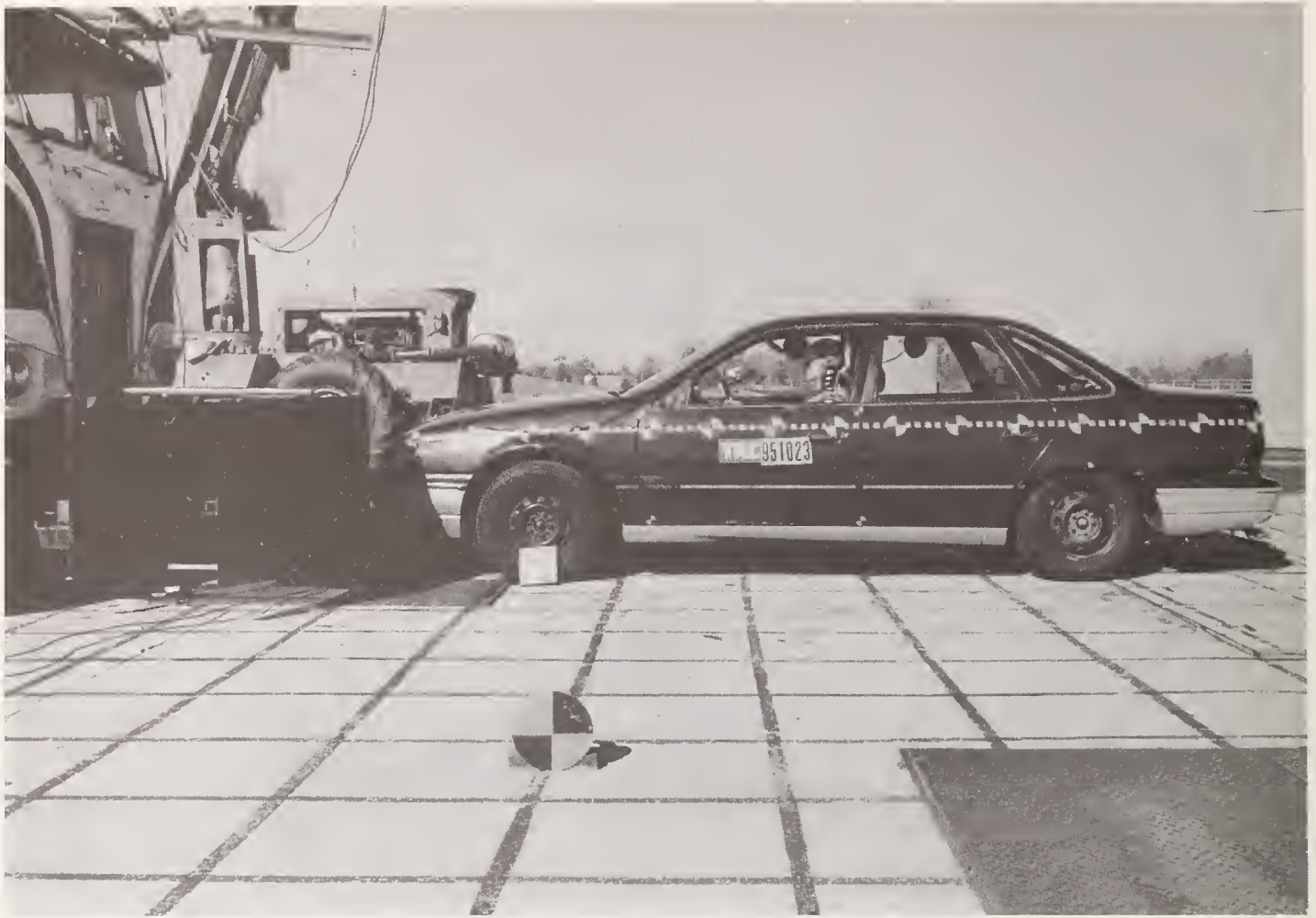


Figure A-3 Pre-Test Left Side View



Figure A-4 Post-Test Left Side View

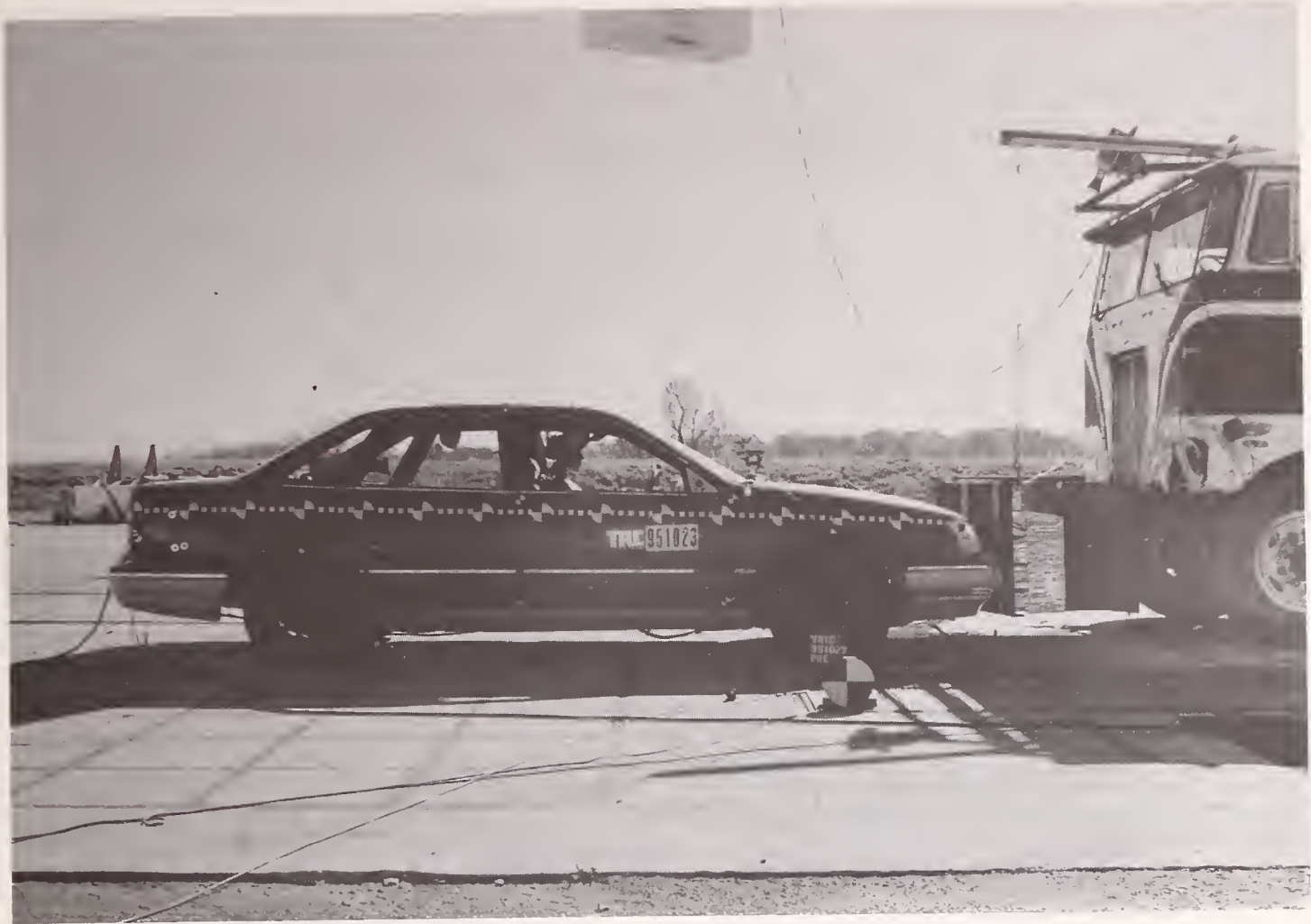


Figure A-5 Pre-Test Right Side View



Figure A-6 Post-Test Right Side View



Figure A-7 Pre-Test Left Front Three-Quarter View



Figure A-8 Pre-Test Right Front Three-Quarter View

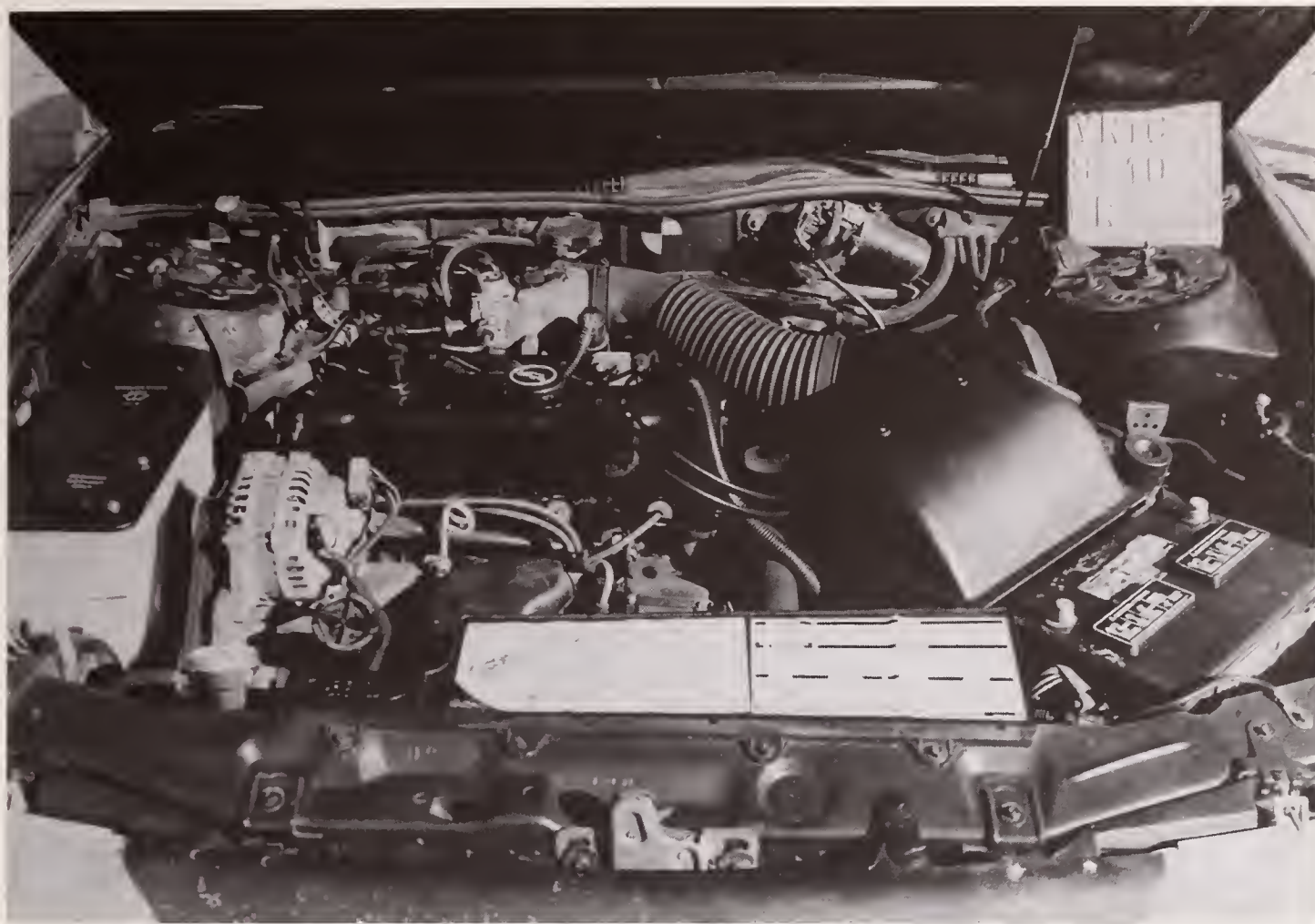


Figure A-9 Pre-Test Engine Compartment View

Intentionally Left Blank

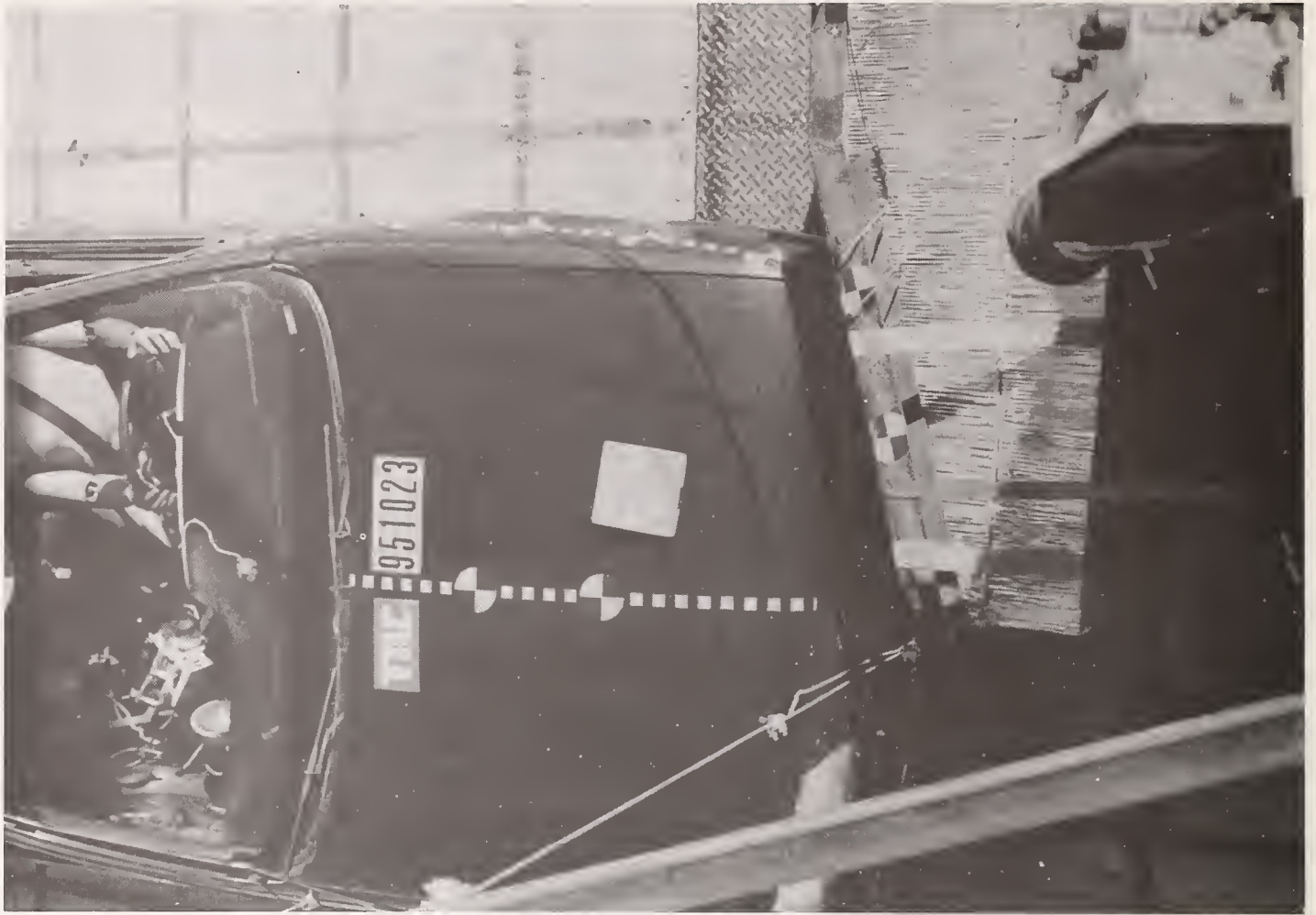


Figure A-10 Pre-Test Vehicle Truck Alignment - View 1



Figure A-11 Pre-Test Vehicle Truck Alignment - View 2



Figure A-12 Pre-Test Driver Dummy Frontal View



Figure A-13 Pre-Test Driver Dummy Left Side View

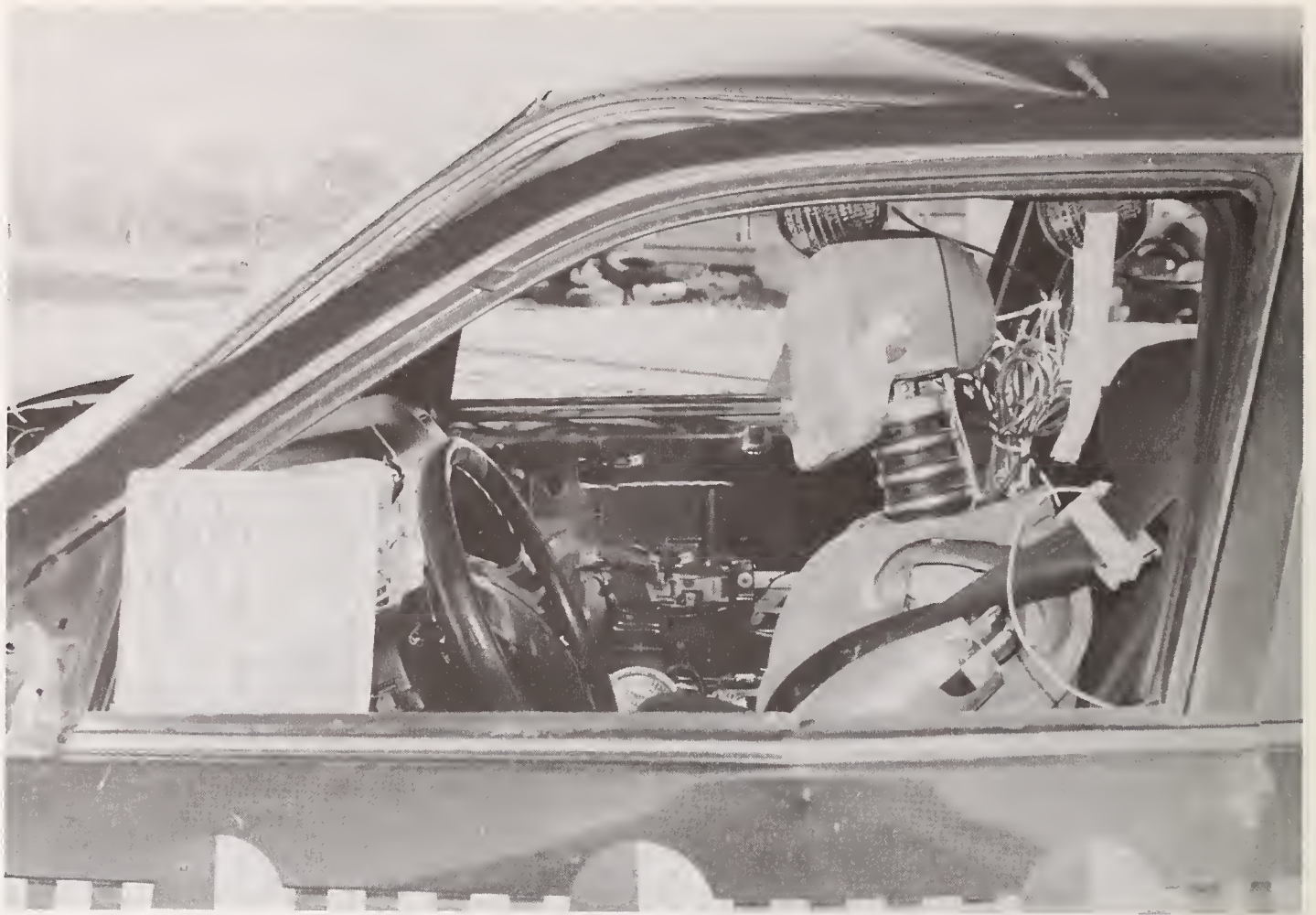


Figure A-14 Post-Test Driver Dummy Left Side - View 1



Figure A-15 Post-Test Driver Dummy Left Side - View 2





Figure A-16 Pre-Test Driver Dummy and Vehicle Interior - View 1



Figure A-17 Pre-Test Driver Dummy and Vehicle Interior - View 2



Figure A-18 Post-Test Heavy Truck Frontal View

Intentionally Left Blank



Figure A-19 Post-Test Heavy Truck Left Side View

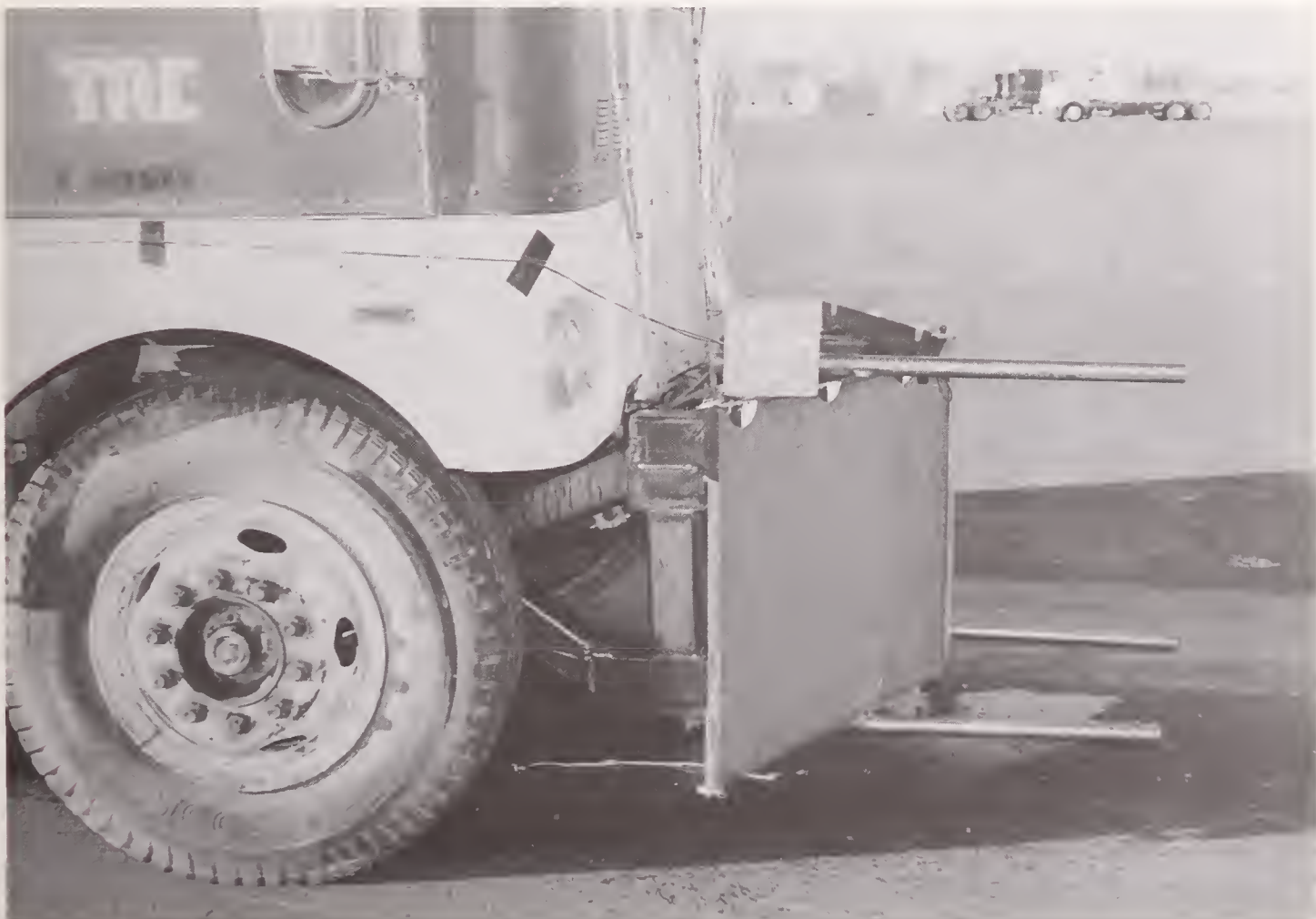


Figure A-20 Post-Test Heavy Truck Right Side View



Figure A-21 Post-Test Heavy Truck Rear View



Figure A-22 Post-Test Heavy Truck Windshield View

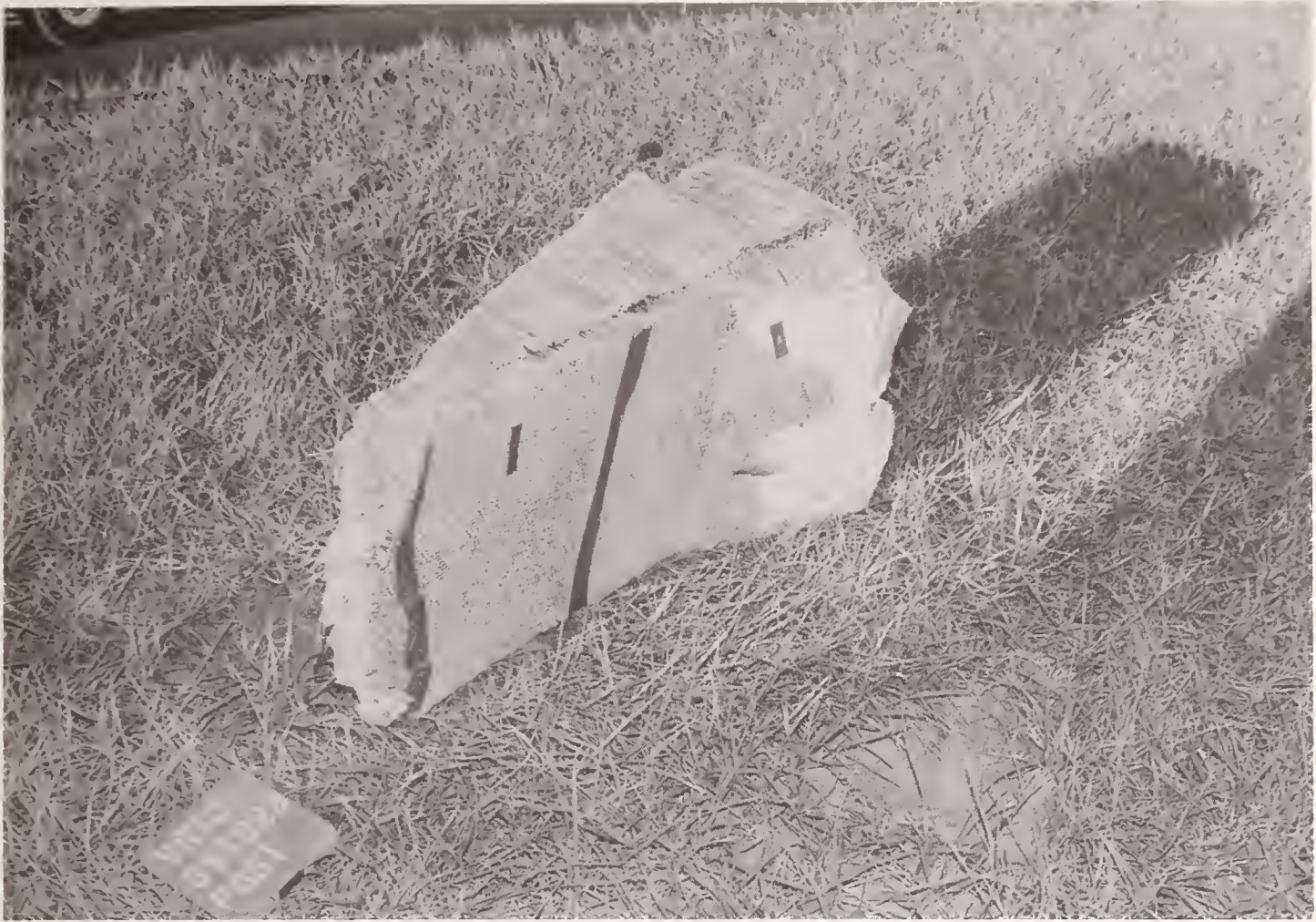


Figure A-25 Post-Test Heavy Truck Bumper Hexcel View



Figure A-26 Pre-Test Vehicle Ballast Location View

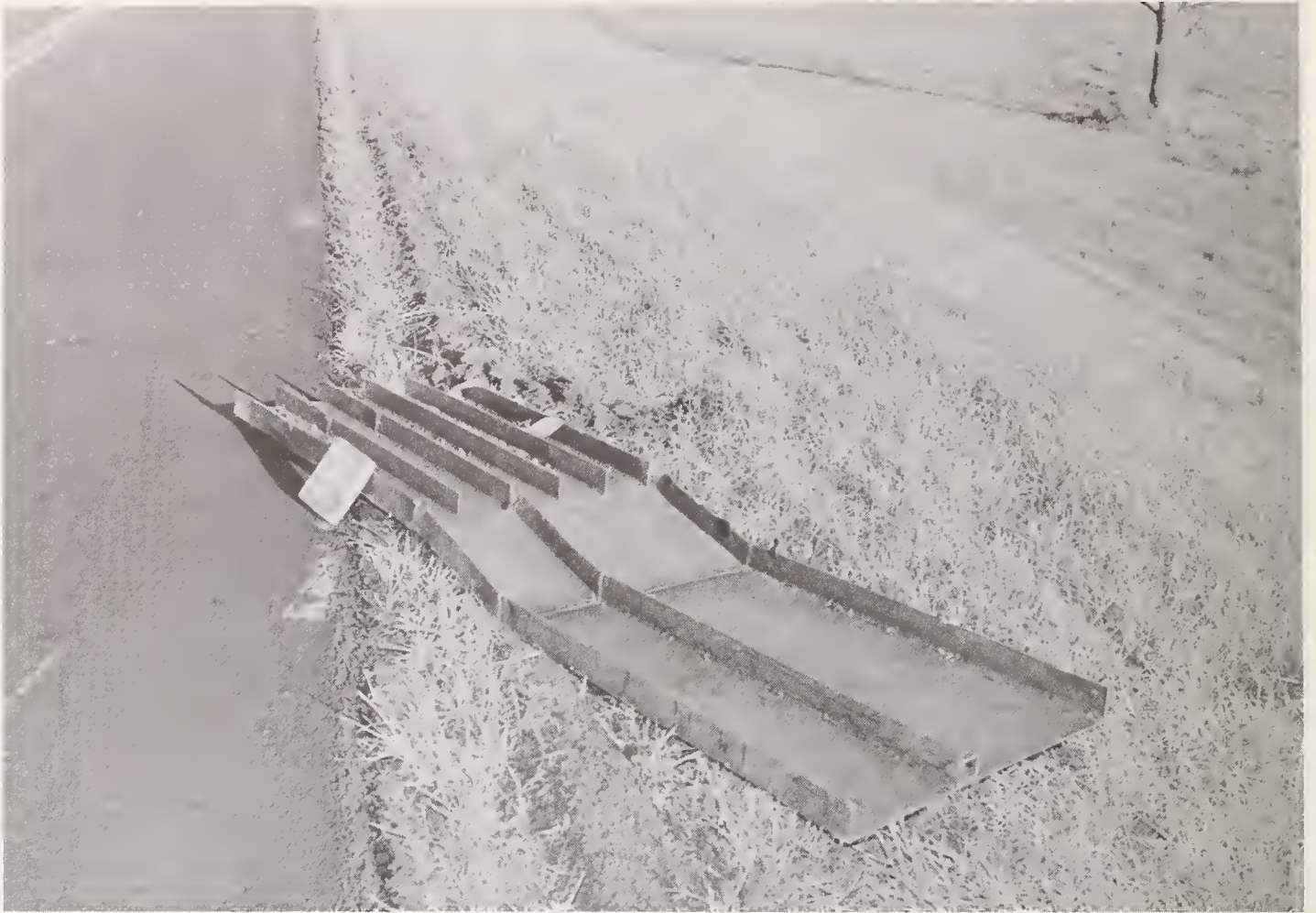


Figure A-23 Post-Test Heavy Truck Bumper - View 1



Figure A-24 Post-Test Heavy Truck Bumper - View 2

Appendix B

Data Plots

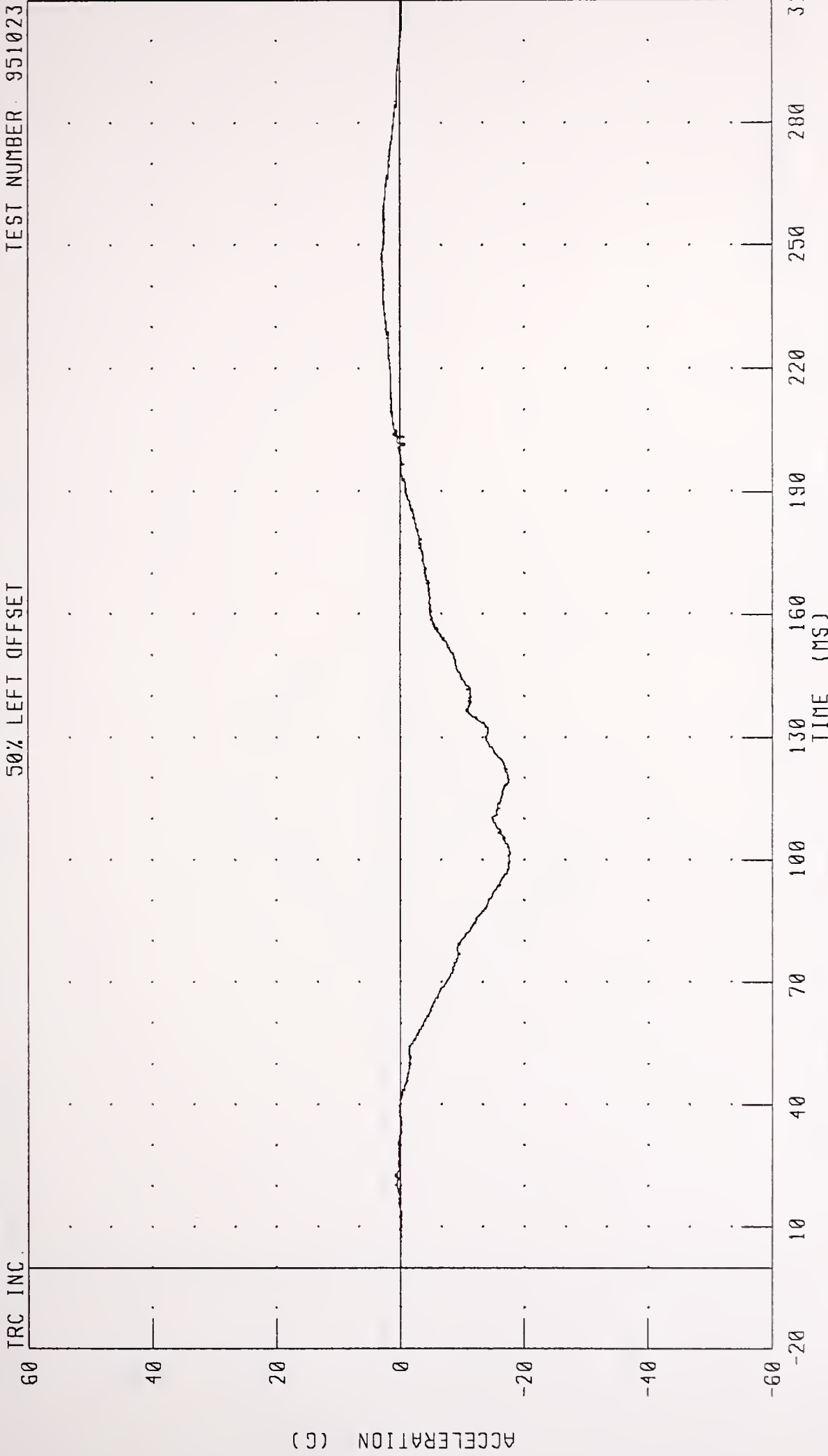




HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER HEAD X-AXIS ACCELERATION

TRC INC. TEST NUMBER 951023

50% LEFT OFFSET



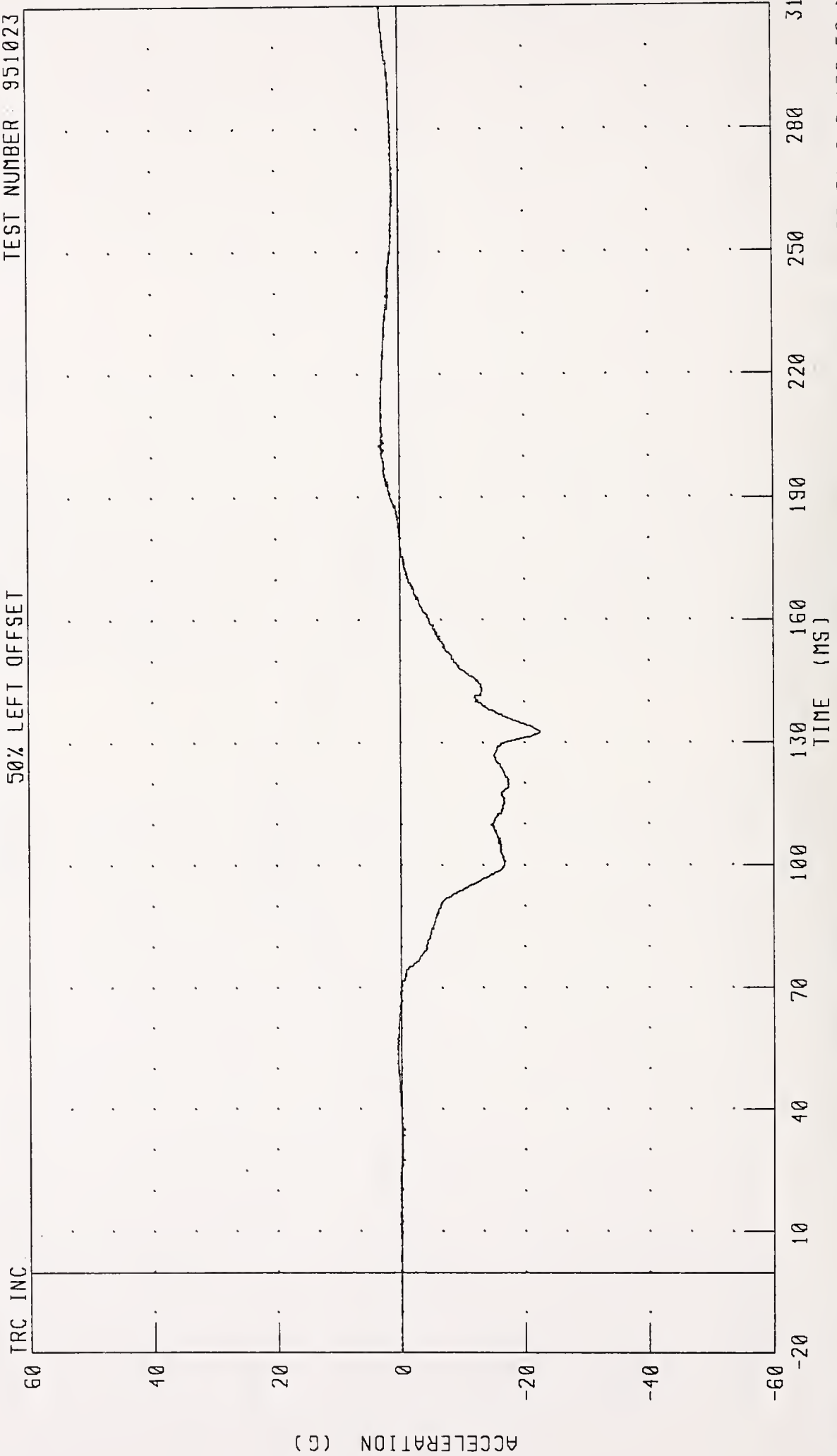
CHANNEL HEDXG1 FILTER CH CLASS 1000

PEAK DATA 3 13 G @ 246 64 MS, -17 77 G @ 99 60 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER HEAD Y-AXIS ACCELERATION

50% LEFT OFFSET

TEST NUMBER 951023



CHANNEL: HEDYG1 FILTER: CH CLASS 1000

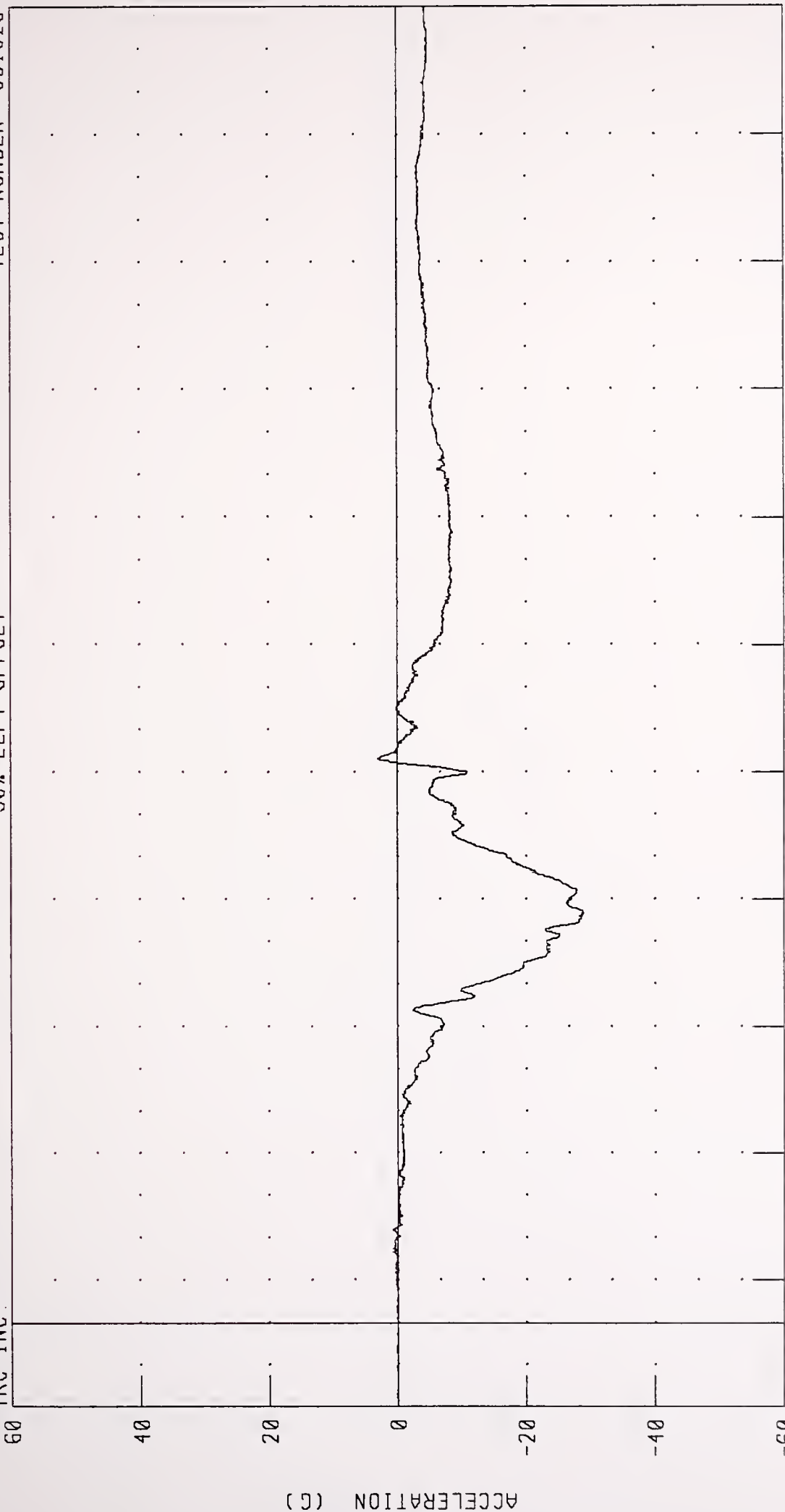
PEAK DATA 3.32 G @ 202.64 MS; -22.51 G @ 132.56 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER HEAD Z-AXIS ACCELERATION

TEST NUMBER 951023

50% LEFT OFFSET

TRC INC



TIME (MS) 310 280 250 220 190 160 130

CHANNEL HEDZG1 FILTER: CH. CLASS 1000

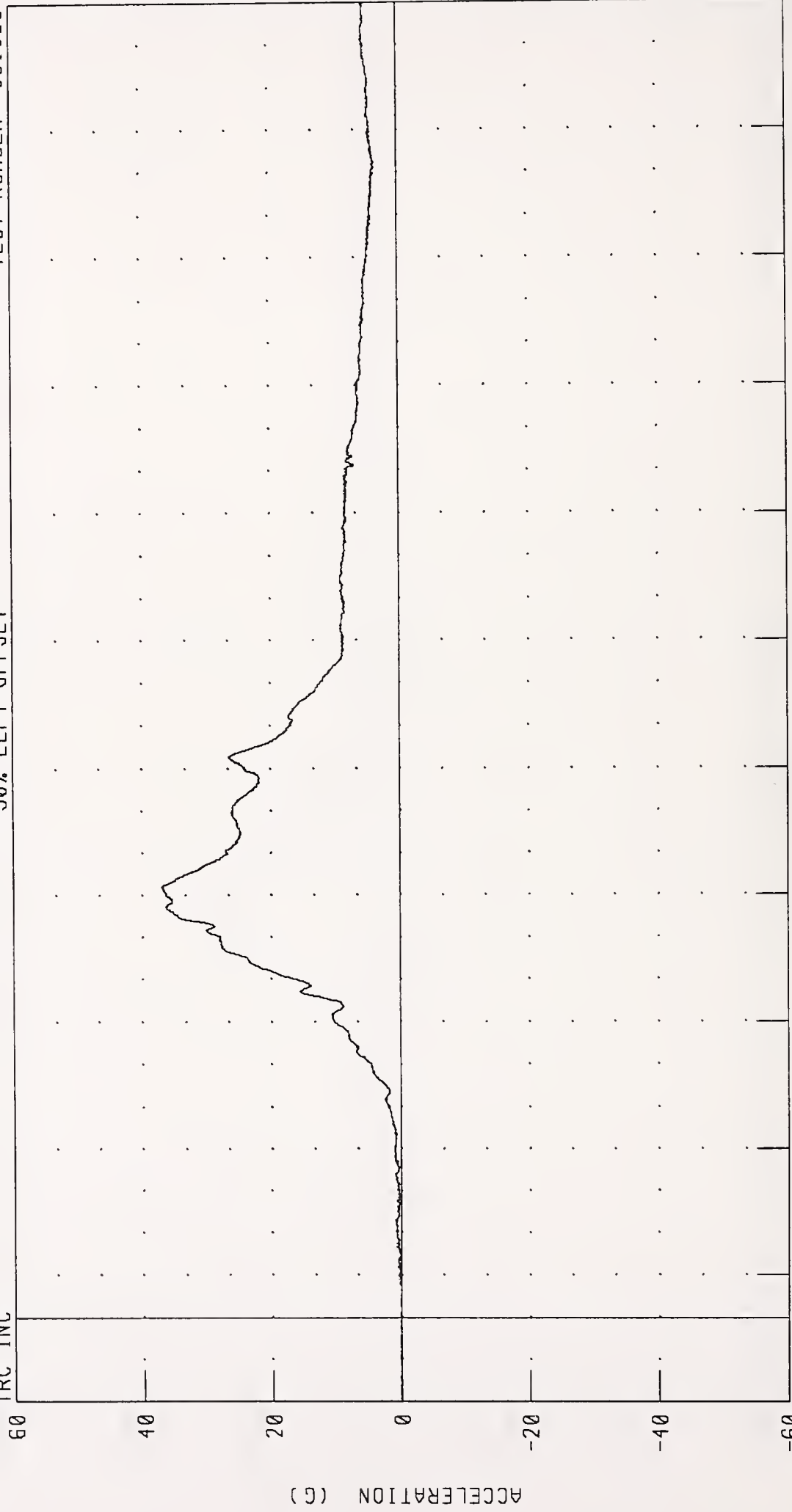
PEAK DATA: 3 14 G @ 133 04 MS, -28 93 G @ 96 72 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER HEAD RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



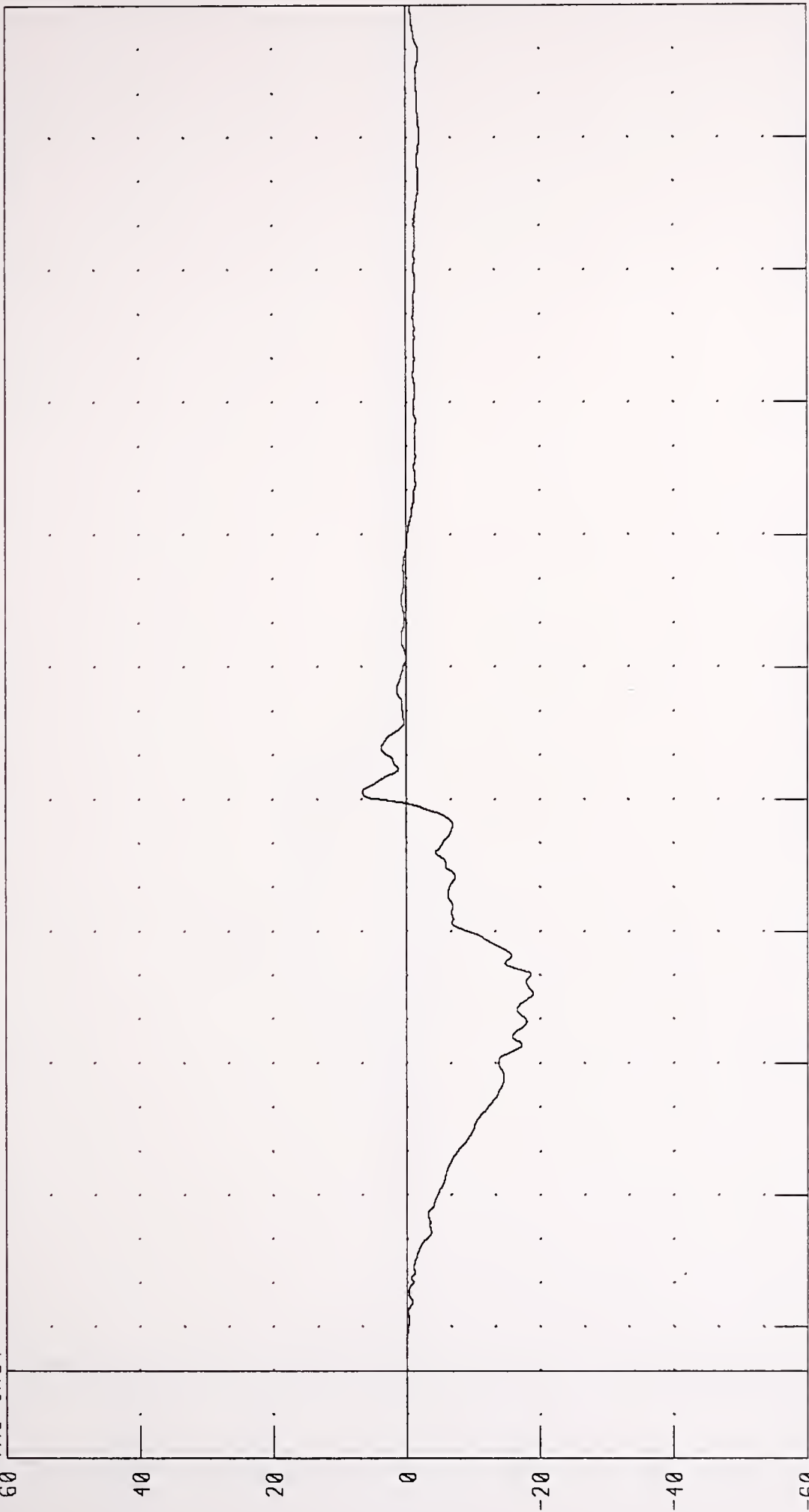
CHANNEL: HEDRG1 FILTER: CH CLASS 1000  
PEAK DATA: 37 05 G @ 101.92 MS, 0 04 G @ -20 00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER CHEST X-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



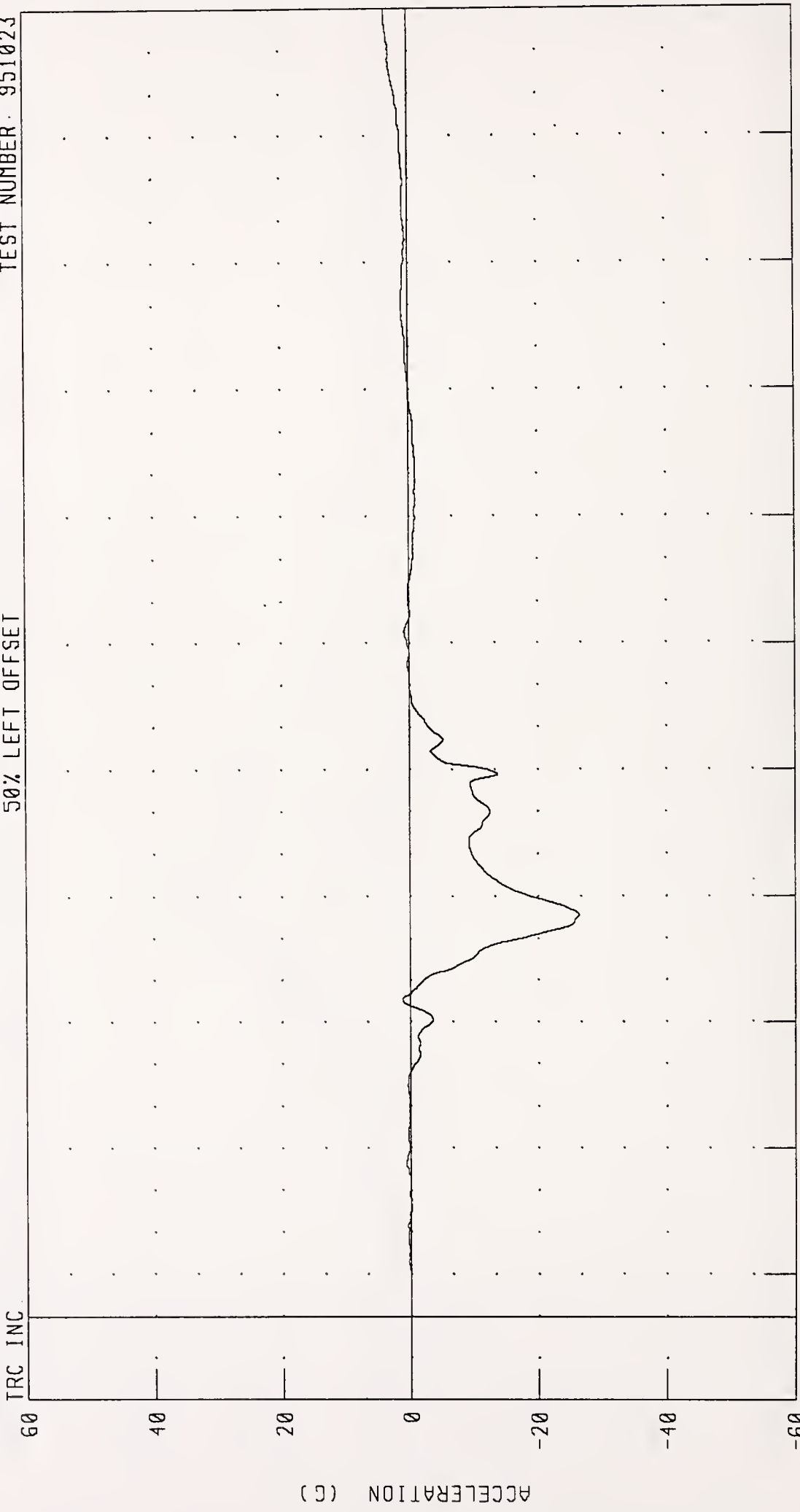
CHANNEL: CSTXG1 FILTER: CH CLASS 180  
PEAK DATA: 6 57 G @ 131 76 MS; -18 93 G @ 85 76 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER CHEST Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



CHANNEL: CSTYG1 FILTER: CH. CLASS 180

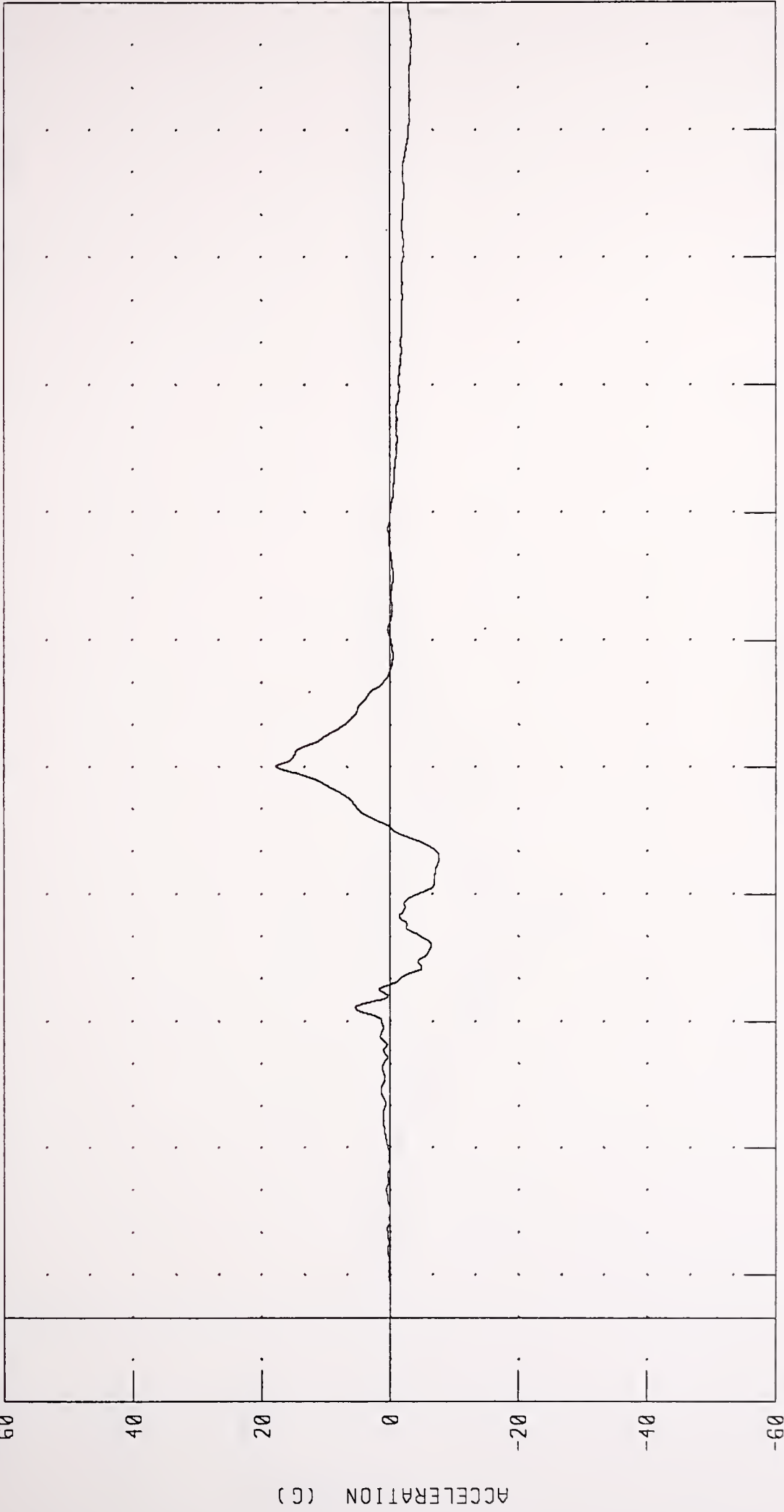
PEAK DATA: 3.63 G @ 307.52 MS, -26.35 G @ 95.68 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER CHEST Z-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



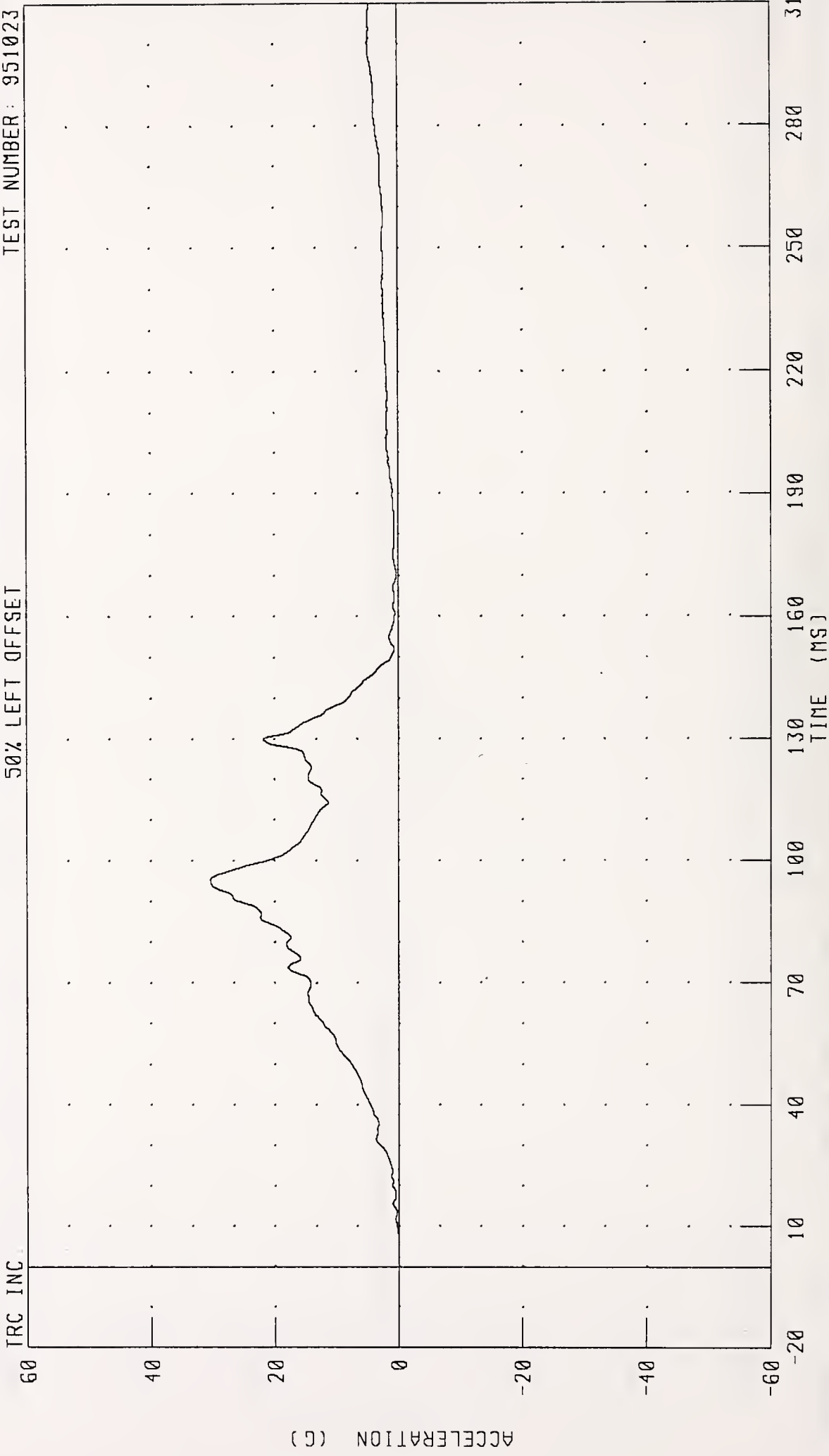
CHANNEL CSTZG1 FILTER CH CLASS 180  
PEAK DATA: 17 80 G @ 130 16 MS, -7 66 G @ 109 04 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER CHEST RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



CHANNEL: CSTRG1 FILTER: CH CLASS 180

PEAK DATA: 30.42 G @ 95.36 MS; 0.00 G @ -20.00 MS

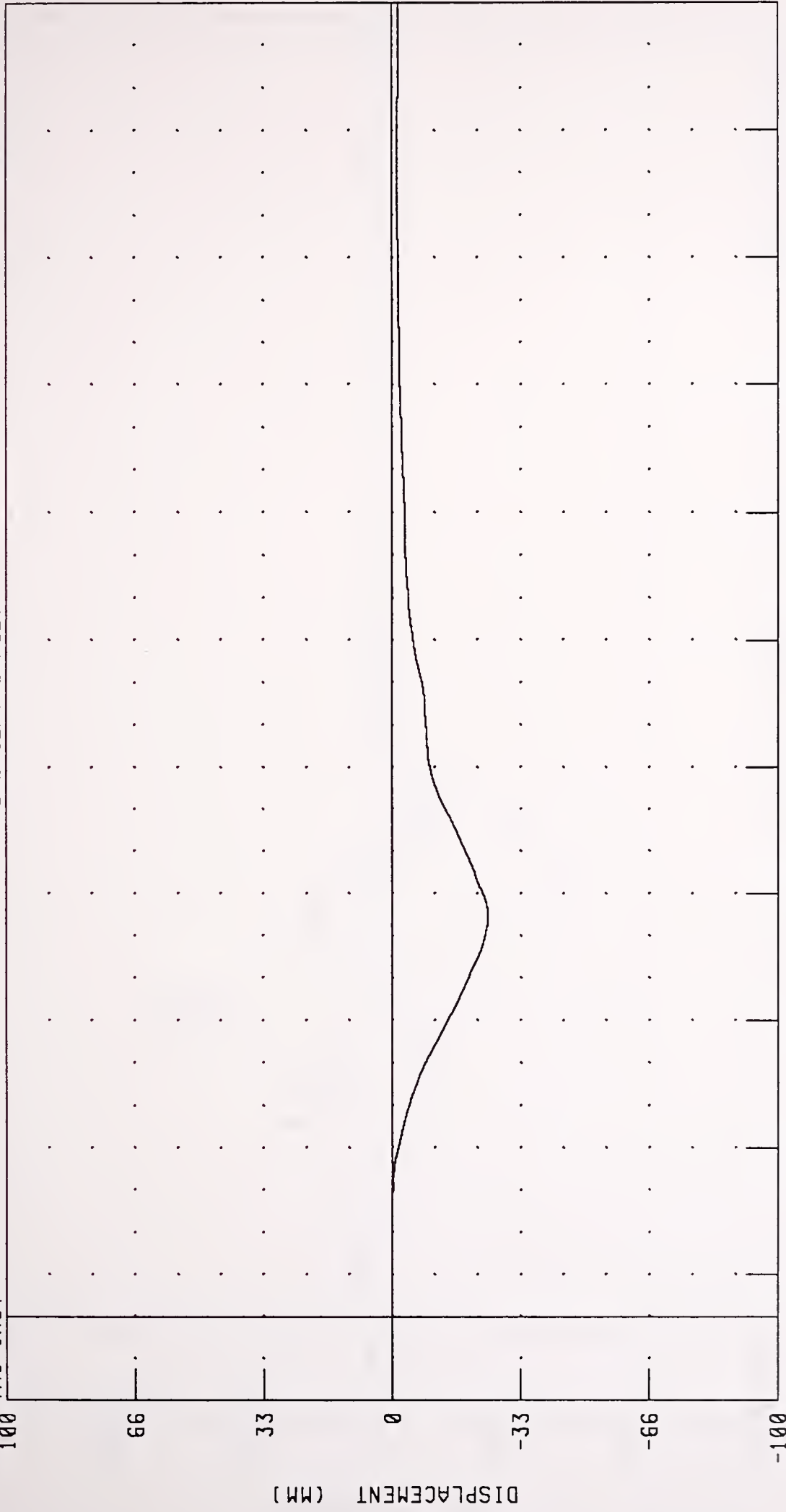


HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 DRIVER CHEST DEFLECTION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



100  
66  
33  
0  
-33  
-66  
-100

DISPLACEMENT (MM)

10 40 70 100 130 160 190 220 250 280 310

TIME (MS)

CHANNEL: CSTXD1 FILTER: CH. CLASS 180

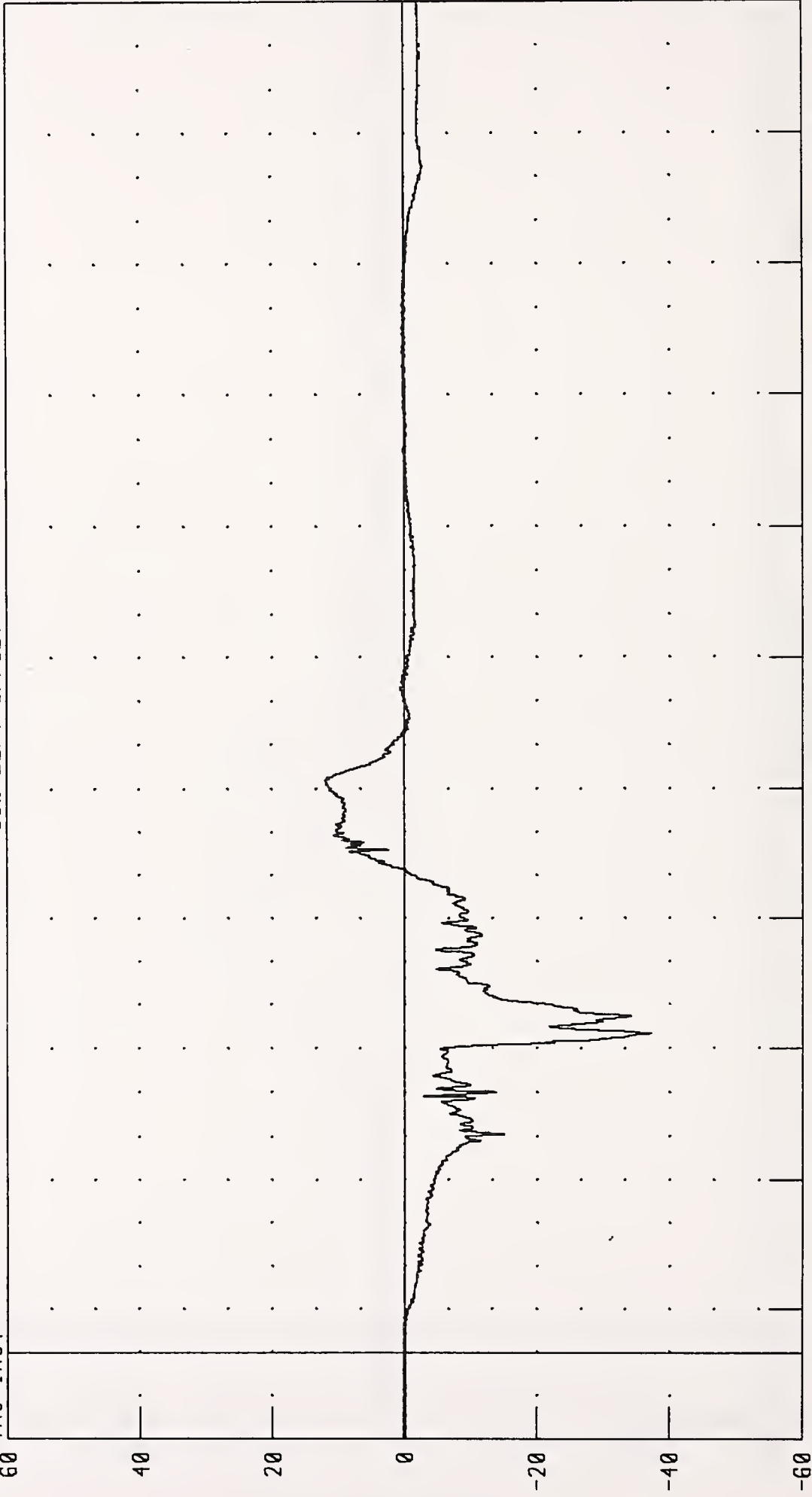
PEAK DATA: 0.01 MM @ -6.72 MS; -24.81 MM @ 95.12 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER PELVIS X-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



CHANNEL: PEVXG1 FILTER: CH. CLASS 1000

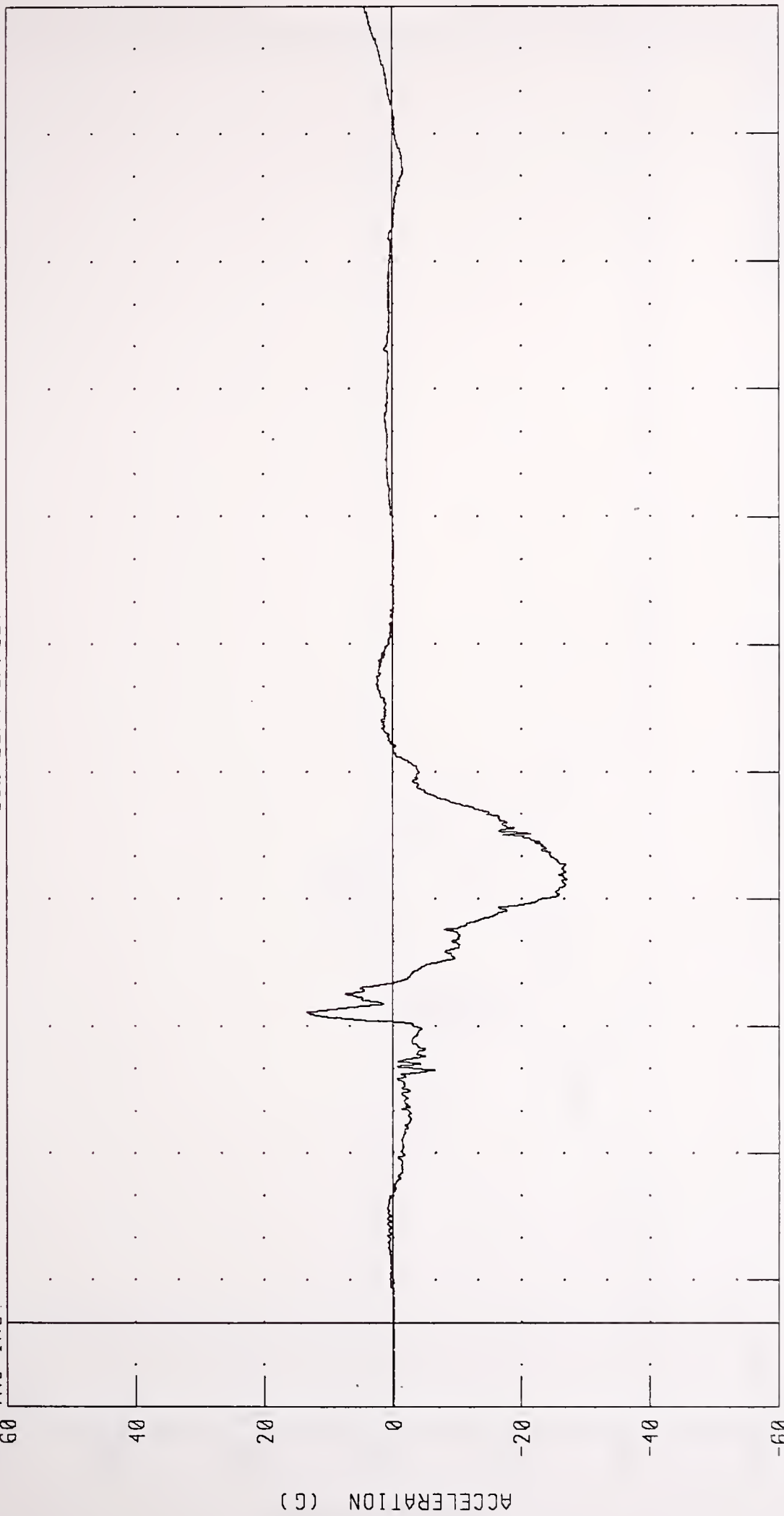
PEAK DATA: 12.07 G @ 131.92 MS; -37.18 G @ 73.44 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER PELVIS Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



60  
40  
20  
0  
-20  
-40  
-60

TRC INC.

60  
40  
20  
0  
-20  
-40  
-60

310 280 250 220 190 160 130 100 70 40 10

TIME (MS)

CHANNEL PEVYG1 FILTER CH. CLASS 1000

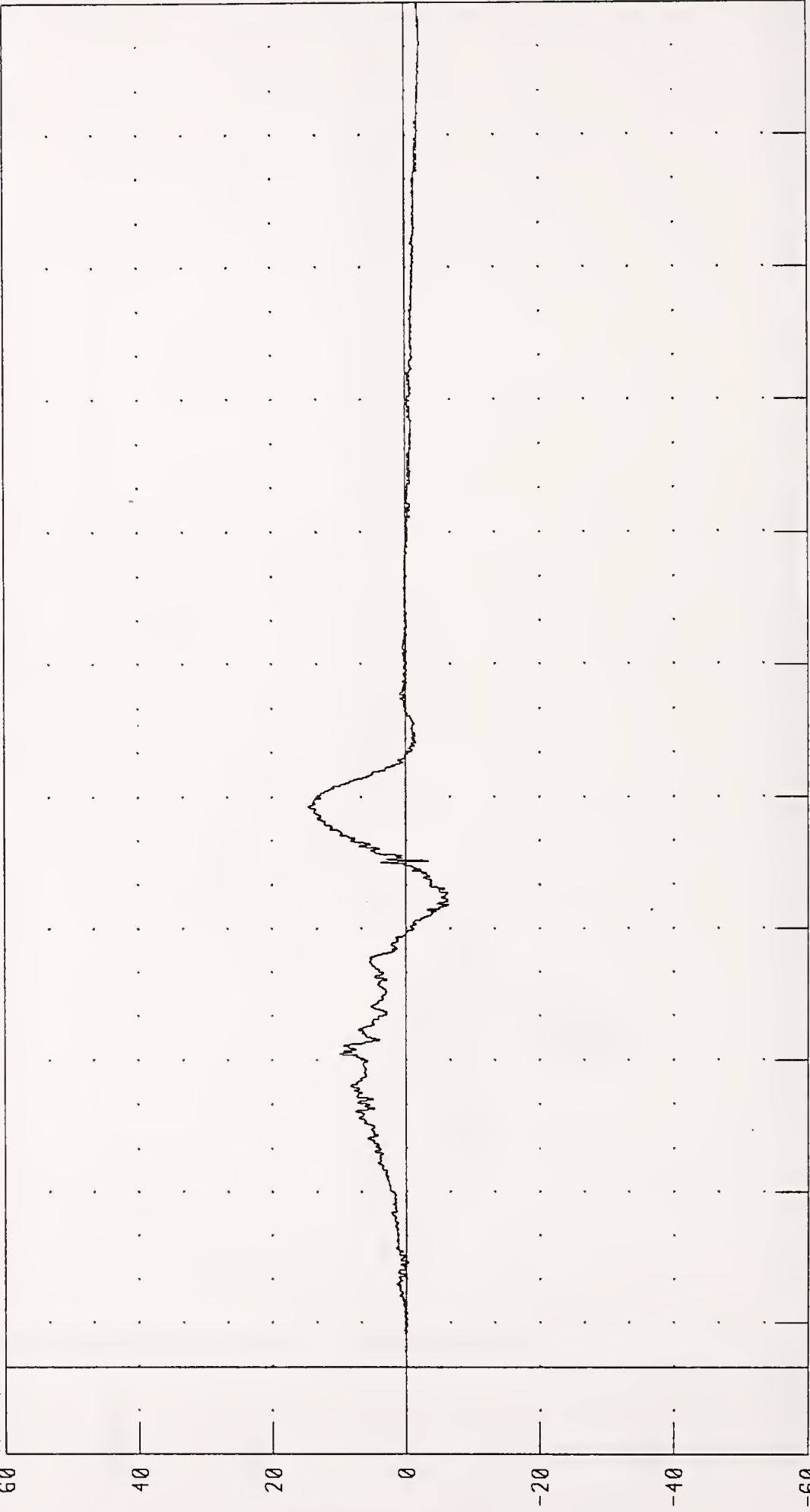
PEAK DATA 13 38 G @ 73 28 MS, -27 14 G @ 104 64 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER PELVIS Z-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



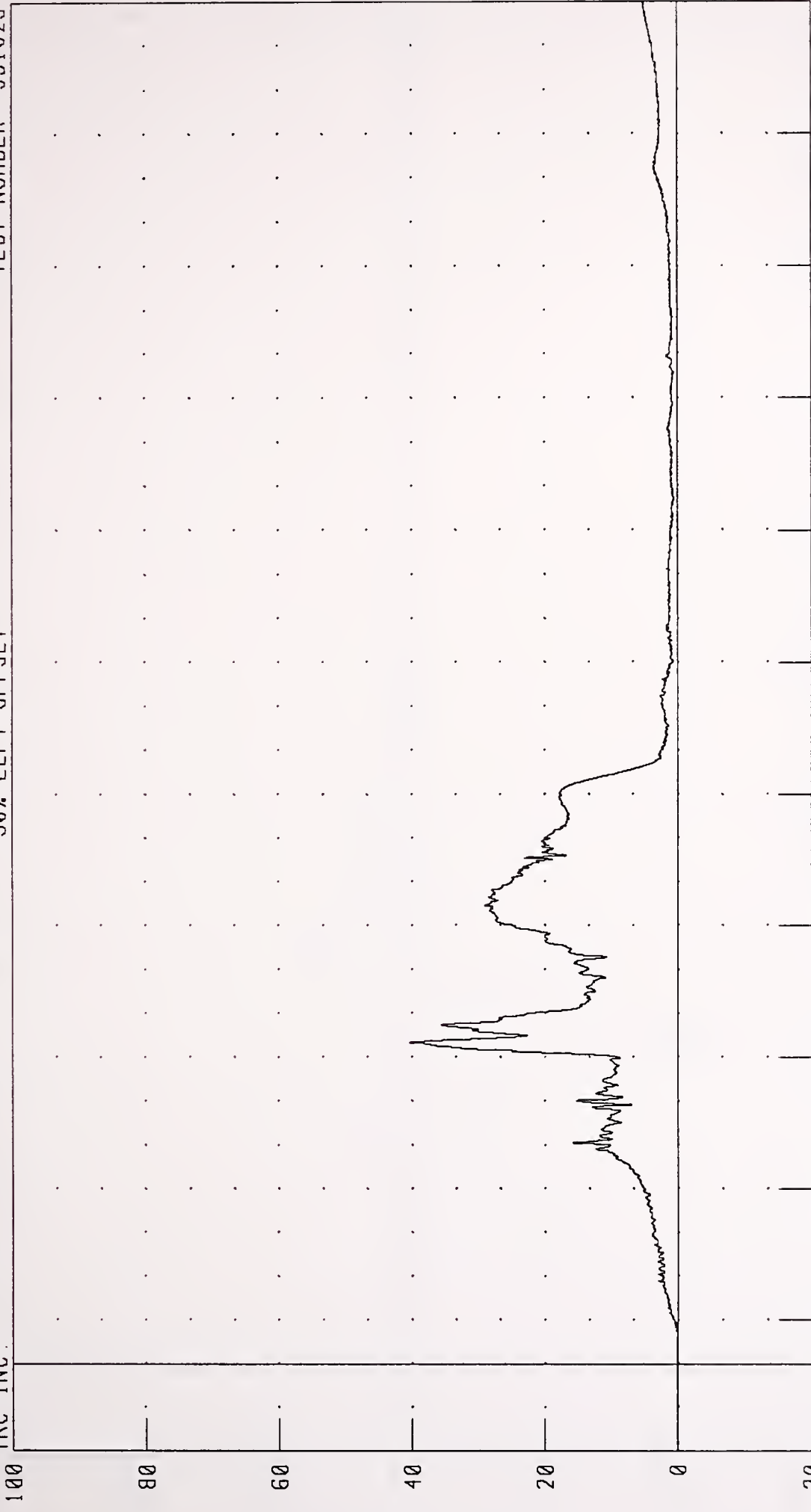
CHANNEL: PEVZG1 FILTER: CH CLASS 1000  
PEAK DATA: 14.55 G @ 127.76 MS; -6.50 G @ 105.44 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER PELVIS RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



100  
80  
60  
40  
20  
0  
-20  
-20 10 40 70 100 130 160 190 220 250 280 310  
TIME (MS)

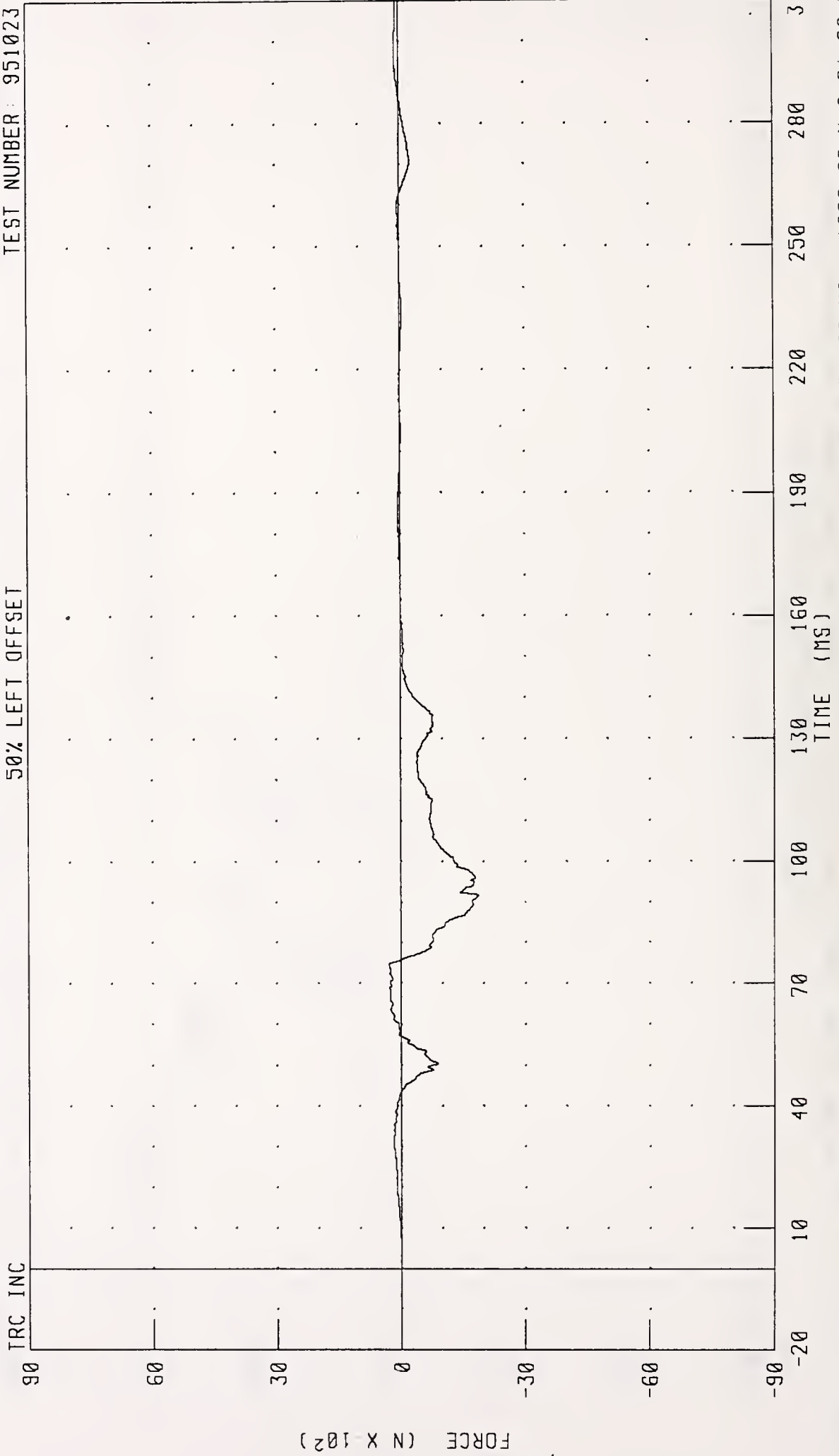
CHANNEL: PEVRG1 FILTER: CH. CLASS 1000

PEAK DATA: 40.40 G @ 73.36 MS, 0.12 G @ -19.84 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER LEFT FEMUR FORCE

50% LEFT OFFSET

TEST NUMBER: 951023



CHANNEL: LFMF1 FILTER: CH. CLASS 600

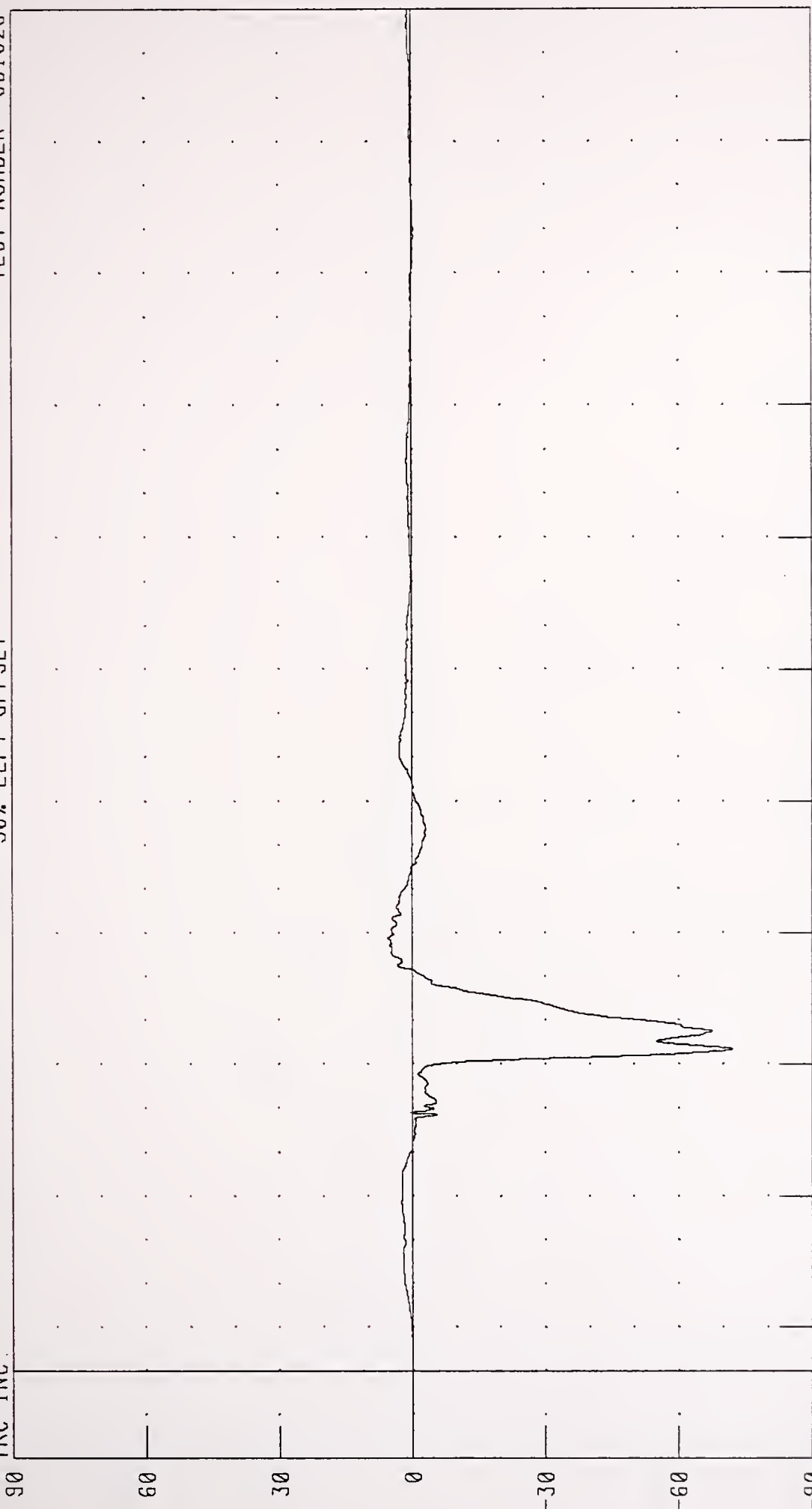
PEAK DATA: 295 17 N @ 74.80 MS, -1868 86 N @ 91.68 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER RIGHT FEMUR FORCE

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



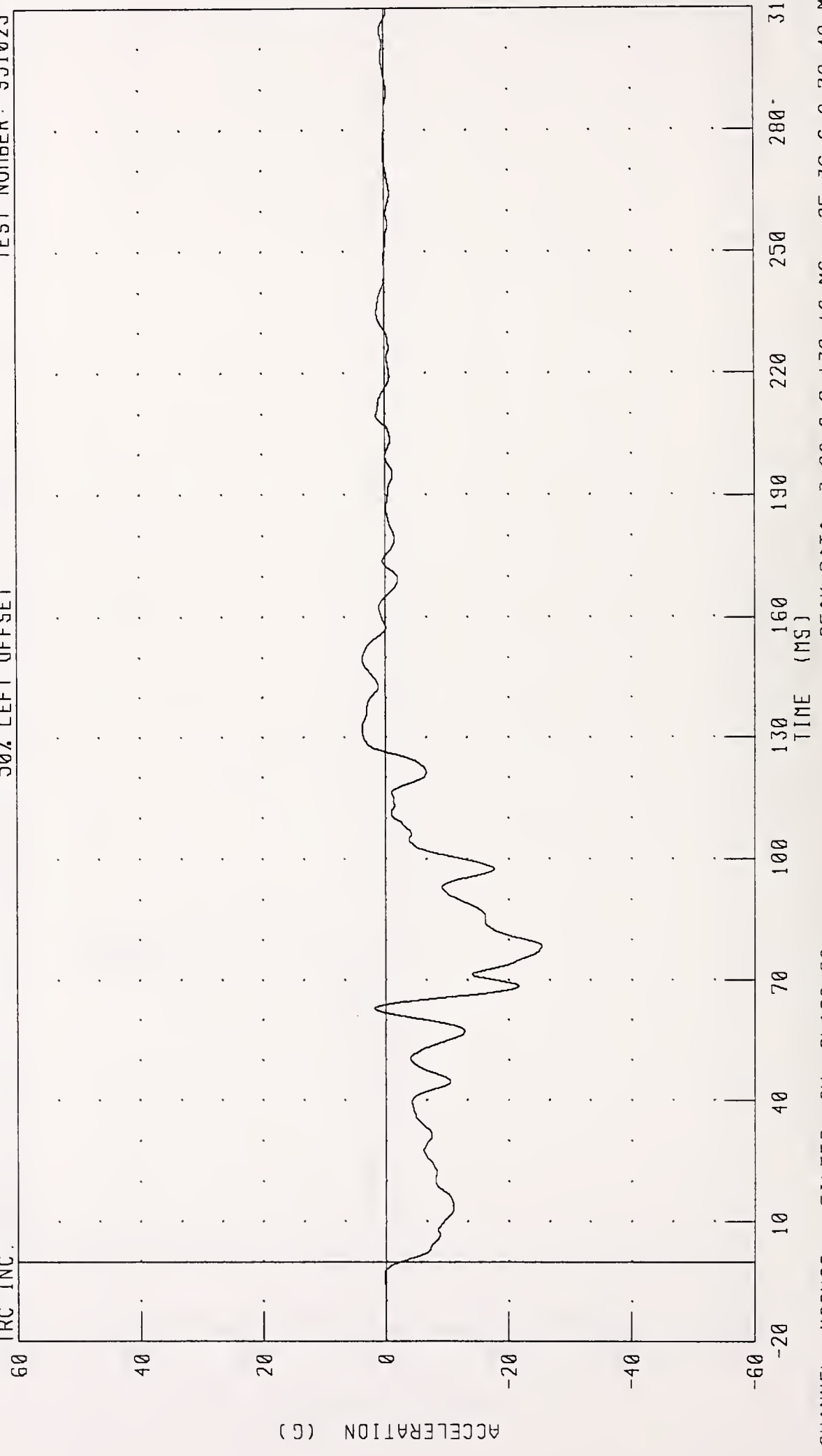
CHANNEL RFMFI FILTER CH CLASS 600  
PEAK DATA 561 20 N @ 98 72 MS, -7211 14 N @ 73 44 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
CAR CENTER OF GRAVITY X-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



CHANNEL: VCGXG2 FILTER: CH. CLASS 60

PEAK DATA: 3 82 G @ 132 16 MS; -25 36 G @ 78 48 MS

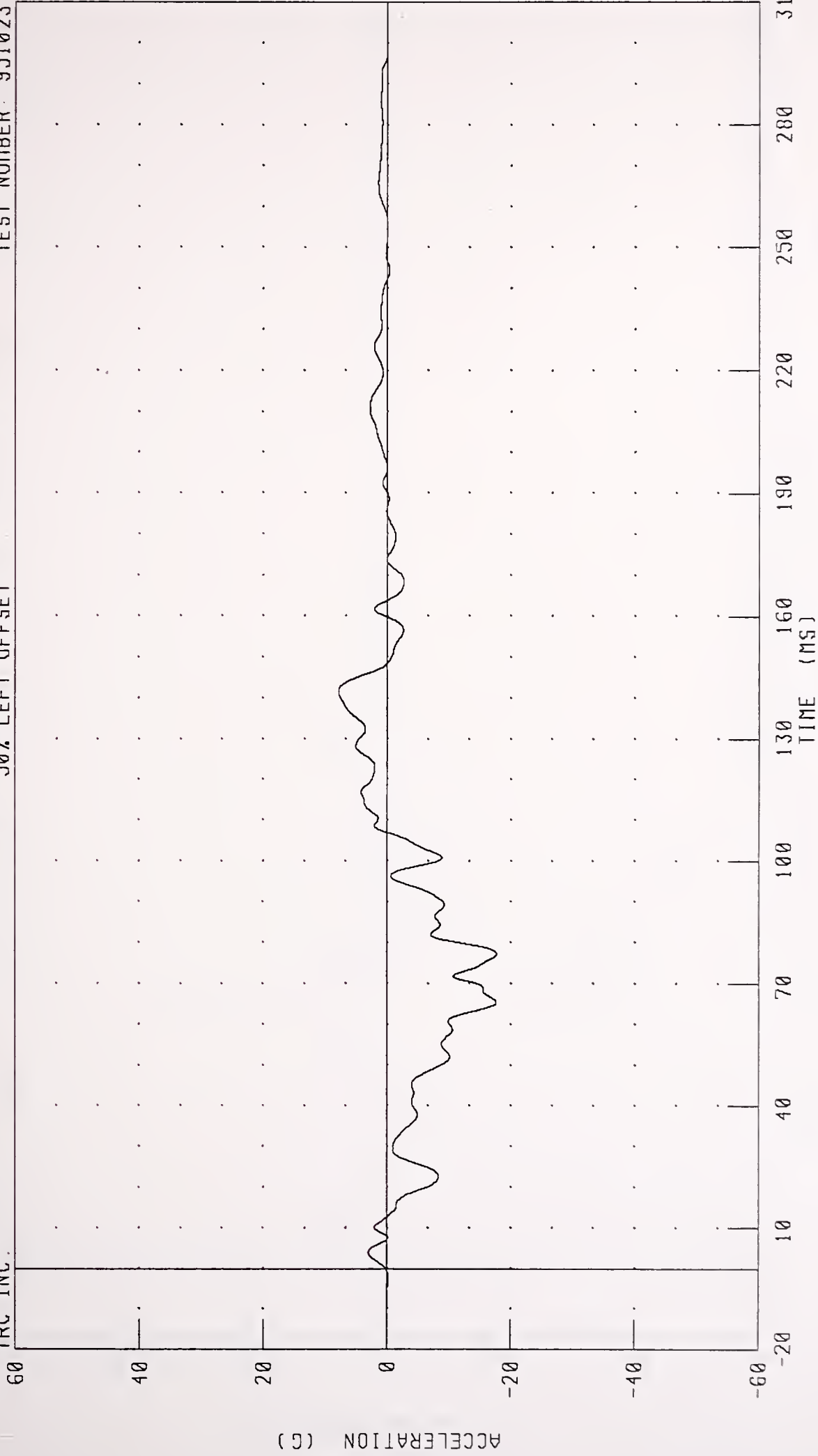


HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
CAR CENTER OF GRAVITY Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



CHANNEL VCCYG2 FILTER CH CLASS 60

PEAK DATA 7 87 G @ 141 84 MS, -17 75 G @ 77 36 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
CAR CENTER OF GRAVITY Z-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.

60

40

20

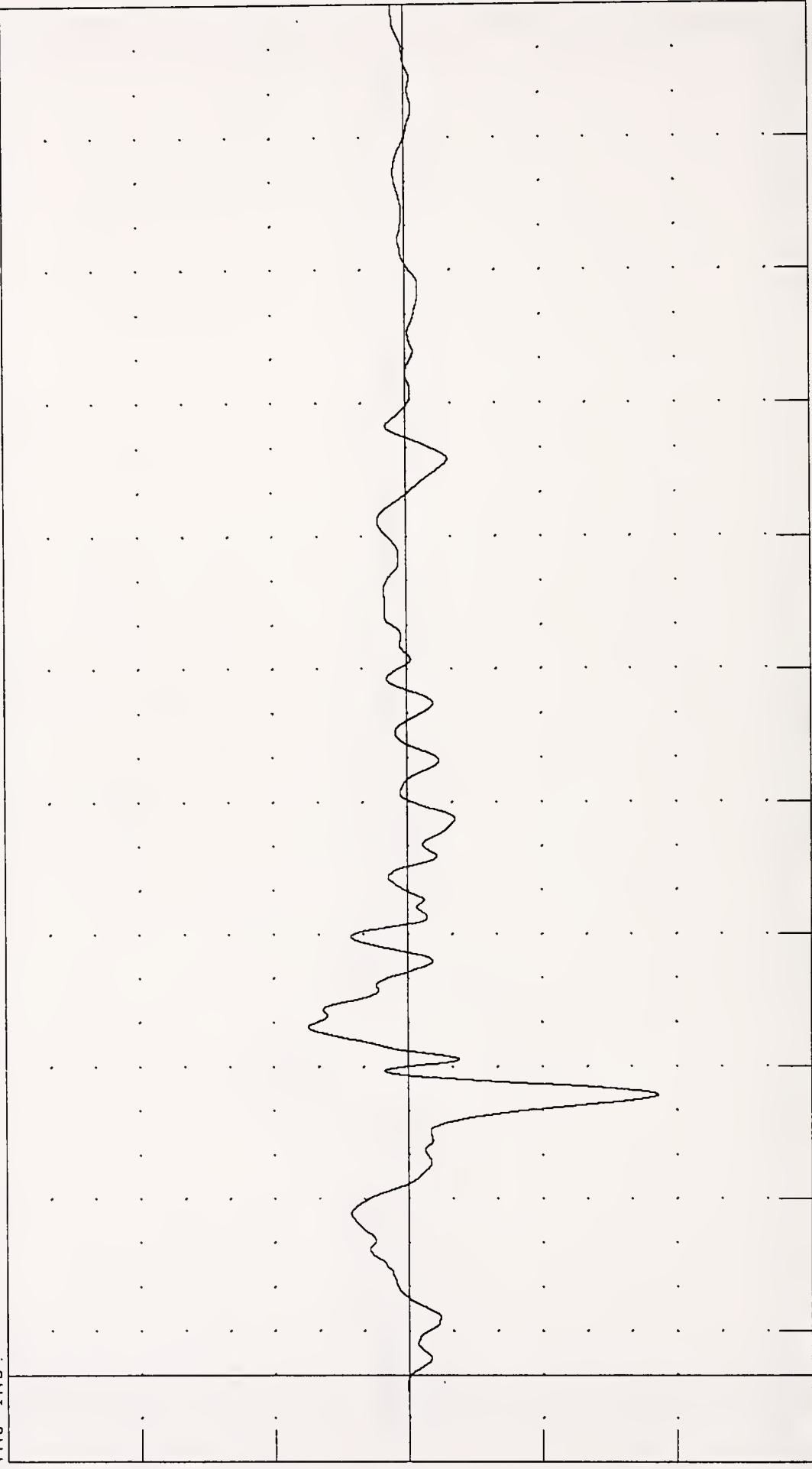
0

-20

-40

-60

ACCELERATION (G)



310

280

250

220

190

160

130

100

70

40

10

-20

TIME (MS)

CHANNEL: VCGZG2 FILTER: CH. CLASS 60

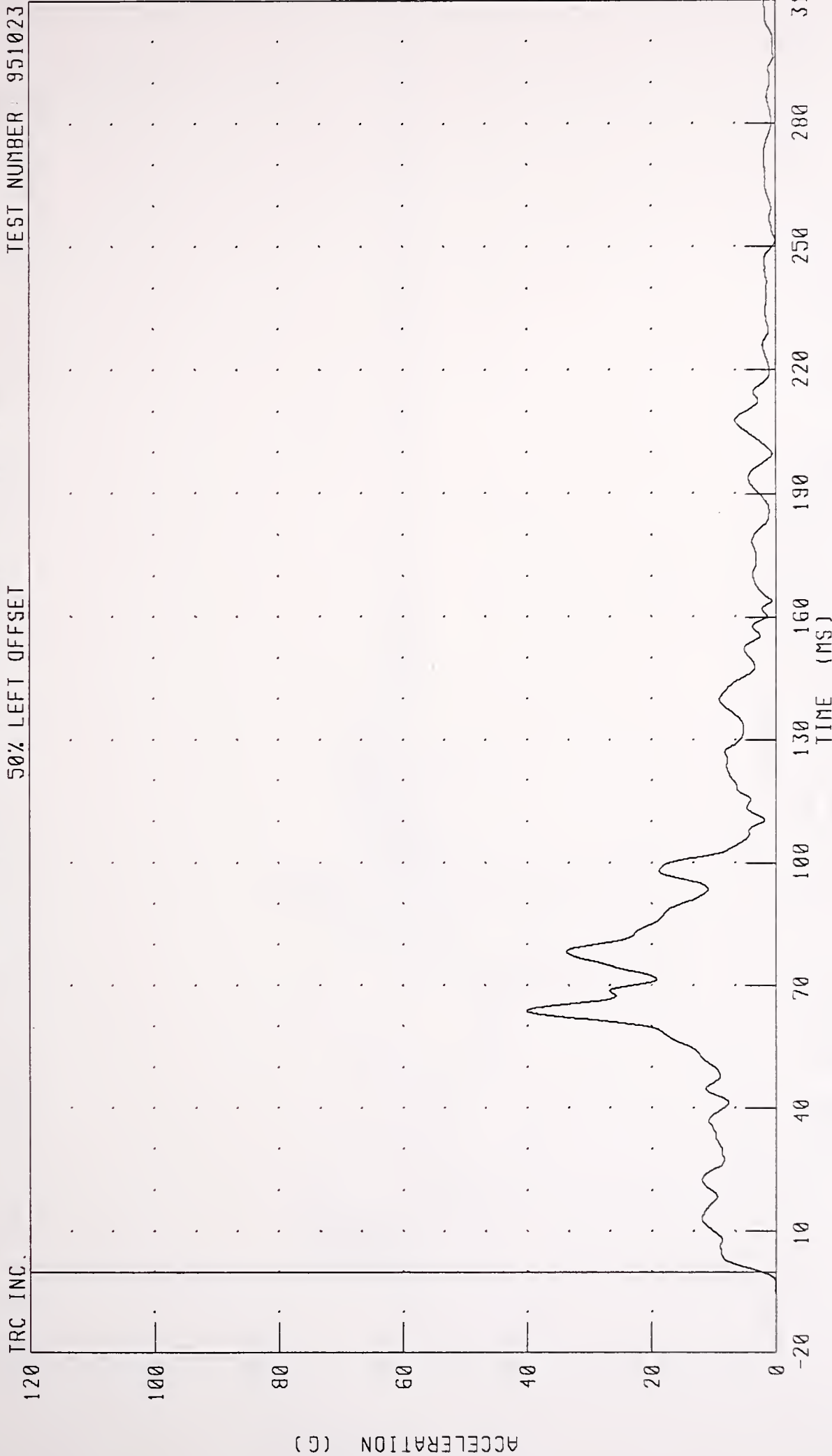
PEAK DATA: 14.96 G @ 79.04 MS; -37.22 G @ 63.60 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
CAR CENTER OF GRAVITY RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



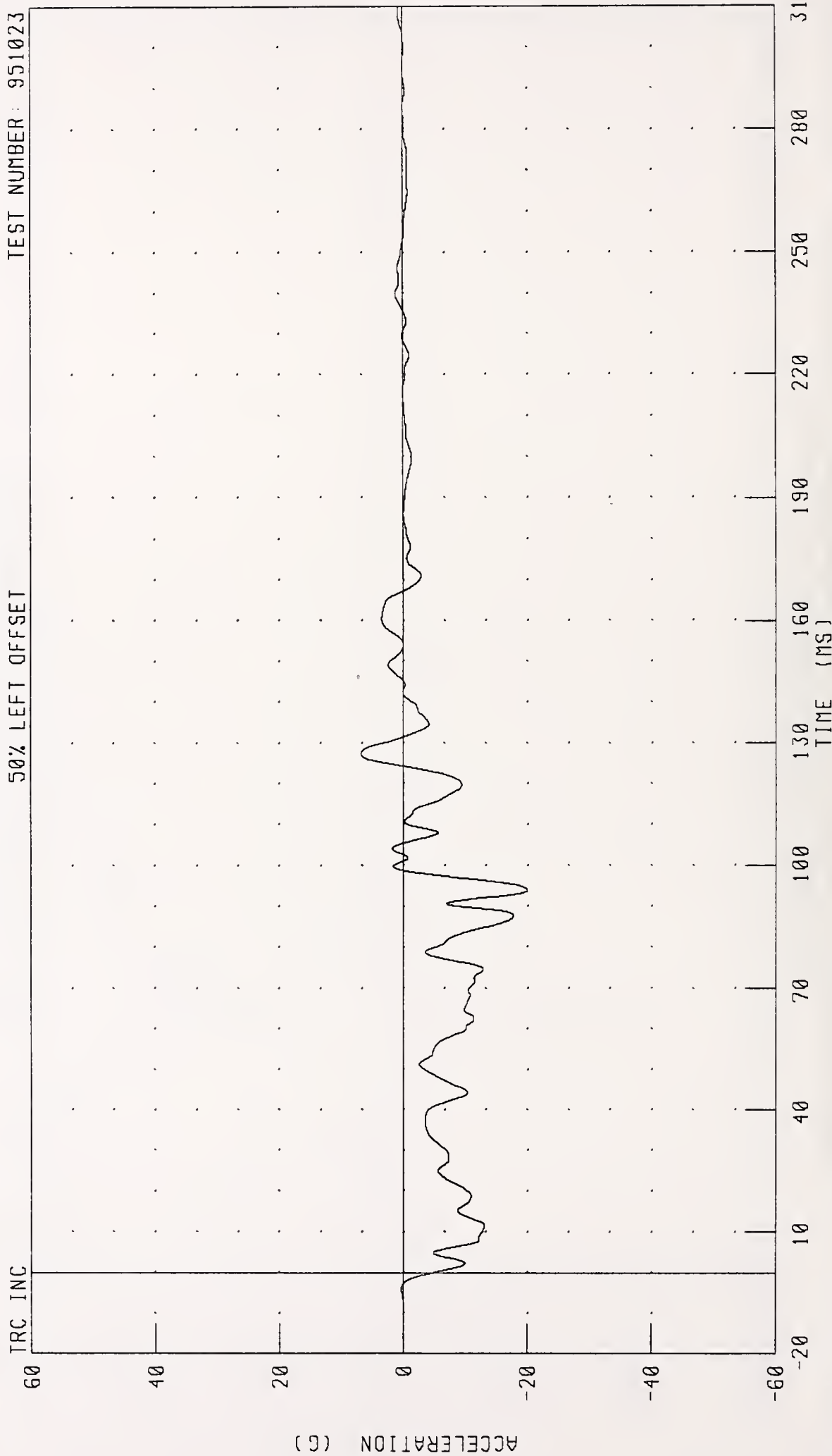
CHANNEL VCCRG2 FILTER CH CLASS 60

PEAK DATA: 40 09 G @ 63 76 MS, 0 01 G @ -10 80 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT FRONT SILL X-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL LFSXG2 FILTER: CH CLASS 60

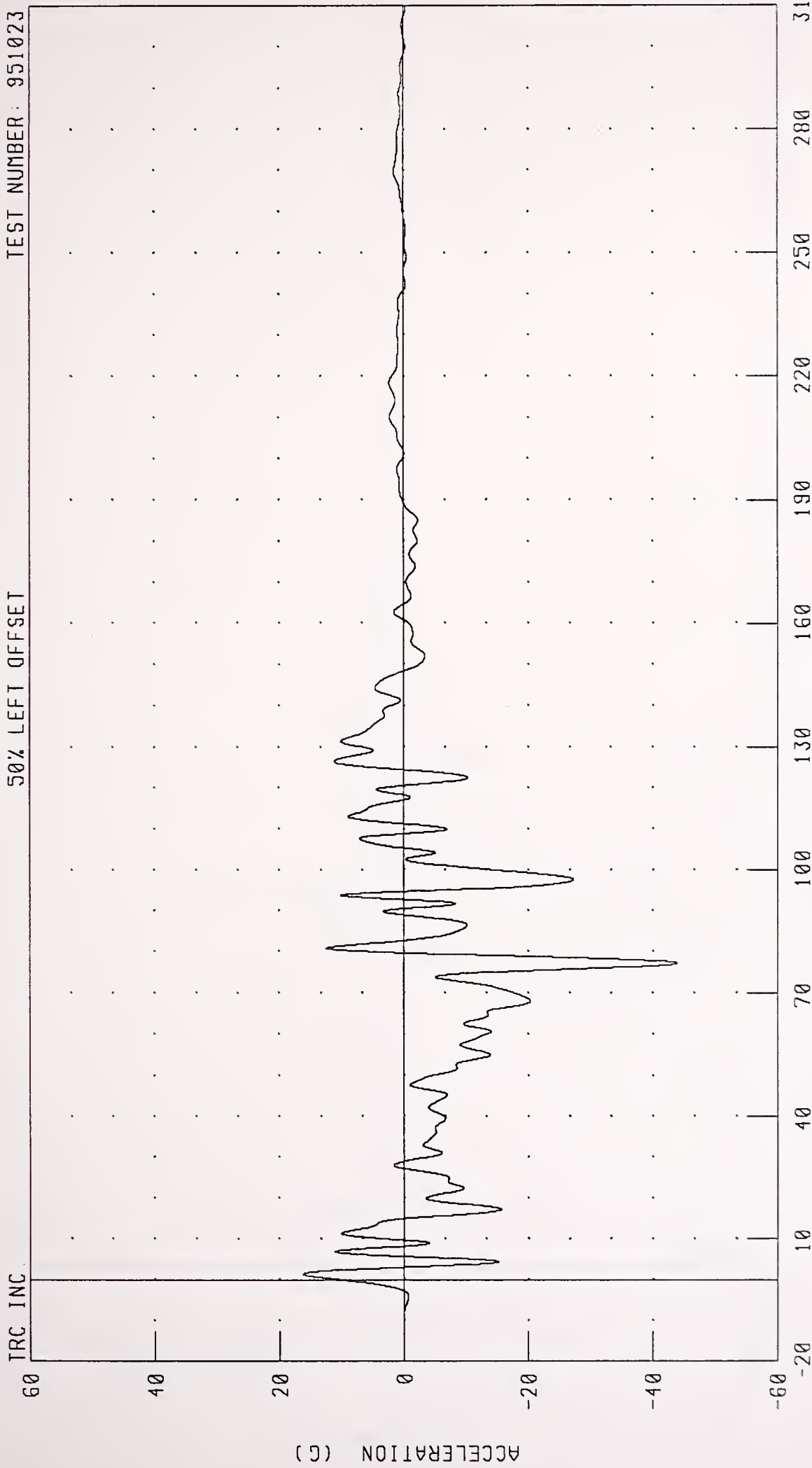
PEAK DATA: 6 82 G @ 127 20 MS, -20 02 G @ 93 92 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT FRONT SILL Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



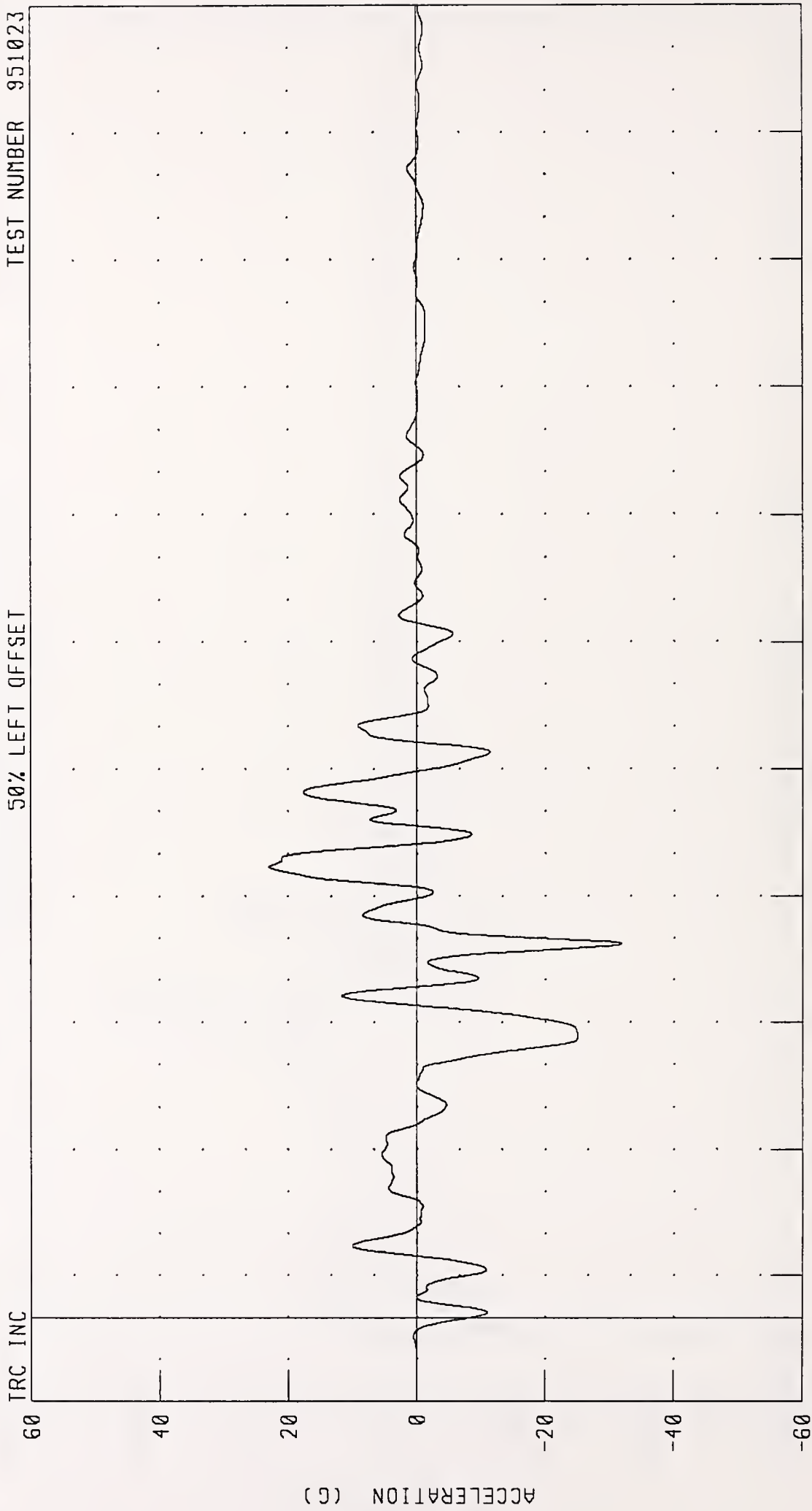
CHANNEL LFSYG2 FILTER CH CLASS 60

PEAK DATA 16 27 G @ 1.36 MS, -43 88 G @ 77 28 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT FRONT SILL Z-AXIS ACCELERATION

TEST NUMBER 951023

50% LEFT OFFSET



CHANNEL: LFSZG2 FILTER: CH. CLASS 60

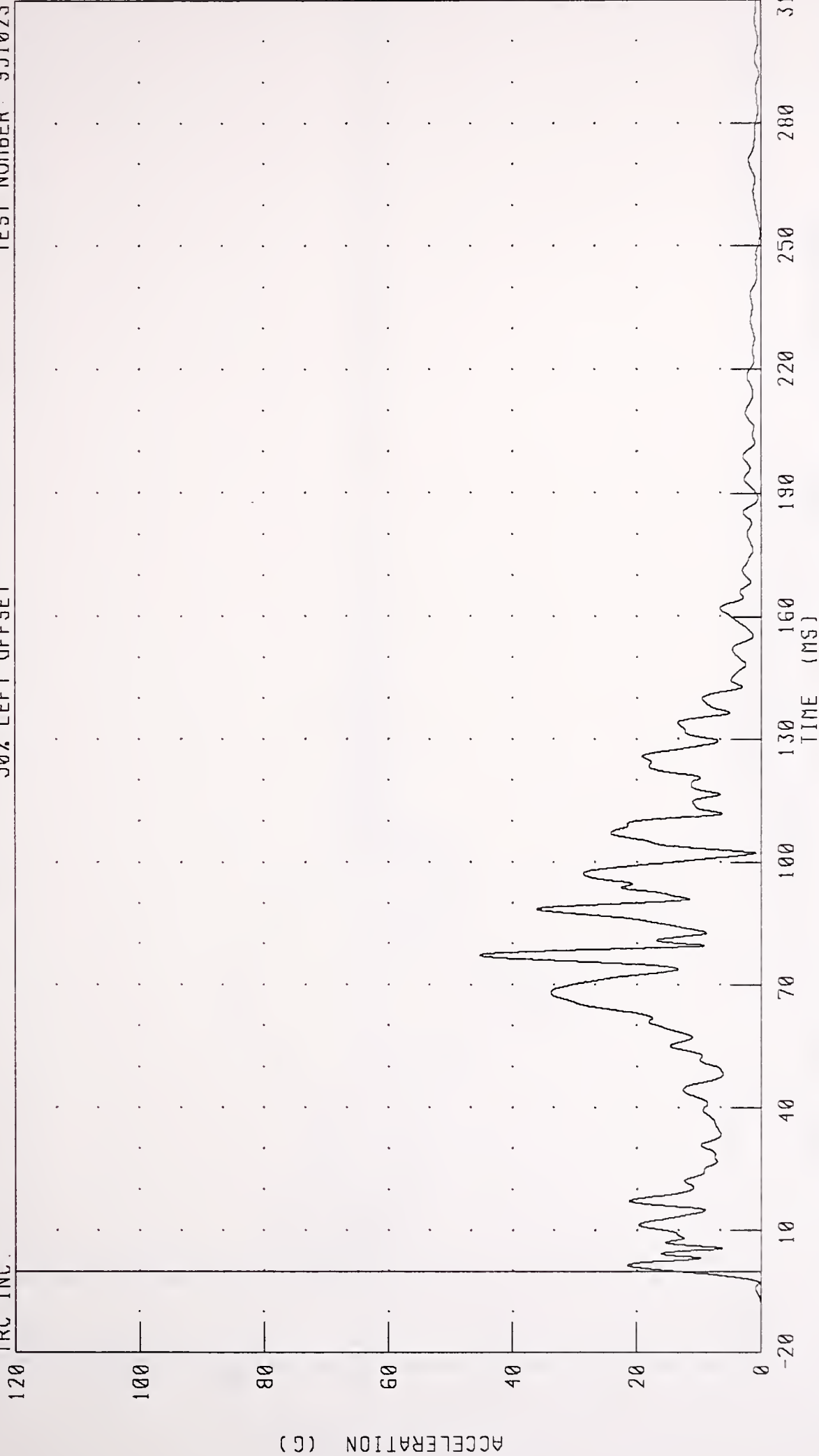
PEAK DATA: 22 97 G @ 106 96 MS; -31.86 G @ 88 64 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT FRONT SILL RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



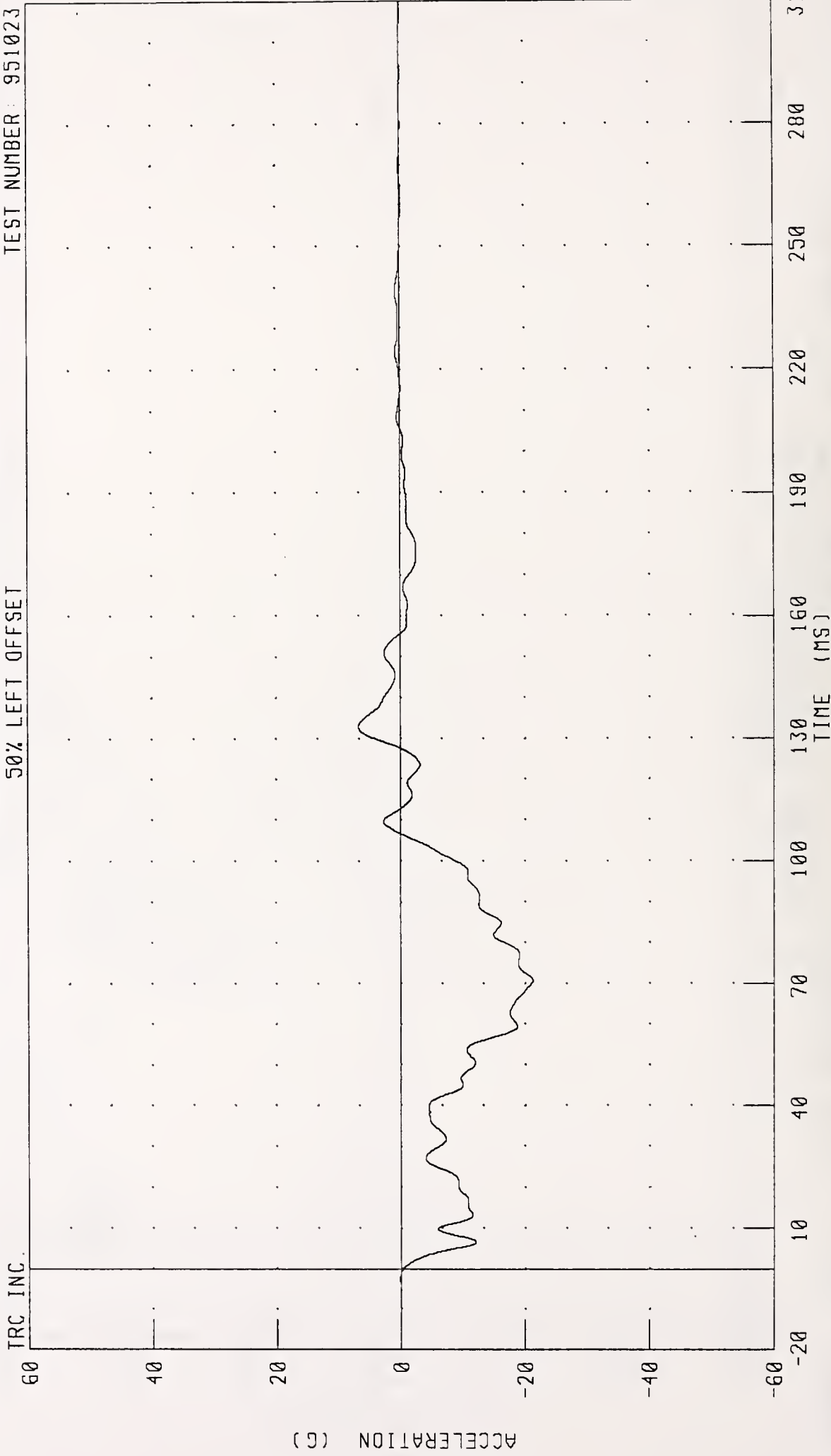
CHANNEL LFSRC2 FILTER CH CLASS 60

PEAK DATA 45 27 G @ 77 20 MS, 0 02 G @ -16 48 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT FRONT SILL X-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL: RFSXG2 FILTER: CH CLASS 60

PEAK DATA 6.75 G @ 132.88 MS, -21.30 G @ 70.72 MS

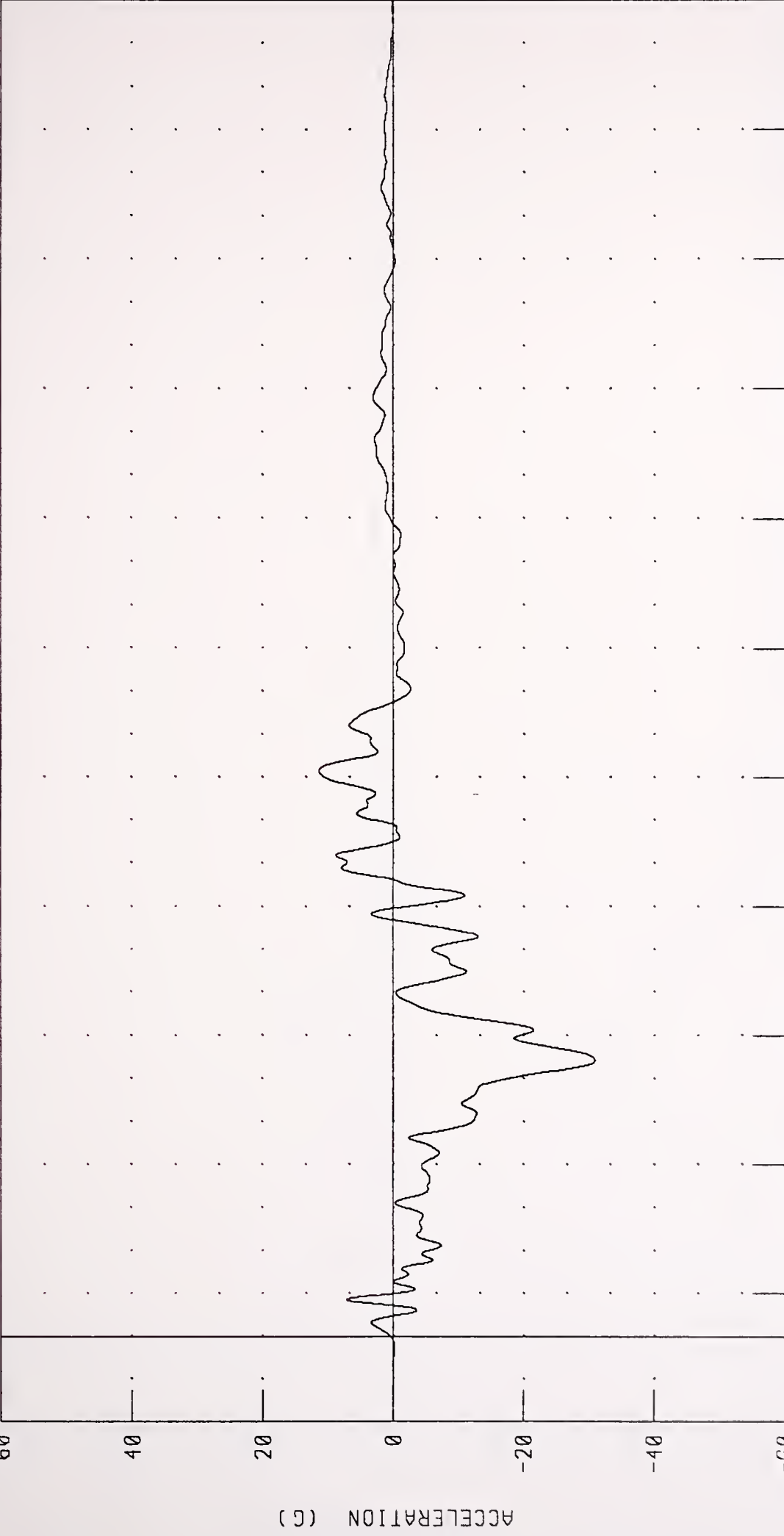


HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT FRONT SILL Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



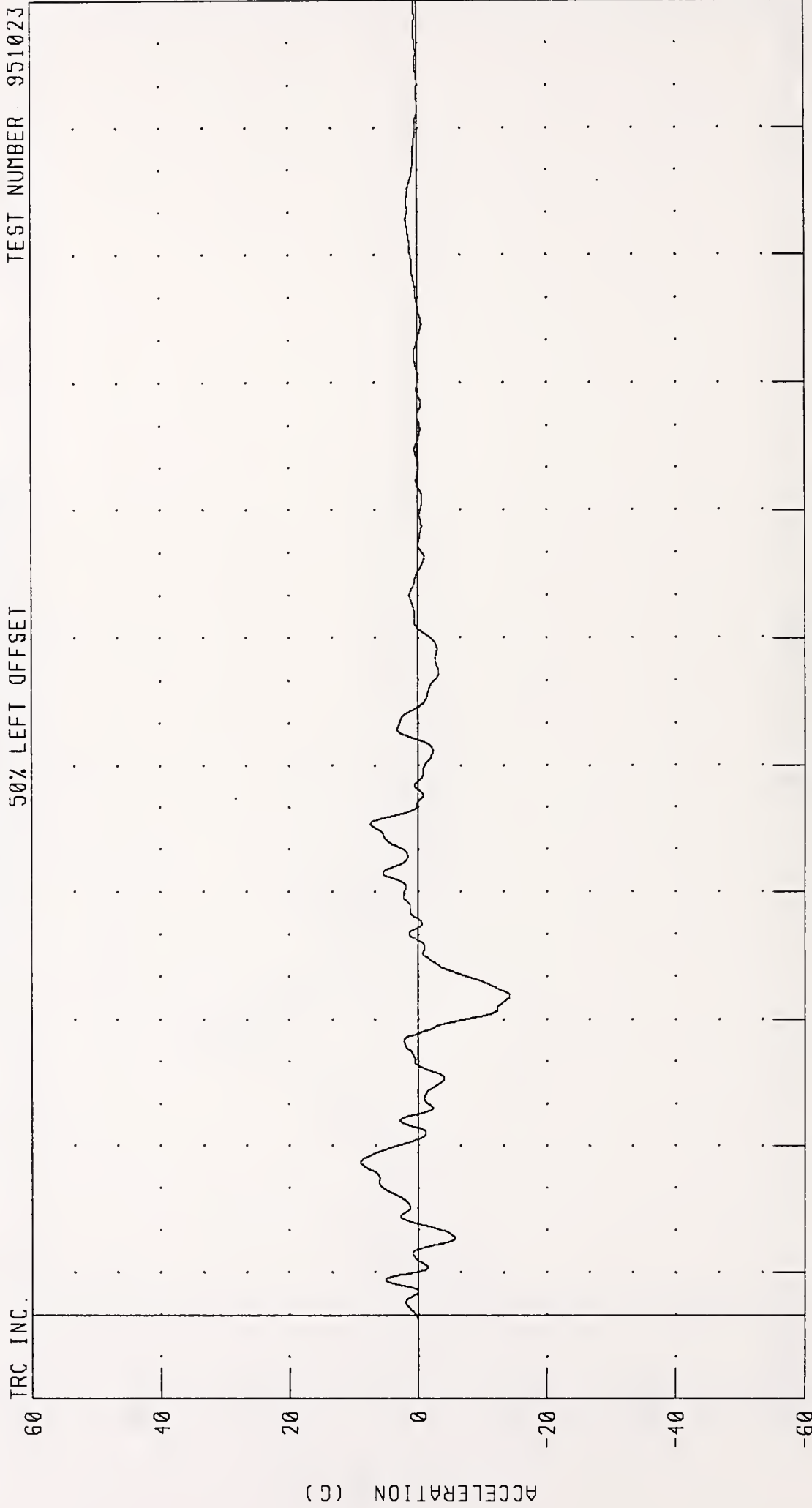
60  
40  
20  
0  
-20  
-40  
-60  
-20  
10  
40  
70  
100  
130  
160  
190  
220  
250  
280  
310  
TIME (MS)

CHANNEL RFSYG2 FILTER CH CLASS 60 PEAK DATA 11 40 G @ 131 52 MS, -30 91 G @ 64 16 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT FRONT SILL Z-AXIS ACCELERATION

TRC INC. TEST NUMBER 951023

50% LEFT OFFSET



CHANNEL: RFSZG2 FILTER: CH. CLASS 60

PEAK DATA: 9 01 G @ 36 16 MS; -14 27 G @ 75 60 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT FRONT SILL RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC

120

100

80

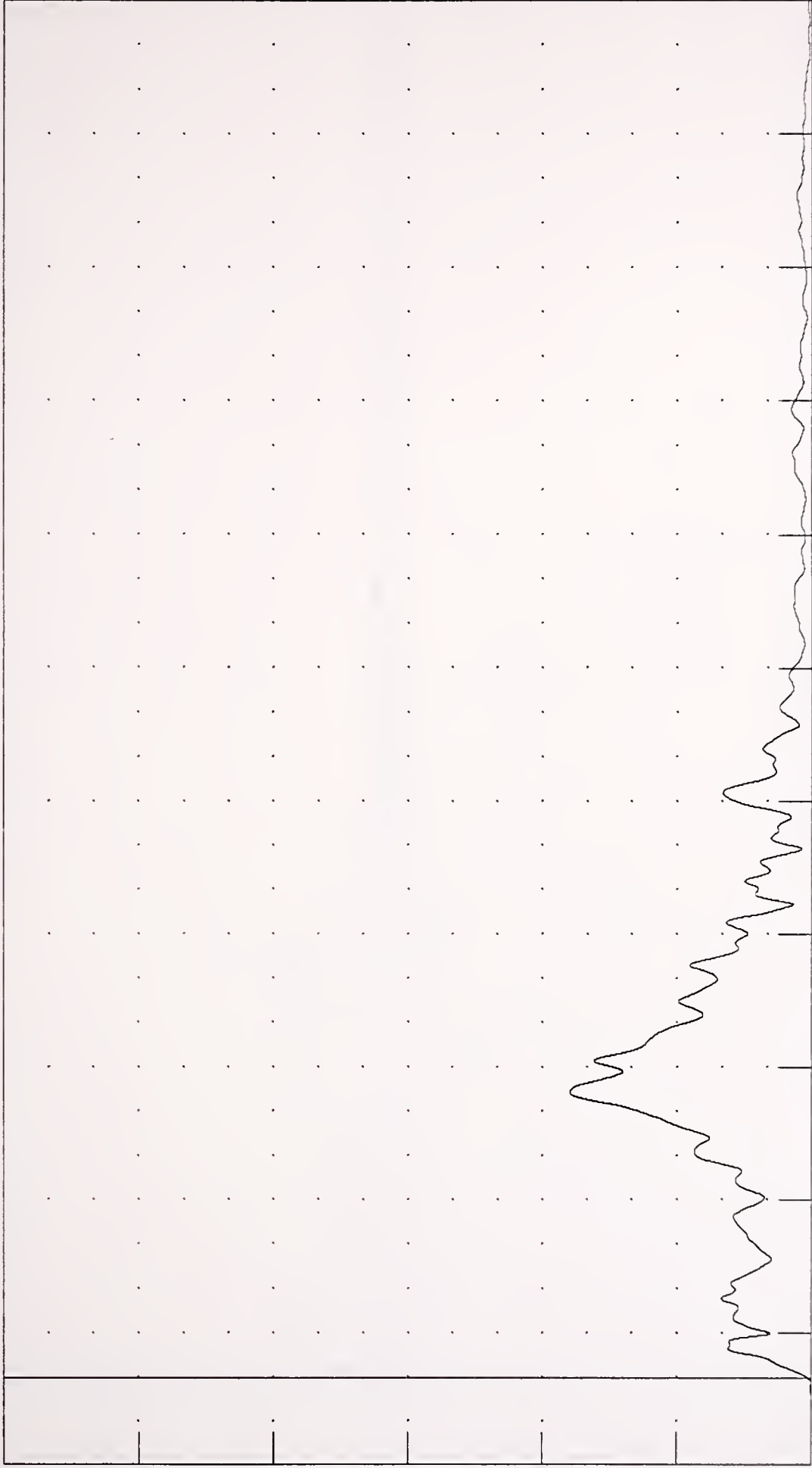
60

40

20

0

ACCELERATION (G)



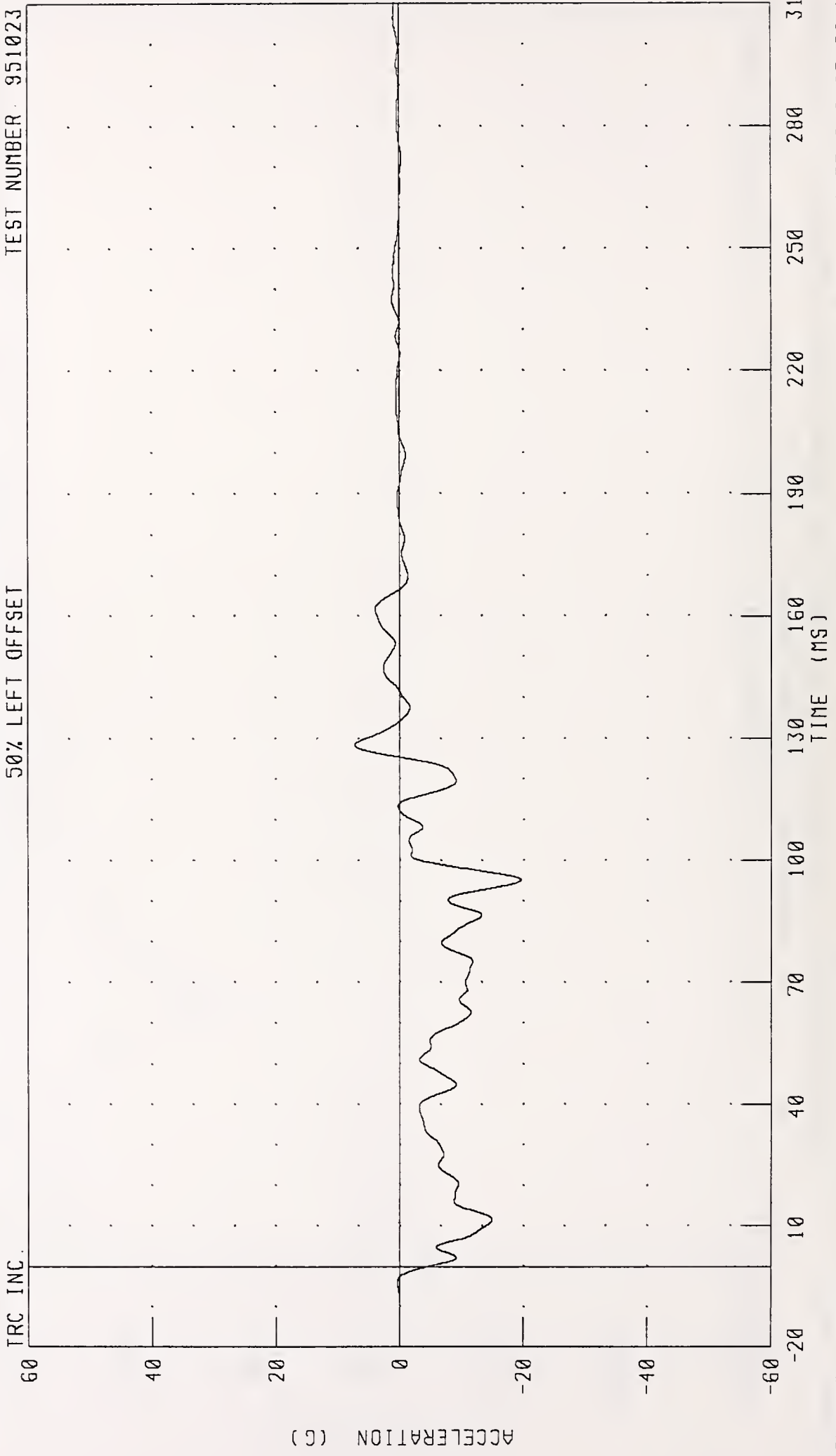
TIME (MS)

CHANNEL RFSRC2 FILTER CH CLASS 60

PEAK DATA 35 80 G @ 64 40 MS, 0 00 G @ -16 16 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT REAR SEAT X-AXIS ACCELERATION

TRC INC. 50% LEFT OFFSET TEST NUMBER 951023



CHANNEL: TLRXG2 FILTER CH CLASS 60 PEAK DATA: 7 25 G @ 128 40 MS, -19 57 G @ 95 20 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT REAR SEAT Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC

60

40

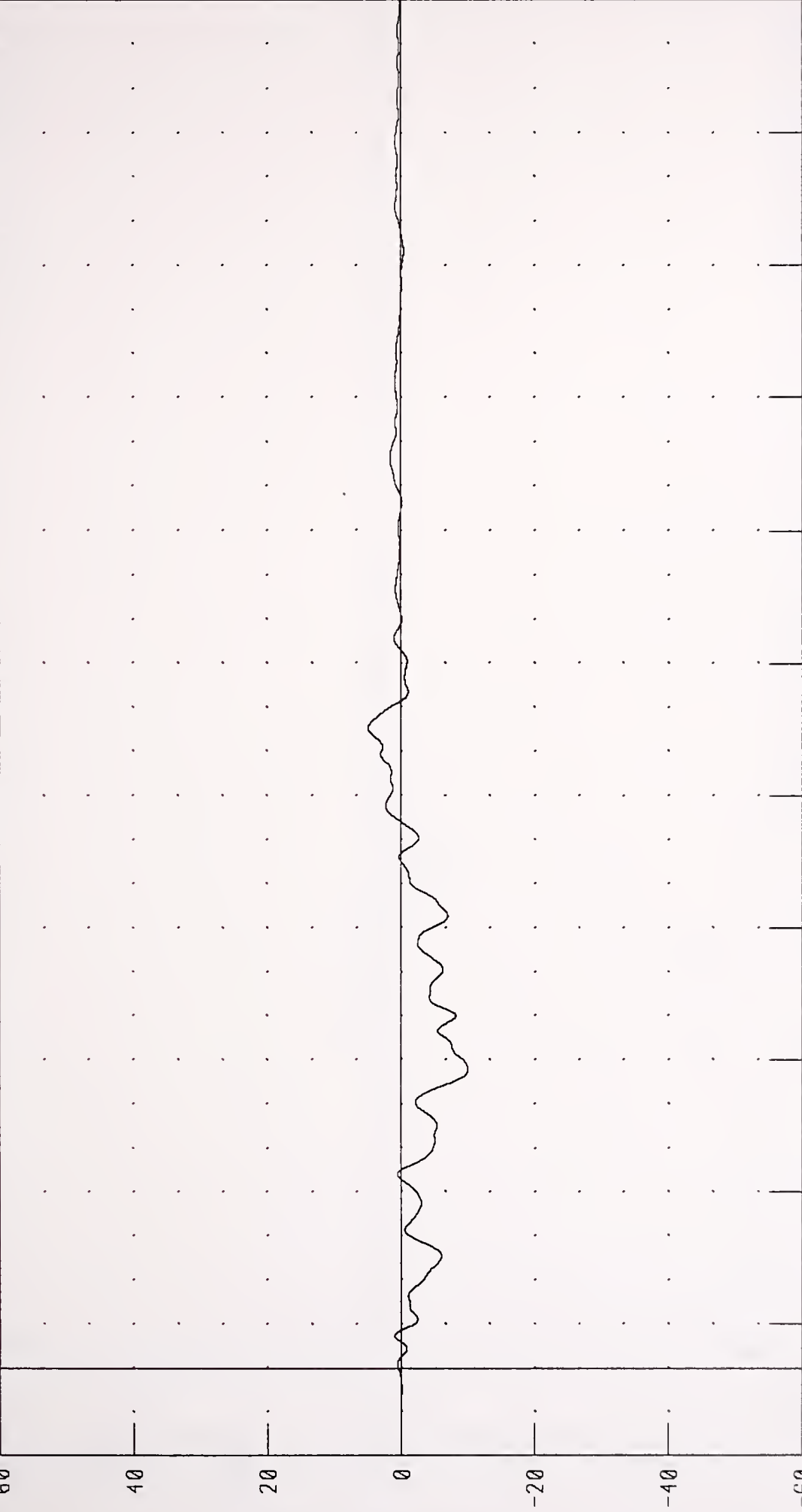
20

0

-20

-40

-60



310 280 250 220 190 160 130 100 70 40 10

TIME (MS)

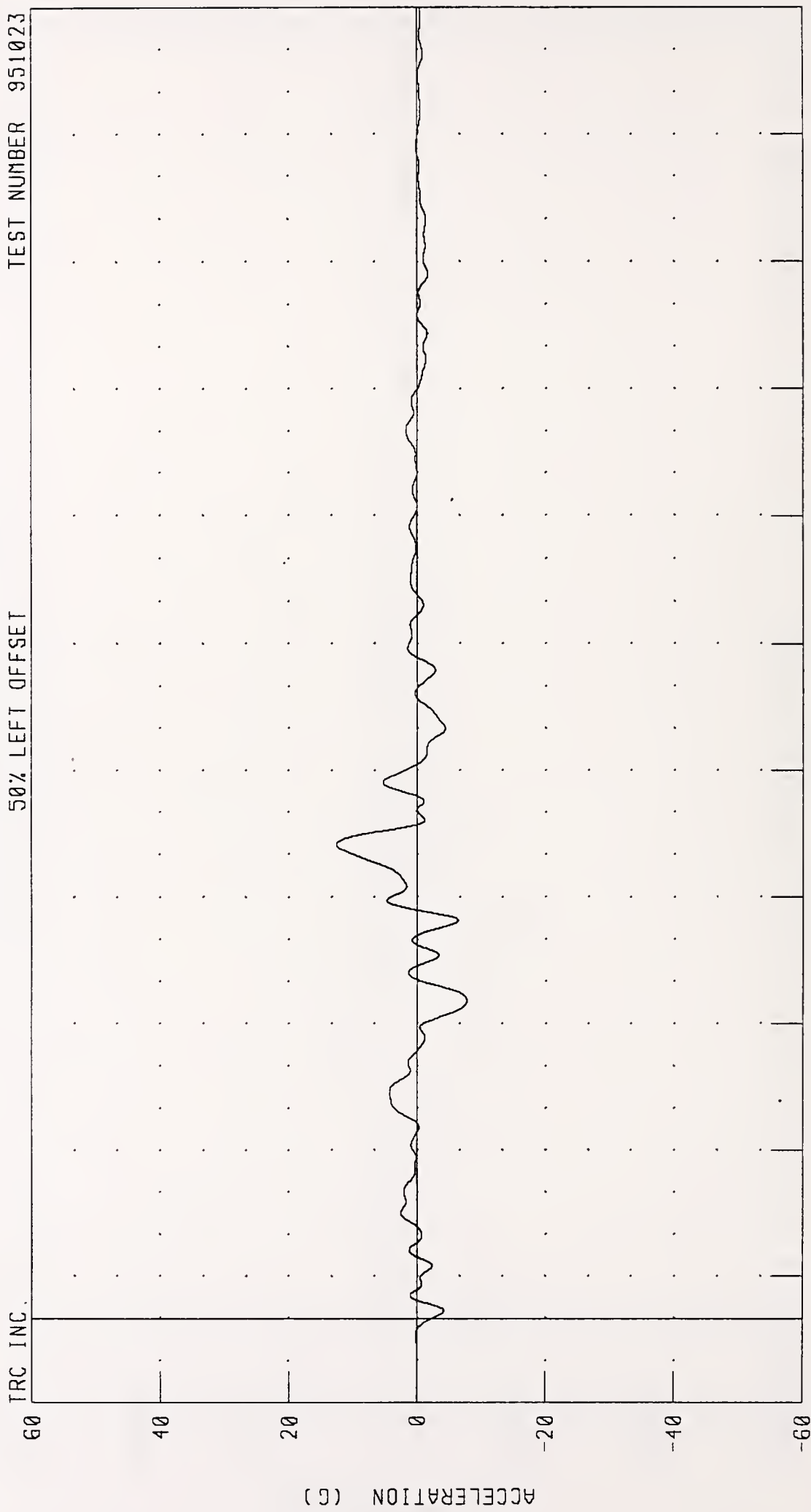
CHANNEL TLRYG2 FILTER CH CLASS 60

PEAK DATA 4 97 G @ 145 28 MS, -10 03 G @ 67 84 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT REAR SEAT Z-AXIS ACCELERATION

TRC INC. TEST NUMBER 951023

50% LEFT OFFSET



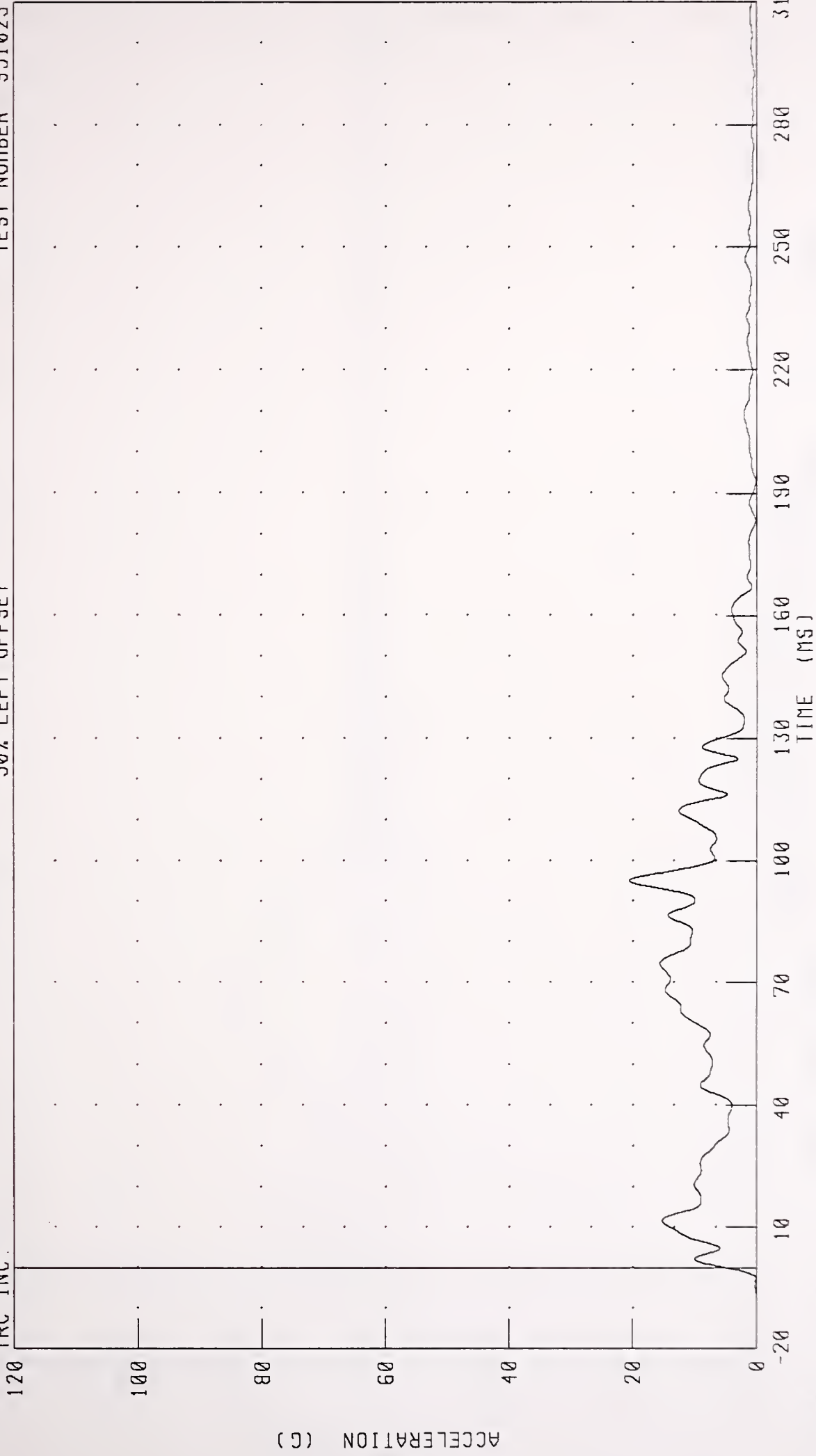
CHANNEL: TLRZG2 FILTER: CH CLASS 60 PEAK DATA 12 60 G @ 112 32 MS, -7.74 G @ 75.44 MS  
TIME (MS)

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT REAR SEAT RESULTANT ACCELERATION

TEST NUMBER 951023

50% LEFT OFFSET

TRC INC.



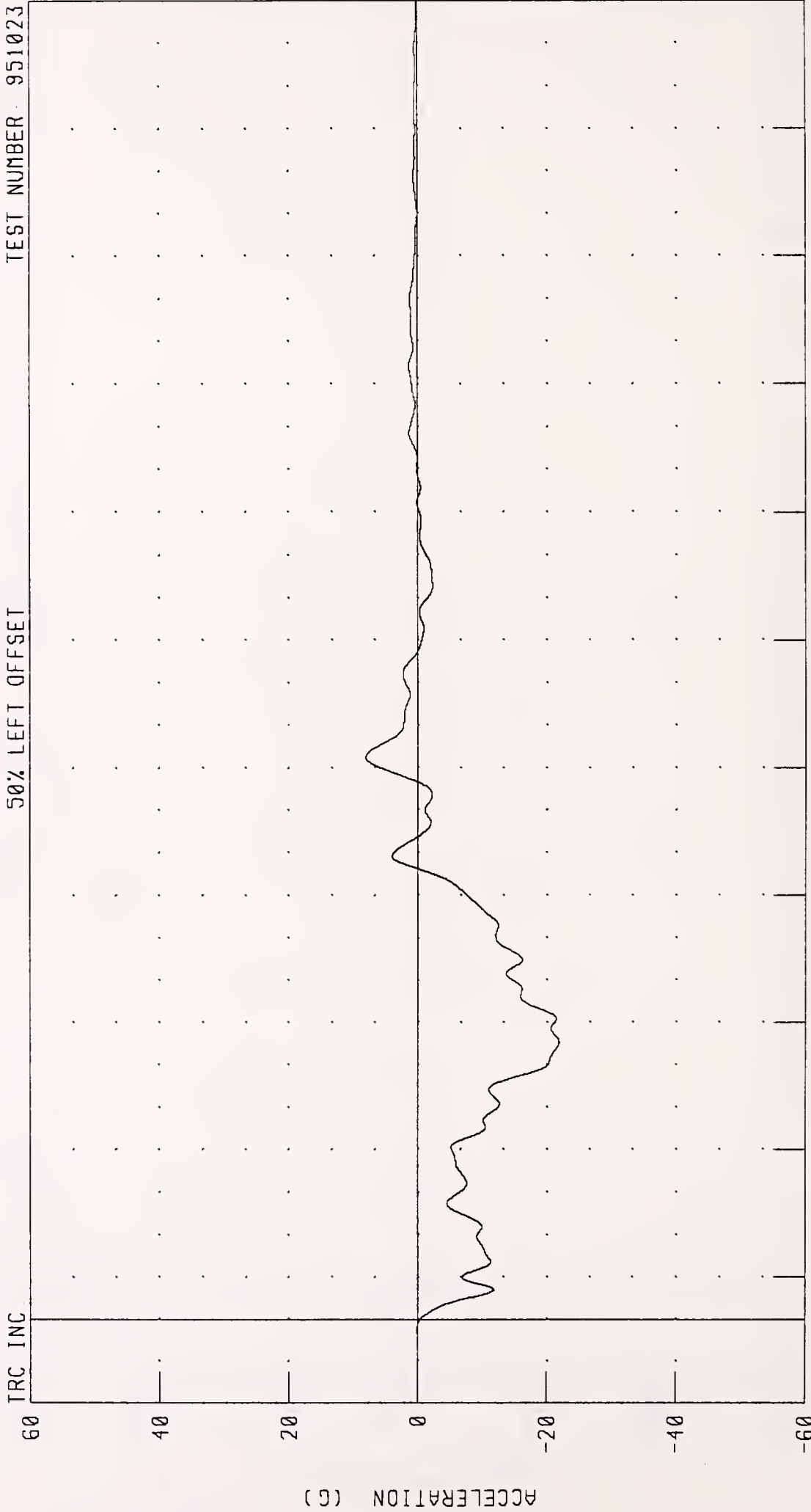
CHANNEL TLRRG2 FILTER CH CLASS 60

PEAK DATA 20 61 G @ 95 04 MS, 0 01 G @ -19 52 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT REAR SEAT X-AXIS ACCELERATION

TEST NUMBER 951023

50% LEFT OFFSET



CHANNEL: TRRXG2 FILTER: CH. CLASS 60

PEAK DATA: 8.08 G @ 132.56 MS; -21.93 G @ 65.20 MS

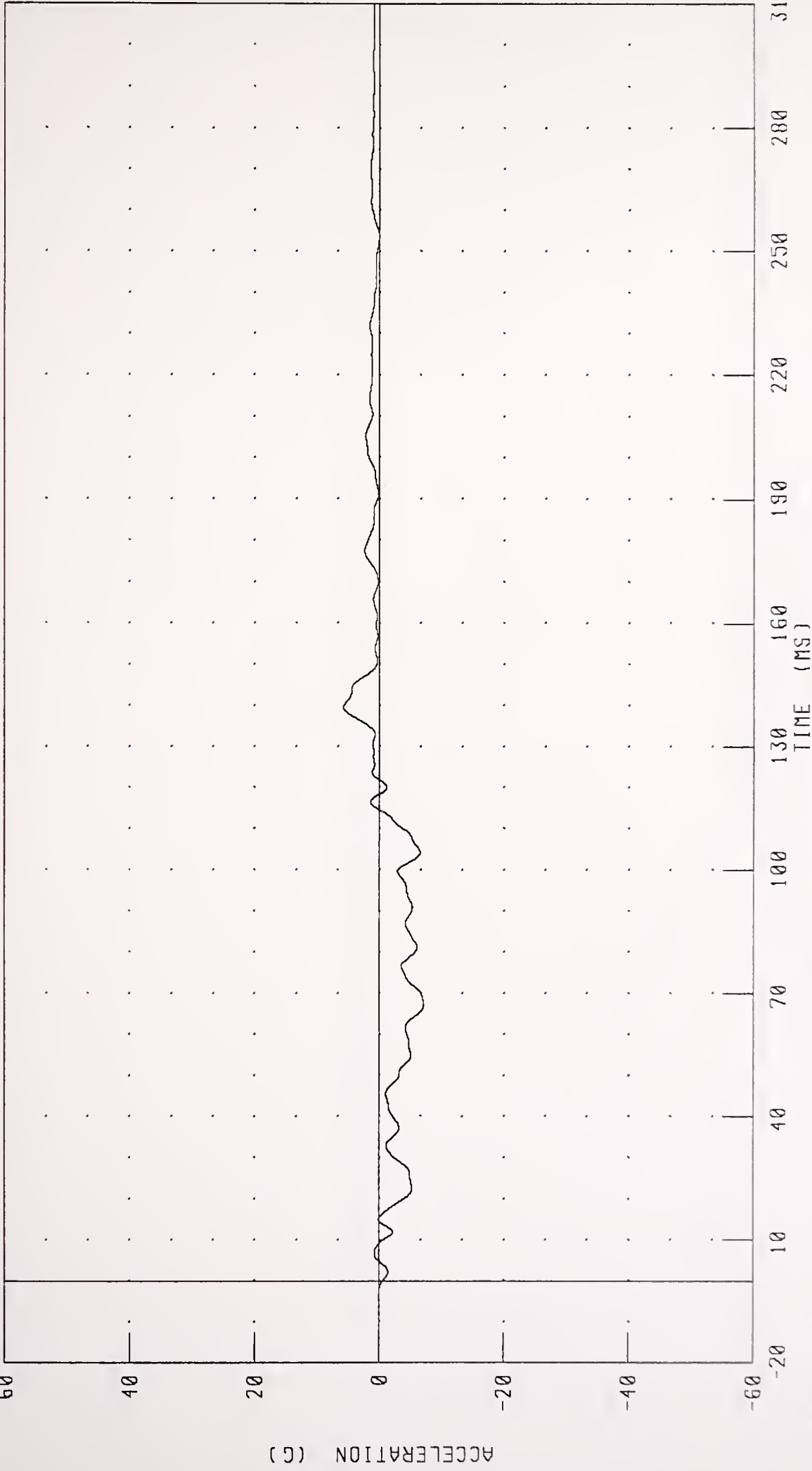


HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT REAR SEAT Y-AXIS ACCELERATION

TRC INC.

50% LEFT OFFSET

TEST NUMBER: 951023



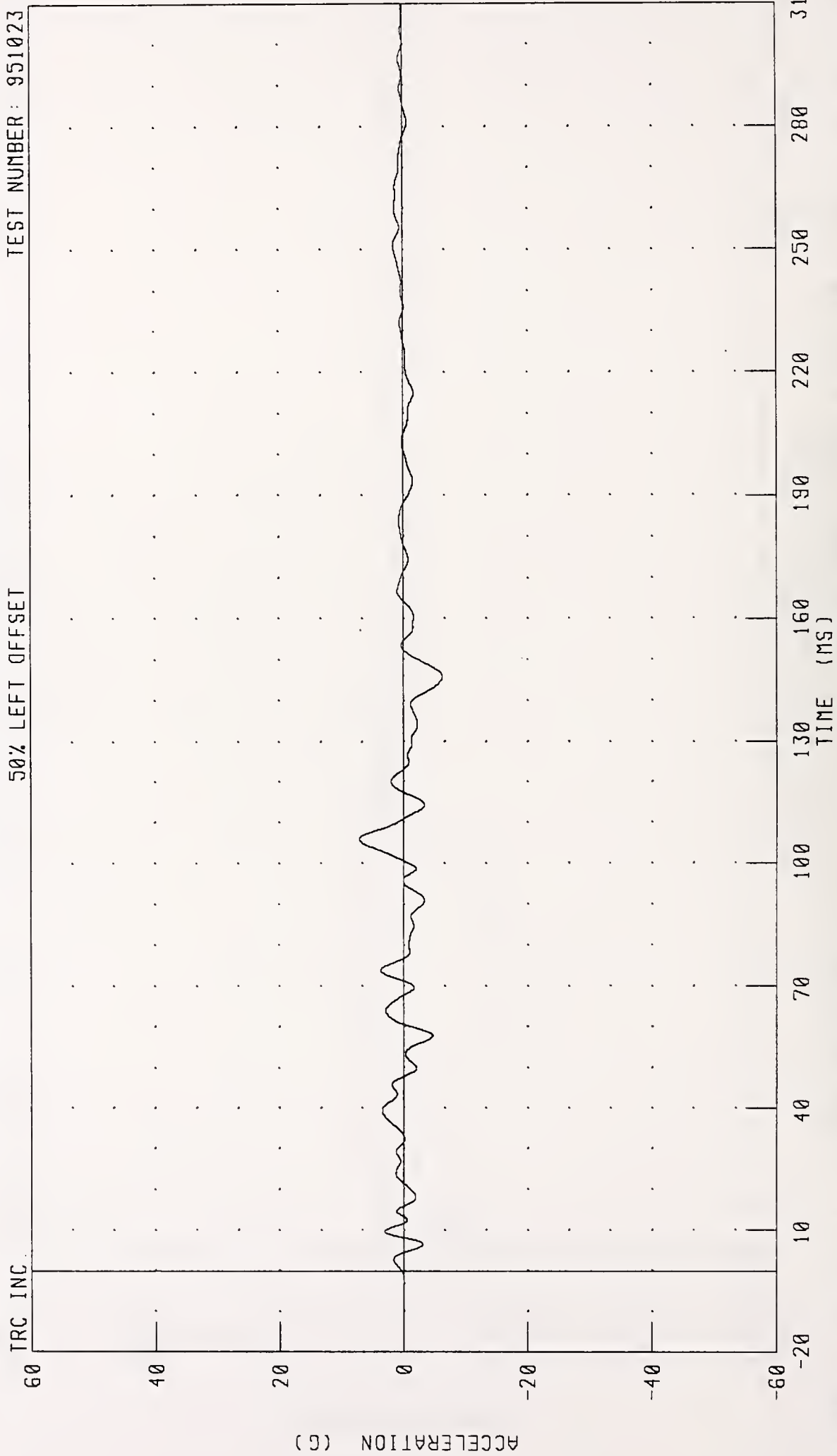
CHANNEL TTRYG2 FILTER CH CLASS 60

PEAK DATA 5 75 G @ 139 60 MS, -7 10 G @ 67 20 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT REAR SEAT Z-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL TRRZG2 FILTER: CH CLASS 60

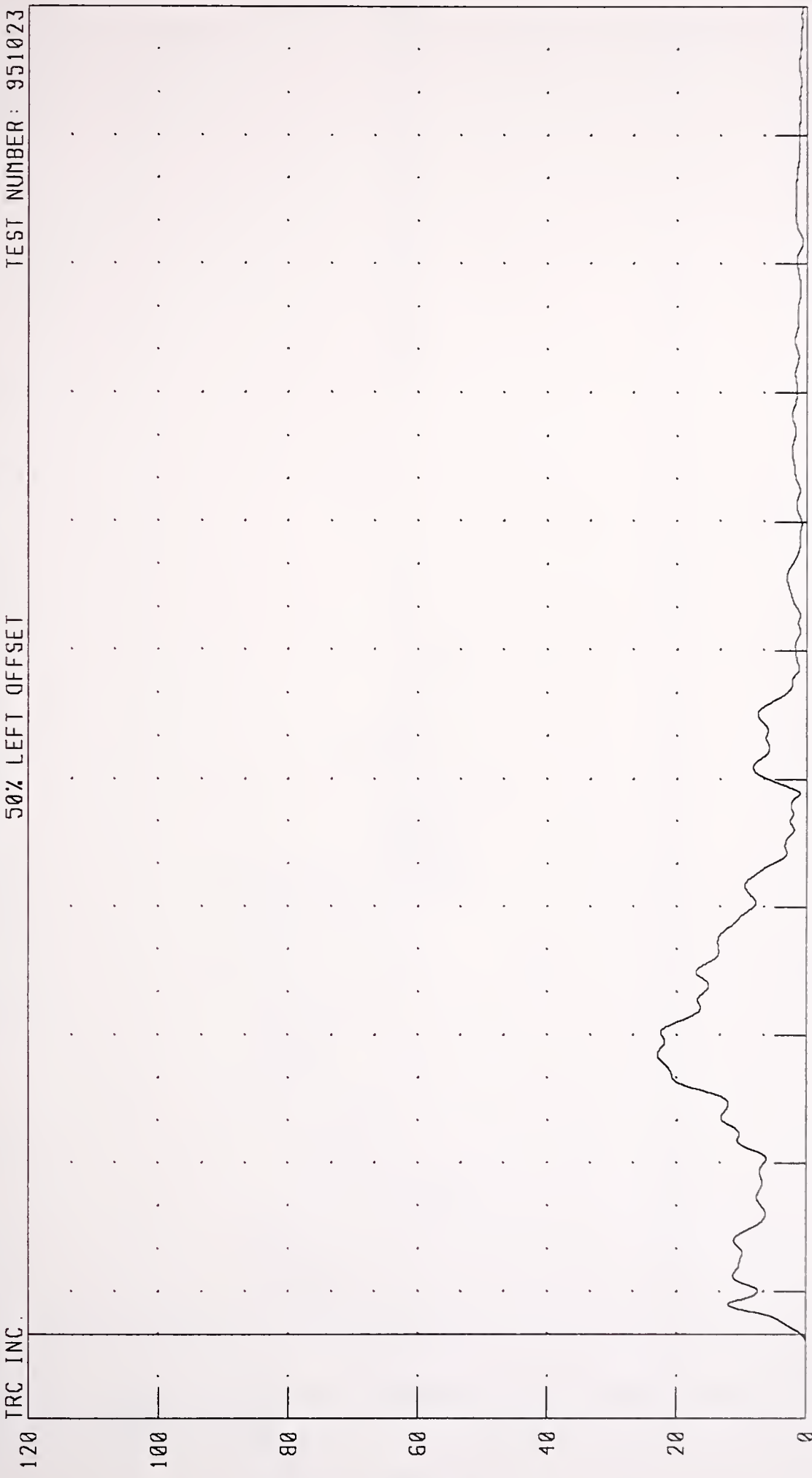
PEAK DATA 7 16 G @ 105 84 MS; -6 29 G @ 145 84 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT REAR SEAT RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



CHANNEL TRRRG2 FILTER CH CLASS 60

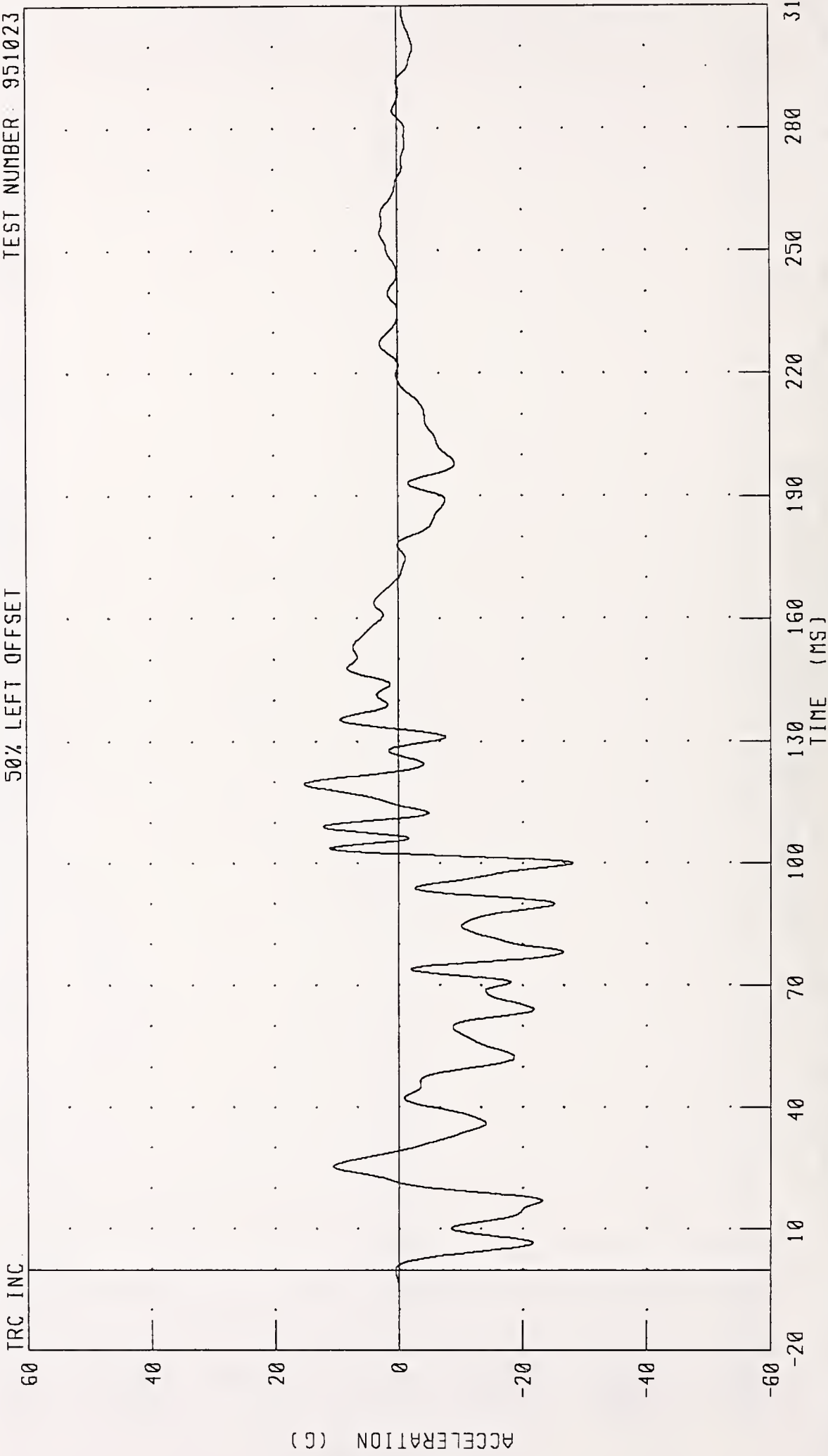
PEAK DATA: 22 99 G @ 65 44 MS, 0 00 G @ -17 92 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
INSTRUMENT PANEL CENTER X-AXIS ACCELERATION

TEST NUMBER 951023

50% LEFT OFFSET

TRC INC



CHANNEL: OPCXG2 FILTER: CH CLASS 60

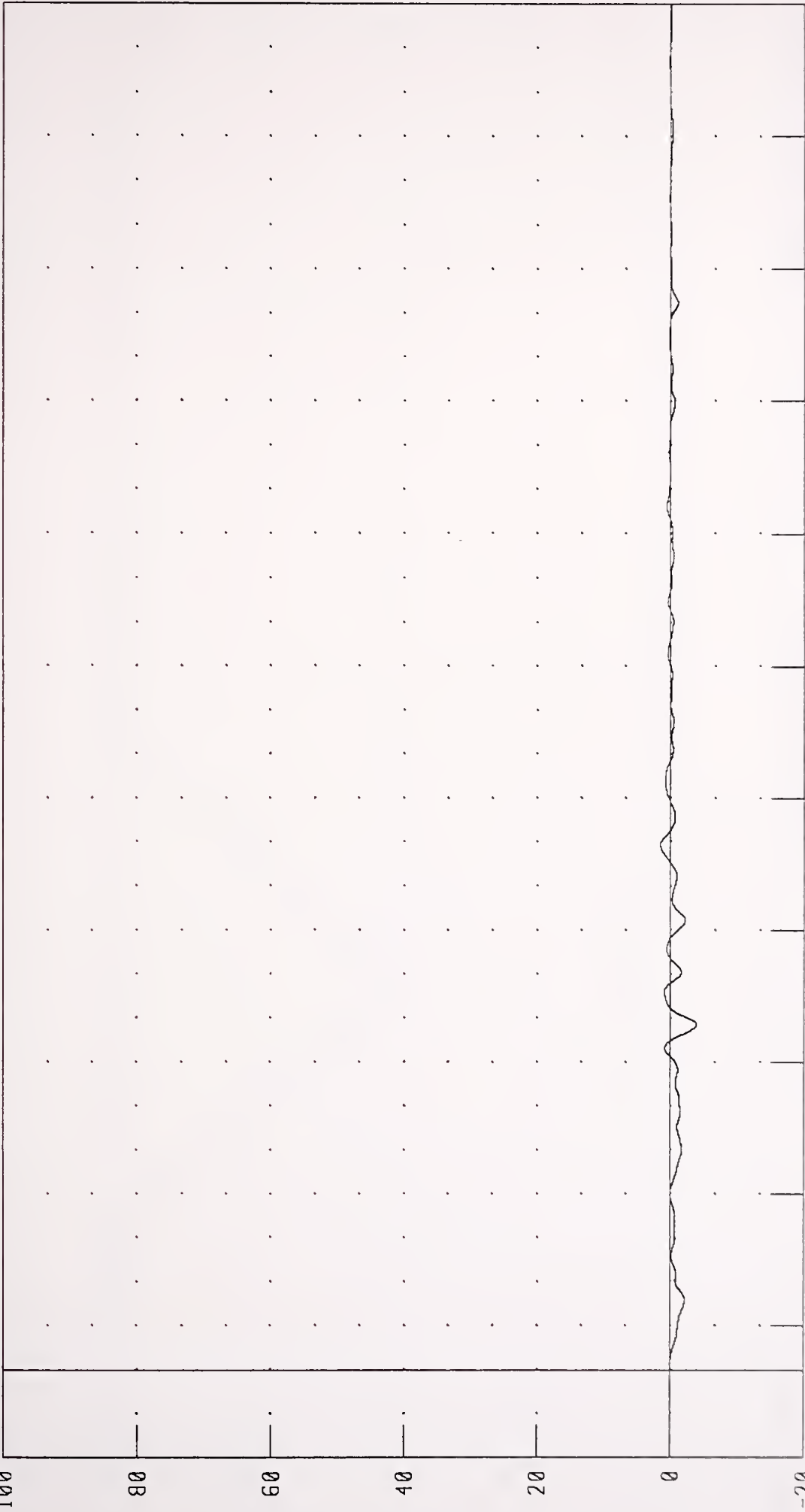
PEAK DATA 15 19 G @ 119 60 MS; -28 11 G @ 100 00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 STEERING WHEEL HUB X-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



CHANNEL STHXG2 FILTER CH CLASS 60  
 PEAK DATA 15 33 G @ 119 36 MS, -39 24 G @ 78 48 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER SHOULDER BELT FORCE

TEST NUMBER 951023

50% LEFT OFFSET

TRC INC.

100

80

60

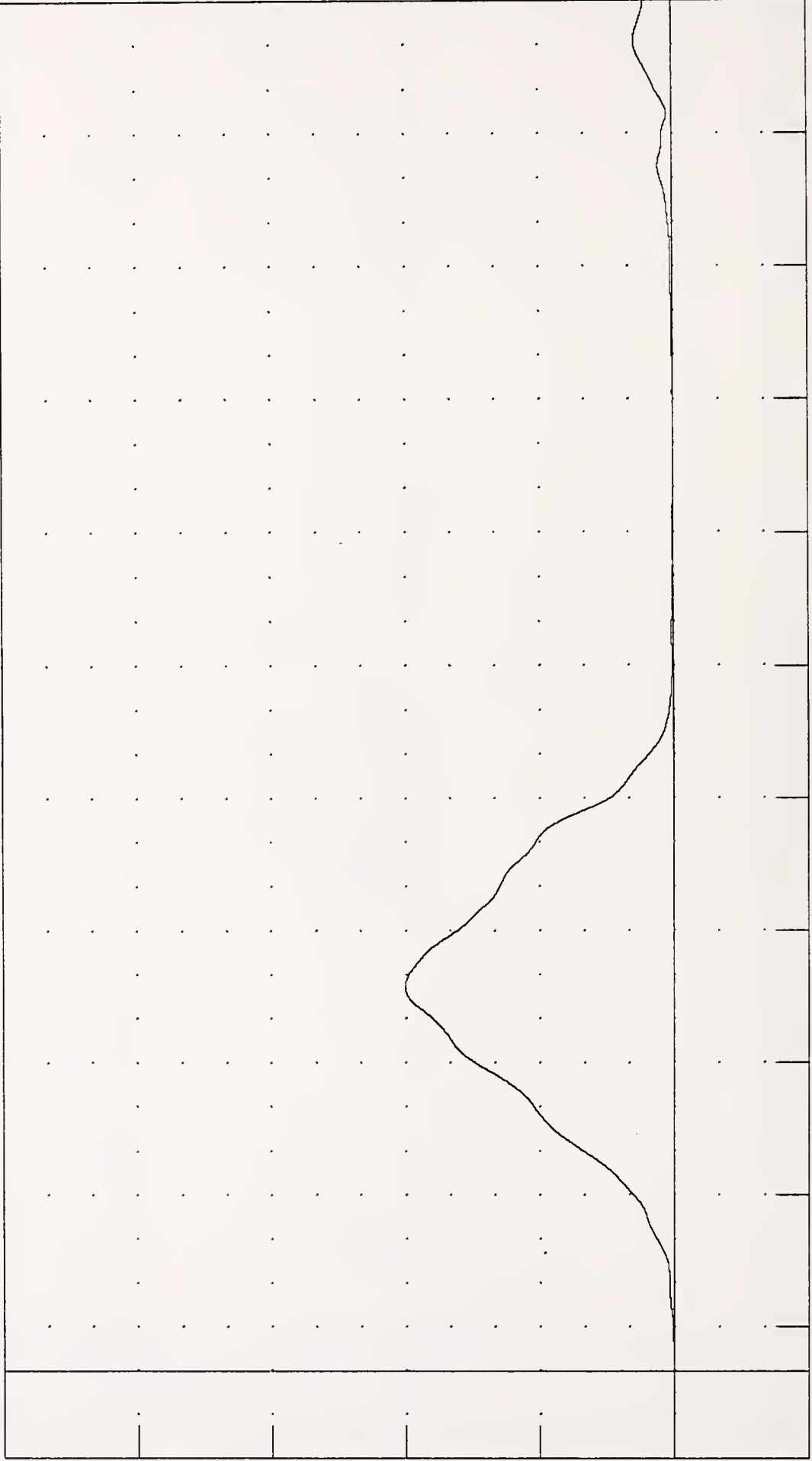
40

20

0

-20

FORCE (N X 10<sup>2</sup>)



310 280 250 220 190 160 130 TIME (MS)

CHANNEL: SHBFI FILTER: CH CLASS 60

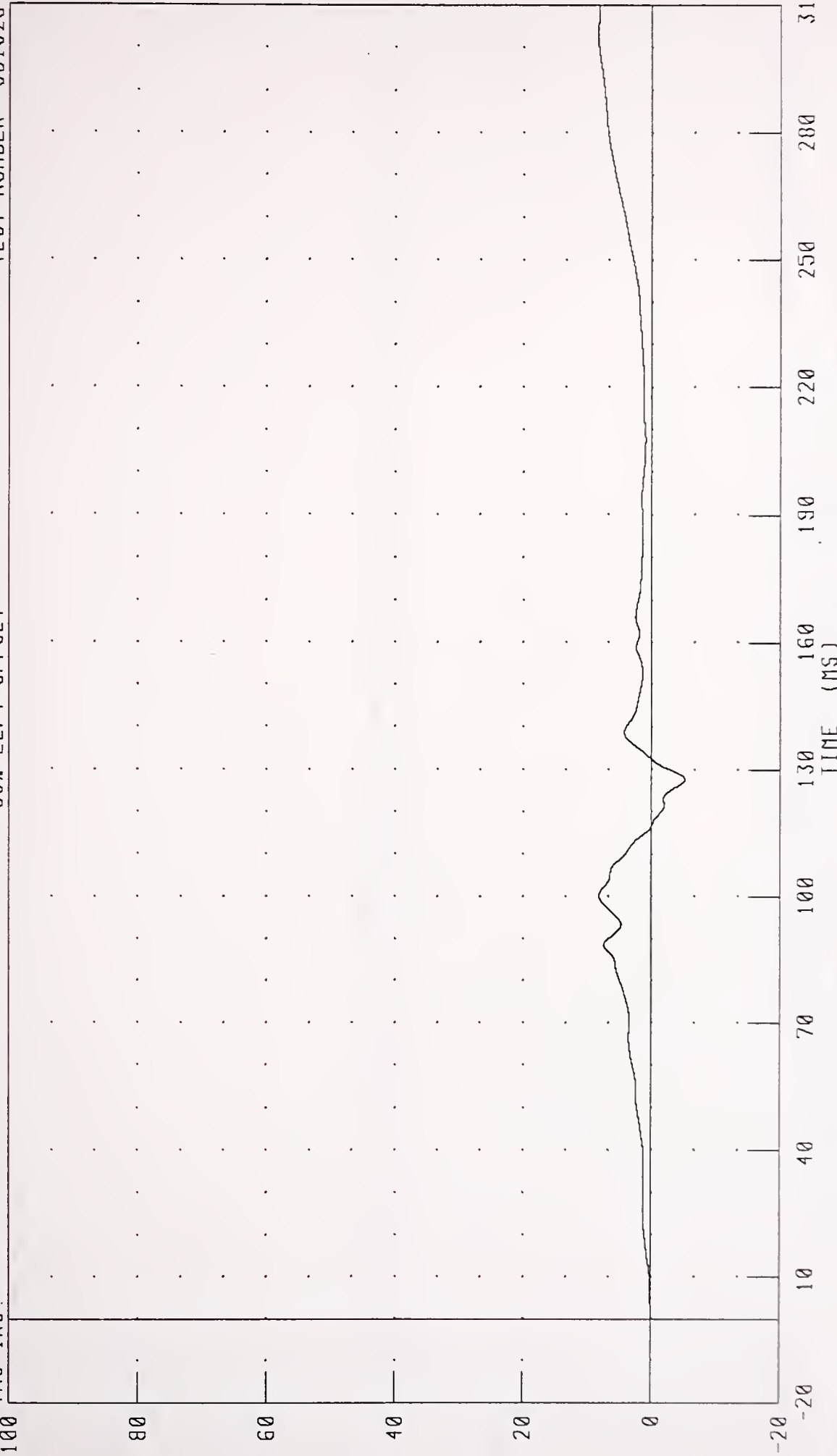
PEAK DATA 4005 52 N @ 87 20 MS, -1 85 N @ 0 16 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
DRIVER LAP BELT OUTBOARD FORCE

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



FORCE (N X 10<sup>2</sup>)

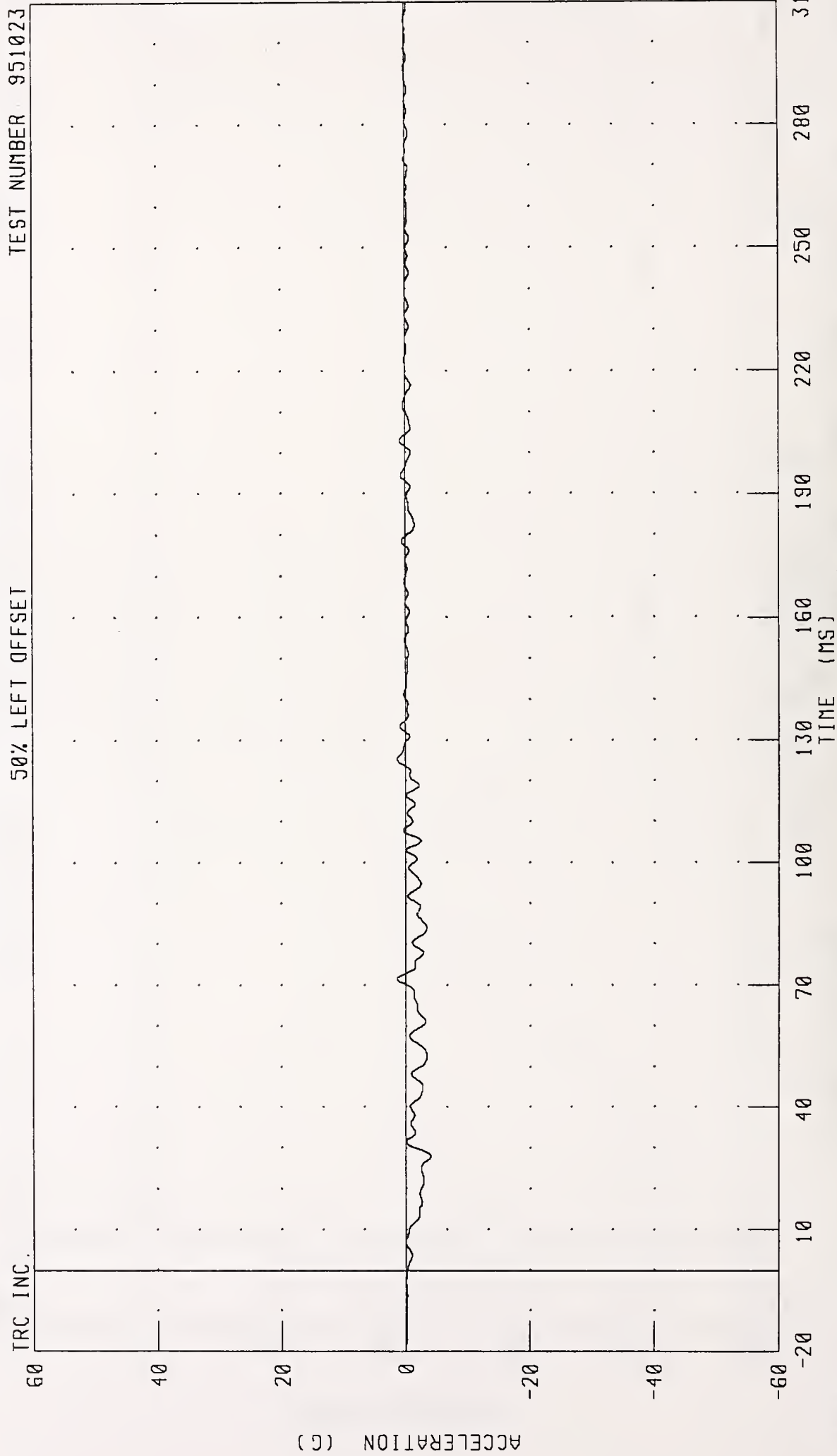
TIME (MS)

CHANNEL LBOFI FILTER CH CLASS 60 PEAK DATA 833 61 N @ 302 72 MS, -513 65 N @ 127 68 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 TRUCK CENTER OF GRAVITY X-AXIS ACCELERATION

TEST NUMBER 951023

50% LEFT OFFSET



CHANNEL: YCGXG1 FILTER: CH CLASS 60

PEAK DATA 1.37 G @ 71.52 MS, -4.04 G @ 28.08 MS

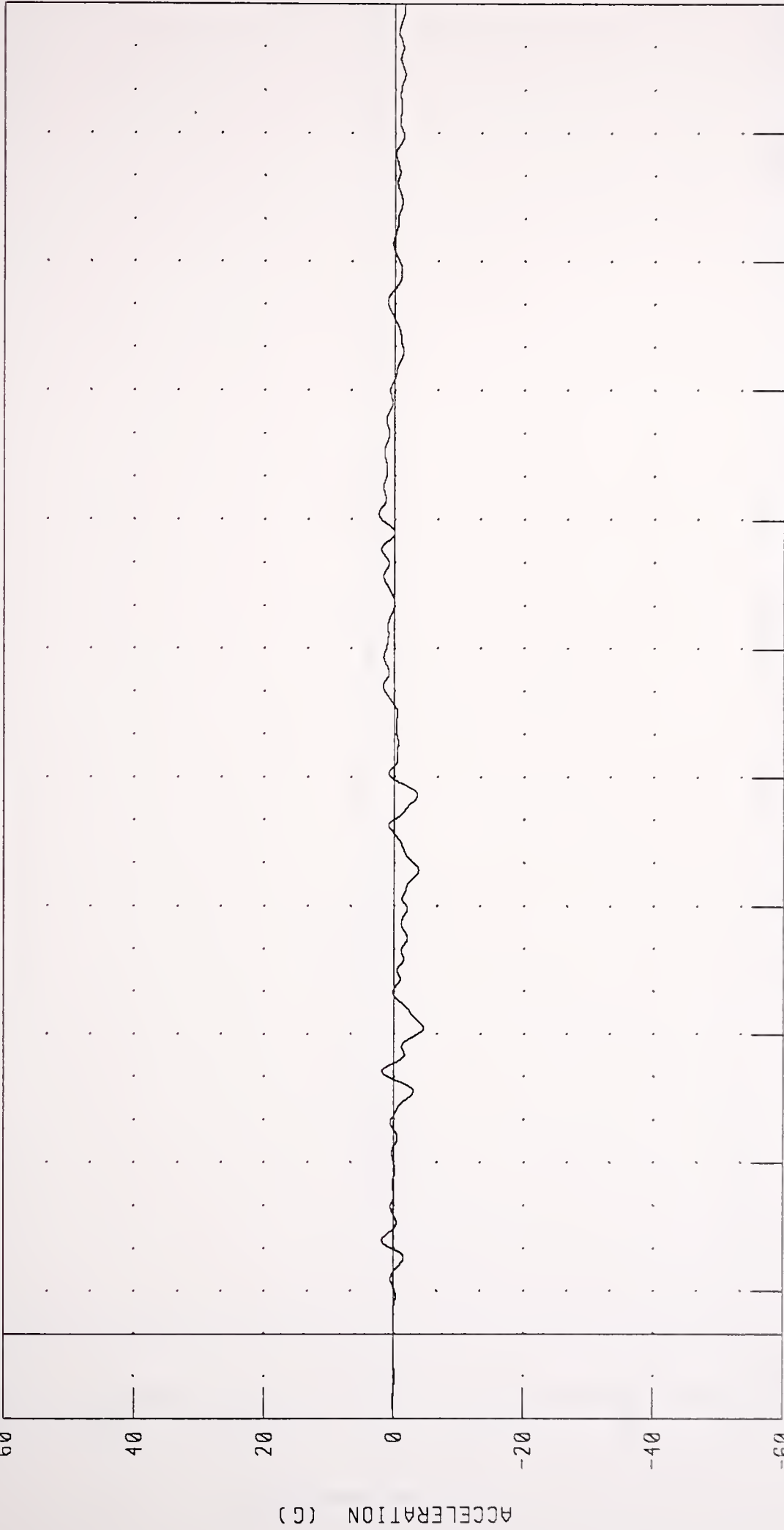


HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 TRUCK CENTER OF GRAVITY Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC

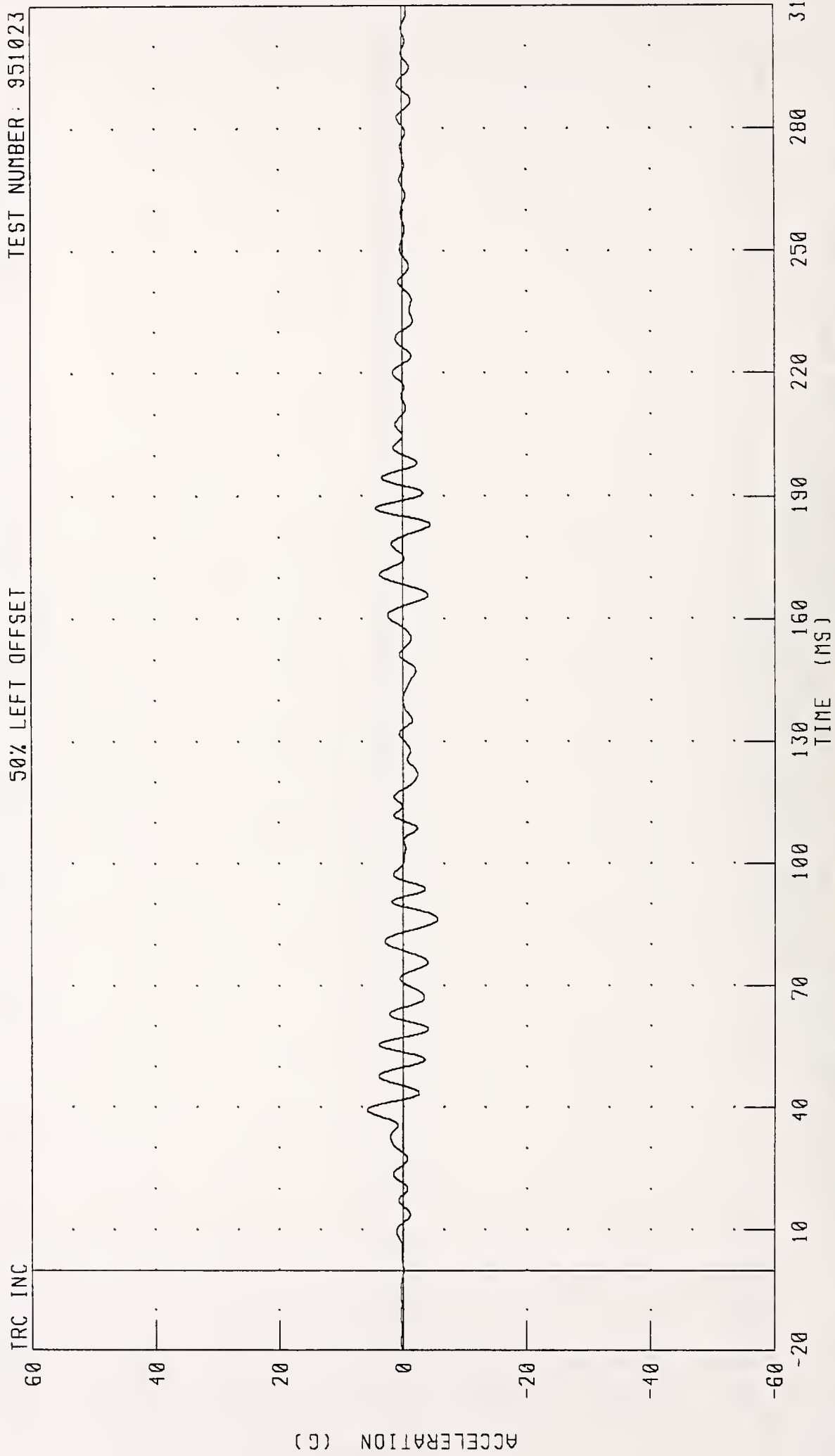


CHANNEL VCGYG1 FILTER CH CLASS 60  
 PEAK DATA 2 47 G @ 191 44 MS, -4 55 G @ 71 52 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK CENTER OF GRAVITY Z-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL: VCGZG1 FILTER: CH. CLASS 60

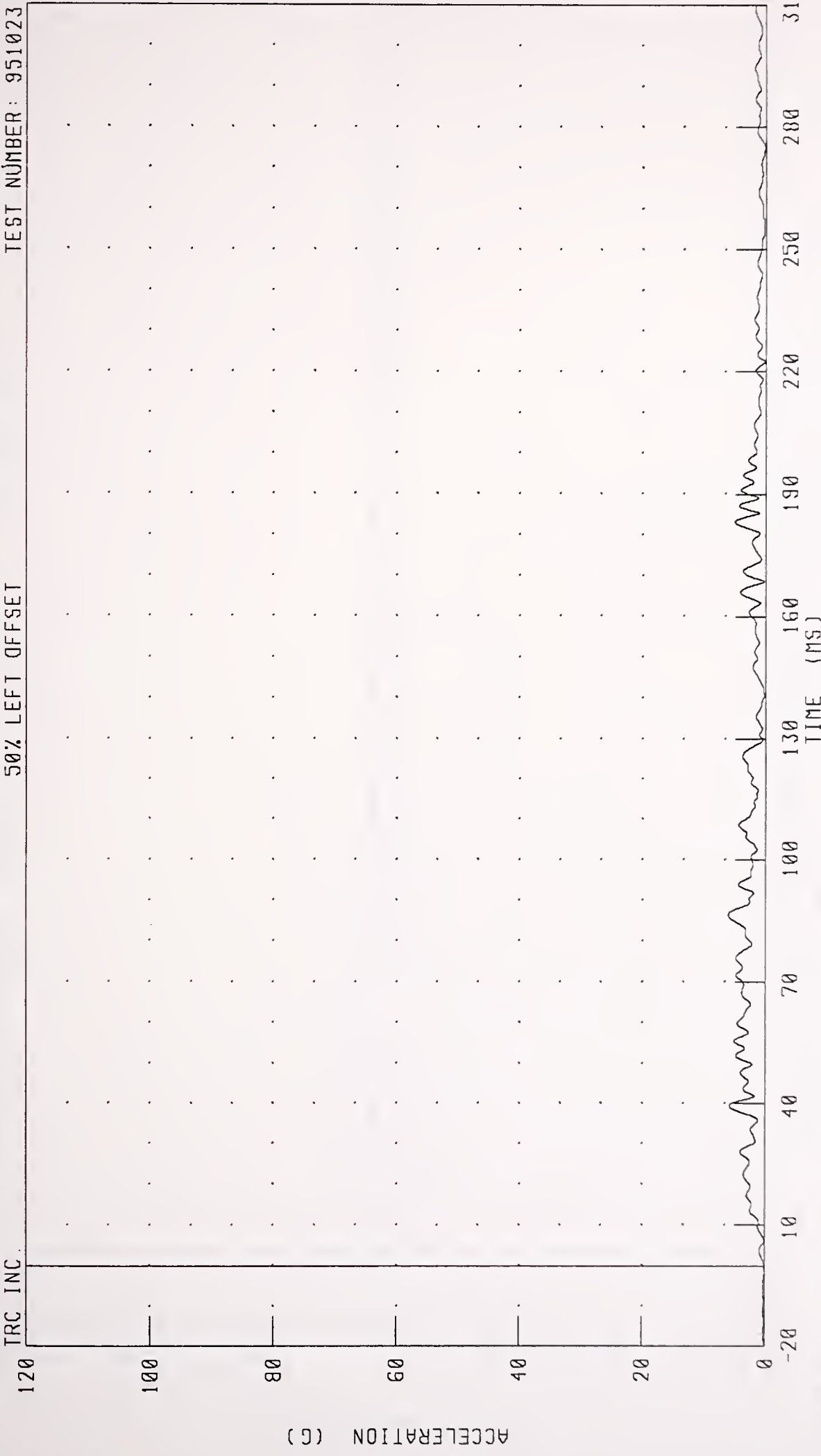
PEAK DATA: 5 78 G @ 39 44 MS, -5 59 G @ 86 48 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK CENTER OF GRAVITY RESULTANT ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



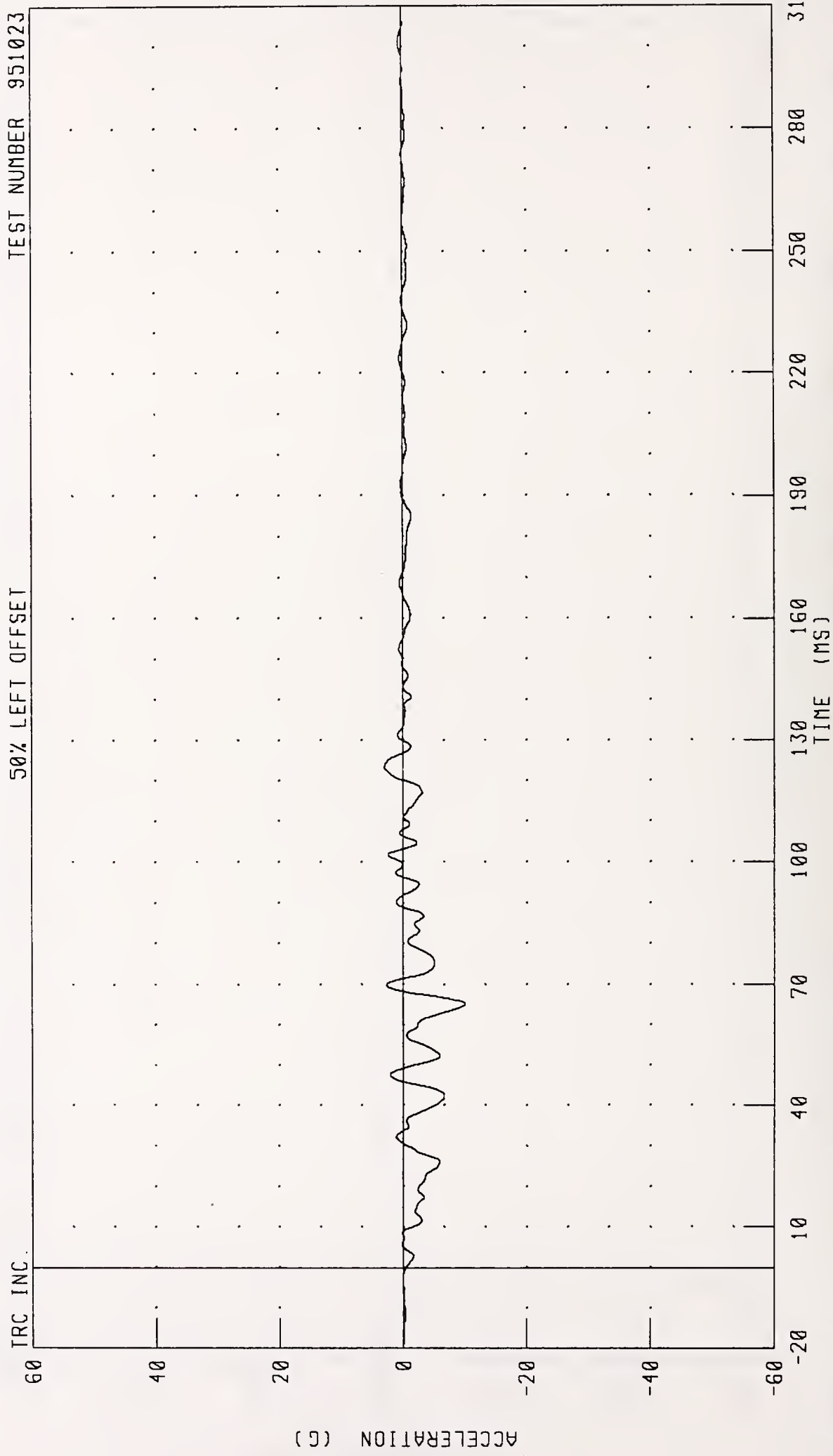
CHANNEL VCCRG1 FILTER CH CLASS 60

PEAK DATA: 6 11 G @ 86 32 MS, 0 04 G @ -20 00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK FRONT FRAME CROSSMEMBER X-AXIS ACCELERATION

TRC INC. TEST NUMBER 951023

50% LEFT OFFSET



CHANNEL: FFCXG1 FILTER: CH CLASS 60

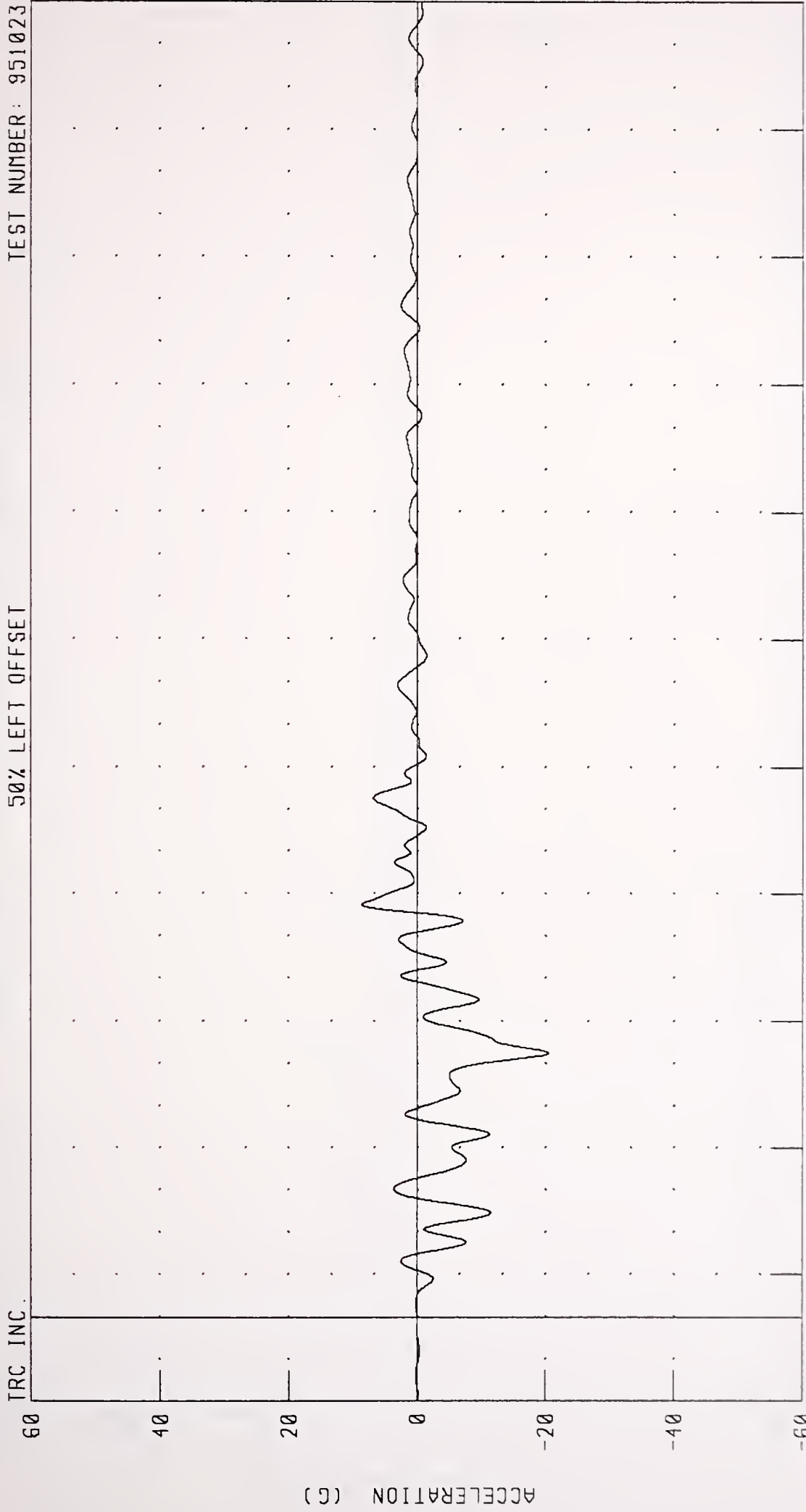
PEAK DATA: 3 04 G @ 123 28 MS; -9.99 G @ 65 28 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK FRONT FRAME CROSSMEMBER Y-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.

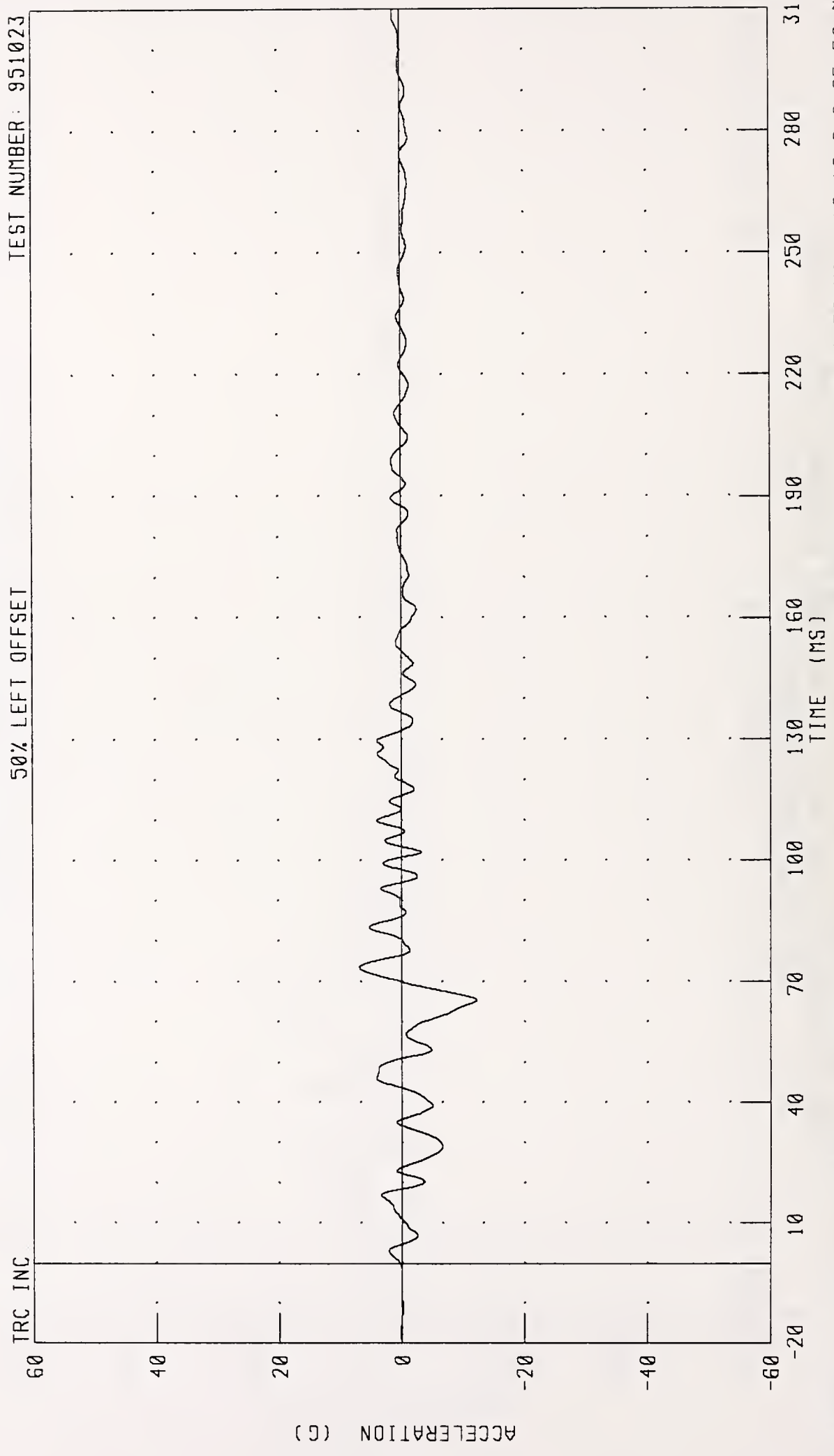


CHANNEL FFCYGI FILTER CH CLASS 60  
PEAK DATA 8 63 G @ 97 36 MS, -20 43 G @ 62 48 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK FRONT FRAME CROSSMEMBER Z-AXIS ACCELERATION

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL: FFCZG1 FILTER: CH CLASS 60

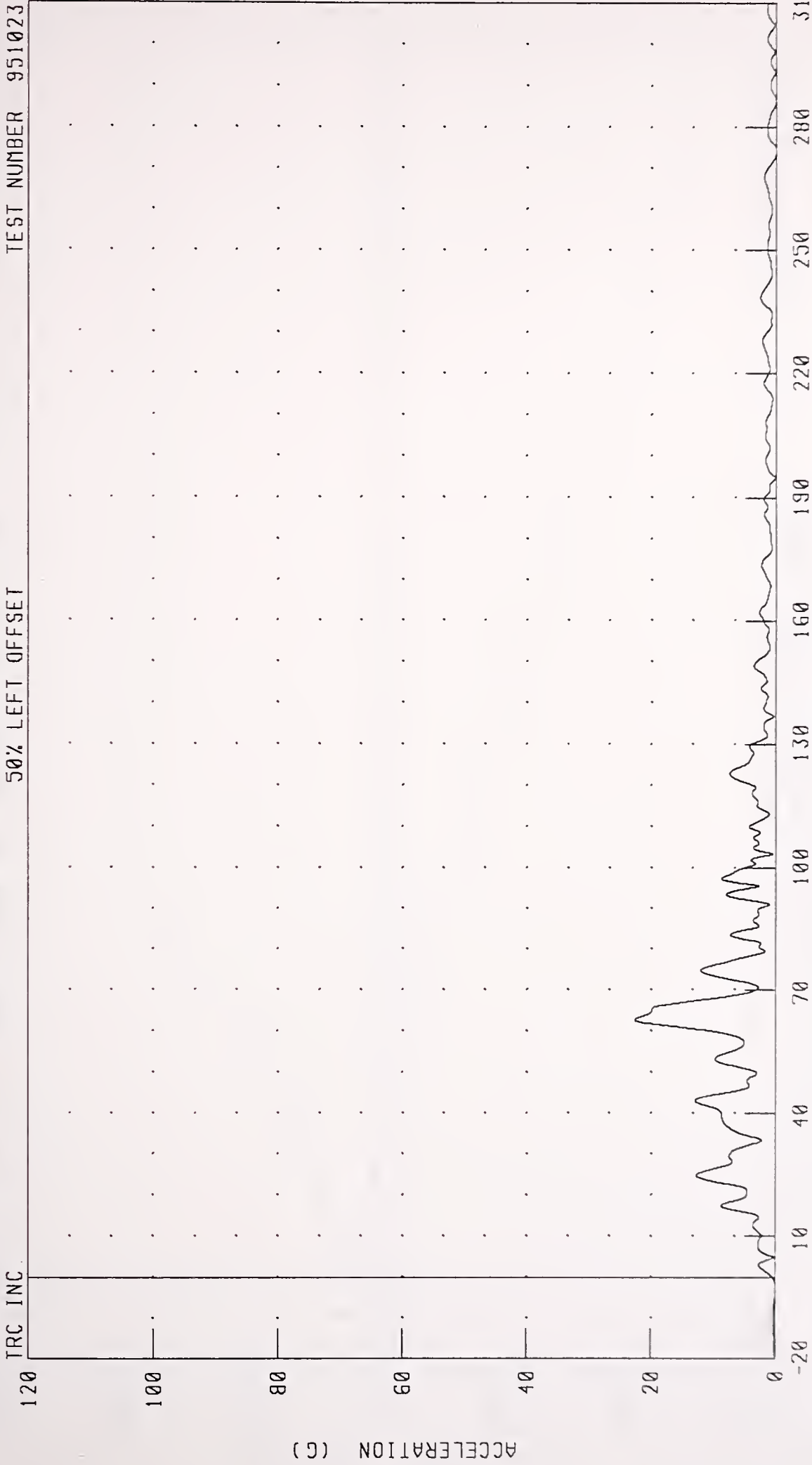
PEAK DATA: 6.89 G @ 73.52 MS, -12.19 G @ 65.52 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK FRONT FRAME CROSSMEMBER RESULTANT ACCELERATION

TEST NUMBER 951023

50% LEFT OFFSET

TRC INC



CHANNEL FFCRG1 FILTER CH CLASS 60

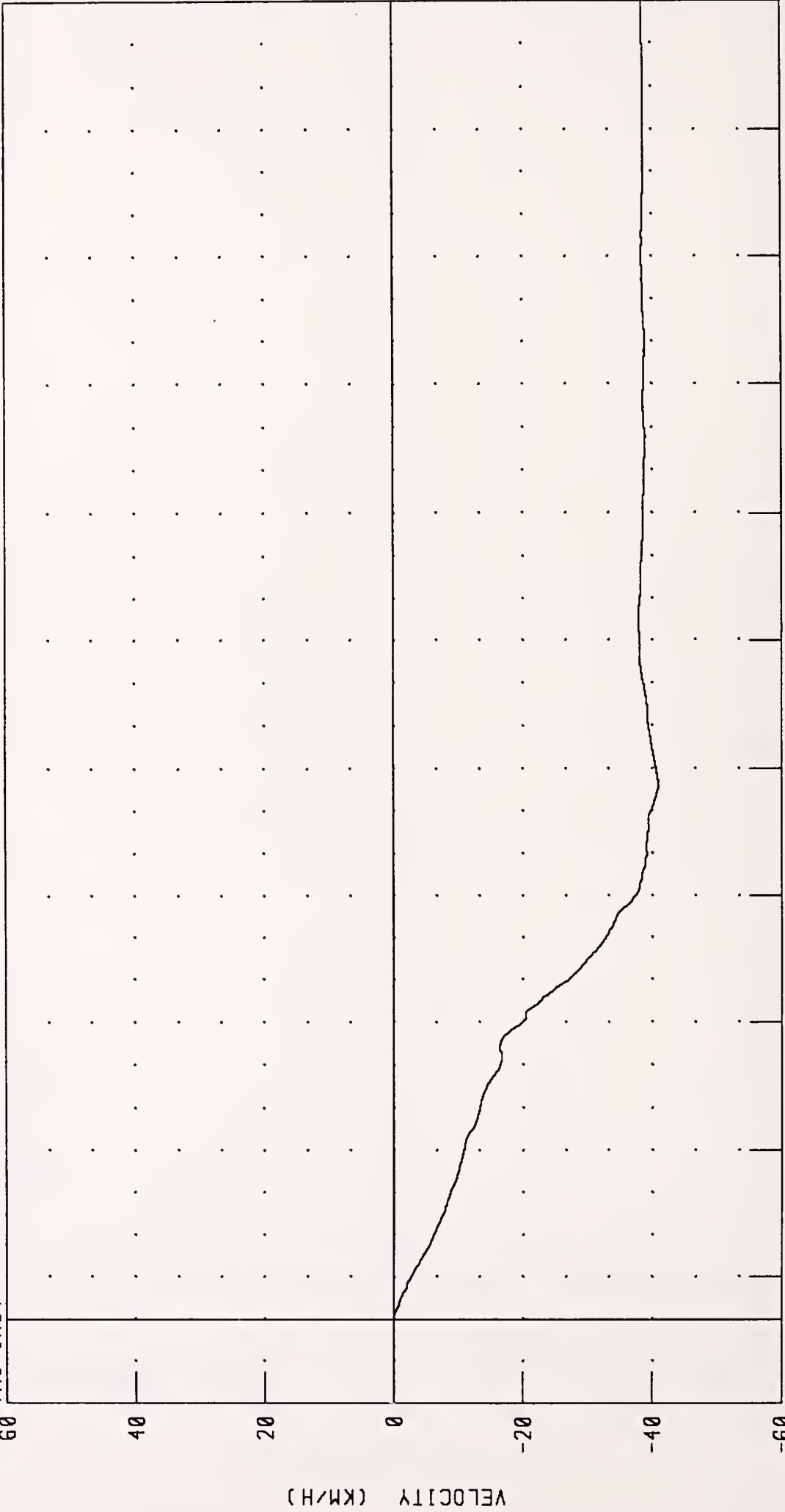
PEAK DATA 22.63 G @ 62.64 MS, 0.02 G @ 274.88 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 CAR CENTER OF GRAVITY X-AXIS VELOCITY

TRC INC. TEST NUMBER: 951023

50% LEFT OFFSET

60



310 280 250 220 190 160 130 100 70 40 10 -20 -40 -60

TIME (MS)

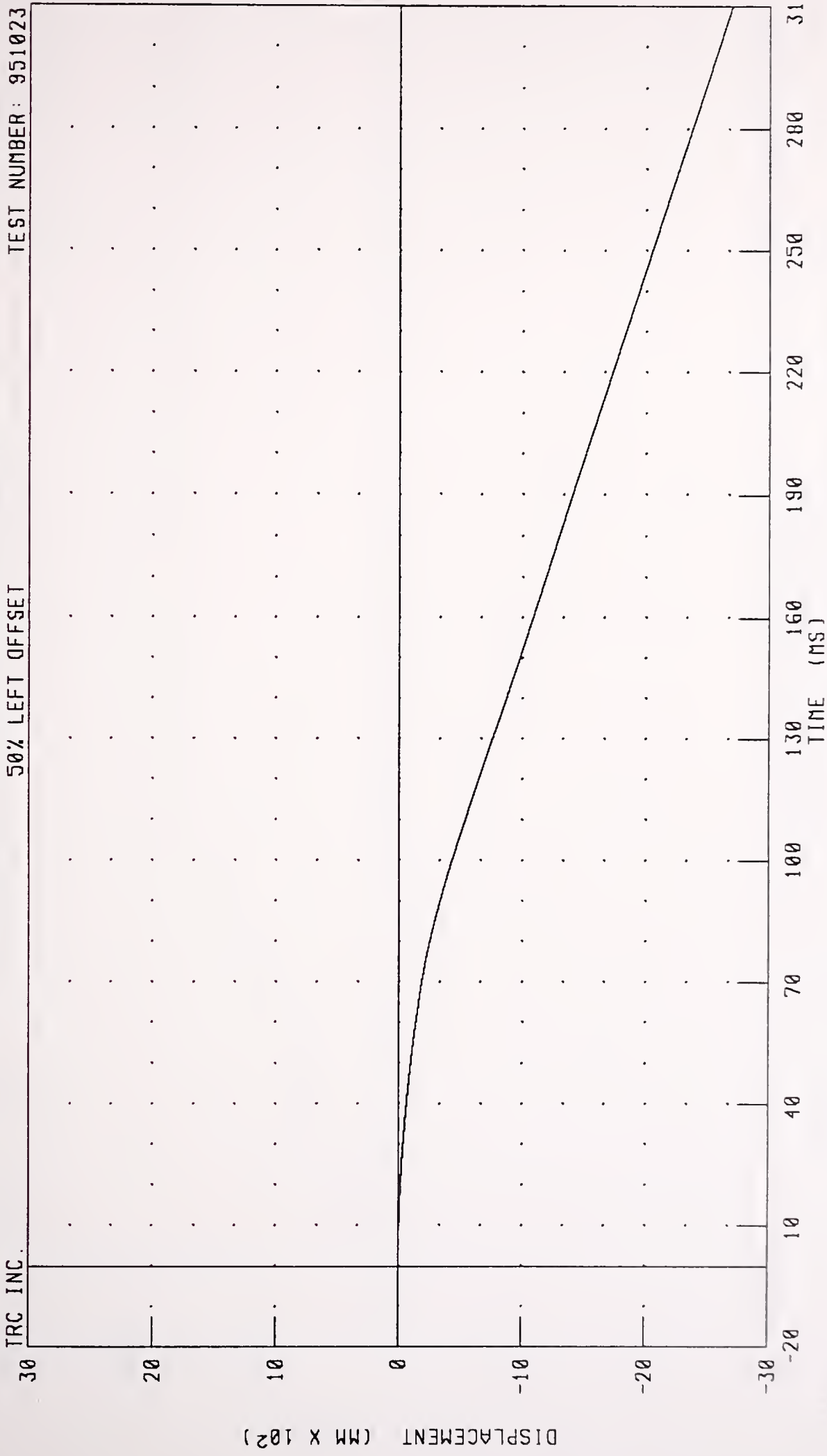
CHANNEL: VCGXV2 FILTER: CH. CLASS 180 PEAK DATA: 0.00 KM/H @ 0.00 MS; -41.01 KM/H @ 126.24 MS



HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
CAR CENTER OF GRAVITY X-AXIS DISPLACEMENT

TEST NUMBER: 951023

50% LEFT OFFSET



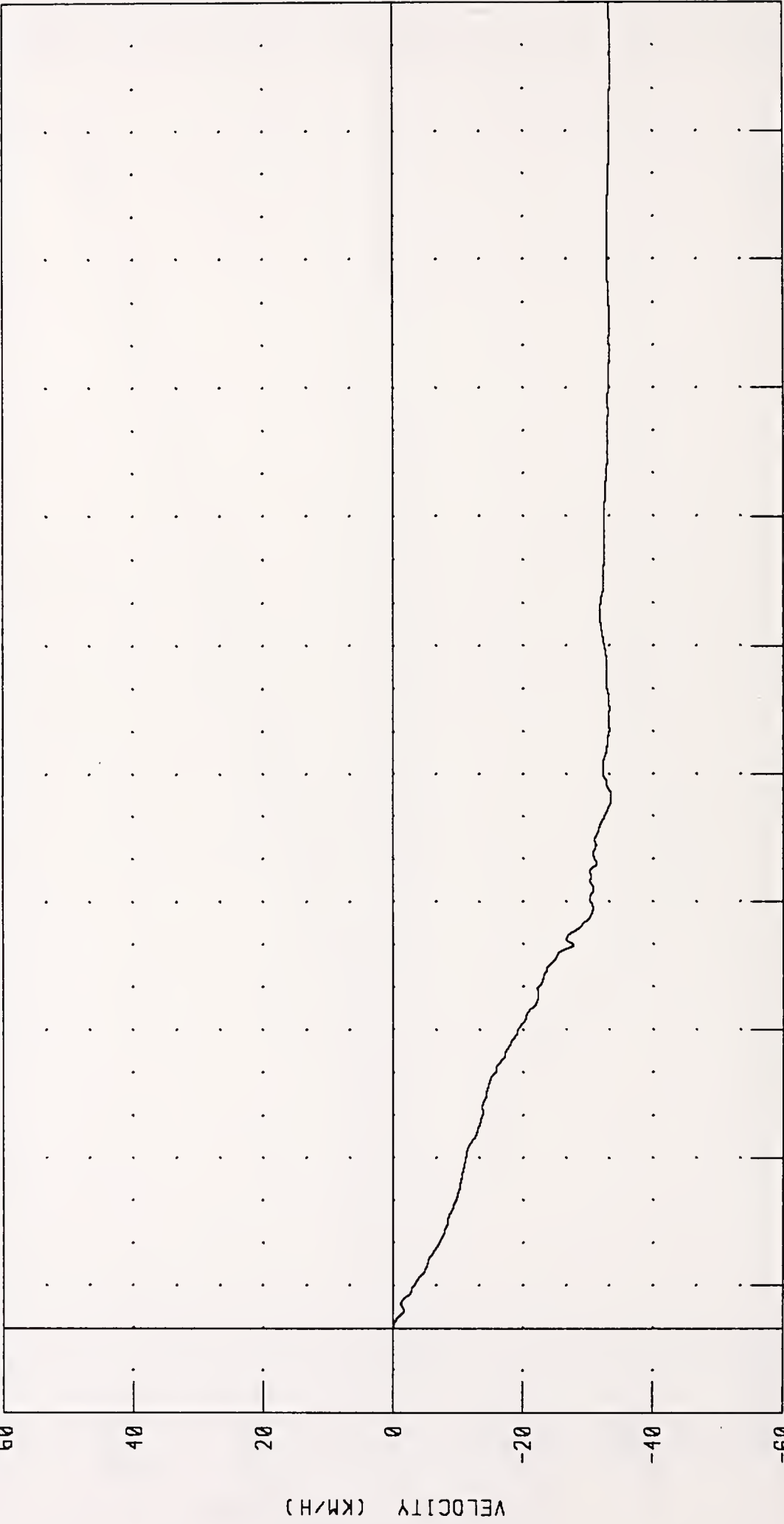
CHANNEL YCGXD2 FILTER CH CLASS 180 PEAK DATA: 0 00 NM @ 0.00 MS; -2694.54 MM @ 310 00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 LEFT FRONT SILL X-AXIS VELOCITY

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.

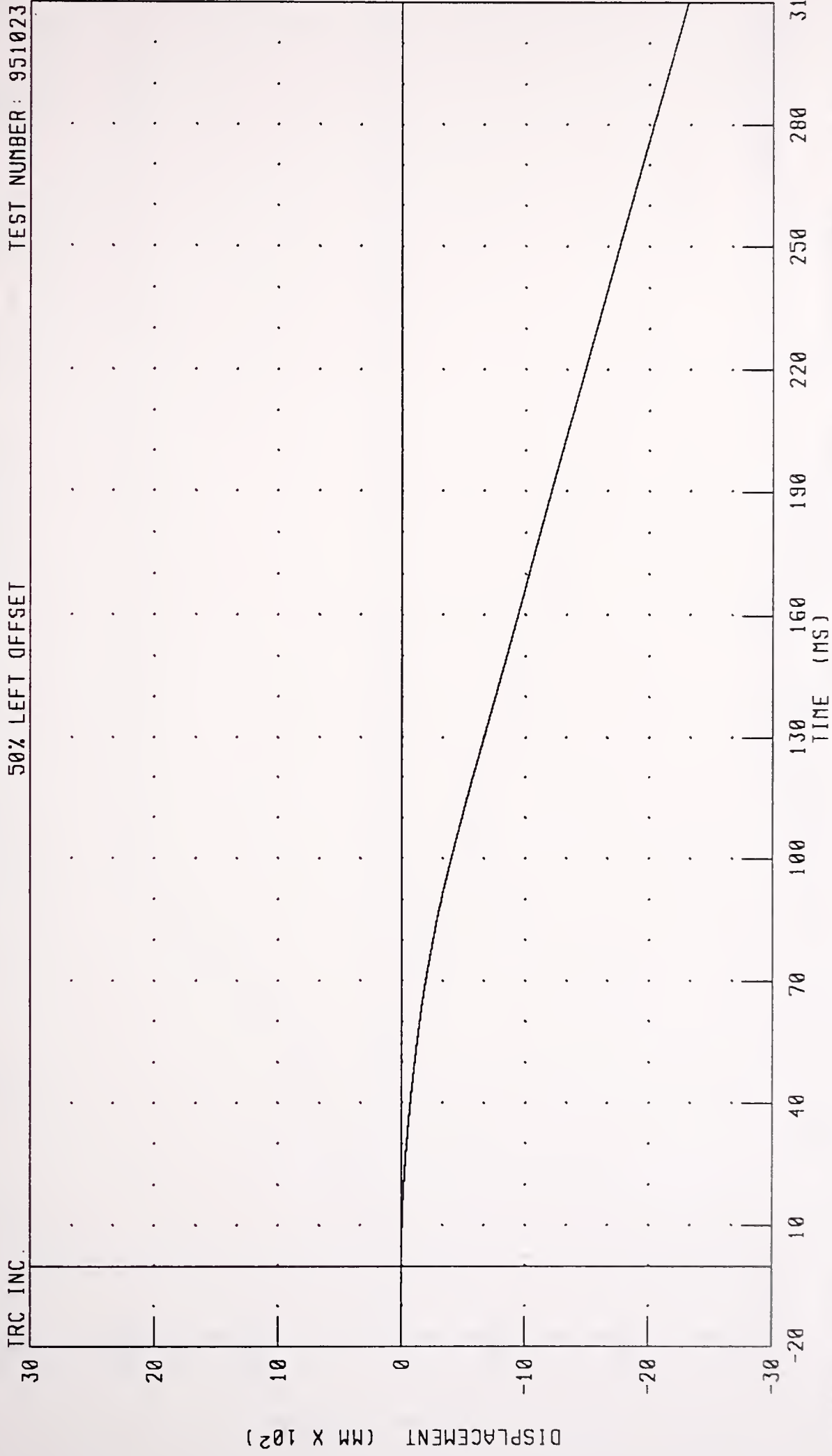


CHANNEL: LFSXV2 FILTER: CH. CLASS 180

PEAK DATA: 0 00 KM/H @ 0.00 MS; -33.57 KM/H @ 125 12 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 LEFT FRONT SILL X-AXIS DISPLACEMENT

TRC INC. 50% LEFT OFFSET TEST NUMBER: 951023

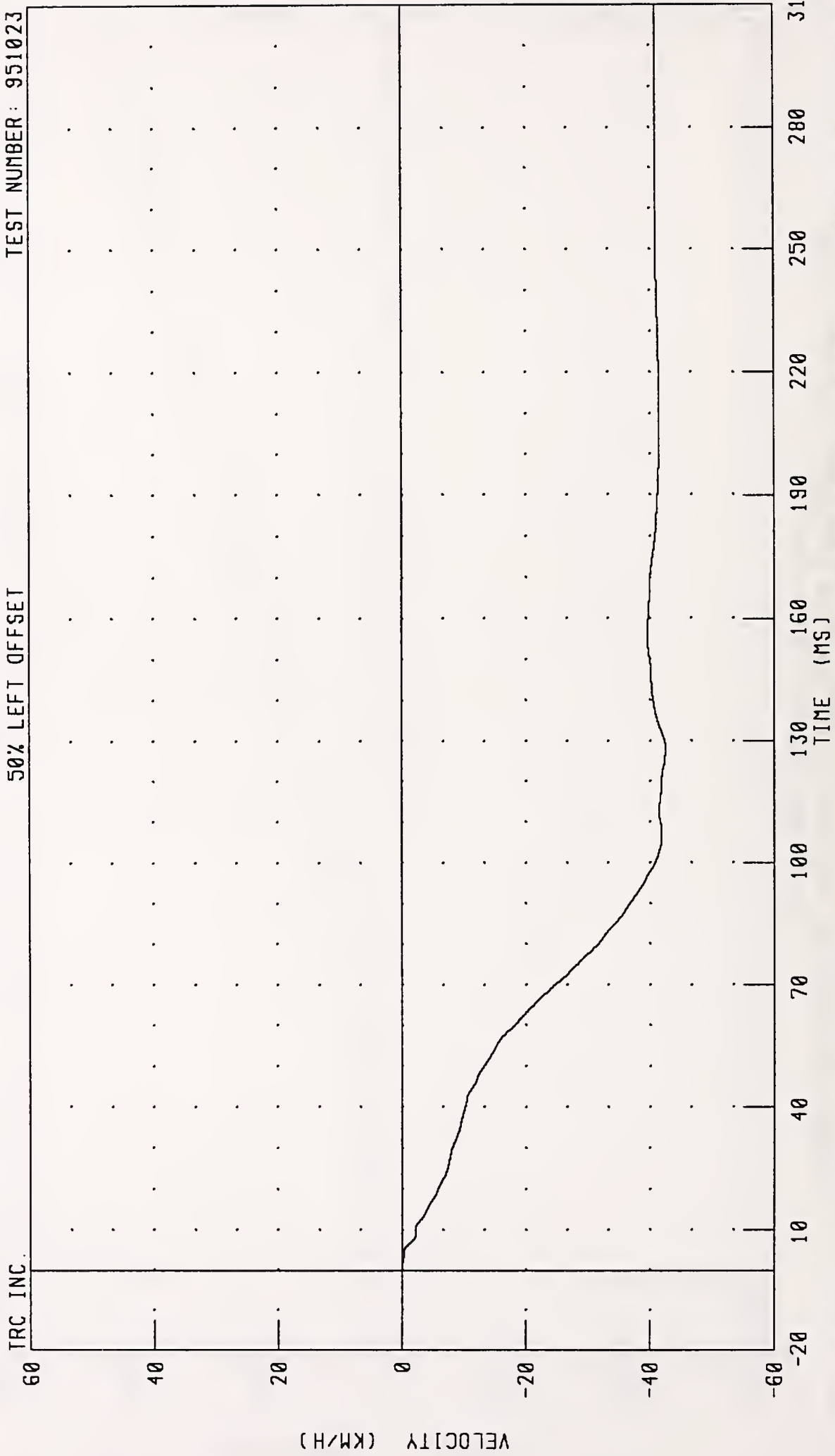


CHANNEL: LFSXD2 FILTER: CH CLASS 180 PEAK DATA: 0.00 MM @ 0.00 MS; -2314.61 MM @ 310.00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 RIGHT FRONT SILL X-AXIS VELOCITY

TEST NUMBER: 951023

50% LEFT OFFSET



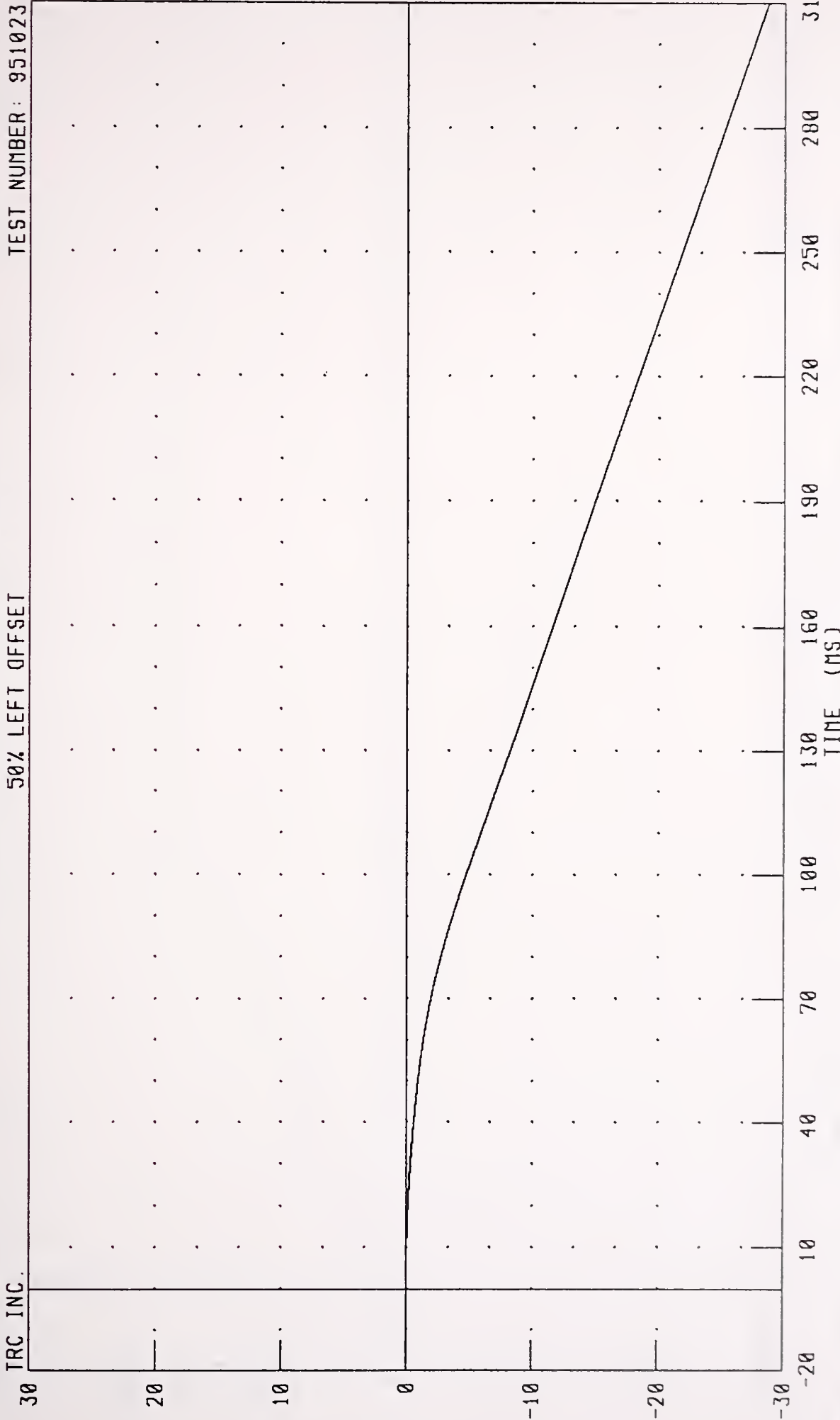
CHANNEL: RFSXV2 FILTER: CH. CLASS 180

PEAK DATA: 0.00 KM/H @ 0.00 MS; -42.44 KM/H @ 128.40 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT FRONT SILL X-AXIS DISPLACEMENT

TRC INC. TEST NUMBER: 951023

50% LEFT OFFSET

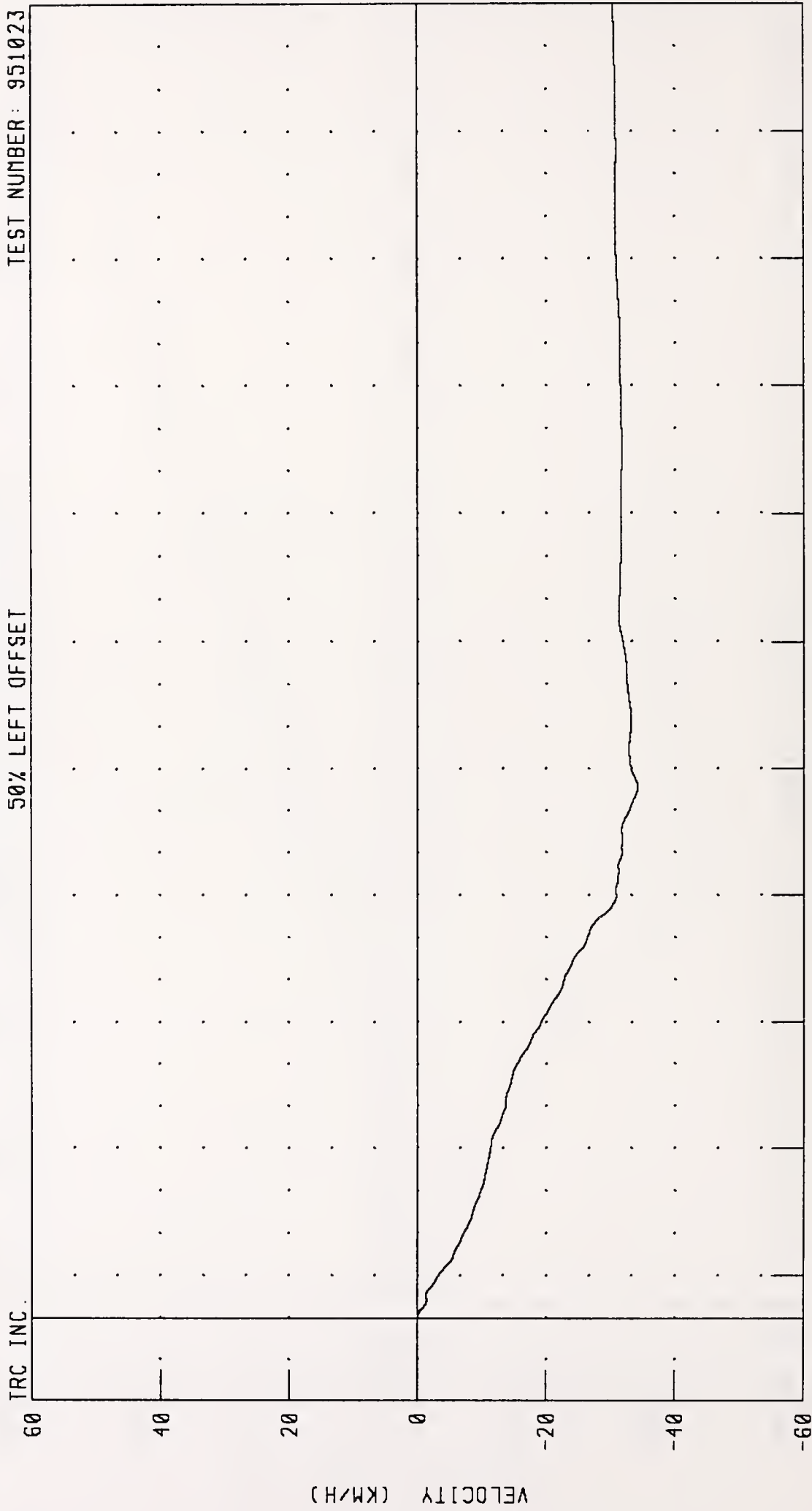


CHANNEL: RFSXD2 FILTER: CH, CLASS 180 PEAK DATA: 0.00 MM @ 0 00 MS; -2867.99 MM @ 310.00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT REAR SEAT X-AXIS VELOCITY

TRC INC. TEST NUMBER: 951023

50% LEFT OFFSET



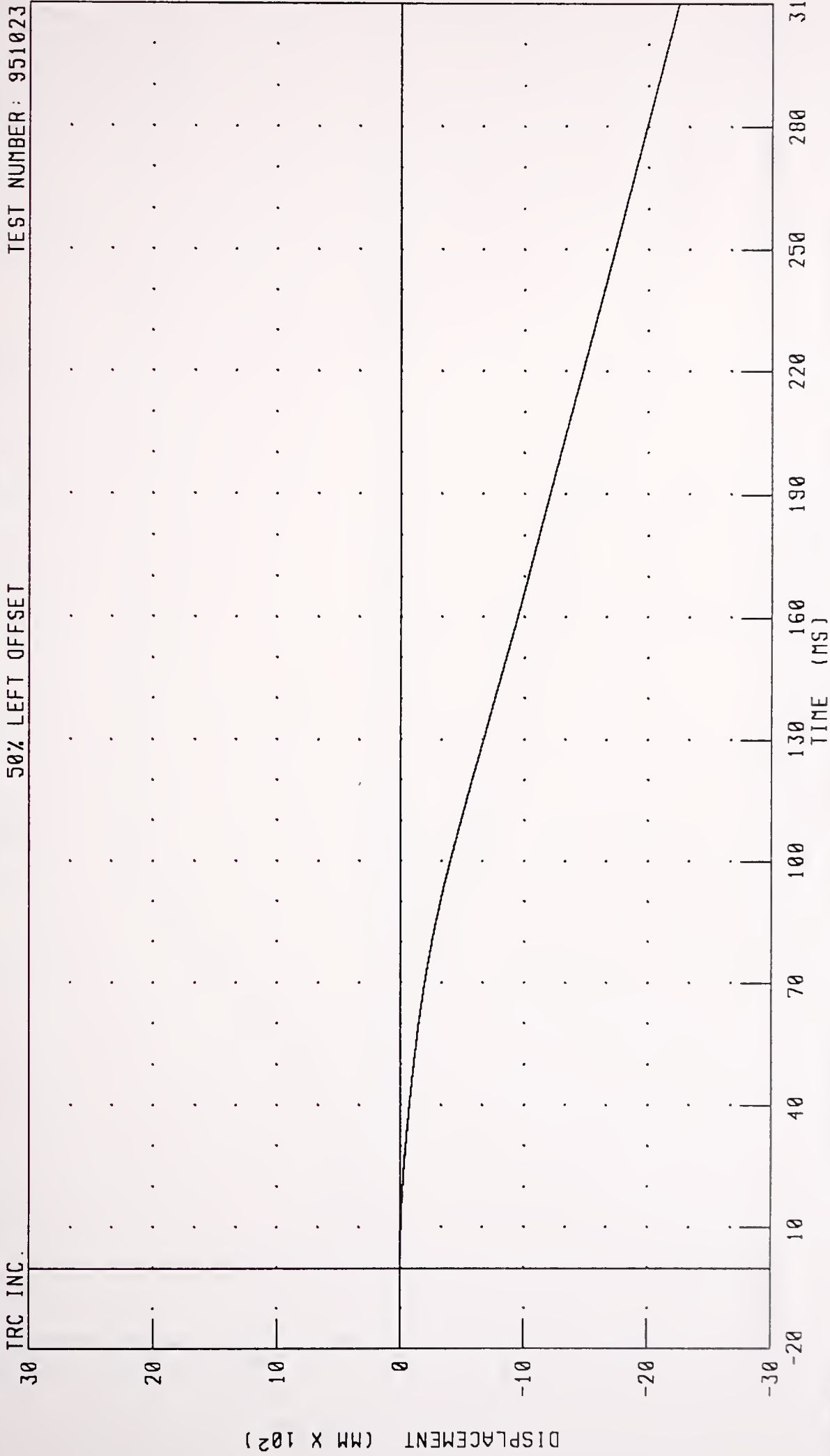
CHANNEL: TLRXV2 FILTER: CH. CLASS 180

PEAK DATA: 0 00 KM/H @ 0 00 MS; -34.22 KM/H @ 125.68 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT REAR SEAT X-AXIS DISPLACEMENT

TRC INC. TEST NUMBER: 951023

50% LEFT OFFSET

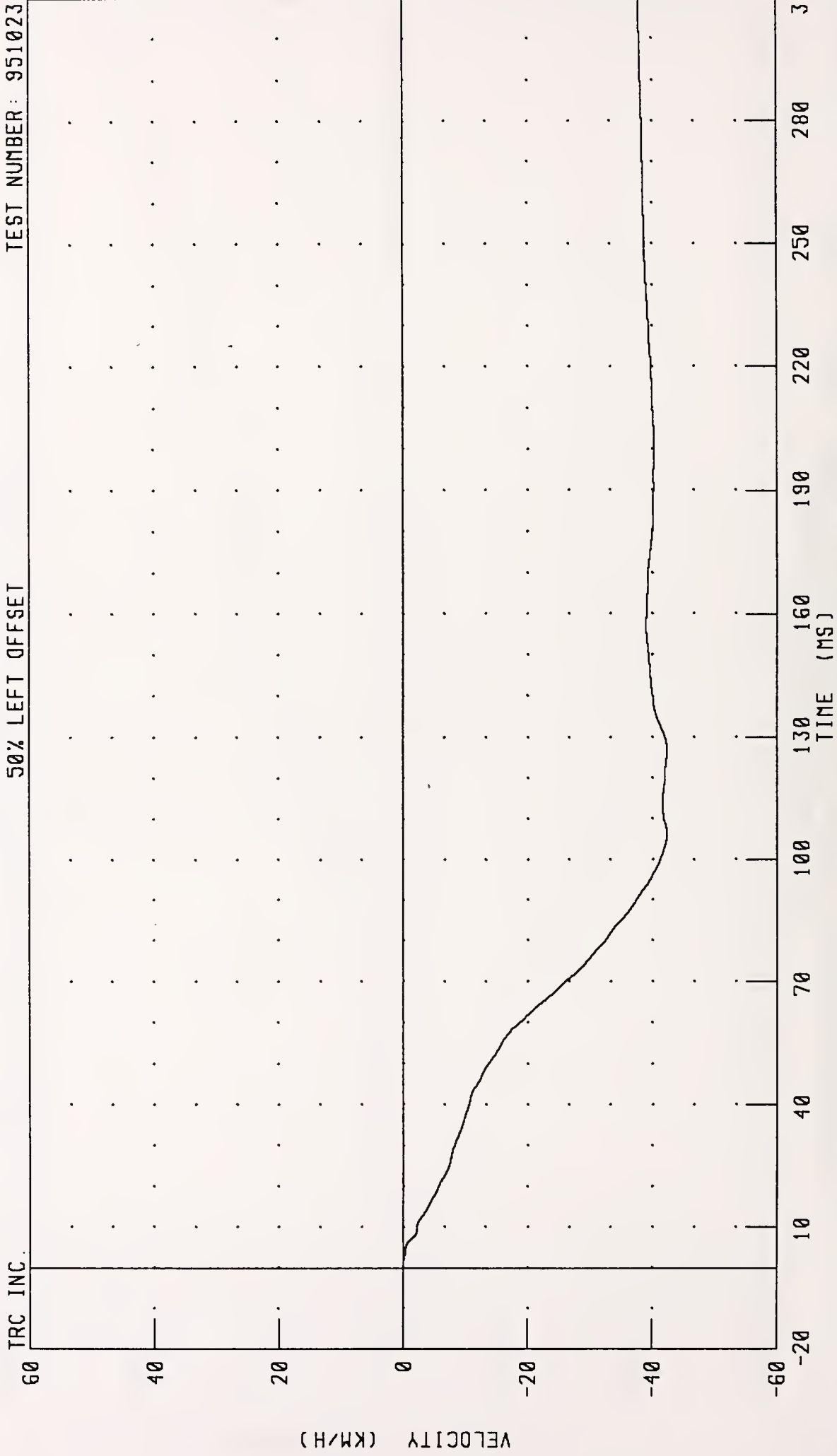


CHANNEL TLRX02 FILTER: CH. CLASS 180

PEAK DATA: 0 00 NM @ 0 00 MS; -2245.55 MM @ 310.00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT REAR SEAT X-AXIS VELOCITY

TRC INC. 50% LEFT OFFSET TEST NUMBER: 951023



CHANNEL: TRRXV2 FILTER: CH. CLASS 180

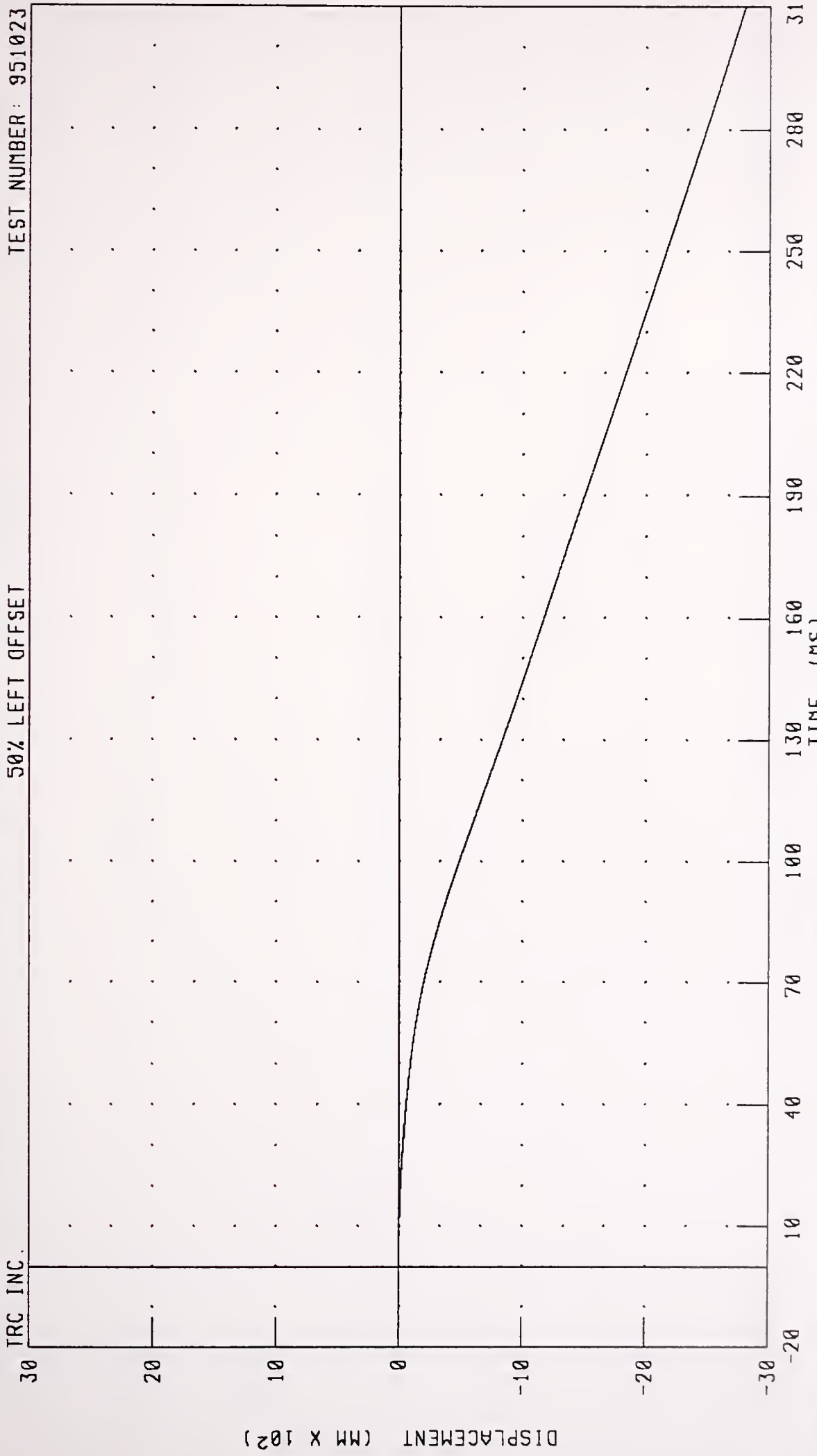
PEAK DATA: 0.00 KM/H @ 0.16 MS; -42.35 KM/H @ 126.80 MS



HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 RIGHT REAR SEAT X-AXIS DISPLACEMENT

TEST NUMBER: 951023

50% LEFT OFFSET



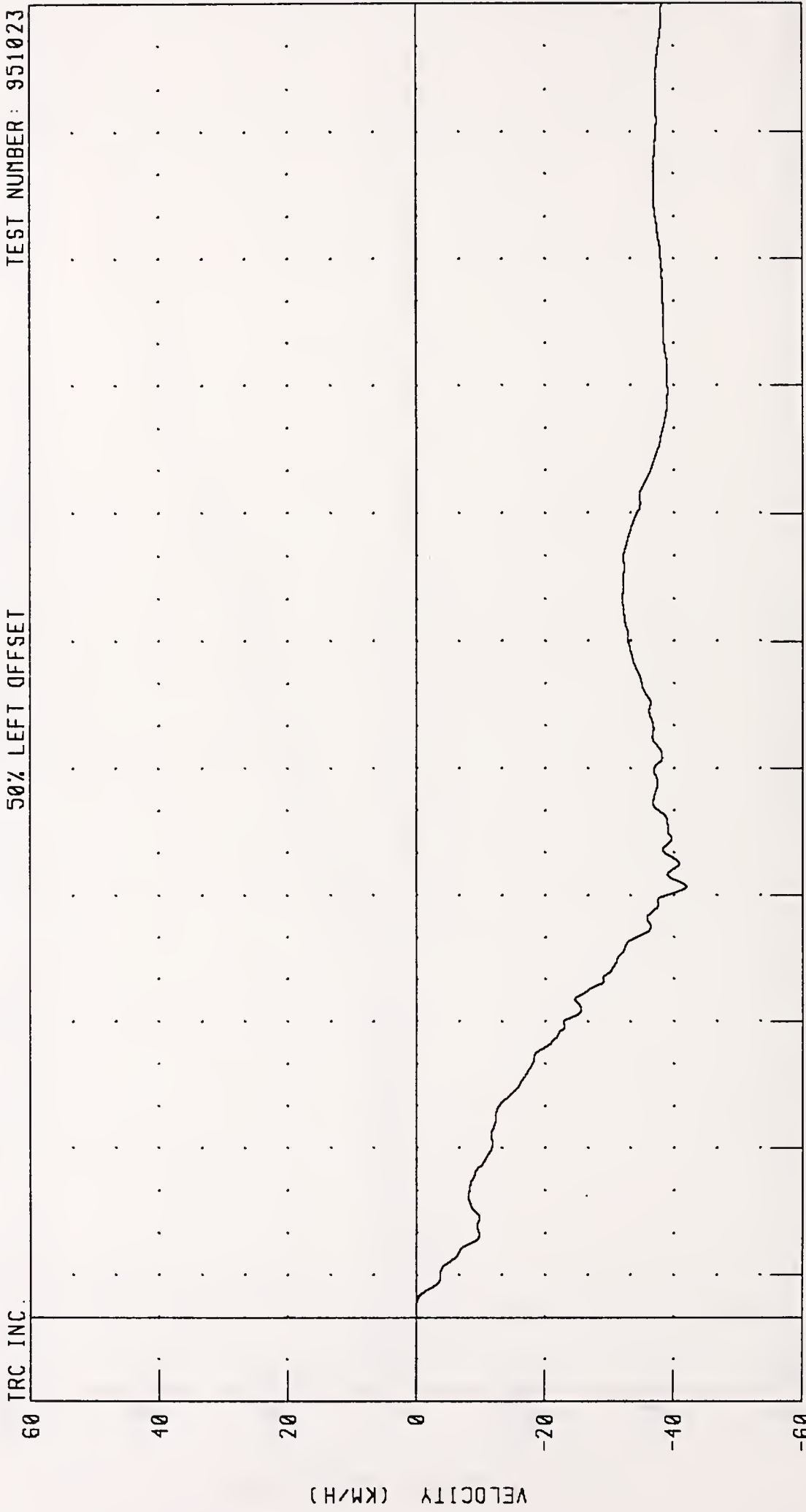
CHANNEL TRRXD2 FILTER: CH CLASS 180

PEAK DATA: 0.00 MM @ 32 MS; -2799.91 MM @ 310.00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
INSTRUMENT PANEL CENTER X-AXIS VELOCITY

TRC INC. TEST NUMBER: 951023

50% LEFT OFFSET



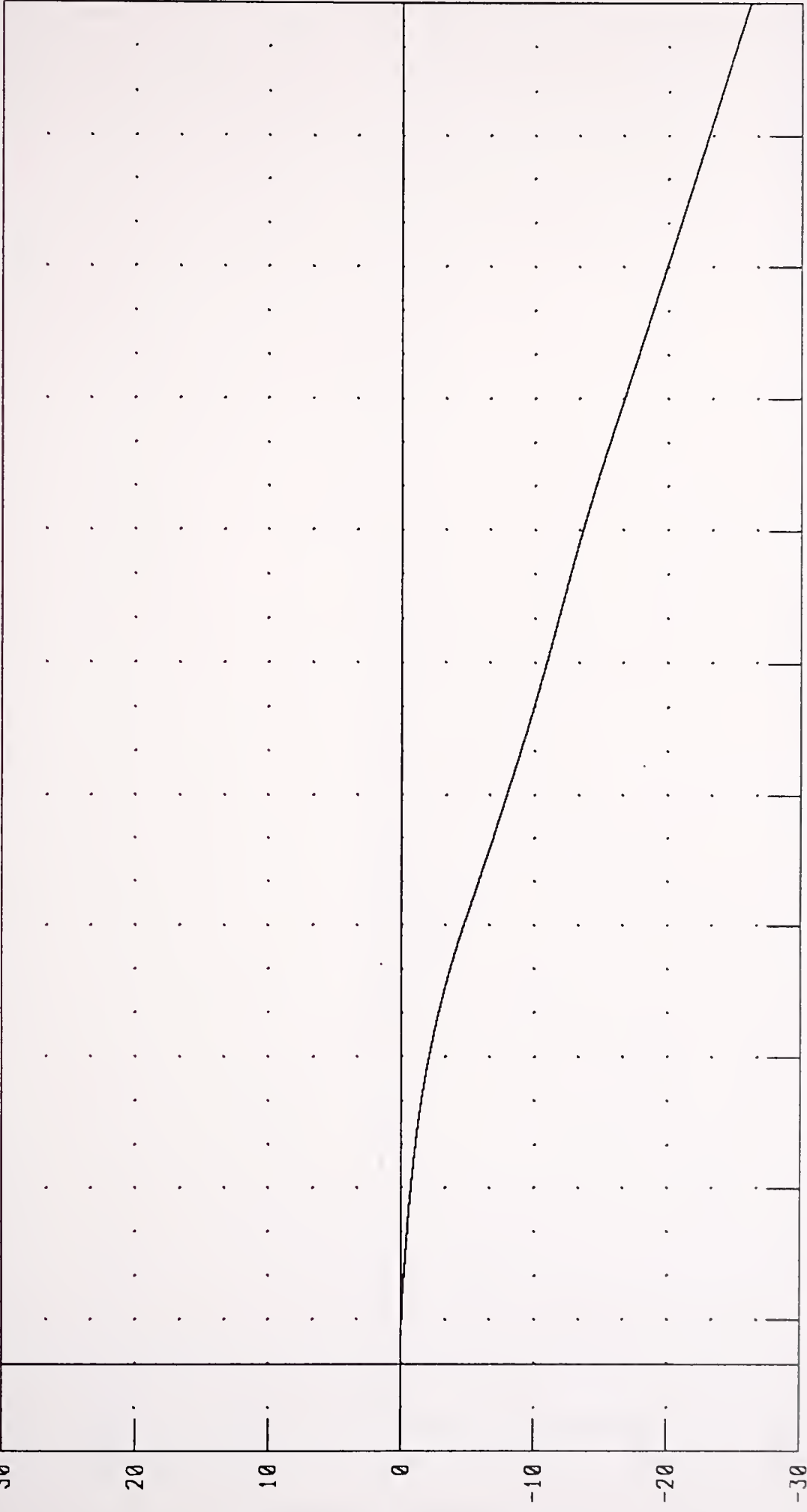
CHANNEL: DPCXV2 FILTER: CH. CLASS 180  
PEAK DATA: 0.00 KM/H @ 0.00 MS; -41.93 KM/H @ 102.16 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
INSTRUMENT PANEL CENTER X-AXIS DISPLACEMENT

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC.



DISPLACEMENT (MM X 10<sup>2</sup>)

TIME (MS)

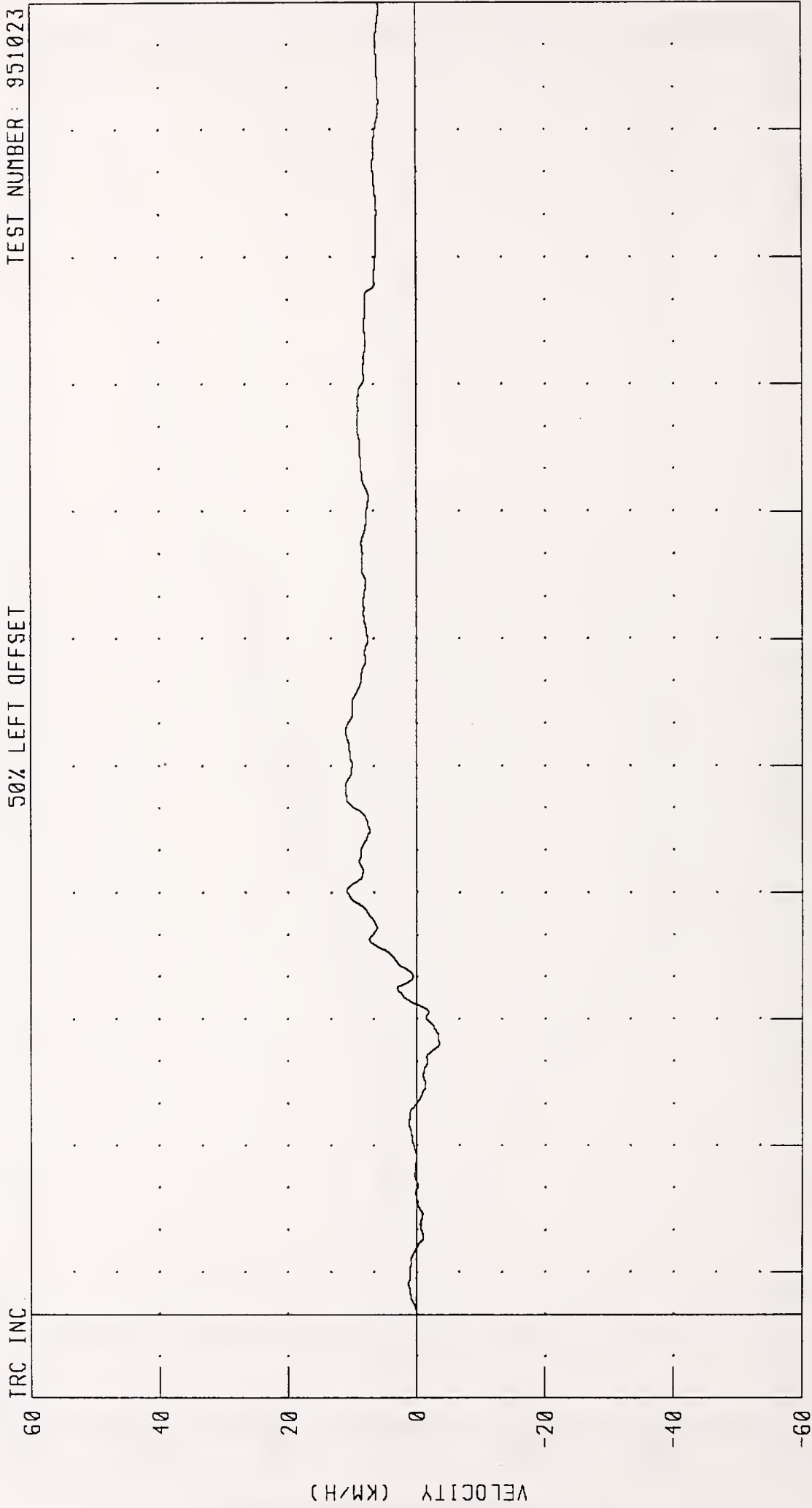
PEAK DATA: 0 00 MM @ 0 00 MS; -2613.39 MM @ 310.00 MS

CHANNEL: DPCX02 FILTER: CH CLASS 180

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
STEERING WHEEL HUB X-AXIS VELOCITY RELATIVE TO VEHICLE

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL: STRXV2 FILTER: CH CLASS 180

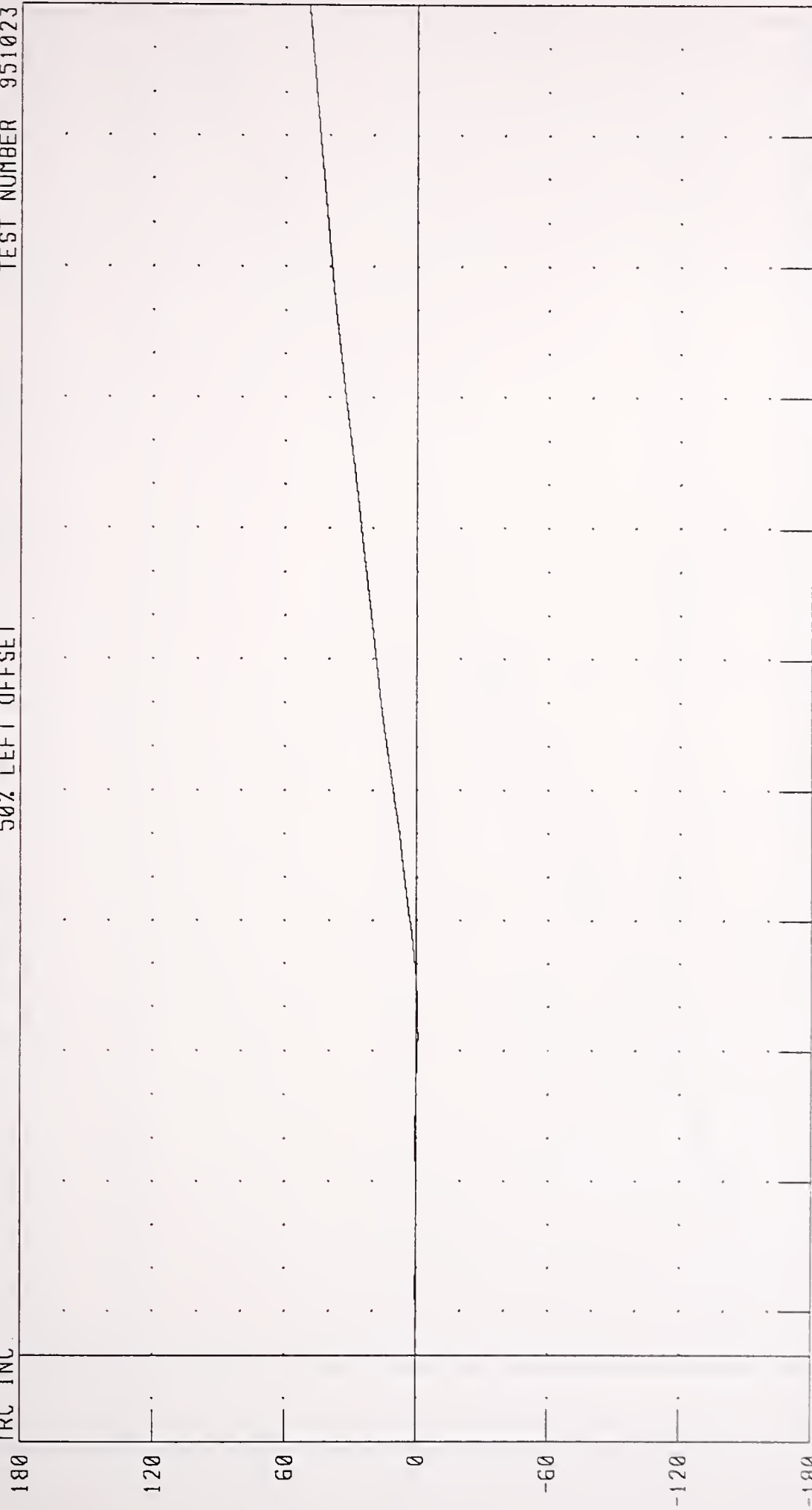
PEAK DATA: 11.10 KM/H @ 123.92 MS; -3.49 KM/H @ 64.24 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 STEERING WHEEL HUB X-AXIS DISPLACEMENT RELATIVE TO VEHICLE

TEST NUMBER 951023

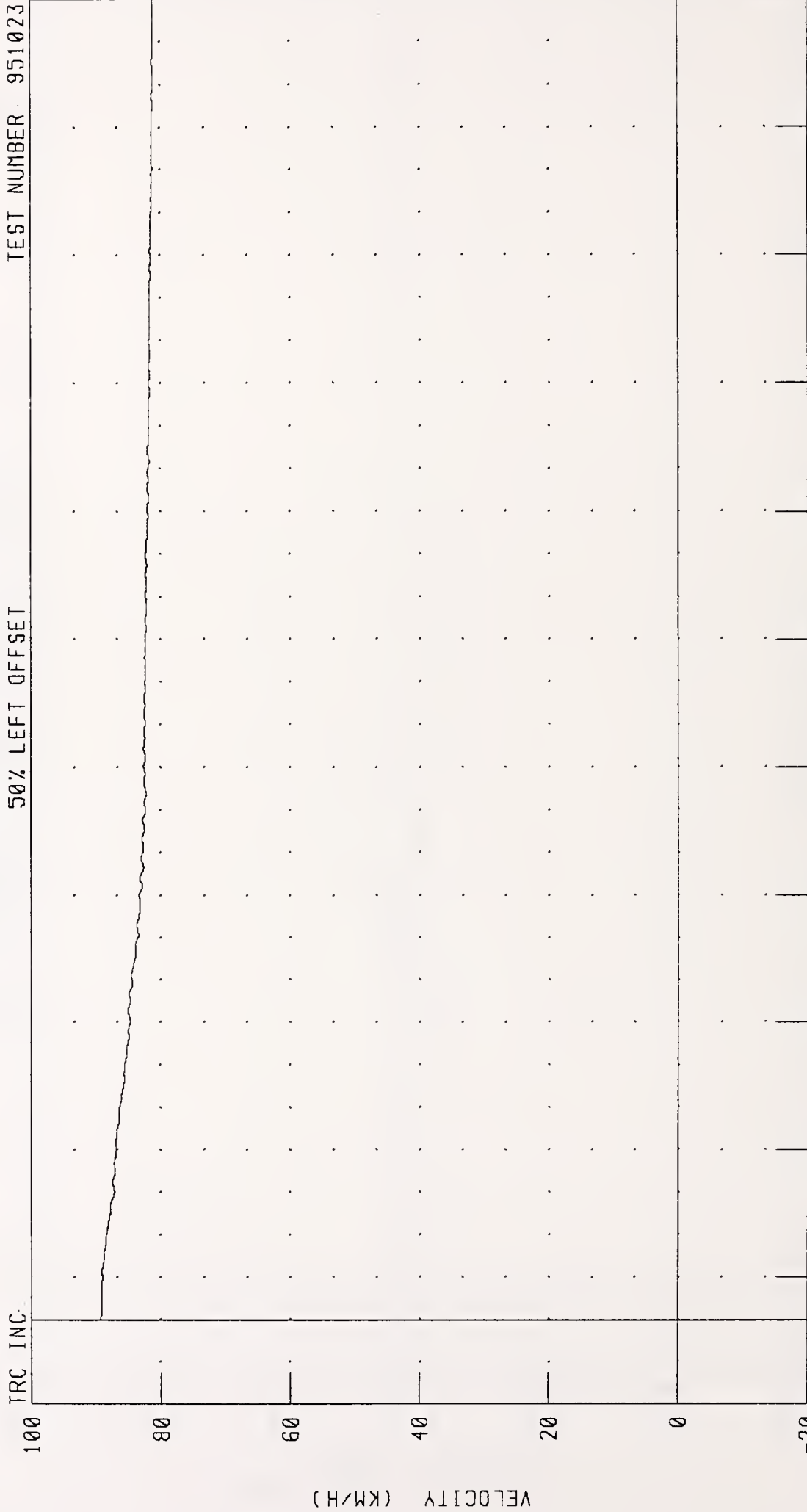
50% LEFT OFFSET

TRC INC.



CHANNEL STRXD2 FILTER CH CLASS 180  
 PEAK DATA 493 57 MM @ 310 00 MS, -7 45 MM @ 73 44 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK CENTER OF GRAVITY X-AXIS VELOCITY



CHANNEL: VCGXV1 FILTER: CH CLASS 180

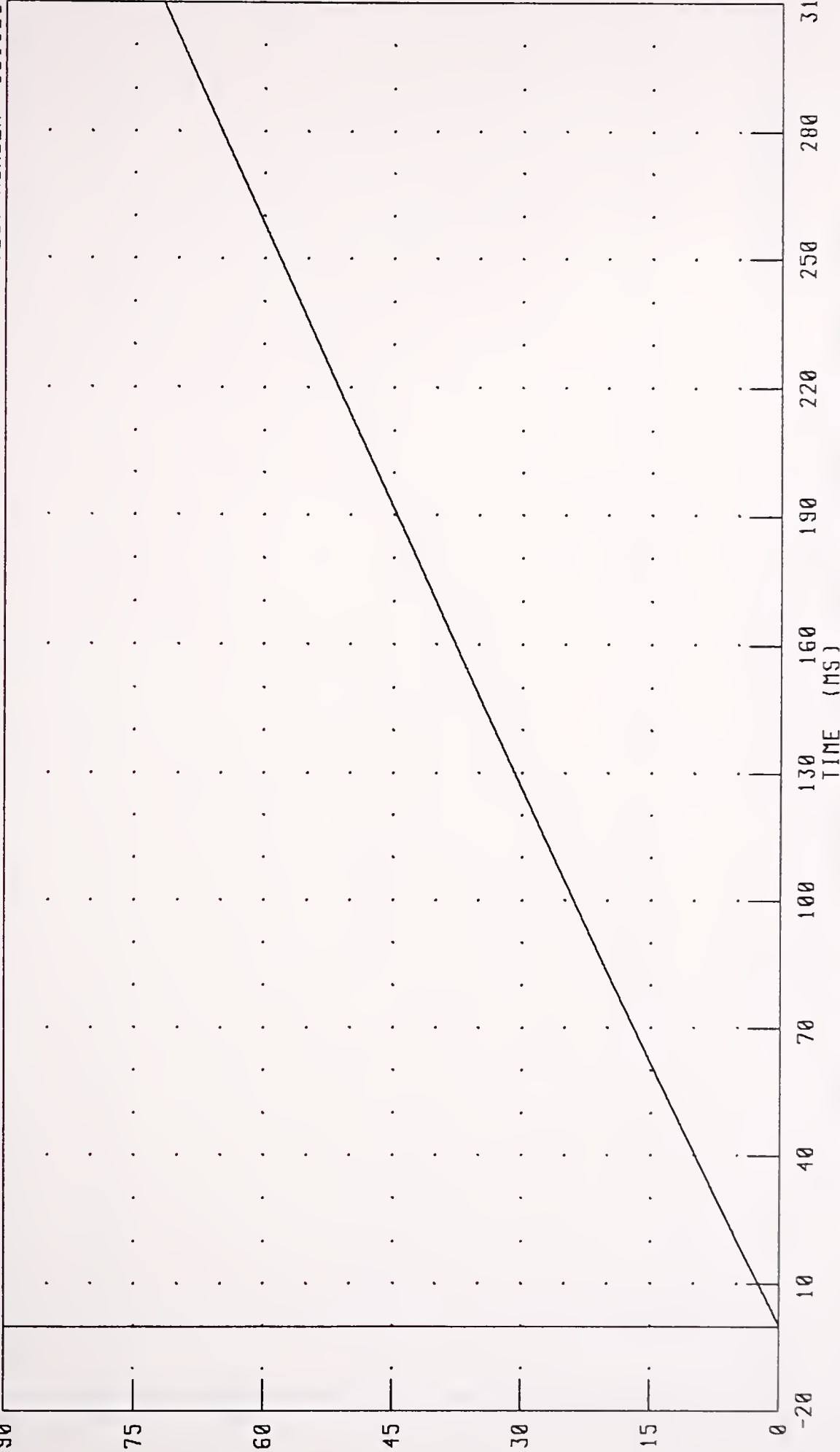
PEAK DATA: 89.20 KM/H @ 0 00 MS; 81 14 KM/H @ 297 68 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK CENTER OF GRAVITY X-AXIS DISPLACEMENT

TRC INC.

50% LEFT OFFSET

TEST NUMBER: 951023



DISPLACEMENT (MM X 10<sup>2</sup>)

TIME (MS)

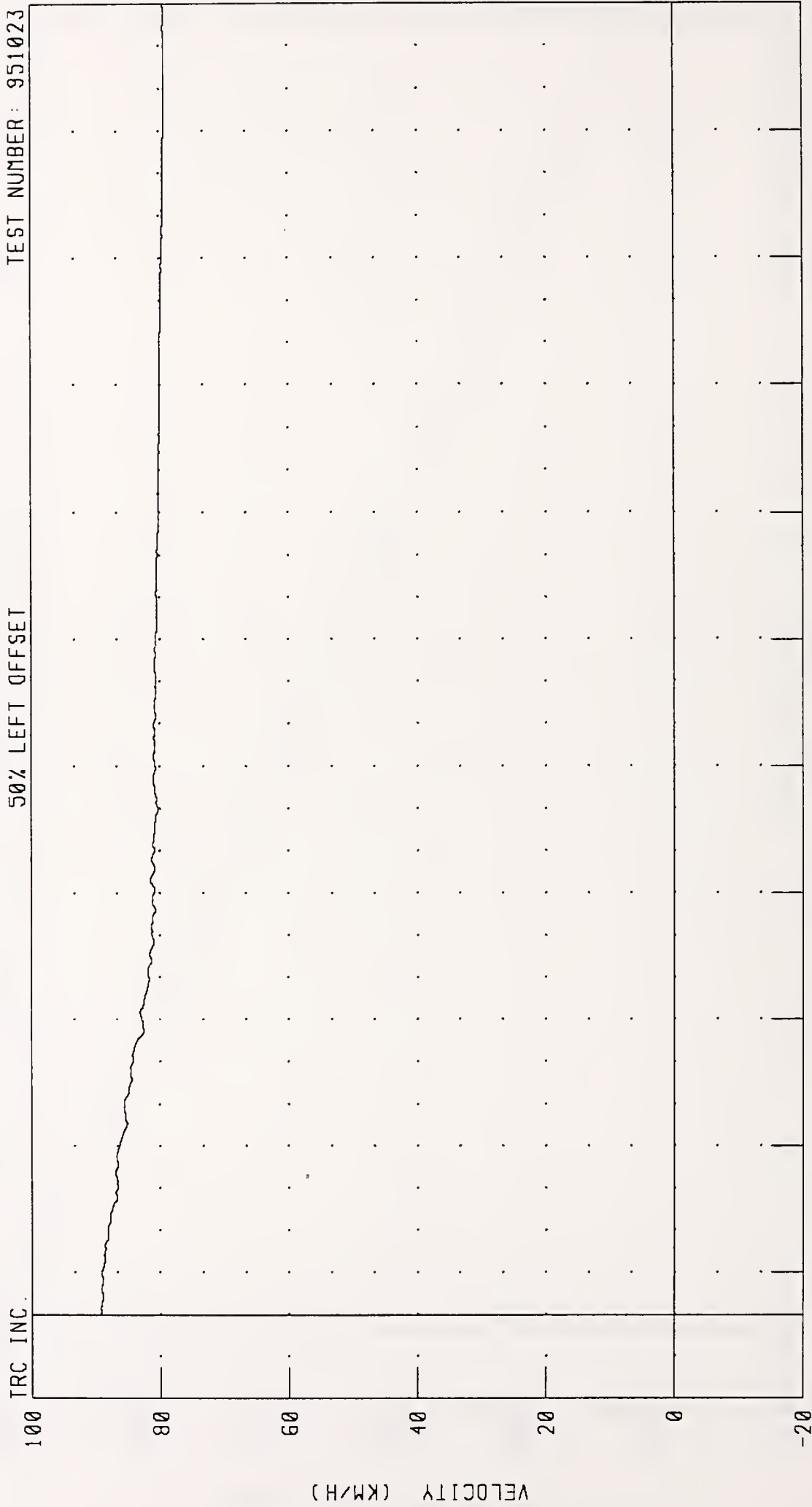
CHANNEL: VCGXD1 FILTER: CH. CLASS 180

PEAK DATA: 7174.33 MM @ 310.00 MS; 0.00 MM @ 0.00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
TRUCK FRONT FRAME CROSSMEMBER X-AXIS VELOCITY

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL: FFCXV1 FILTER: CH CLASS 180

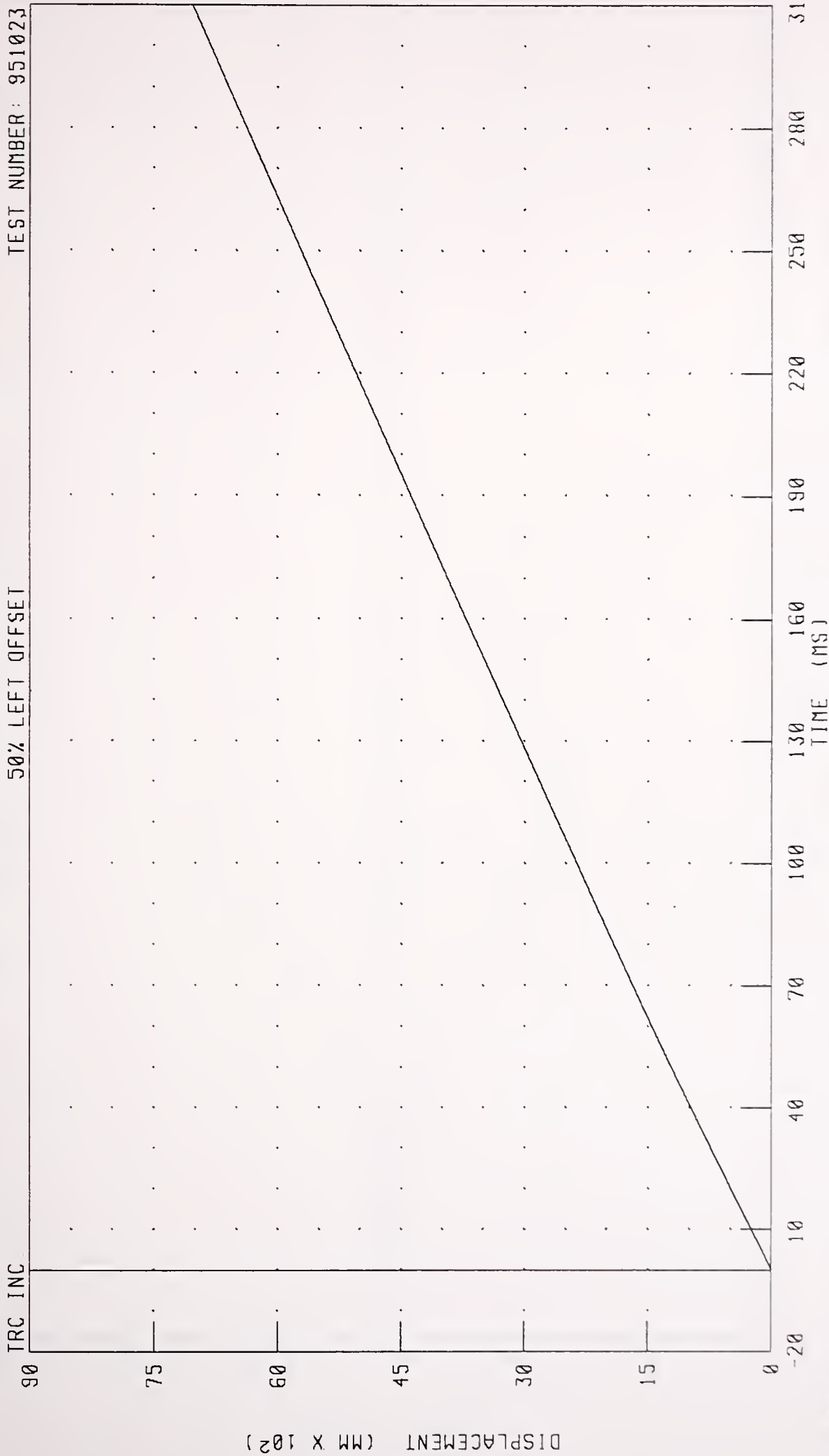
PEAK DATA: 89 20 KM/H @ 1 68 MS, 79 27 KM/H @ 298 24 MS



HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 TRUCK FRONT FRAME CROSSMEMBER X-AXIS DISPLACEMENT

TEST NUMBER: 951023

50% LEFT OFFSET



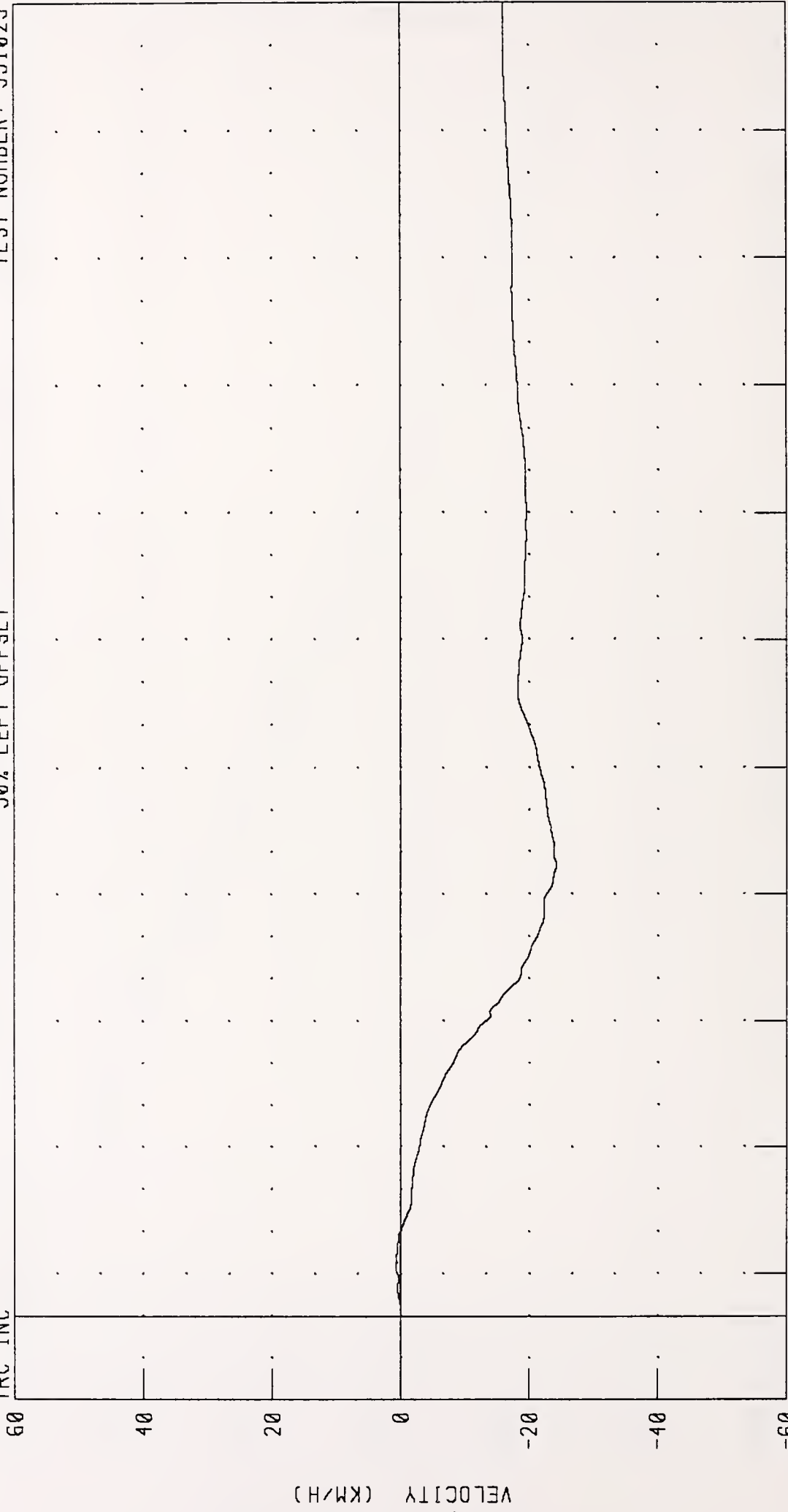
CHANNEL FFCX01 FILTER CH CLASS 180 PEAK DATA 7036 37 MM @ 310 00 MS, 0 00 MM @ 0 00 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 CAR CENTER OF GRAVITY Y-AXIS VELOCITY

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



60  
40  
20  
0  
-20  
-40  
-60

VELOCITY (KM/H)

10 40 70 100 130 160 190 220 250 280 310

TIME (MS)

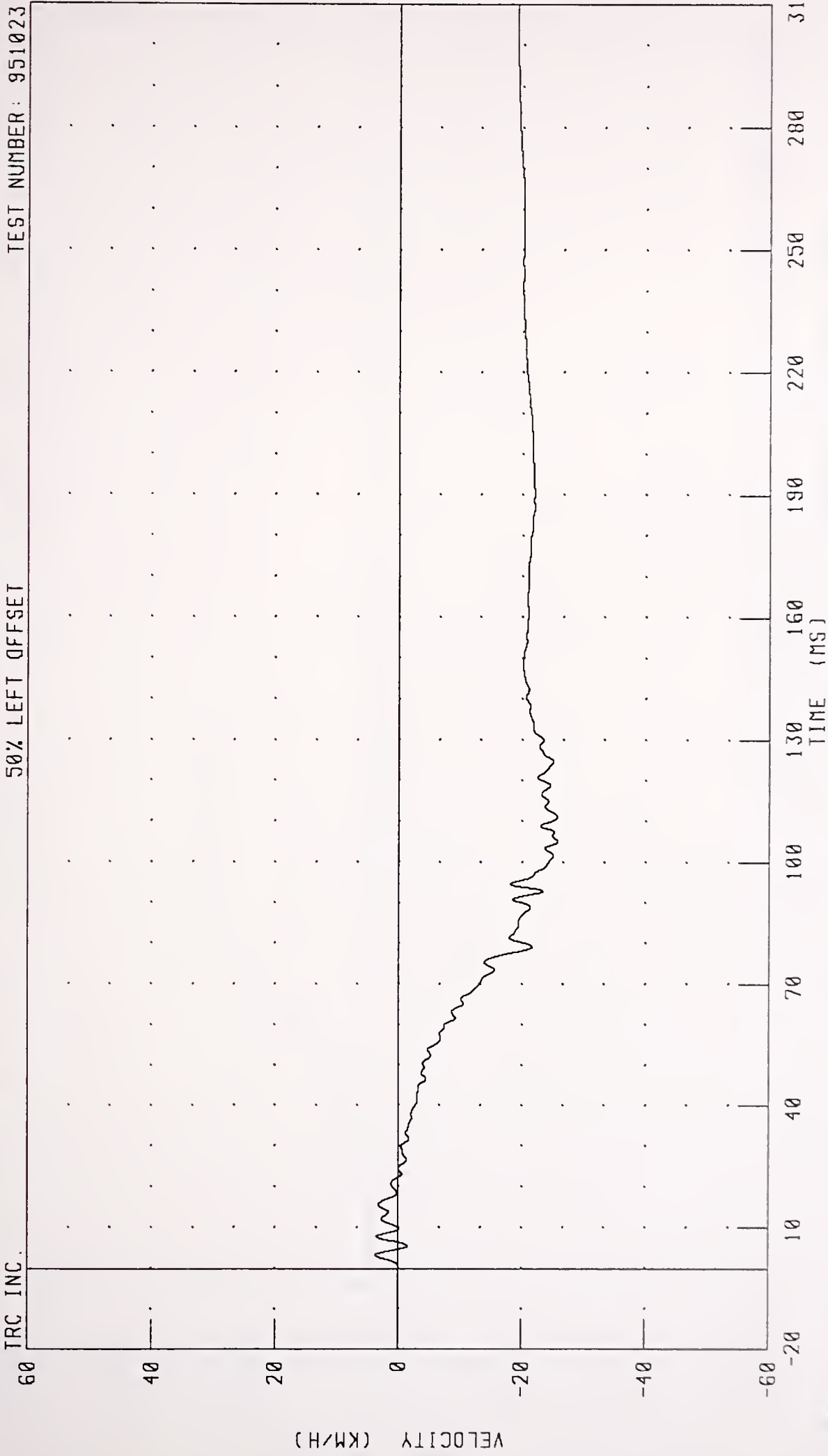
CHANNEL: VCGYV2 FILTER: CH. CLASS 180

PEAK DATA: 0.71 KM/H @ 11.12 MS, -24.25 KM/H @ 106.96 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
LEFT FRONT SILL Y-AXIS VELOCITY

TRC INC. TEST NUMBER: 951023

50% LEFT OFFSET



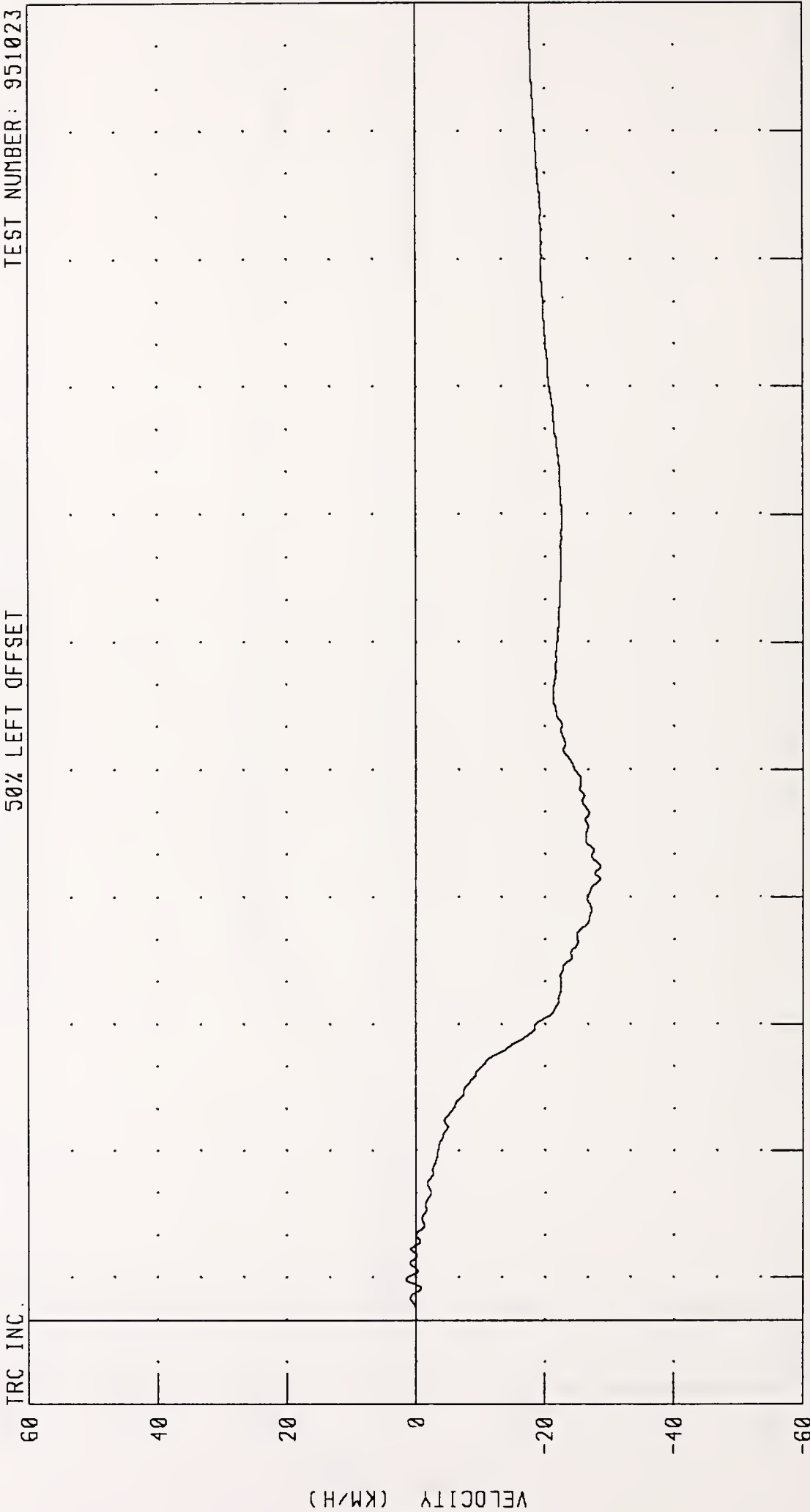
CHANNEL LFSYV2 FILTER CH CLASS 180

PEAK DATA 3.65 KM/H @ 3.28 MS, -25.77 KM/H @ 105.04 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT FRONT SILL Y-AXIS VELOCITY

TRC INC. TEST NUMBER: 951023

50% LEFT OFFSET



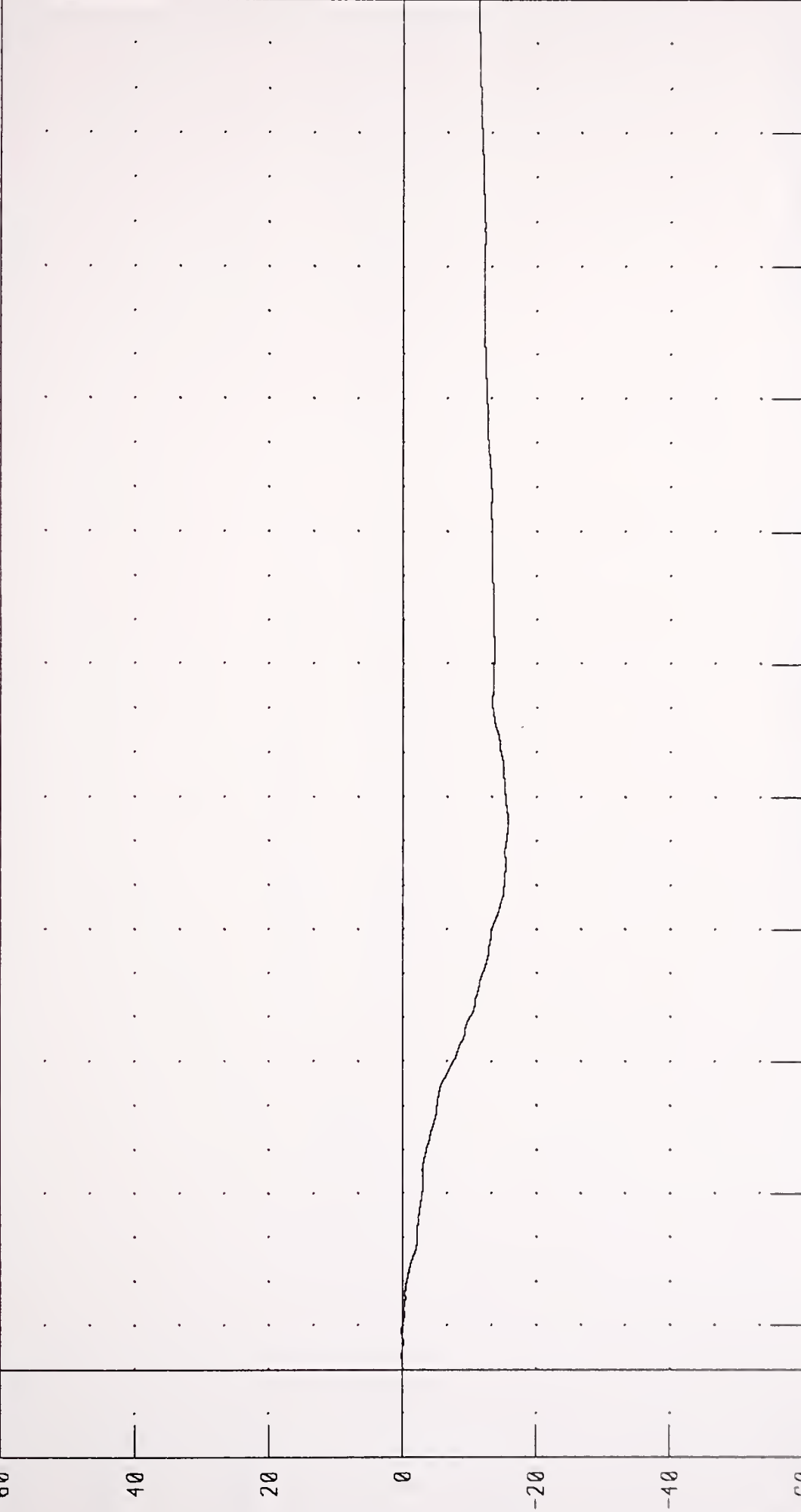
CHANNEL: RFSYV2 FILTER: CH. CLASS 180

PEAK DATA: 1.61 KM/H @ 9.52 MS; -28.61 KM/H @ 104.16 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 LEFT REAR SEAT Y-AXIS VELOCITY

TRC INC. 50% LEFT OFFSET TEST NUMBER: 951023

60



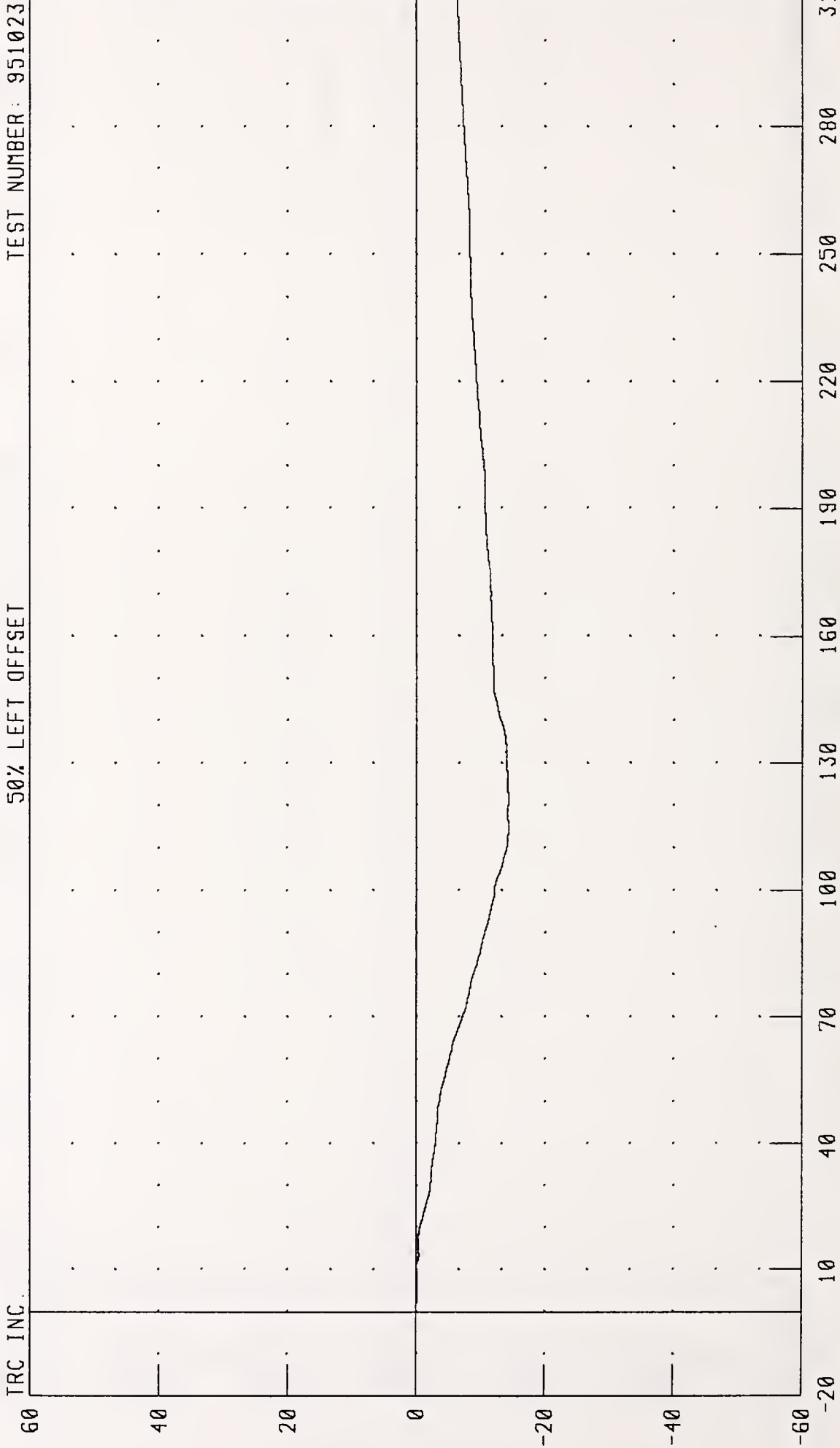
310 280 250 220 190 160 130 TIME (MS)

CHANNEL TLRV2 FILTER CH CLASS 180 PEAK DATA 0 16 KM/H @ 8.80 MS, -15.73 KM/H @ 124.48 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
RIGHT REAR SEAT Y-AXIS VELOCITY

TEST NUMBER: 951023

50% LEFT OFFSET



CHANNEL: TRRYV2 FILTER: CH CLASS 180

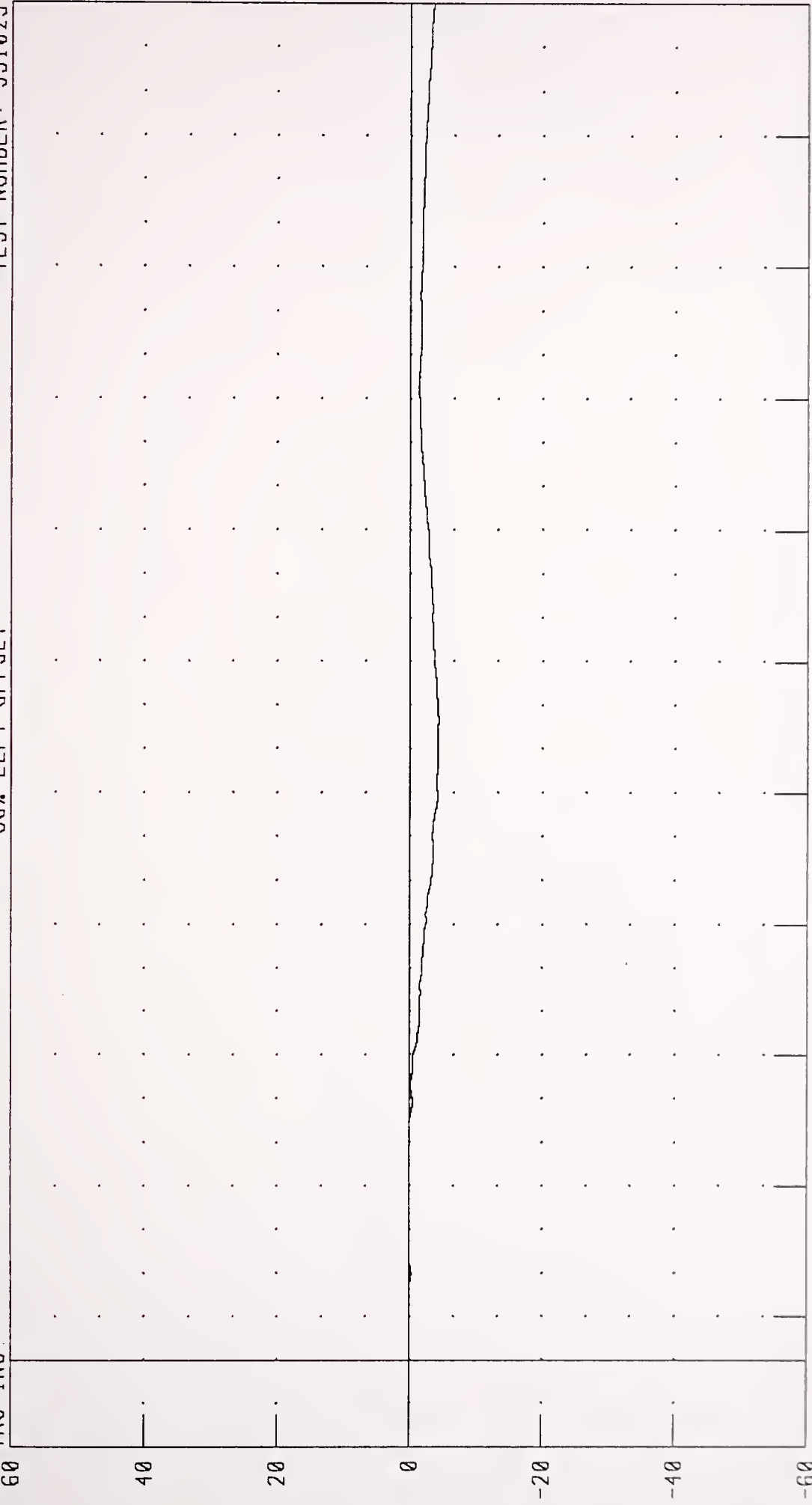
PEAK DATA: 0 00 KM/H @ 0 00 MS; -14.43 KM/H @ 114.72 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 TRUCK CENTER OF GRAVITY Y-AXIS VELOCITY

TEST NUMBER: 951023

50% LEFT OFFSET

TRC INC



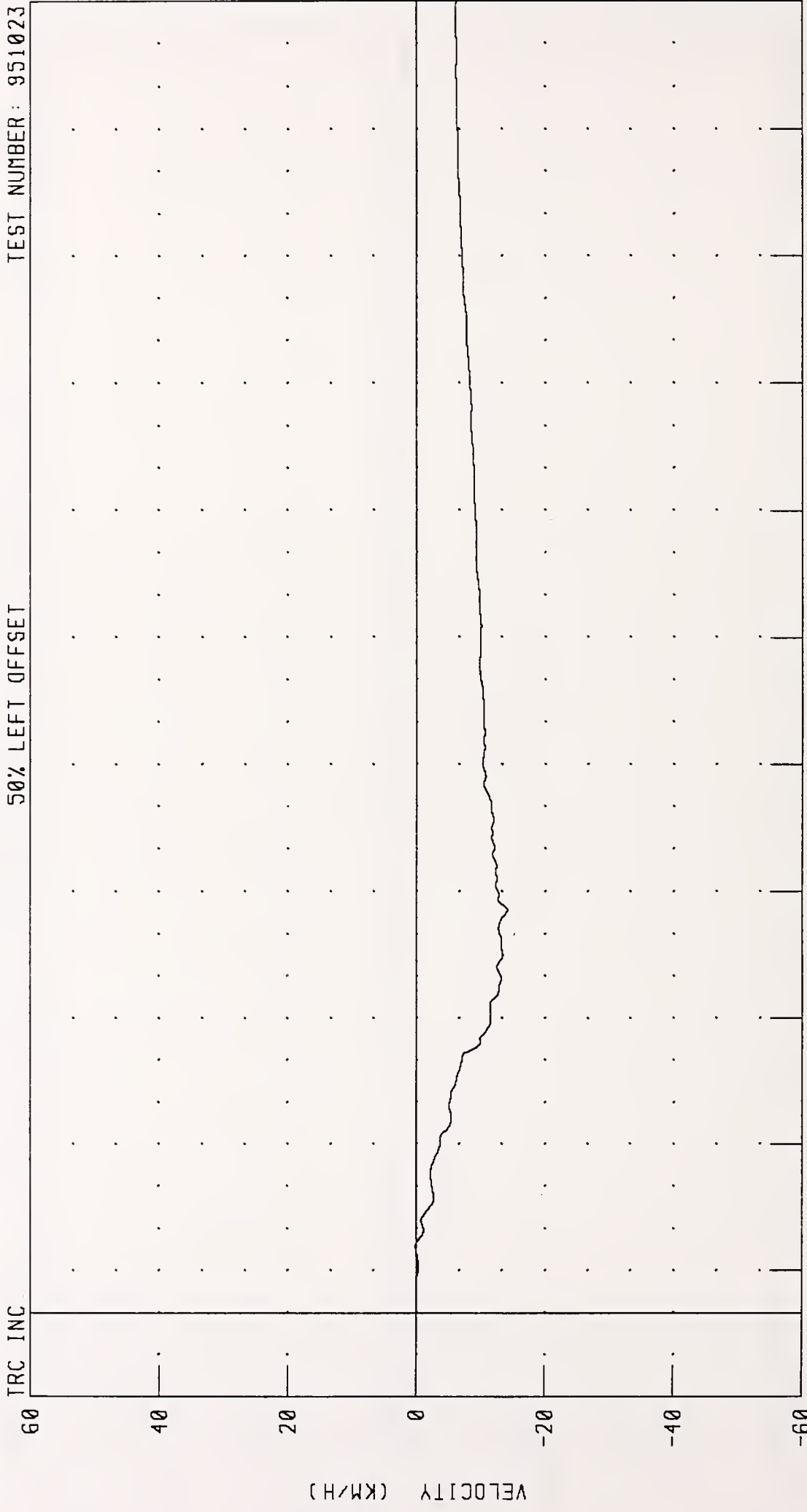
CHANNEL YCGYV1 FILTER CH CLASS 180

PEAK DATA: 0 10 KM/H @ 50 48 MS, -4 33 KM/H @ 146 40 MS

HEAVY TRUCK WITH CAB AND MODIFIED BUMPER INTO STATIONARY 1987 FORD TAURUS  
 TRUCK FRONT FRAME CROSSMEMBER Y-AXIS VELOCITY

TEST NUMBER: 951023

50% LEFT OFFSET



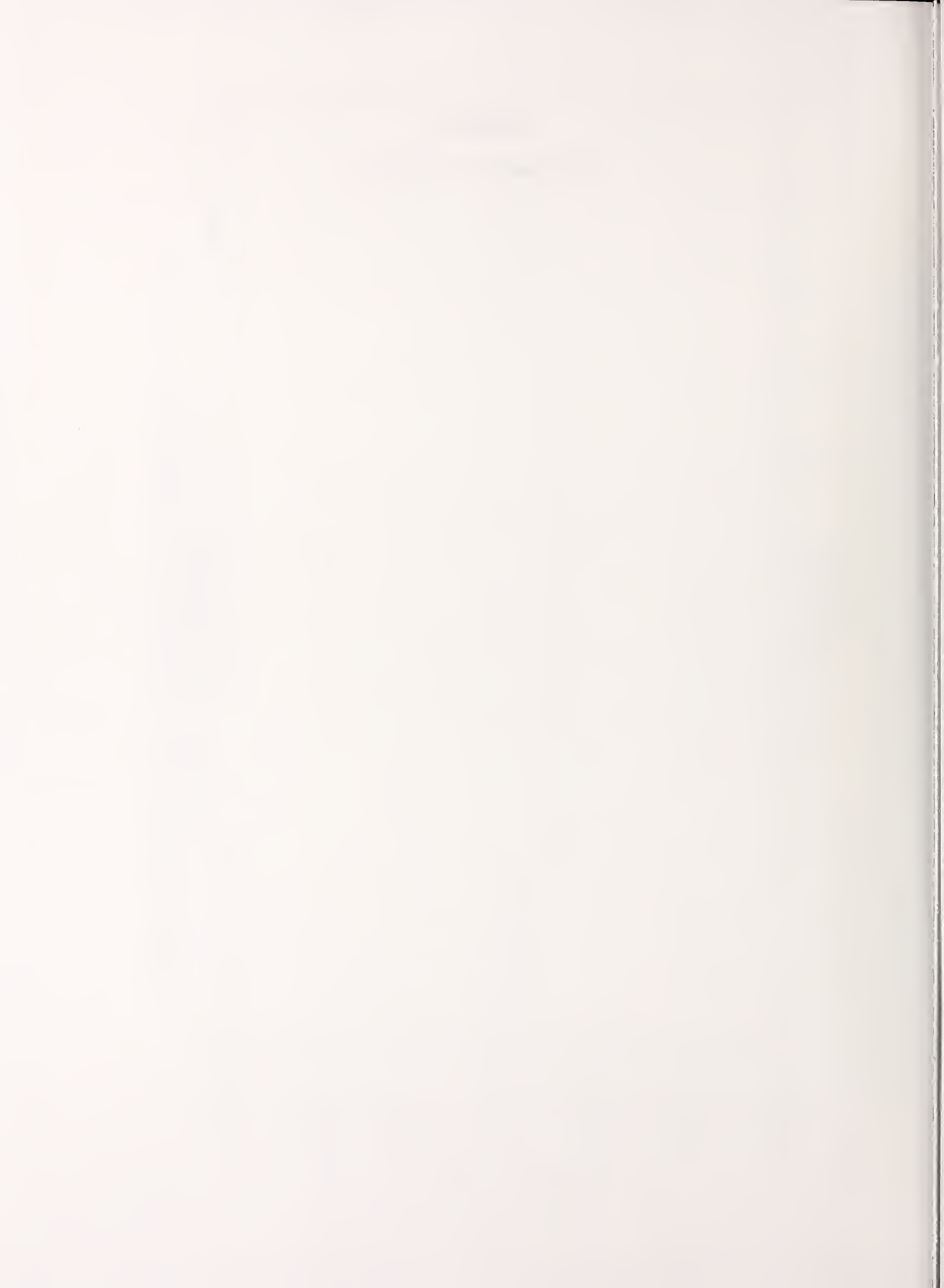
CHANNEL: FFCYV1 FILTER: CH. CLASS 180

PEAK DATA: 0.11 KM/H @ 15.68 MS; -14.20 KM/H @ 95.60 MS



Appendix C

Miscellaneous Test Information



Dummy Instrumentation Placement

Dummy Mfr. & S/N: Humanoid/043

Seating Position: Driver

Location	Axis	Mfr.	Model	S/N	Orientation (+ Sensing)
Head Acceleration	X	Endevco	7264	DC54J	Rear
Head Acceleration	Y	Endevco	7264	EY99J	Left
Head Acceleration	Z	Endevco	7264	EH75J	Up
Chest Acceleration	X	Endevco	7264	DC72J	Front
Chest Acceleration	Y	Endevco	7264	BC26J	Left
Chest Acceleration	Z	Endevco	7264	DG50J	Up
Chest Deflection	X	Servo	14CB1-2897	CP043	Outward
Pelvis Acceleration	X	Endevco	7264	BF42J	Rear
Pelvis Acceleration	Y	Endevco	7264	FJ66J	Left
Pelvis Acceleration	Z	Endevco	7264	AJ4W2	Up
Left Femur Force		GSE	2435	739	Tension
Right Femur Force		GSE	2430	741	Tension

Vehicle Instrumentation Information

Test No. 951023

No.	Location	Axis	Mfr.	Model	S/N	Orientation (+ Sensing)
1	Vehicle Center of Gravity					
	Longitudinal	X	Endevco	7264	AL40	Front
	Lateral	Y	Endevco	7264	BE24J	Right
	Vertical	Z	Endevco	7264	EH78J	Up
2	Left Front Sill					
	Longitudinal	X	Endevco	7264	AJ7K0	Front
	Lateral	Y	Endevco	7264	BH95J	Right
	Vertical	Z	Endevco	7264	BF24J	Up
3	Right Front Sill					
	Longitudinal	X	Endevco	7264	DP87J	Front
	Lateral	Y	Endevco	7264	DM66J	Left
	Vertical	Z	Endevco	7264	BI30J	Down
4	Left Rear Seat					
	Longitudinal	X	Endevco	7264	FB67J	Front
	Lateral	Y	Endevco	7264	DF92J	Left
	Vertical	Z	Endevco	7264	BT29J	Up
5	Right Rear Seat					
	Longitudinal	X	Endevco	7264	EJ69J	Front
	Lateral	Y	Endevco	7264	EH65J	Right
	Vertical	Z	Endevco	7264	AP87	Up
6	Instrument Panel Center					
Longitudinal	X	Endevco	7264	BE02J	Rear	
7	Steering Wheel Hub					
Longitudinal	X	Endevco	7264	BH14J	Rear	
	Lap Belt Outboard Force		Lebow	3419	249	Tension
	Shoulder Belt Outboard Force		Lebow	3419	616	Tension

Heavy Truck Instrumentation Information

Test No. 951023

No.	Location	Axis	Mfr.	Model	S/N	Orientation (+ Sensing)
1	Center of Gravity					
	Longitudinal	X	Endevco	7264	BC75J	Front
	Lateral	Y	Endevco	7264	BH91J	Left
	Vertical	Z	Endevco	7264	AW52	Up
2	Front Frame Crossmember					
	Longitudinal	X	Endevco	7264	BF99J	Rear
	Lateral	Y	Endevco	7264	AG24	Right
	Vertical	Z	Endevco	7264	BF04	Down

Sign Convention  
NHTSA Data Tape Reference Guide

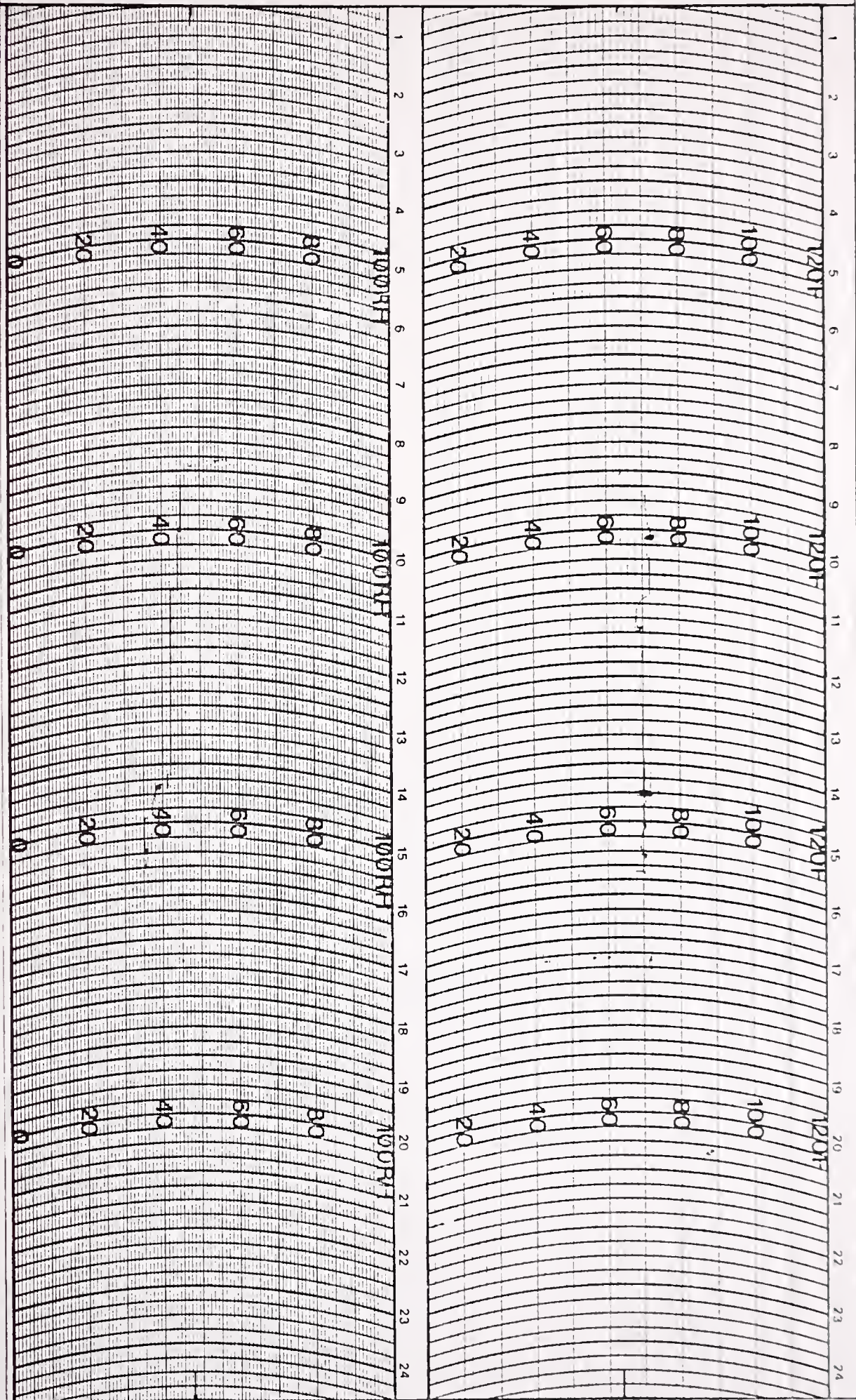
Accelerometers: +X: Forward  
+Y: Leftward  
+Z: Upward

Potentiometers: +Chest Longitudinal Deflection: outward  
+Chest Lateral Deflection: leftward  
+Seat Belt Displacement: outward  
+Seat Belt Extension: elongation  
+Knee Slider Displacement: distance between femur and tibia  
increased (in relation to a seated  
dummy)

Load Cells: +Femur Force: tension  
+Seat Belt Force: tension  
+Barrier Force: tension

Neck Load Cells: +X Force: head pushed forward  
+Y Force: head pushed leftward  
+Z Force: head pulled upward (tension on neck)  
+X Moment: right ear rotating toward right shoulder  
+Y Moment: chin rotating toward chest  
+Z Moment: chin rotating toward left shoulder

Tibia Load Cells: +X Force: tension  
+Y Force: tension  
+Z Force: tension  
+X Moment: bottom of tibia moving leftward  
+Y Moment: bottom of tibia moving rearward



WEATHER MEASURE  
 P.O. BOX 41257  
 SACRAMENTO, CA 95841  
 PHONE (916) 481-7565

HYGROTHERMOGRAPH  
 1 DAY

CHART # C311 O HF  
 PART # 699123

STATION 951023

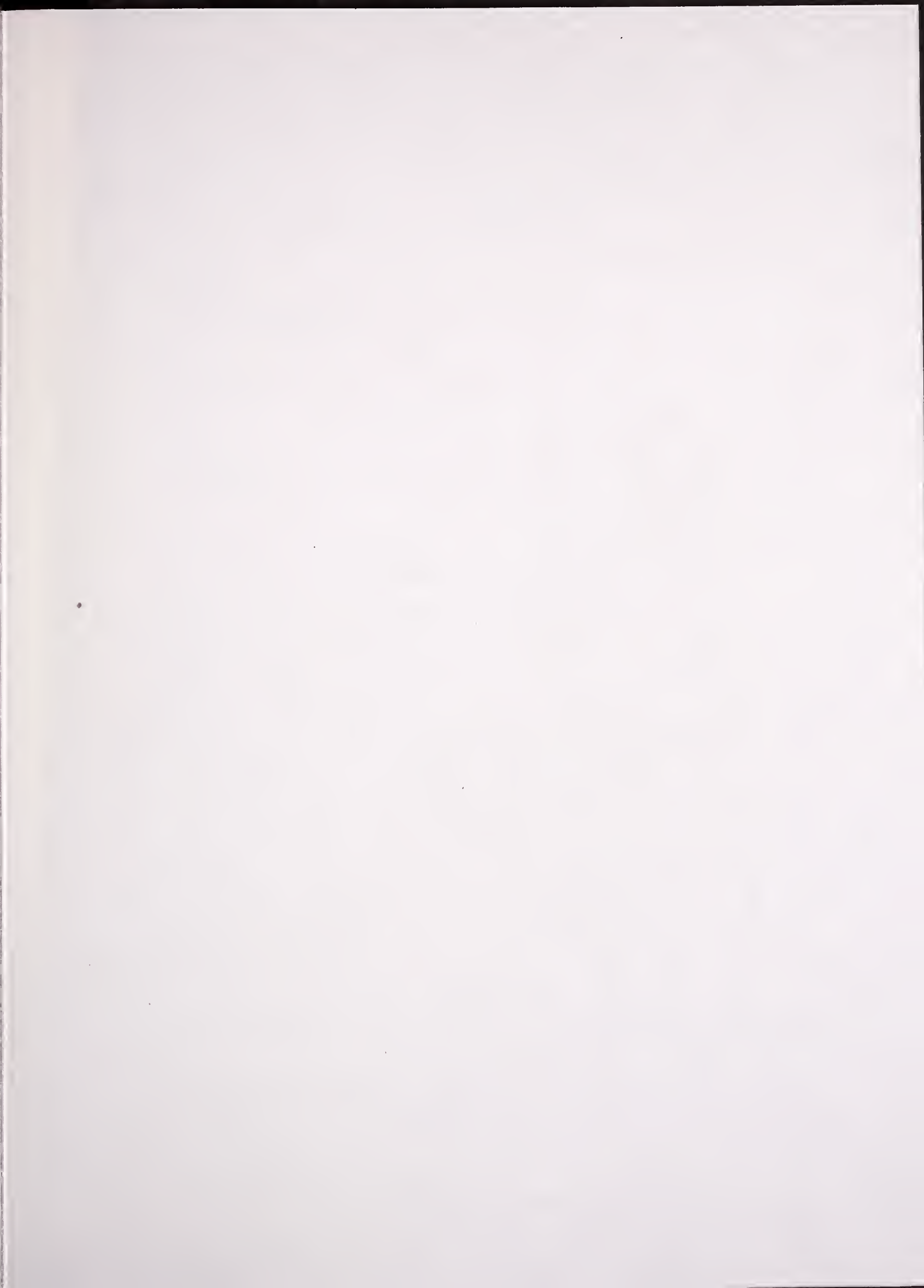
DATE ON

DATE OFF

Occupant Compartment Thermograph











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