3199

1999 Saturn SL1
into a Flat Frontal Barrier
TRC Test Number: 990816-1

Prepared by:
Transportation Research Center Inc.
10820 State Route 347
East Liberty, OH 43319

Final Report
August - September 1999

Prepared For:
Vehicle Research and Test Center
P. O. Box 37
East Liberty, OH 43319

Notice

Transportation Research Center Inc. does not endorse or certify products of manufacturers. The manufacturer's name appears solely to identify the test article. Transportation Research Center Inc. assumes no liability for the report or use thereof. It is responsible for the facts and the accuracy of the data presented herein. This report does not constitute a standard, specification, or regulation.

This publication is distributed by the U. S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Table of Contents

List of Tables

List of Figures

List of Photographs

List of Photographs, Cont'd.

List of Photographs, Cont'd.

Section 1.0

Purpose and Test Procedure

Purpose and Test Summary

This 30 mph flat frontal impact test has as the main objective to investigate both vehicle and occupant dynamics during a flat frontal test. A secondary objective is to gather information on depowered airbags.

This test was conducted with a 1999 Saturn that impacted a flat frontal barrier. The test vehicle contained two instrumented Hybrid III 5th percentile adult female dummies.

Section 2.0

Flat Frontal Barrier Impact Test Summary

Test Procedure

This test was conducted per VRTC personnel's instructions. Data was obtained relative to FMVSS 208, "Occupant Crash Protection," performance.

The test vehicle was instrumented with twelve (12) accelerometers to measure longitudinal, lateral, and vertical axis accelerations and two (2) inductive pickup switches to measure the driver and passenger airbag fire times. The vehicle's specified impact velocity range was 47.5 to 49.1 km/h. The vehicle impacted a flat frontal.

The test vehicle contained two (2) Hybrid III 5th percentile adult female anthropomorphic test devices (dummies). The dummies were positioned in the front outboard designated seating positions according to the FMVSS 208 laboratory seating procedure. Both dummies were restrained with 3-point unibelts and airbags.

Both dummies were instrumented with head and chest accelerometers to measure longitudinal, lateral, and vertical accelerations; chest deflection potentiometers; left and right femur load cells to measure axial forces; and upper neck load cells to measure forces and moments. Additionally, the passenger dummy was instrumented with load cells in the upper and lower tibias of both legs.

The fifty-four (54) data channels were digitally sampled at 12,500 samples per second and processed per Sections 11.13 through 11.15 of the Laboratory Test Procedure.

The crash event was recorded by one (1) real-time panning motion picture camera and fifteen (15) high-speed motion picture cameras. The pre-test and post-test conditions were recorded by one (1) real-time motion picture camera.

The vehicle and occupant data are summarized in Section 2.0. The FMVSS 208 data are presented in Section 3.0. The vehicle, occupant, and camera measurements are presented in Section 4.0. Appendix A contains the still photographic prints. Appendix B contains the data plots. Appendix C contains the dummy certification. Appendix D contains the miscellaneous test information.

Test Results Summary

This flat frontal barrier test was conducted at TRC on August 16, 1999.

The test vehicle, a 1999 Saturn SL1, was equipped with airbags at the driver's and right front passenger's seating positions. The vehicle's test weight was 1186.1 kilograms. The vehicle's impact speed was 50.2 km/h. The vehicle's maximum static crush was 488 millimeters.

The driver's 15-millisecond HIC was 173 and its 36-millisecond HIC was 323. The driver's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 33.7 g. The driver's chest deflection was 31.3 millimeters. The driver's left and right femur maximum compressive forces were 3266 N and 632 N, respectively. The left front driver's tibia indices are: upper left leg, 0.31; upper right leg, 0.23; lower left leg, 0.20; and lower right leg, 0.16.

The right front passenger's 15-millisecond HIC was 282 and its 36-millisecond HIC was 462. The right front passenger's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 34.0 g.[1] The passenger's chest deflection was 25.8 millimeters. The right front passenger's left and right femur maximum compressive forces were 1806 N and 705 N, respectively.

[1] See Data Acquisition Explanations

Data Acquisition Explanations

The right front passenger dummy's chest Y-axis acceleration data channel, CSTYG2, failed to record valid data throughout the test. This anomaly also affects the resultant acceleration for the chest. The chest resultant acceleration used in this report was calculated using only the X and Z data channels.

The vehicle's right brake caliper X-axis acceleration data channel, BCRXG1, lost data after approximately 66 milliseconds.

The vehicle's passenger side airbag inductive pickup data channel, ABSQ2, did not record valid data.

Table 1 Crash Test Summary

Test type:	Flat frontal impact
Test date:	990816-1
Test time:	1339
Ambient temperature at impact area:	21° C
Vehicle year/make/ model/body style:	1999/Saturn/SL1/4-door
Vehicle test weight:	1186.1 kg
Impact angle[1]:	0°
Impact velocity[2]:	
Primary:	50.2 km/h
Secondary:	48.2 km/h
Maximum static crush:	488 mm
Average rebound:	1456 mm
Number of cameras:	
Real-time:	1
High-speed:	15
Door opening data:	
Left-front:	Easy
Right-front:	Easy

[1] With respect to tow track centerline.
[2] Speed trap measurement (± .08 km/h accuracy)

Table 1 Crash Test Summary, Cont'd.

Dummies:	Driver #289	Passenger #369
Type:	Hybrid III 5th percentile adult female	Hybrid III 5th percentile adult female
Location:	Left front	Right front
Restraint:	Airbag	Airbag
Number of data channels:	25	15
Front seat data:		
Seat track failure:	None	None
Seat back failure:	None	None
Visible dummy contact points:		
Head:	Airbag/Seatback	Airbag/Seatback
Chest:	Airbag	Airbag
Abdomen:	None	None
Left knee:	Instrument panel	Instrument panel
Right knee:	Instrument panel	Instrument panel

Table 2 Test Vehicle Information

Vehicle year/make/ model/body style:	1999/Saturn/SL1/4-door
Color:	Gold
VIN:	1G8ZG5289XZ208090
Engine data:	
Placement:	Transverse/lateral
Cylinders:	4
Displacement:	1.9 liters
Transmission data:	_5_ speed, _X_ manual, ___ automatic, ___ overdrive
Final drive:	_X_ fwd, ___ rwd, ___ 4wd
Date vehicle received:	N/A
Odometer reading:	98 miles
Dealer's name and address:	N/A

Accessories:

Power steering	Yes	Automatic transmission	No
Power brakes	Yes	Automatic speed control	No
Power seats	No	Tilting steering wheel	Yes
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
Power door locks	No	Other:	None

Certification data from vehicle's label:

Vehicle manufactured by:		Saturn Corporation
Date of manufacture:		11/98
VIN:		1G8ZG5289XZ208090
GVWR:		3251 lb.
GAWR:	Front:	1647 lb.
	Rear:	1604 lb.

Table 2 Test Vehicle Information, Cont'd.

Size of tires on vehicle:	P175/70R14
Spare tire:	Space saver
Type of front seats:	Bucket

Tire & capacity data from vehicle's label:

Recommended tire size:	P175/70R14
Recommended cold tire pressure:	
Front:	30 psi
Rear:	26 psi
Designated Seating Capacity:	
Front	2
Rear	3
Total	5
Vehicle Cargo Weight:	849 lb.

Test vehicle attitudes:

Delivered attitude:	LF:	671 mm	RF:	677 mm	LR:	678 mm	RR:	671 mm
Fully loaded attitude:	LF:	659 mm	RF:	666 mm	LR:	650 mm	RR:	651 mm
Pre-test attitude:	LF:	655 mm	RF:	656 mm	LR:	648 mm	RR:	644 mm
Post-test attitude:	LF:	659 mm	RF:	645 mm	LR:	650 mm	RR:	636 mm

Table 2 Test Vehicle Information, Cont'd.

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

Right front	317.1 kg	Right rear	207.3 kg
Left front	322.1 kg	Left rear	206.4 kg
Total front weight	639.2 kg	(61% of total vehicle weight)	
Total rear weight	413.7 kg	(39% of total vehicle weight)	
Total delivered weight	1052.9 kg		

Calculation of test vehicle's target test weight:

RCLW = Rated Cargo and Luggage Weight

UDW = Unloaded Delivered Weight (1052.9 kg)

DSC[1] = Designated Seating Capacity (5)

RCLW[2] = 44.9 kg

Target test weight = UDW + RCLW + (number of Hybrid III Dummies x 47.6 kg per dummy)

Target test weight = 1052.9 + 44.9 + 95.2 = 1193.0 kg

Weight of test vehicle with required dummies and 38.0 kg of cargo weight:

Right front	325.7 kg	Right rear	265.8 kg
Left front	346.5 kg	Left rear	248.1 kg
Total front weight	672.2 kg	(56% of total vehicle weight)	
Total rear weight	513.9 kg	(43% of total vehicle weight)	
Total test weight	1186.1 kg	(0.58% under target test weight)	

Weight of ballast secured in vehicle: None

Components removed to meet target test weight: rear seat, package shelf liner, rear speakers, rear bumper facia, rear wheel well liners, muffler, rear tie-down hook, rear door seals, rear door panels, rear door glass, spare tire, jack, rear door window crank assemblies, C-pillar trim, rear seatbelt retractors, third brake light, and license light.

CG rearward of front wheel centerline: 1126 mm

Vehicle Wheelbase: 2600 mm

[1] The designated seating capacity is determined by counting the number of seat belts installed in the vehicle.

[2] From vehicle's tire label.

Table 3 Post-Impact Data

Test number:	990816-1
Test date:	08/16/99
Test time:	1339
Test type:	flat frontal impact
Impact angle:	0°
Ambient temperature at impact area:	21° C
Temperature in occupant compartment:	21° C

Impact velocity:

Primary:	50.2 km/h
Secondary	48.2 km/h
Specified range:	47.5 to 49.1 km/h

Distance from vehicle to barrier:

Entering velocity trap:	356 mm
Exiting velocity trap:	51 mm

Test vehicle static crush:

Overall length of test vehicle:

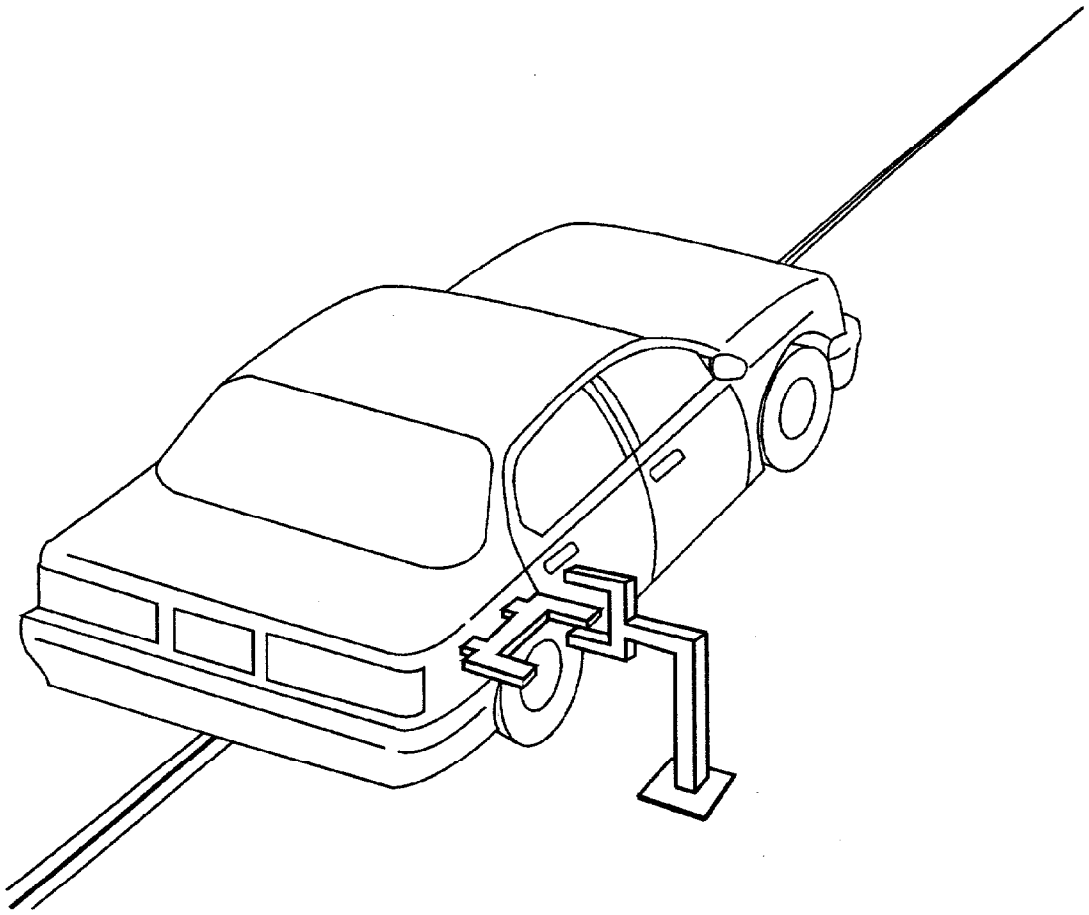
Pre-test:	L: 4555 mm	C: 4700 mm	R: 4555 mm
Post-test:	L: 4400 mm	C: 4212 mm	R: 4252 mm
Total crush:	L: 155 mm	C: 488 mm	R: 303 mm
Average crush:	379 mm		

Test vehicle rebound from flat frontal:

Distance from test vehicle to barrier:

Post-test:	L: 1498 mm	C: 1379 mm	R: 1493 mm
Average rebound:	1456 mm		

Figure 1 Impact Velocity Measurement System

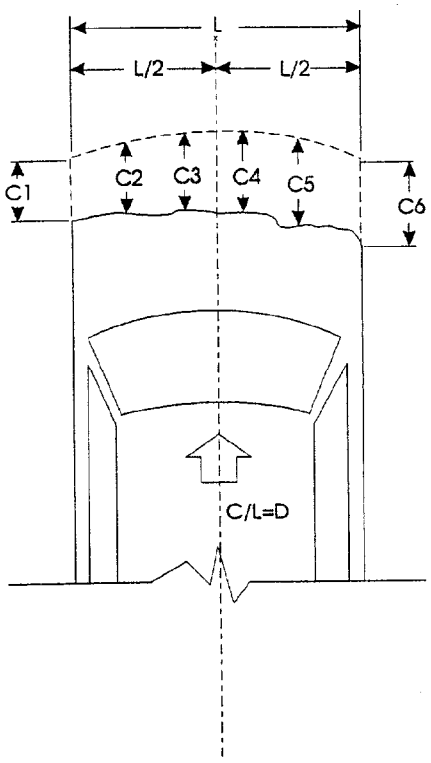


The final vane clears the final emitter/receiver pair 51 millimeters before impact.

The vanes have 305-millimeter spacing.

Figure 2 Accident Investigation Division Data for 30 mph Flat Frontal Barrier Impact

Test date:	990816-1
Vehicle year/make/ model/body style:	1999/Saturn/SL1/4-door
VIN:	1G8ZG5289XZ208090
Build date:	11/98
Test weight:	1186.1 kg
Vehicle wheelbase:	2600 mm
Maximum width:	1688 mm
Front overhang:	980 mm



Collision Deformation Classification (CDC) Code: 12FDEW2

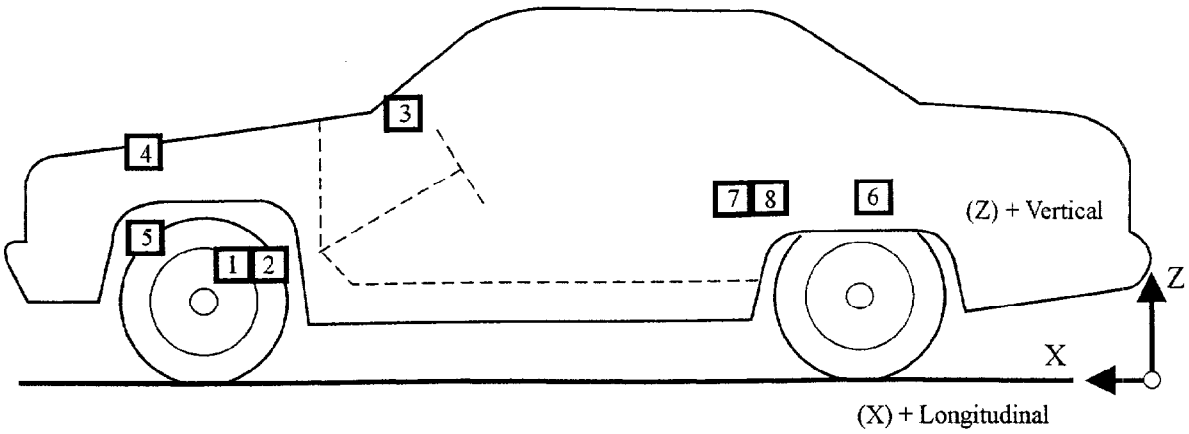
Crush depth measurements:

C1:	245
C2:	355
C3:	439
C4:	430
C5:	399
C6:	303

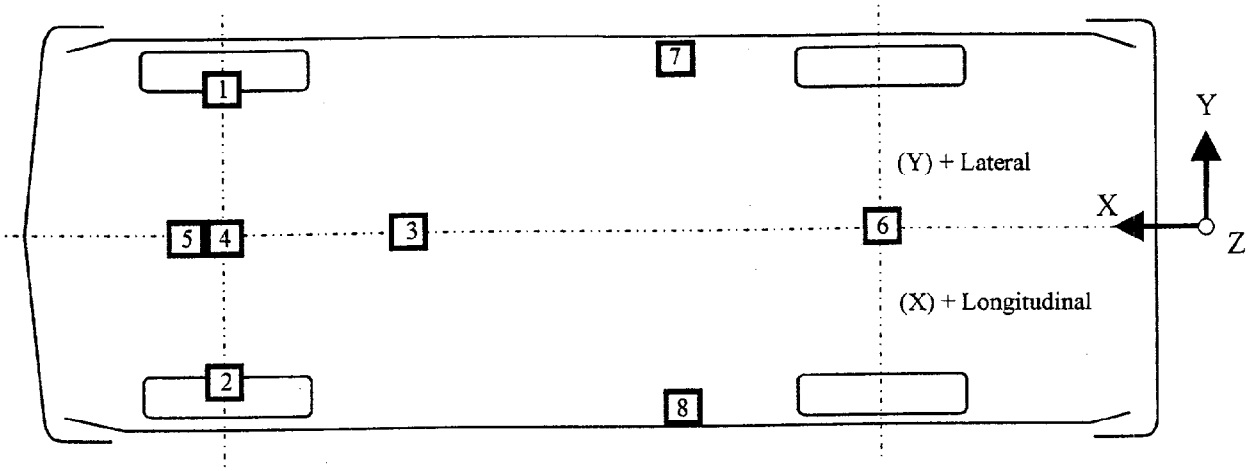
Midpoint of damage: D: Vehicle Longitudinal Centerline

Length of damaged region: L: 1525 mm

Figure 3 Vehicle Accelerometer Placement



Side View



Bottom View

Table 4 Vehicle Accelerometer Locations and Data Summary

TEST NUMBER: 990816-1 No. LOCATION		X	Y	Z	POSITIVE DIRECTION		NEGATIVE DIRECTION	
1 LEFT BRAKE CALIPER	PRE	3635 mm	630 mm	323 mm				
	POST	3474 mm	624 mm	283 mm				
LONGITUDINAL					19.9 g	@ 78.5 ms	57.9 g	@ 61.0 ms
2 RIGHT BRAKE CALIPER	PRE	3635 mm	-134 mm	180 mm				
	POST	3472 mm	630 mm	325 mm				
LONGITUDINAL[1]					---	---	---	---
3 INSTRUMENT PANEL CENTER	PRE	3098 mm	0 mm	857 mm				
	POST	3000 mm	0 mm	837 mm				
LONGITUDINAL					29.8 g	@ 38.6 ms	71.1 g	@ 49.9 ms
LATERIAL					10.5 g	@ 29.7 ms	15.4 g	@ 25.5 ms
4 ENGINE TOP	PRE	3859 mm	-186 mm	800 mm				
	POST	3656 mm	-141 mm	816 mm				
LONGITUDINAL					23.7 g	@ 59.4 ms	68.0 g	@ 28.3 ms
5 ENGINE BOTTOM	PRE	3600 mm	-179 mm	236 mm				
	POST	3597 mm	-134 mm	180 mm				
LONGITUDINAL					25.8 g	@ 65.8 ms	65.9 g	@ 46.1 ms

Table 4 Vehicle Accelerometer Locations and Data Summary, Cont'd.

TEST NUMBER: 990816-1 No. LOCATION		X	Y	Z	POSITIVE DIRECTION		NEGATIVE DIRECTION	
6 REAR VEHICLE	PRE	444 mm	0 mm	495 mm				
CENTERLINE	POST	440 mm	0 mm	486 mm				
LATERAL					3.1 g	@ 94.7 ms	4.3 g	@ 70.3 ms
VERTICAL					11.3 g	@ 35.9 ms	9.5 g	@ 190.2 ms
7 LEFT REAR SEAT	PRE	1790 mm	595 mm	313 mm				
	POST	1790 mm	595 mm	307 mm				
LONGITUDINAL					2.0 g	@ 137.3 ms	23.6 g	@ 79.6 ms
LATERAL					2.6 g	@ 18.3 ms	4.0 g	@ 24.3 ms
8 RIGHT REAR SEAT	PRE	1790 mm	-595 mm	315 mm				
	POST	1790 mm	-595 mm	291 mm				
LONGITUDINAL					1.7 g	@ 145.0 ms	24.8 g	@ 64.5 ms
LATERAL					4.9 g	@ 20.8 ms	3.1 g	@ 25.4 ms

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

[1]See DATA ACQUISITION EXPLANATIONS

Section 3.0

FMVSS 208 Data

Table 5 Dummy Injury Criteria

Maximum Acceleration

	Head				Chest		
	X	Y	Z	R	X	Y	Z
Driver	-43.9 g	-10.8 g	18.6 g	44.9 g	-36.7 g	-3.4 g	-8.7 g
Passenger	-51.7 g	-3.4 g	18.8 g	54.6 g	-35.2 g	N/A	8.5 g

Maximum Femur Compressive Force

	Left Femur	Right Femur
Driver	3266 N	632 N
Passenger	1806 N	705 N

15-millisecond Head Injury Criteria [1]

	HIC	Time t_1	Time t_2
Driver	173	55.2 ms	70.2 ms
Passenger	282	71.8 ms	86.8 ms

36-millisecond Head Injury Criteria[1]

	HIC	Time t_1	Time t_2
Driver	323	43.4 ms	79.4 ms
Passenger	462	59.0 ms	95.0 ms

Chest Maximum Resultant Acceleration[2]

	Acceleration	Time t_1	Time t_2
Driver	33.7 g	45.2 ms	48.2 ms
Passenger[3]	34.0 g	61.5 ms	64.5 ms

Maximum Chest Deflection

Driver	31.3 mm
Passenger	25.8 mm

[1] As defined in FMVSS No. 208
[2] Defined as equal to or exceeding 0.003 sec. duration
[3] See Data Acquisition Explanations

Dummy Kinematic Summary

Driver Dummy

Upon impact, the driver dummy translated forward on the seat impacting both knees into the instrument panel. The dummy's head and chest impacted the airbag. The driver dummy then rebounded back into the driver's seat. The back of the driver dummy's head hit the headrest. The driver dummy came to rest seated in an upright position in the driver's seat.

Right Front Passenger Dummy

Upon impact, the passenger dummy translated forward on the seat impacting both knees into the instrument panel. The dummy's head and chest impacted the airbag. The passenger dummy then rebounded back into the passenger's seat. The back of the passenger dummy's head hit the headrest. The passenger dummy came to rest seated in an upright position in the passenger seat.

Section 4.0

Vehicle, Occupant, and Camera Measurements

Figure 4 Pre-test and Post-test Measurement Points

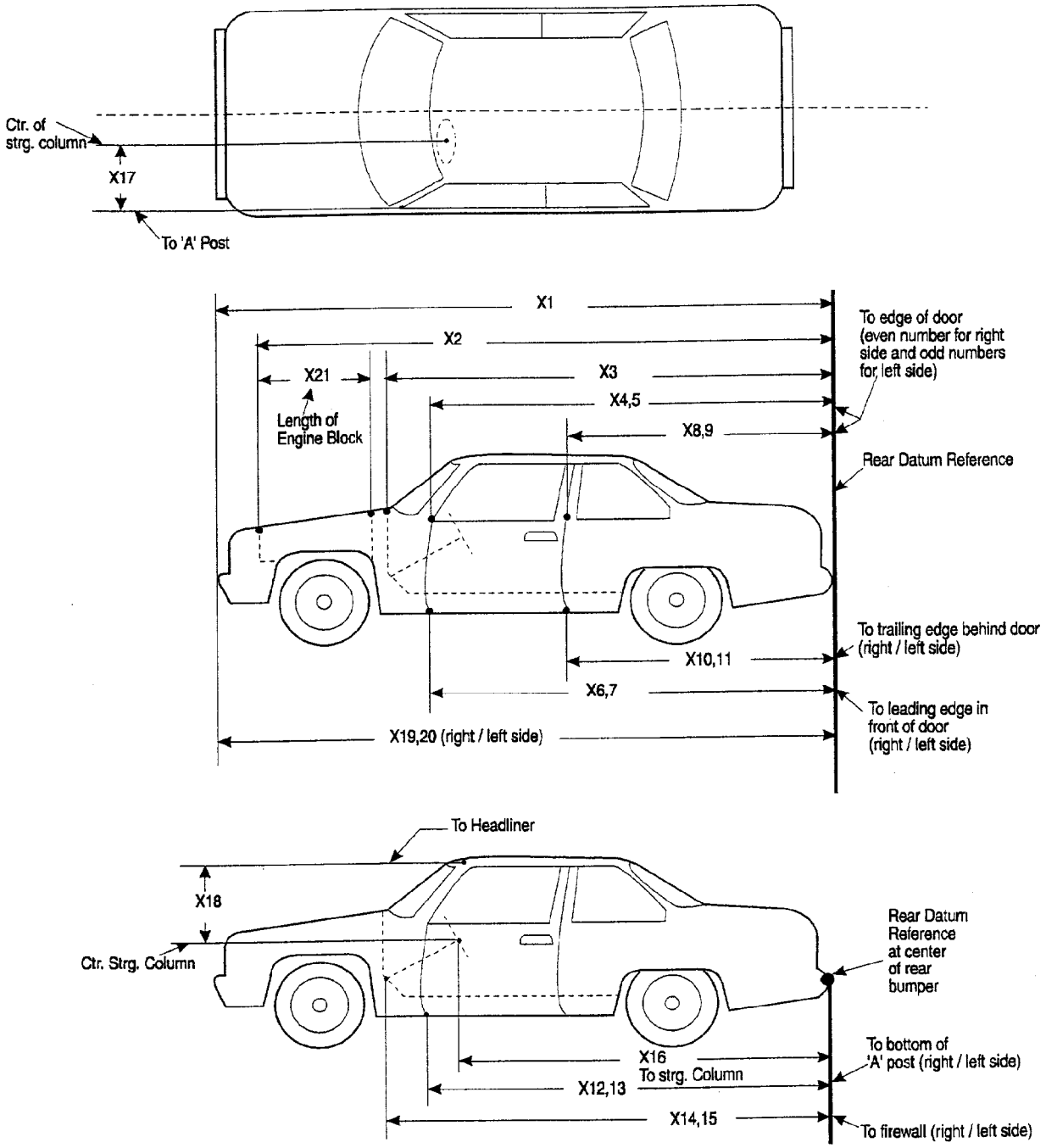


Table 6 Impacted Vehicle Measurements

1999/Satunr/SL1/4-door

Test Number: 990816-1

No.	Type of measurement	Pre-Test	Post-Test	Difference
X1	Total Length of Veh. at Centerline	4700	4212	488
X2	Rear Surface of Veh. to Front of Engine Block	3994	3773	221
X3	Rear Surface of Veh. to Firewall	3610	3545	65
X4	Rear Surface of Veh. to Upper Leading Edge of Right Door	3178	3174	4
X5	Rear Surface of Veh. to Upper Leading Edge of Left Door	3184	3186	-2
X6	Rear Surface of Veh. to Lower Leading Edge of Right Door	3161	3156	5
X7	Rear Surface of Veh. to Lower Leading Edge of Left Door	3171	3169	2
X8	Rear Surface of Veh. to Upper Trailing Edge of Right Door	2221	2219	2
X9	Rear Surface of Veh. to Upper Trailing Edge of Left Door	2225	2228	-3
X10	Rear Surface of Veh. to Lower Trailing Edge of Right Door	2235	2232	3
X11	Rear Surface of Veh. to Lower Trailing Edge of Left Door	2246	2244	2
X12	Rear Surface of Veh. to Bottom of " A " Post on Right Side	3180	3150	30
X13	Rear Surface of Veh. to Bottom of " A " Post on Left Side	3180	3163	17
X14	Rear Surface of Veh. to Firewall--Right Side	3555	3541	14
X15	Rear Surface of Vehicle to Firewall --Left Side	3565	3503	62
X16	Rear Surface of Veh. to Steering Wheel Center	2760	2765	-5
X17	Center of Steering Column to " A " Post	280	298	-18
X18	Center of Steering Column to Headliner	460	440	20
X19	Rear Surface of Veh. to Right Side of Front Bumper	4555	4252	303
X20	Rear Surface of Veh. to Left Side of Front Bumper	4555	4400	155
X21	Length of Engine Block	410	410	0

Figure 5 Vehicle Target Locations

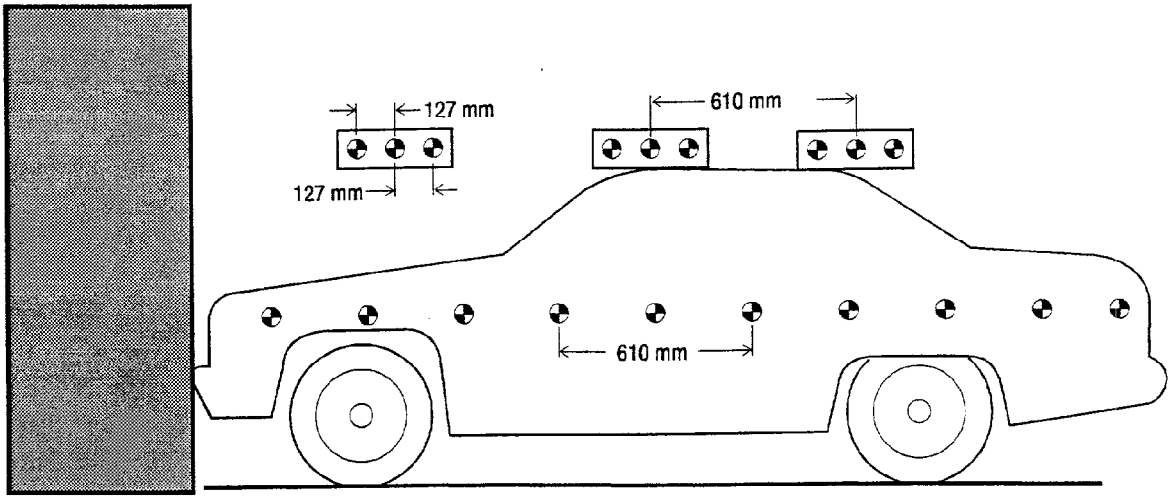


Figure 6 Dummy Measurement Locations for Front Seat Occupants

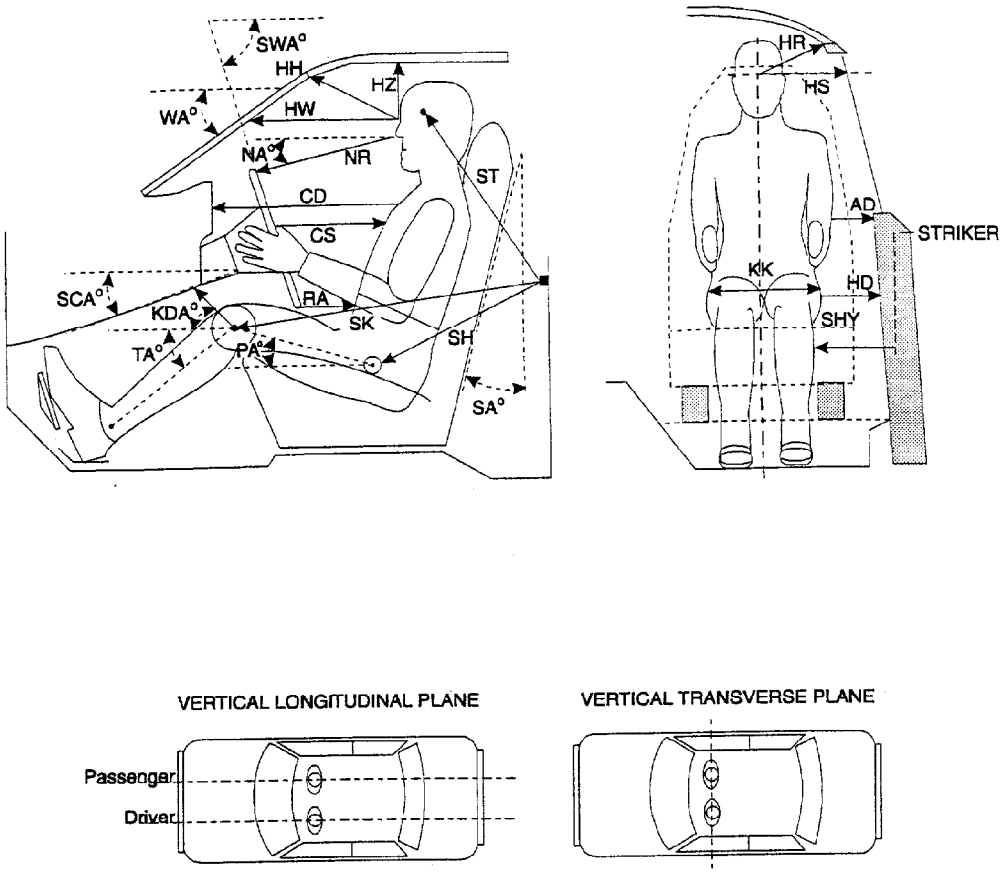


Table 7 Dummy Measurement Data For Front Seat Occupants

Designation	Type of Measurement	Driver (Serial #289)	Passenger (Serial #369)
WA	Windshield angle	25.0°	25.0°
SWA	Steering wheel angle	72.2°	N/A
SCA	Steering column angle	17.8°	N/A
SA	Seat back angle	71.5°	66.9°
HZ	Head to roof	215 mm	207 mm
HH	Head to header	279 mm	268 mm
HW	Head to windshield	603 mm	618 mm
HR	Head to side header	250 mm	252 mm
NR	Nose to rim	248 mm	N/A
NA	Nose to rim angle	8.2°	N/A
CD	Chest to dash	424 mm	383 mm
CS	Steering wheel to chest	223 mm	N/A
RA	Rim to abdomen	172 mm	N/A
KDL	Left knee to dash	127 mm	129 mm
KDR	Right knee to dash	143 mm	134 mm
KDA	Outboard knee to dash angle	57.1°	54.3°
PA	Pelvic angle	20.9°	18.5°
TA	Tibial angle	61.6°	55.4°
KK	Knee to knee	287 mm	203 mm
ST[1]	Striker to head	413 mm	417 mm
	Striker to head angle	-72.7°	-64.6°
SK[1]	Striker to knee	610 mm	613 mm
	Striker to knee angle	4.5°	6.8°
SH[1]	Striker to H-point	372 mm	386 mm
	Striker to H-point angle	32.5°	37.2°
SHY	Striker to H-point (Y-direction)	220 mm	225 mm
HS	Head to side window	345 mm	344 mm
HD	H-point to door	160 mm	172 mm
AD	Arm to door	155 mm	155 mm

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

[1] A negative angle indicates the measurement point was above the striker.

Figure 7 Camera Positions

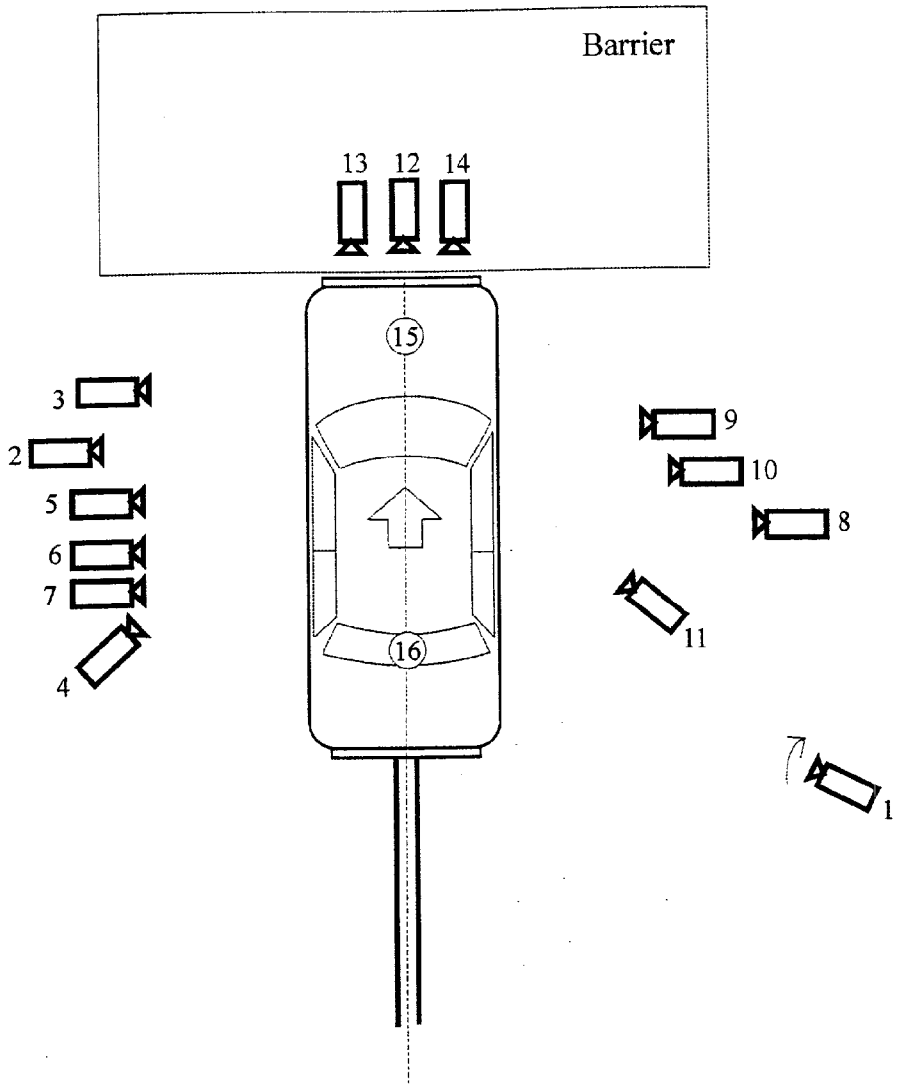


Table 8 Motion Picture Camera Locations

Vehicle year/make/model/body style: 1999/Saturn/SL1/4-door

Test number: 990816-1

Camera Number	View	Camera Positions[1] X	Y	Z	Camera Angle[2]	Film Plane to Head Target	Camera Lens	Film Speed
1	Real-time panning	NA	NA	NA	NA	NA	16 mm	24 frames/s
2	Left vehicle crush	1499 mm	660 mm	8738 mm	0°	mm	25 mm	1000 frames/s
3	Left windshield intrusion	1041 mm	5613 mm	7137 mm	0°	mm	50 mm	995 frames/s
4	Driver kinematics	2667 mm	5537 mm	1473 mm	0°	mm	25 mm	1030 frames/s
5	Driver kinematics	3861 mm	1600 mm	2032 mm	-20°	mm	25 mm	995 frames/s
6	Steering column motion	2692 mm	5283 mm	2921 mm	-17°	mm	25 mm	950 frames/s
7	Steering column motion	2692 mm	5410 mm	1905 mm	-6°	mm	25 mm	1005 frames/s
8	Right overall	2794 mm	-6782 mm	813 mm	0°	mm	13 mm	960 frames/s
9	Right windshield intrusion	940 mm	-6579 mm	1118 mm	0°	mm	50 mm	982 frames/s
10	Passenger kinematics	2667 mm	-5537 mm	1473 mm	-3°	mm	25 mm	1035 frames/s
11	Passenger kinematics	3861 mm	-1600 mm	2032 mm	-20°	mm	25 mm	995 frames/s
12	Windshield front view	-381 mm	0 mm	2413 mm	-60°	NA	8.5 mm	1000 frames/s
13	Driver - front view	-381 mm	305 mm	2413 mm	-48°	NA	17 mm	1000 frames/s
14	Passenger - front view	-381 mm	-305 mm	2413 mm	-48°	NA	17 mm	1000 frames/s
15	Pit tight	1295 mm	0 mm	-3048 mm	90°	NA	13 mm	1000 frames/s
16	Pit wide	2946 mm	0 mm	-3048 mm	90°	NA	13 mm	835 frames/s
	Real-time documentation	NA	NA	NA	NA	NA	12-120 mm	24 frames/s

[1] +X: Film plane forward of barrier face
+Y: Film plane to left of monorail centerline
+Z: Film plane above ground level

[2] +Angle: Film plane angled upward from horizontal plane

Figure A-1 Pre-Test Front View

Figure A-2 Post-Test Front View

Figure A-3 Pre-Test Left Side View

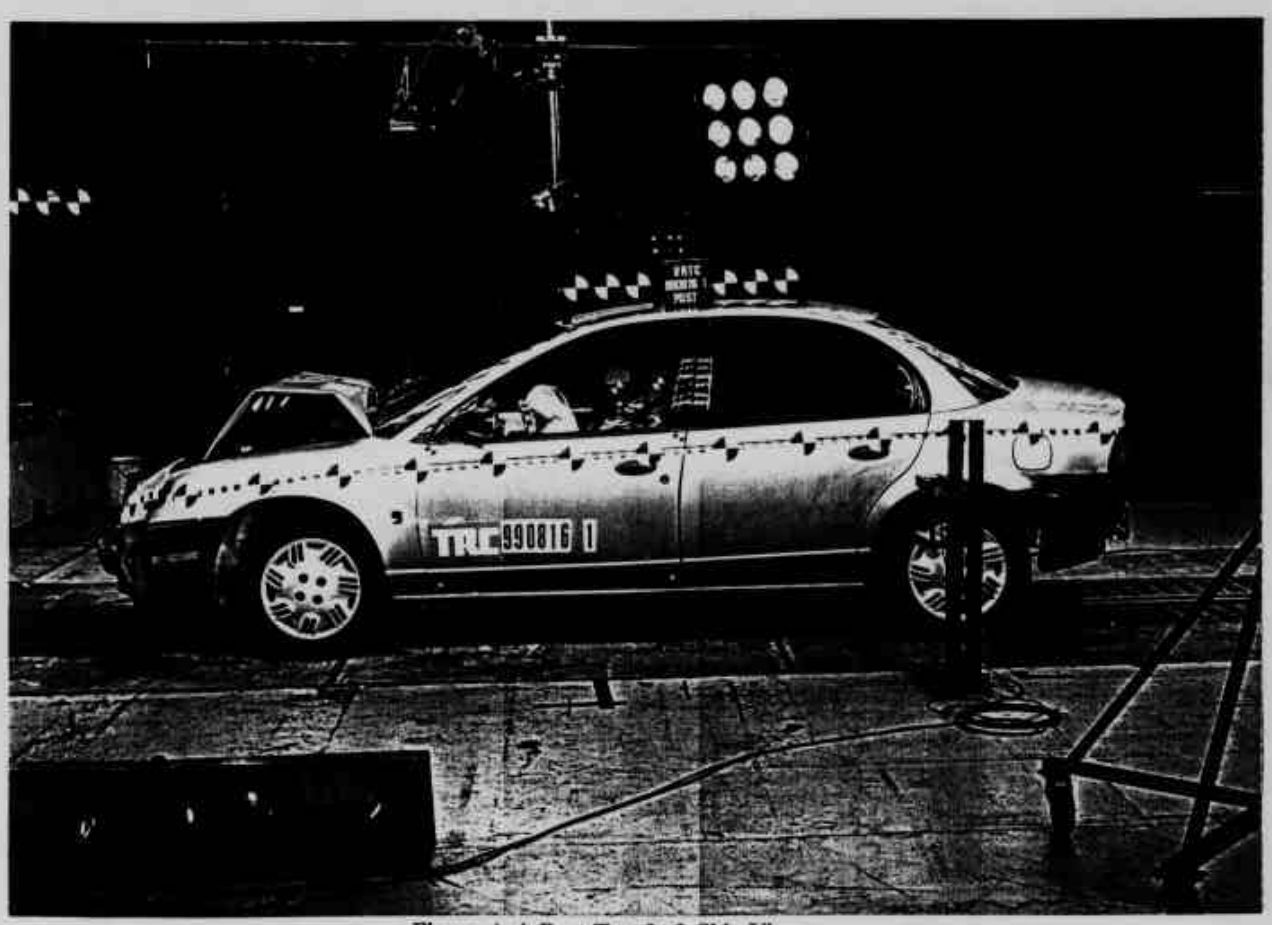


Figure A-4 Post-Test Left Side View

Figure A-5 Pre-Test Left Rear Three-Quarter View

Figure A-6 Post-Test Left Rear Three-Quarter View

Figure A-7 Pre-Test Rear View

Figure A-8 Post-Test Rear View

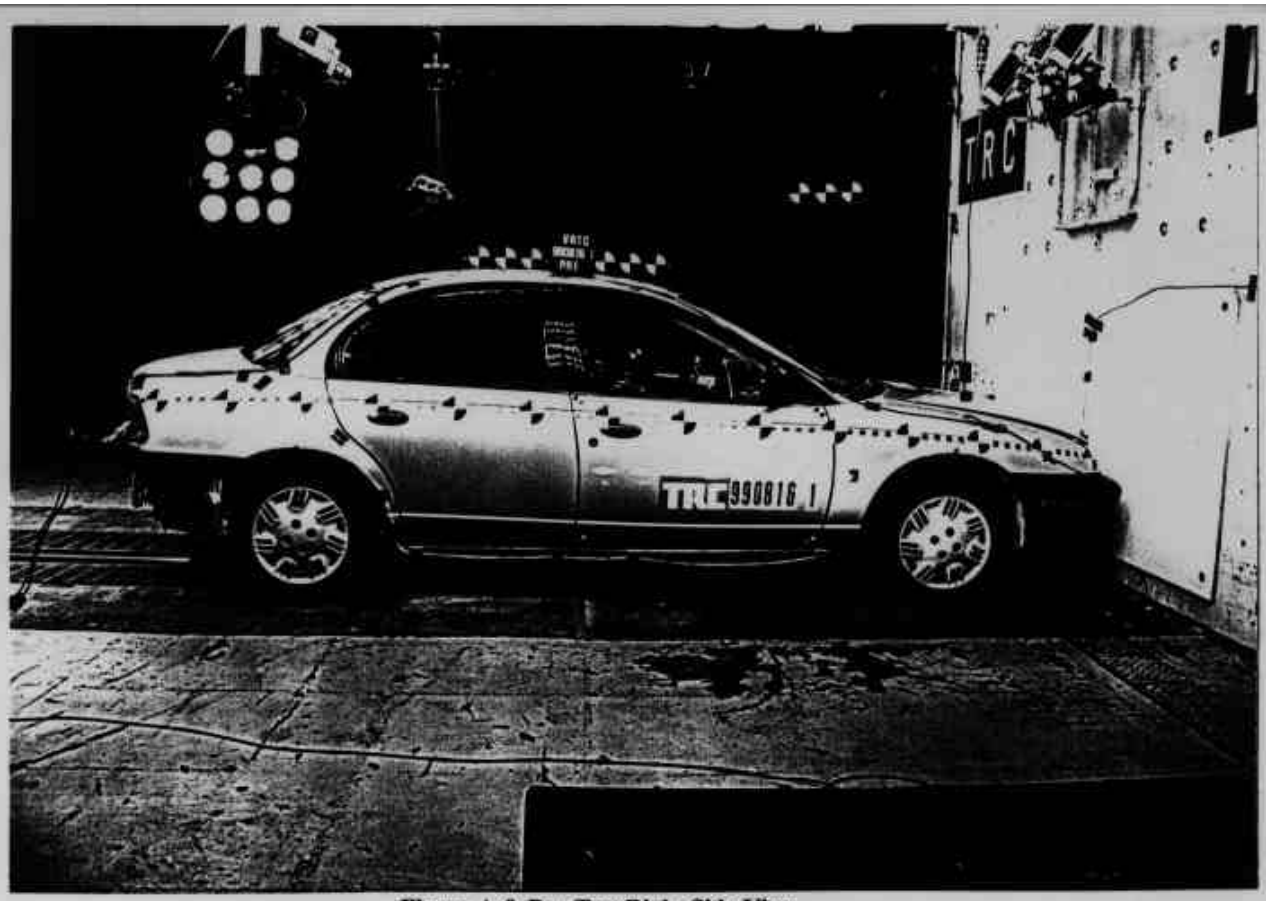


Figure A-9 Pre-Test Right Side View

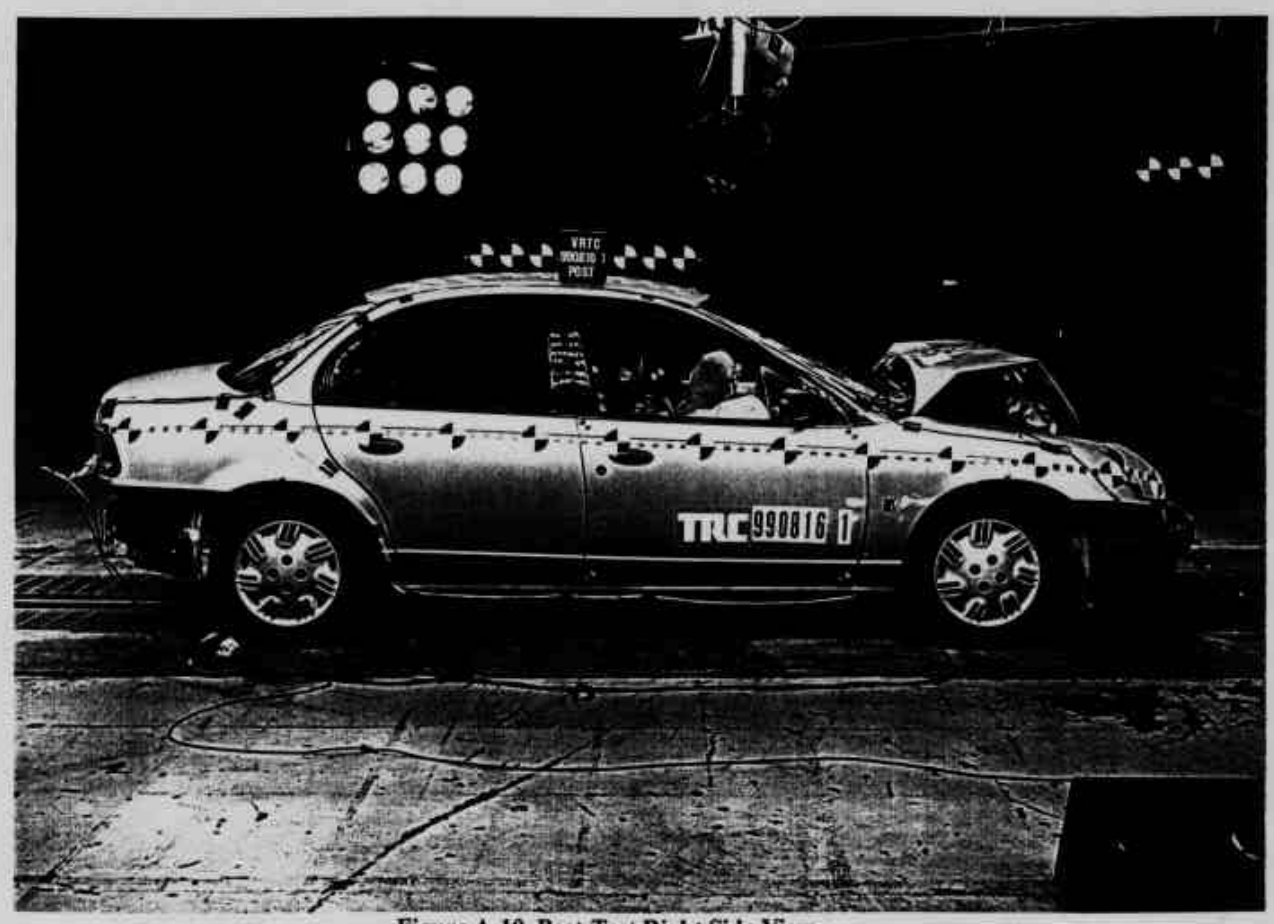


Figure A-10 Post-Test Right Side View

Figure A-11 Pre-Test Right Front Three-Quarter View

Figure A-12 Post-Test Right Front Three-Quarter View

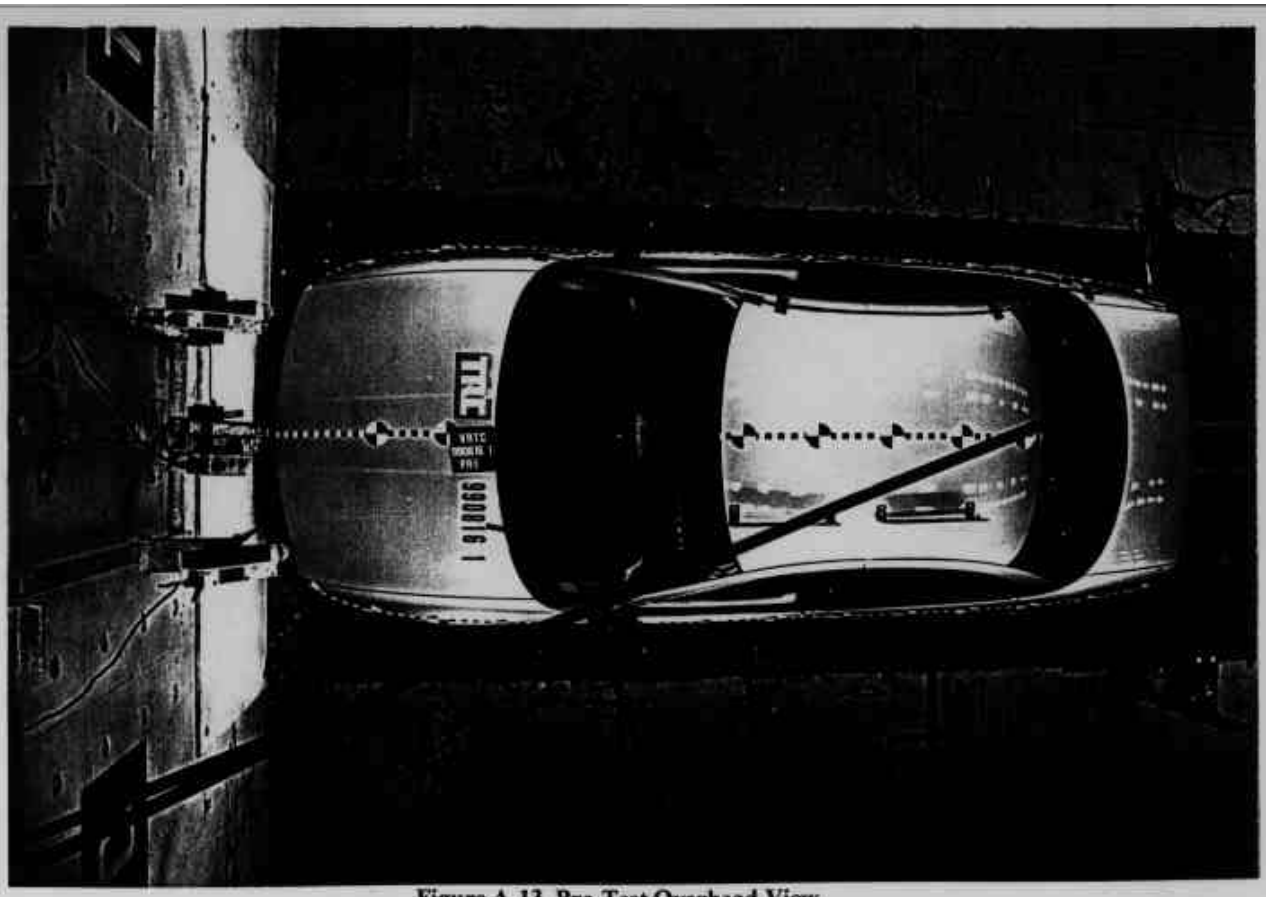


Figure A-13 Pre-Test Overhead View

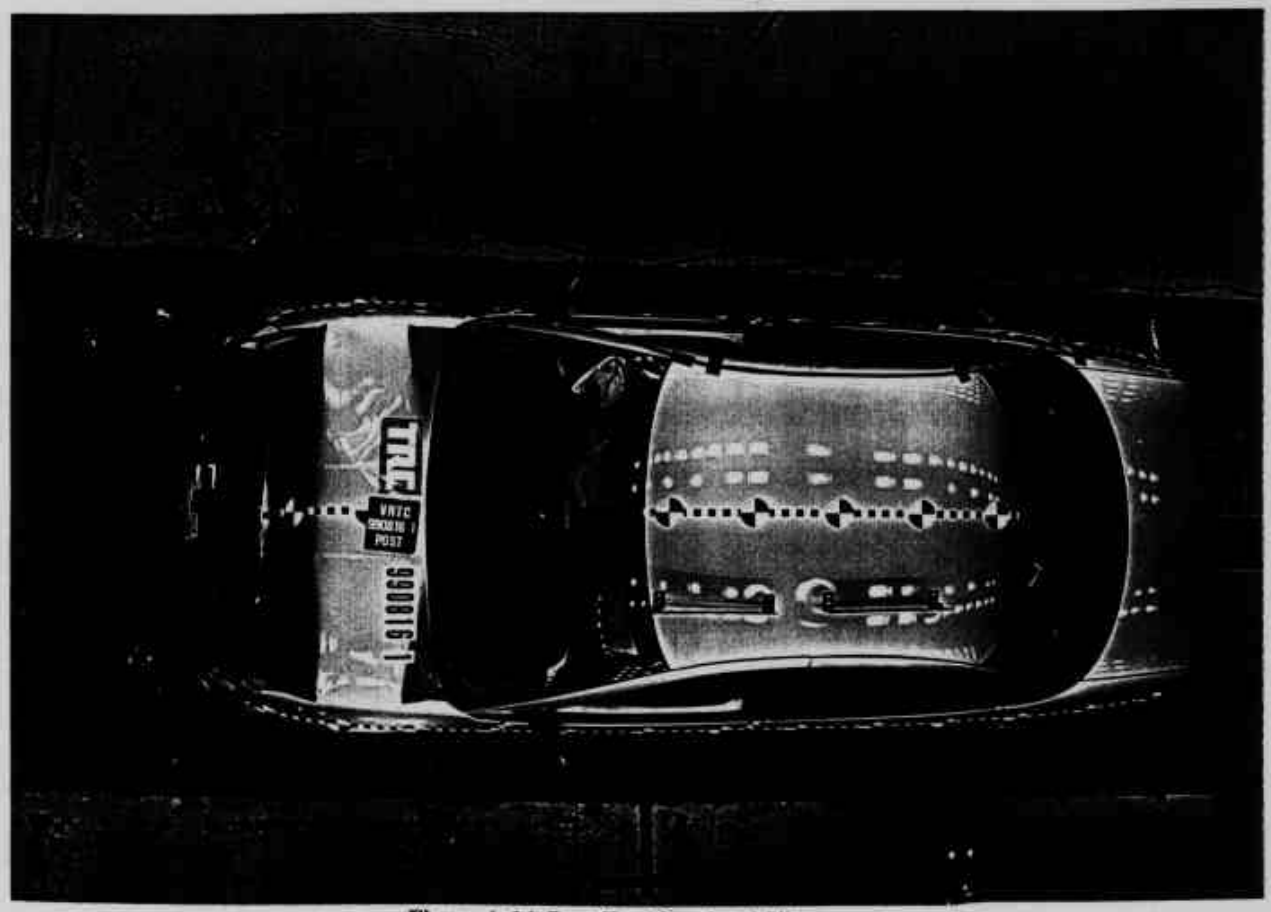


Figure A-14 Post-Test Overhead View

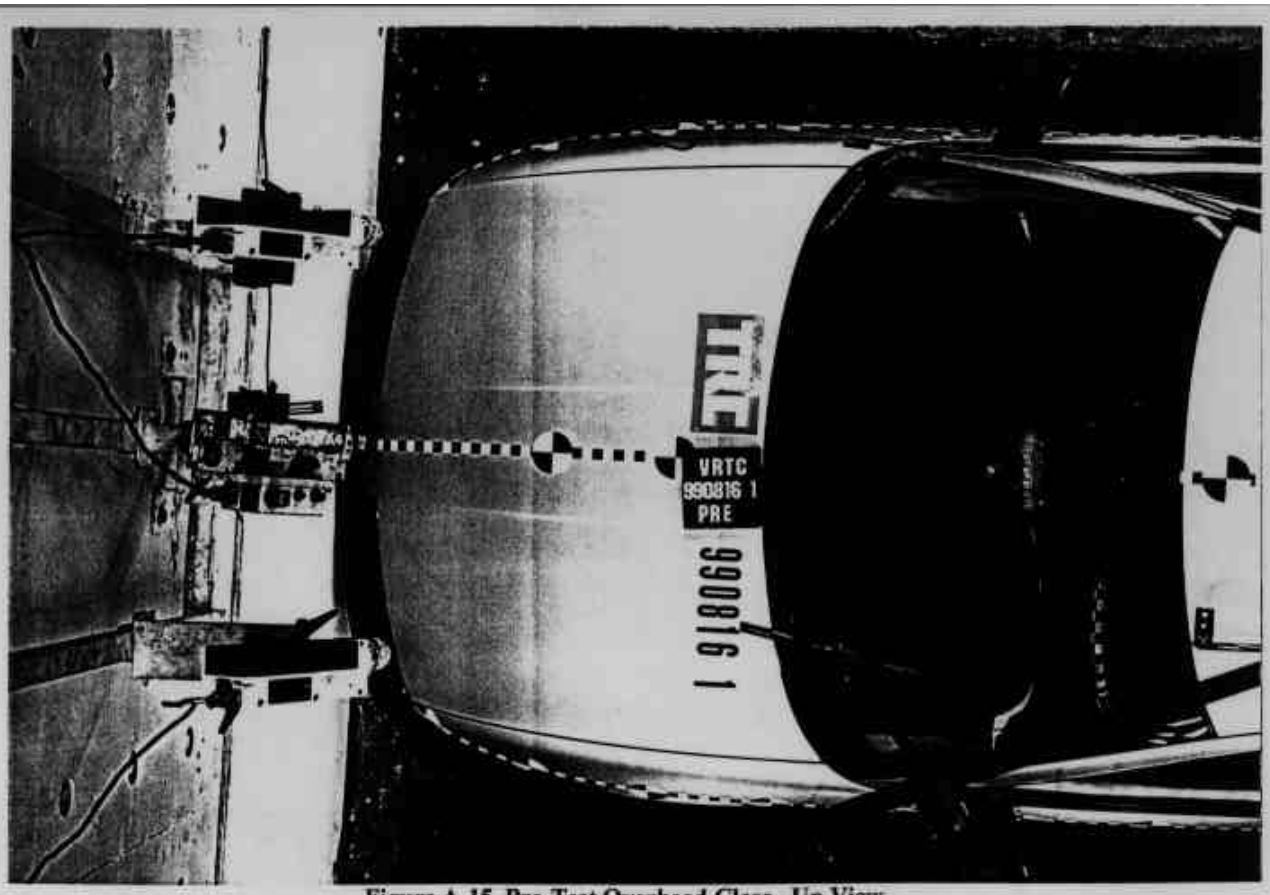


Figure A-15 Pre-Test Overhead Close –Up View

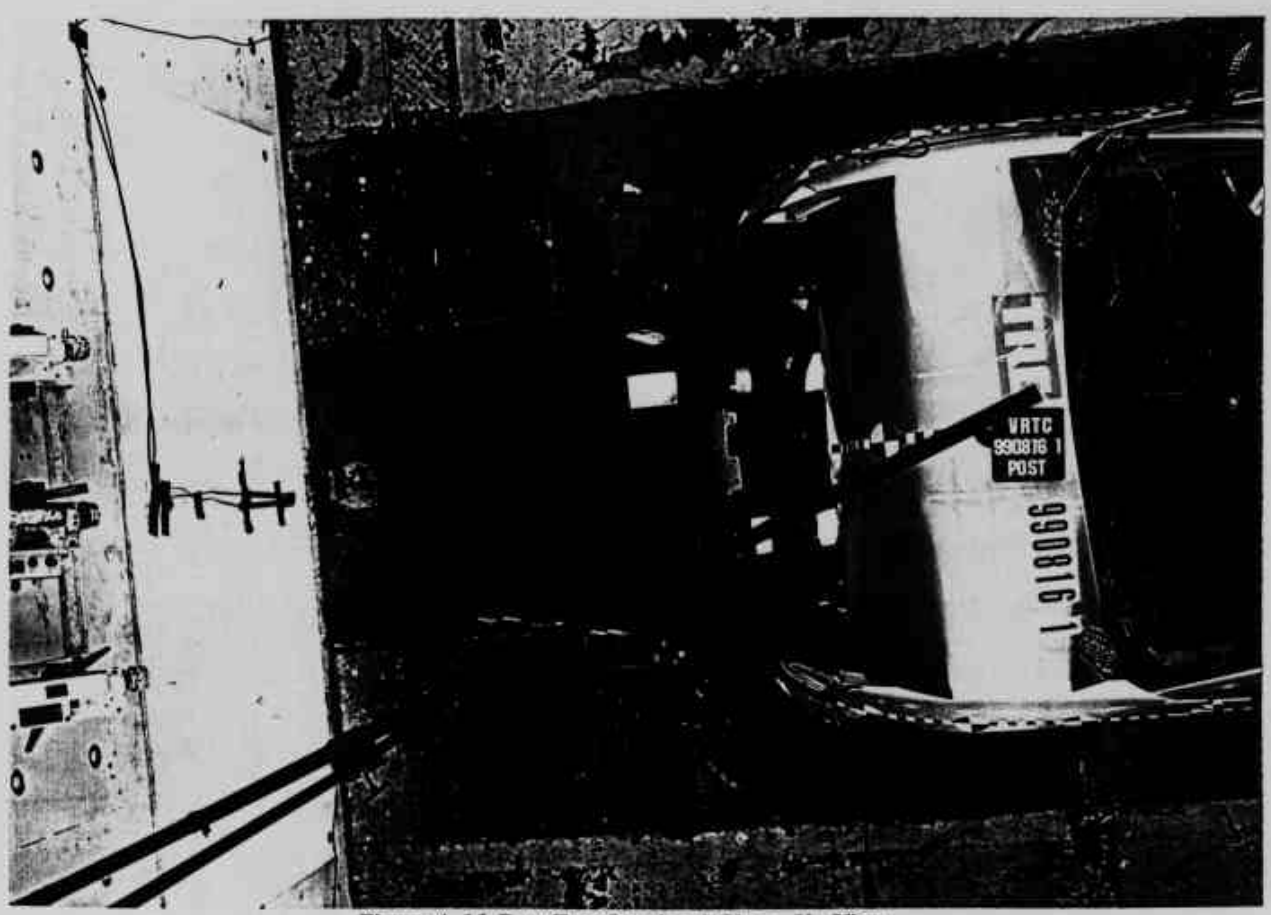


Figure A-16 Post-Test Overhead Close –Up View

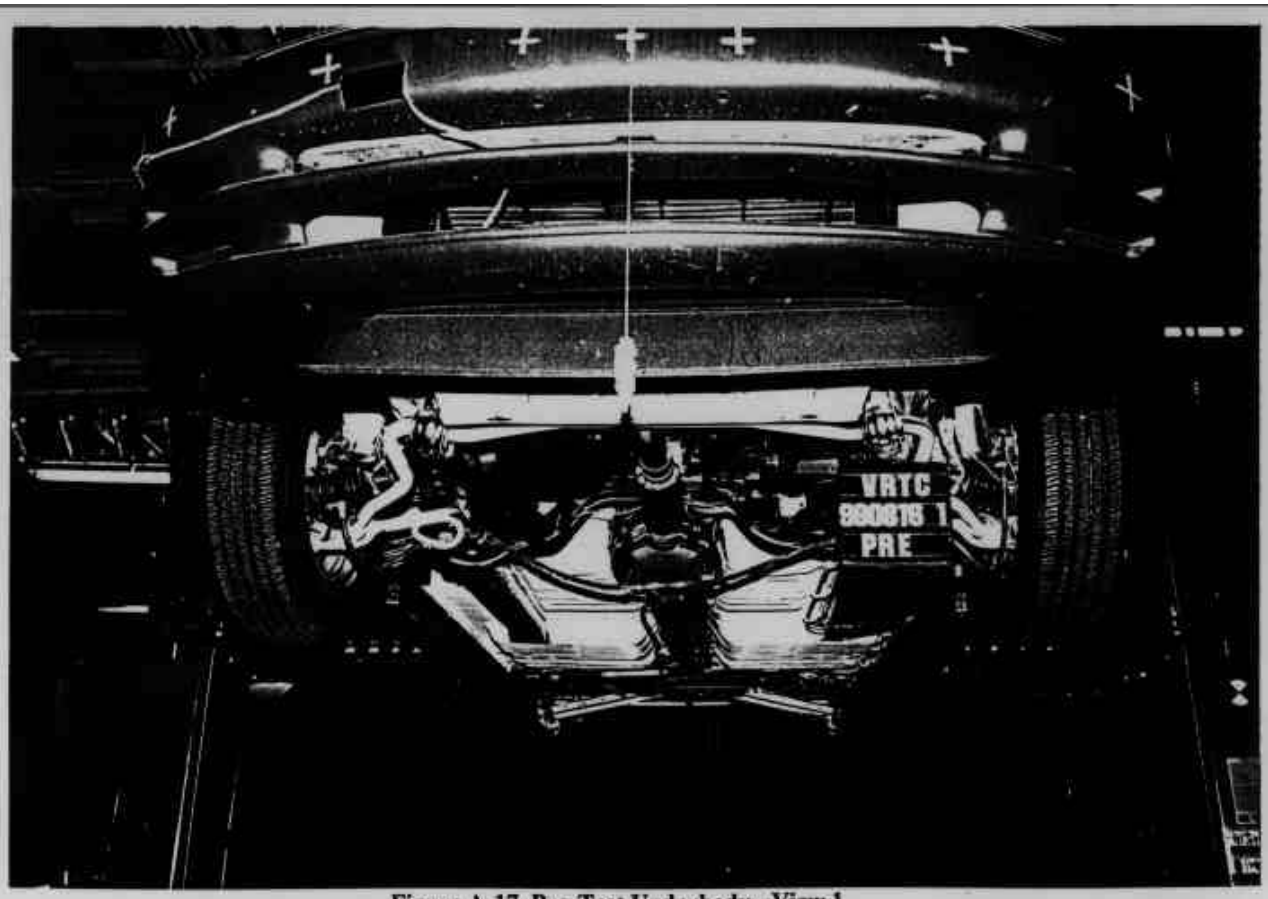


Figure A-17 Pre-Test Underbody - View 1

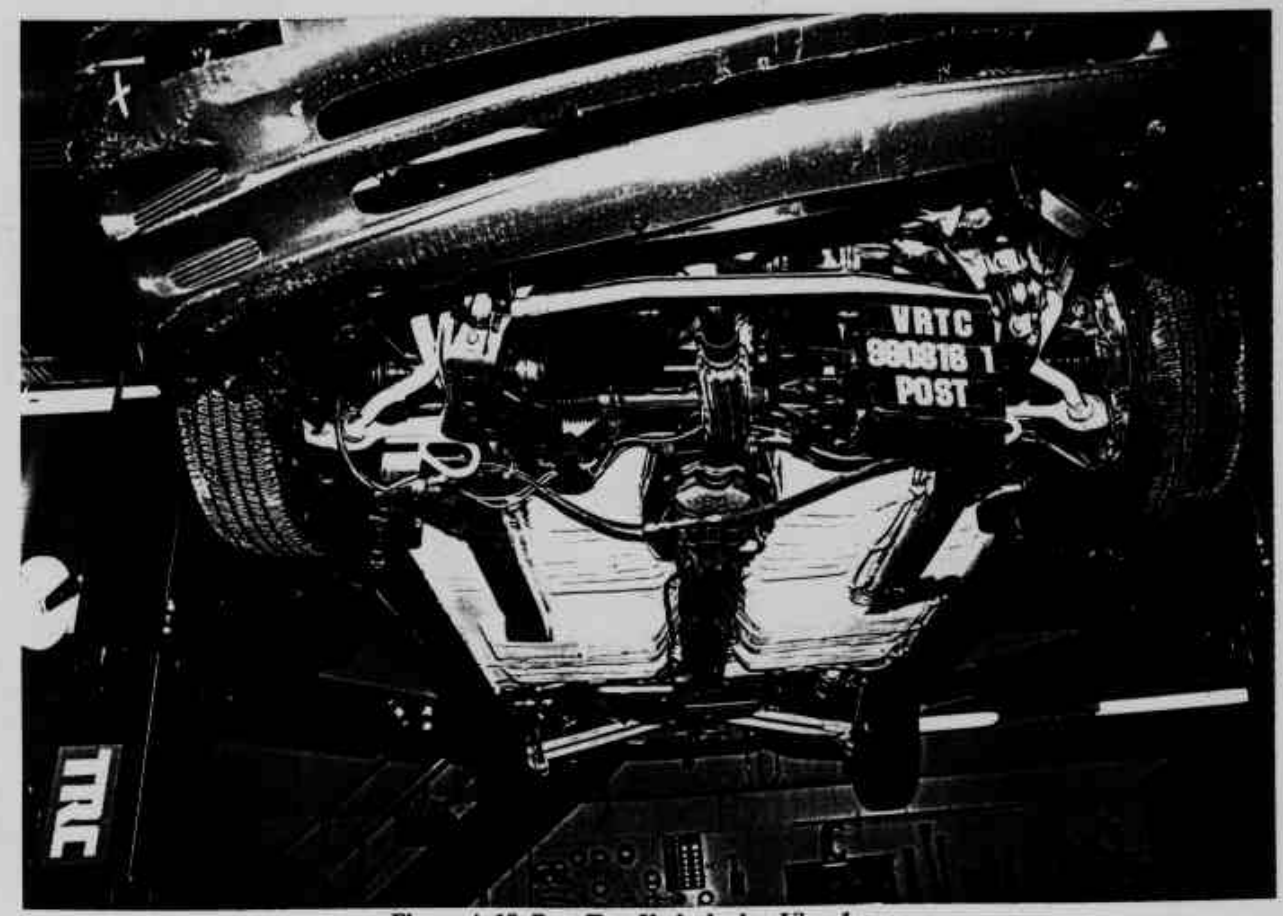


Figure A-18 Post-Test Underbody - View 1

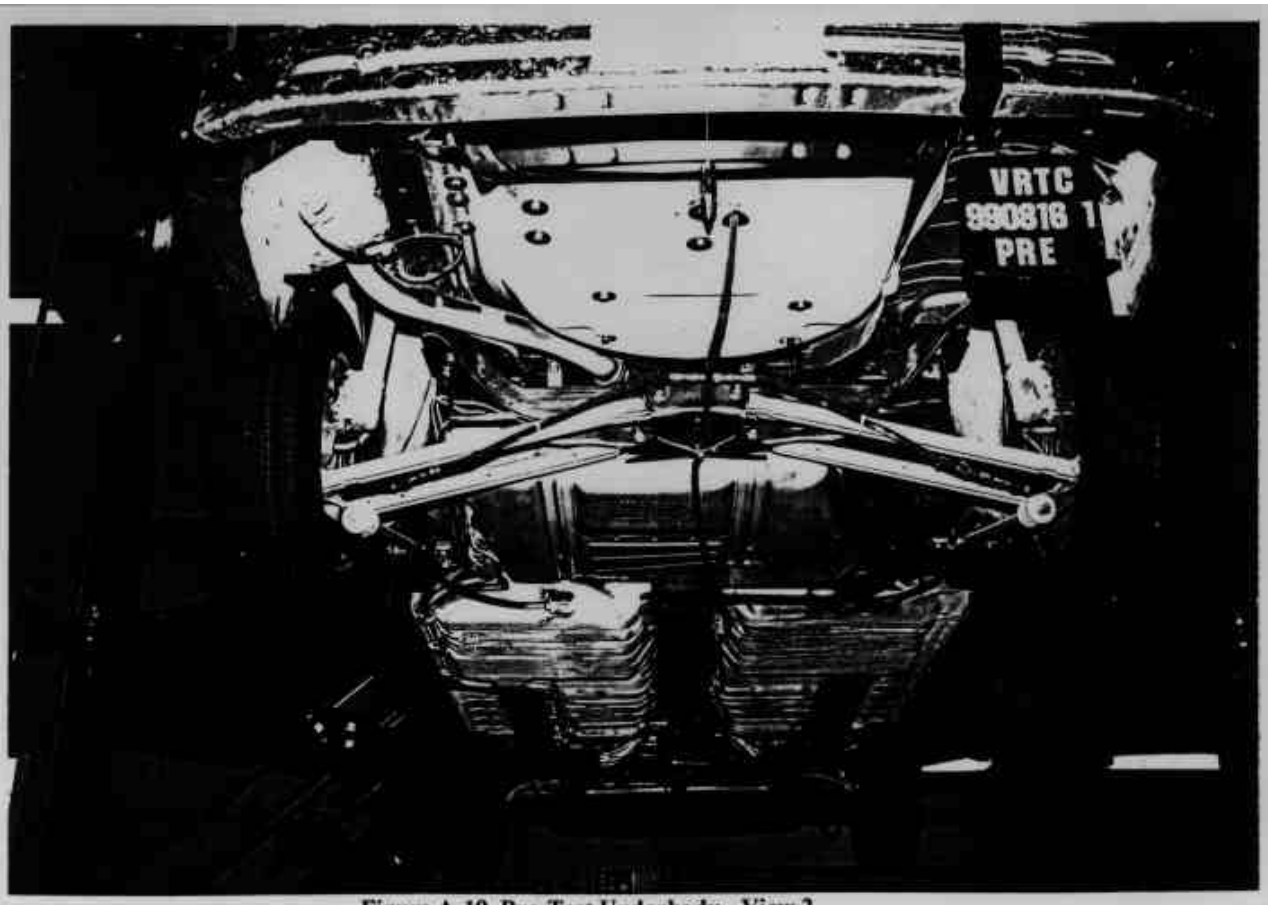


Figure A-19 Pre-Test Underbody - View 2

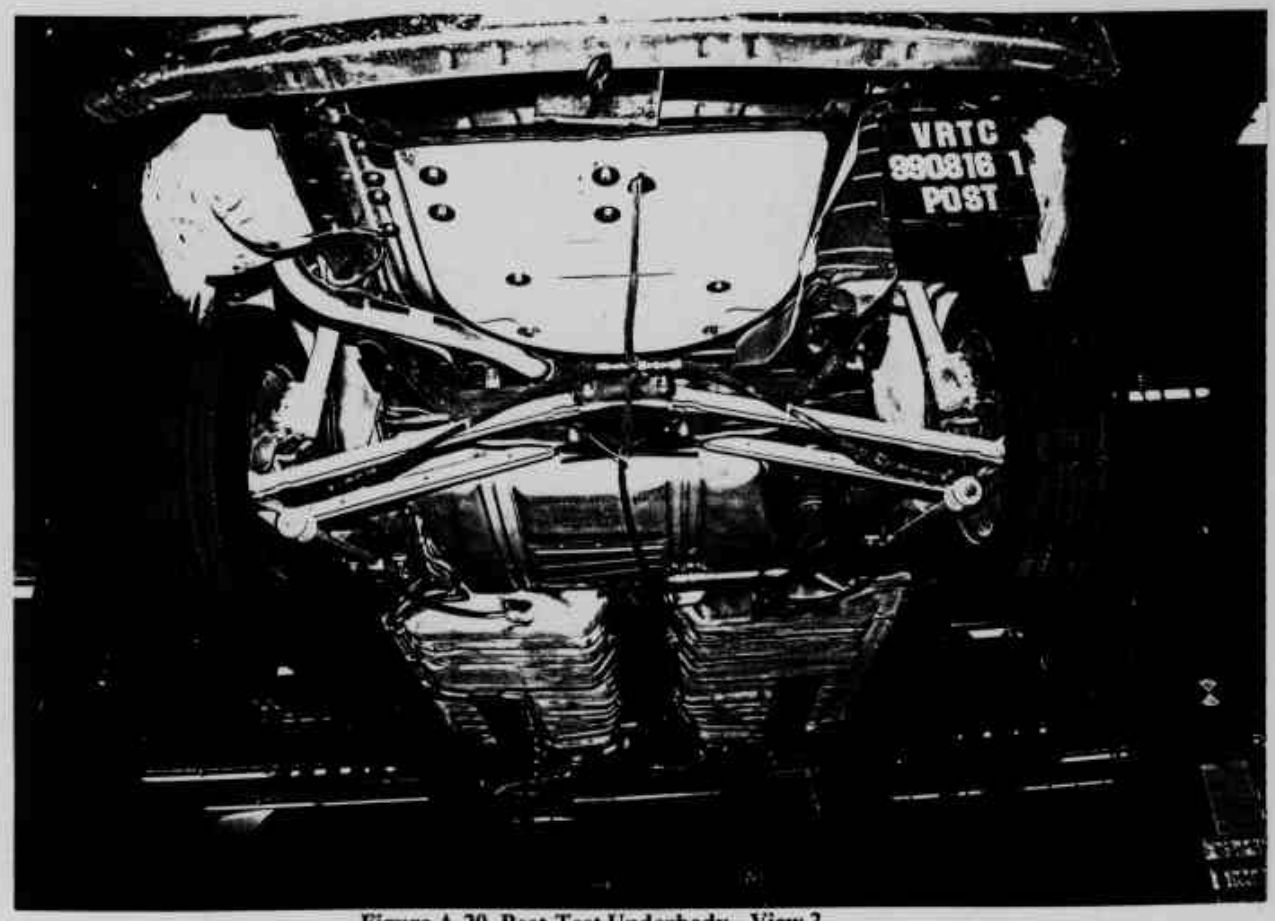


Figure A-20 Post-Test Underbody - View 2

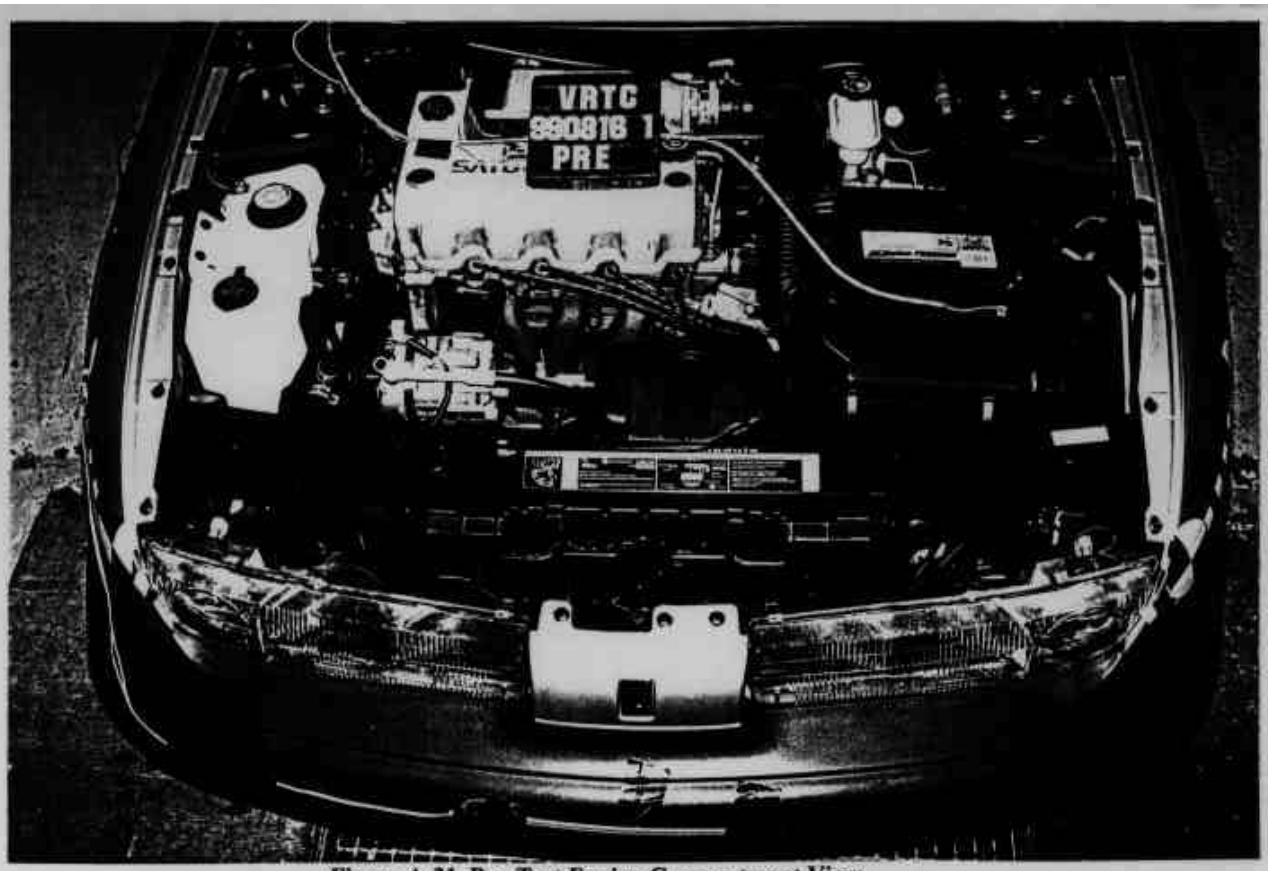


Figure A-21 Pre-Test Engine Compartment View

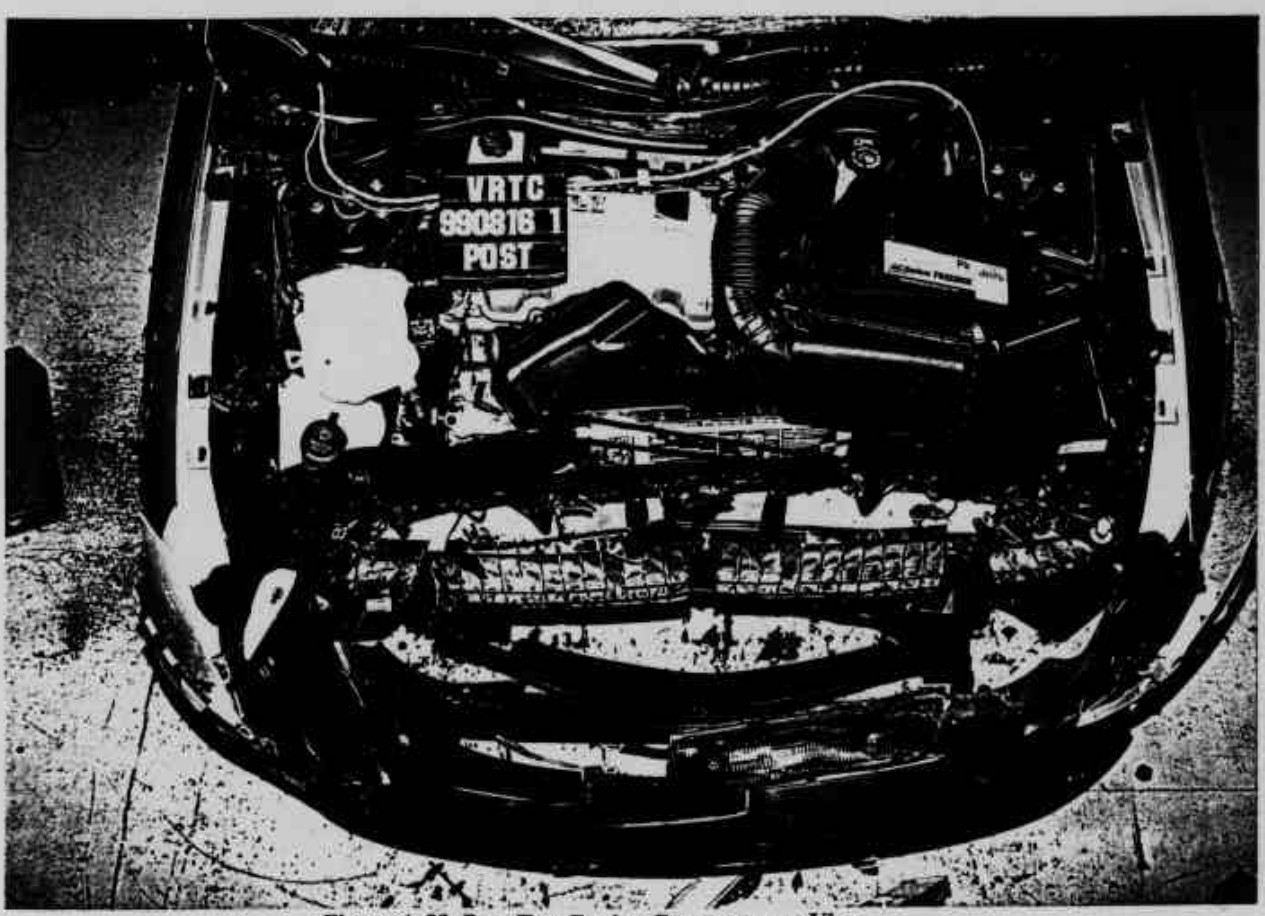


Figure A-22 Post-Test Engine Compartment View

Figure A-23 Pre-Test Windshield - View 1

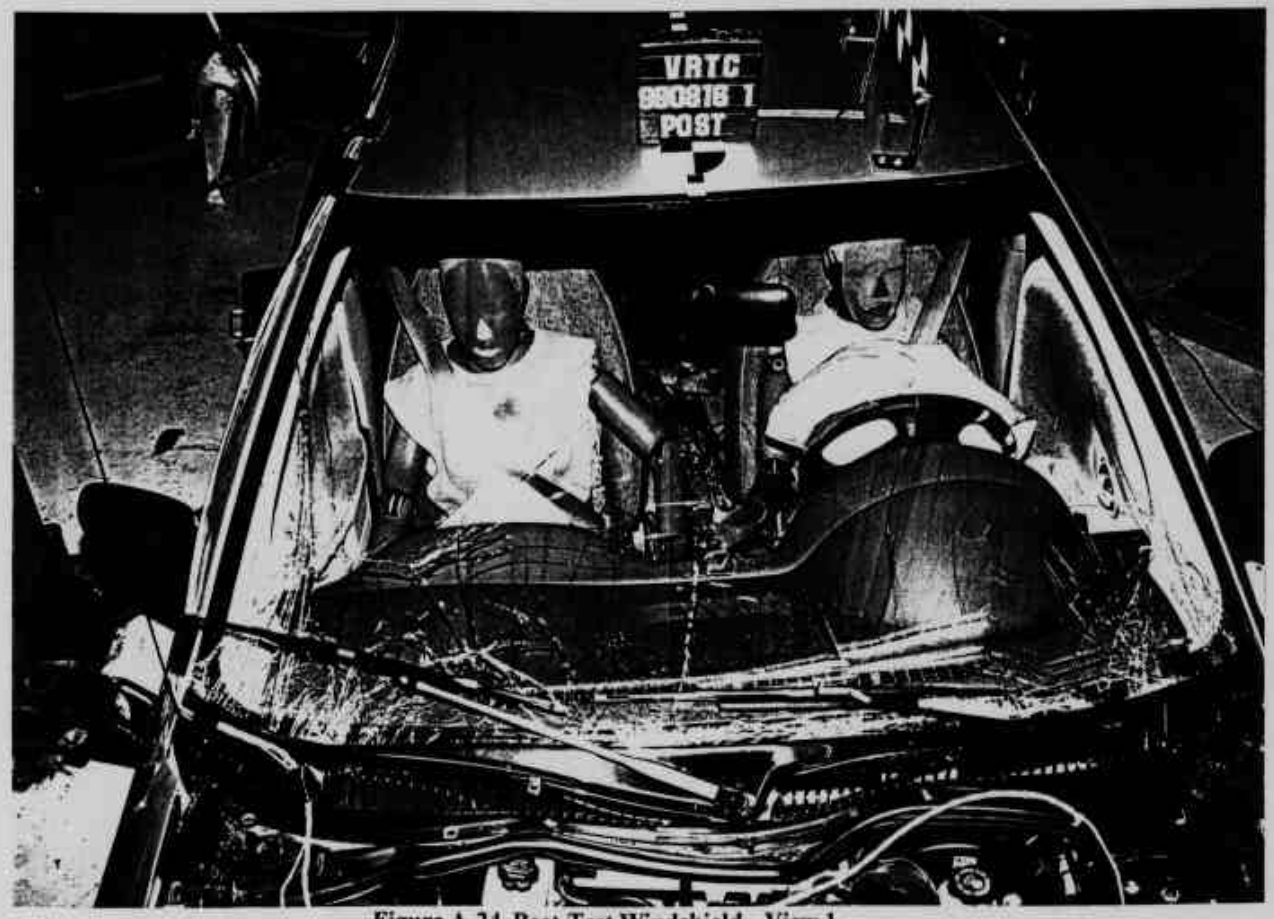


Figure A-24 Post-Test Windshield - View 1

Figure A-25 Pre-Test Windshield - View 2

Figure A-26 Post-Test Windshield - View 2

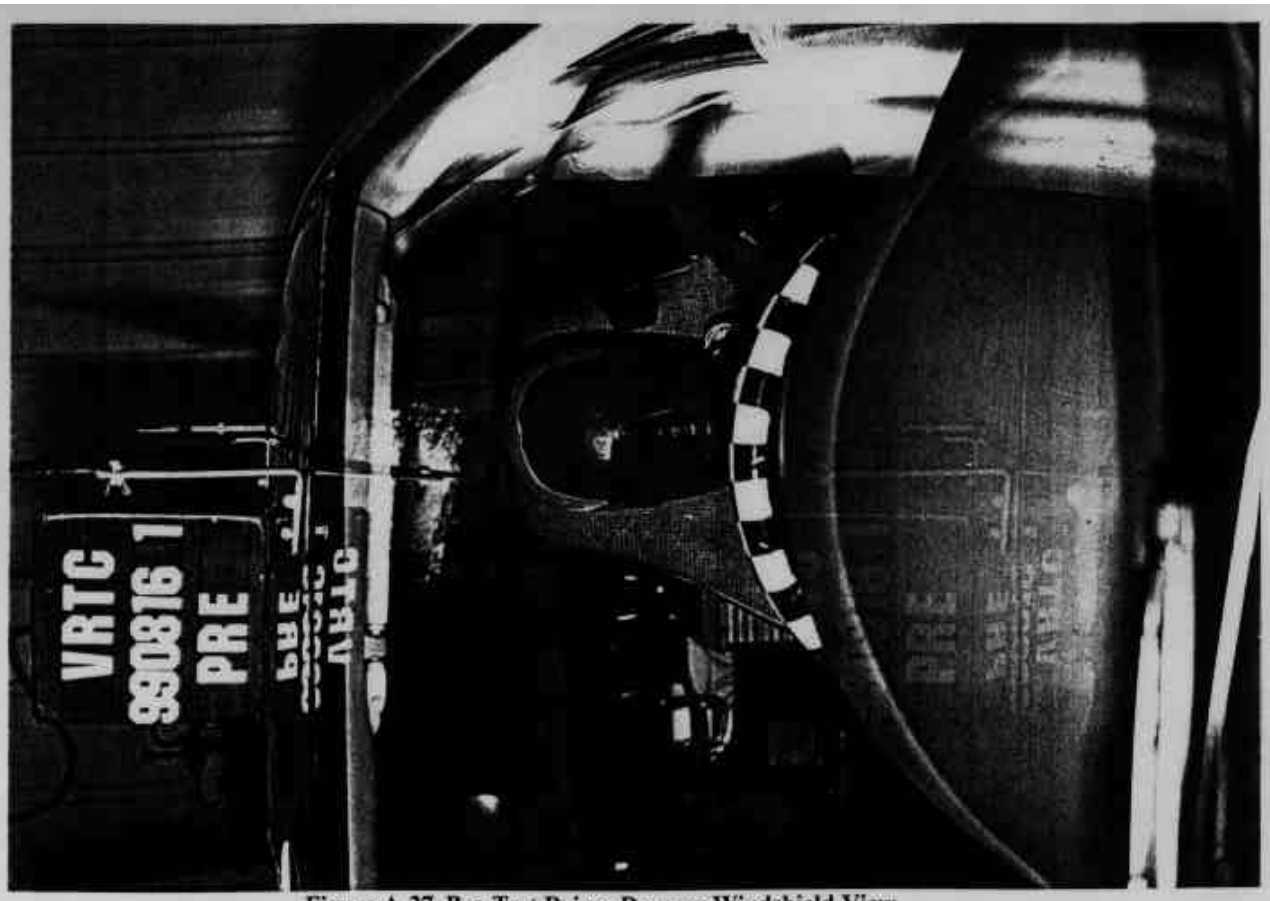


Figure A-27 Pre-Test Driver Dummy Windshield View

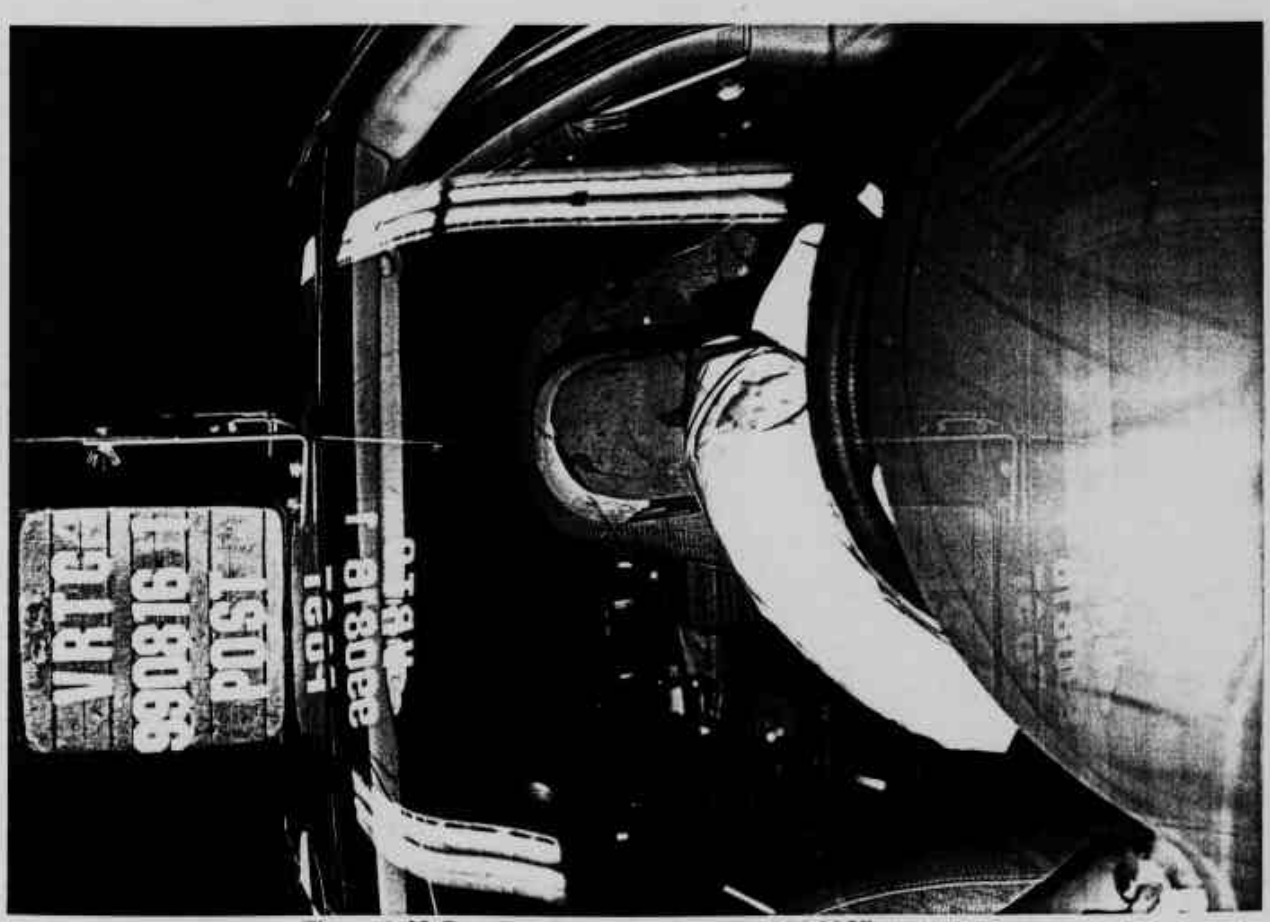


Figure A-28 Post-Test Driver Dummy Windshield View

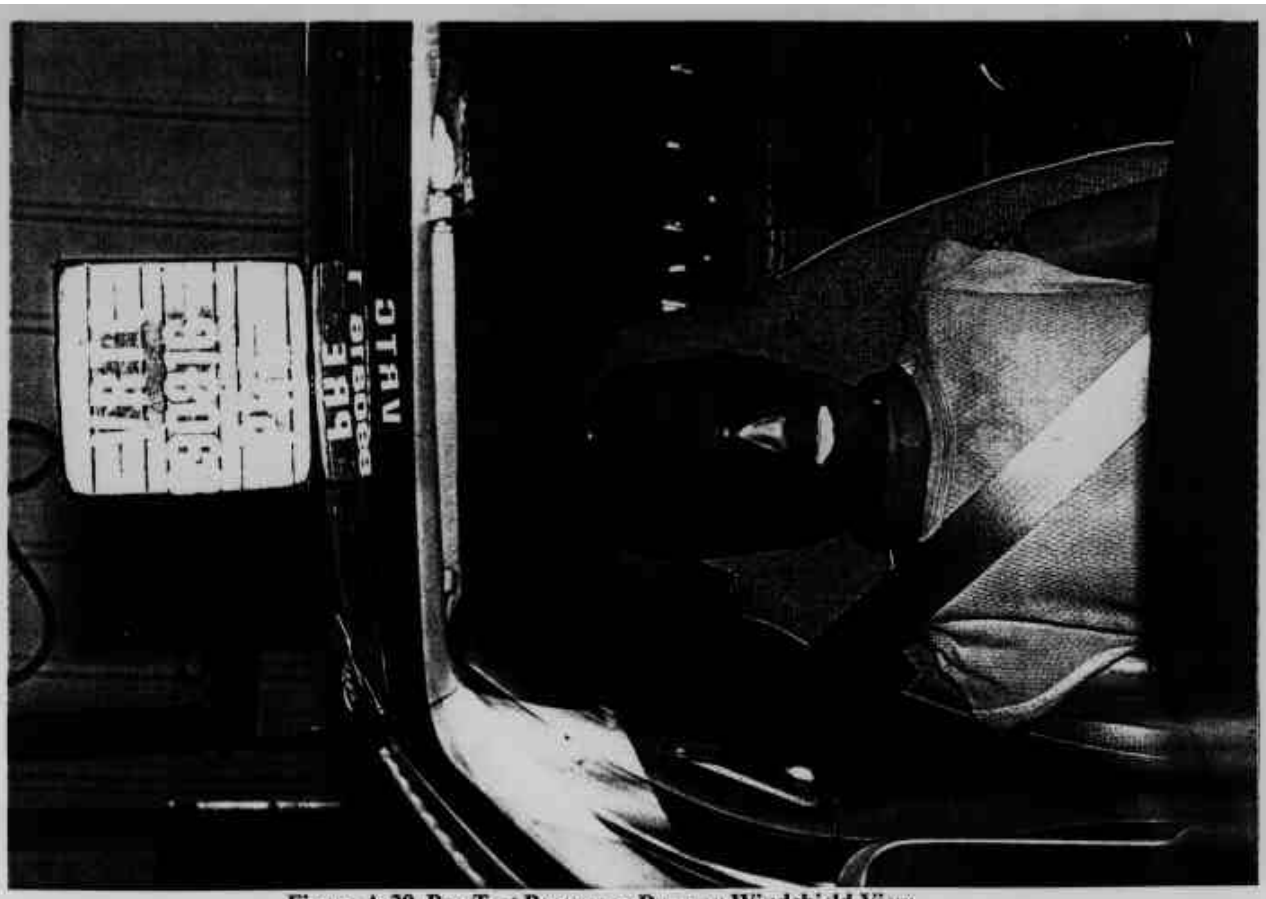


Figure A-29 Pre-Test Passenger Dummy Windshield View

Figure A-30 Post-Test Passenger Dummy Windshield View

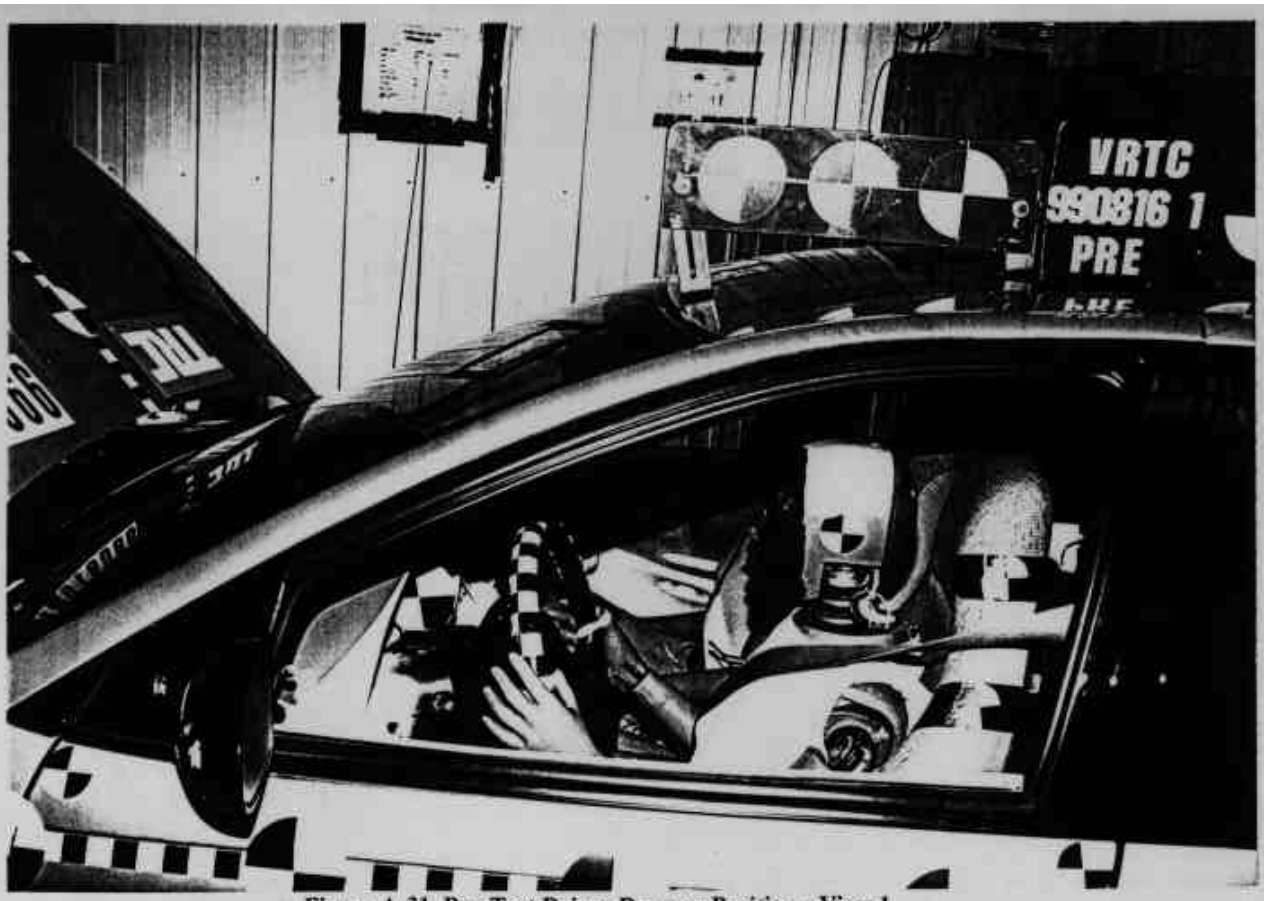


Figure A-31 Pre-Test Driver Dummy Position - View 1

Figure A-32 Post-Test Driver Dummy Position - View 1

Figure A-33 Pre-Test Driver Dummy Position -View 2

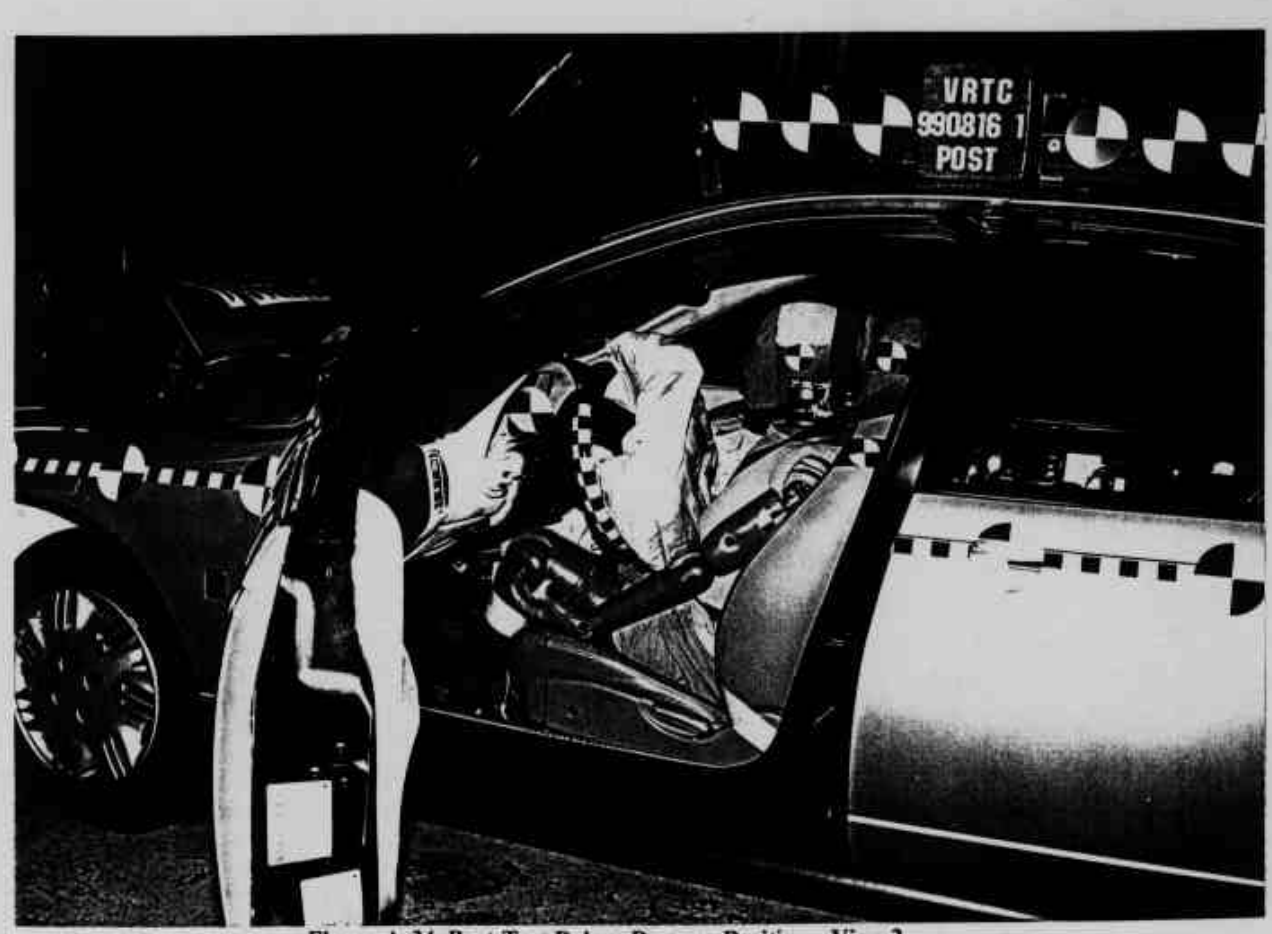


Figure A-34 Post-Test Driver Dummy Position - View 2

Figure A-35 Pre-Test Driver Dummy Position -View 3

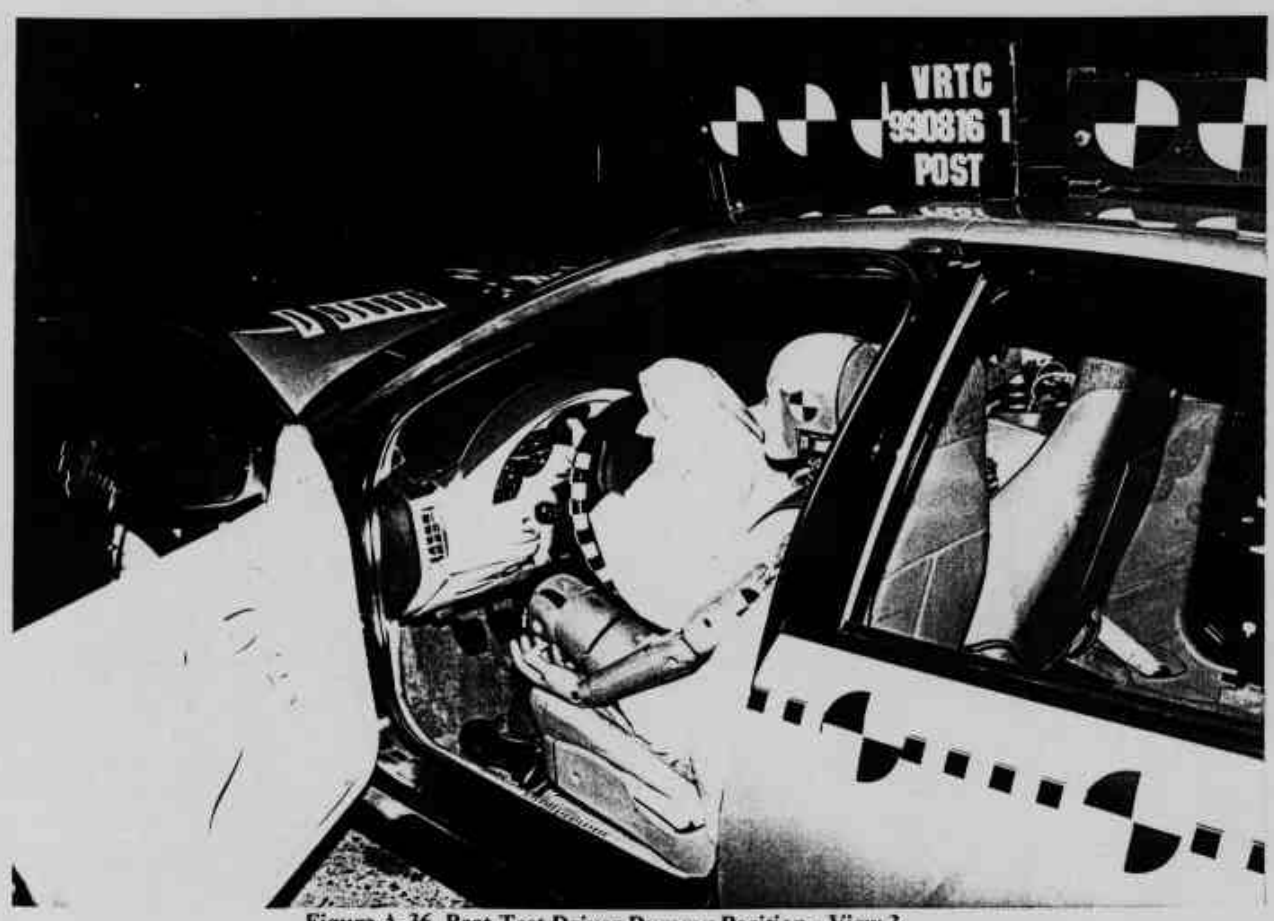


Figure A-36 Post-Test Driver Dummy Position - View 3

Figure A-37 Pre-Test Passenger Dummy Position - View 1

Figure A-38 Post-Test Passenger Dummy Position - View 1

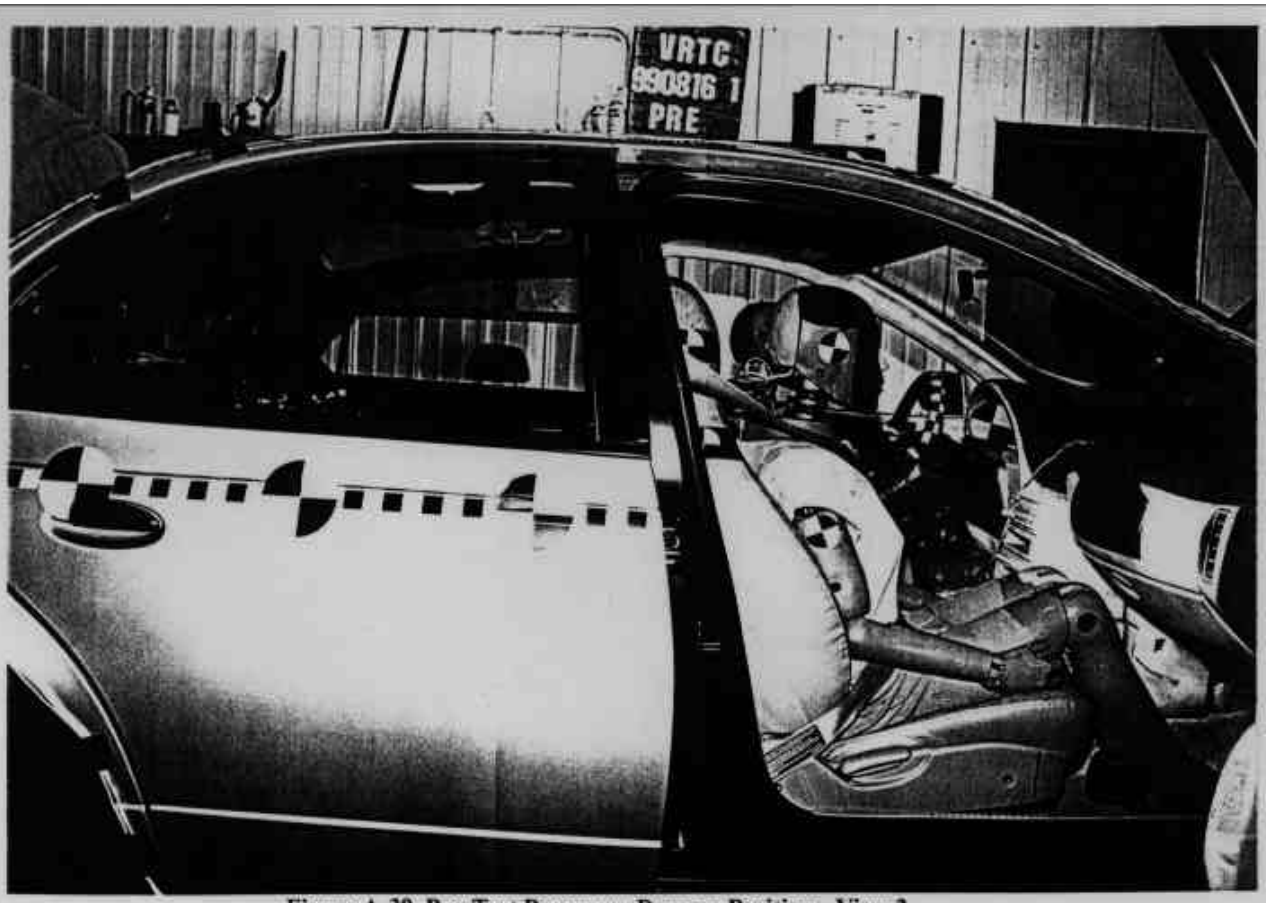


Figure A-39 Pre-Test Passenger Dummy Position - View 2

Figure A-40 Post-Test Passenger Dummy Position - View 2

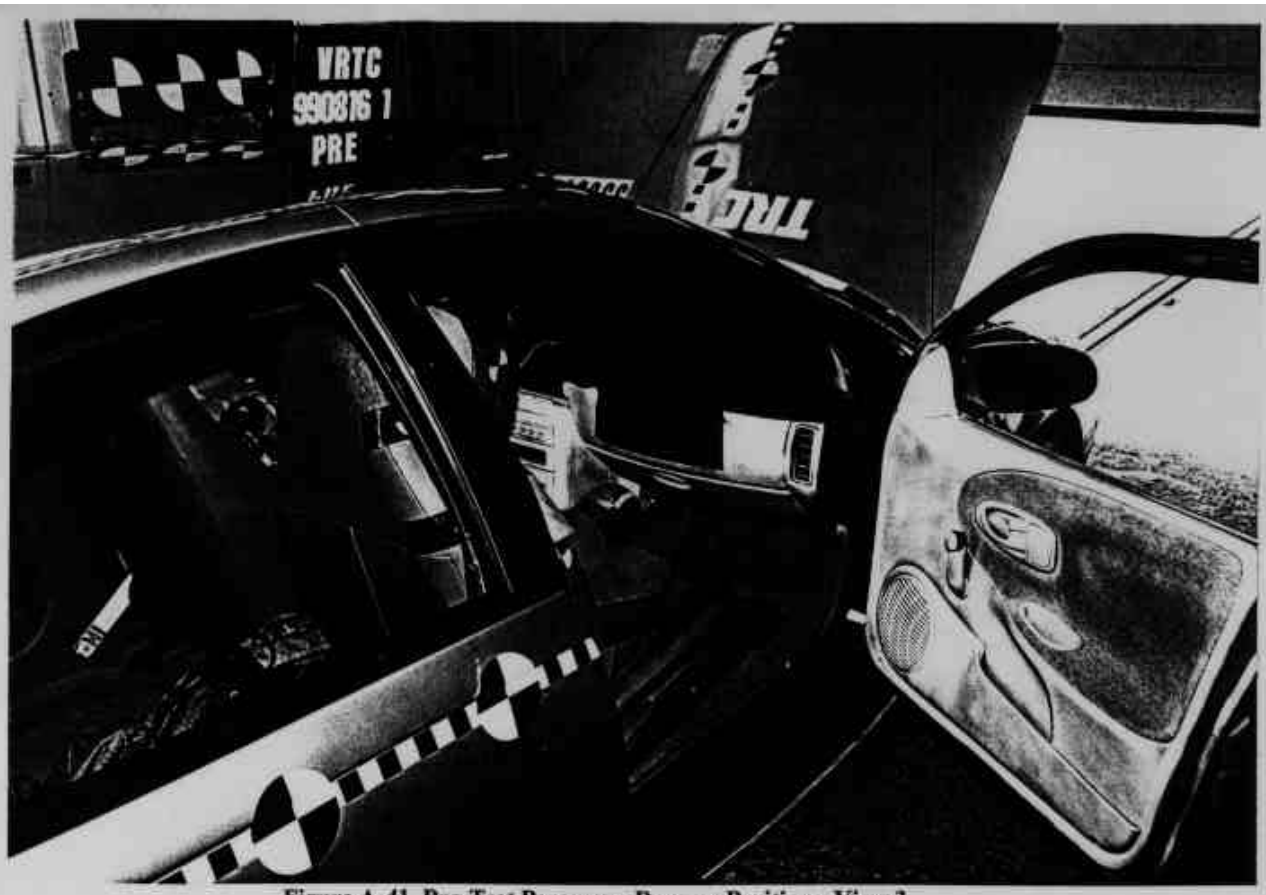


Figure A-41 Pre-Test Passenger Dummy Position - View 3

Figure A-42 Post-Test Passenger Dummy Position - View 3

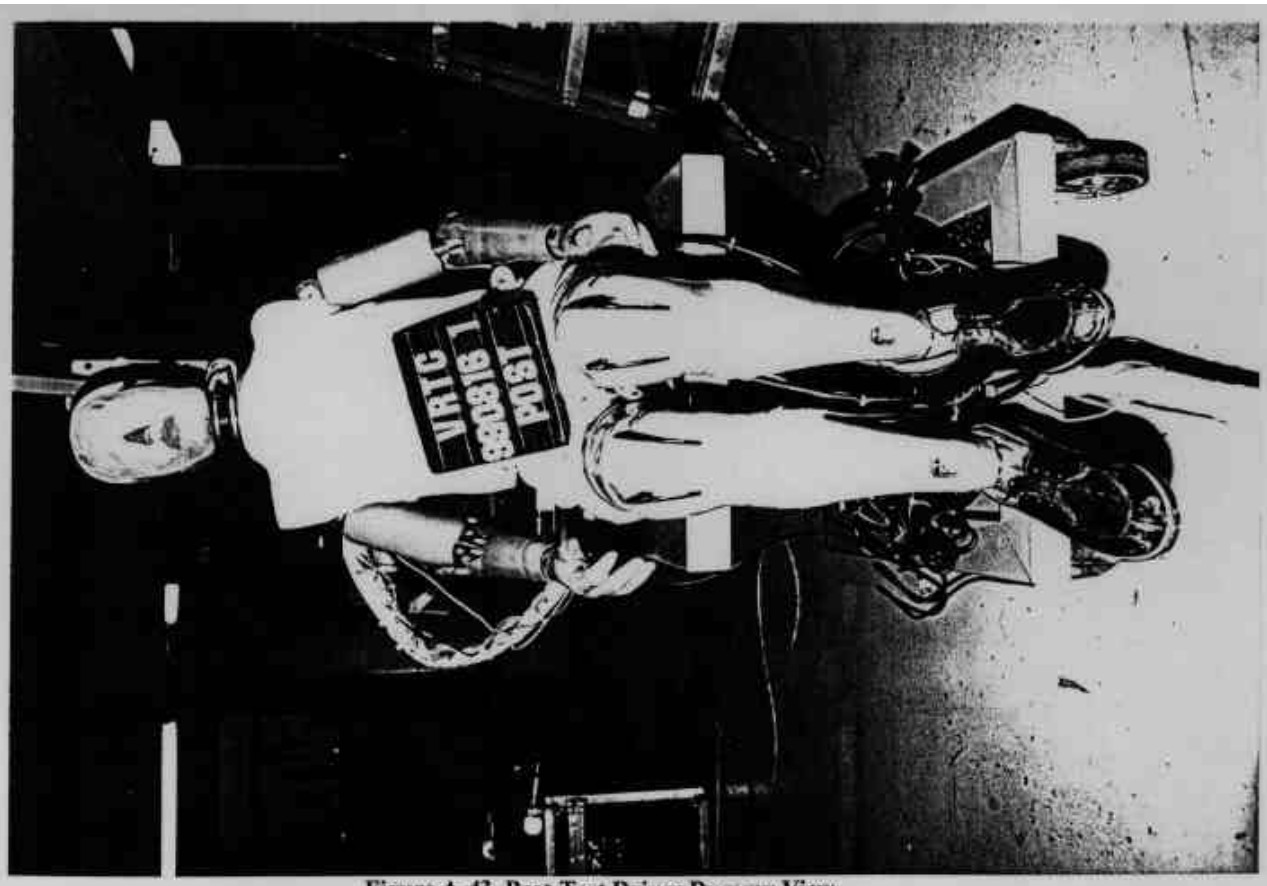


Figure A-43 Post-Test Driver Dummy View

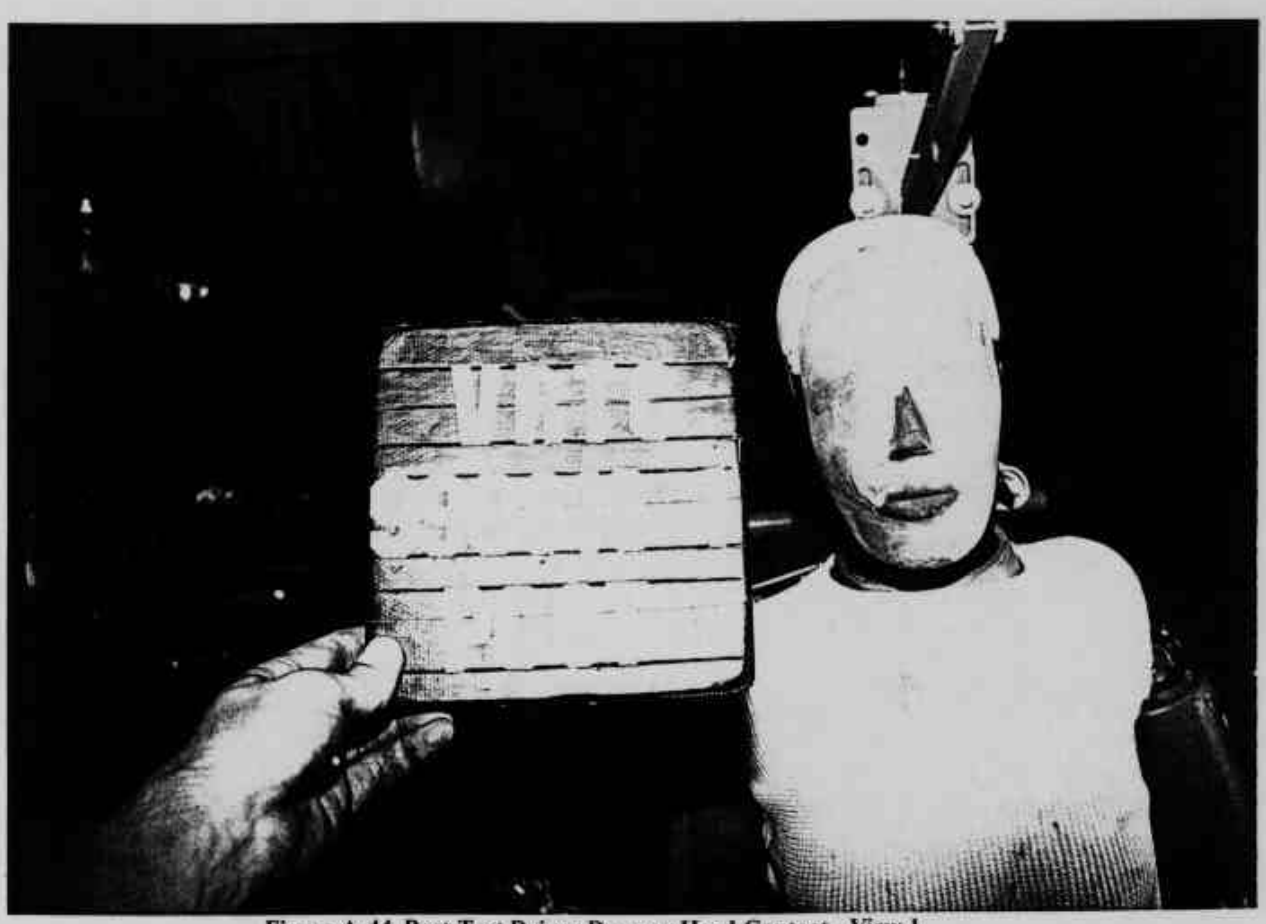


Figure A-44 Post-Test Driver Dummy Head Contact - View 1

Figure A-45 Post-Test Driver Dummy Head Contact - View 2

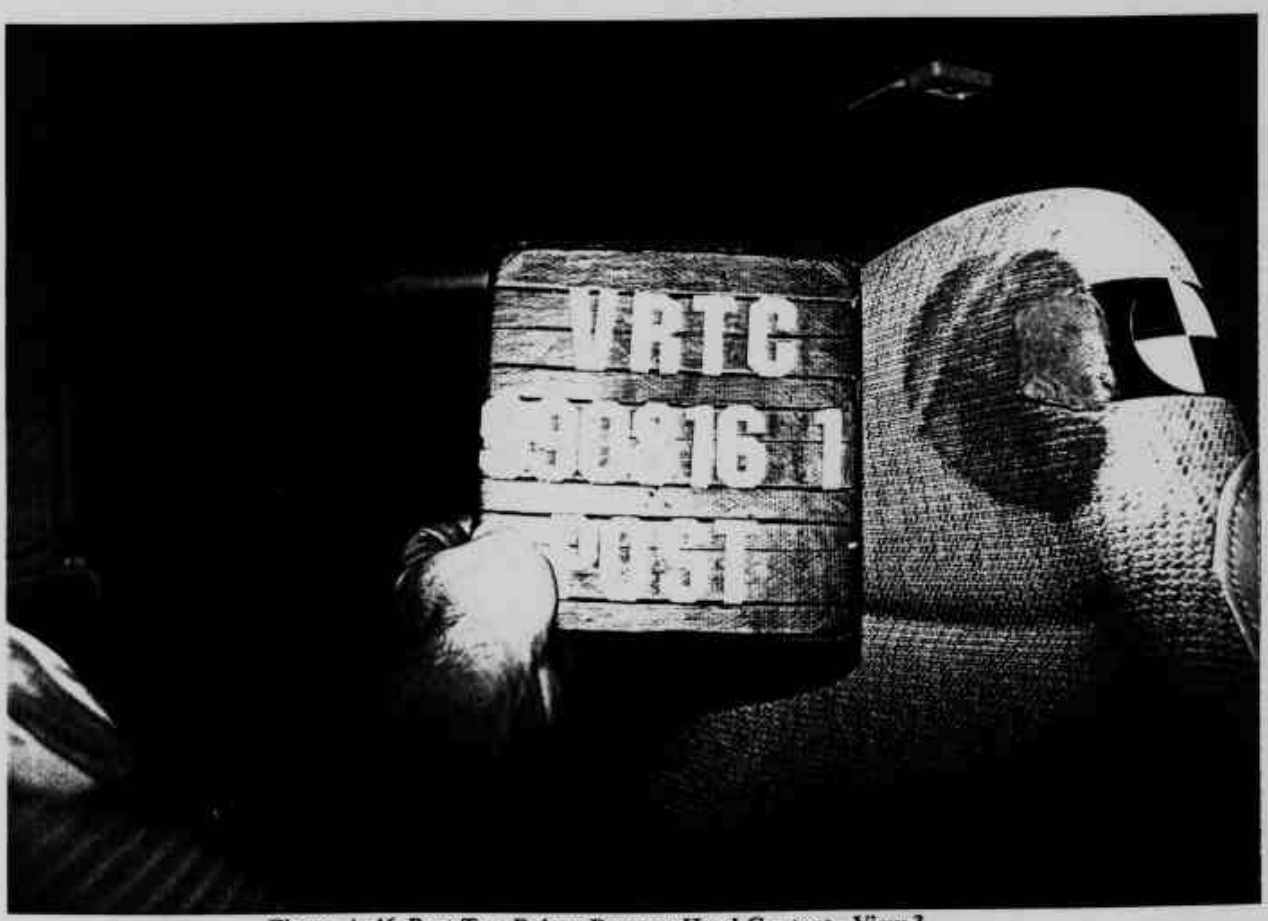


Figure A-46 Post-Test Driver Dummy Head Contact - View 3

Figure A-47 Post-Test Driver Dummy Knee Contact - View 1

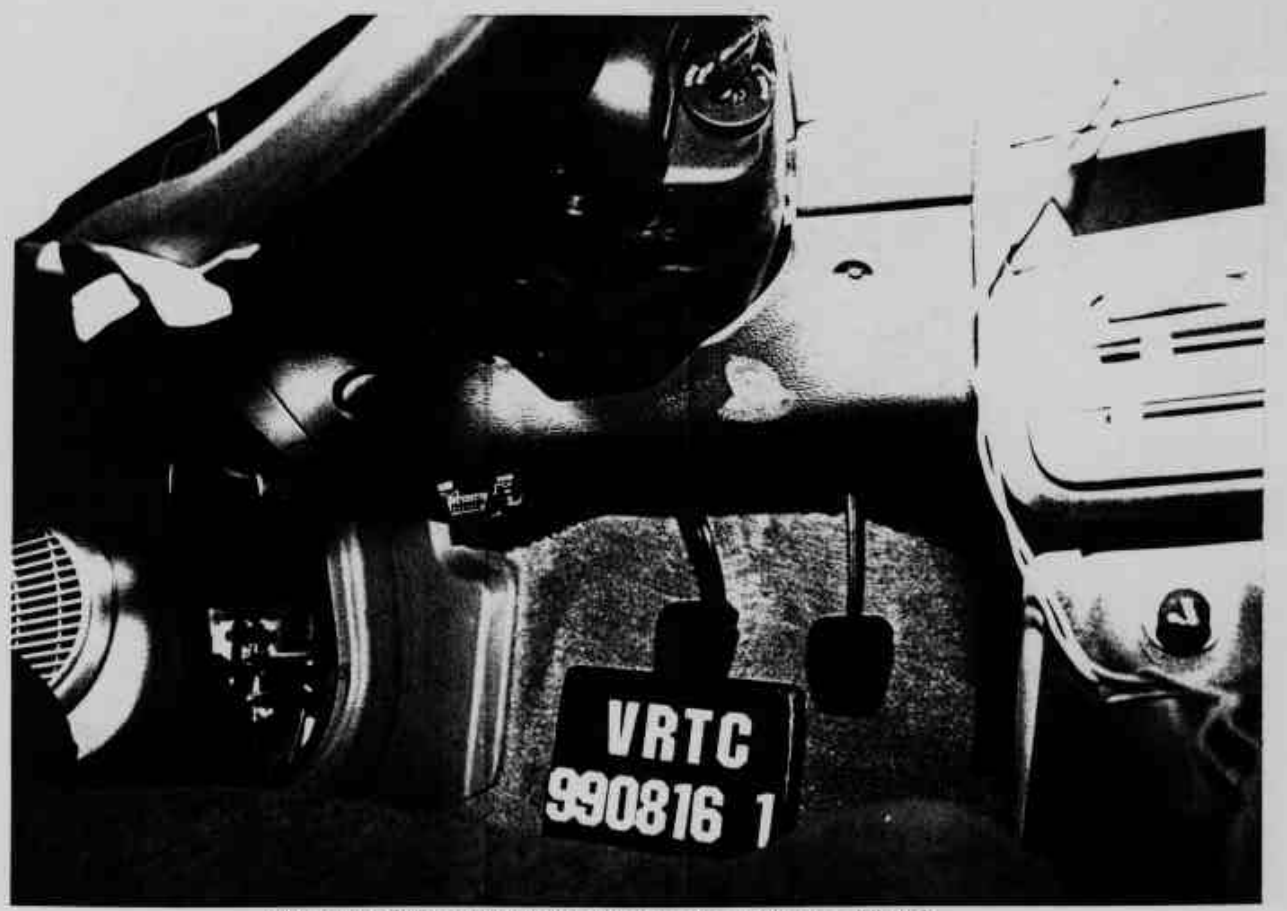


Figure A-48 Post-Test Driver Dummy Knee Contact - View 2

Figure A-49 Post-Test Driver Footwell Deformation View

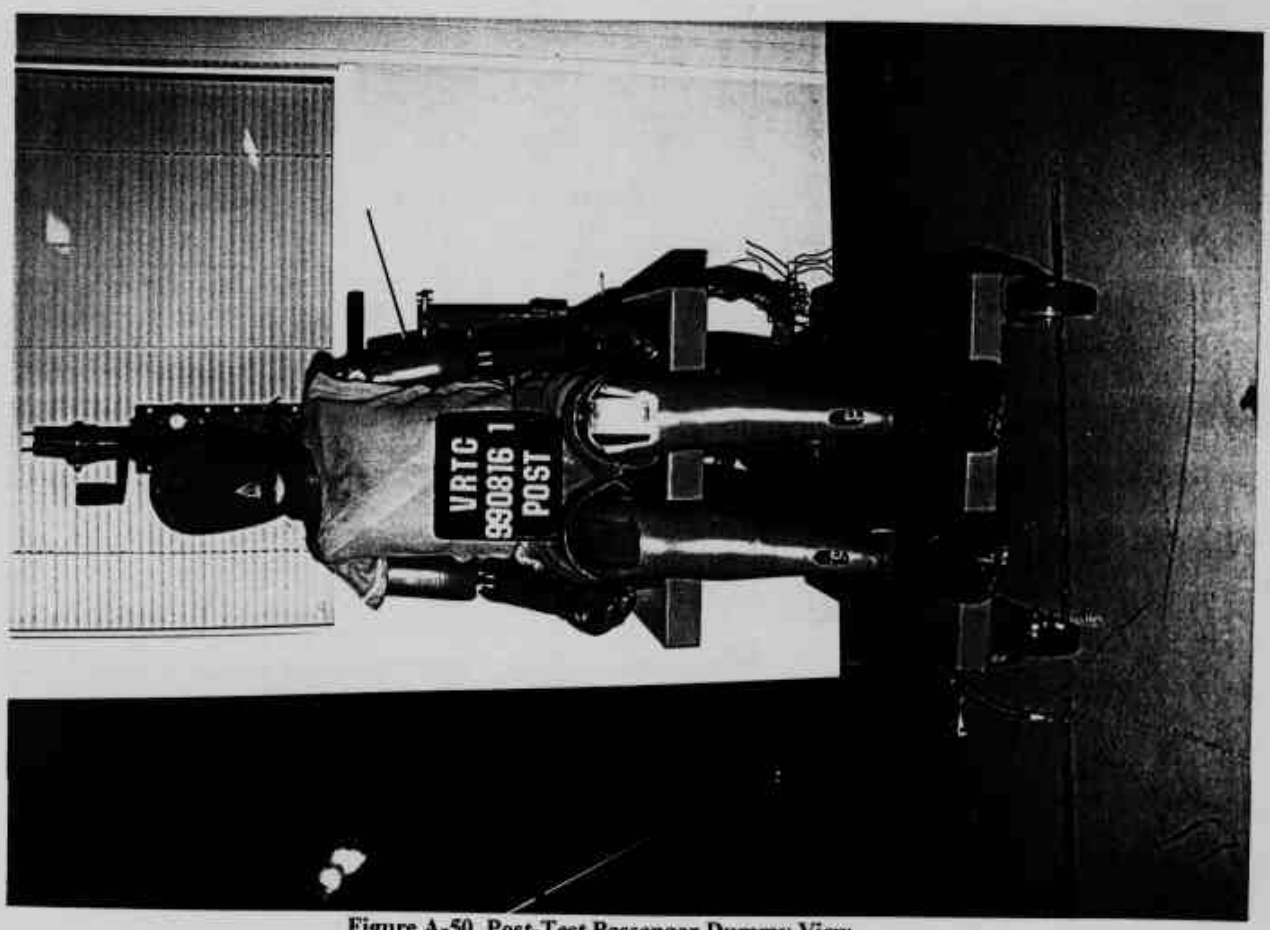


Figure A-50 Post-Test Passenger Dummy View

Figure A-51 Post-Test Passenger Dummy Head Contact - View 1

Figure A-52 Post-Test Passenger Dummy Head Contact - View 2

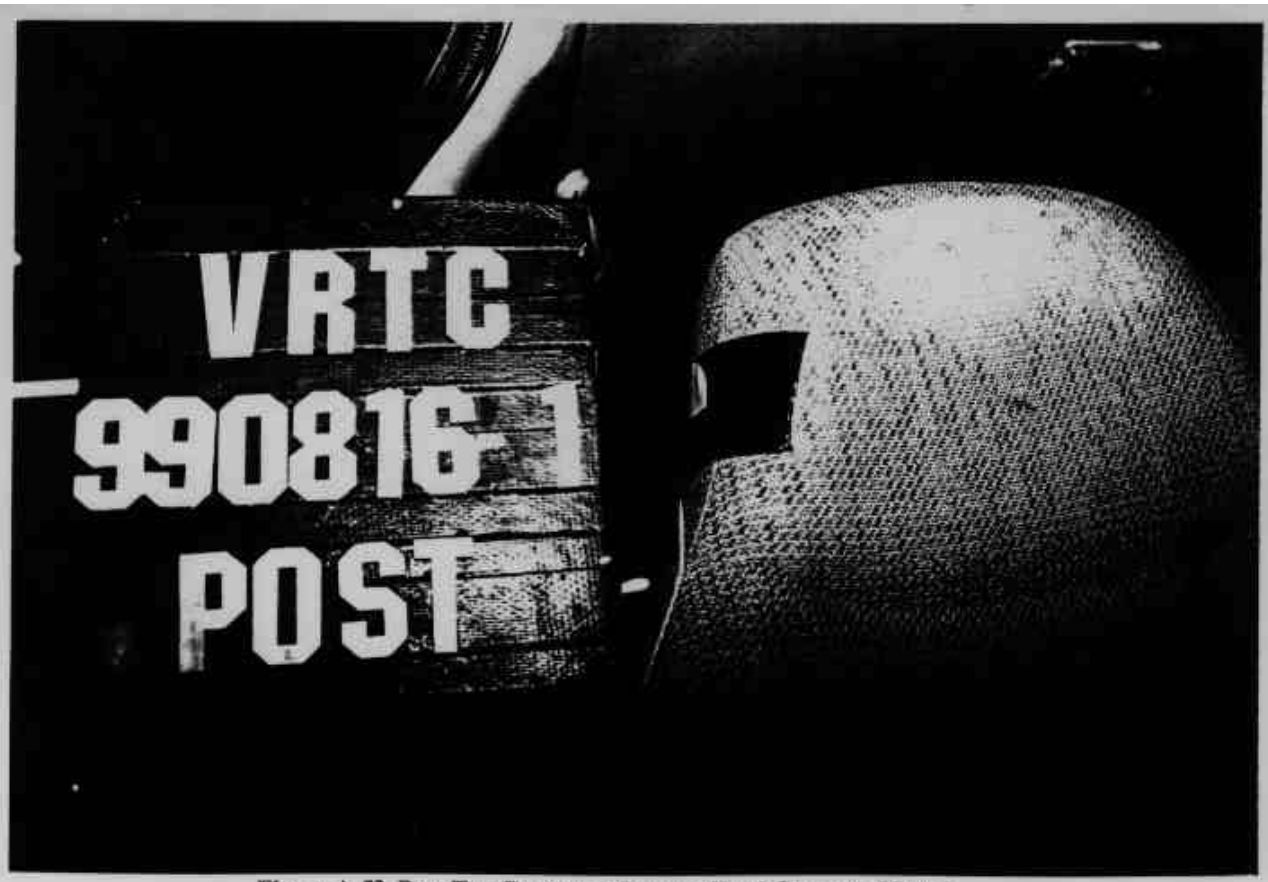


Figure A-53 Post-Test Passenger Dummy Head Contact - View 3

Figure A-54 Post-Test Passenger Dummy Knee Contact - View 1

Figure A-55 Post-Test Passenger Dummy Knee Contact - View 2

Figure A-56 Post-Test Passenger Footwell Deformation View

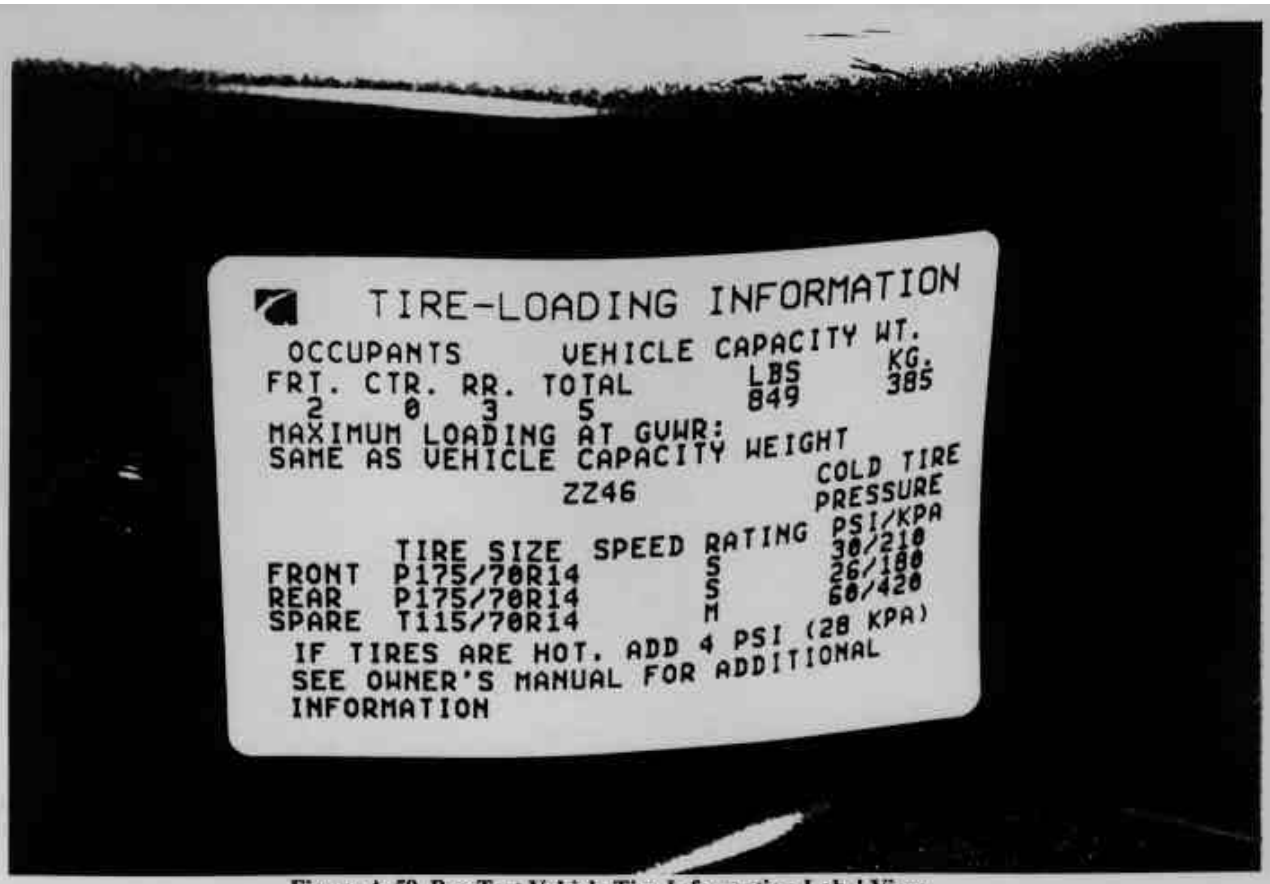


Figure A-59 Pre-Test Vehicle Tire Information Label View

Figure A-60 Impact Event

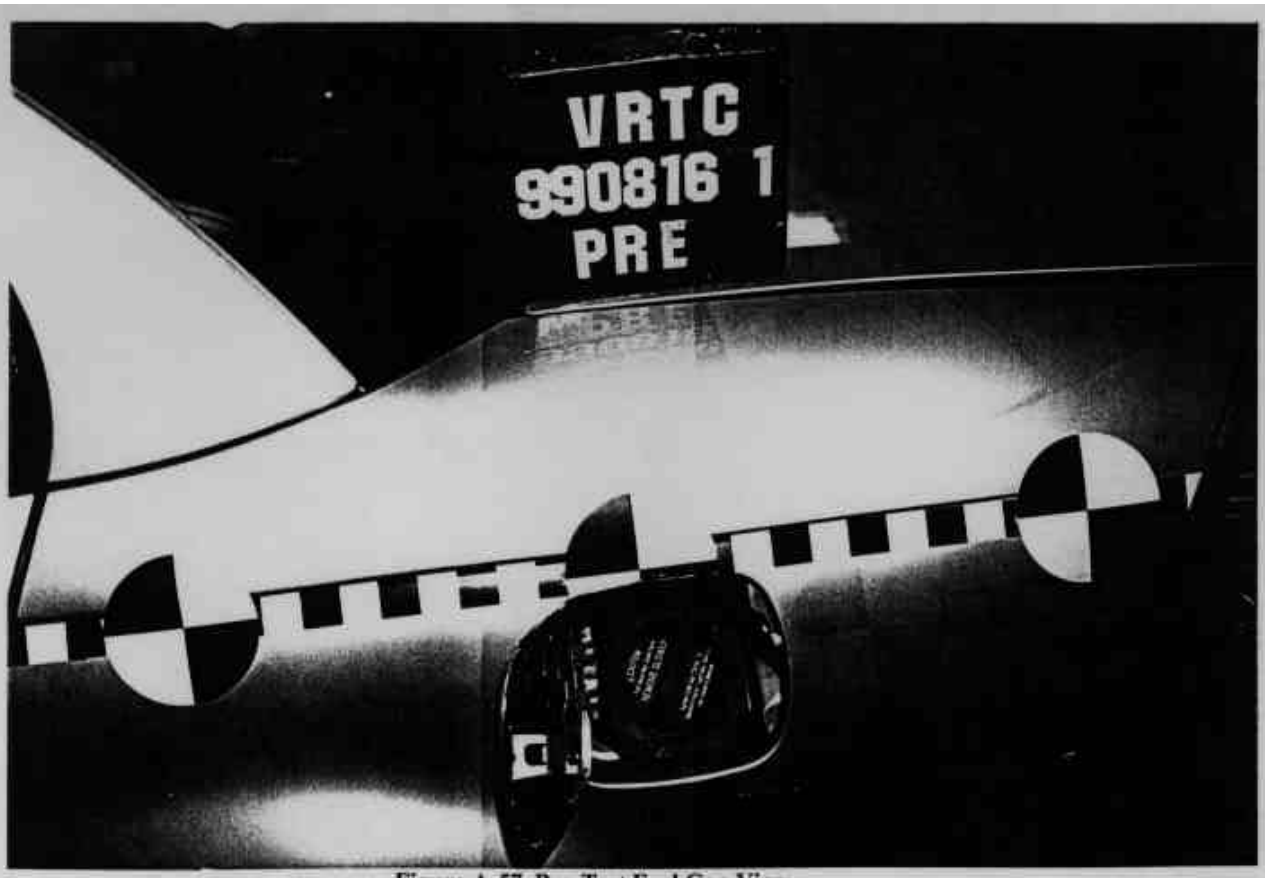


Figure A-57 Pre-Test Fuel Cap View

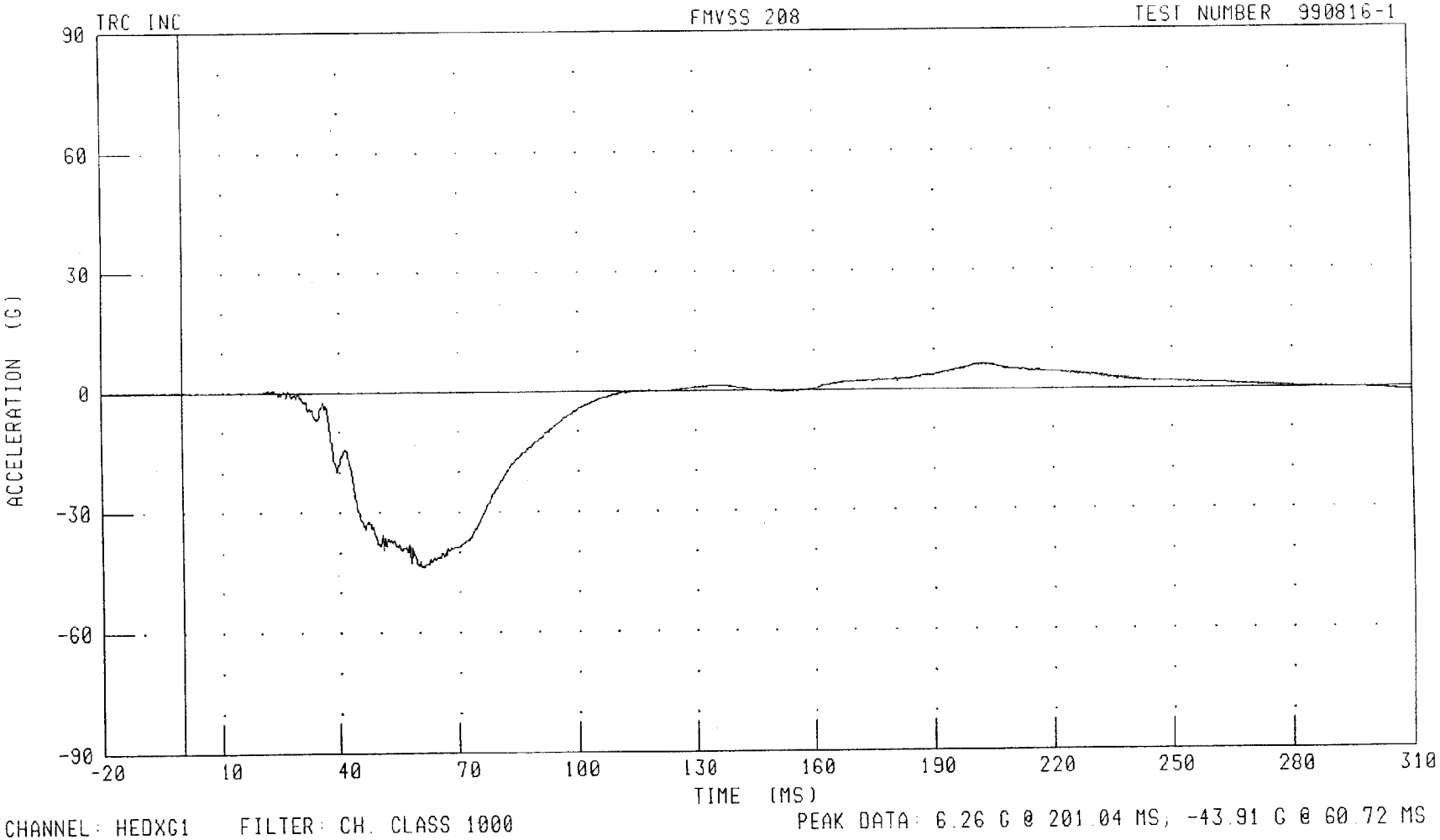
Figure A-58 Pre-Test Vehicle Certification Label View

Appendix B

Data Plots

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

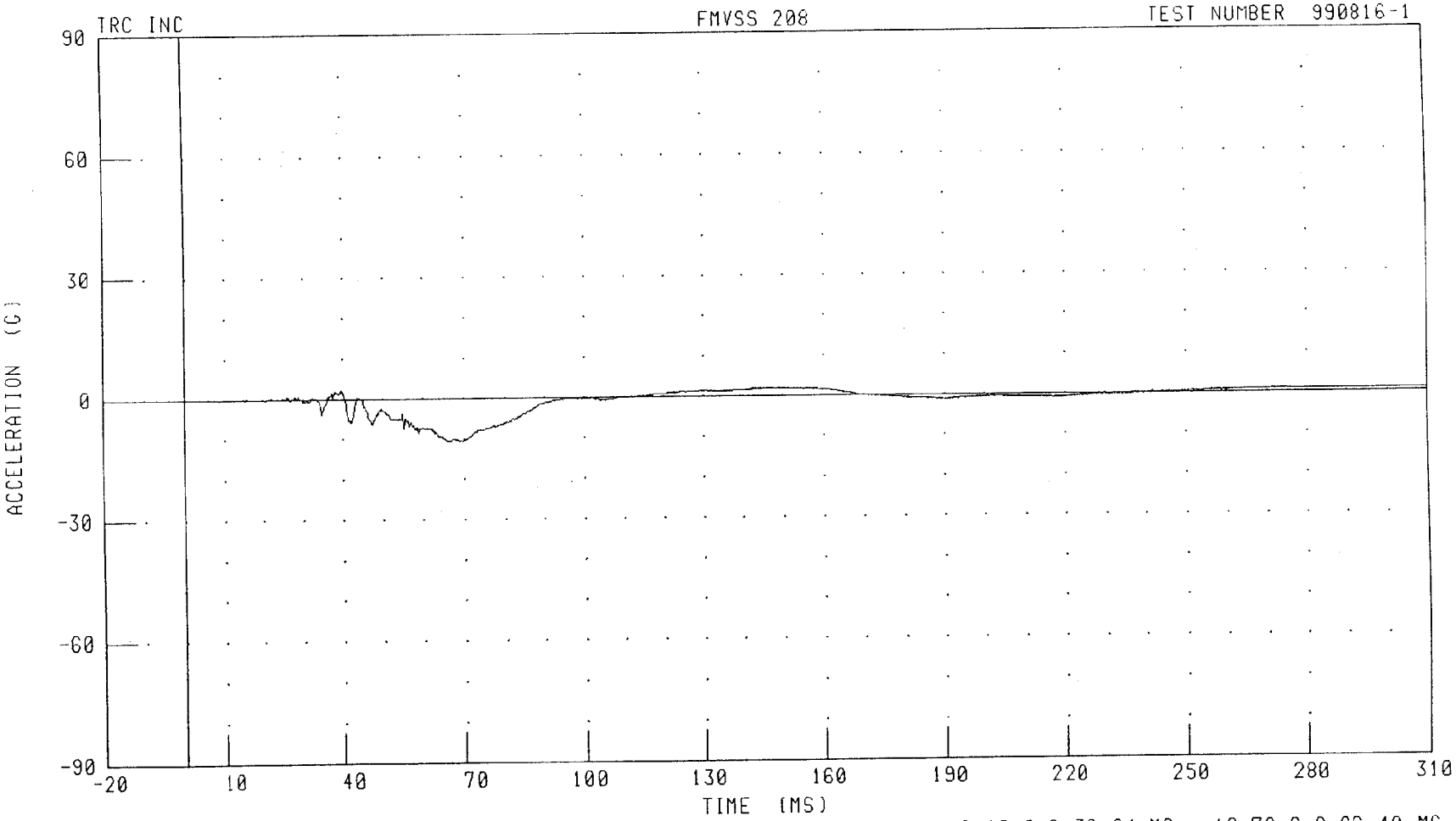
DRIVER HEAD X-AXIS ACCELERATION



CHANNEL: HEDXG1 FILTER: CH. CLASS 1000

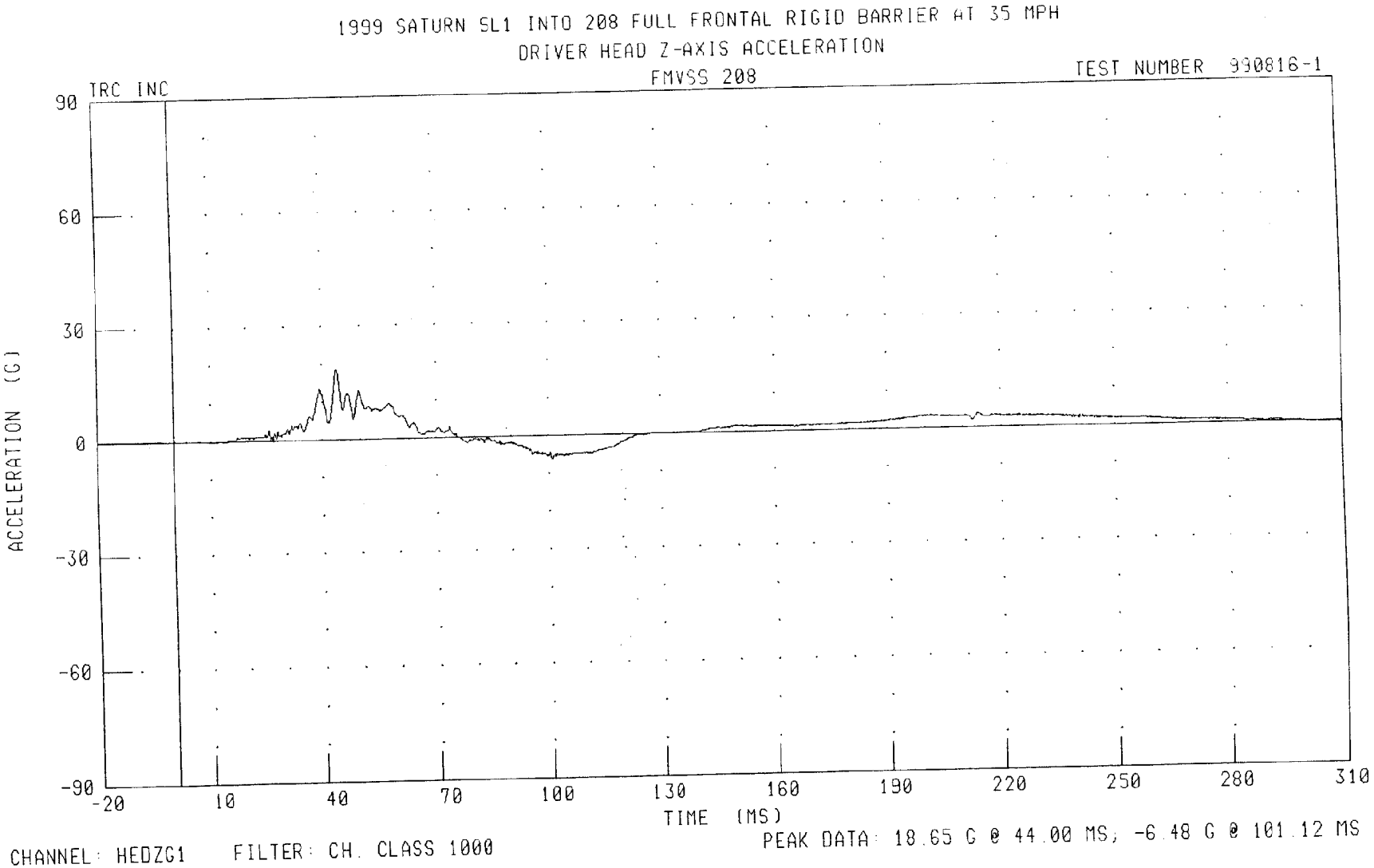
PEAK DATA: 6.26 G @ 201.04 MS; -43.91 G @ 60.72 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER HEAD Y-AXIS ACCELERATION
FMVSS 208

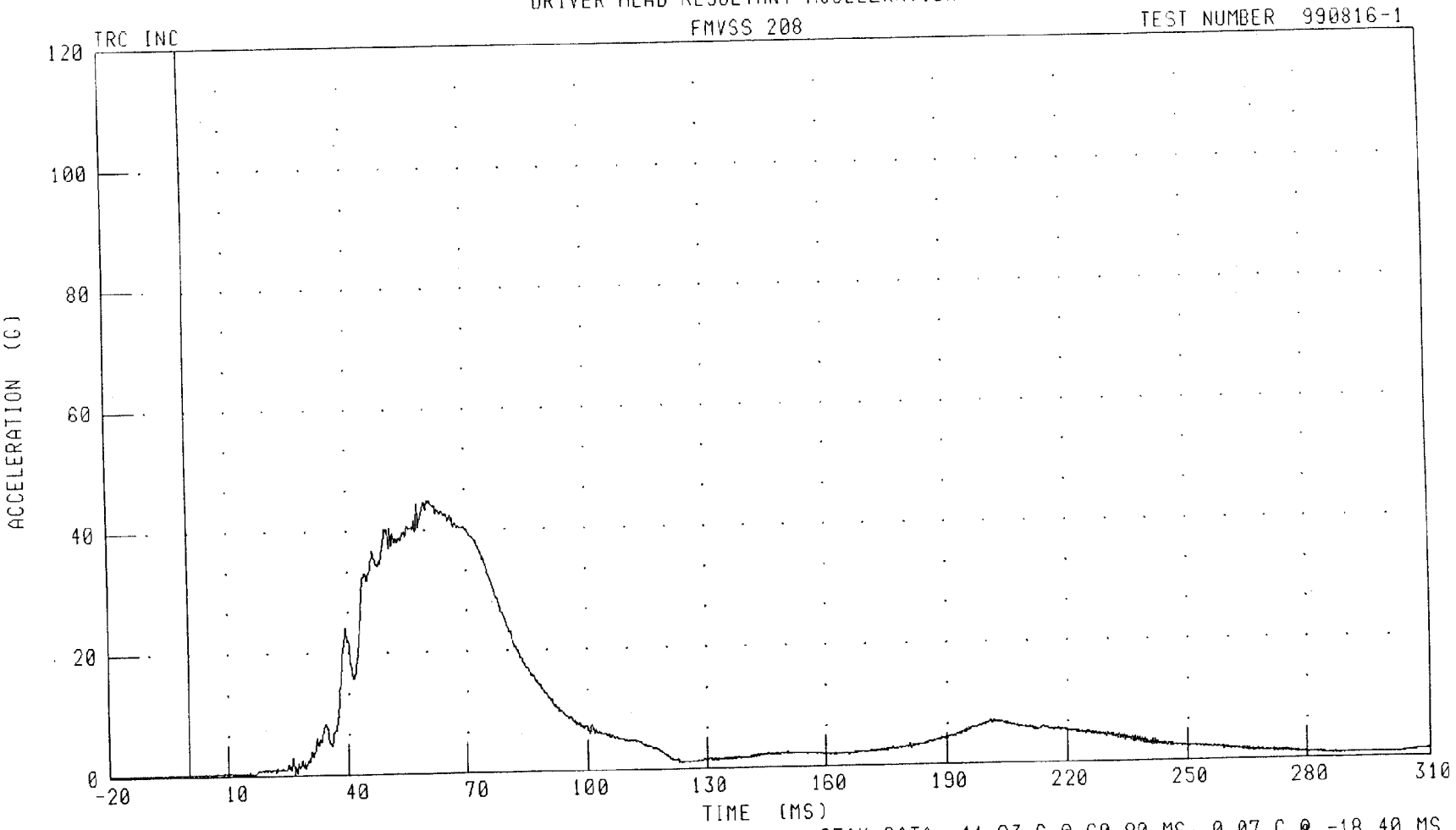


CHANNEL: HEDYG1 FILTER: CH. CLASS 1000

PEAK DATA: 2.16 G @ 39.84 MS; -10.76 G @ 66.40 MS


1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER HEAD Z-AXIS ACCELERATION
FMVSS 208
TRC INC
TEST NUMBER 990816-1
ACCELERATION (G)
90
60
30
0
-30
-60
-90
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL: HEDZC1
FILTER: CH. CLASS 1000
PEAK DATA: 18.65 G @ 44.00 MS, -6.48 G @ 101.12 MS

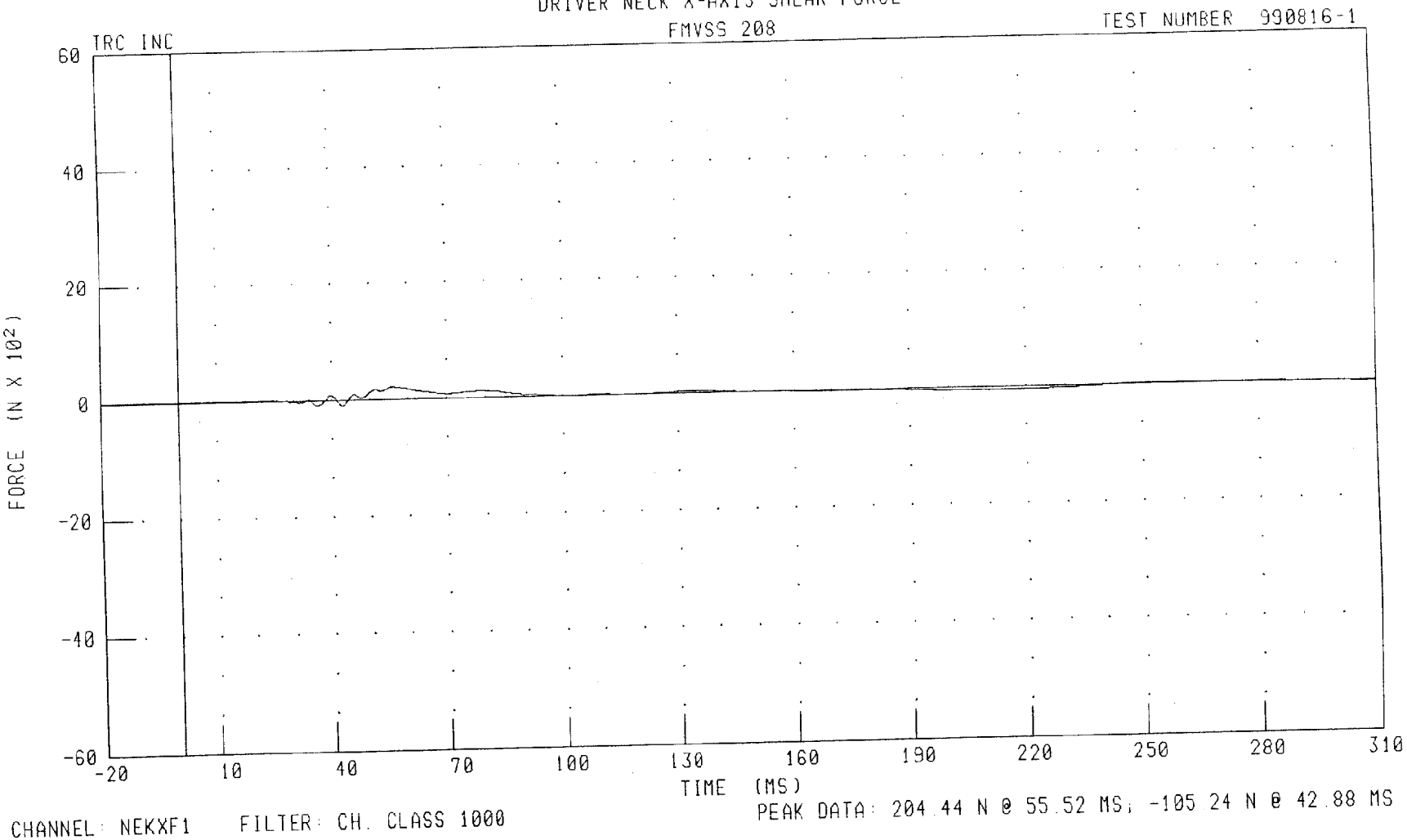
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER HEAD RESULTANT ACCELERATION
FMVSS 208



CHANNEL: HEDRG1 FILTER: CH. CLASS 1000

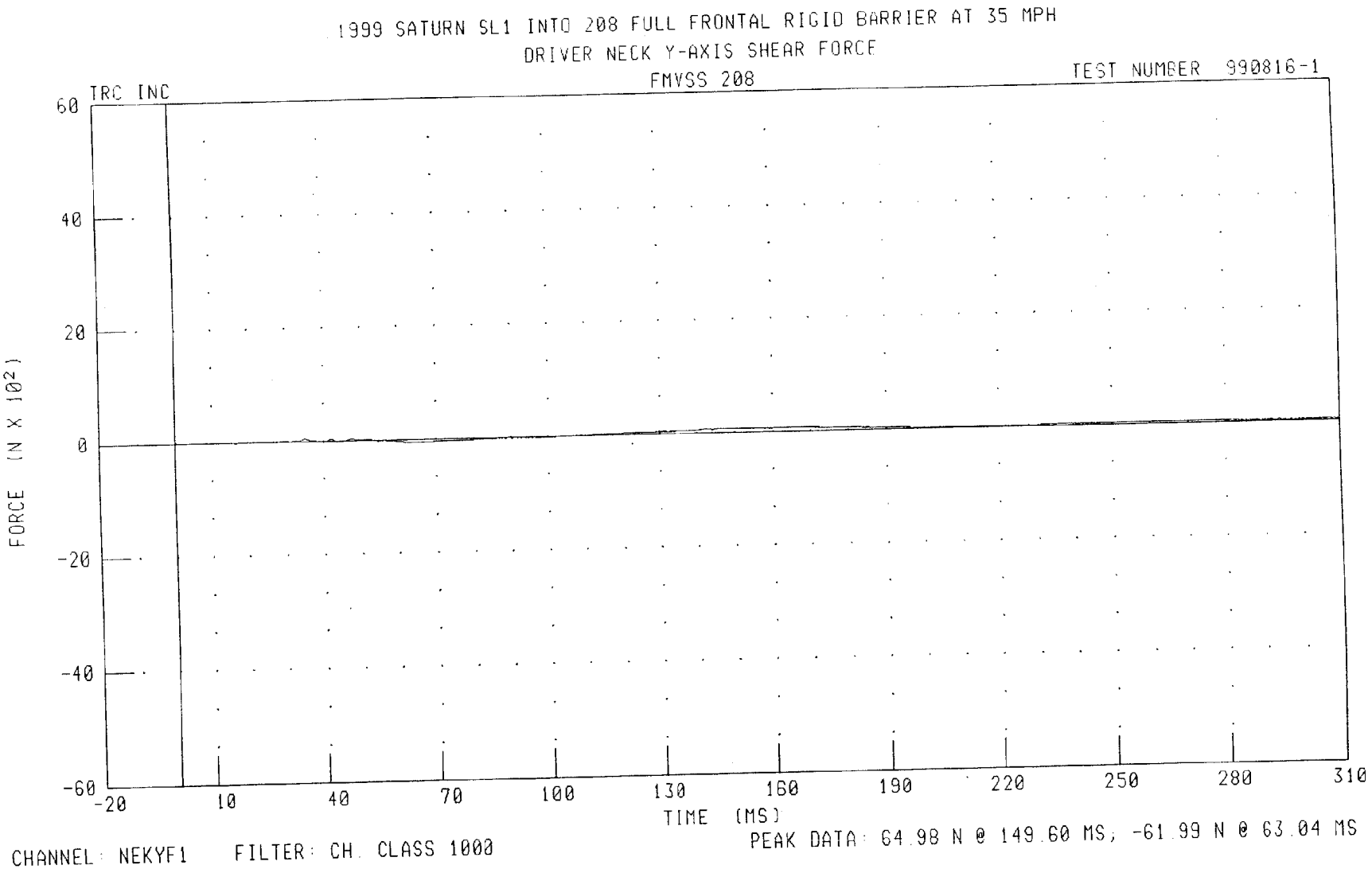
PEAK DATA: 44.93 G @ 60.80 MS; 0.07 G @ -18.40 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER NECK X-AXIS SHEAR FORCE
FMVSS 208

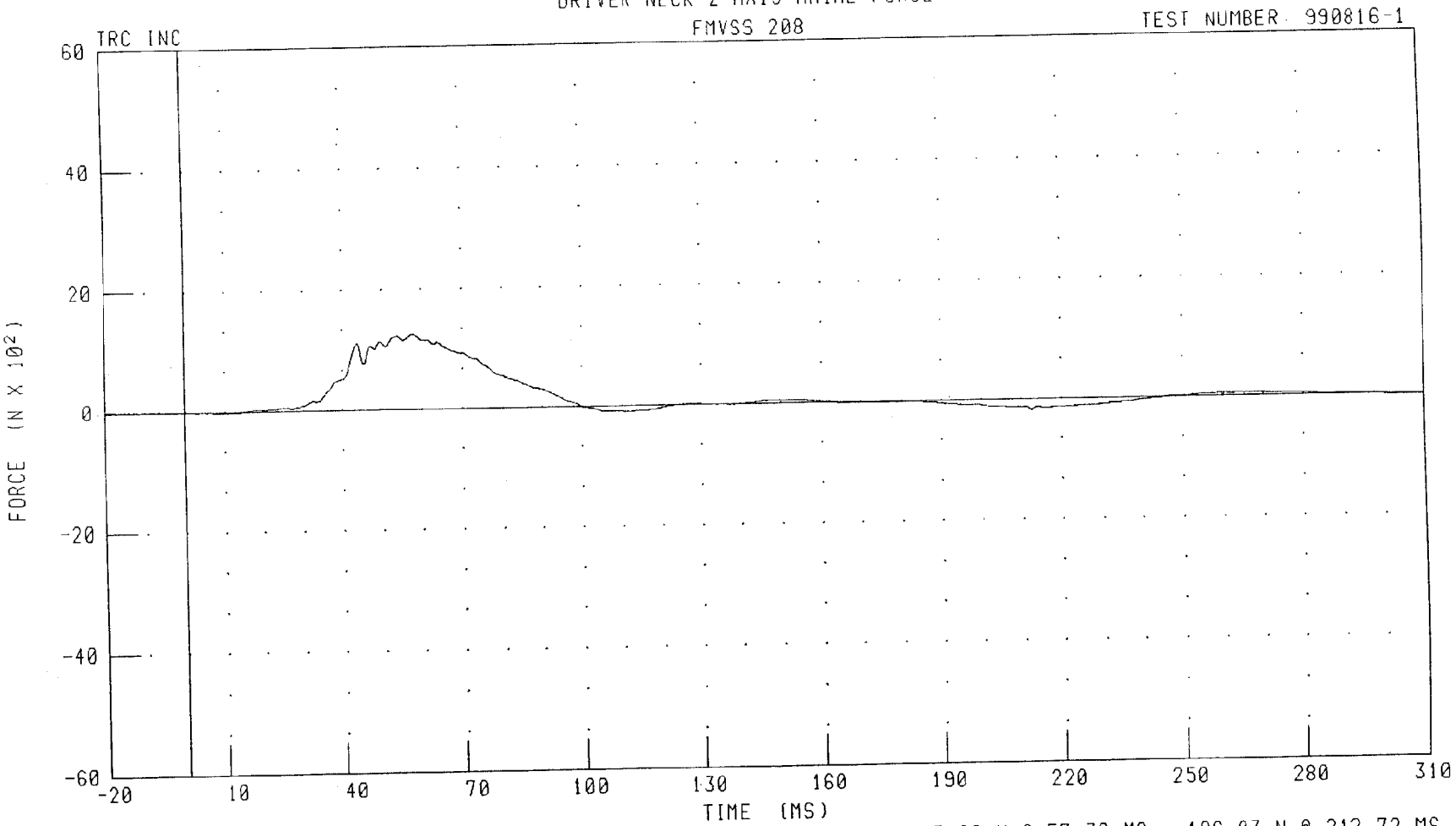


CHANNEL: NEKXF1 FILTER: CH. CLASS 1000

PEAK DATA: 204.44 N @ 55.52 MS; -105.24 N @ 42.88 MS


1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER NECK Y-AXIS SHEAR FORCE
FMVSS 208
TEST NUMBER 990816-1
TRC INC
60
40
20
0
-20
-40
-60
FORCE (N X 10²)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL: NEKYF1
FILTER: CH. CLASS 1000
PEAK DATA: 64.98 N @ 149.60 MS, -61.99 N @ 63.04 MS

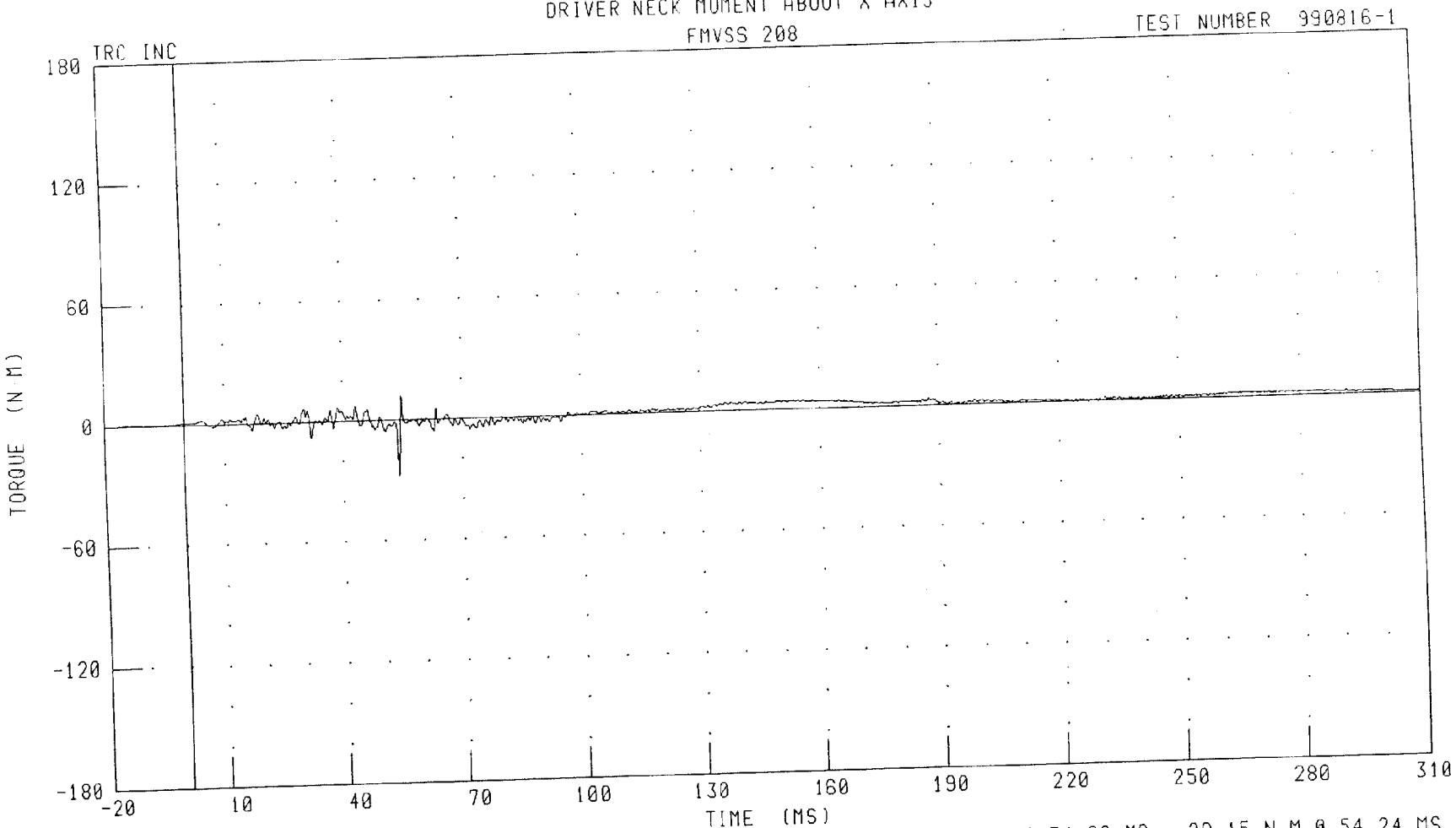
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER NECK Z-AXIS AXIAL FORCE
FMVSS 208



CHANNEL: NEKZF1 FILTER: CH. CLASS 1000

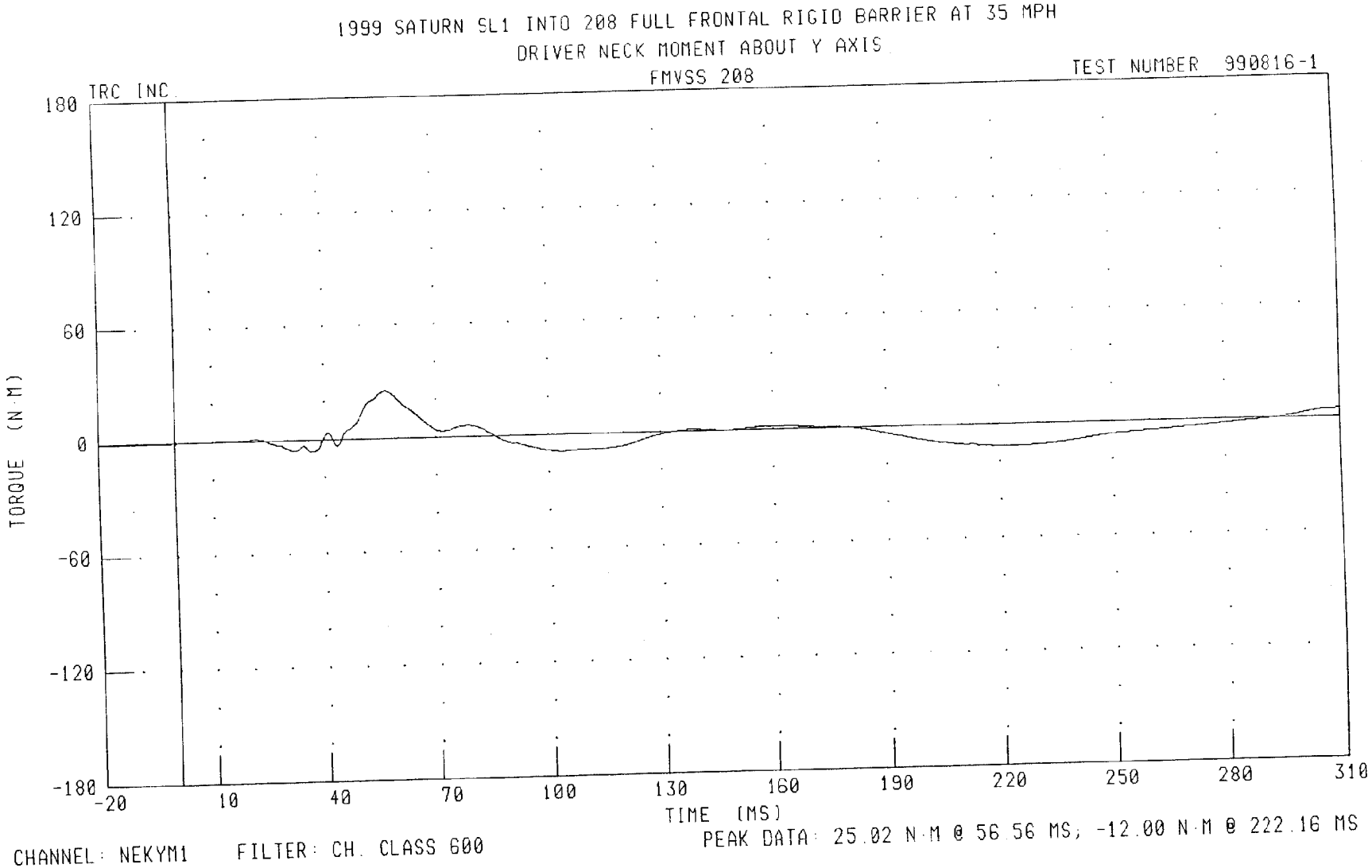
PEAK DATA: 1247.92 N @ 57.36 MS; -186.03 N @ 212.72 MS

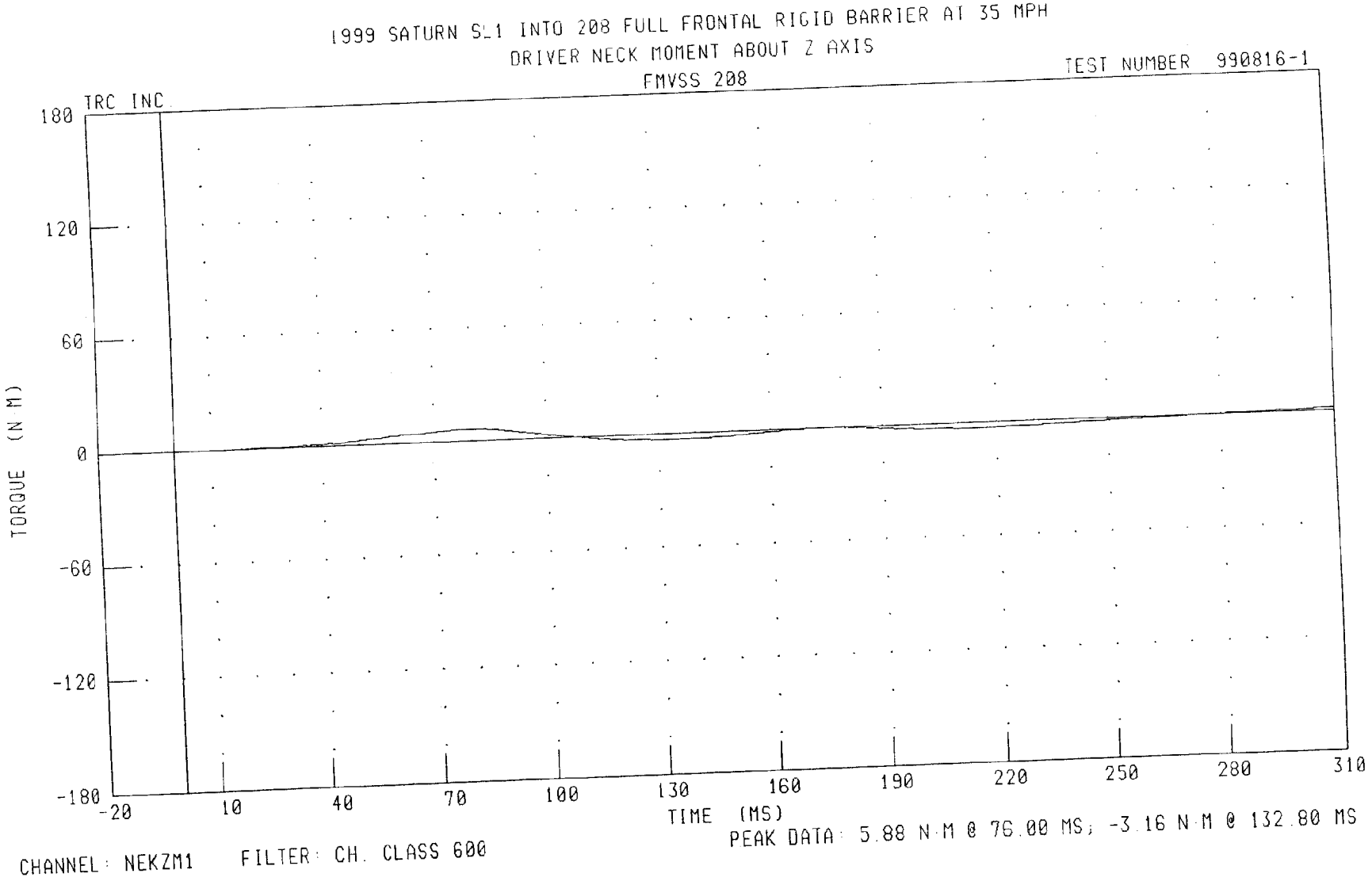
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER NECK MOMENT ABOUT X AXIS
FMVSS 208



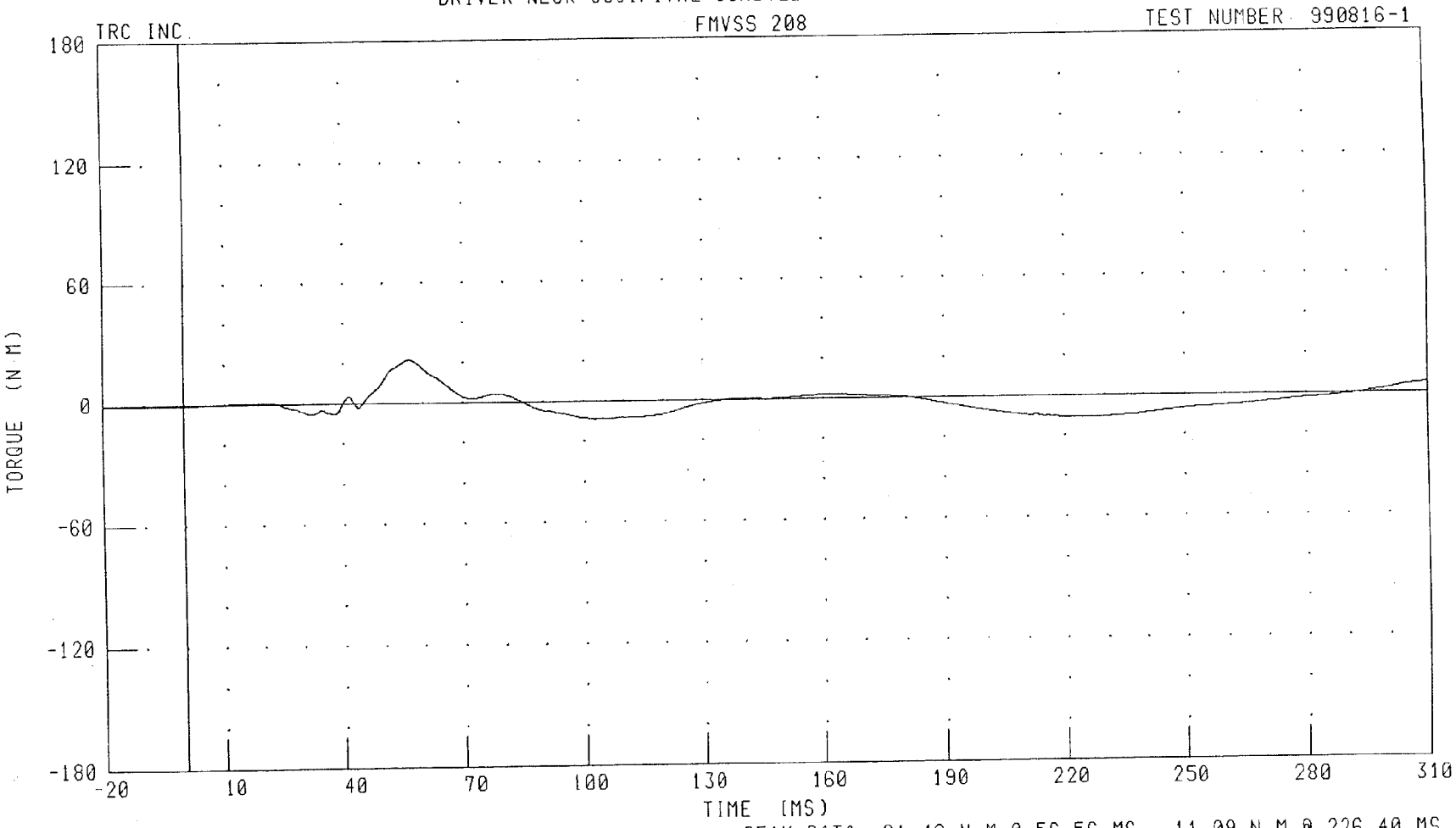
CHANNEL: NEKXM1 FILTER: CH. CLASS 600

PEAK DATA: 11.91 N M @ 54.96 MS; -28.15 N M @ 54.24 MS


1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER NECK MOMENT ABOUT Y AXIS
FMVSS 208
TEST NUMBER 990816-1
TRC INC
180
120
60
0
-60
-120
-180
TORQUE (N-M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL: NEKYM1
FILTER: CH. CLASS 600
PEAK DATA: 25.02 N-M @ 56.56 MS; -12.00 N-M @ 222.16 MS


1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER NECK MOMENT ABOUT Z AXIS
FMVSS 208
TEST NUMBER 990816-1
TRC INC
180
120
60
0
-60
-120
-180
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL: NEKZM1
FILTER: CH. CLASS 600
PEAK DATA: 5.88 N-M @ 76.00 MS; -3.16 N-M @ 132.80 MS

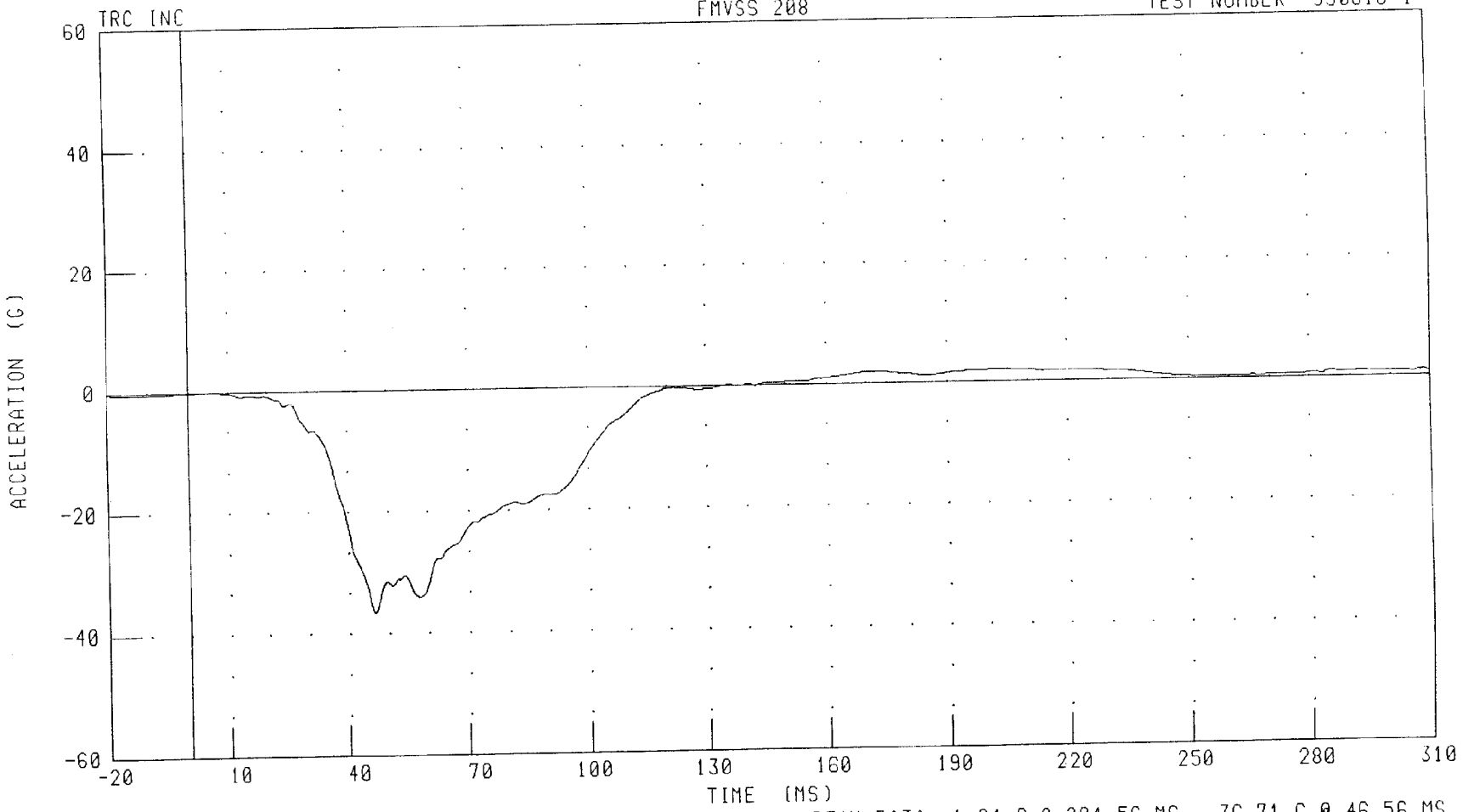
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER NECK OCCIPITAL CONDYLE MOMENT ABOUT Y AXIS



CHANNEL: NEKOM1 FILTER: CH. CLASS 600

PEAK DATA: 21.46 N.M @ 56.56 MS; -11.09 N.M @ 226.40 MS

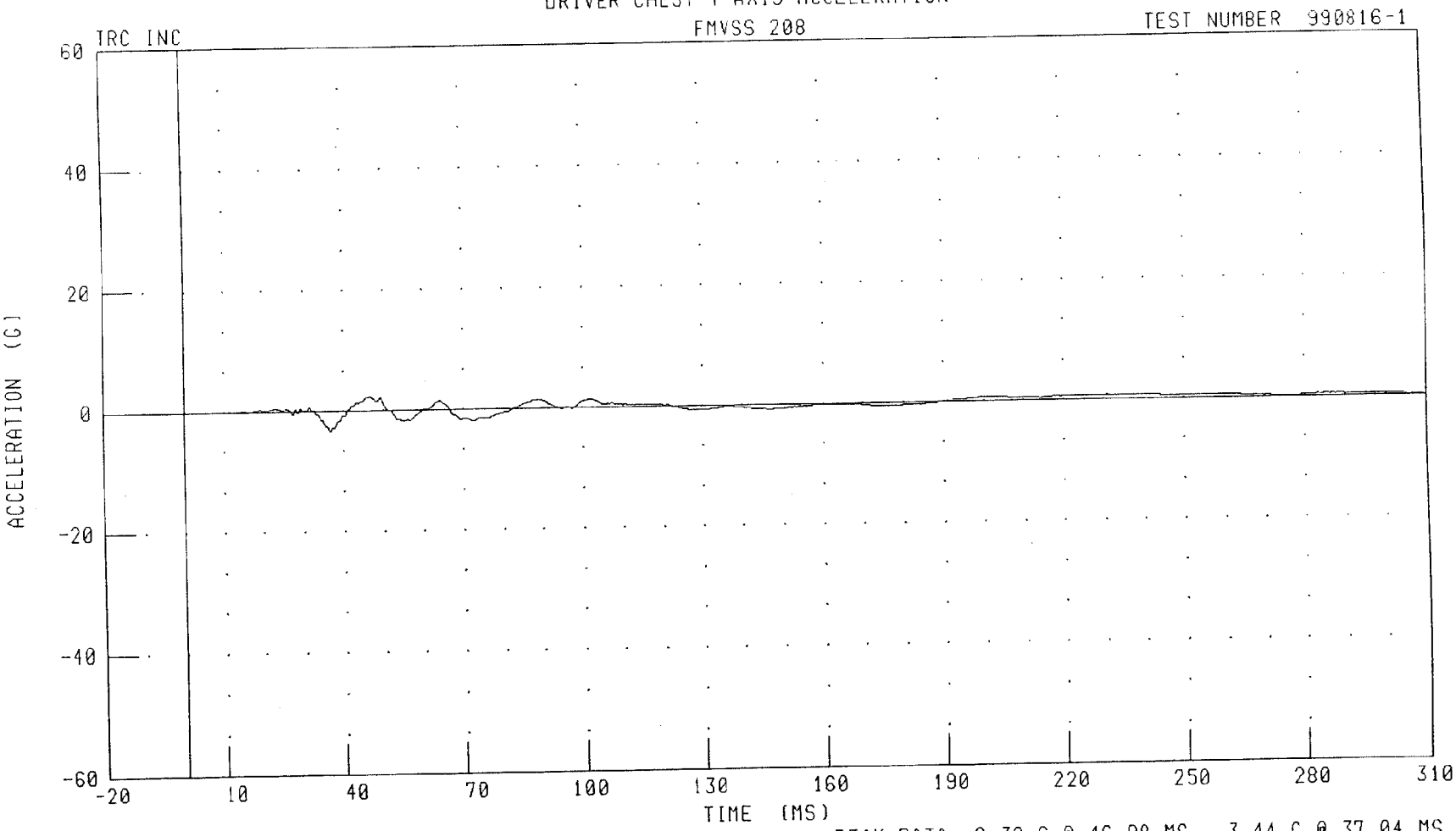
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER CHEST X-AXIS ACCELERATION
FMVSS 208



CHANNEL: CSTXG1 FILTER: CH. CLASS 180

PEAK DATA: 1.94 G @ 204.56 MS, -36.71 G @ 46.56 MS

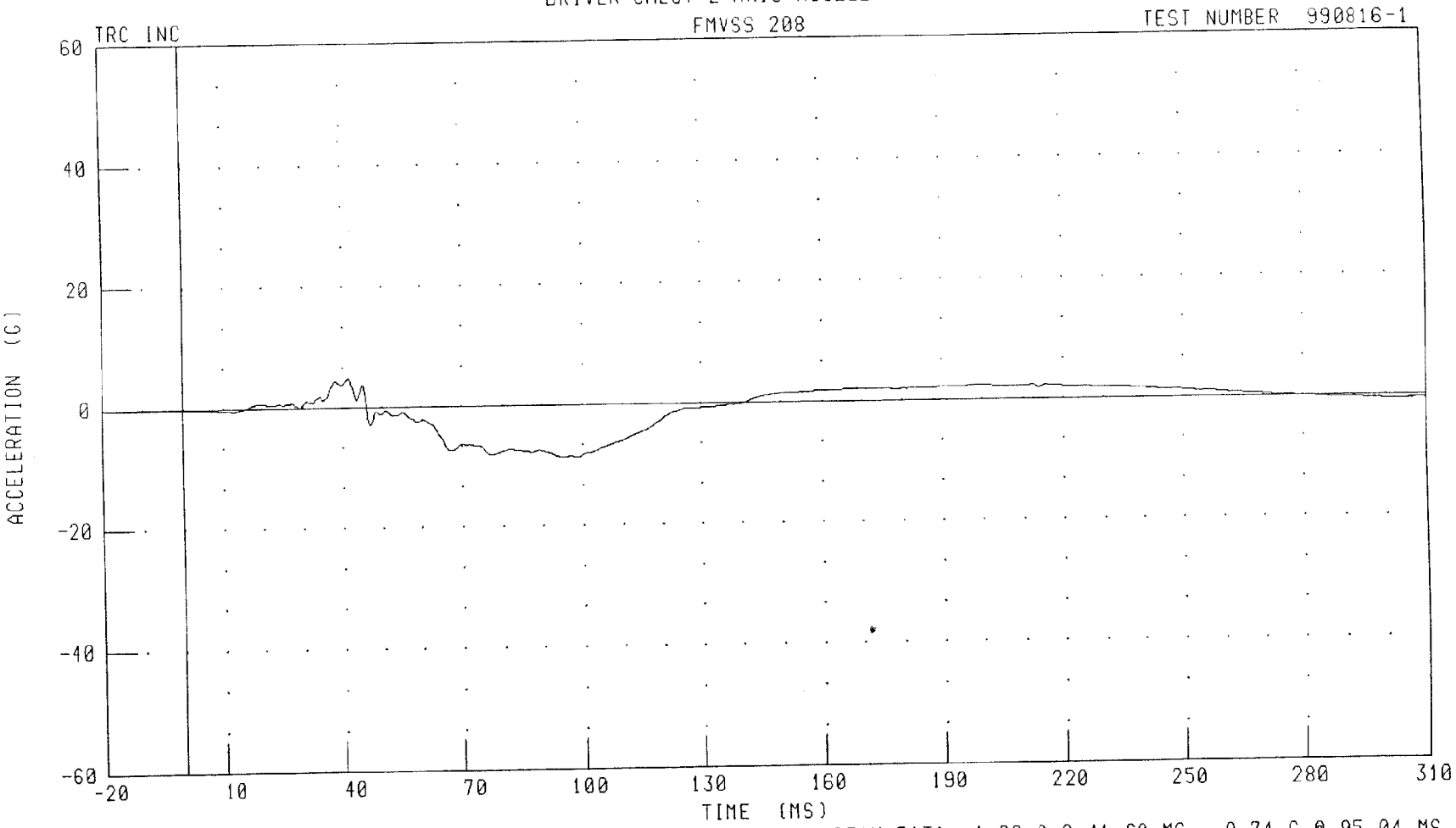
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER CHEST Y-AXIS ACCELERATION
FMVSS 208



CHANNEL: CSTYG1 FILTER: CH. CLASS 180

PEAK DATA: 2.30 G @ 46.88 MS, -3.44 G @ 37.04 MS

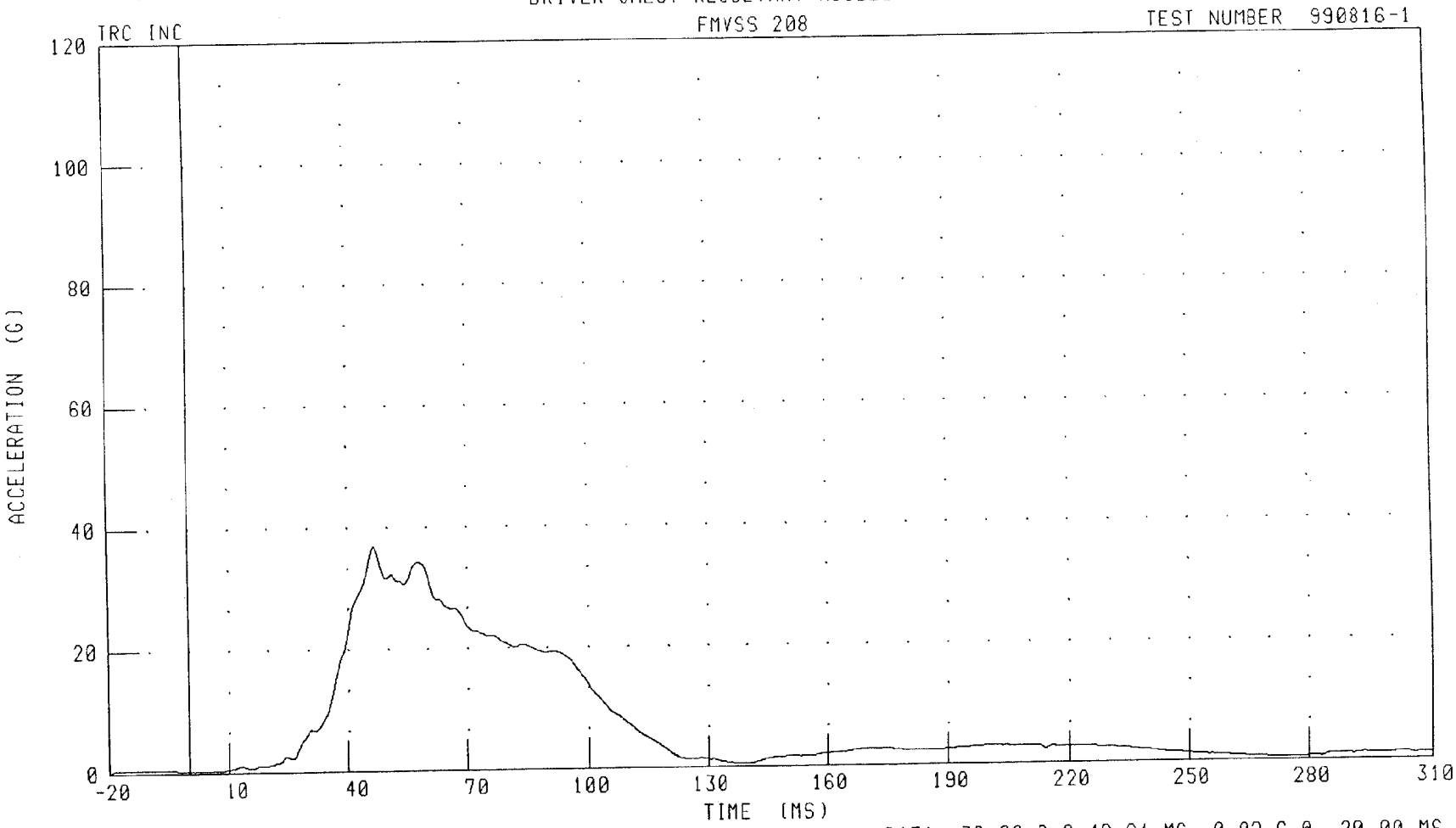
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER CHEST Z-AXIS ACCELERATION



CHANNEL: CSTZG1 FILTER: CH. CLASS 180

PEAK DATA: 4.82 G @ 41.60 MS, -8.74 G @ 95.04 MS

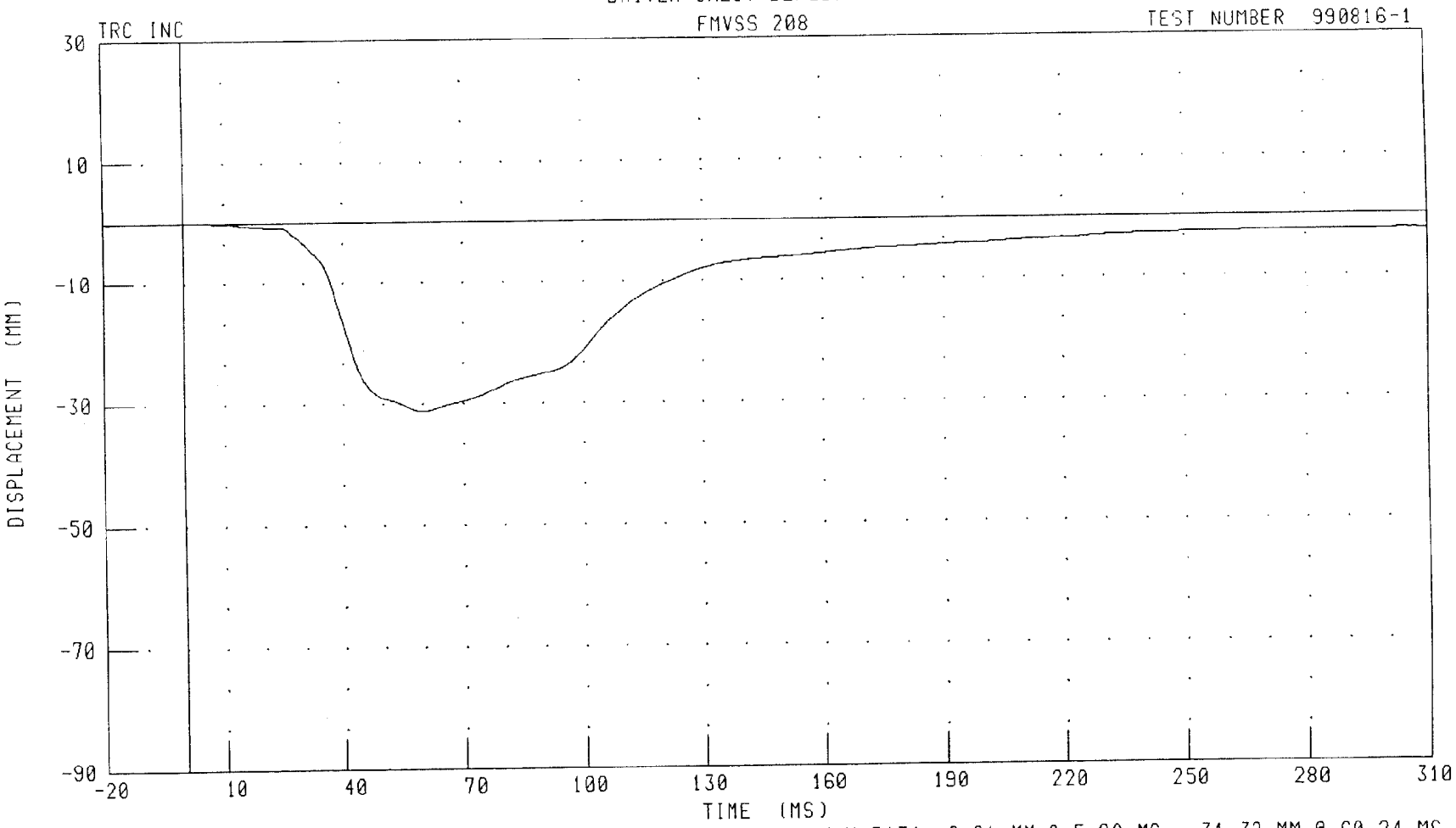
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER CHEST RESULTANT ACCELERATION
FMVSS 208



CHANNEL: CSTRG1 FILTER: CH. CLASS 180

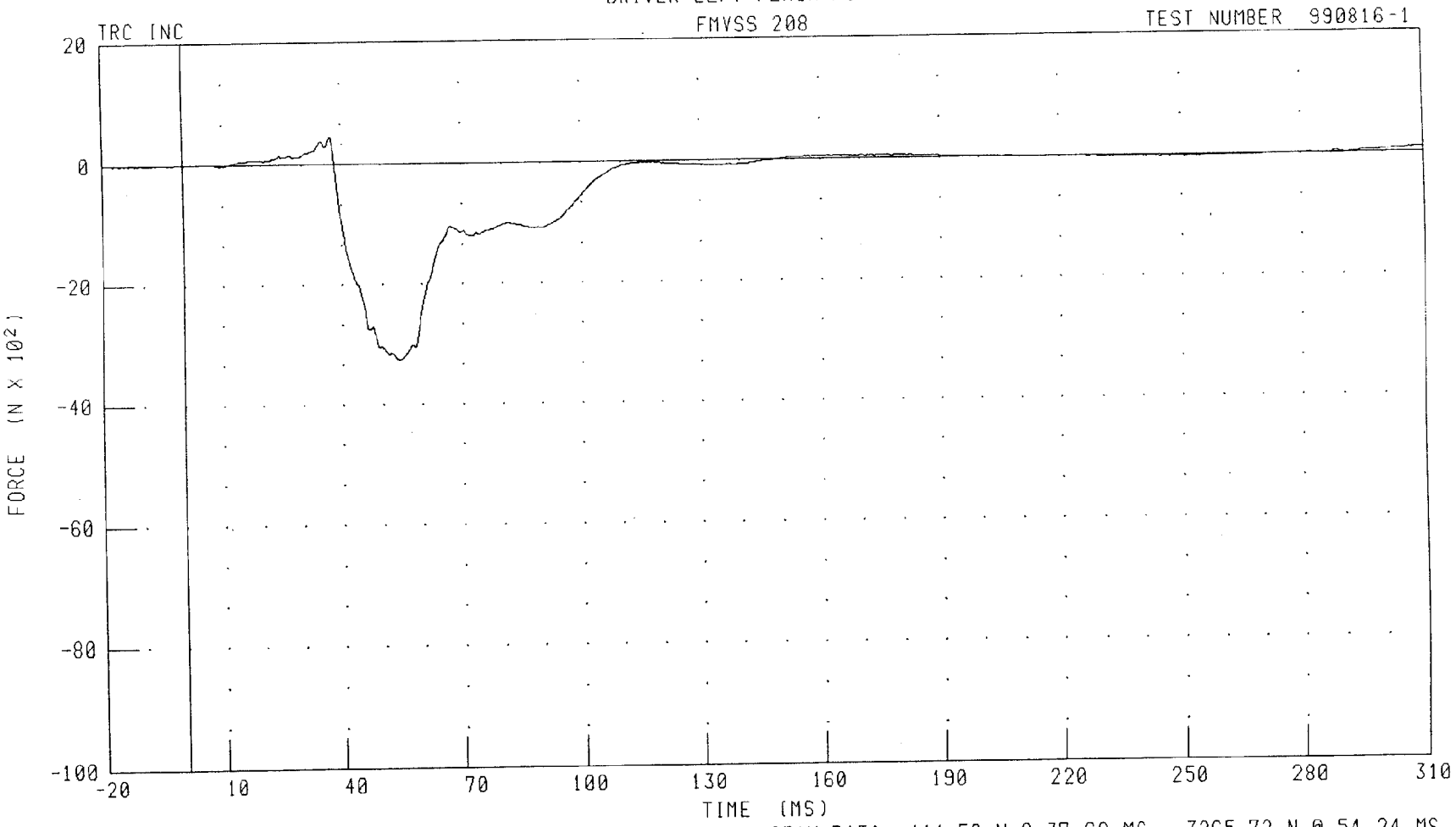
PEAK DATA: 36.82 G @ 46.64 MS; 0.02 G @ -20.00 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER CHEST DEFLECTION
FMVSS 208



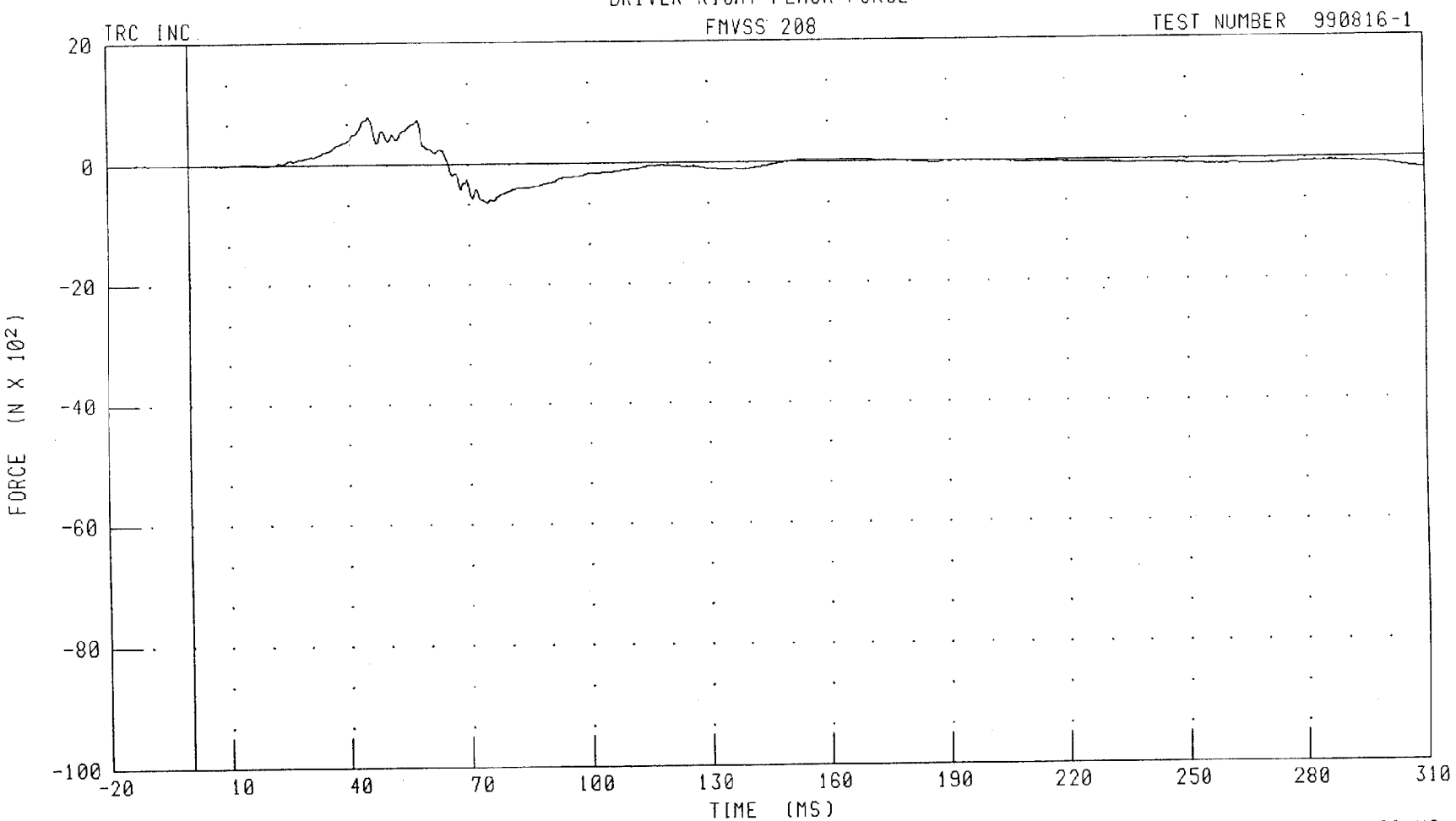
CHANNEL: CSTXD1 FILTER: CH. CLASS 180 PEAK DATA: 0.01 MM @ 5.20 MS; -31.32 MM @ 60.24 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER LEFT FEMUR FORCE
FMVSS 208



CHANNEL: LFMF1 FILTER: CH. CLASS 600 PEAK DATA: 444.56 N @ 37.68 MS; -3265.72 N @ 54.24 MS

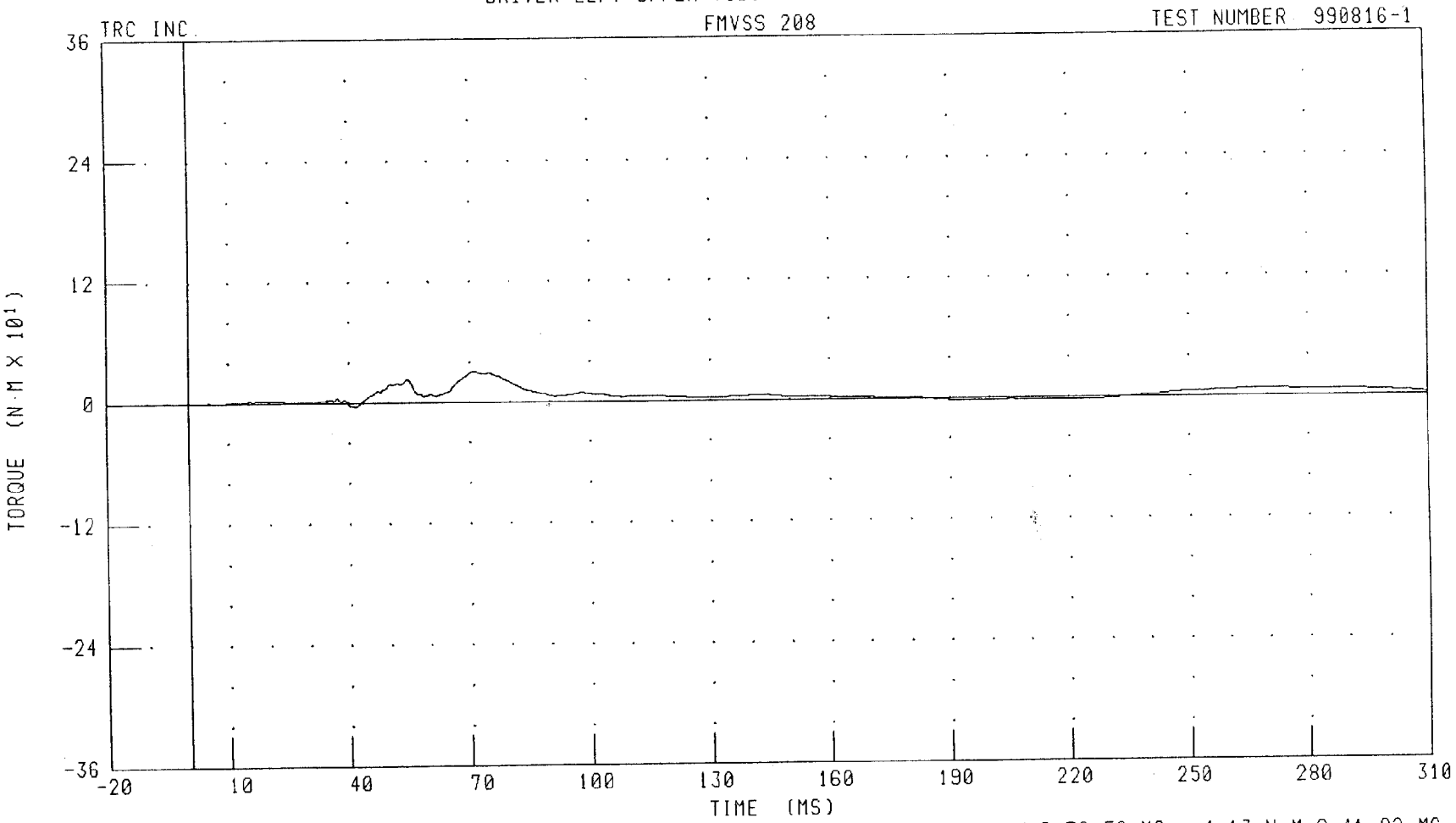
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER RIGHT FEMUR FORCE



CHANNEL: RFMF1 FILTER: CH. CLASS 600

PEAK DATA: 785.84 N @ 45.52 MS; -631.88 N @ 74.80 MS

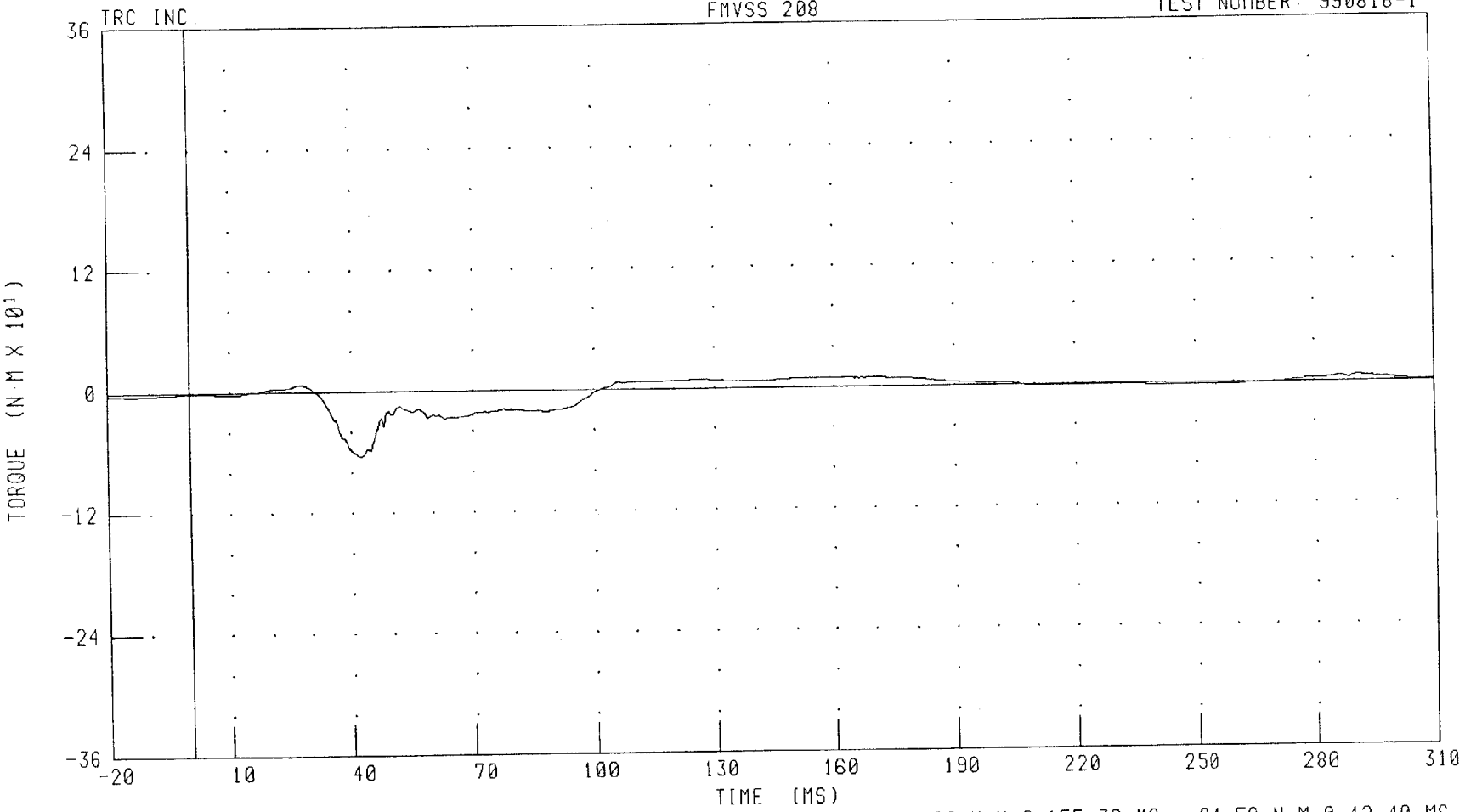
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER LEFT UPPER TIBIA MOMENT ABOUT X AXIS



CHANNEL: TBLXM1 FILTER: CH. CLASS 600

PEAK DATA: 29.62 N-M @ 70.56 MS; -4.13 N-M @ 41.92 MS

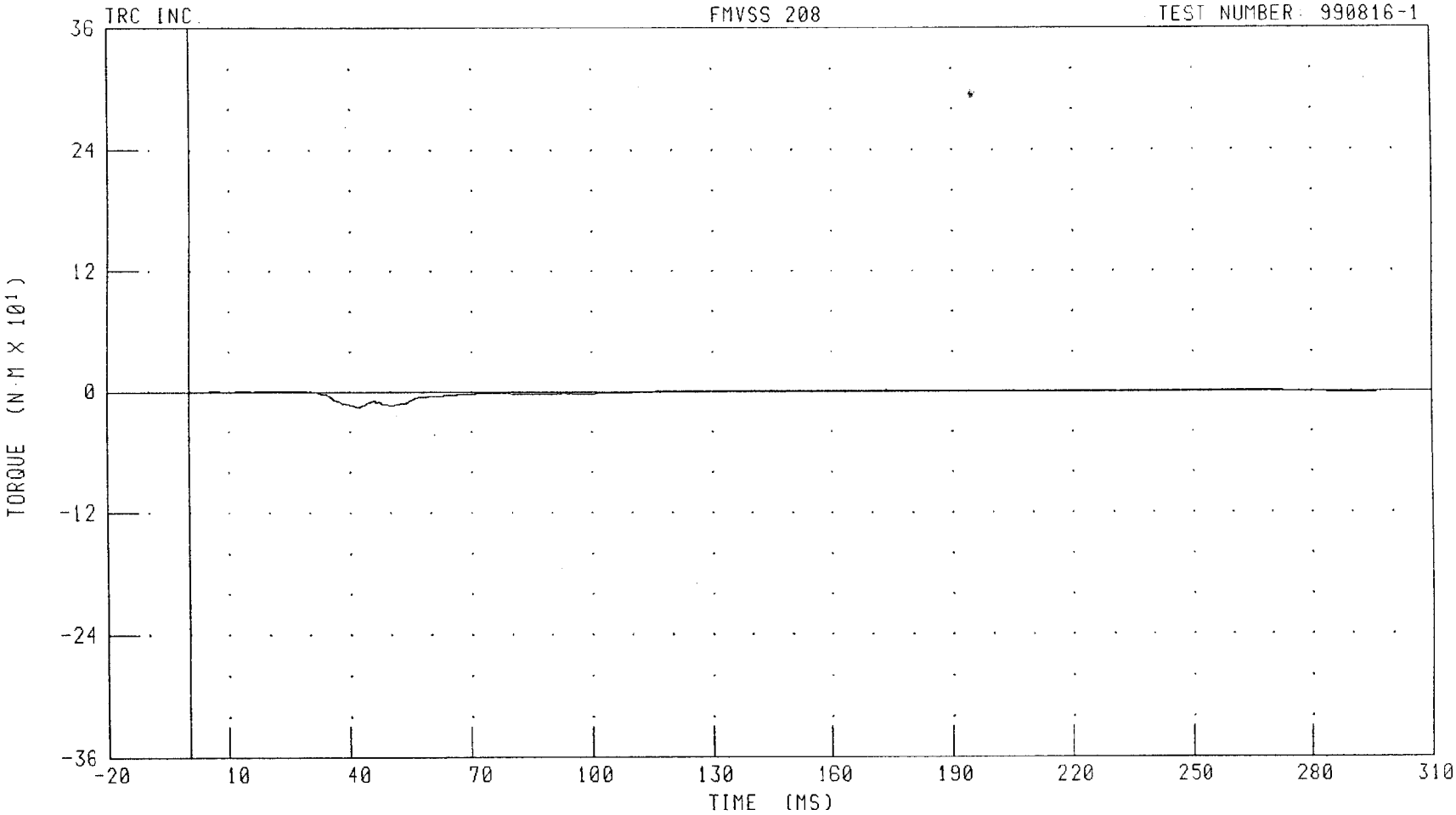
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER LEFT UPPER TIBIA MOMENT ABOUT Y AXIS
FMVSS 208
TEST NUMBER: 990816-1



CHANNEL: TBLYM1 FILTER: CH. CLASS 600

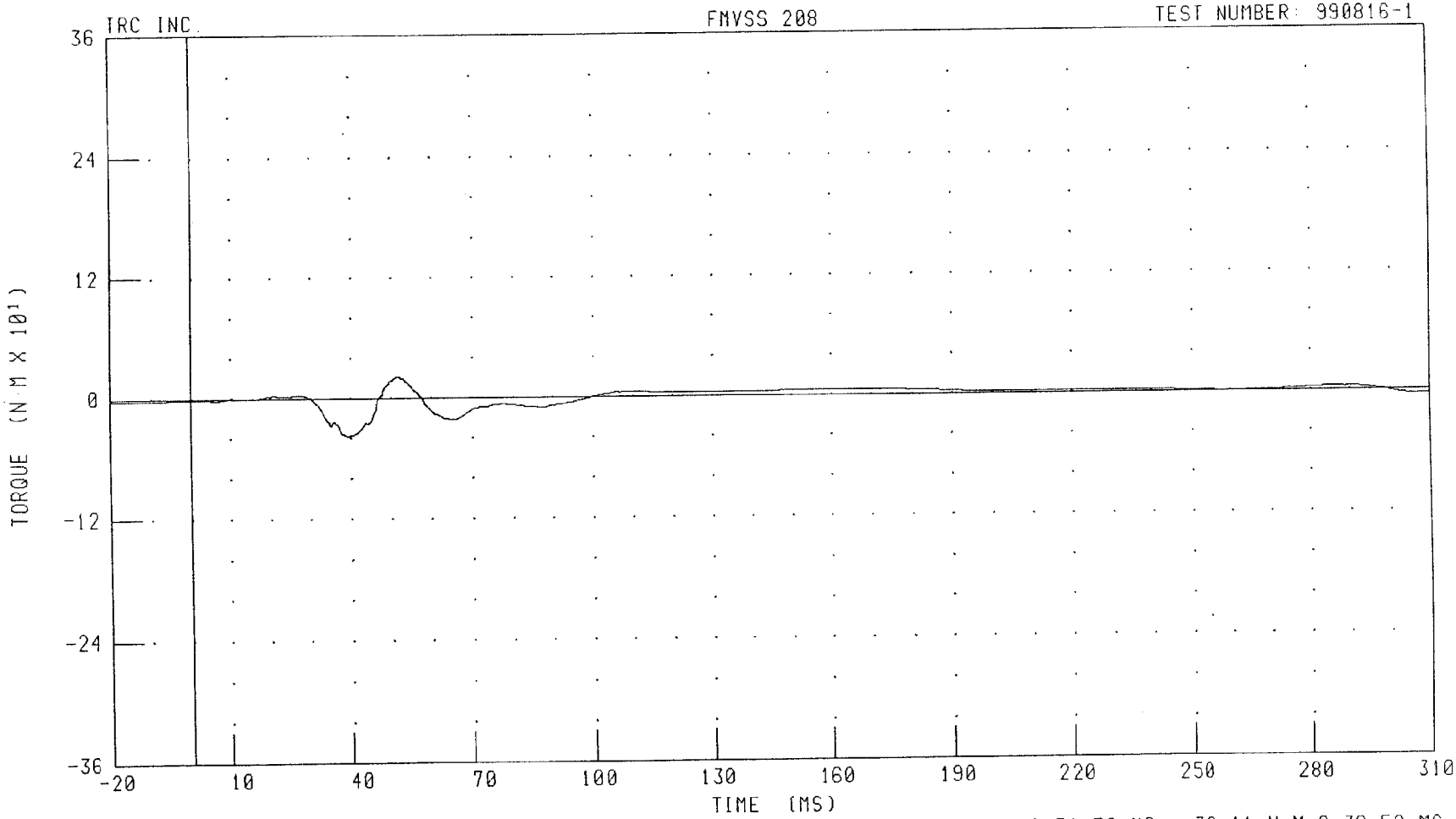
PEAK DATA: 8.60 N·M @ 155.36 MS, -64.50 N·M @ 42.40 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER LEFT LOWER TIBIA MOMENT ABOUT X AXIS



CHANNEL: ANLXM1 FILTER: CH. CLASS 600 PEAK DATA: 1.26 N-M @ 173.68 MS; -15.34 N-M @ 42.16 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER LEFT LOWER TIBIA MOMENT ABOUT Y AXIS

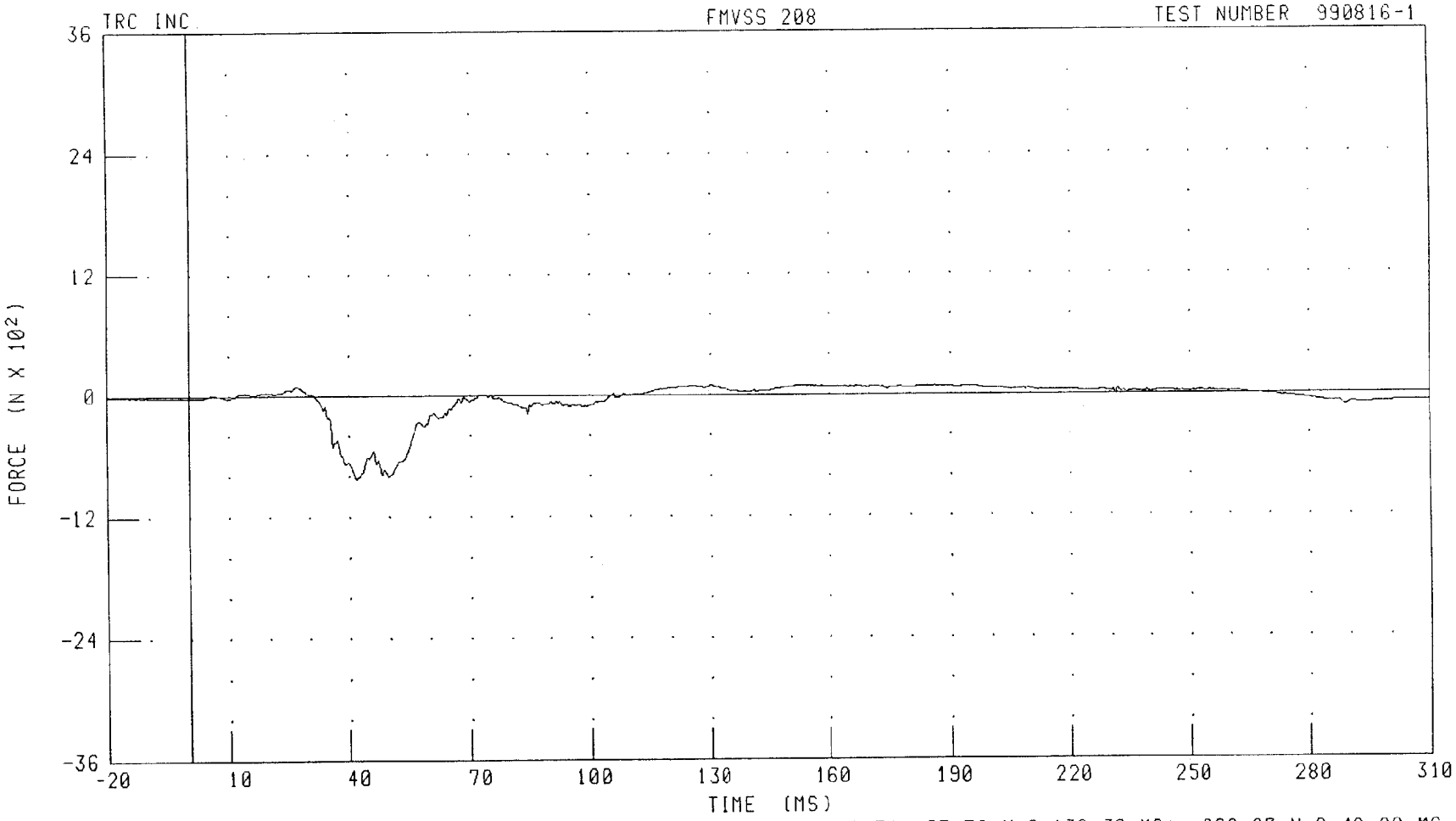


CHANNEL: ANLYM1 FILTER: CH. CLASS 600

PEAK DATA: 20.55 N-M @ 51.76 MS; -38.11 N-M @ 39.52 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

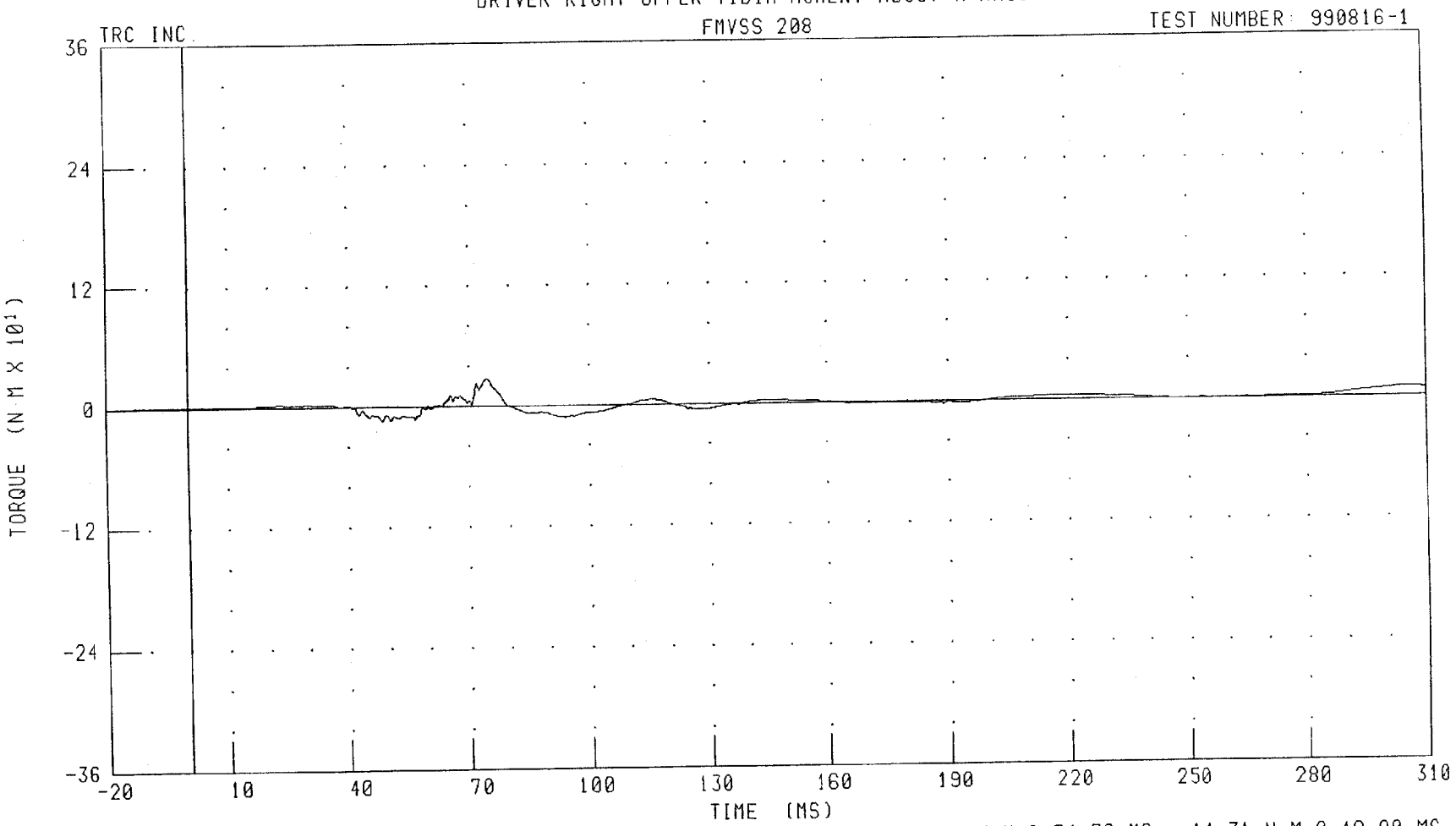
DRIVER LEFT TIBIA Z-AXIS FORCE



CHANNEL: TBLZF1 FILTER: CH. CLASS 600

PEAK DATA: 95.70 N @ 130.32 MS; -822.97 N @ 42.00 MS

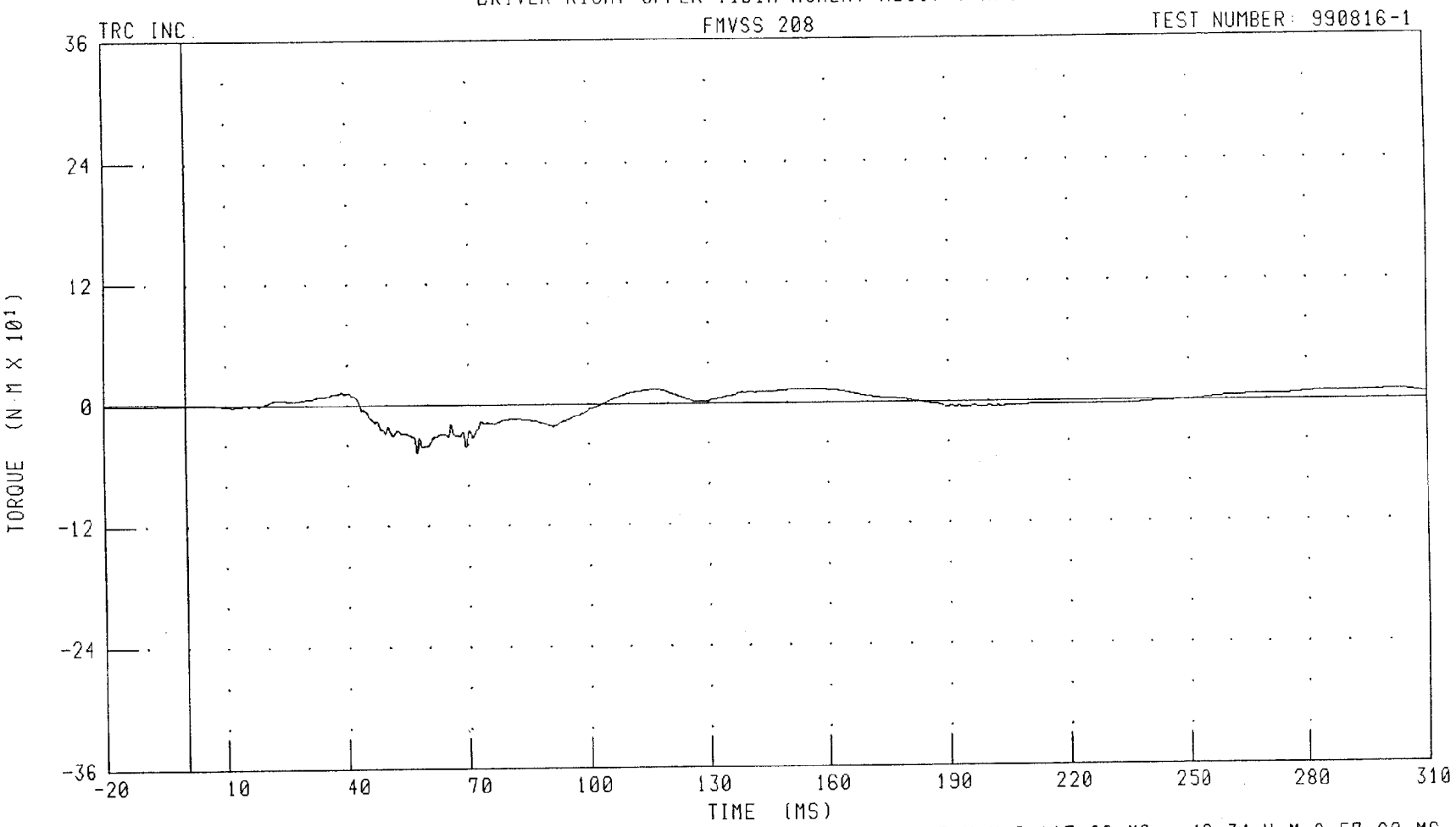
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER RIGHT UPPER TIBIA MOMENT ABOUT X AXIS



CHANNEL: TBRXM1 FILTER: CH. CLASS 600

PEAK DATA: 27.20 N M @ 74.72 MS; -14.31 N M @ 48.80 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER RIGHT UPPER TIBIA MOMENT ABOUT Y AXIS

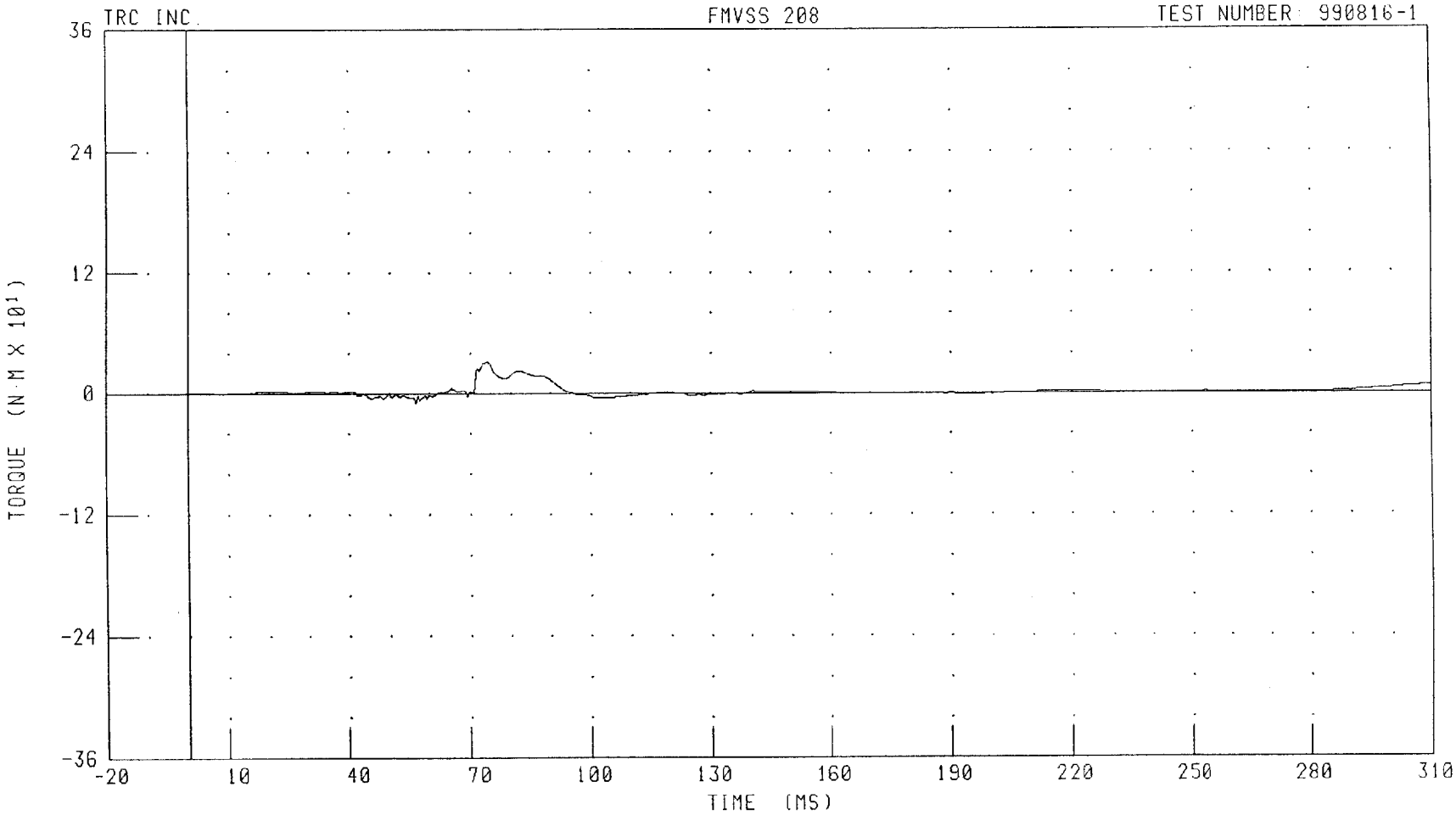


CHANNEL: TBRYM1 FILTER: CH. CLASS 600

PEAK DATA: 13.67 N M @ 117.68 MS; -48.34 N M @ 57.60 MS

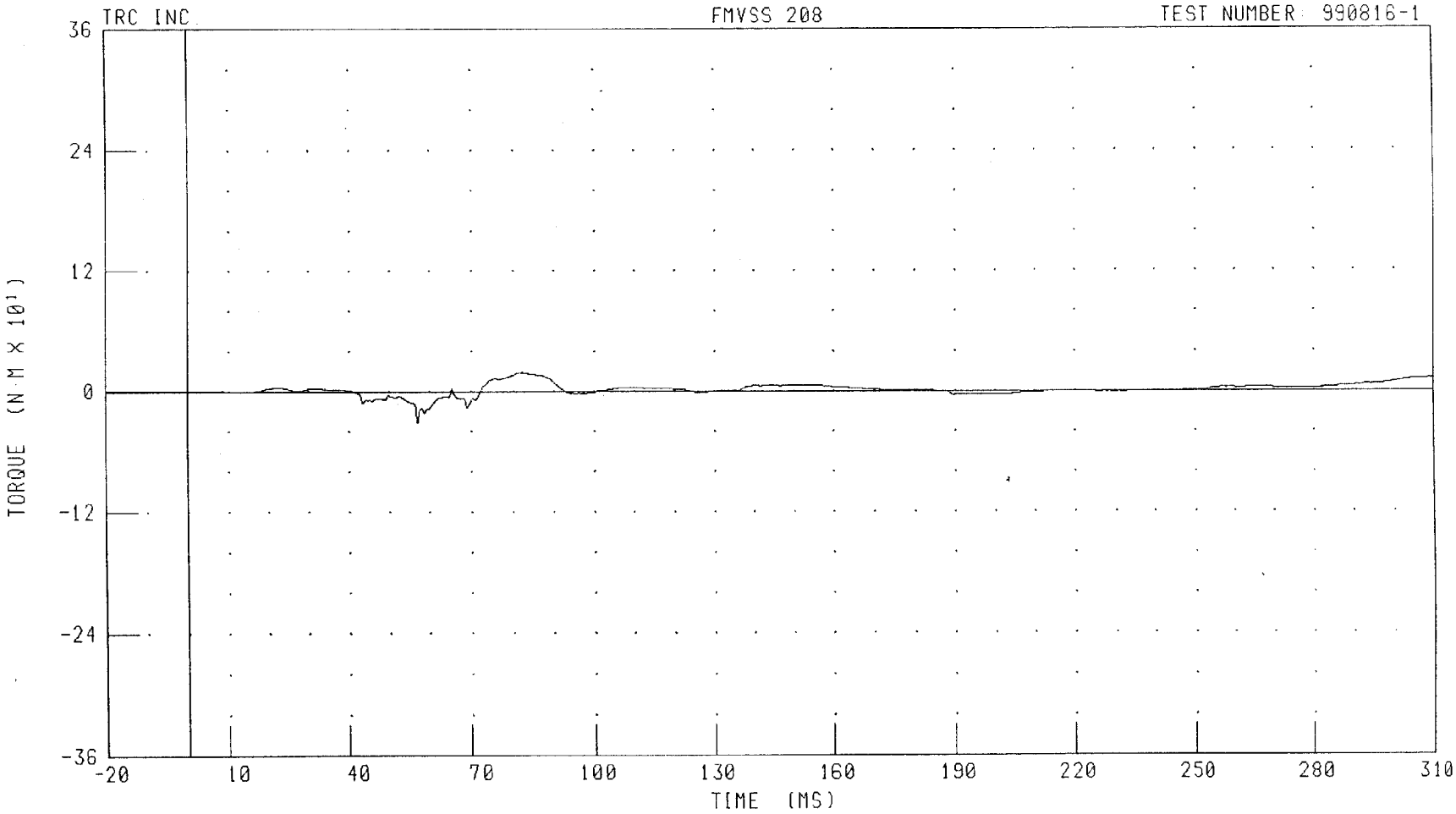
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

DRIVER RIGHT LOWER TIBIA MOMENT ABOUT X AXIS



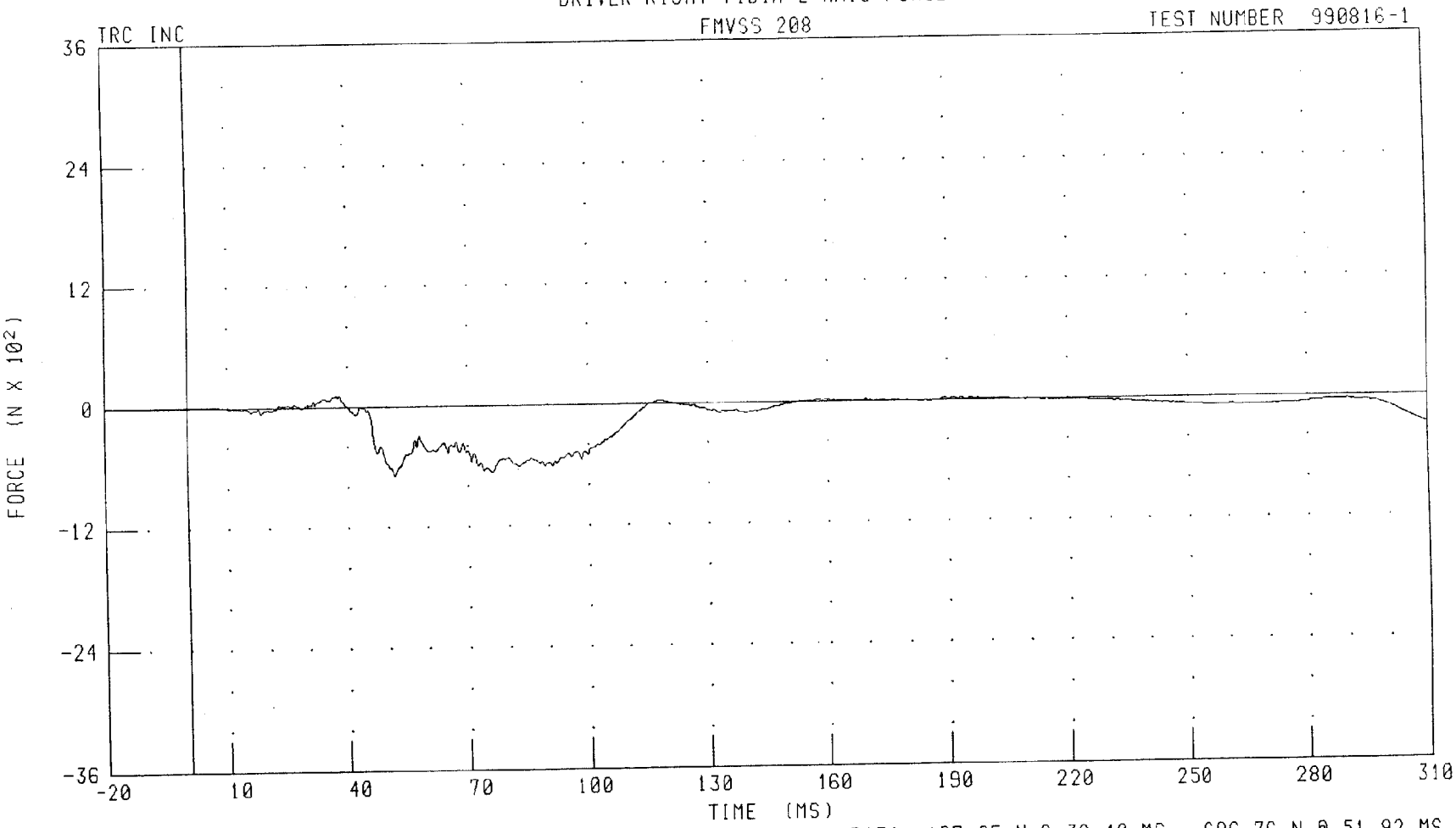
CHANNEL: ANRXM1 FILTER: CH. CLASS 600 PEAK DATA: 31.22 N-M @ 74.32 MS; -9.45 N-M @ 56.80 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER RIGHT LOWER TIBIA MOMENT ABOUT Y AXIS



CHANNEL: ANRYM1 FILTER: CH. CLASS 600 PEAK DATA: 18.36 N-M @ 82.48 MS; -30.81 N-M @ 57.28 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER RIGHT TIBIA Z-AXIS FORCE
FMVSS 208

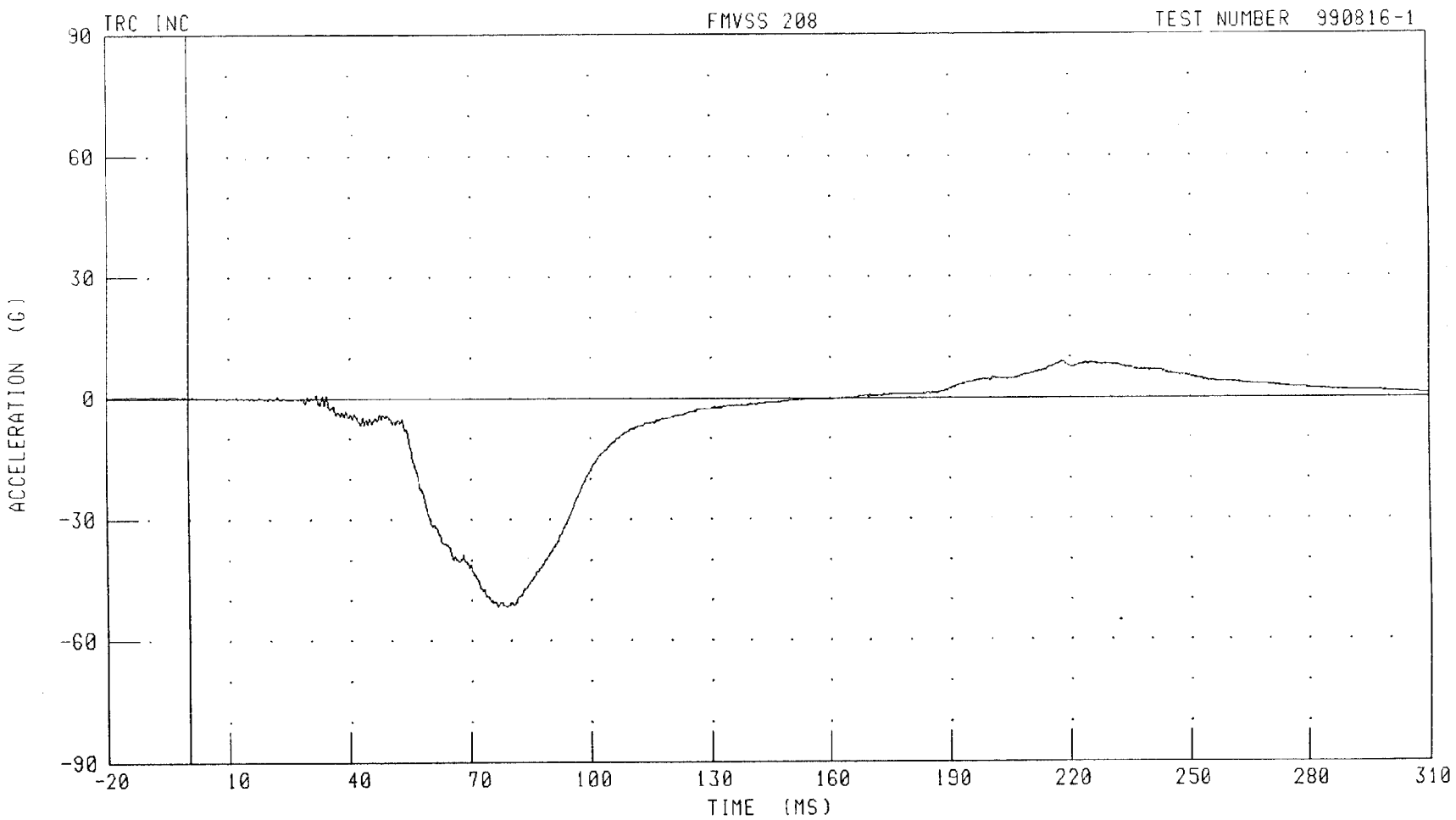


CHANNEL: TBRZF1 FILTER: CH. CLASS 600

PEAK DATA: 107.85 N @ 38.40 MS; -696.76 N @ 51.92 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

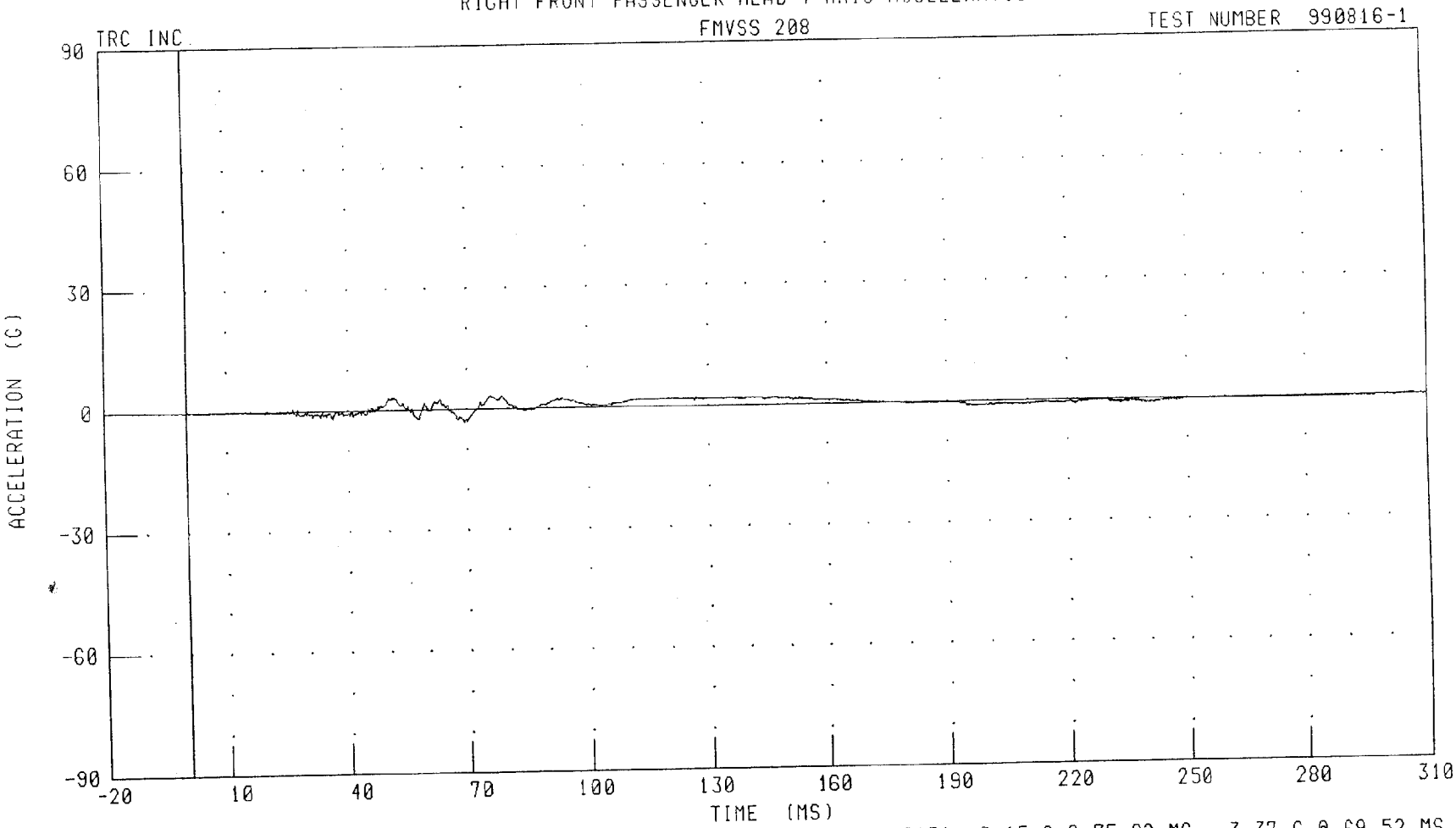
RIGHT FRONT PASSENGER HEAD X-AXIS ACCELERATION



CHANNEL: HEDXG2 FILTER: CH. CLASS 1000

PEAK DATA: 8.98 G @ 218.00 MS; -51.74 G @ 76.96 MS

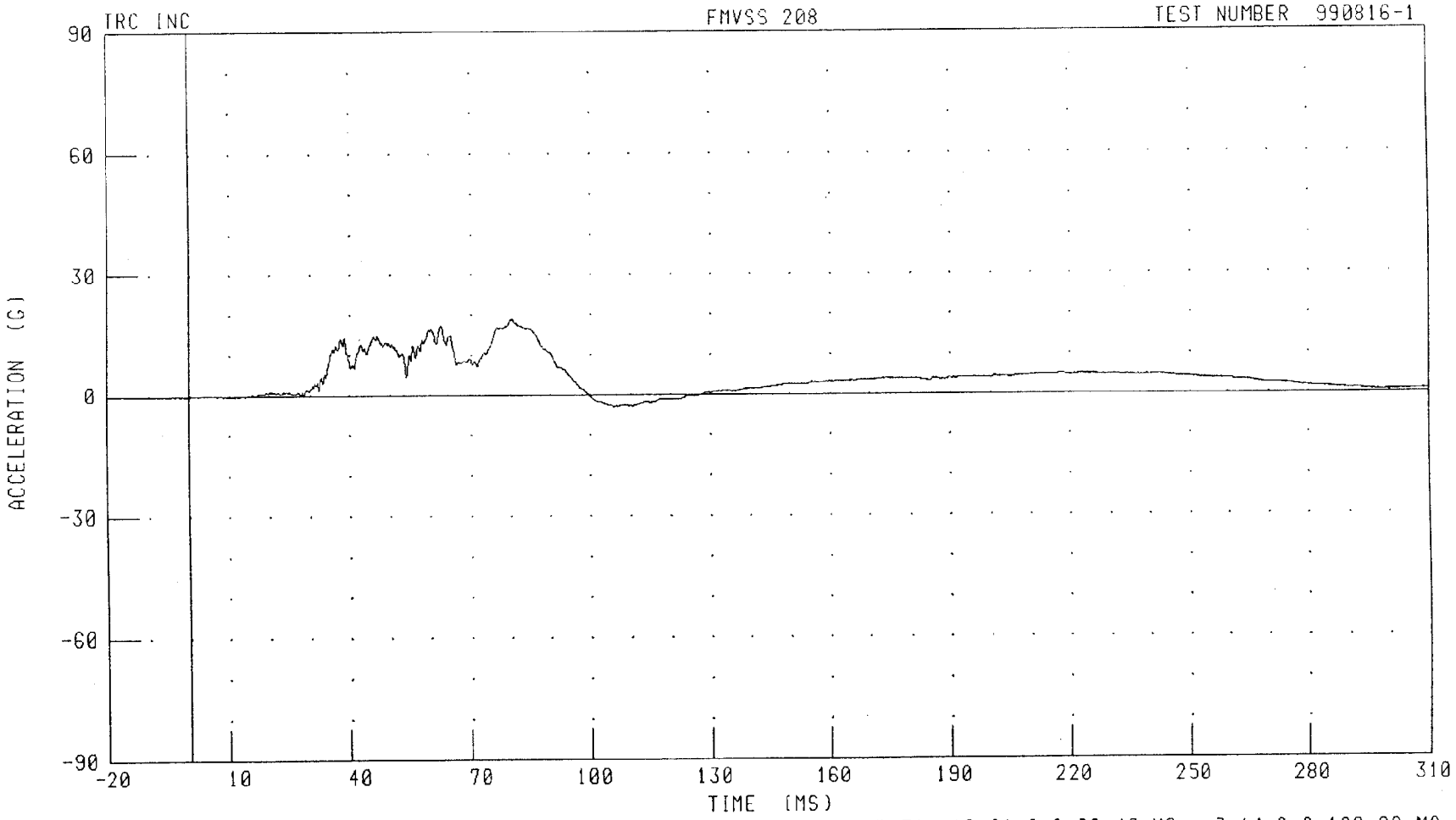
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER HEAD Y-AXIS ACCELERATION
FMVSS 208



CHANNEL: HEDYG2 FILTER: CH. CLASS 1000

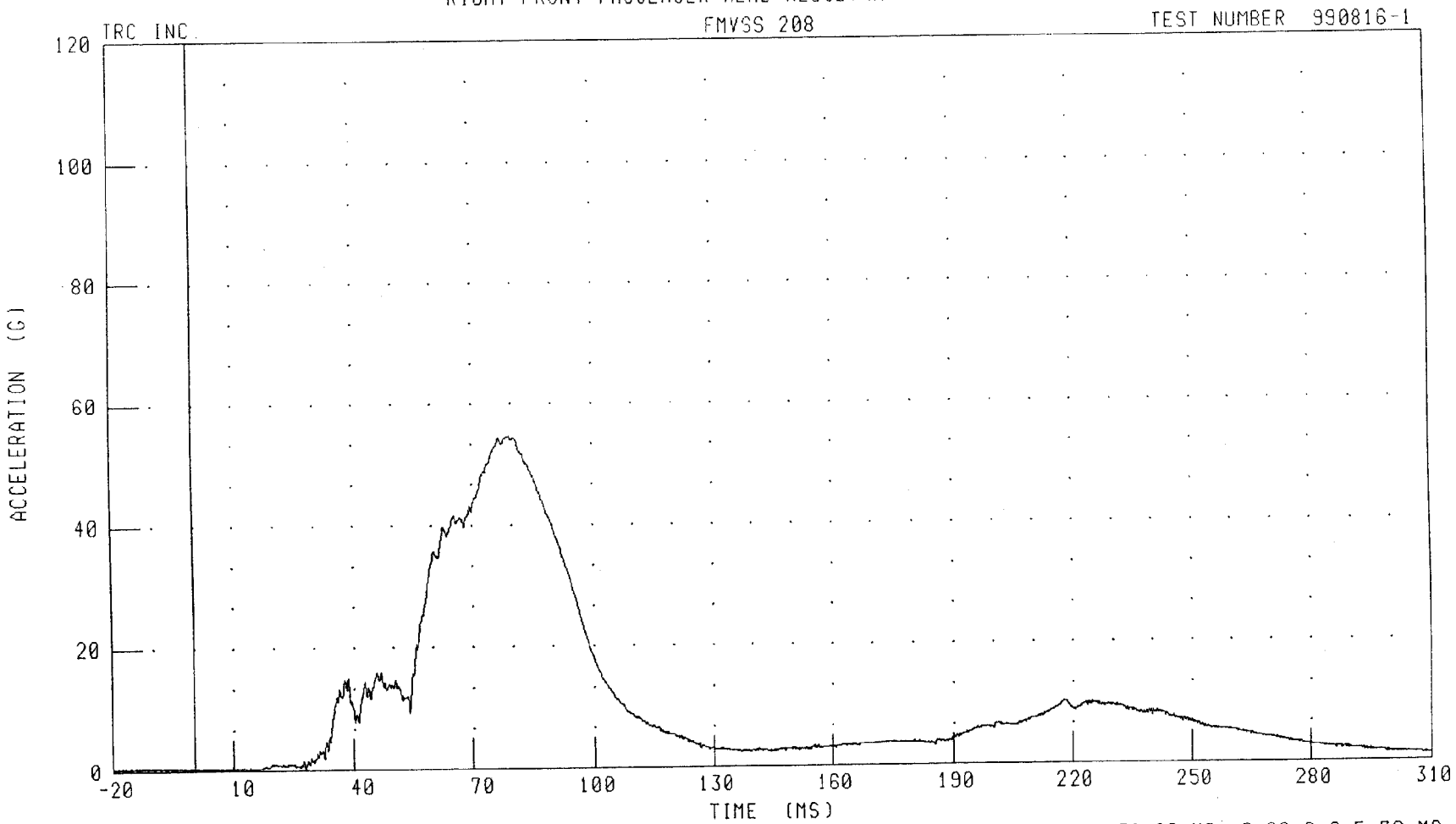
PEAK DATA: 3.15 G @ 75.92 MS; -3.37 G @ 69.52 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER HEAD Z-AXIS ACCELERATION



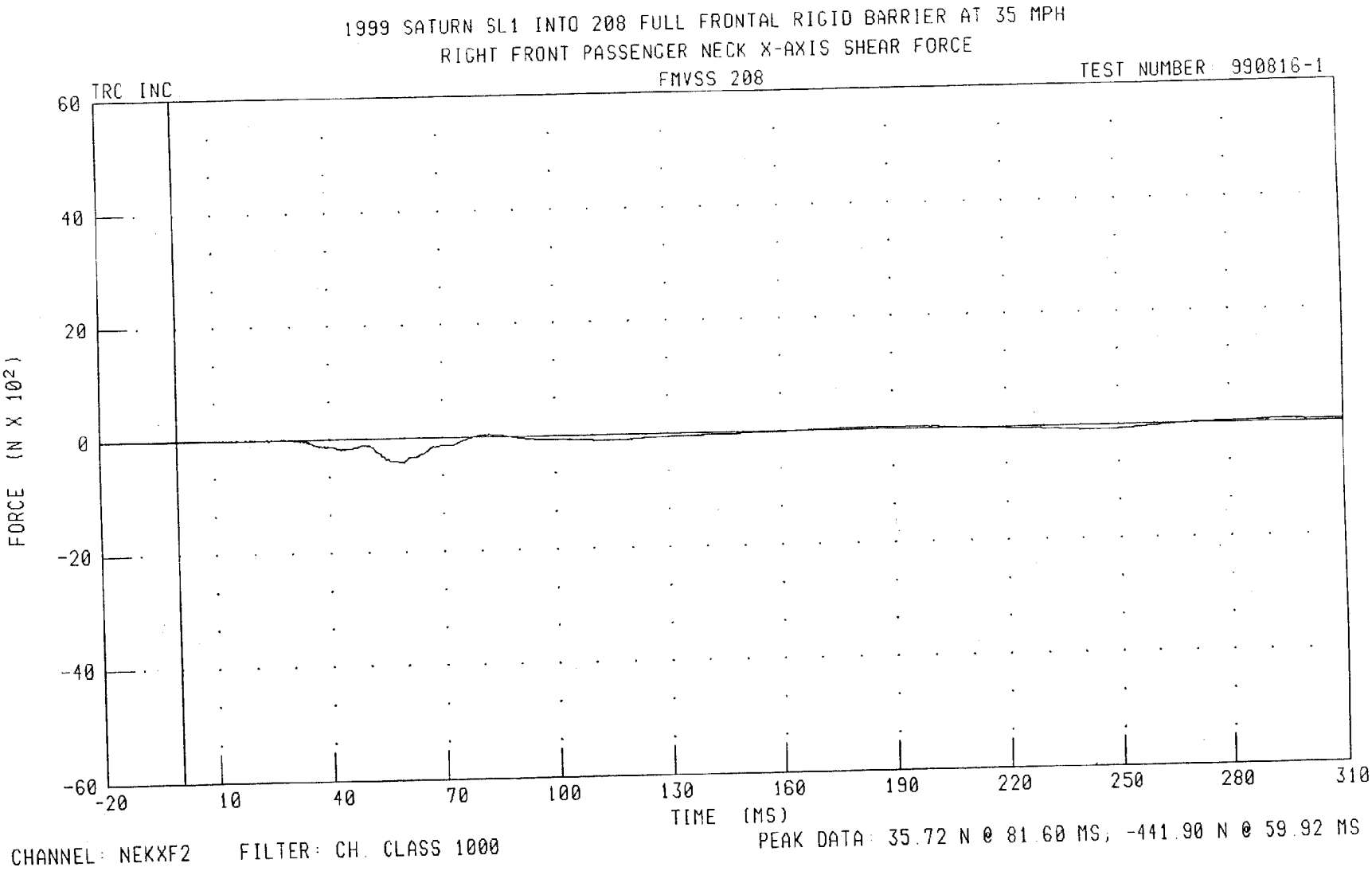
CHANNEL: HEDZG2 FILTER: CH. CLASS 1000 PEAK DATA: 18.81 G @ 80.40 MS; -3.14 G @ 106.00 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER HEAD RESULTANT ACCELERATION
FMVSS 208

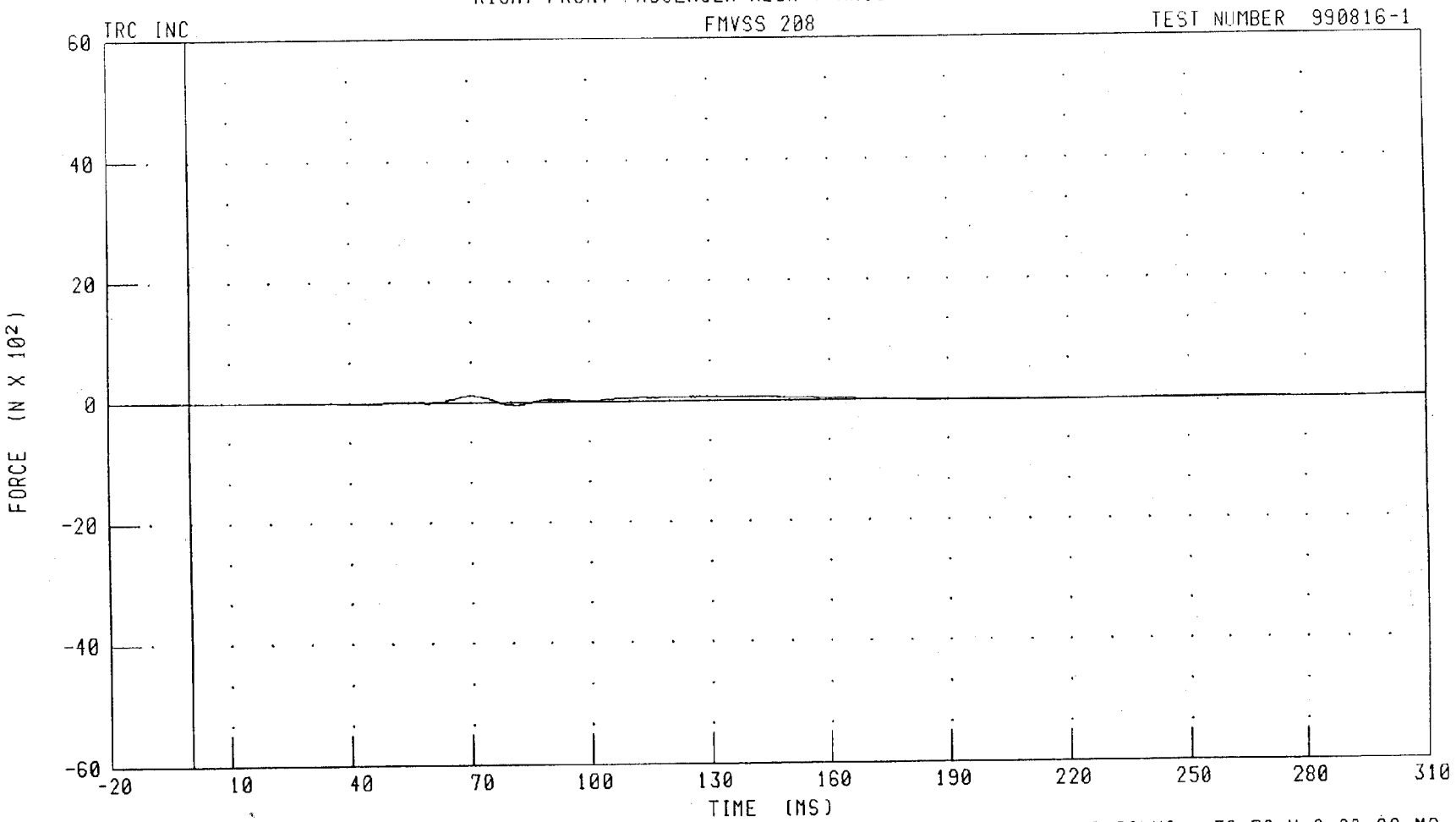


CHANNEL: HEDRC2 FILTER: CH. CLASS 1000

PEAK DATA: 54.60 G @ 79.68 MS; 0.02 G @ 5.76 MS


1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER NECK X-AXIS SHEAR FORCE
FMVSS 208
TRC INC
TEST NUMBER: 990816-1
FORCE (N X 10²)
60
40
20
0
-20
-40
-60
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL: NEKXF2
FILTER: CH. CLASS 1000
PEAK DATA: 35.72 N @ 81.60 MS, -441.90 N @ 59.92 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER NECK Y-AXIS SHEAR FORCE



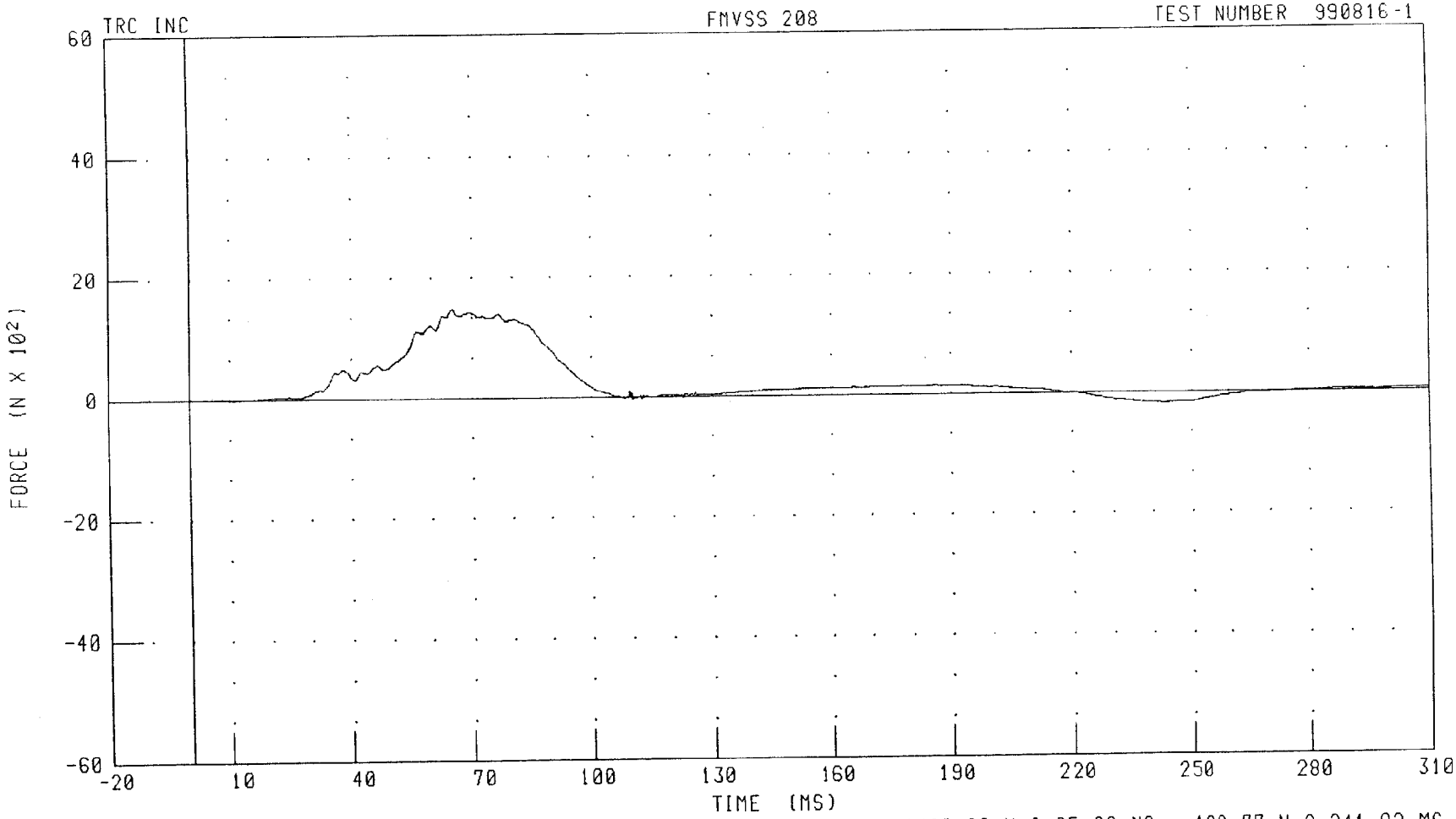
CHANNEL: NEKYF2 FILTER: CH. CLASS 1000

PEAK DATA: 117.70 N @ 70.08 MS; -50.70 N @ 80.80 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

RIGHT FRONT PASSENGER NECK Z-AXIS AXIAL FORCE

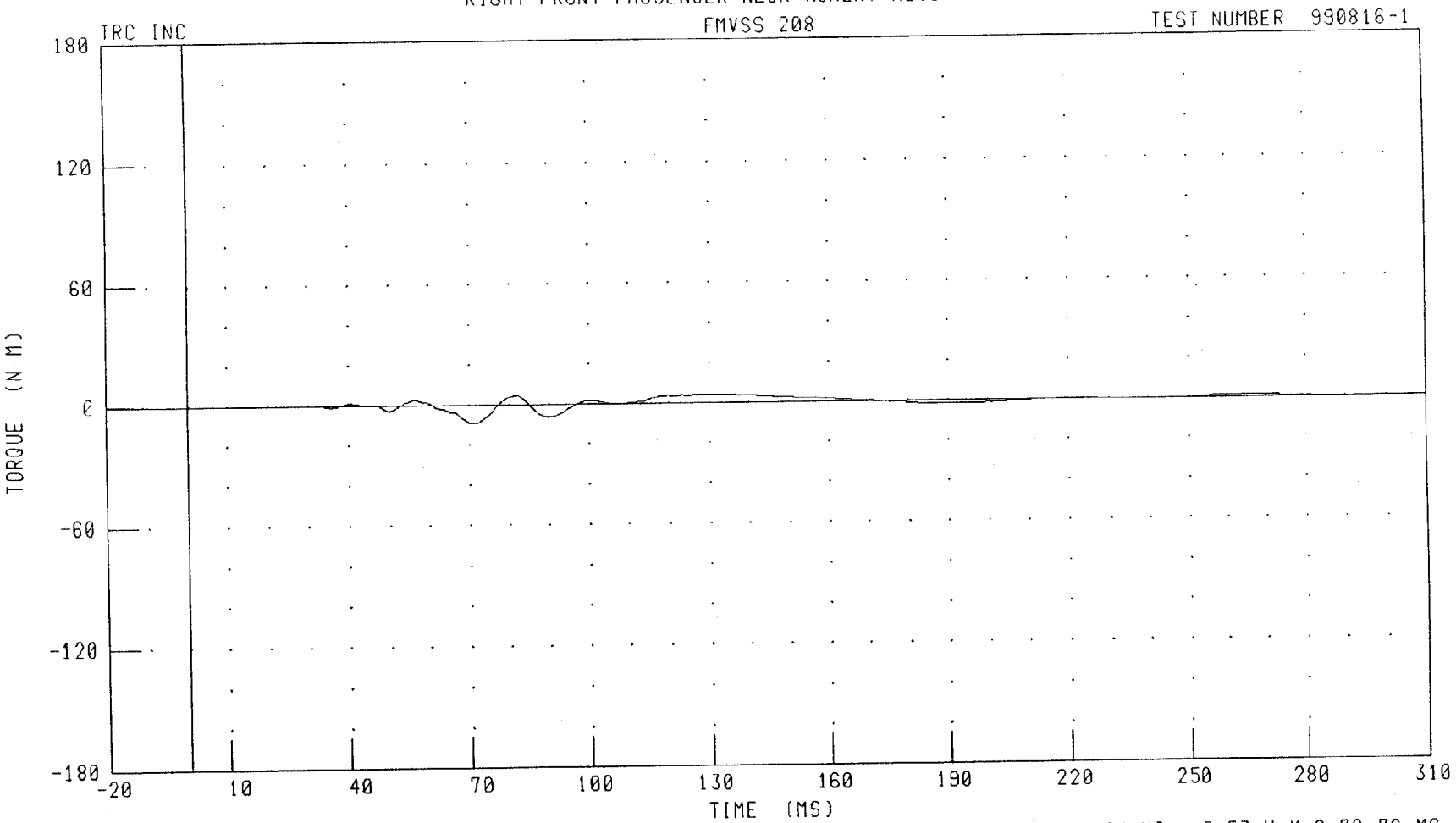
TRC INC FMVSS 208 TEST NUMBER 990816-1



CHANNEL: NEKZF2 FILTER: CH. CLASS 1000

PEAK DATA: 1480.82 N @ 65.60 MS; -186.77 N @ 241.92 MS

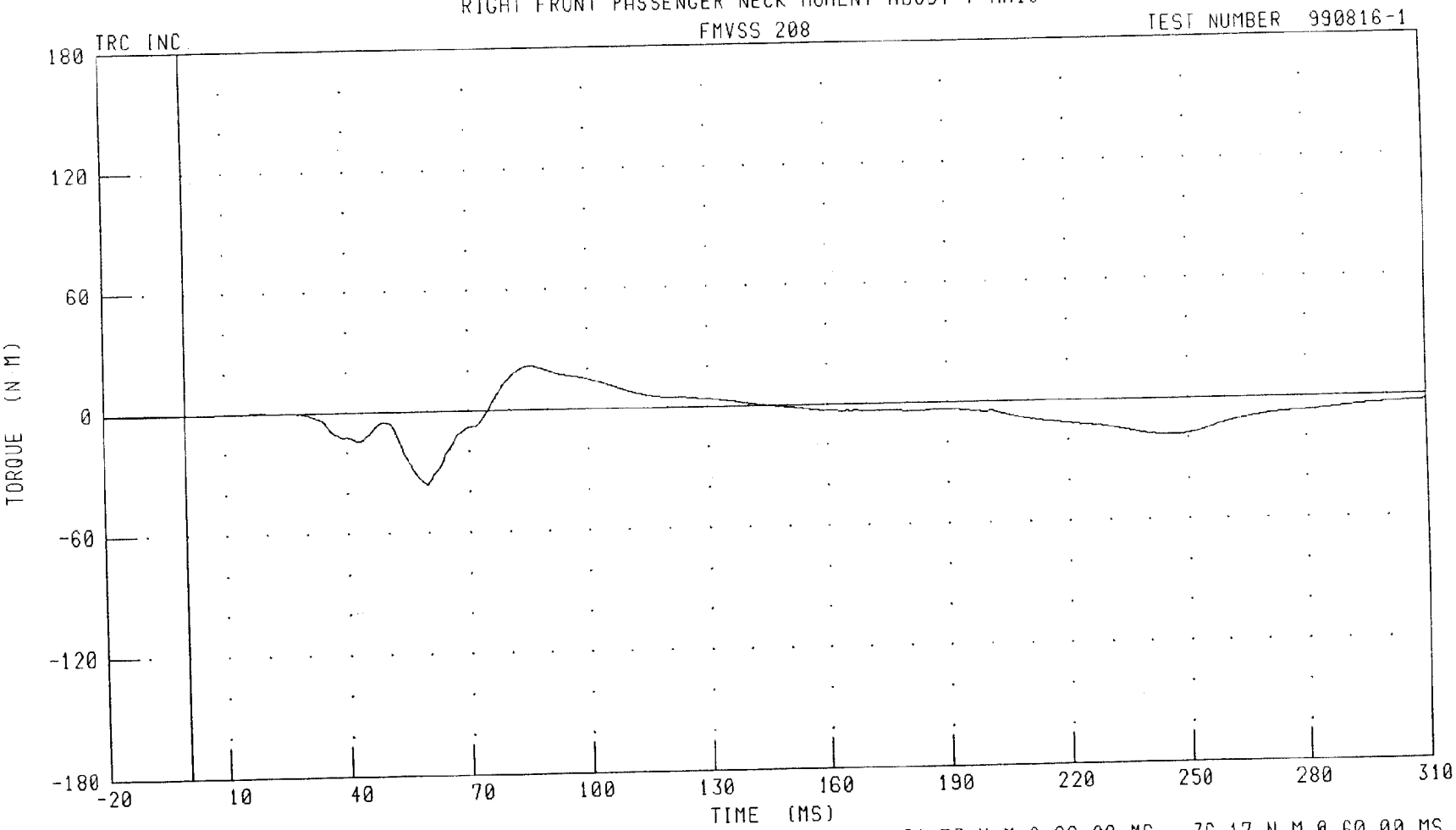
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER NECK MOMENT ABOUT X AXIS



CHANNEL: NEKXM2 FILTER: CH. CLASS 600

PEAK DATA: 4.37 N-M @ 82.24 MS; -9.53 N-M @ 70.72 MS

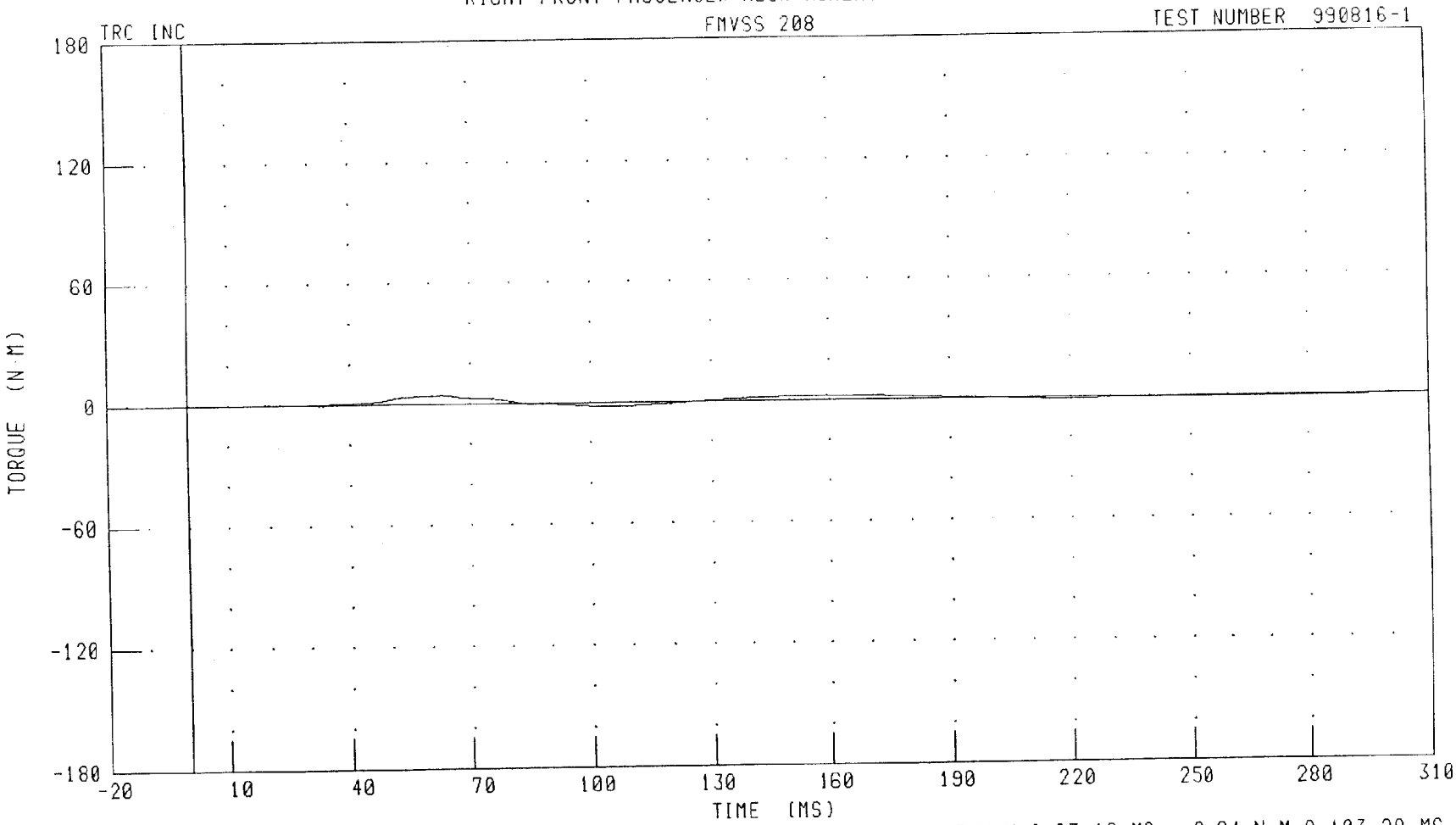
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER NECK MOMENT ABOUT Y AXIS
FMVSS 208



CHANNEL: NEKYM2 FILTER: CH. CLASS 600

PEAK DATA: 21.73 N-M @ 86.08 MS; -36.17 N-M @ 60.00 MS

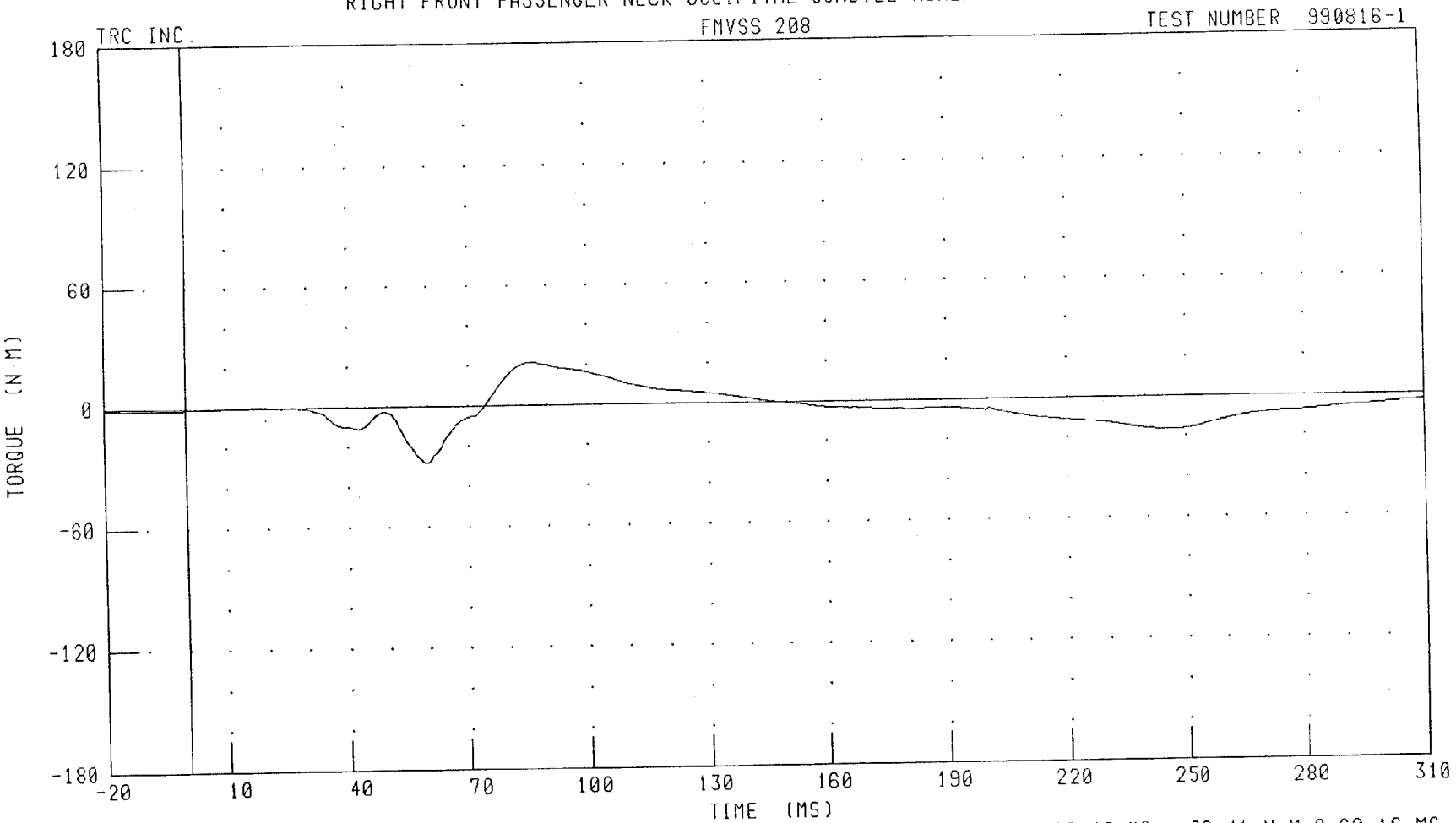
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER NECK MOMENT ABOUT Z AXIS



CHANNEL: NEKZM2 FILTER: CH. CLASS 600

PEAK DATA: 4.17 N-M @ 63.12 MS; -2.24 N-M @ 103.28 MS

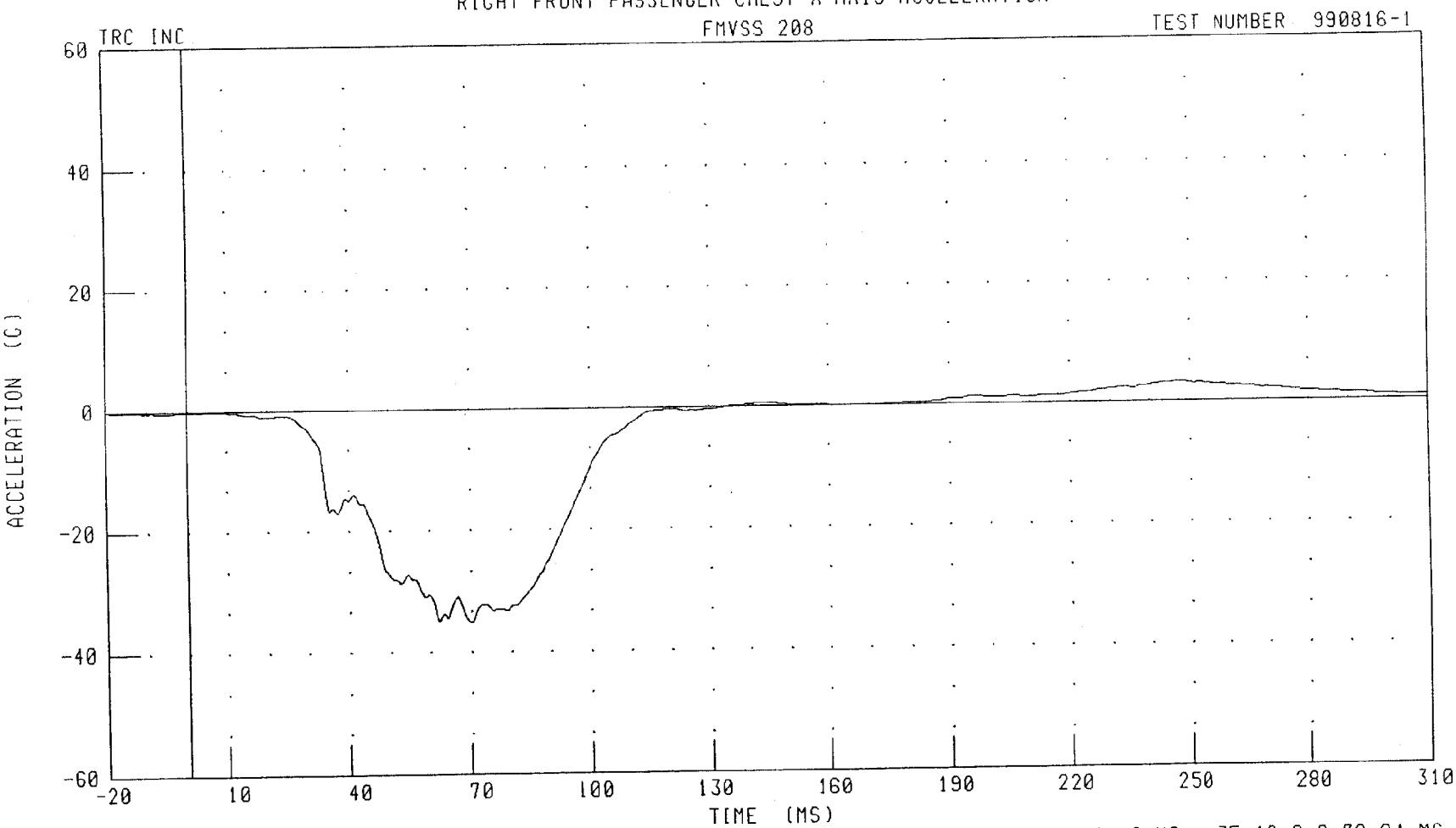
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER NECK OCCIPITAL CONDYLE MOMENT ABOUT Y AXIS



CHANNEL: NEKOM2 FILTER: CH. CLASS 600

PEAK DATA: 21.34 N-M @ 86.40 MS; -28.41 N-M @ 60.16 MS

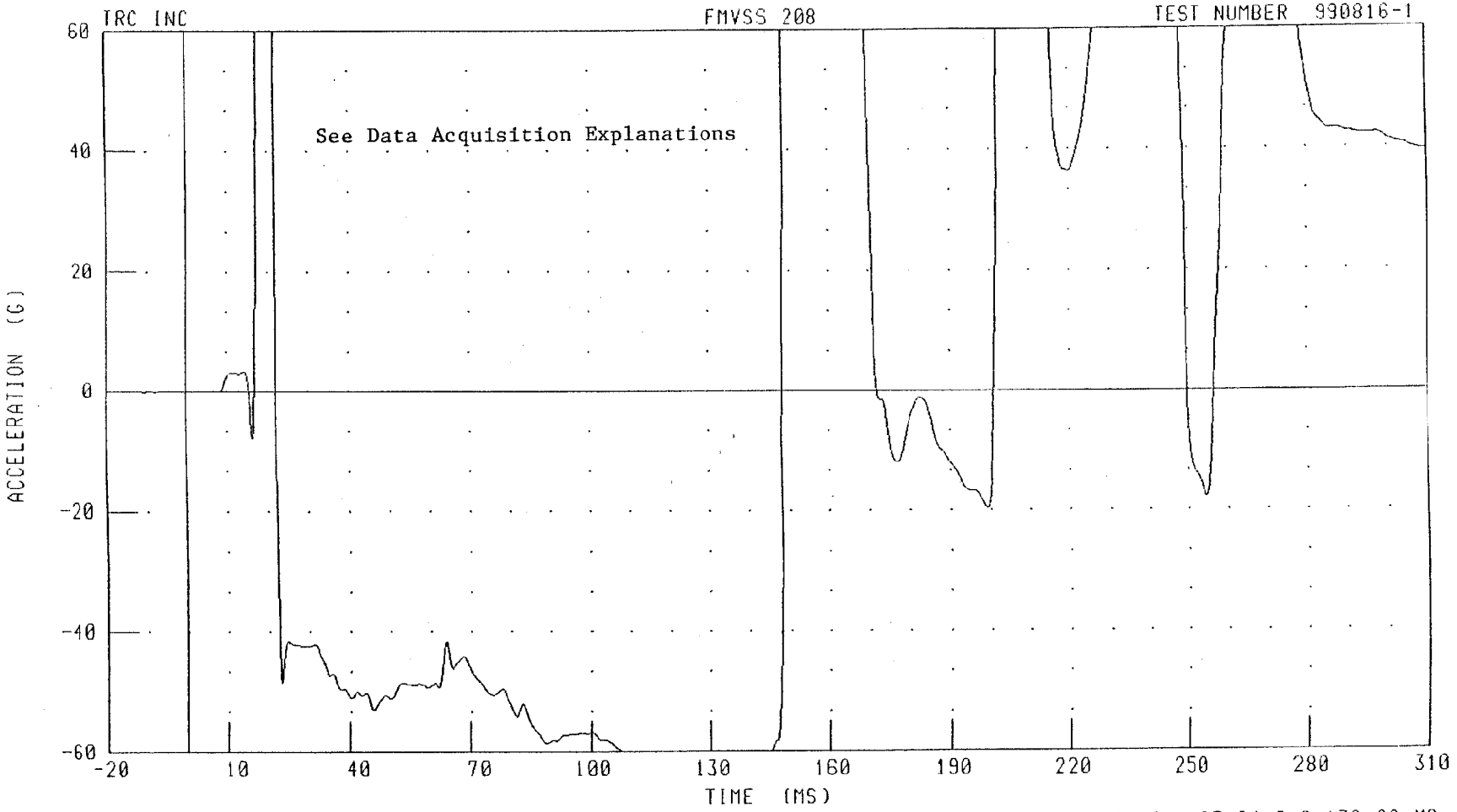
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER CHEST X-AXIS ACCELERATION
FMVSS 208



CHANNEL: CSTXG2 FILTER: CH. CLASS 180

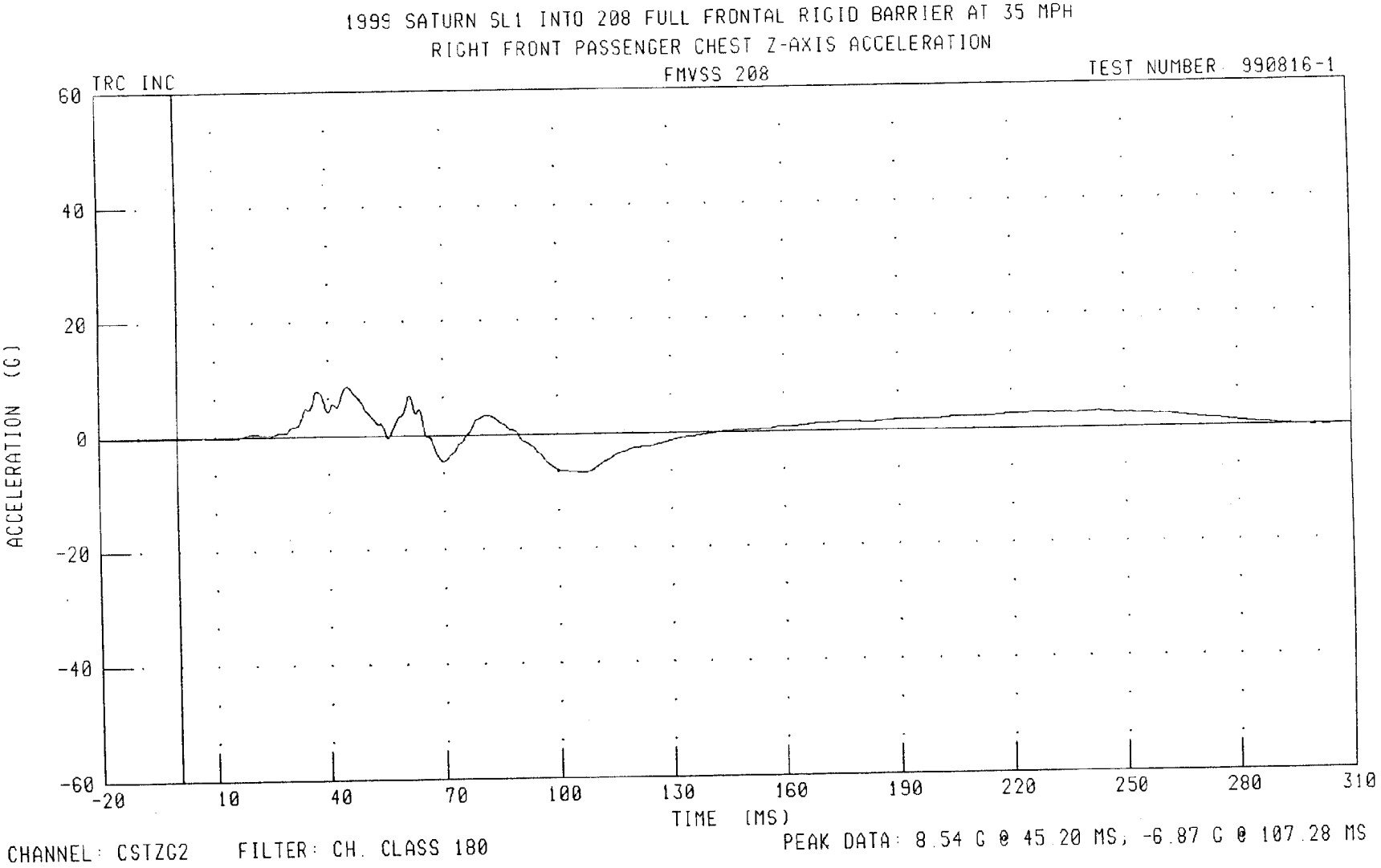
PEAK DATA: 3.16 G @ 246.40 MS; -35.19 G @ 70.24 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER CHEST Y-AXIS ACCELERATION

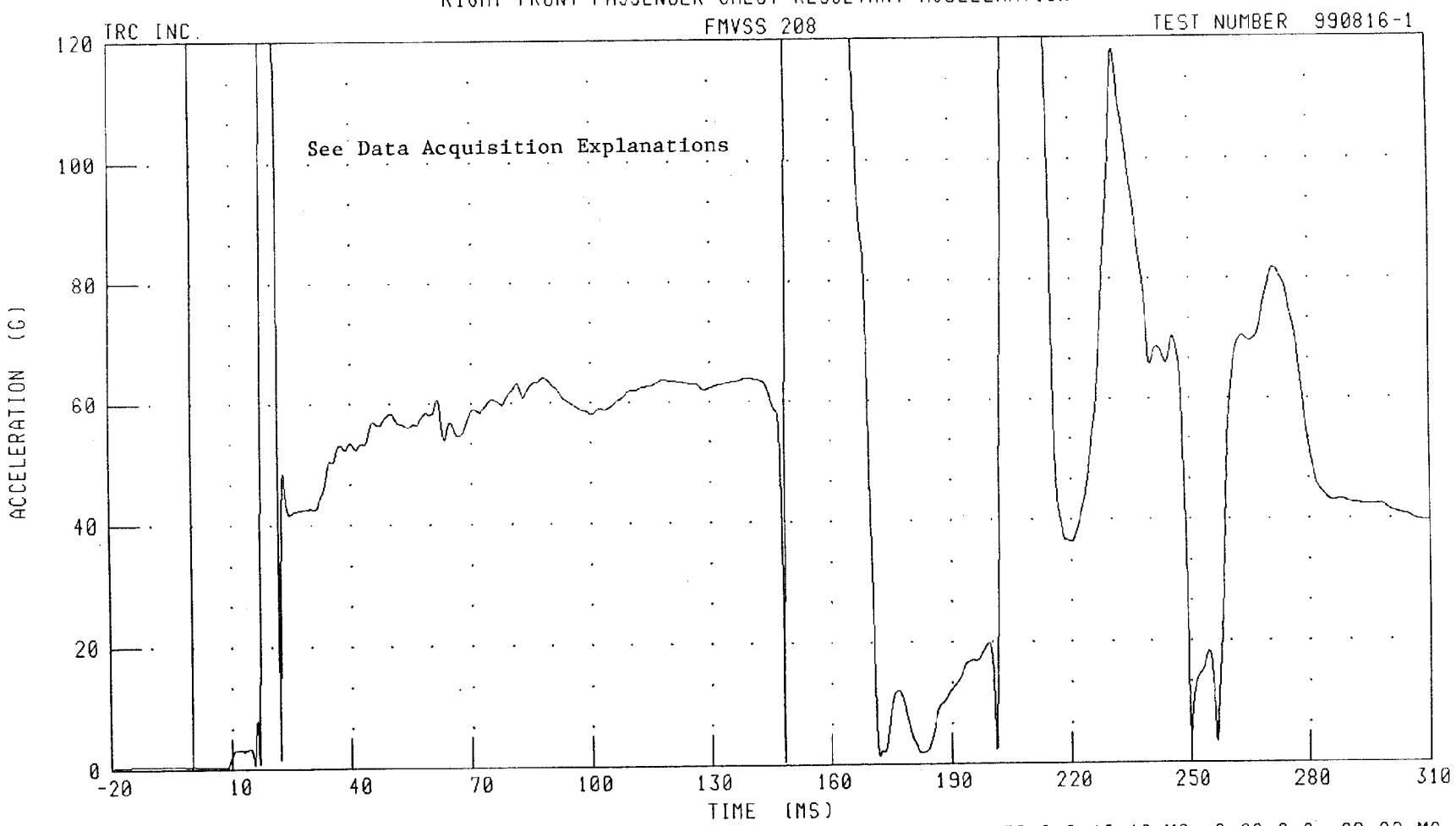


CHANNEL: CSTYC2 FILTER: CH. CLASS 180

PEAK DATA: 366.49 G @ 19.12 MS; -63.84 G @ 139.28 MS

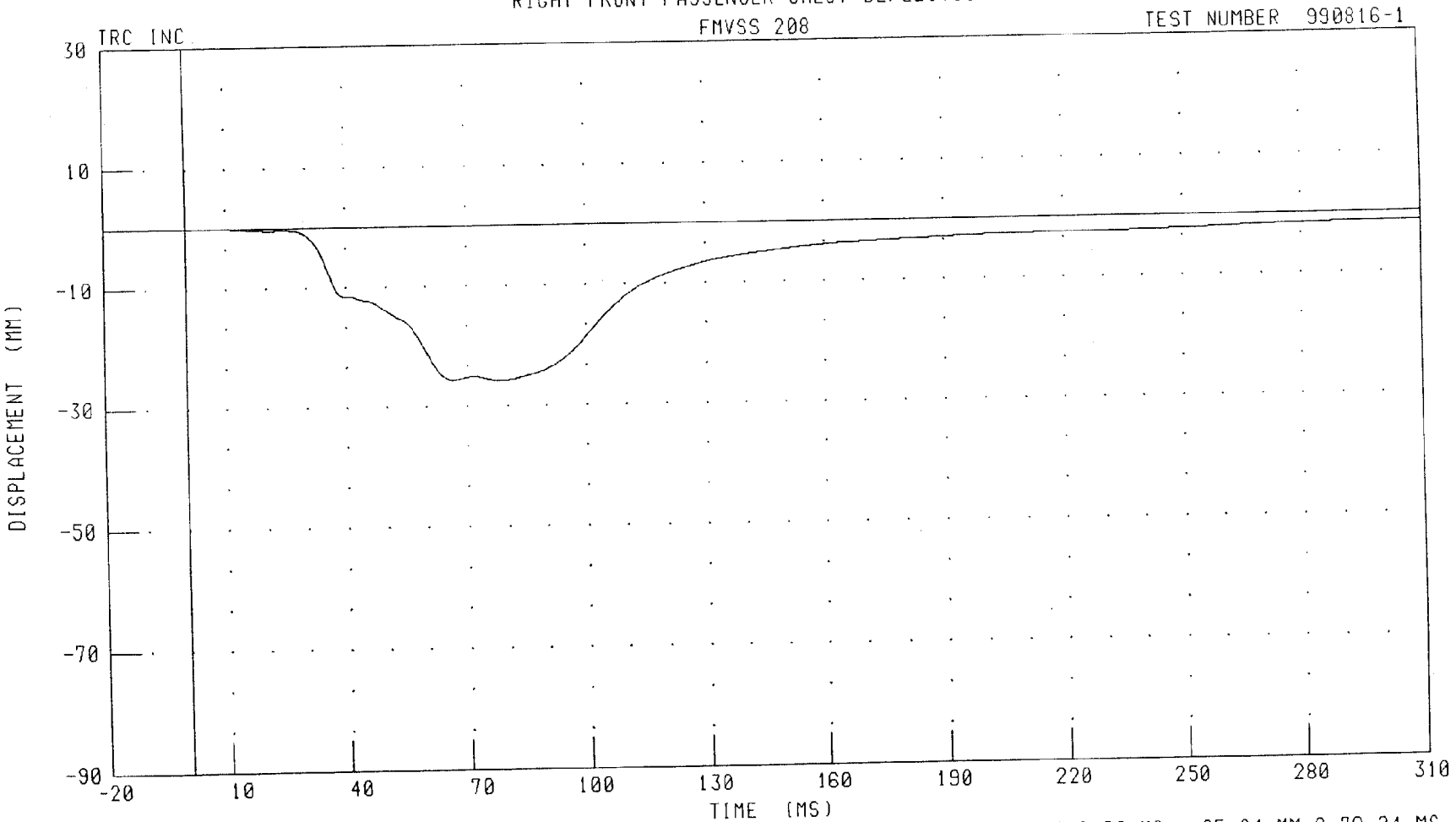

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER CHEST Z-AXIS ACCELERATION
FMVSS 208
TRC INC
TEST NUMBER 990816-1
60
40
20
0
-20
-40
-60
ACCELERATION (G)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL: CSTZG2
FILTER: CH. CLASS 180
PEAK DATA: 8.54 G @ 45.20 MS, -6.87 G @ 107.28 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER CHEST RESULTANT ACCELERATION



CHANNEL: CSTRG2 FILTER: CH. CLASS 180 PEAK DATA: 366.50 G @ 19.12 MS, 0.02 G @ -20.00 MS

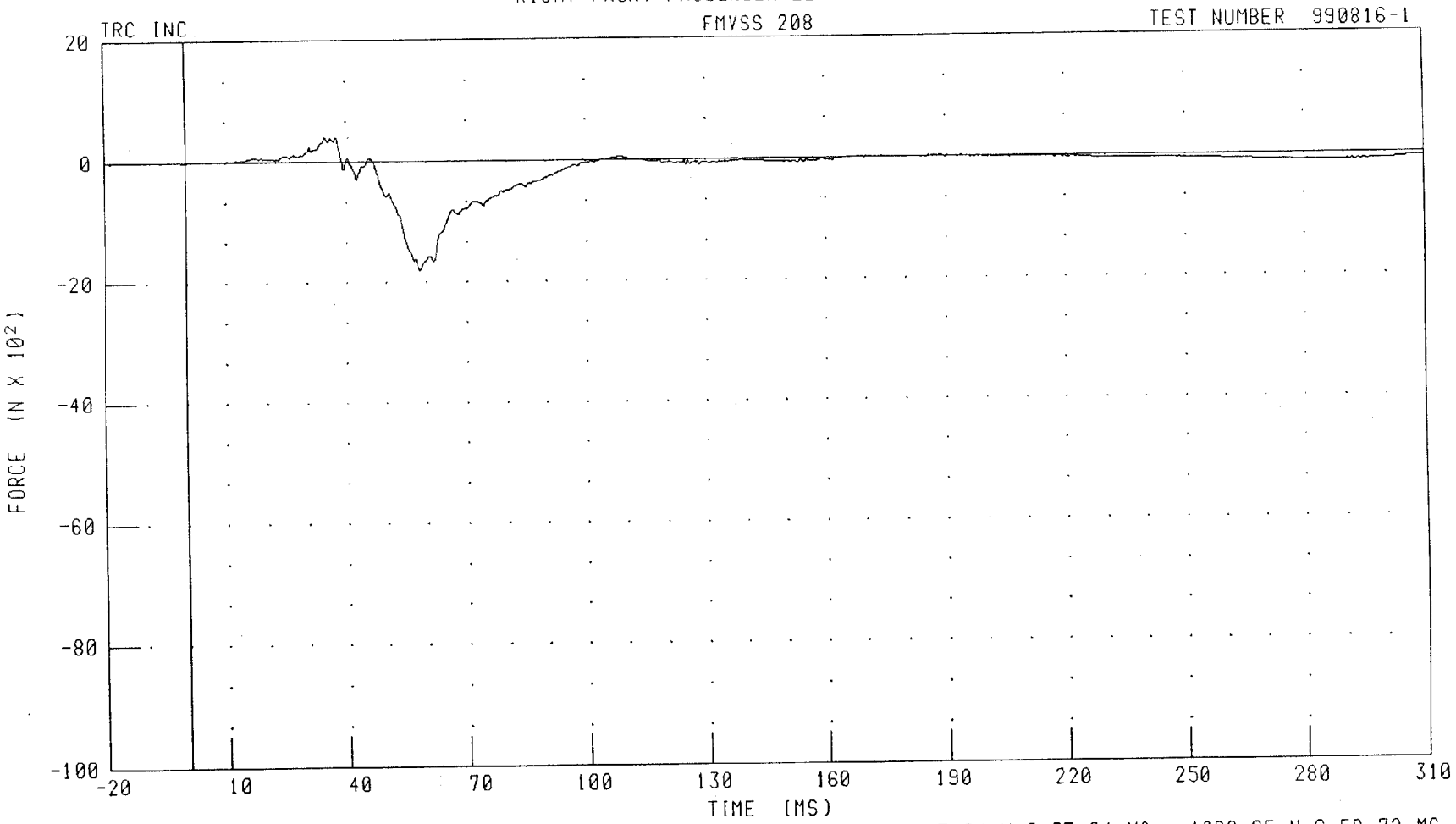
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER CHEST DEFLECTION
FMVSS 208



CHANNEL: CSTXD2 FILTER: CH. CLASS 180

PEAK DATA: 0.01 MM @ 2.80 MS, -25.84 MM @ 78.24 MS

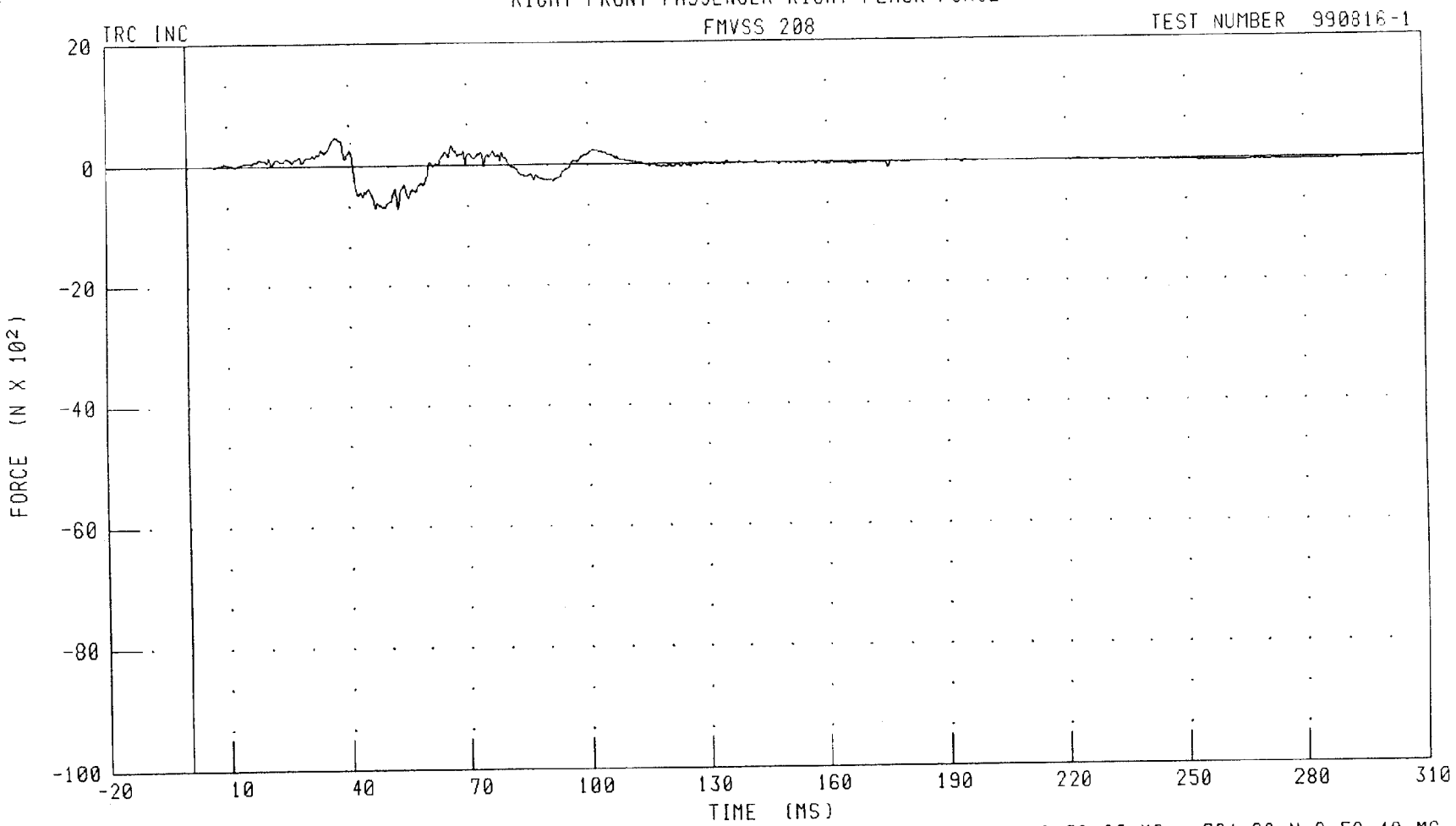
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT FRONT PASSENGER LEFT FEMUR FORCE



CHANNEL: LFMF2 FILTER: CH. CLASS 600 PEAK DATA: 415.04 N @ 35.04 MS; -1806.25 N @ 58.72 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

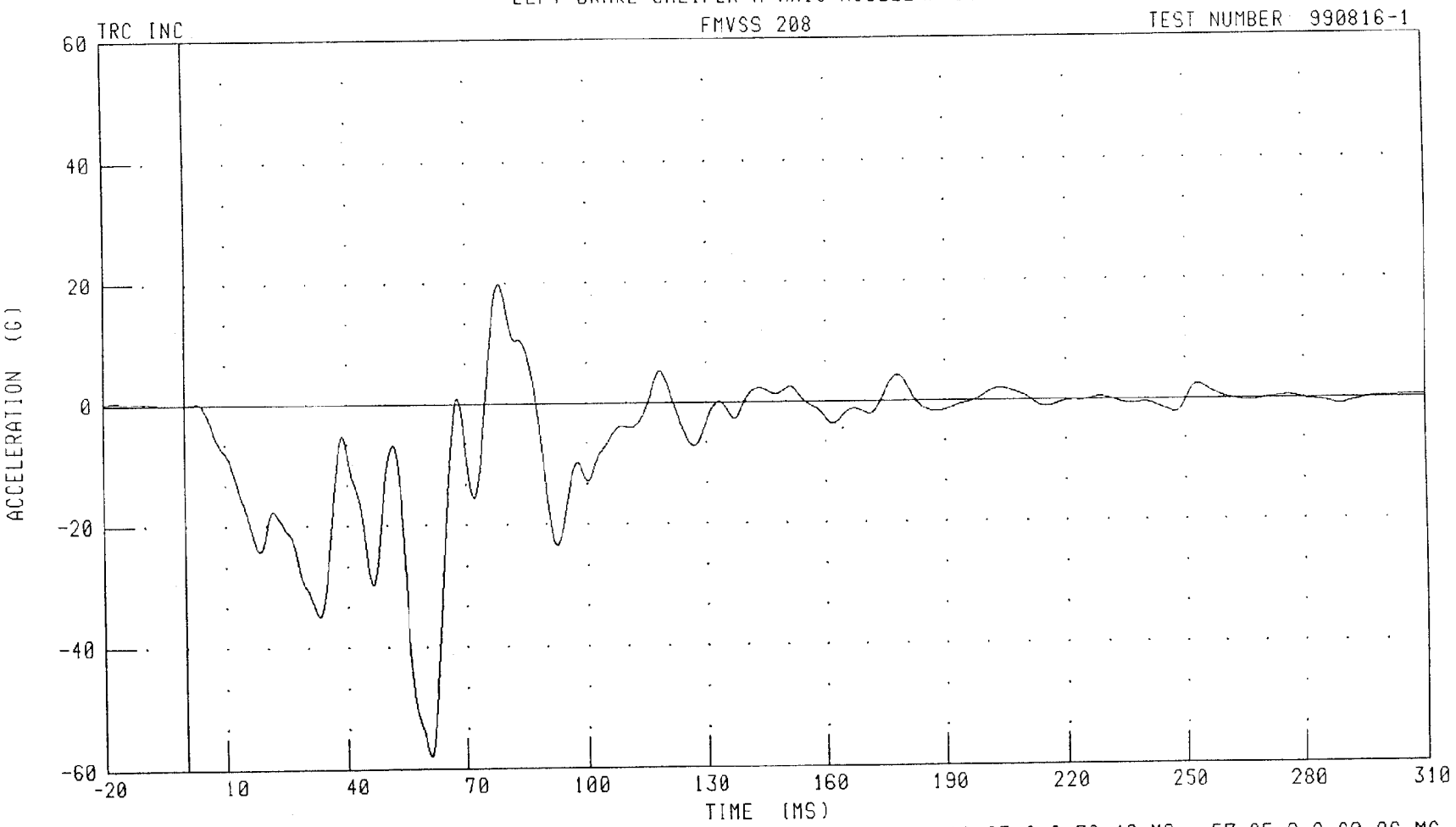
RIGHT FRONT PASSENGER RIGHT FEMUR FORCE



CHANNEL: RFMF2 FILTER: CH. CLASS 600

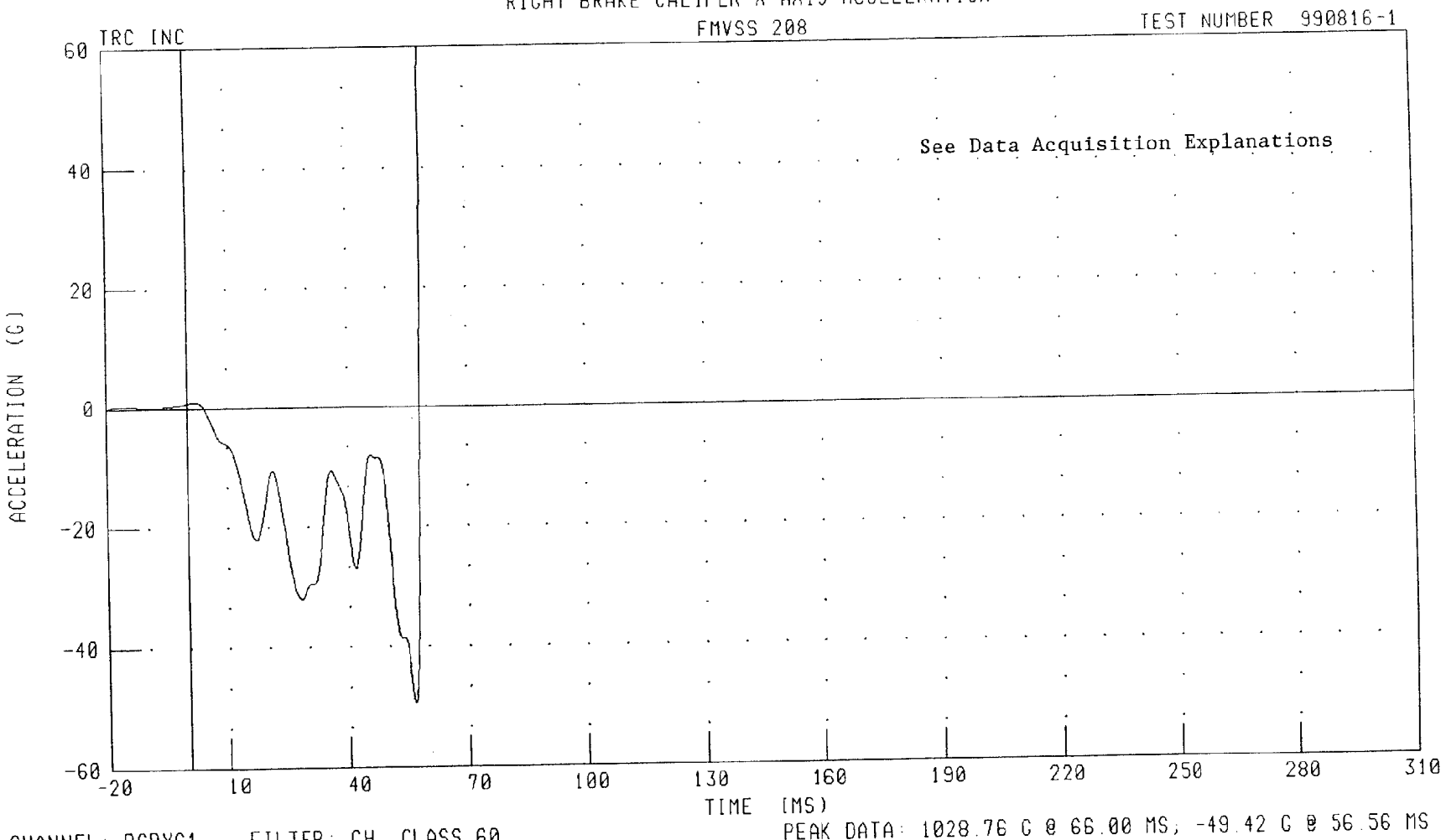
PEAK DATA: 472.09 N @ 36.96 MS; -704.09 N @ 52.40 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
LEFT BRAKE CALIPER X-AXIS ACCELERATION



CHANNEL: BCLXG1 FILTER: CH. CLASS 60 PEAK DATA: 19.85 G @ 78.48 MS, -57.95 G @ 60.96 MS

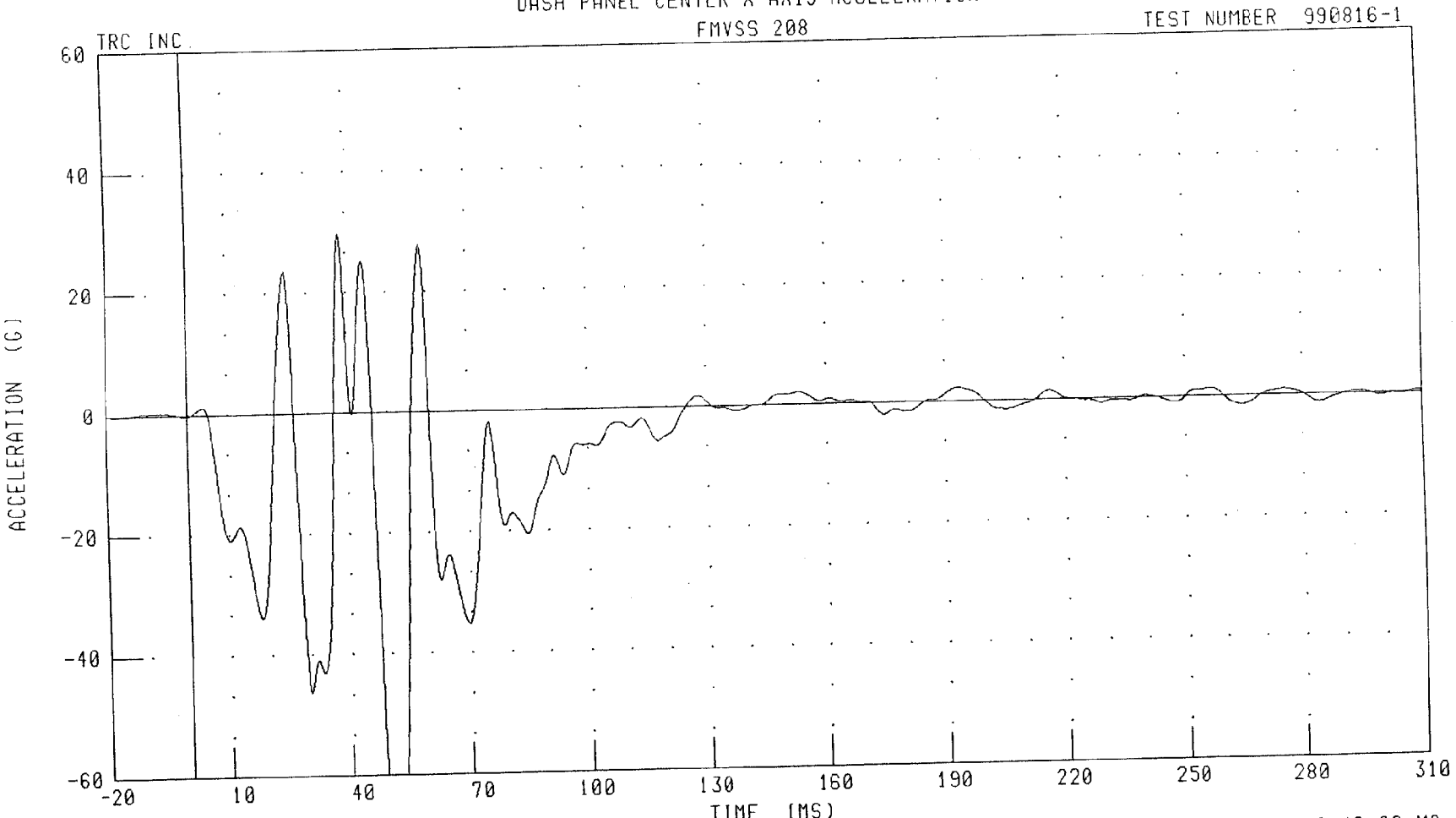
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT BRAKE CALIPER X-AXIS ACCELERATION
FMVSS 208



CHANNEL: BCRXG1 FILTER: CH. CLASS 60

PEAK DATA: 1028.76 G @ 66.00 MS, -49.42 G @ 56.56 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DASH PANEL CENTER X-AXIS ACCELERATION
FMVSS 208



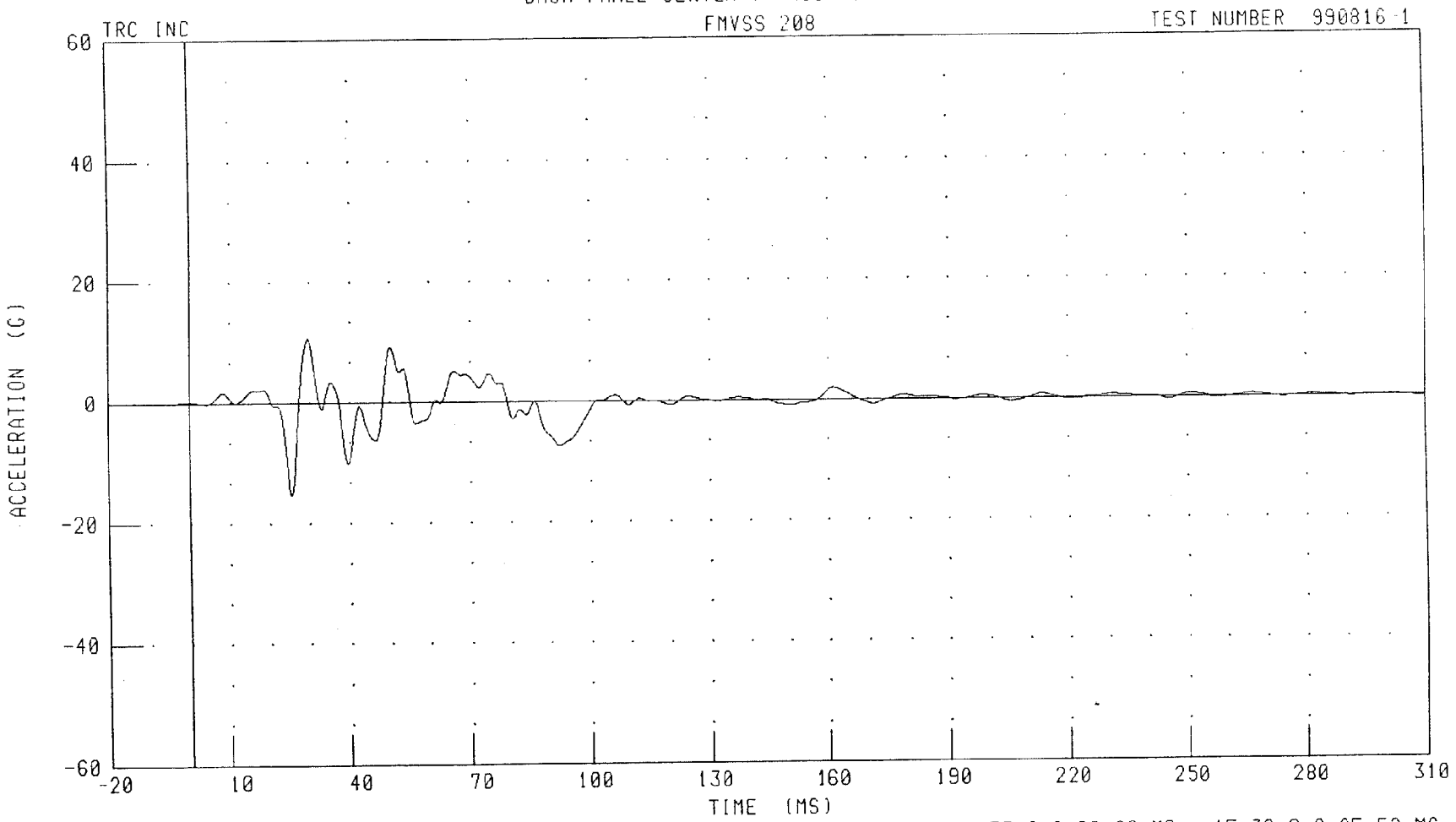
CHANNEL: DPCXG1 FILTER: CH. CLASS 60

PEAK DATA: 29.81 G @ 38.56 MS; -71.08 G @ 49.92 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

DASH PANEL CENTER Y-AXIS ACCELERATION

FMVSS 208



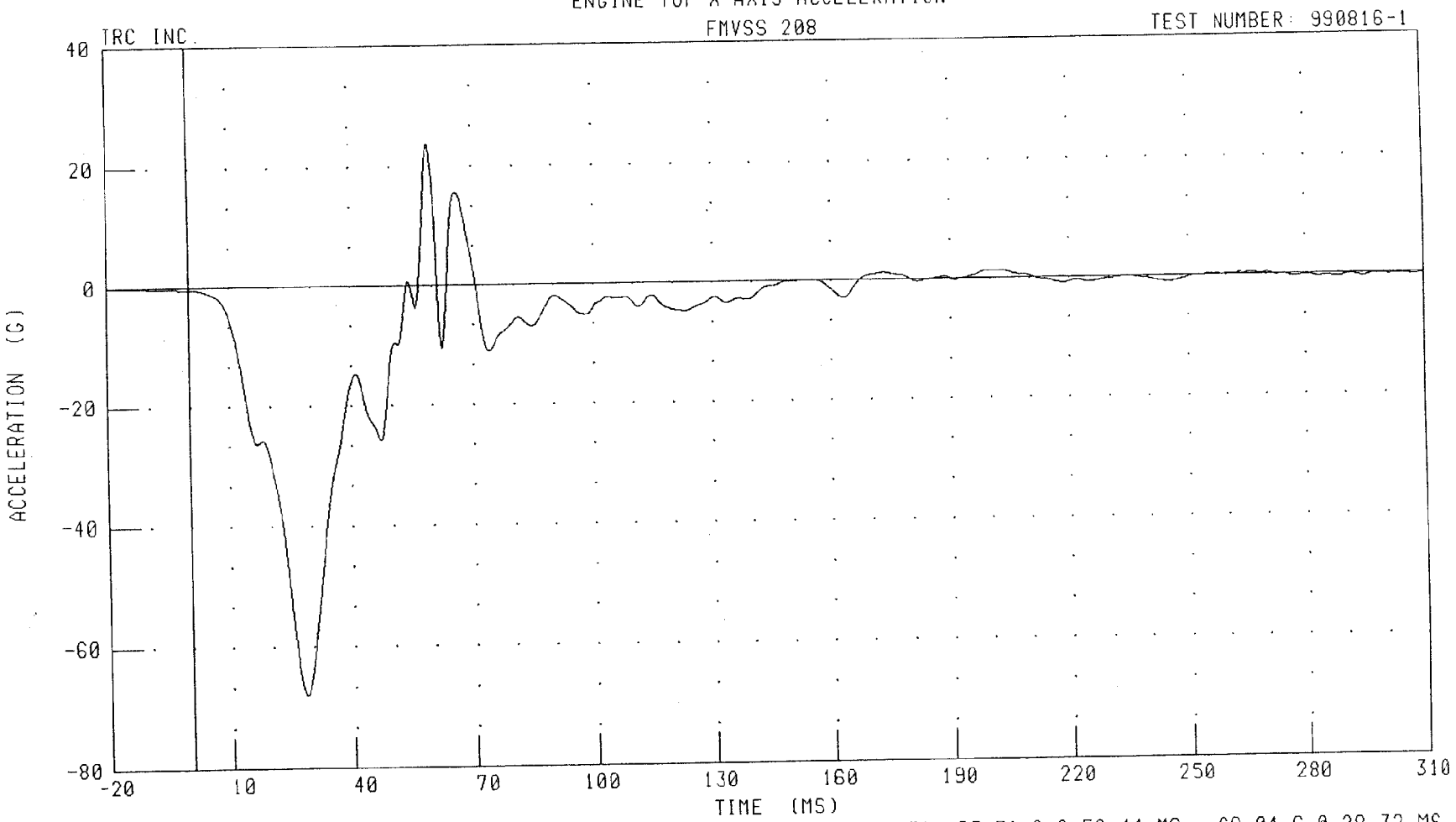
CHANNEL: DPCYG1 FILTER: CH. CLASS 60

PEAK DATA: 10.53 G @ 29.68 MS; -15.38 G @ 25.52 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

ENGINE TOP X-AXIS ACCELERATION

FMVSS 208

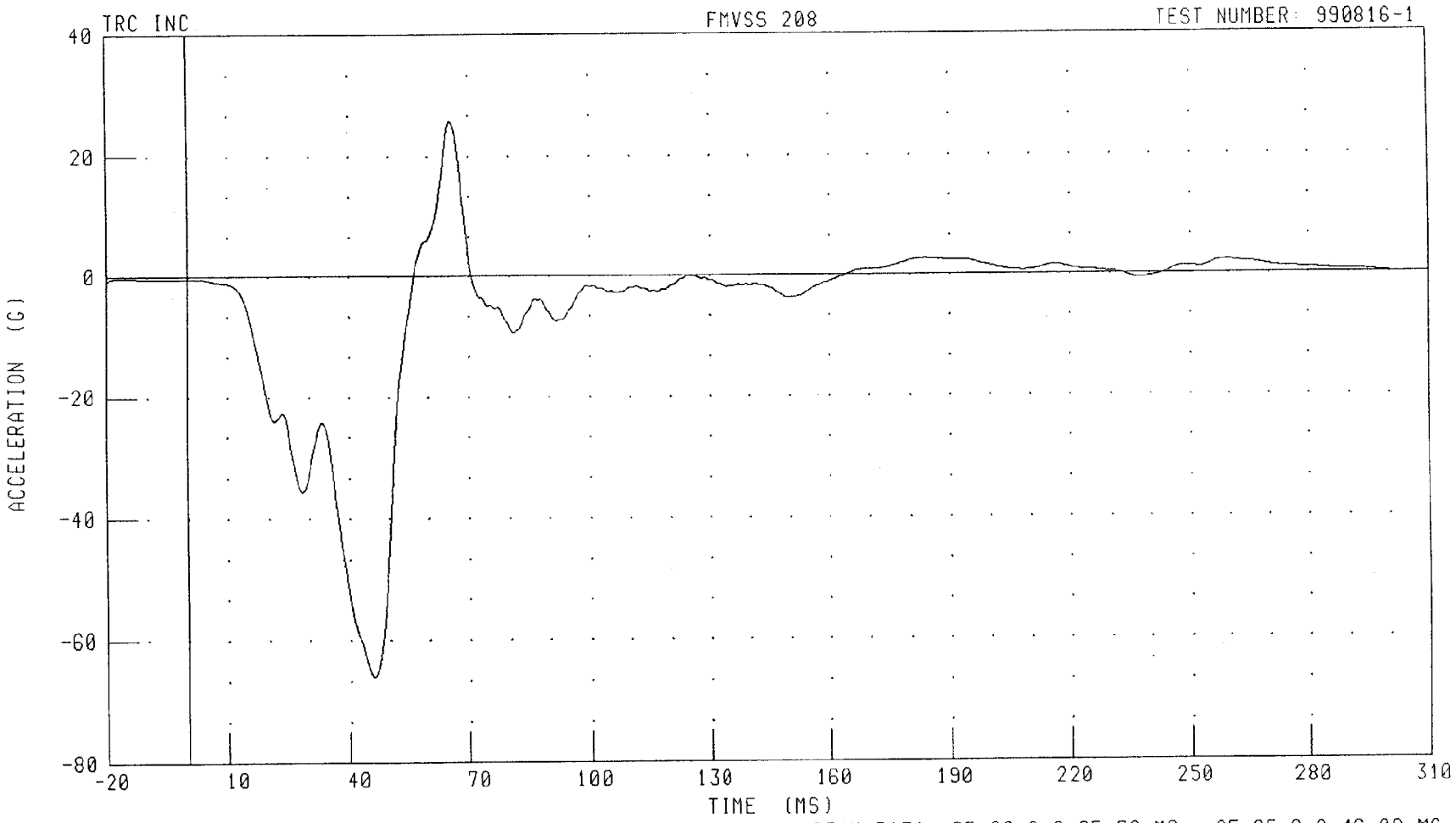


CHANNEL: ENCXG1 FILTER: CH CLASS 60

PEAK DATA: 23.71 G @ 59.44 MS; -68.04 G @ 28.32 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

ENGINE BOTTOM X-AXIS ACCELERATION

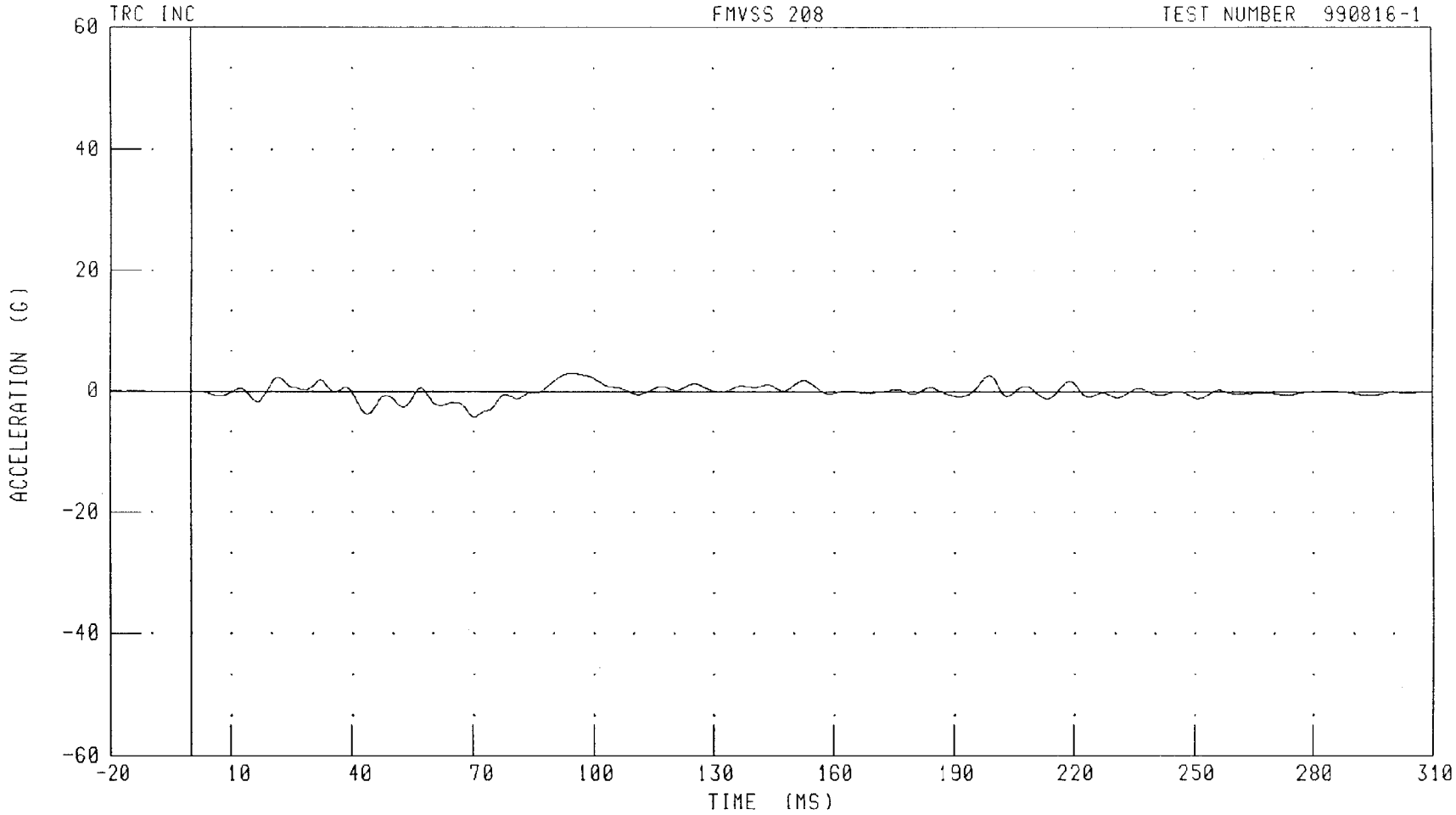


CHANNEL: ENCXG2 FILTER: CH. CLASS 60

PEAK DATA: 25.80 G @ 65.76 MS, -65.95 G @ 46.08 MS

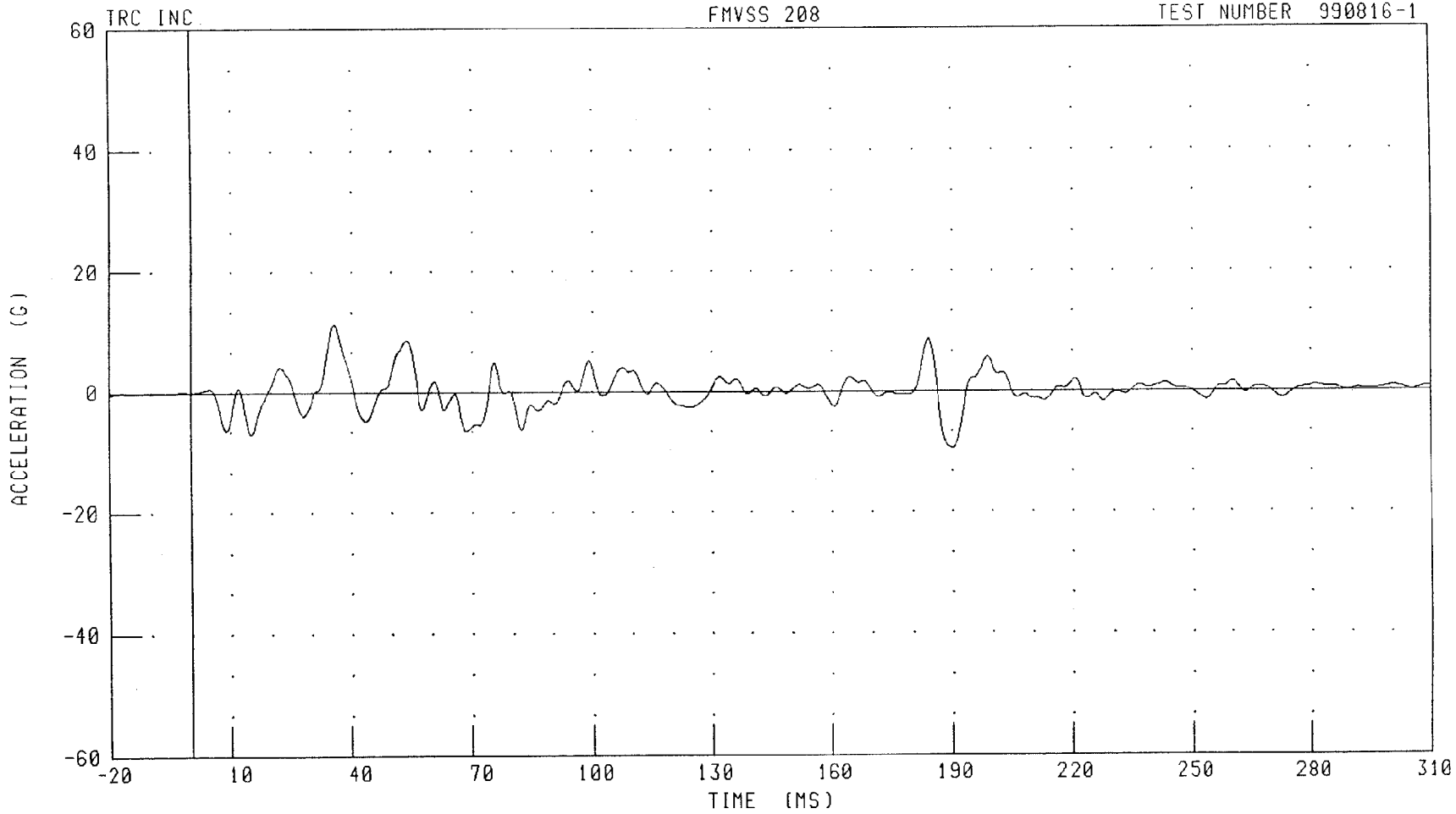
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH

VEHICLE REAR CENTER Y-AXIS ACCELERATION



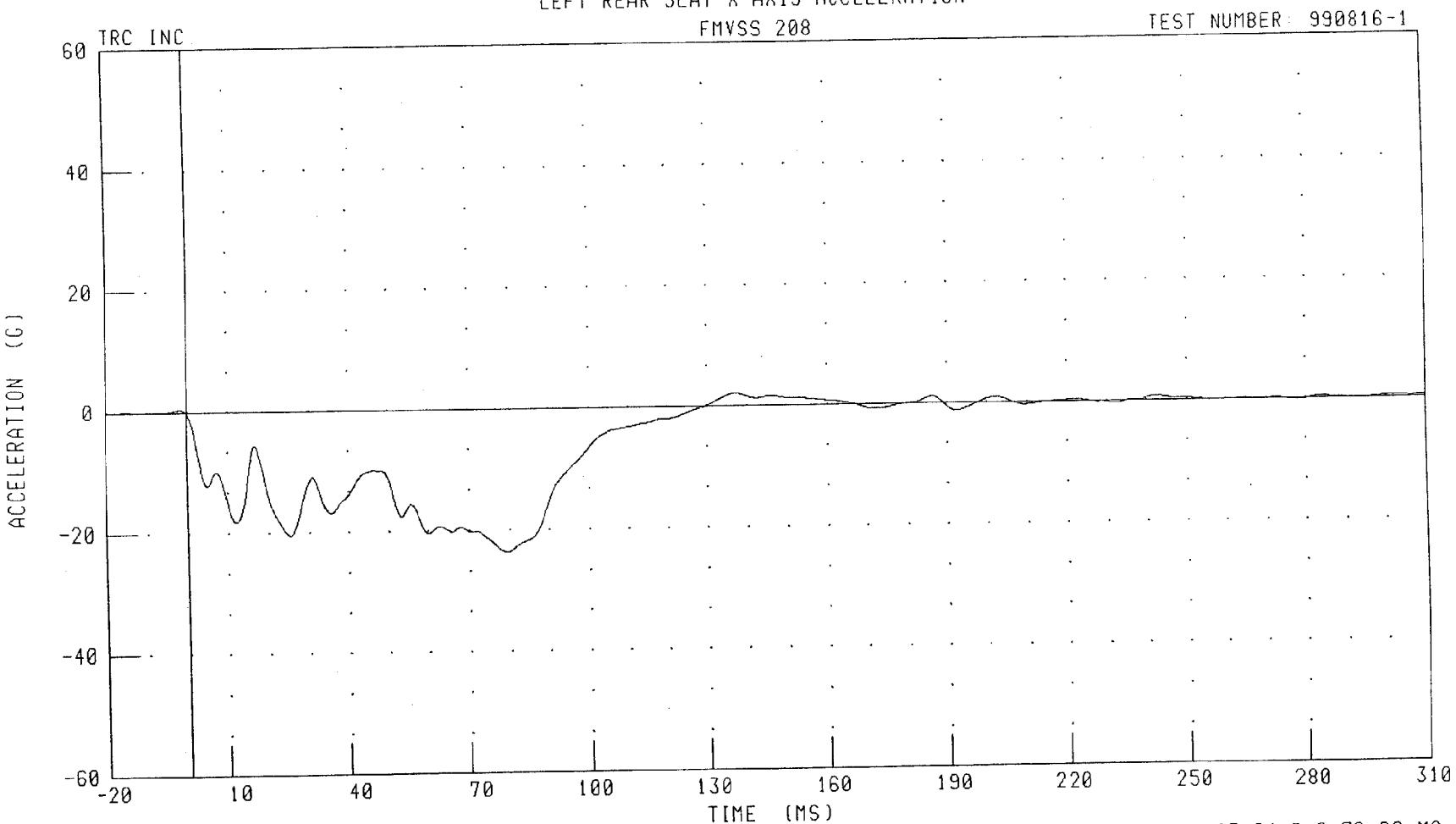
CHANNEL: RDKYC1 FILTER: CH. CLASS 60 PEAK DATA: 3.06 G @ 94.72 MS; -4.32 G @ 70.32 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
VEHICLE REAR CENTER Z-AXIS ACCELERATION



CHANNEL: RDKZG1 FILTER: CH. CLASS 60 PEAK DATA: 11.27 G @ 35.92 MS; -9.51 G @ 190.24 MS

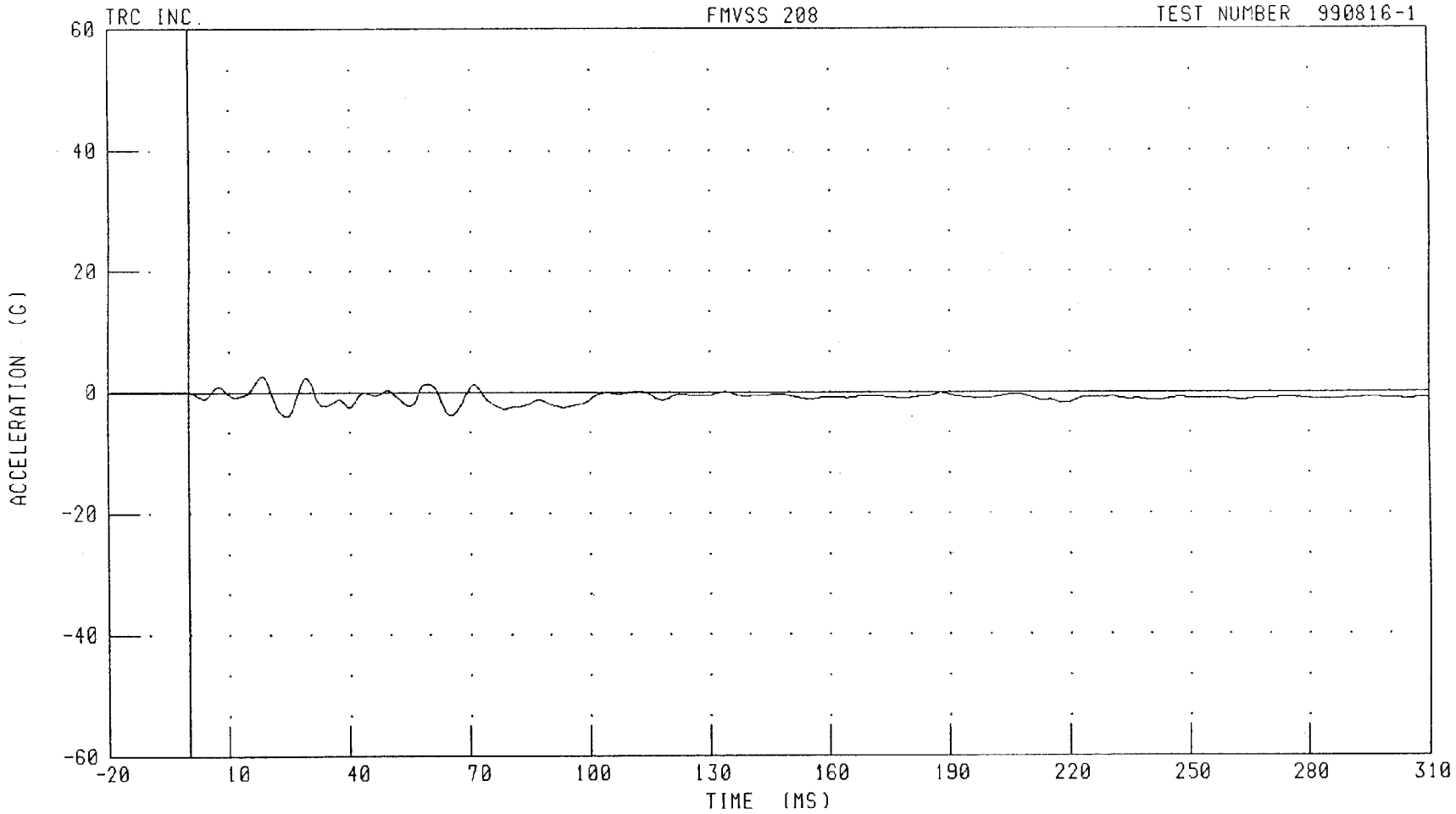
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
LEFT REAR SEAT X-AXIS ACCELERATION
FMVSS 208



CHANNEL: TLRXG1 FILTER: CH. CLASS 60

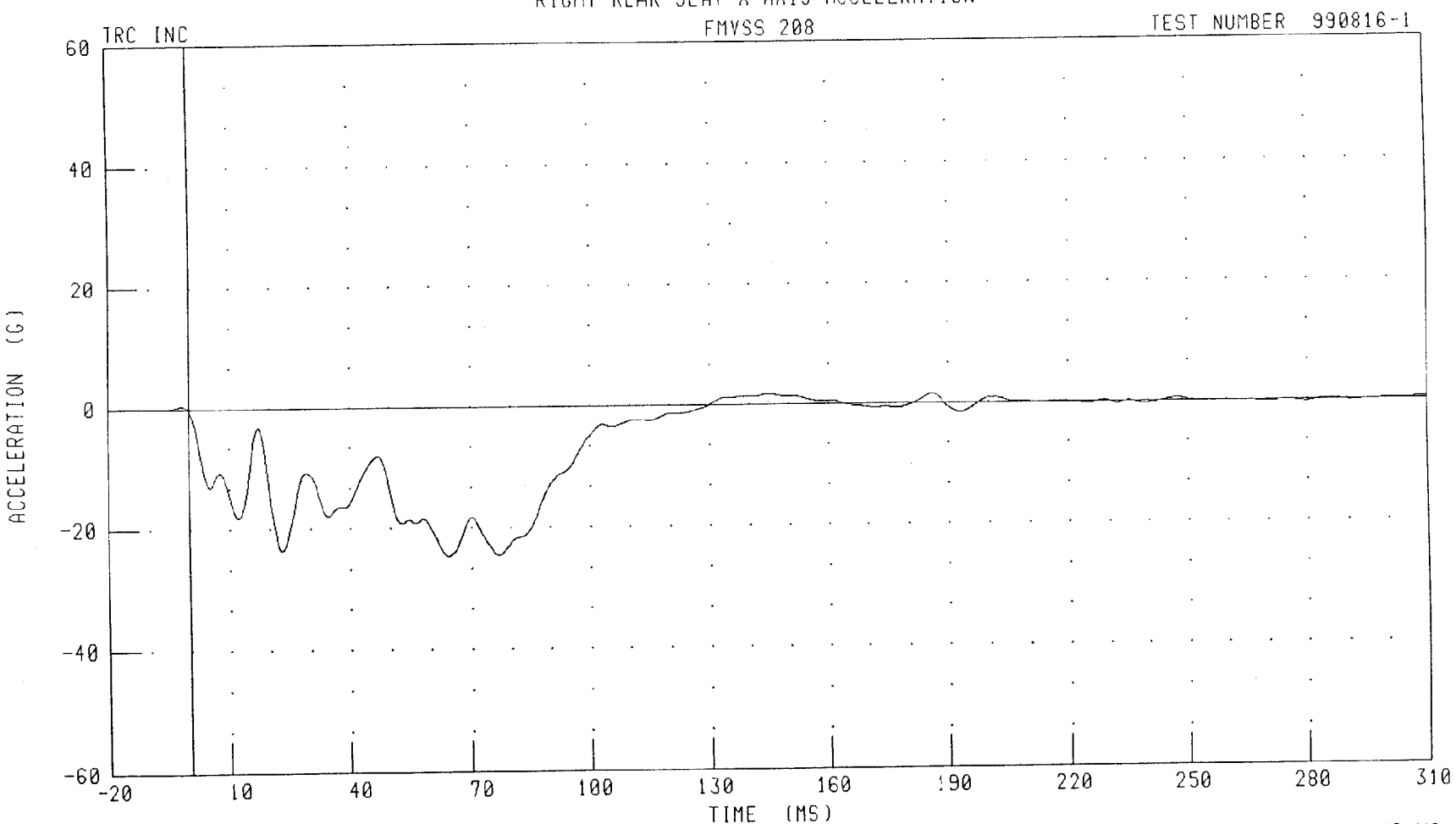
PEAK DATA: 1.96 G @ 137.28 MS; -23.64 G @ 79.60 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
LEFT REAR SEAT Y-AXIS ACCELERATION



CHANNEL: TLRYG1 FILTER: CH. CLASS 60 PEAK DATA: 2.59 G @ 18.32 MS, -3.95 G @ 24.32 MS

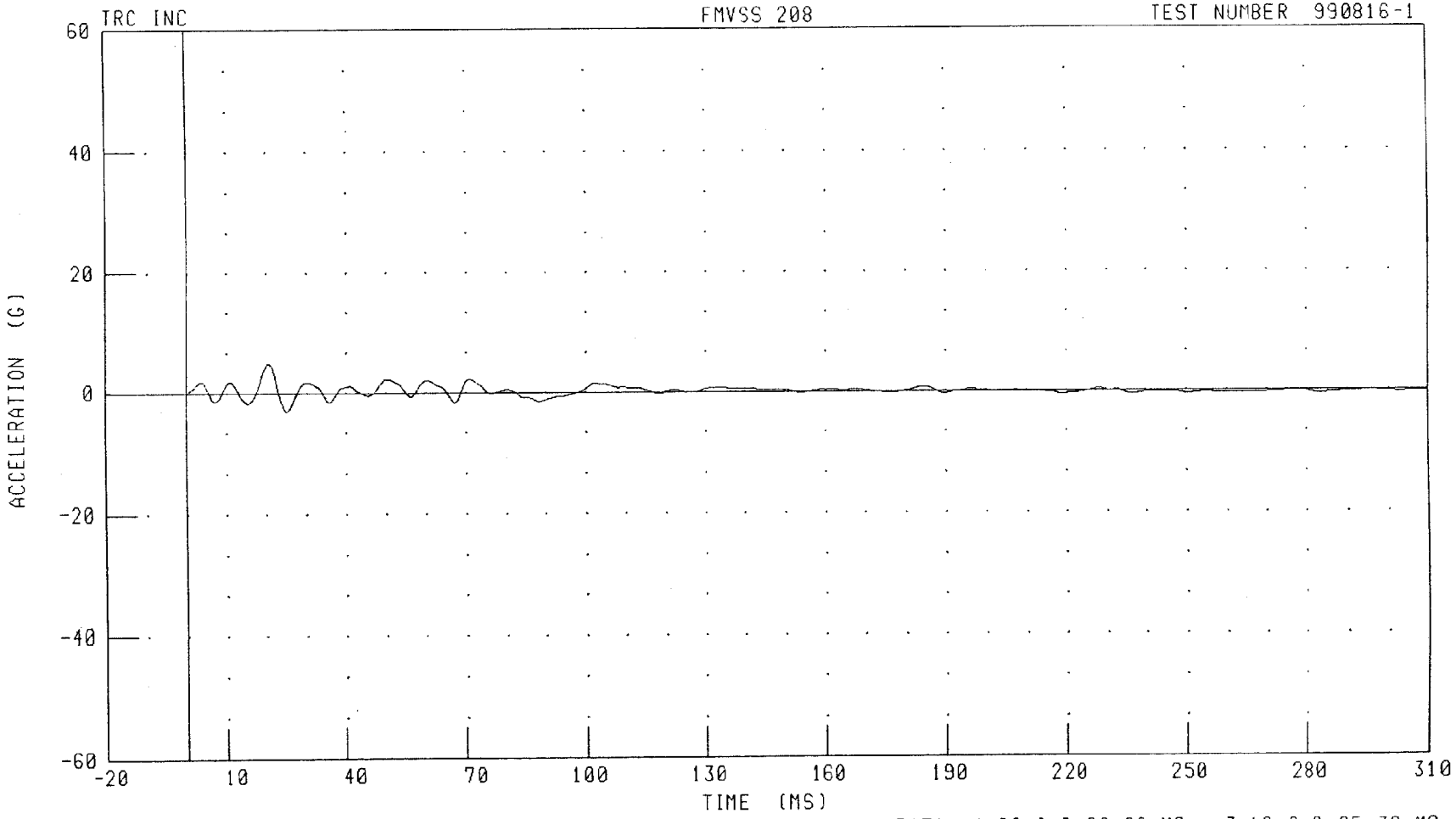
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT REAR SEAT X-AXIS ACCELERATION
FMVSS 208



CHANNEL: TRRXG1 FILTER: CH. CLASS 60

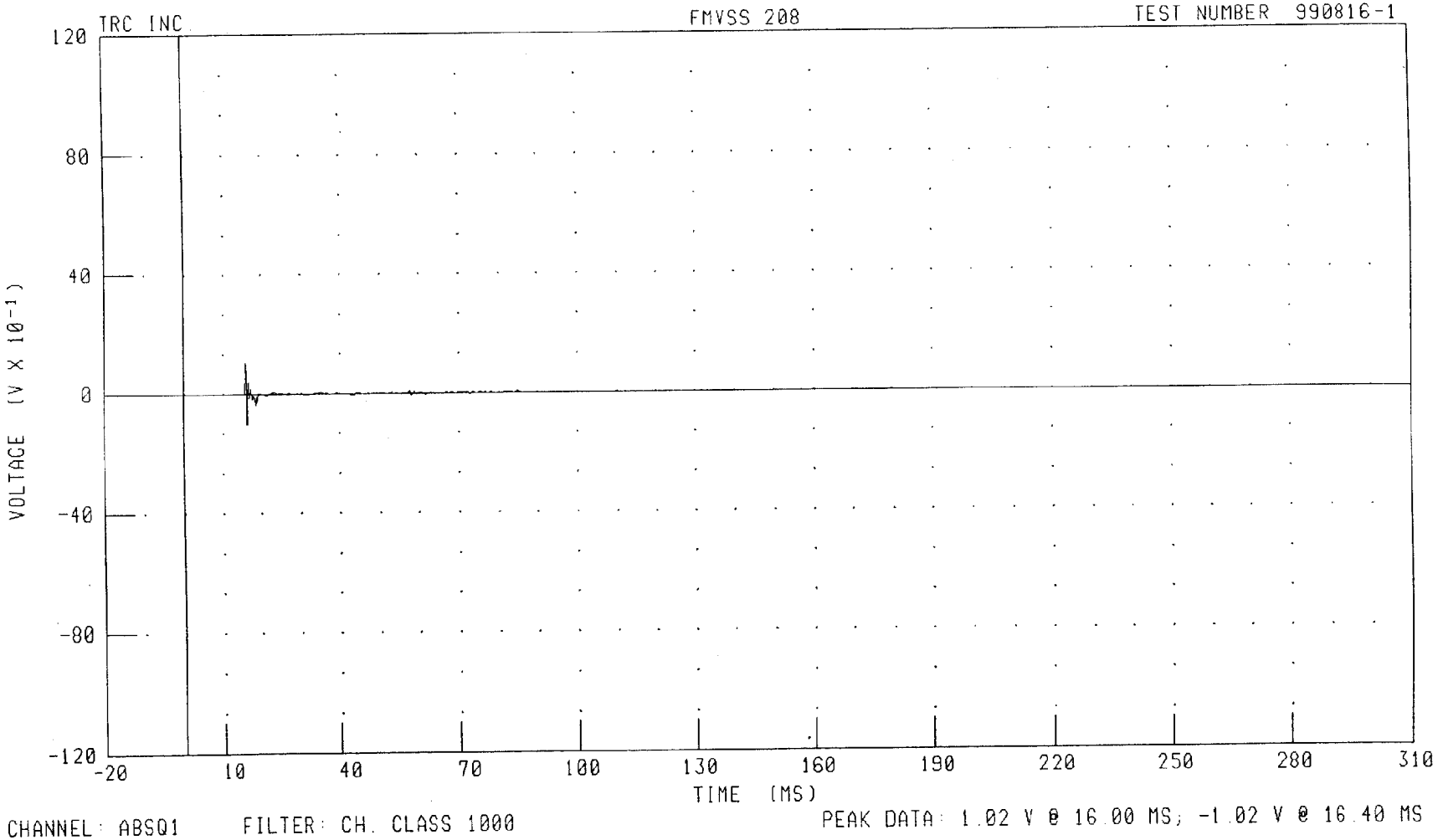
PEAK DATA: 1.69 G @ 145.04 MS; -24.75 G @ 64.48 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
RIGHT REAR SEAT Y-AXIS ACCELERATION



CHANNEL: TRRYG1 FILTER: CH. CLASS 60 PEAK DATA: 4.86 G @ 20.80 MS, -3.10 G @ 25.36 MS

1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
DRIVER SIDE INDUCTIVE AIRBAG FIRE PICKUP



CHANNEL: ABSQ1 FILTER: CH. CLASS 1000 PEAK DATA: 1.02 V @ 16.00 MS; -1.02 V @ 16.40 MS

Appendix C

Dummy Certification

Post-Test Dummy Certification

Passenger Dummy S/N 369

TRANSPORTATION RESEARCH CENTER INC.

HEAD DROP TEST

HYBRID III SMALL FEMALE 24-AUG-99

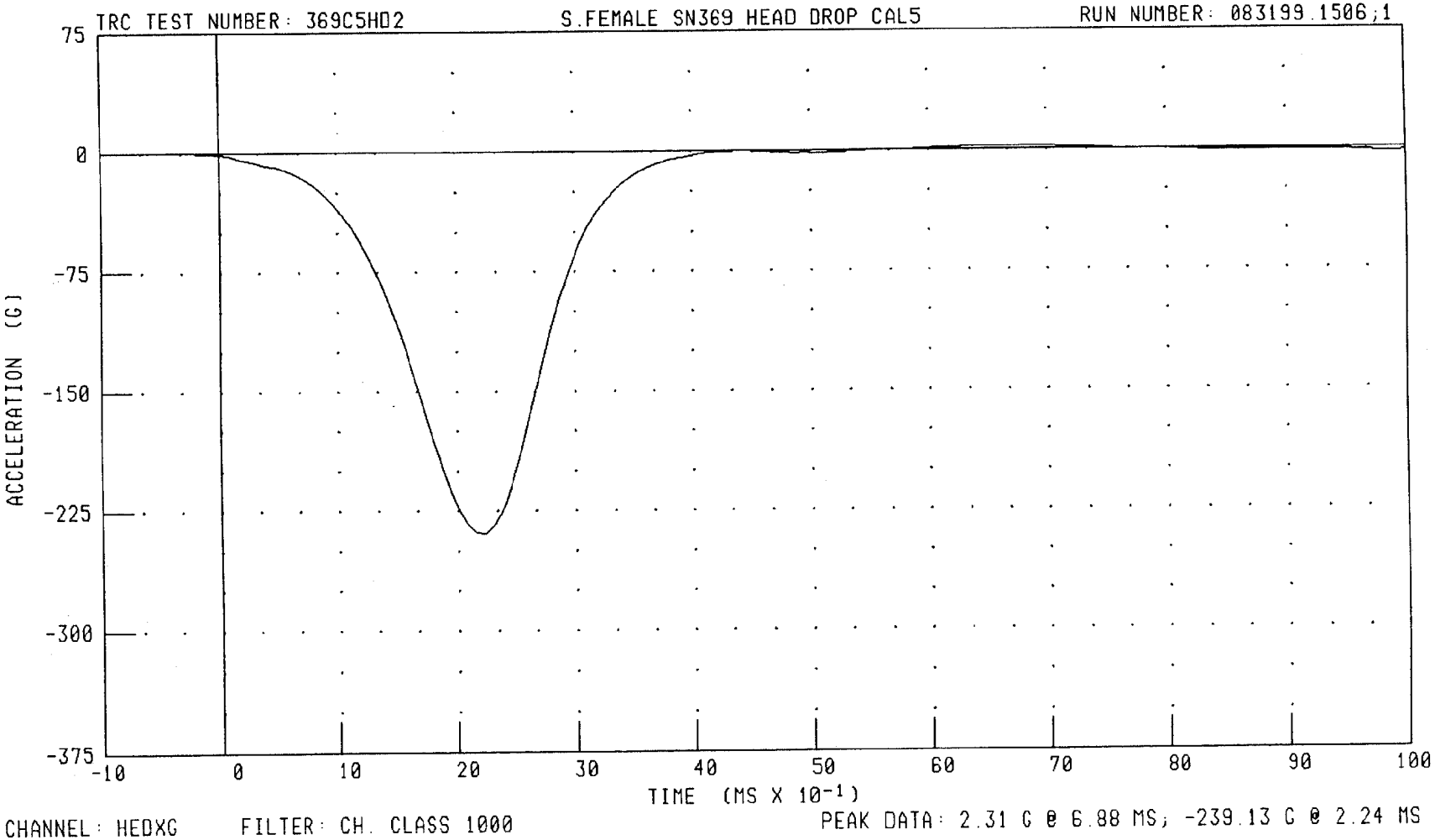
TRC INC. TEST NO: 369C5HD2 S.FEMALE SN369 HEAD DROP CAL5

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	18.9-25.6 DEG. C	21.7 DEG. C
RELATIVE HUMIDITY	10 - 70 %	55.0 %
PEAK RESULTANT ACCELERATION	250 - 300 G	277.69 G
PEAK LATERAL ACCELERATION	15 G MAX	-9.28 G
IS ACCELERATION CURVE UNIMODAL?	YES	YES

TEST MEETS SPECIFICATIONS

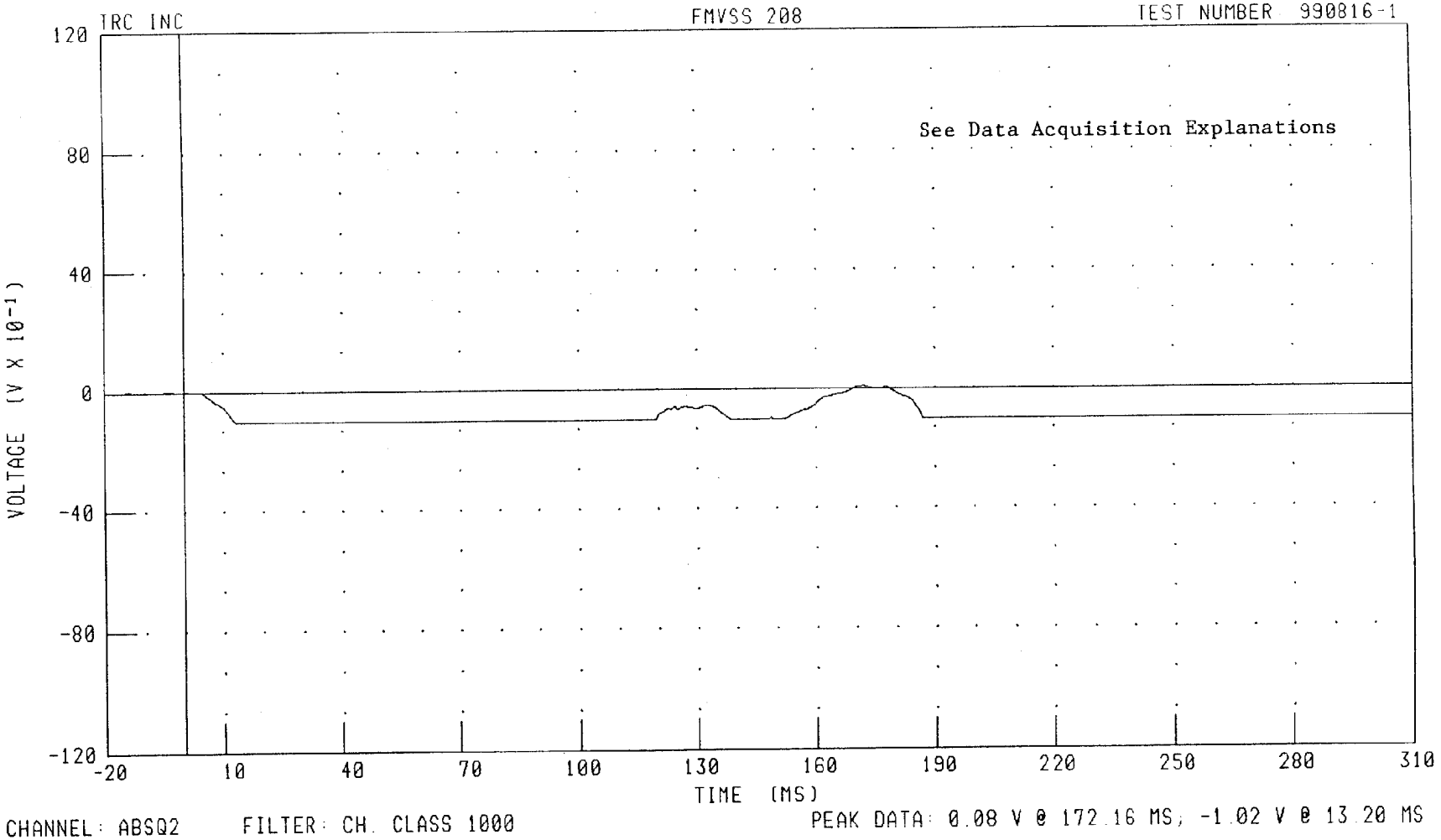
TECHNICIAN _____ RUN NUMBER: 082499.1559;1

SMALL FEMALE HYBRID III HEAD CALIBRATION
HEAD ACCELERATION X AXIS



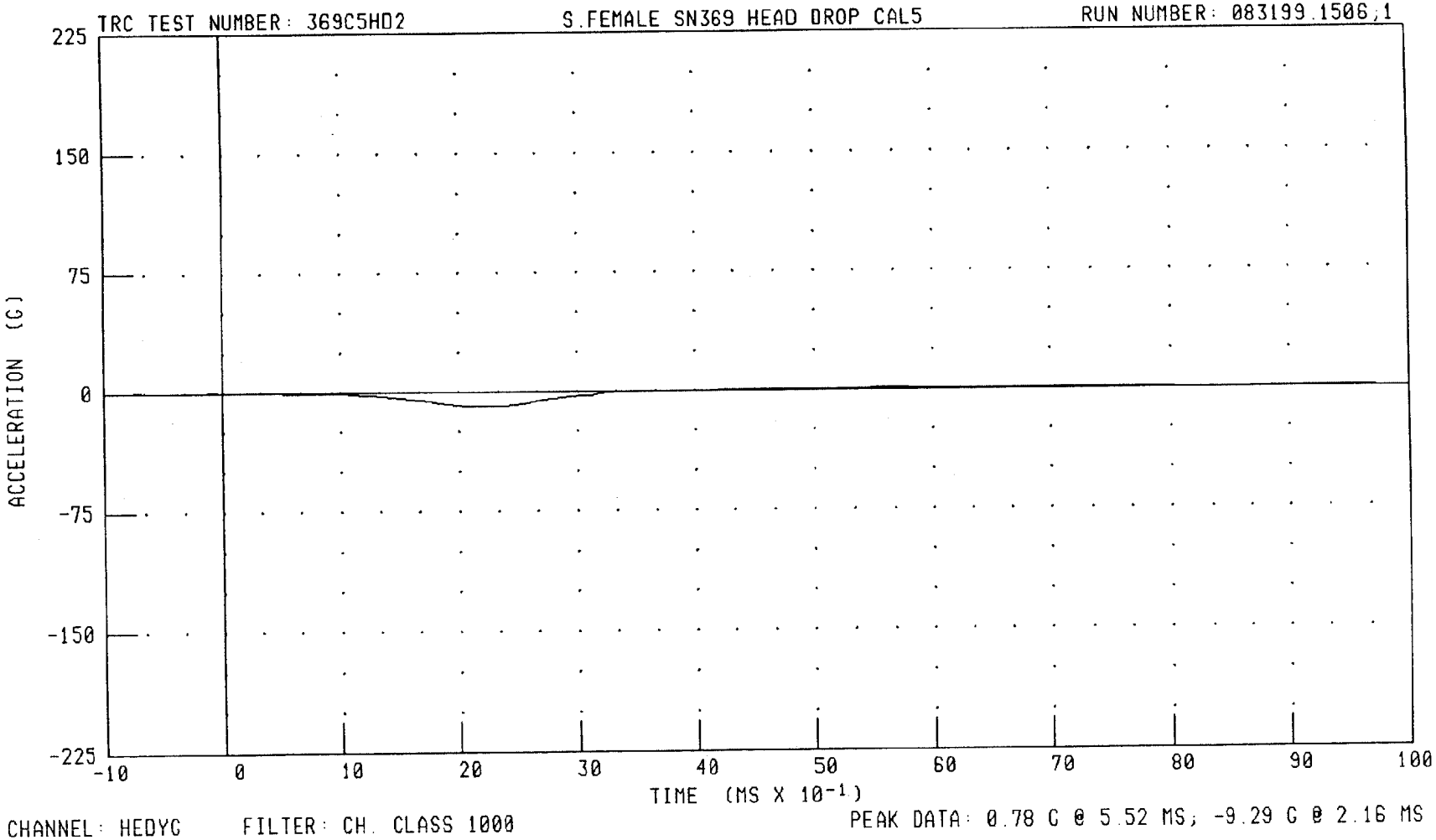
CHANNEL: HEDXG FILTER: CH. CLASS 1000 PEAK DATA: 2.31 G @ 6.88 MS; -239.13 G @ 2.24 MS

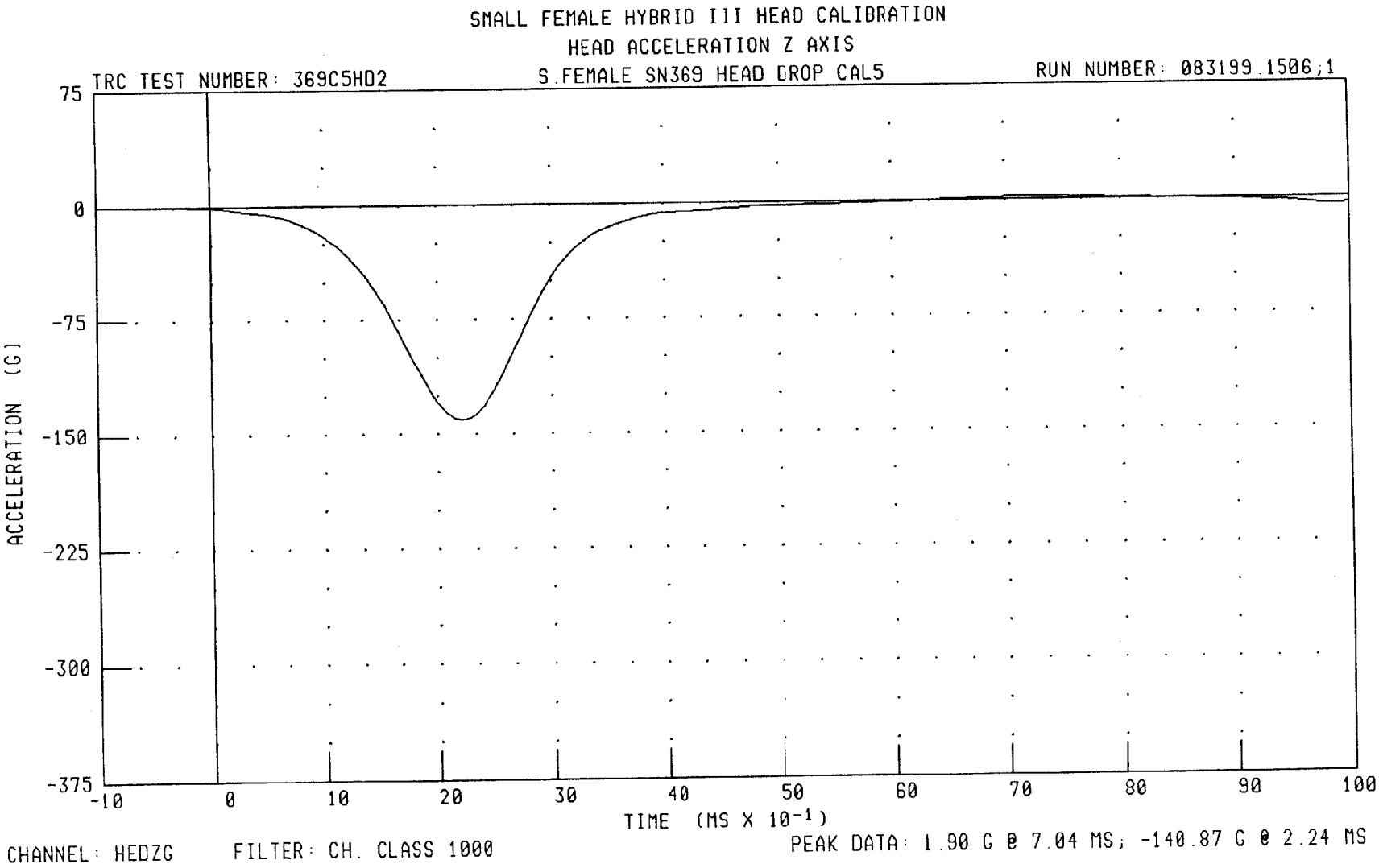
1999 SATURN SL1 INTO 208 FULL FRONTAL RIGID BARRIER AT 35 MPH
PASSENGER SIDE INDUCTIVE AIRBAG FIRE PICKUP



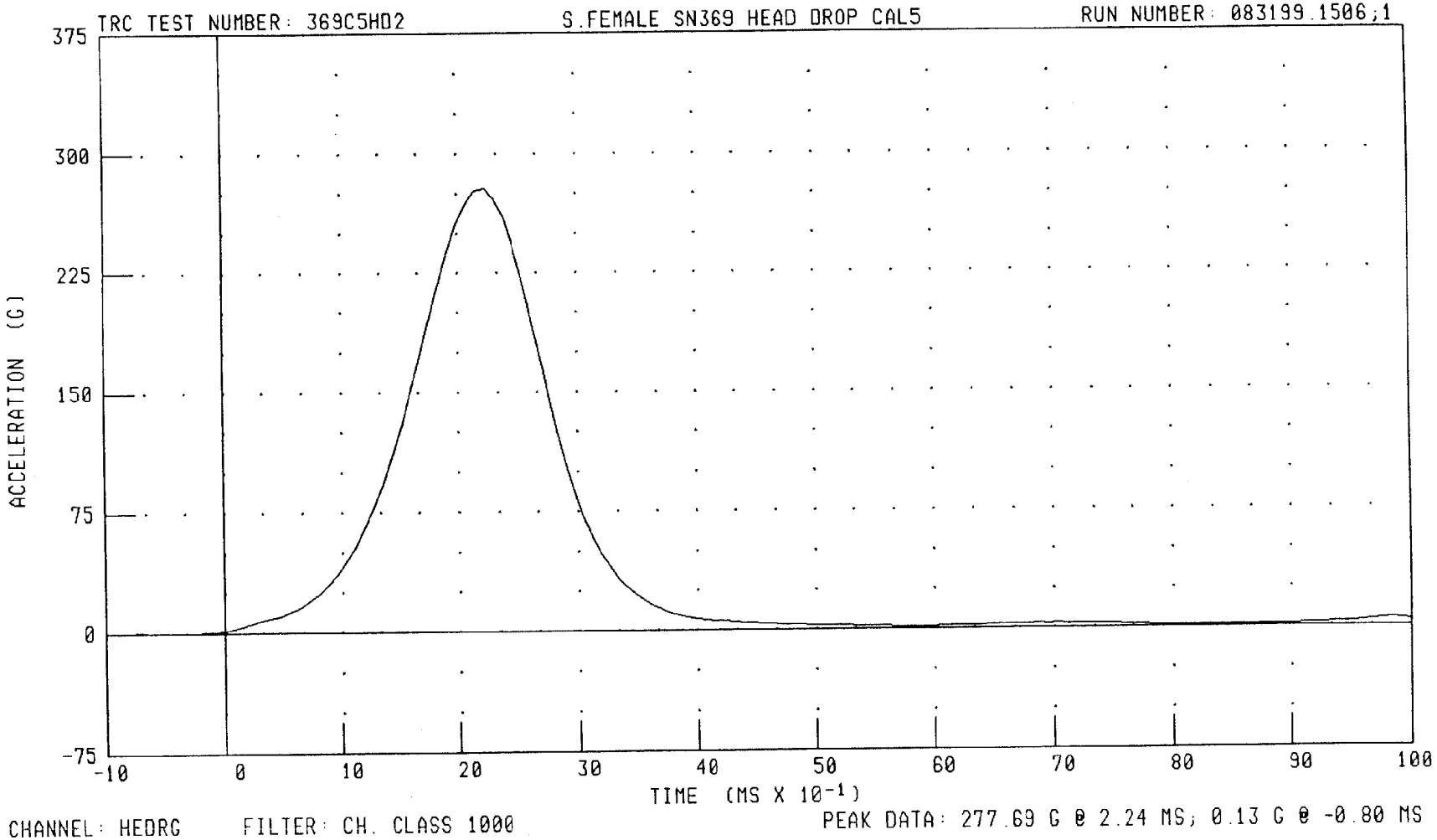
CHANNEL: ABSQ2 FILTER: CH. CLASS 1000 PEAK DATA: 0.08 V @ 172.16 MS; -1.02 V @ 13.20 MS

SMALL FEMALE HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Y AXIS

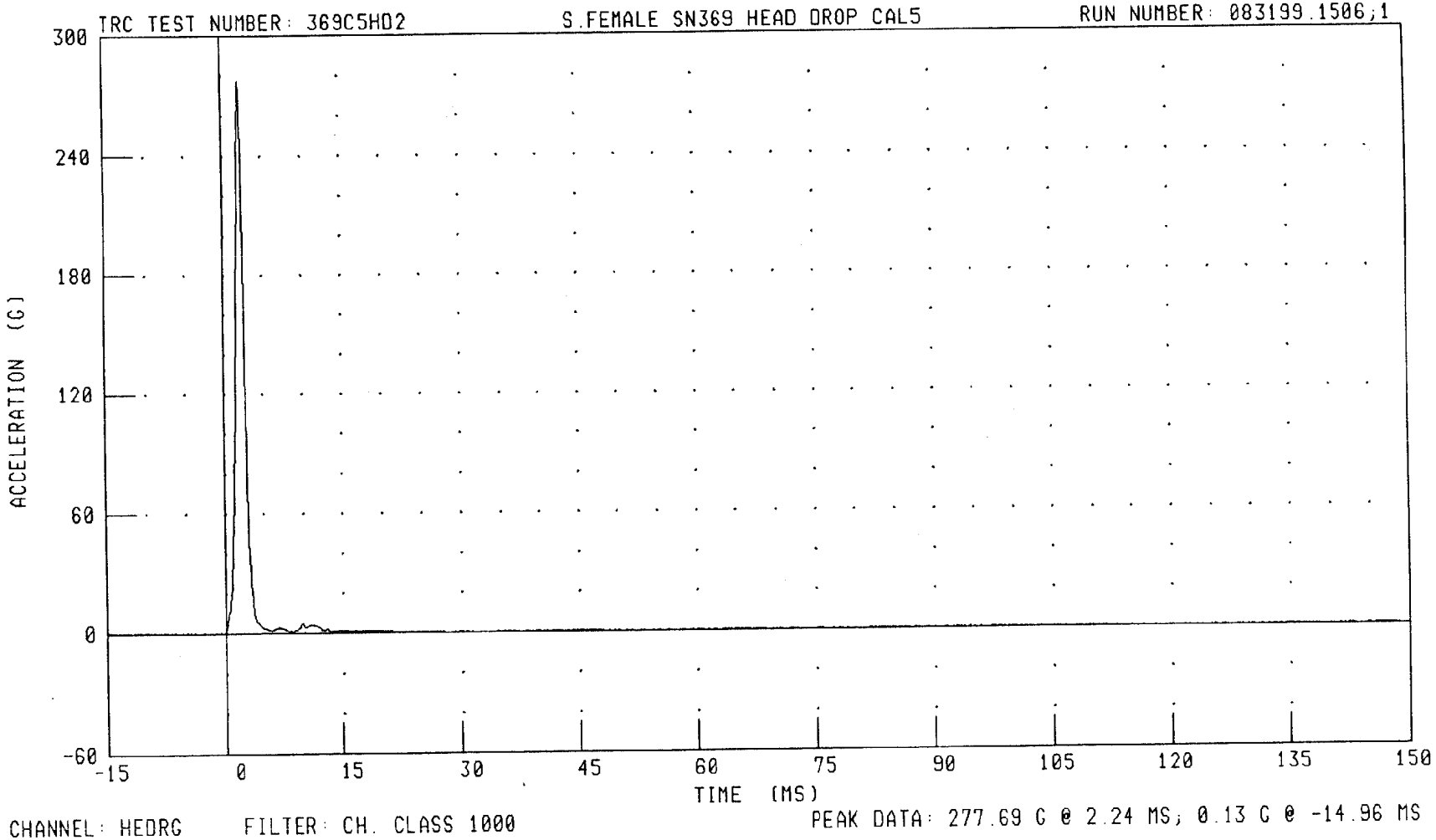



SMALL FEMALE HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Z AXIS
TRC TEST NUMBER: 369C5HD2
S.FEMALE SN369 HEAD DROP CAL5
RUN NUMBER: 083199.1506;1
75
0
-75
-150
-225
-300
-375
ACCELERATION (G)
-10
0
10
20
30
40
50
60
70
80
90
100
TIME (MS X 10-1)
CHANNEL: HEDZC
FILTER: CH. CLASS 1000
PEAK DATA: 1.90 G @ 7.04 MS; -140.87 G @ 2.24 MS

SMALL FEMALE HYBRID III HEAD CALIBRATION
HEAD RESULTANT ACCELERATION



SMALL FEMALE HYBRID III HEAD CALIBRATION
CHECK PLOT - HEAD RESULTANT ACCELERATION



TRANSPORTATION RESEARCH CENTER INC.

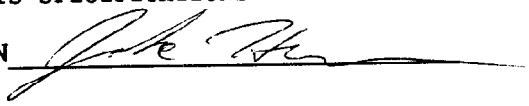
HYBRID III SMALL FEMALE 24-AUG-99

NECK FLEXION TEST - 6 CHANNEL TRANSDUCER

TRC INC. TEST NO: 369C5NF1 S.FEMALE SN369 NECK FLEX. CAL5

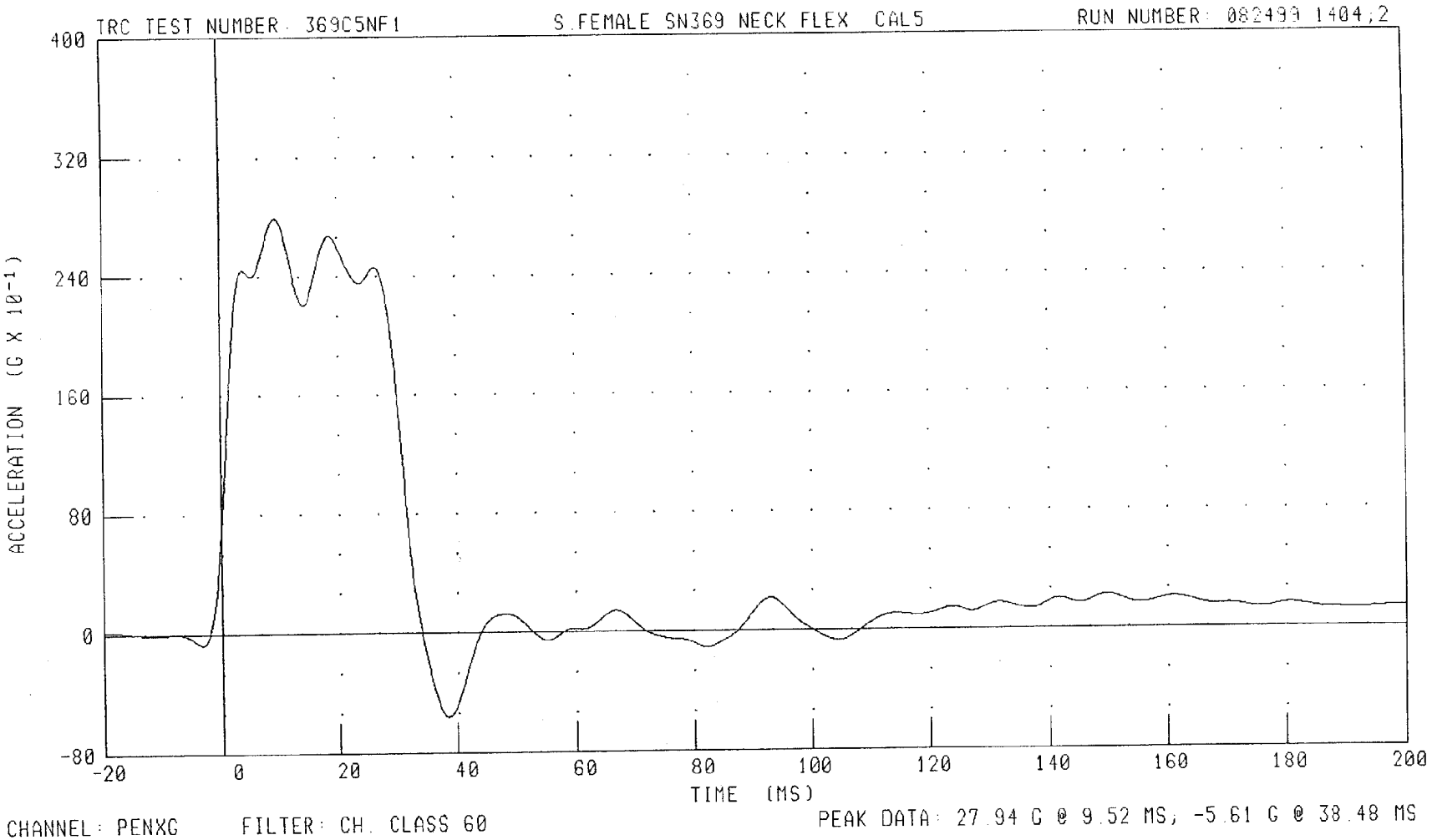
TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		20.6-22.2 DEG. C	22.2 DEG. C
RELATIVE HUMIDITY		10 - 70 %	55.0 %
IMPACT VELOCITY		6.89 - 7.13 M/S	7.06 M/S
INTEGRATED PENDULUM VELOCITY	10 MS	2.1 - 2.5 M/S	2.27 M/S
	20 MS	4.0 - 5.0 M/S	4.70 M/S
	30 MS	5.8 - 7.0 M/S	7.00 M/S
PEAK D-PLANE ROTATION		80 - 92 DEG.	81.46 DEG.
PEAK MOMENT ABOUT OCCIPITAL CONDYLE DURING ROTATION INT		69 - 83 NM	75.71 NM
POSITIVE MOMENT DECAY TIME FROM TO TO 10 NM		80 - 100 MS	94.64 MS

TEST MEETS SPECIFICATIONS

TECHNICIAN  RUN NUMBER: 082499.1403;2

SMALL FEMALE HYBRID III NECK FLEXION CALIBRATION

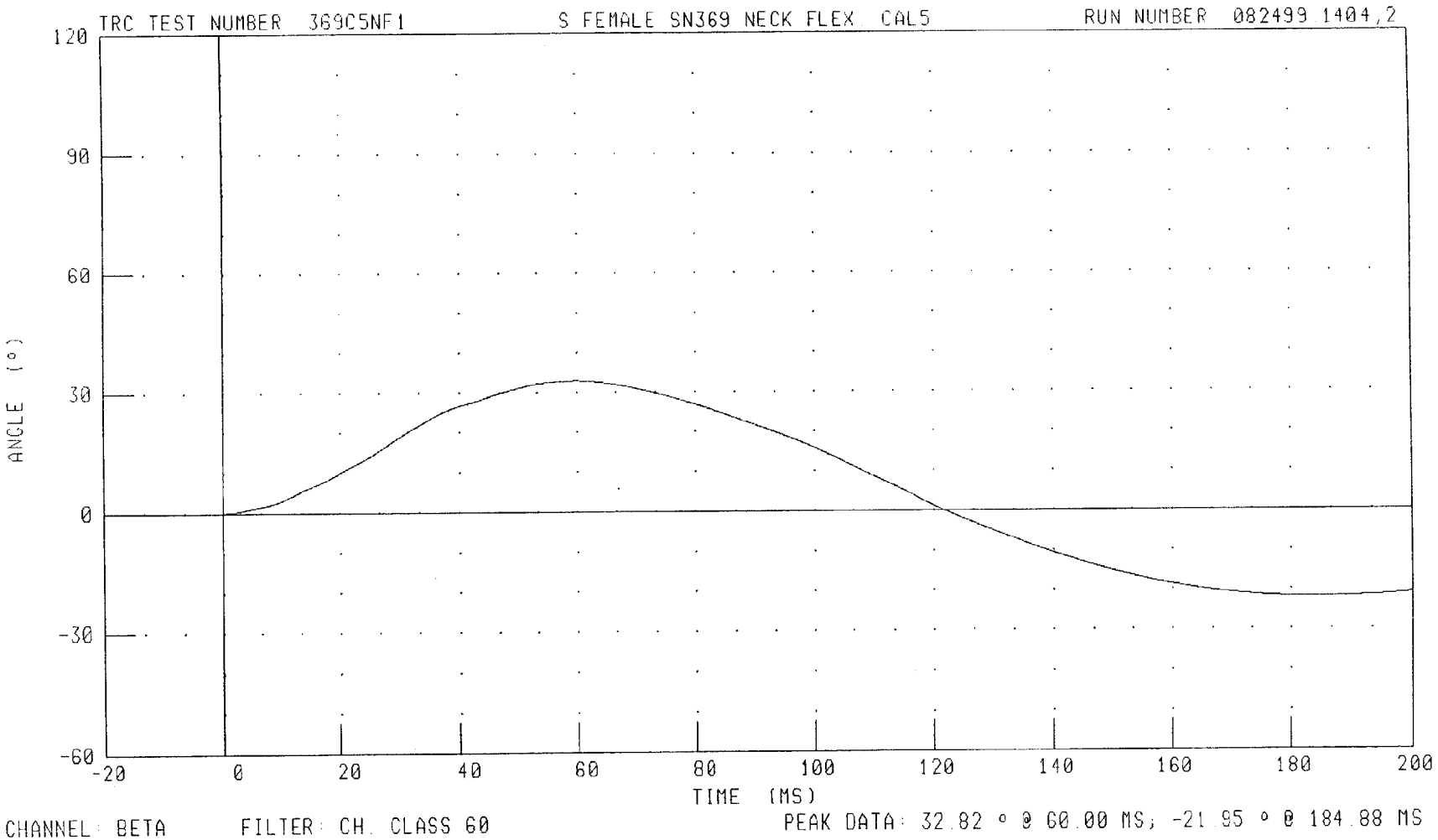
PENDULUM DECELERATION



CHANNEL: PENXG FILTER: CH. CLASS 60

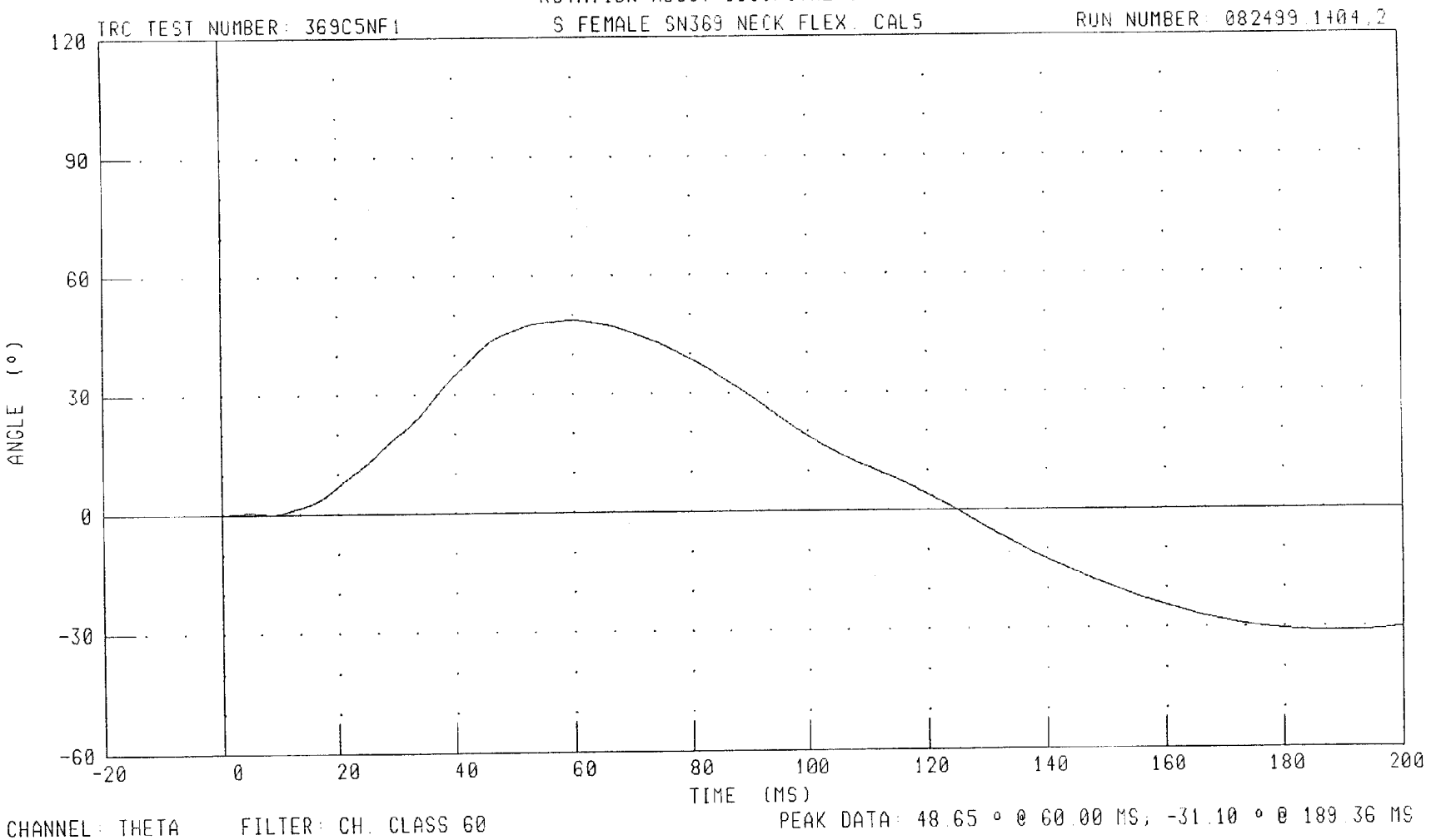
PEAK DATA: 27.94 G @ 9.52 MS, -5.61 G @ 38.48 MS

SMALL FEMALE HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT BASE OF NECK



CHANNEL: BETA FILTER: CH. CLASS 60 PEAK DATA: 32.82 ° @ 60.00 MS; -21.95 ° @ 184.88 MS

SMALL FEMALE HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT OCCIPITAL CONDYLE

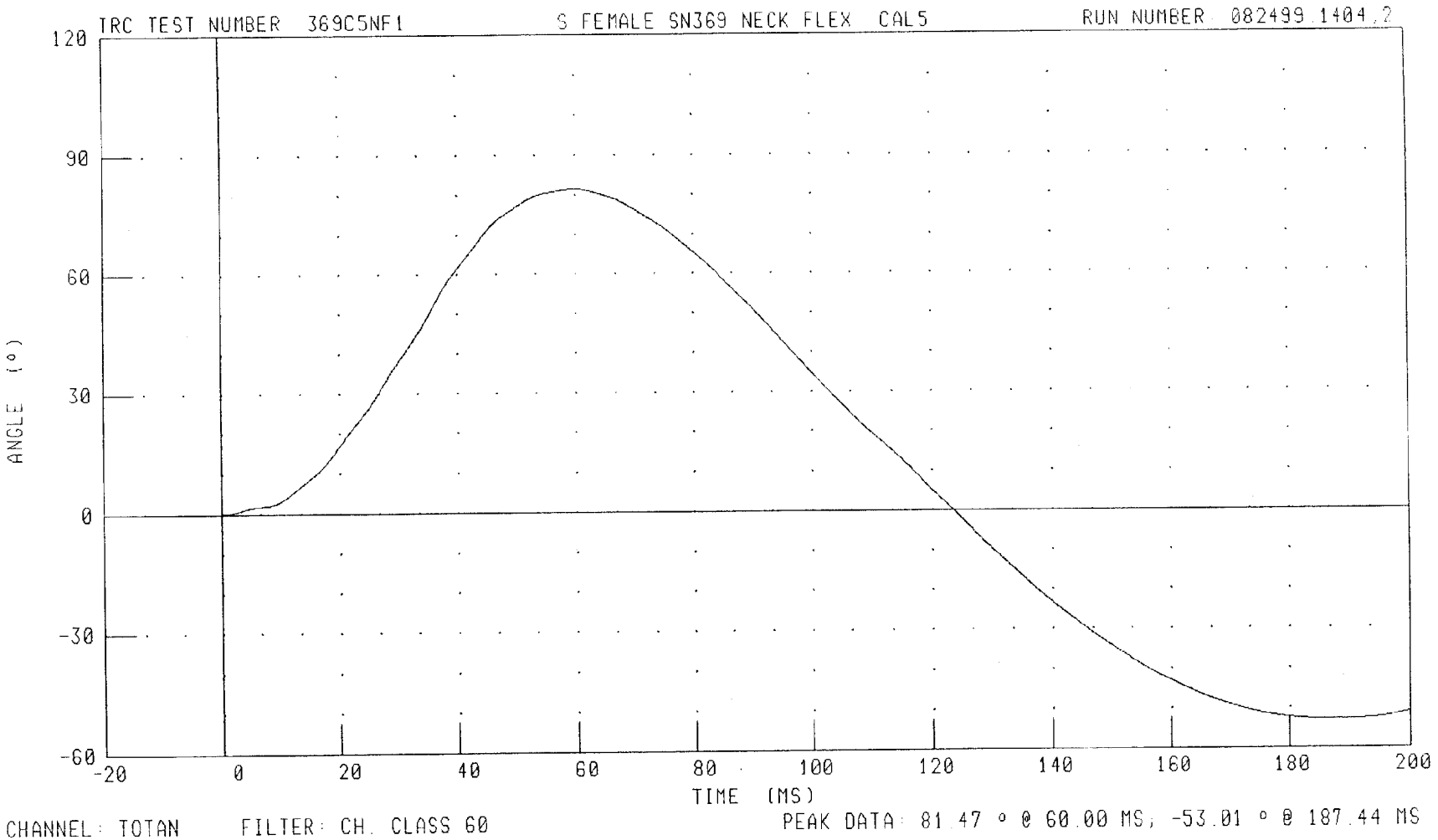


CHANNEL: THETA FILTER: CH. CLASS 60

PEAK DATA: 48.65 ° @ 60.00 MS; -31.10 ° @ 189.36 MS

SMALL FEMALE HYBRID III NECK FLEXION CALIBRATION

TOTAL ROTATION

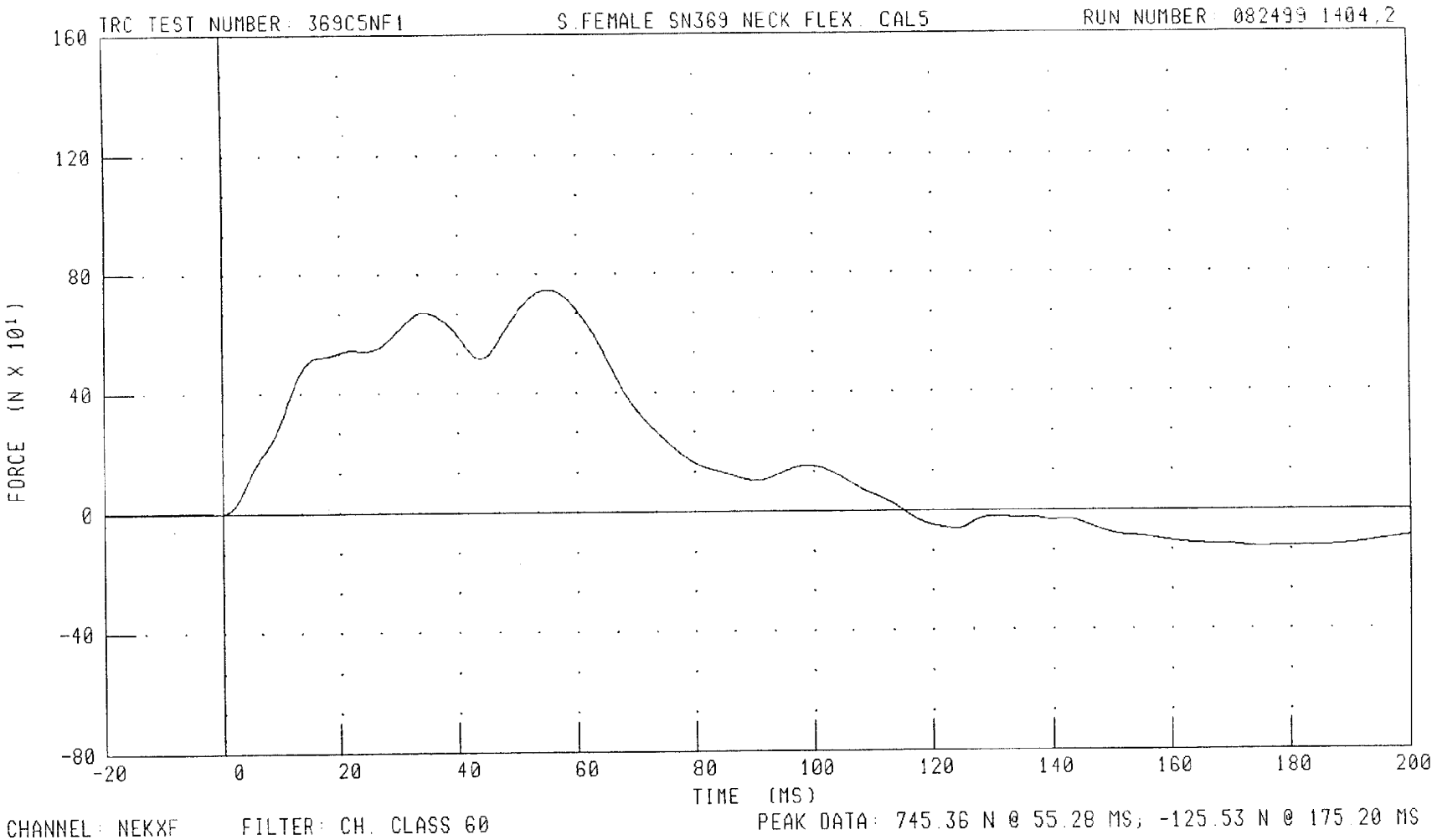


CHANNEL: TOTAN FILTER: CH. CLASS 60

PEAK DATA: 81.47 ° @ 60.00 MS, -53.01 ° @ 187.44 MS

SMALL FEMALE HYBRID III NECK FLEXION CALIBRATION

NECK FORCE X AXIS

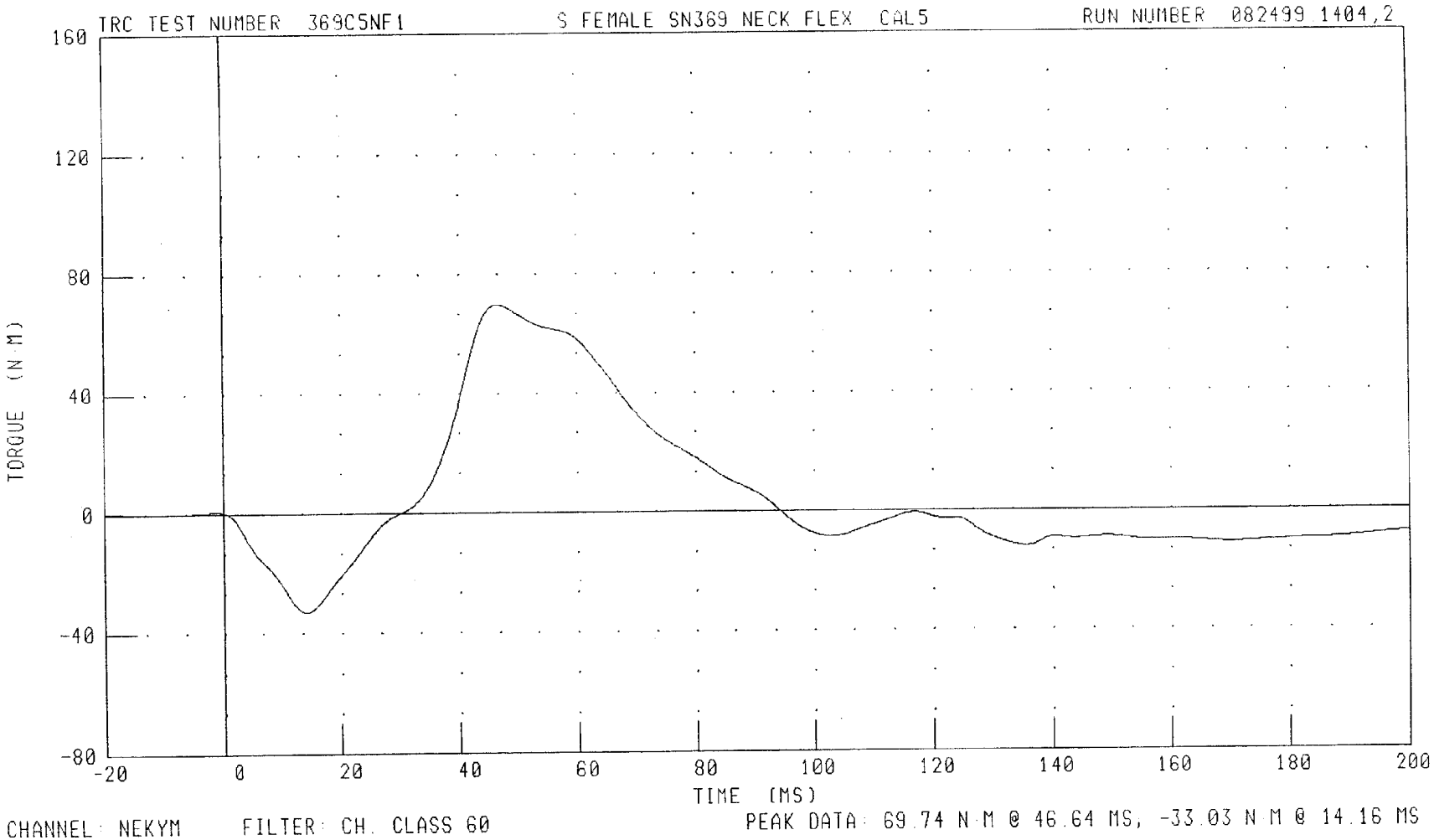


CHANNEL: NEKXF FILTER: CH. CLASS 60

PEAK DATA: 745.36 N @ 55.28 MS; -125.53 N @ 175.20 MS

SMALL FEMALE HYBRID III NECK FLEXION CALIBRATION

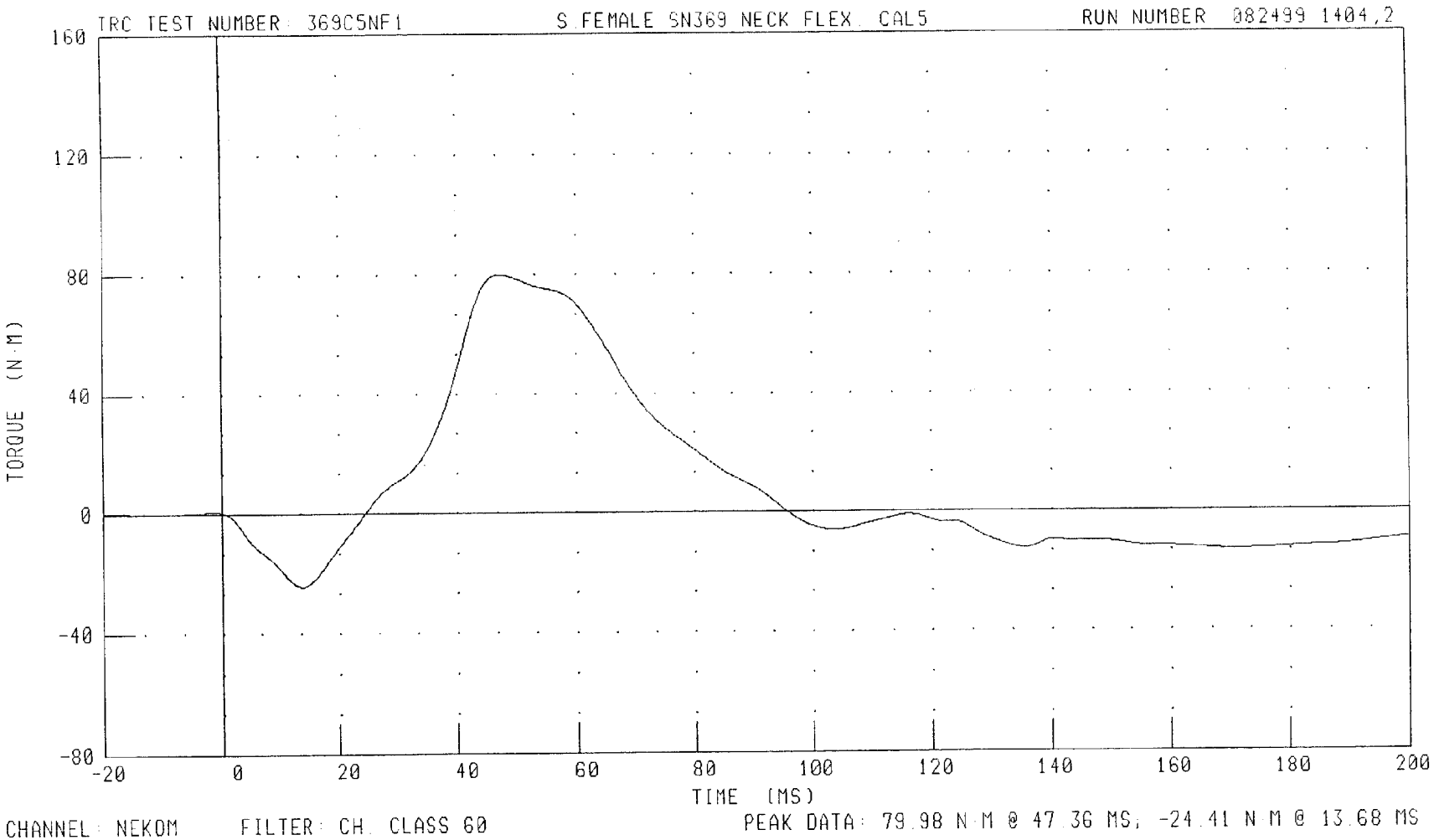
NECK MOMENT Y AXIS



CHANNEL: NEKYM FILTER: CH. CLASS 60

PEAK DATA: 69.74 N-M @ 46.64 MS, -33.03 N-M @ 14.16 MS

SMALL FEMALE HYBRID III NECK FLEXION CALIBRATION
TOTAL MOMENT ABOUT OCCIPITAL CONDYLE



CHANNEL: NEKOM FILTER: CH. CLASS 60

PEAK DATA: 79.98 N-M @ 47.36 MS, -24.41 N-M @ 13.68 MS

TRANSPORTATION RESEARCH CENTER INC.

HYBRID III SMALL FEMALE 24-AUG-99

NECK EXTENSION TEST - 6 CHANNEL TRANSDUCER

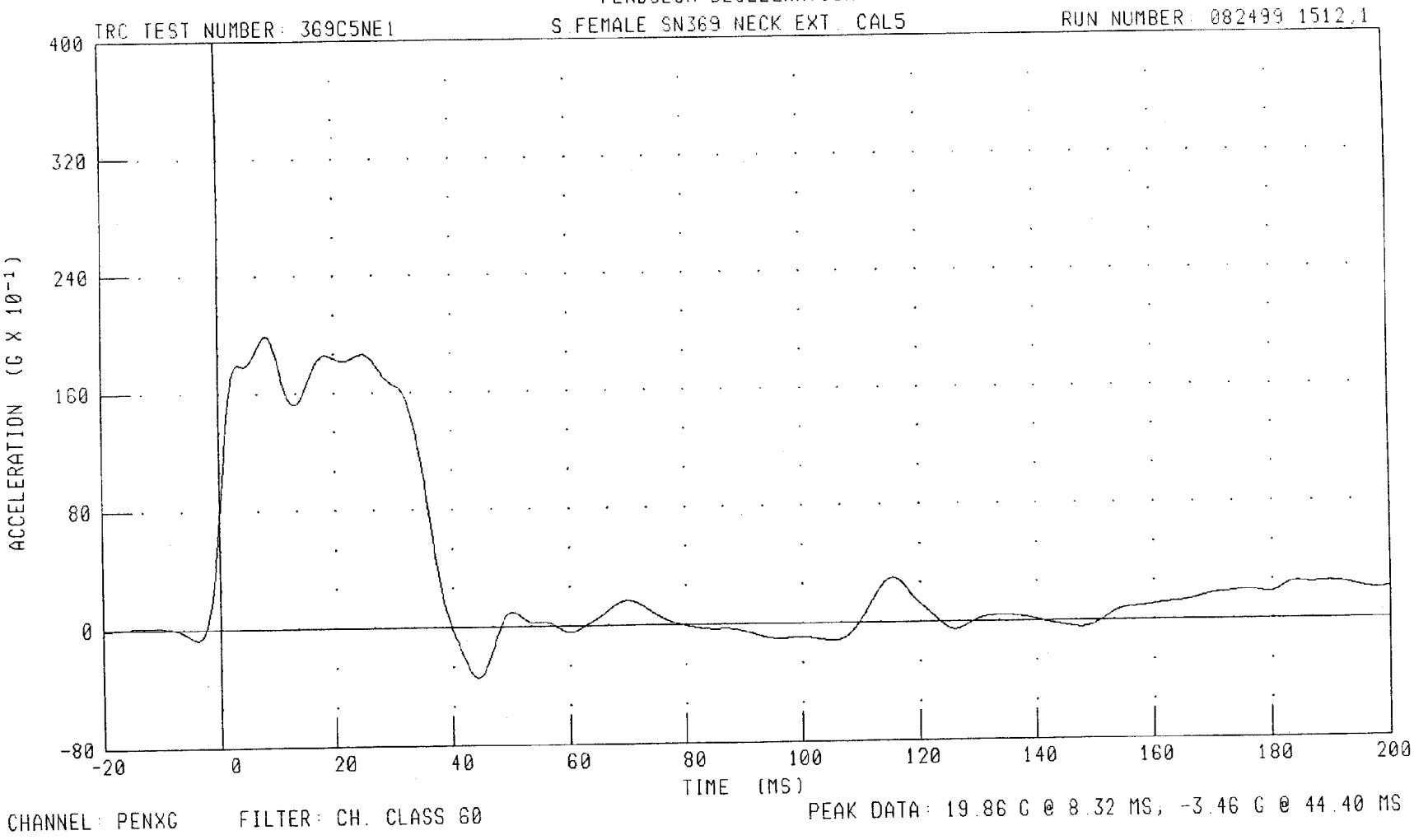
TRC INC. TEST NO: 369C5NE1 S.FEMALE SN369 NECK EXT. CAL5

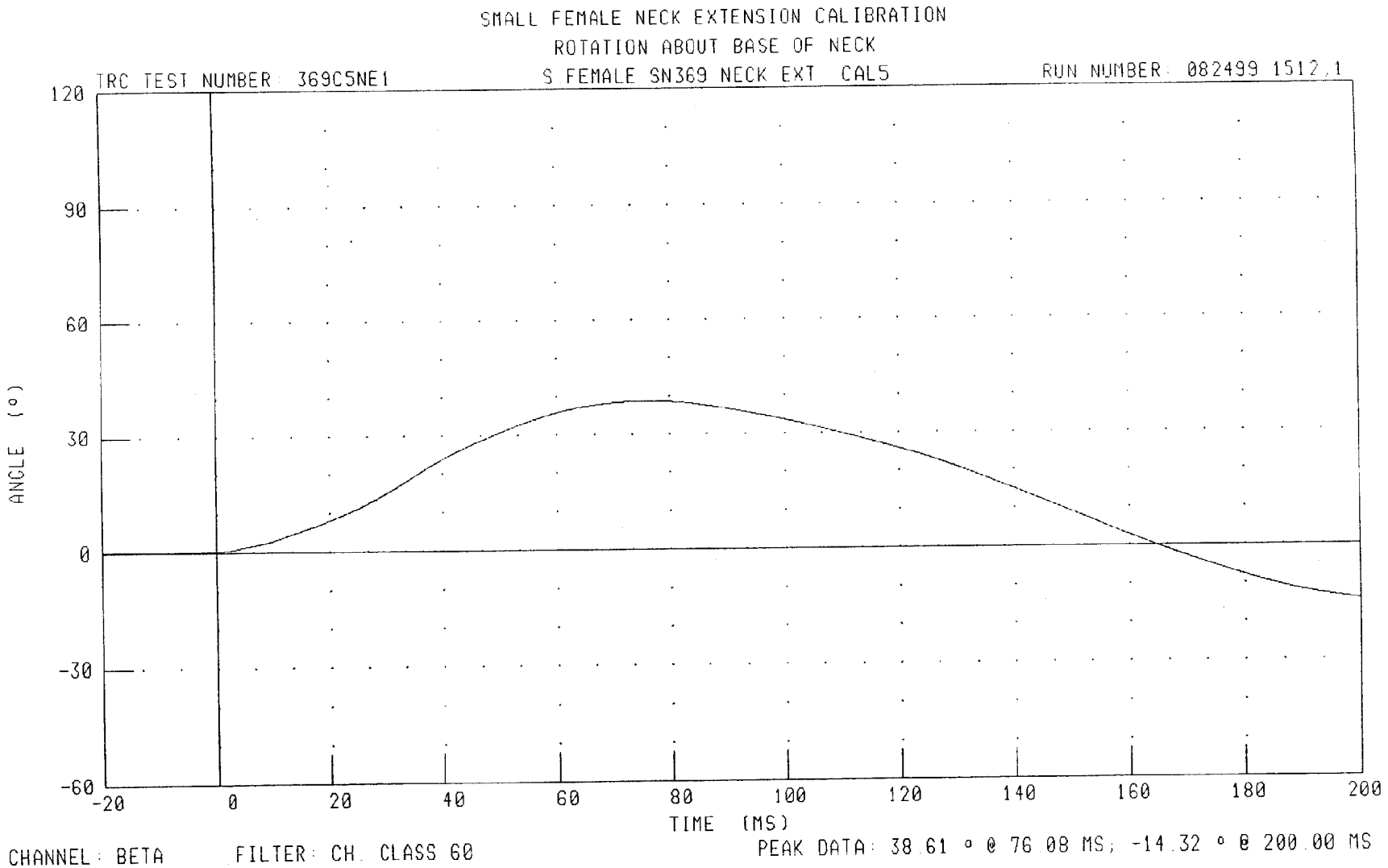
TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		20.6 - 22.2 DEG. C	21.7 DEG. C
RELATIVE HUMIDITY		10 - 70 %	55.0 %
IMPACT VELOCITY		5.95 - 6.19 M/S	6.00 M/S
INTEGRATED PENDULUM VELOCITY	10 MS	1.5 - 1.9 M/S	1.75 M/S
	20 MS	3.1 - 3.9 M/S	3.42 M/S
	30 MS	4.6 - 5.6 M/S	5.18 M/S
PEAK D-PLANE ROTATION		97 - 109 DEG.	104.15 DEG.
PEAK MOMENT ABOUT OCIPITAL CONDYLE DURING ROTATION INT		-55 \ -69 NM	-55.41 NM
NEGATIVE MOMENT DECAY TIME FROM TO TO -10 NM		94 - 114 MS	108.72 MS
TIME OF PEAK ROTATION AFTER PEAK MOMENT		0 - 10 MS	6.48 MS

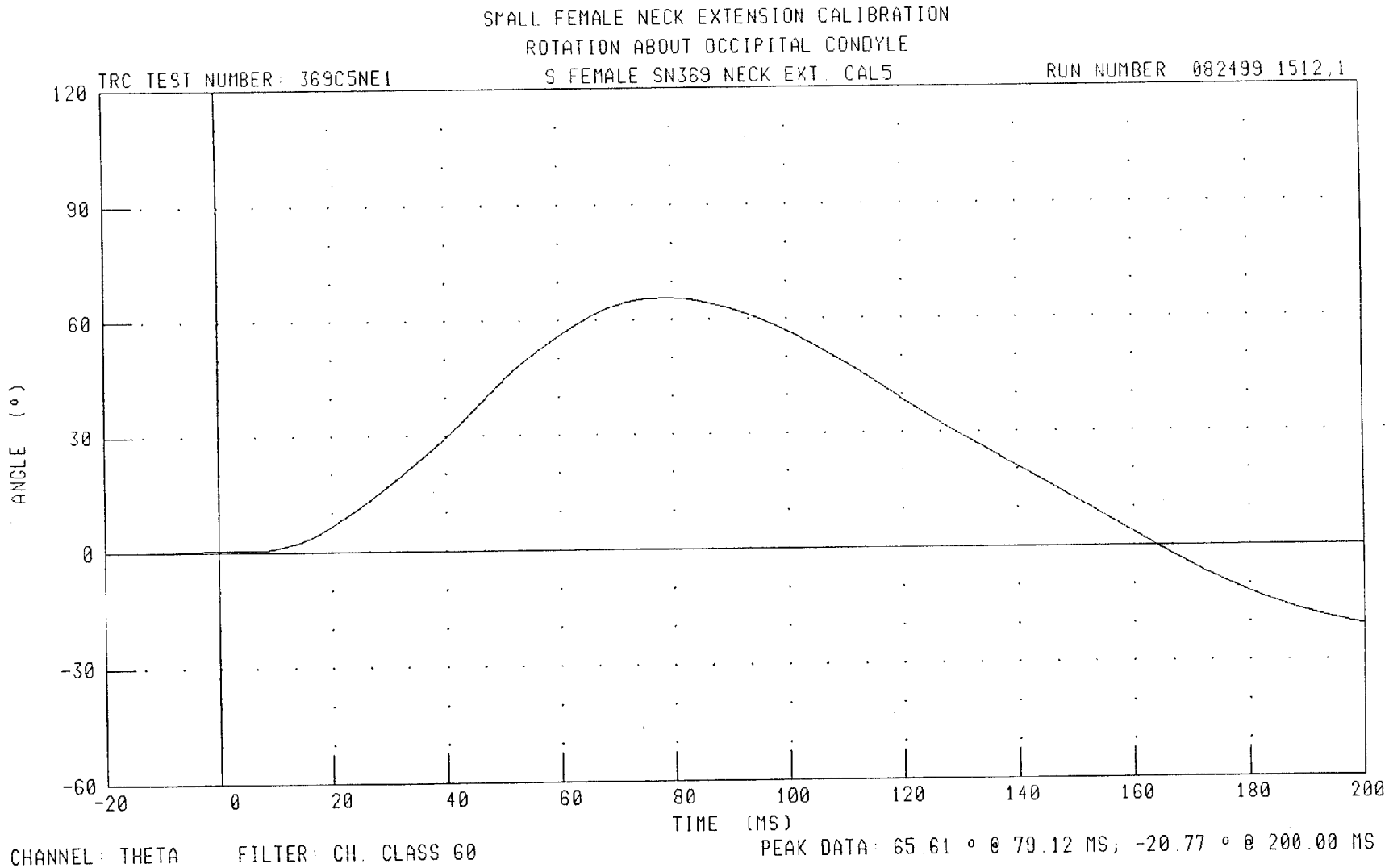
TEST MEETS SPECIFICATIONS

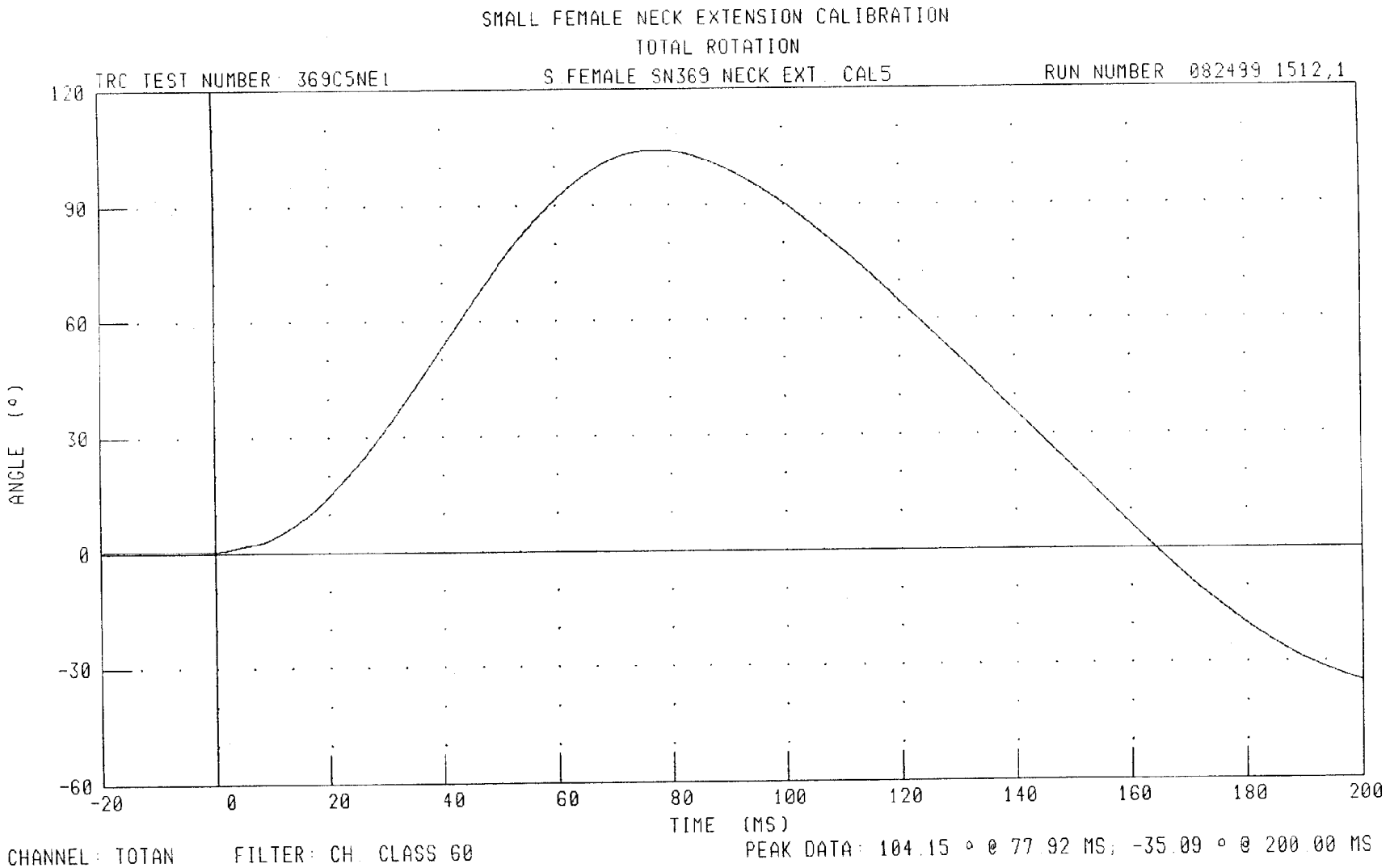
TECHNICIAN _____ RUN NUMBER: 082499.1452;1

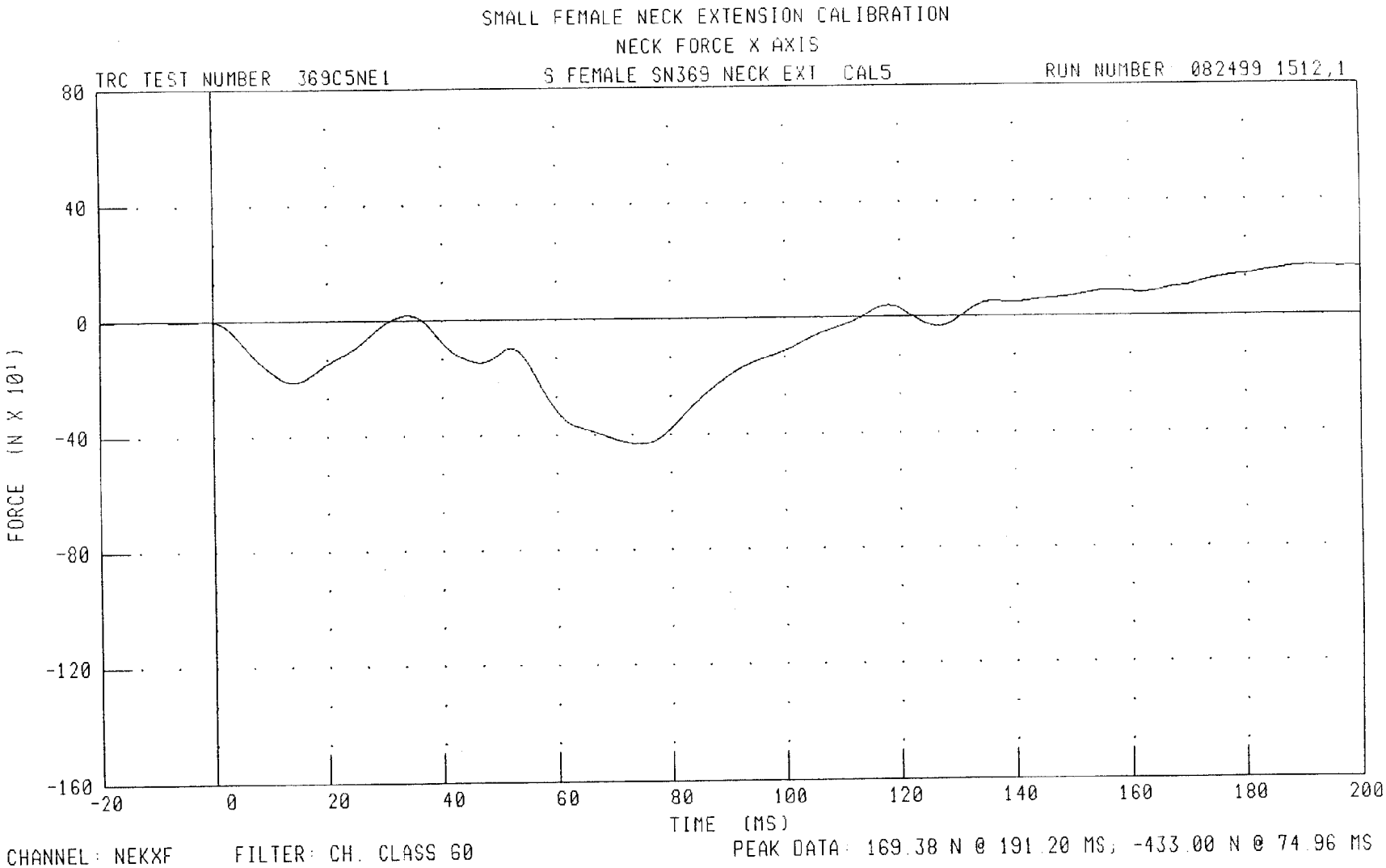
SMALL FEMALE NECK EXTENSION CALIBRATION
PENDULUM DECELERATION

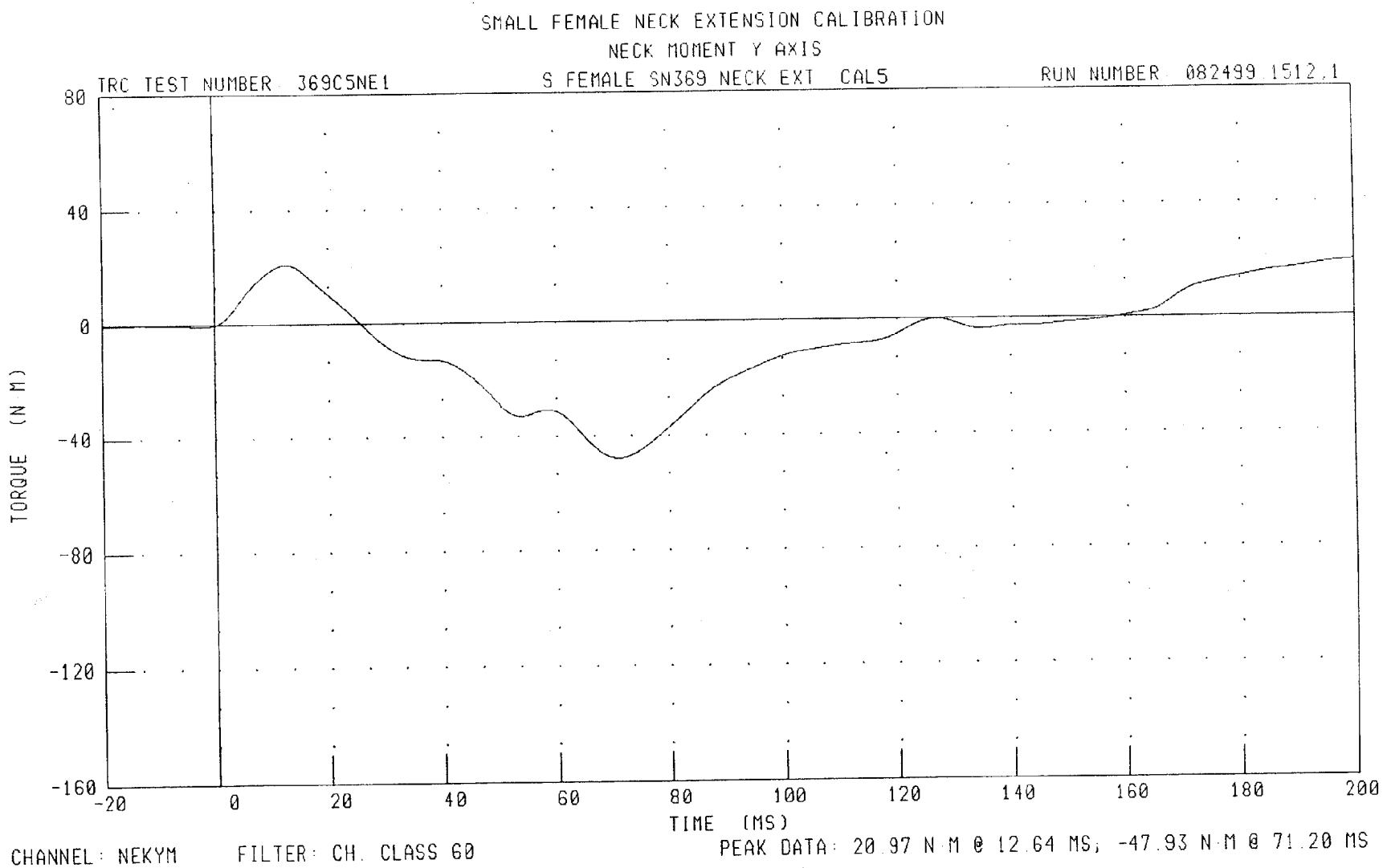


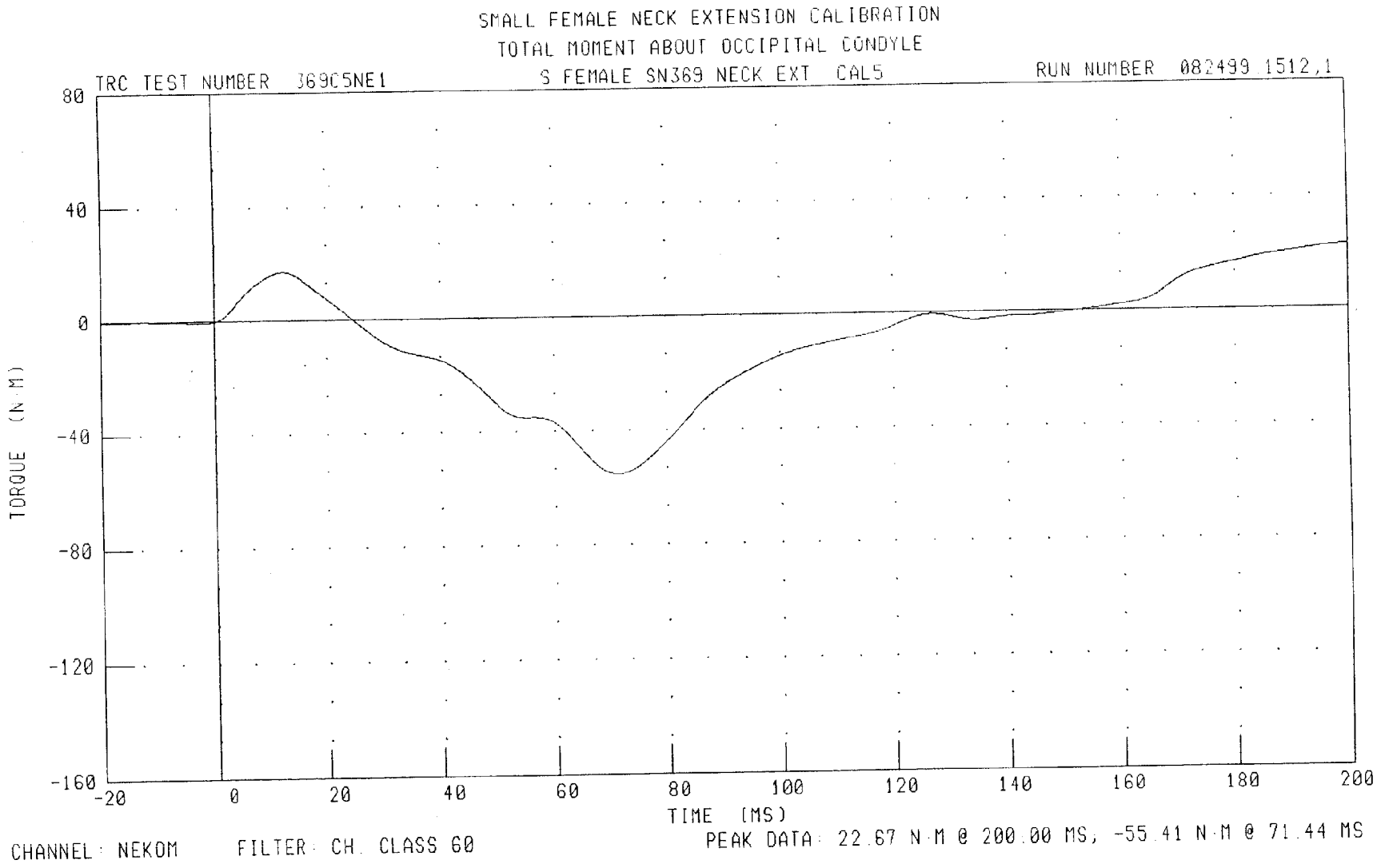

SMALL FEMALE NECK EXTENSION CALIBRATION
ROTATION ABOUT BASE OF NECK
TRC TEST NUMBER: 369C5NE1
S FEMALE SN369 NECK EXT CAL5
RUN NUMBER: 082499 1512.1
120
90
60
30
0
-30
-60
ANGLE (°)
-20
0
20
40
60
80
100
120
140
160
180
200
TIME (MS)
CHANNEL: BETA
FILTER: CH. CLASS 60
PEAK DATA: 38.61 ° @ 76.08 MS; -14.32 ° @ 200.00 MS


SMALL FEMALE NECK EXTENSION CALIBRATION
ROTATION ABOUT OCCIPITAL CONDYLE
TRC TEST NUMBER: 369C5NE1
S FEMALE SN369 NECK EXT. CAL5
RUN NUMBER 082499 1512.1
ANGLE (°)
120
90
60
30
0
-30
-60
-20
0
20
40
60
80
100
120
140
160
180
200
TIME (MS)
CHANNEL: THETA
FILTER: CH. CLASS 60
PEAK DATA: 65.61 ° @ 79.12 MS; -20.77 ° @ 200.00 MS


SMALL FEMALE NECK EXTENSION CALIBRATION
TOTAL ROTATION
TRC TEST NUMBER: 369C5NE1
S FEMALE SN369 NECK EXT CAL5
RUN NUMBER 082499 1512,1
120
90
60
30
0
-30
-60
ANGLE (°)
-20
0
20
40
60
80
100
120
140
160
180
200
TIME (MS)
CHANNEL: TOTAN
FILTER: CH CLASS 60
PEAK DATA: 104.15 ° @ 77.92 MS; -35.09 ° @ 200.00 MS


SMALL FEMALE NECK EXTENSION CALIBRATION
NECK FORCE X AXIS
TRC TEST NUMBER 369C5NE1
S FEMALE SN369 NECK EXT CAL5
RUN NUMBER 082499 1512,1
80
40
0
-40
-80
-120
-160
FORCE (N X 10¹)
-20
0
20
40
60
80
100
120
140
160
180
200
TIME (MS)
CHANNEL: NEKXF
FILTER: CH. CLASS 60
PEAK DATA: 169.38 N @ 191.20 MS; -433.00 N @ 74.96 MS


SMALL FEMALE NECK EXTENSION CALIBRATION
NECK MOMENT Y AXIS
TRC TEST NUMBER: 369C5NE1
S FEMALE SN369 NECK EXT CAL5
RUN NUMBER: 082499.1512.1
80
40
0
-40
-80
-120
-160
TORQUE (N M)
-20
0
20
40
60
80
100
120
140
160
180
200
TIME (MS)
CHANNEL: NEKYM
FILTER: CH. CLASS 60
PEAK DATA: 20.97 N-M @ 12.64 MS; -47.93 N-M @ 71.20 MS


SMALL FEMALE NECK EXTENSION CALIBRATION
TOTAL MOMENT ABOUT OCCIPITAL CONDYLE
TRC TEST NUMBER J69C5NE1
S FEMALE SN369 NECK EXT CAL5
RUN NUMBER 082499.1512.1
80
40
0
-40
-80
-120
-160
TORQUE (N-M)
-20
0
20
40
60
80
100
120
140
160
180
200
TIME (MS)
CHANNEL: NEKOM
FILTER: CH. CLASS 60
PEAK DATA: 22.67 N-M @ 200.00 MS, -55.41 N-M @ 71.44 MS

TRANSPORTATION RESEARCH CENTER INC.

THORAX IMPACT TEST

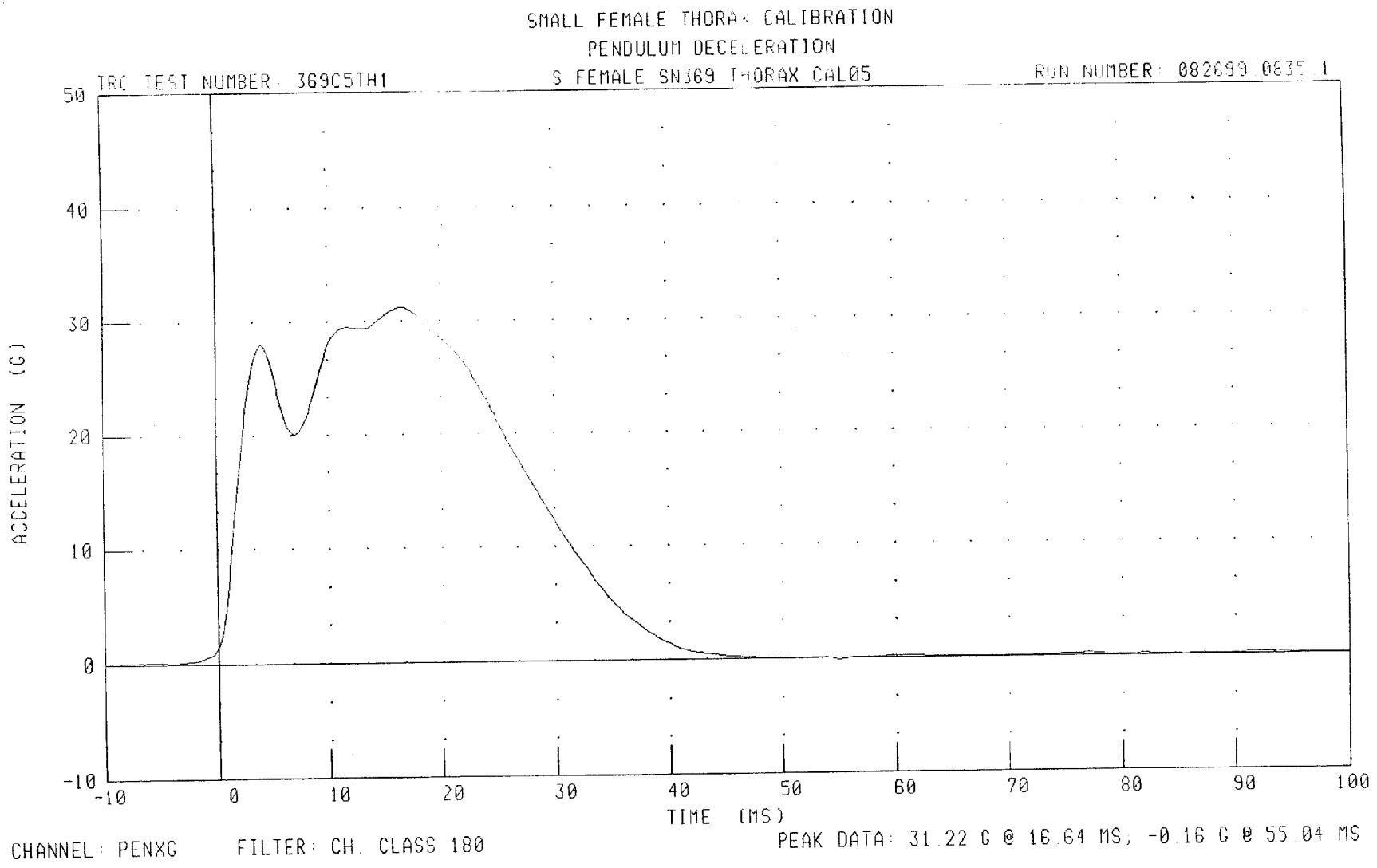
HYBRID III SMALL FEMALE 26-AUG-99

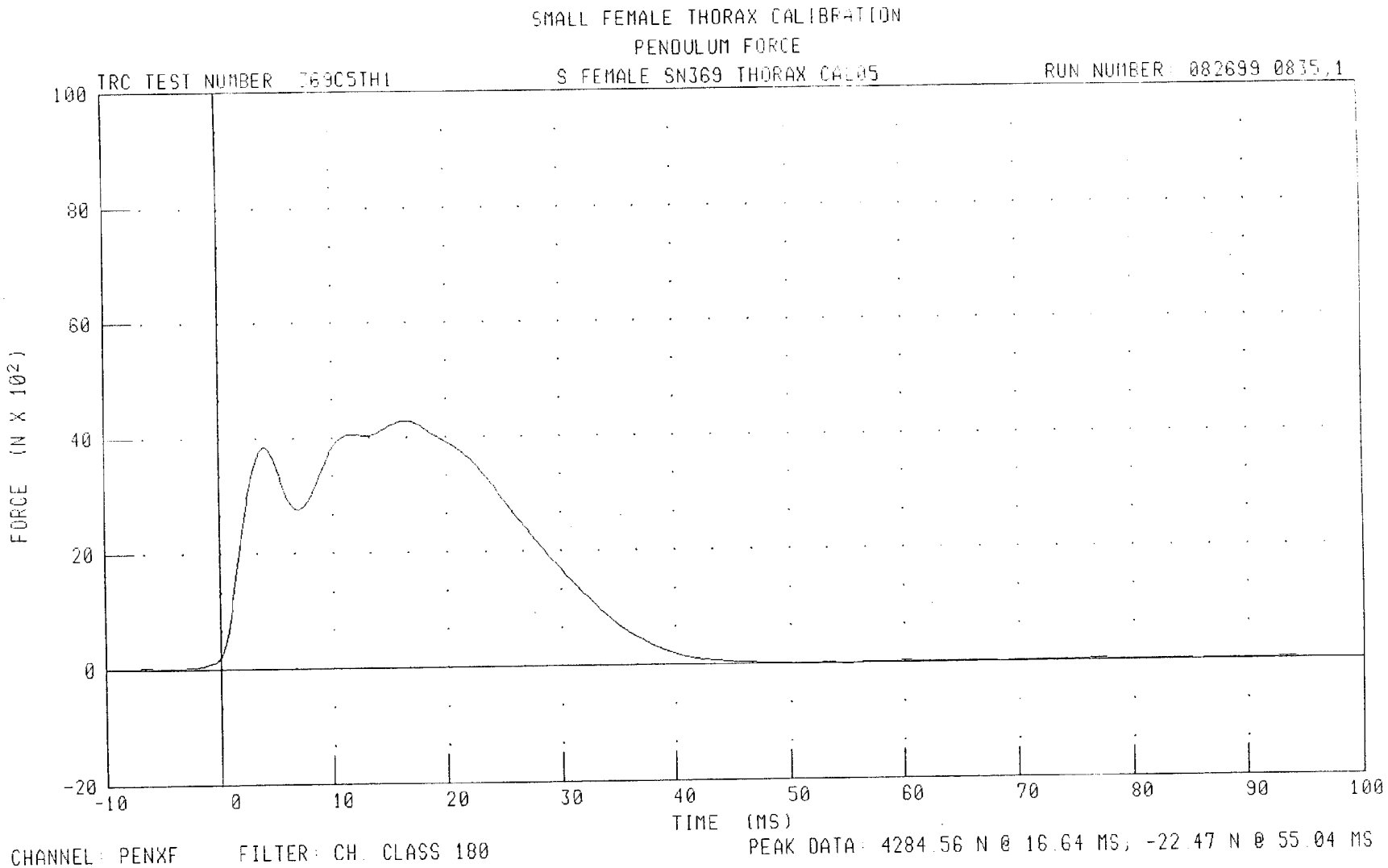
TRC INC. TEST NO: 369C5TH1 S.FEMALE SN369 THORAX CAL05

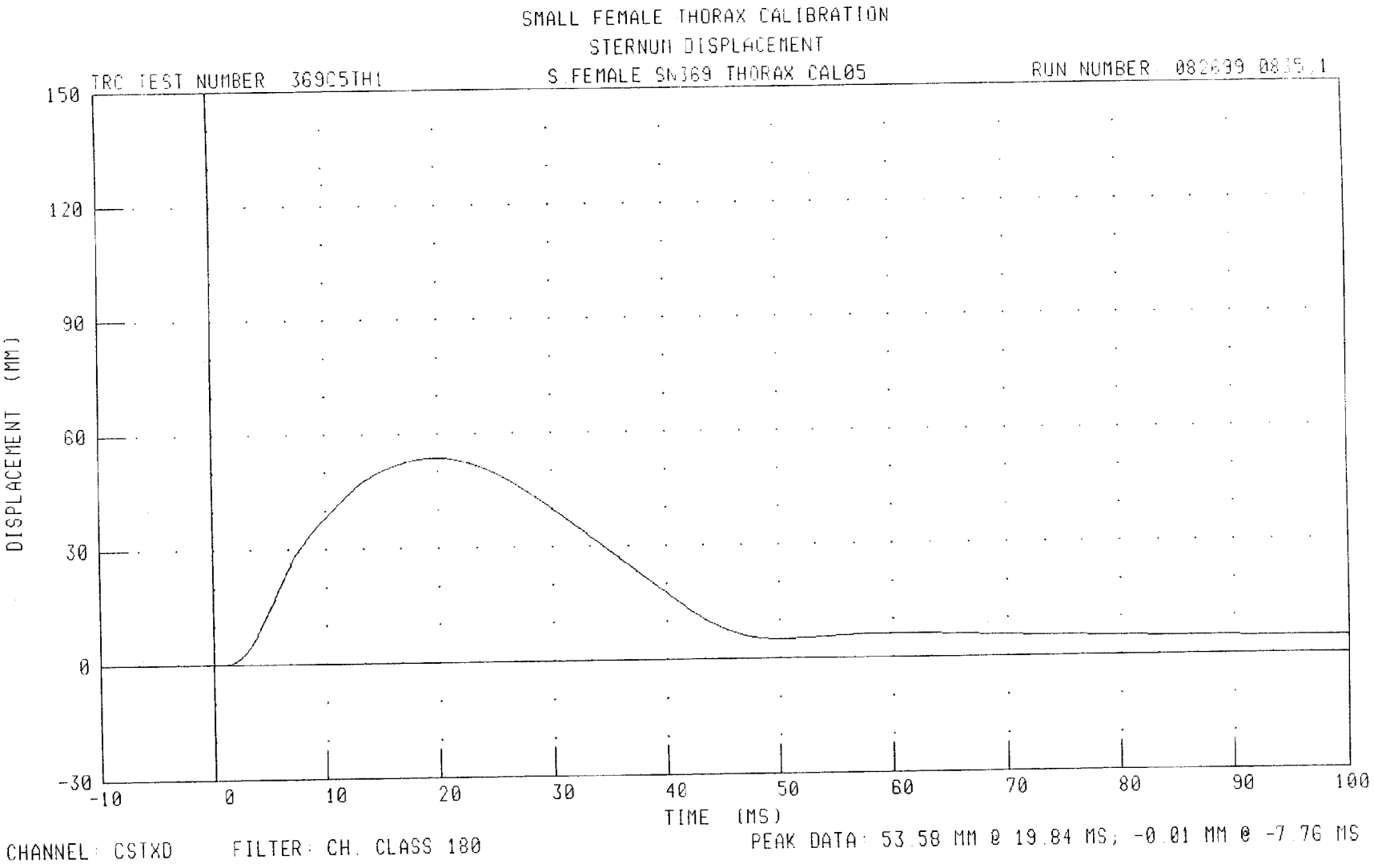
TEST PARAMETER	HIGH SPEED TEST SPECIFICATION	TEST RESULTS
TEMPERATURE	20.6-22.2 DEG. C	21.1 DEG. C
RELATIVE HUMIDITY	10 - 70 %	55.0 %
PENDULUM VELOCITY	6.59 - 6.83 M/S	6.68 M/S
MAXIMUM DEFLECTION	48 - 55 MM	53.5 MM
MAXIMUM RESISTIVE FORCE WITHIN DEFLECTON CORRIDOR	3900 - 4400	4284. N
INTERNAL HYSTERESIS	69% - 85%	71.2%

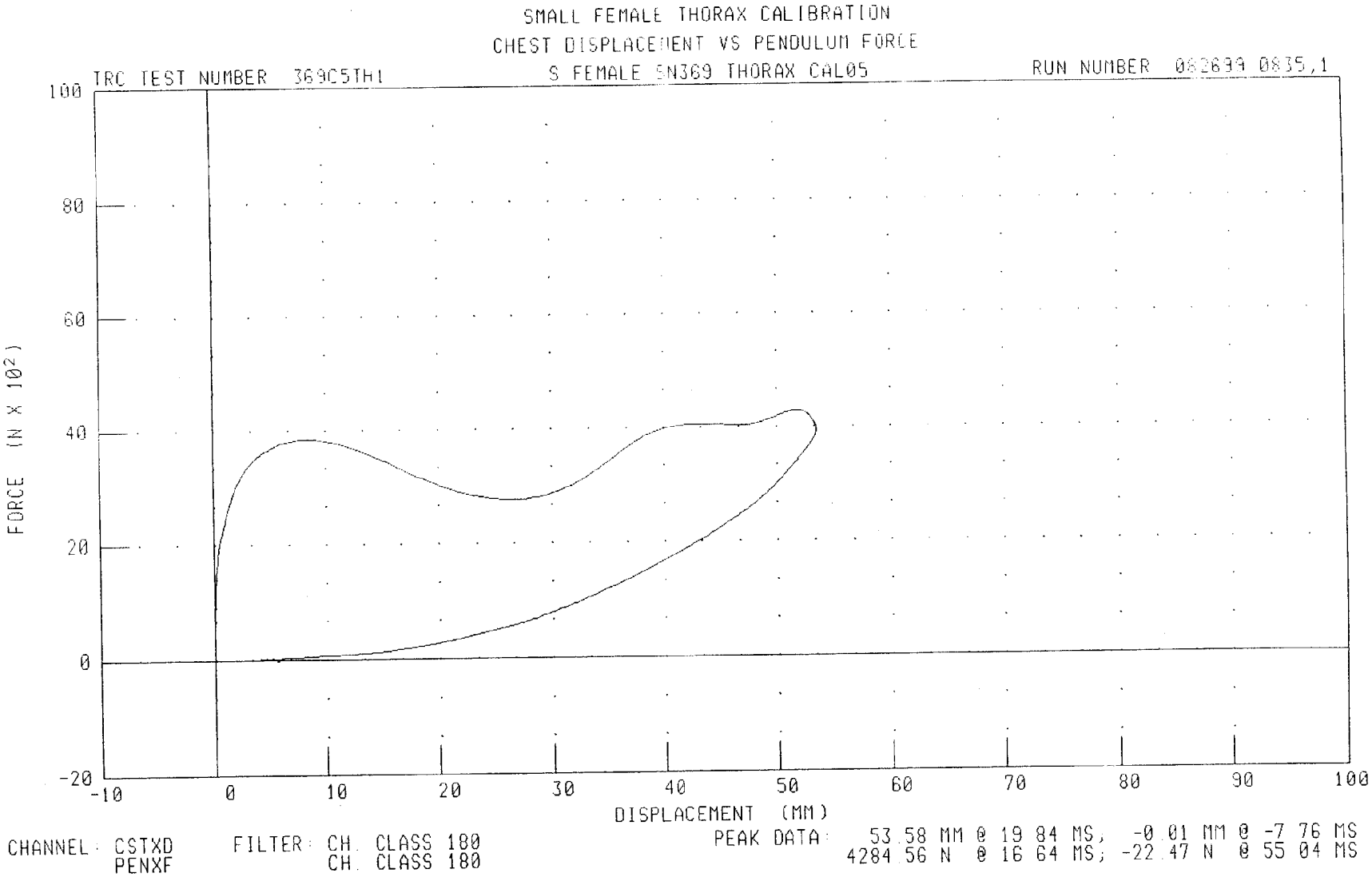
TEST MEETS SPECIFICATIONS

TECHNICIAN _____ RUN NUMBER: 082699.0827;1


SMALL FEMALE THORAX CALIBRATION
PENDULUM DECELERATION
TRC TEST NUMBER: 369C5TH1
S.FEMALE SN369 THORAX CAL05
RUN NUMBER: 082699.0835.1
ACCELERATION (G)
50
40
30
20
10
0
-10
-10
0
10
20
30
40
50
60
70
80
90
100
TIME (MS)
CHANNEL: PENXC
FILTER: CH. CLASS 180
PEAK DATA: 31.22 G @ 16.64 MS, -0.16 G @ 55.04 MS


SMALL FEMALE THORAX CALIBRATION
PENDULUM FORCE
TRC TEST NUMBER
S FEMALE SN369 THORAX CAL05
RUN NUMBER: 082699 0835.1
FORCE (N X 10²)
100
80
60
40
20
0
-20
-10
0
10
20
30
40
50
60
70
80
90
100
TIME (MS)
CHANNEL: PENXF
FILTER: CH. CLASS 180
PEAK DATA: 4284.56 N @ 16.64 MS, -22.47 N @ 55.04 MS


SMALL FEMALE THORAX CALIBRATION
STERNUM DISPLACEMENT
TRC TEST NUMBER 369C5TH1
S.FEMALE SN369 THORAX CAL05
RUN NUMBER 082699 0835.1
DISPLACEMENT (MM)
150
120
90
60
30
0
-30
-10
0
10
20
30
40
50
60
70
80
90
100
TIME (MS)
CHANNEL: CSTXD
FILTER: CH. CLASS 180
PEAK DATA: 53.58 MM @ 19.84 MS; -0.01 MM @ -7.76 MS


SMALL FEMALE THORAX CALIBRATION
CHEST DISPLACEMENT VS PENDULUM FORCE
TRC TEST NUMBER 369C5TH1
S FEMALE SN369 THORAX CAL05
RUN NUMBER 062699 0835,1
FORCE (N X 10²)
100
80
60
40
20
0
-20
-10
0
10
20
30
40
50
60
70
80
90
100
DISPLACEMENT (MM)
CHANNEL: CSTXD
PENXF
FILTER: CH. CLASS 180
CH. CLASS 180
PEAK DATA: 53.58 MM @ 19.84 MS, -0.01 MM @ -7.76 MS
4284.56 N @ 16.64 MS; -22.47 N @ 55.04 MS

TRANSPORTATION RESEARCH CENTER INC.

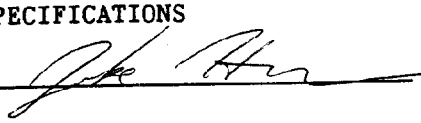
RIGHT KNEE IMPACT TEST

HYBRID III SMALL FEMALE 24-AUG-99

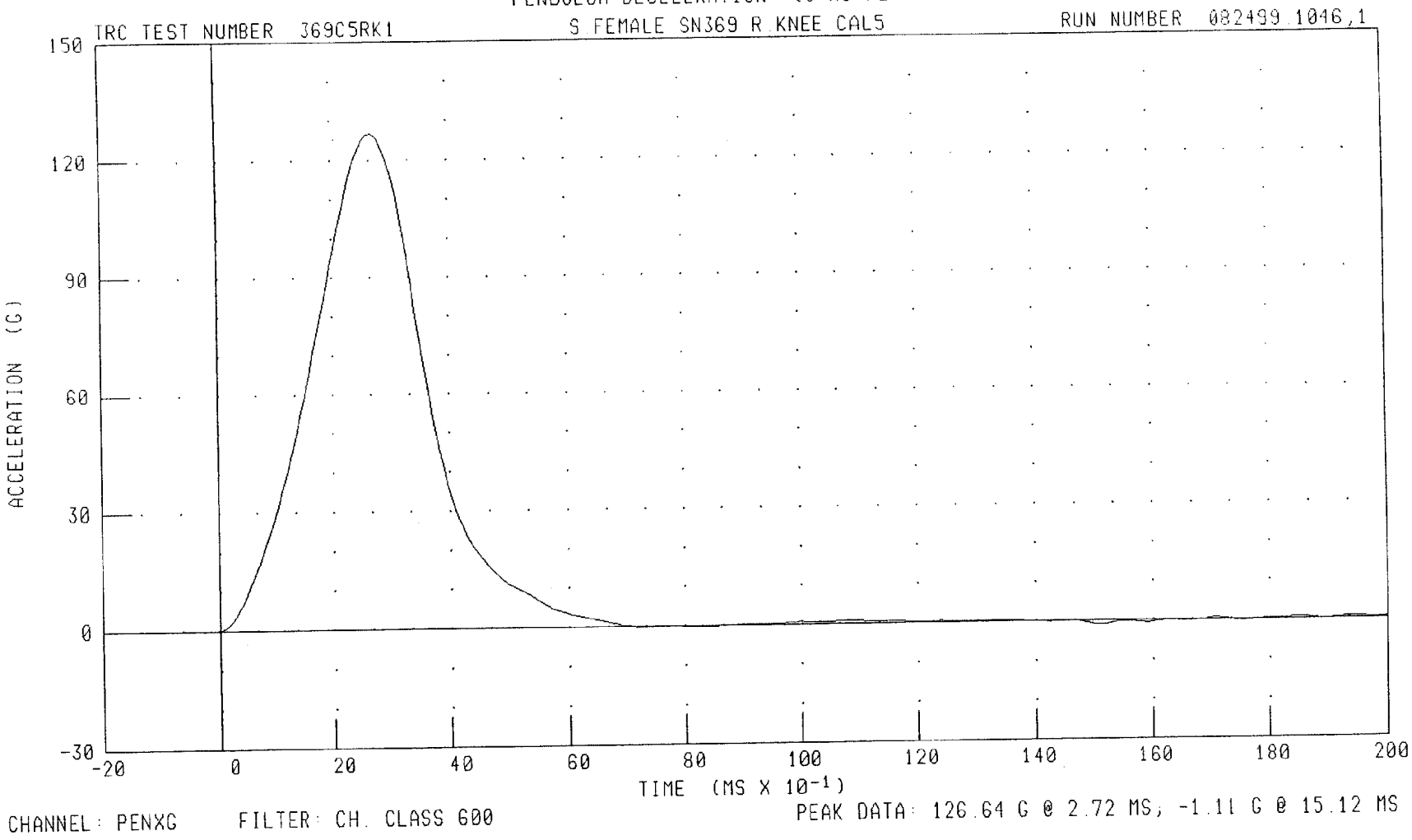
TRC INC. TEST NO: 369C5RK1 S.FEMALE SN369 R.KNEE CAL5

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	18.9-25.6 DEG. C	21.7 DEG. C
RELATIVE HUMIDITY	10 - 70 %	55.0 %
PROBE VELOCITY	2.07 - 2.13 M/S	2.08 M/S
PEAK KNEE IMPACT FORCE 3.0 KG PENDULUM	3360 - 4080 N	3717.6 N

TEST MEETS SPECIFICATIONS

TECHNICIAN  RUN NUMBER: 082499.1045;1

SMALL FEMALE HYBRID III RIGHT KNEE CALIBRATION
PENDULUM DECELERATION (5 KG PEND)

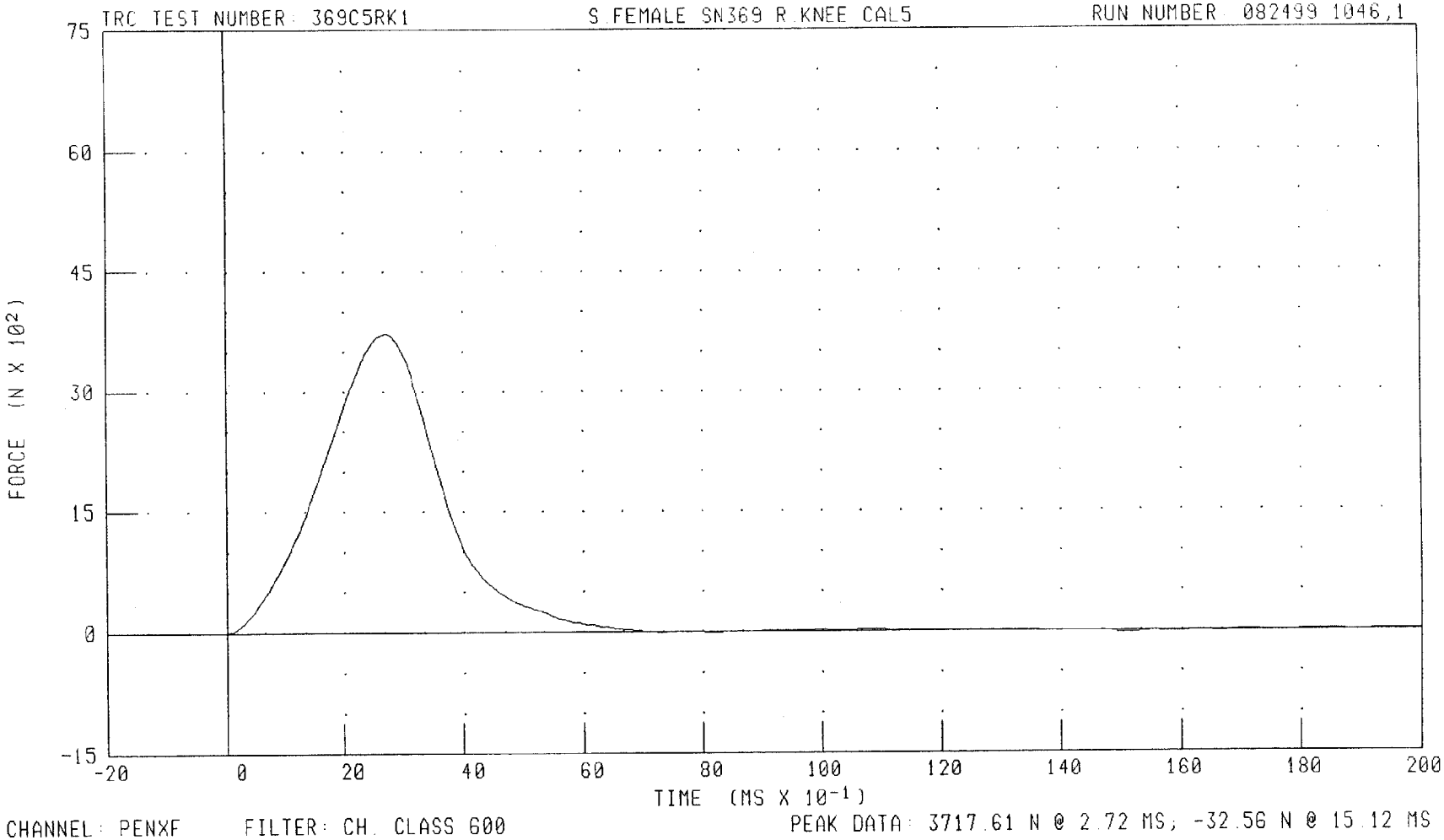


CHANNEL: PENXG FILTER: CH. CLASS 600

PEAK DATA: 126.64 G @ 2.72 MS, -1.11 G @ 15.12 MS

SMALL FEMALE HYBRID III RIGHT KNEE CALIBRATION

PENDULUM FORCE (5 KG PEND.)



CHANNEL: PENXF FILTER: CH. CLASS 600

PEAK DATA: 3717.61 N @ 2.72 MS; -32.56 N @ 15.12 MS

TRANSPORTATION RESEARCH CENTER INC.

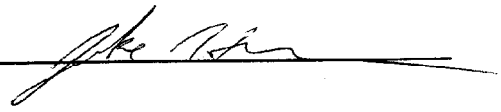
LEFT KNEE IMPACT TEST

HYBRID III SMALL FEMALE 24-AUG-99

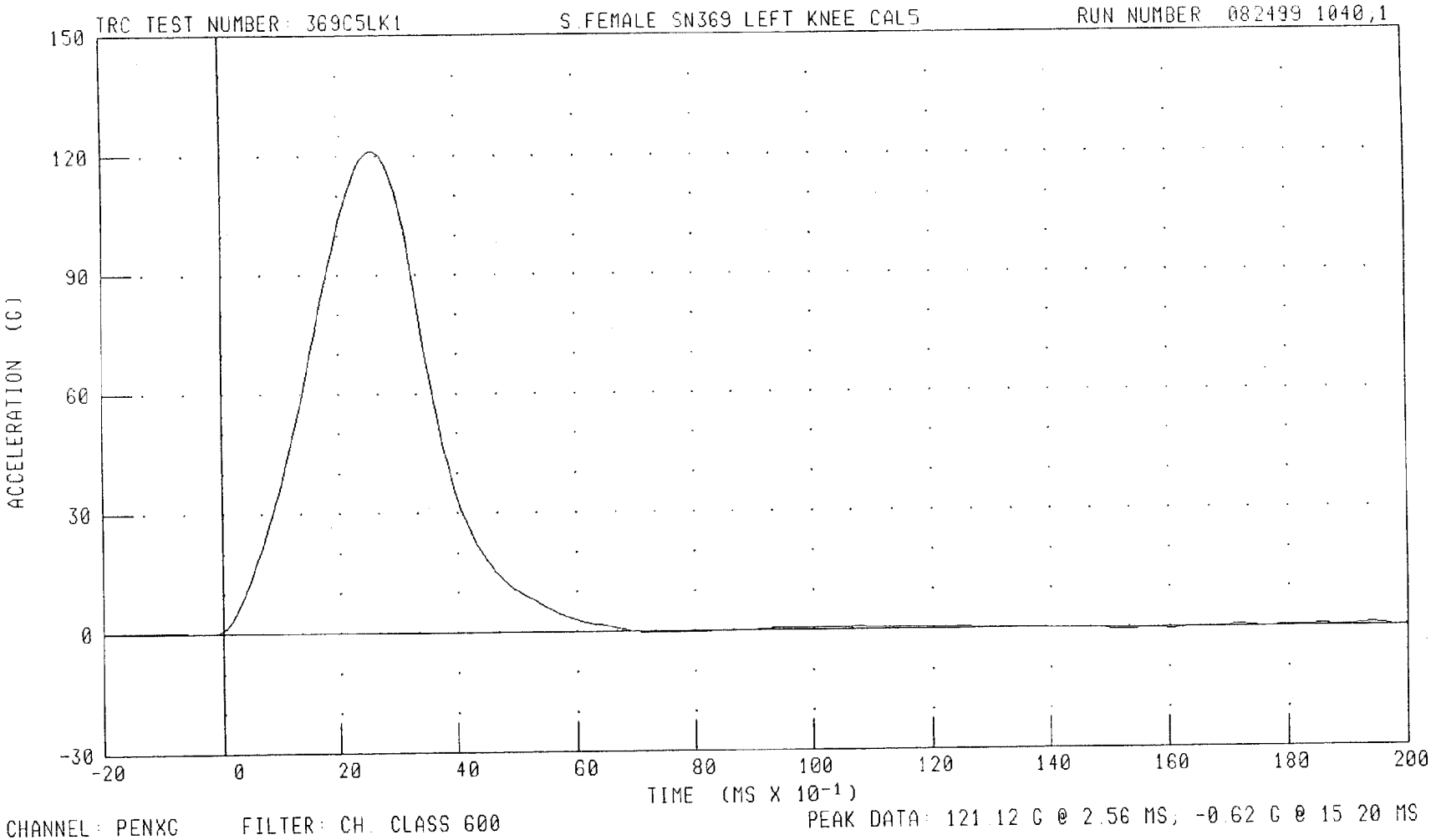
TRC INC. TEST NO: 369C5LK1 S.FEMALE SN369 LEFT KNEE CAL5

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	18.9-25.6 DEG. C	21.7 DEG. C
RELATIVE HUMIDITY	10 - 70 %	55.0 %
PROBE VELOCITY	2.07 - 2.13 M/S	2.08 M/S
PEAK KNEE IMPACT FORCE 3.0 KG PENDULUM	3360 - 4080 N	3555.6 N

TEST MEETS SPECIFICATIONS

TECHNICIAN  RUN NUMBER: 082499.1039;1

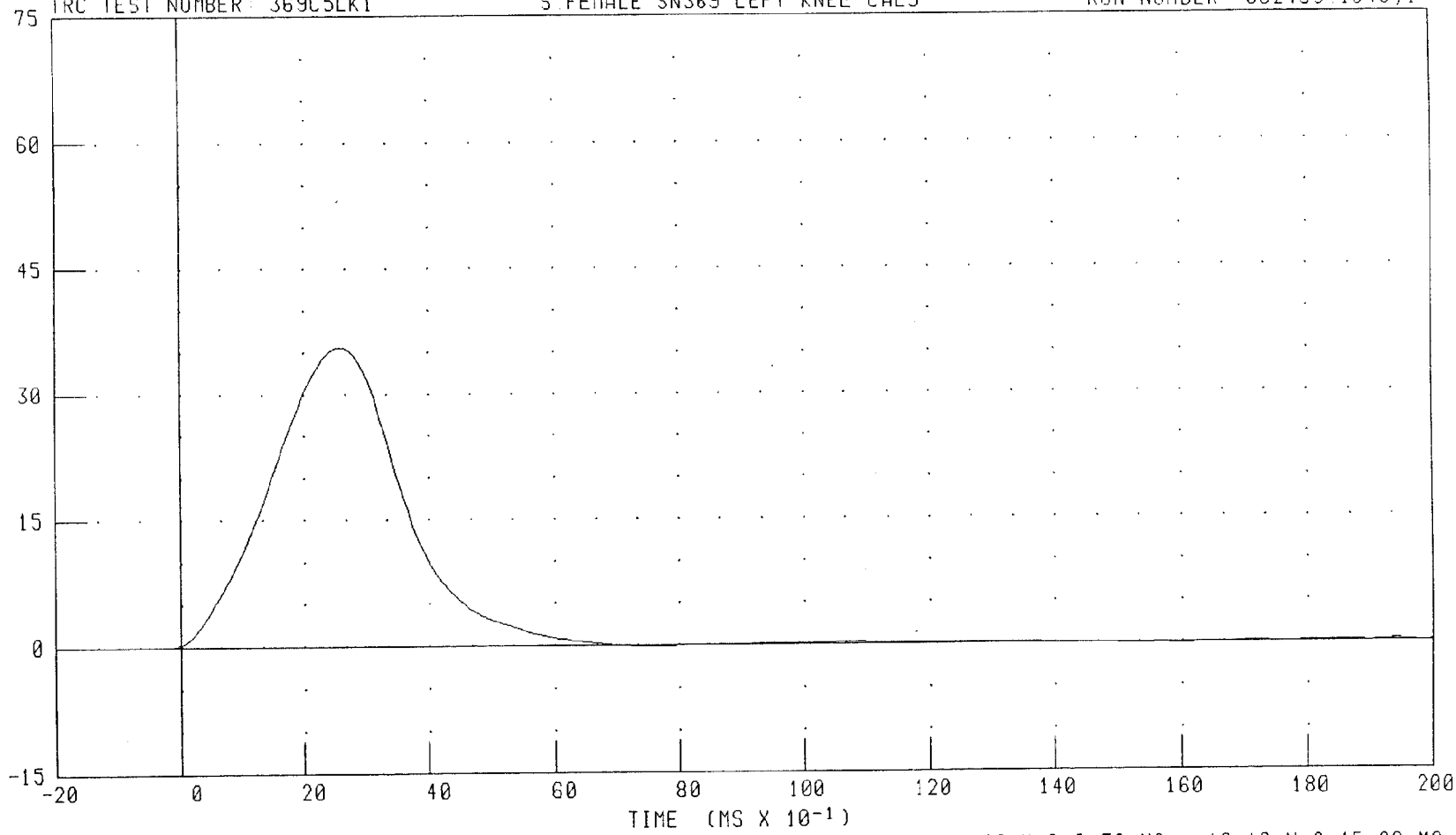
SMALL FEMALE HYBRID III LEFT KNEE CALIBRATION
PENDULUM DECELERATION (5 KG PEND)



SMALL FEMALE HYBRID III LEFT KNEE CALIBRATION

PENDULUM FORCE (5 KG PEND.)

TRC TEST NUMBER: 369C5LK1 S.FEMALE SN369 LEFT KNEE CAL5 RUN NUMBER: 082499.1040,1



CHANNEL: PENXF FILTER: CH. CLASS 600 PEAK DATA: 3555.68 N @ 2.56 MS; -18.16 N @ 15.20 MS

Appendix D

Miscellaneous Test Information

Dummy Sign Convention

Accelerometers:	+X: Forward	
	+Y: Rightward	
	+Z: Downward	
Potentiometers:	+Chest longitudinal deflection:	Outward
Load cells:	+Femur force:	Tension
Neck load cells:	+X force:	Head rearward
	+Y force:	Head leftward
	+Z force:	Head upward (tension on neck)
	+X moment:	Left ear rotating toward left shoulder
	+Y moment:	Chin rotating toward chest
	+Z moment:	Chin rotating toward left shoulder

Filtering Data

J211 MAR95

Load Cell Barrier Forces Class 60

Vehicle Structural Accelerations Class 60

Occupant

Head Accelerometer Class 1000

Neck Class 60

Chest Accelerometer Class 180

Chest Deflection Class 180

Femur Force Class 600

Sternum Accelerometer Class 180

Lower Leg Class 600

Accelerometer Information

Engineer: Rhule
Test Date: August 99
Dummy S/N: 289
Type: 5th female

Mnemonic Parameter Being Measured	Description	Model Number	Serial Number	Mfr.	Sensitivity Mv/g @100 Hz	Cal Due Date	Full-Scale Desired G	Direction Of Positive Polarity
CSTXG	Chest X	7264	J20599	Endevco	0.2054	10/07/99	200	FWD
CSTYG	Chest Y	7264	J20580	Endevco	0.2237	10/07/99	200	LEFT
CSTZG	Chest Z	7264	EH88J	Endevco	0.2833	10/07/99	200	UP
STTXG	Sternum top X	7264	J20569	Endevco	0.2179	10/07/99	2000	FWD
STMXG	Sternum middle X	7264	J20064	Endevco	0.2279	10/07/99	2000	FWD
STBXG	Sternum bottom X	7264	J20570	Endevco	0.2230	10/07/99	2000	FWD
SPTXG	Spine top X	7264	J19872	Endevco	0.2406	10/07/99	200	REAR
SPMXG	Spine middle X	7264	J19877	Endevco	0.2472	10/07/99	200	REAR
SPBXG	Spine bottom X	7264	J19890	Endevco	0.2267	10/07/99	200	REAR
HEDXG	Head X	7264	J20165	Endevco	0.2225	10/07/99	200	REAR
HEDYG	Head Y	7264	J19865	Endevco	0.2129	10/07/99	200	LEFT
HEDZG	Head Z	7264	J19934	Endevco	0.2452	10/07/99	200	UP
PEVXG	Pelvis X	7264	CY06H	Endevco	0.3020	10/07/99	200	REAR
PEVYG	Pelvis Y	7264	AGAC4	Endevco	0.2385	10/07/99	200	LEFT
PEVZG	Pelvis Z	7264	BF65J	Endevco	0.3357	10/07/99	200	UP
PEVYGA	Pelvis Y	7264	J20218	Endevco	0.2473	10/27/99	200	RIGHT

Accelerometer Information

Engineer: Rhule
Test Date: August-99
Dummy S/N: 289
Type: Hybrid III 5th percentile

Mnemonic Parameter Being Measured	Description	Model Number	Serial Number	Sensitivity (mV/V)	Cal Due Date	Full-Scale Desired G	Direction Of Positive Polarity
	Neck Load Cells						
NEKXF	Neck X-force	1716	425	1.6944 @ 2,000 lbs	10/07/99	2000	Head forward/chest rearward
NEKYF	Neck Y-force	1716	425	1.6421 @ 2,000 lbs	10/07/99	2000	Head left/chest right
NEKZF	Neck Z-force	1716	425	1.1515 @ 3,000 lbs	10/07/99	3000	Head up/chest down
NEKXM	Neck X-moment	1716	425	1.5817 @ 2500 in-lbs	10/07/99	2500	Right ear to right shoulder
NEKYM	Neck Y-moment	1716	425	1.6308 @ 2500 in-lbs	10/07/99	2500	Chin forward to sternum
NEKZM	Neck Z-moment	1716	425	2.2688 @ 2500 in-lbs	10/07/99	2500	Chin to left shoulder
	Femur Load Cells						
	Left femur						
LFMXF	Left femur X-force	1914	0259	1.9091 @ 3000 lbs	10/07/99	3000	Knee upward/upper femur down
LFMYF	Left femur Y-force	1914	0259	1.9105 @ 3000 lbs	10/07/99	3000	Knee left/upper femur right
LFMZF	Left femur Z-force	1914	0259	1.1840 @ 5000 lbs	10/07/99	5000	Knee forward/pelvis rearward
LFMXM	Left femur X-moment	1914	0259	1.4989 @ 3000 in-lbs	10/07/99	3000	Knee left, hold upper femur in place
LFMYM	Left femur Y-moment	1914	0259	1.5040 @ 3000 in-lbs	10/07/99	3000	Knee up, hold upper femur in place
LFMZM	Left femur Z-moment	1914	0259	2.6742 @ 3000 in-lbs	10/07/99	3000	Twist knee to right, hold up femur
	Right femur						
RFMXF	Right femur X-force	1914	0257	1.9130 @ 3000 lbs	10/07/99	3000	Knee upward/upper femur down
RFMYF	Right femur Y-force	1914	0257	1.9299 @ 3000 lbs	10/07/99	3000	Knee left/upper femur right
RFMZF	Right femur Z-force	1914	0257	1.1926 @ 5000 lbs	10/07/99	5000	Knee forward/pelvis rearward
RFMXM	Right femur X-moment	1914	0257	1.4705 @ 3000 in-lbs	10/07/99	3000	Knee left, hold upper femur in place
RFMYM	Right femur Y-moment	1914	0257	1.5124 @ 3000 in-lbs	10/07/99	3000	Knee up, hold upper femur in place
RFMZM	Right femur Z-moment	1914	0257	2.5006 @ 3000 in-lbs	10/07/99	3000	Twist knee to right, hold up femur

Accelerometer Information

Engineer: Rhule
Test Date: August-99
Dummy S/N: 289
Type: Hybrid III 5th percentile

Mnemonic Parameter Being Measured	Description	Model Number	Serial Number	Sensitivity	Cal Due Date	Full-Scale Desired G	Direction Of Positive Polarity
	Chest Pot						
CSTXD	Chest deflection		019/289	42.26 mV/V/inch	10/08/99	3 in	
	Knee slider						
KNLXD	Left knee slider deflection		019/289	39.07403 mV/V/mm	04/13/98	20 mm	
KNRXD	Right knee slider deflection		019/289	40.07792 mV/V/mm	04/13/98	20 mm	

TRANSDUCER INFORMATION

5th Female HYBRID III DUMMY SERIAL NO.: _289v____; MFR.: _____; SEATING POSITION: ____DR_____

PROJECT-SEGMENT NO.: ____096017 1521_____; ENGINEER: _____PG_____; TEST DATE: ____8-16-99_-1_____

MNEMONIC PARAMETER BEING MEASURED	TYPE OF TRANSDUCER	MODEL NO.	SERIAL NO.	MFR.	SENSITIVITY	CAL DATE	FULL SCALE (ENGR. UNITS) DESIRED	ACTUAL	DIRECTION OF POSITIVE POLARITY	CABLE NO.
KNLLF	LEFT KNEE LEFT SENSOR FORCE	1587	-LEFT	DEN	1.2872mv/v at 2000 lb.	1997	2,000 lbs. 9,000 N			-LEFT
KNLMF	LEFT KNEE RIGHT SENSOR FORCE	"	-RIGHT	"	1.2866 mv/v at 2000 lb.	"	2,000 lbs. 9,000 N			-RIGHT
KNRMF	RIGHT KNEE LEFT SENSOR FORCE	"	-LEFT	"	1.3049 mv/v at 2000 lb.	"	2,000 lbs. 9,000 N			-LEFT
KNRLF	RIGHT KNEE RIGHT SENSOR FORCE	"	-RIGHT	"	1.2844 mv/v at 2000 lb.	"	2,000 lbs. 9,000 N			-RIGHT
KNLXD	LEFT KNEE DISPLACEMENT	8TC1-2702	018L V	SERVO	981.2 mv/v/in	8-11-1999	1 inch 25 mm			018L
KNRXD	RIGHT KNEE DISPLACEMENT	"	018R V	"	1016 mv/v/in	"	1 inch 25 mm			018R
TBLXF	LEFT UPPER TIBIA X AXIS FORCE	3115	265-FX V	DEN	1.9815 mv/v at 2500 lb.	8-11-1999	2,500 lbs. 11,000 N			265-FX
TBLXM	LEFT UPPER TIBIA MOMENT ABOUT X AXIS	"	265-MX	"	2.9510 mv/v at 3500 in-lb.	"	300 ft·lbs 400 N·m			265-MX
TBLYM	LEFT UPPER TIBIA MOMENT ABOUT Y AXIS	"	265-MY	"	3.0172 mv/v at 3500 in-lb.	"	300 ft·lbs 400 N·m			265-MY

TRANSDUCER INFORMATION

5th Female HYBRID III DUMMY SERIAL NO.: _289v____; MFR.: _____; SEATING POSITION: ____DR_____

PROJECT-SEGMENT NO.: ____096017 1521_____; ENGINEER: _____PG_____; TEST DATE: ____8-16-99_-1_____

MNEMONIC PARAMETER BEING MEASURED	TYPE OF TRANSDUCER	MODEL NO.	SERIAL NO.	MFR.	SENSITIVITY	CAL DATE	FULL SCALE (ENGR. UNITS) DESIRED	ACTUAL	DIRECTION OF POSITIVE POLARITY	CABLE NO.
TBLZF	LEFT UPPER TIBIA Z AXIS FORCE	3115	265-FZ	DEN	1.1181 mv/v at 2500 lb.	8-11-1999	2,500 lbs. 11,000 N			265-FZ
TBRXF	RIGHT UPPER TIBIA X AXIS FORCE	"	266-FX V	"	1.9341 mv/v at 2500 lb.	"	2,500 lbs. 11,000 N			266-FX
TBRXM	RIGHT UPPER TIBIA MOMENT ABOUT X AXIS	"	266-MX	"	2.9020 mv/v at 3500 in-lb.	"	300 ft·lbs 400 N·m			266-MX
TBRYM	RIGHT UPPER TIBIA MOMENT ABOUT Y AXIS	"	266-MY	"	2.9367 mv/v at 3500 in-lb.	"	300 ft·lbs 400 N·m			266-MY
TBRZF	RIGHT UPPER TIBIA Z AXIS FORCE	"	266-FZ	"	1.0885 mv/v at 2500 lb.	"	2,500 lbs. 11,000 N			266-FZ
ANLXF	LEFT LOWER TIBIA X-AXIS FORCE	3287	178-FX V	"	1.9204 mv/v at 2500 lb.	"	2,500 lbs. 11,000 N			178-FX
ANLZF	LEFT LOWER TIBIA Z-AXIS FORCE	"	178-FZ	"	1.0526 mv/v at 2500 lb.	"	2,500 lbs. 11,000 N			178-FZ
ANLXM	LEFT LOWER TIBIA MOMENT ABOUT X AXIS	"	178-MX	"	2.9612 mv/v at 3500 in-lb.	"	300 ft·lbs 400 N·m			178-MX
ANLYM	LEFT LOWER TIBIA MOMENT ABOUT Y AXIS	"	178-MY	"	2.9779 mv/v at 3500 in - lb.	"	300 ft·lbs 400 N·m			178-MY

TRANSDUCER INFORMATION

5th Female HYBRID III DUMMY SERIAL NO.: _289v___; MFR.: _____; SEATING POSITION: ____DR_____

PROJECT-SEGMENT NO.: ____096017 1521_____; ENGINEER: _____PG_____; TEST DATE: ____8-16-99_-1_____

MNEMONIC PARAMETER BEING MEASURED	TYPE OF TRANSDUCER	MODEL NO.	SERIAL NO.	MFR.	SENSITIVITY	CAL DATE	FULL SCALE (ENGR. UNITS) DESIRED	ACTUAL	DIRECTION OF POSITIVE POLARITY	CABLE NO.
ANRXF	RIGHT LOWER TIBIA X-AXIS FORCE	3287	179-FX V	"	1.9645 mv/v at 2500 lb.	8-11-1999	2,500 lbs. 11,000 N			179-FX
ANRZF	RIGHT LOWER TIBIA Z-AXIS FORCE	"	179-FZ	"	1.0327 mv/v at 2500 lb.	"	2,500 lbs. 11,000 N			179-FZ
ANRXM	RIGHT LOWER TIBIA MOMENT ABOUT X AXIS	"	179-MX	"	2.9819 mv/v at 3500 in-lb.	"	300 ft·lbs 400 N·m			179-MX
ANRYM	RIGHT LOWER TIBIA MOMENT ABOUT Y AXIS	"	179-MY	"	3.0247 mv/v at 3500 in - lb.	"	300 ft·lbs 400 N·m			179-MY

TRANSDUCER INFORMATION

5th Female HYBRID III DUMMY SERIAL NO.: _369t____; MFR.: _____; SEATING POSITION: ____PASS_____

PROJECT-SEGMENT NO.: ____096017 1521_____; ENGINEER: _____PG_____; TEST DATE: ____8-16-99_-1_____

MNEMONIC PARAMETER BEING MEASURED	TYPE OF TRANSDUCER	MODEL NO.	SERIAL NO.	MFR.	SENSITIVITY	CAL DUE DATE	FULL SCALE (ENGR. UNITS) DESIRED	ACTUAL	DIRECTION OF POSITIVE POLARITY	CABLE NO.
HEDXG HAP	HEAD X-AXIS ACCEL.	7264	A20FJ	End.	.2563 mv/g at 10 volts	12-2-1999	400 g		Rear	A20FJ
HEDYG HLR	HEAD Y-AXIS ACCEL.	"	A31FJ	"	.2683 mv/g at 10 volts	"	400 g		Left	A31FJ
HEDZG HIS	HEAD Z-AXIS ACCEL.	"	CL95H	"	.2822 mv/g at 10 volts	"	400 g		Up	CL95H
NEKXF NFX	NECK X-AXIS SHEAR FORCE	1716A	0534	DEN	1.7247 mv/v at 2000 lbs.	12-2-1999	2,000 lbs. 9,000 N			FX
NEKYF NFY	NECK Y-AXIS SHEAR FORCE	"	"	"	1.6643 mv/v at 2000 lbs.	"	2,000 lbs. 9,000 N			FY
NEKZF NFZ	NECK Z-AXIS AXIAL FORCE	"	"	"	1.1561 mv/v at 3000 lbs.	"	3,000 lbs. 13,500 N			FZ
NEKXM NMX	NECK MOMENT ABOUT X AXIS	"	"	"	1.6355 mv/v at 2500 in. lbs.	"	200 ft·lbs 275 N·m			MX
NEKYM NMY	NECK MOMENT ABOUT Y AXIS	"	"	"	1.6430 mv/v at 2500 in. lbs.	"	200 ft·lbs 275 N·m			MY
NEKZM NMZ	NECK MOMENT ABOUT Z AXIS	"	"	"	2.3186 mv/v at 2500 in. lbs.	"	200 ft·lbs 275 N·m			MZ

TRANSDUCER INFORMATION

5th Female HYBRID III DUMMY SERIAL NO.: _369t___; MFR.: _____; SEATING POSITION: ____PASS_____

PROJECT-SEGMENT NO.: ____096017 1521_____; ENGINEER: _____PG_____; TEST DATE: ____8-16-99_-1_____

MNEMONIC PARAMETER BEING MEASURED	TYPE OF TRANSDUCER	MODEL NO.	SERIAL NO.	MFR.	SENSITIVITY	CAL DUE DATE	FULL SCALE (ENGR. UNITS) DESIRED	ACTUAL	DIRECTION OF POSITIVE POLARITY	CABLE NO.
CSTXG CAP	CHEST X-AXIS ACCEL.	7264	A72JJ	End.	.2773 mv/g at 10 volts	12-2-1999	400 g		Forward	A72JJ
CSTYG CLR	CHEST Y-AXIS ACCEL.	"	A69JJ	"	.2702 mv/g at 10 volts	"	400 g		Left	A69JJ
CSTZG CIS	CHEST Z-AXIS ACCEL.	"	A34FJ	"	.2565 mv/g at 10 volts	"	400 g		Up	A34FJ
CSTXD CAPD	CHEST DEFLECTION	14CB1-2897	1188	Bourn	43.6 mv/v/in	"	6 inch 150 mm		Extension	1188
PEVXG PAP	PELVIS X-AXIS ACCEL.	7264	CY31H	End.	.2031 mv/g at 10 volts	"	400 g		Rear	C14981
PEVYG PLR	PELVIS Y-AXIS ACCEL.	"	A51JJ	"	.2917 mv/g at 10 volts	"	400 g		Left	C15183
PEVZG PIS	PELVIS Z-AXIS ACCEL.	"	A75JJ	"	.2695 mv/g at 10 volts	"	400 g		Up	C15184
LFMF LF	LEFT FEMUR FORCE	2430	1006	DEN	0.9459 mv/v at 3000 lbs.	12-2-1999	1300 Kg 3,000 lbs. 13,500 N		Extension	1518
RFMF RF	RIGHT FEMUR FORCE	"	1007	"	0.9114 mv/v at 3000 lbs.	"	1300 Kg 3,000 lbs. 13,500 N		Extension	71

TRANSDUCER INFORMATION

5th Female HYBRID III DUMMY SERIAL NO.: _369t____; MFR.: _____; SEATING POSITION: ____PASS_____

PROJECT-SEGMENT NO.: ____096017 1521_____; ENGINEER: _____PG_____; TEST DATE: ____8-16-99_-1_____

MNEMONIC PARAMETER BEING MEASURED	TYPE OF TRANSDUCER	MODEL NO.	SERIAL NO.	MFR.	SENSITIVITY	CAL DUE DATE	FULL SCALE (ENGR. UNITS) DESIRED	ACTUAL	DIRECTION OF POSITIVE POLARITY	CABLE NO.
STMXG	STERNUM MID X - AXIS ACCEL.	7264	AGRH9	End.	.2481 mv/g at 10 volts	12-2-1999	800gs		Fwd	AGRH9
SPMXG	SPINE MID X - AXIS ACCEL.	"	AGRG5	"	.2241 mv/g at 10 volts	"	400gs		Rwd	AGRG5

Vehicle Instrumentation Placement

Vehicle year/make/model/body style: 1999/Saturn/SL1/4-door

Test number: 990816-1

Number	Location	Axis	Manufacturer	Model	S/N	Orientation (+ Sensing)
1	Left Brake Caliper	X	Endevco	7264-2000T	J28377	Rearward
2	Right Brake Caliper	X	Endevco	7264-2000T	J27729	Rearward
3	Instrument Panel	X	Endevco	7264-2000T	J22660	Forward
	Center	Y	Endevco	7264-2000T	J26861	Right
4	Engine Top	X	Endevco	7264-2000T	J26513	Forward
5	Engine Bottom	X	Endevco	7264-2000T	J27157	Rearward
6	Vehicle Rear Center	X	Endevco	7264-2000T	J28159	Forward
		Y	Endevco	7264-2000T	J27189	Right
7	Left Rear Seat	X	Endevco	7264-2000T	J29367	Rearward
	Crossmember	Y	Endevco	7264-2000T	J29581	Left
8	Right Rear Seat	X	Endevco	7264-2000T	J29421	Forward
	Crossmember	Y	Endevco	7264-2000T	J27471	Right
9	Driver Airbag	N/A	Fluke	Y8101A	IP1	N/A
10	Passenger Airbag	N/A	Fluke	Y8101A	IP2	N/A

Description Of Timing Marks On TRC High-Speed Film

All TRC high-speed cameras are equipped with red LEDs which put timing marks on the right edge of the film. TRC uses a single timing generator to generate the timing for all cameras. This allows the timing marks to be common to all cameras. The timing marks can be used to measure camera speed (frames per second) or to locate a point in time before or after the time-zero event.

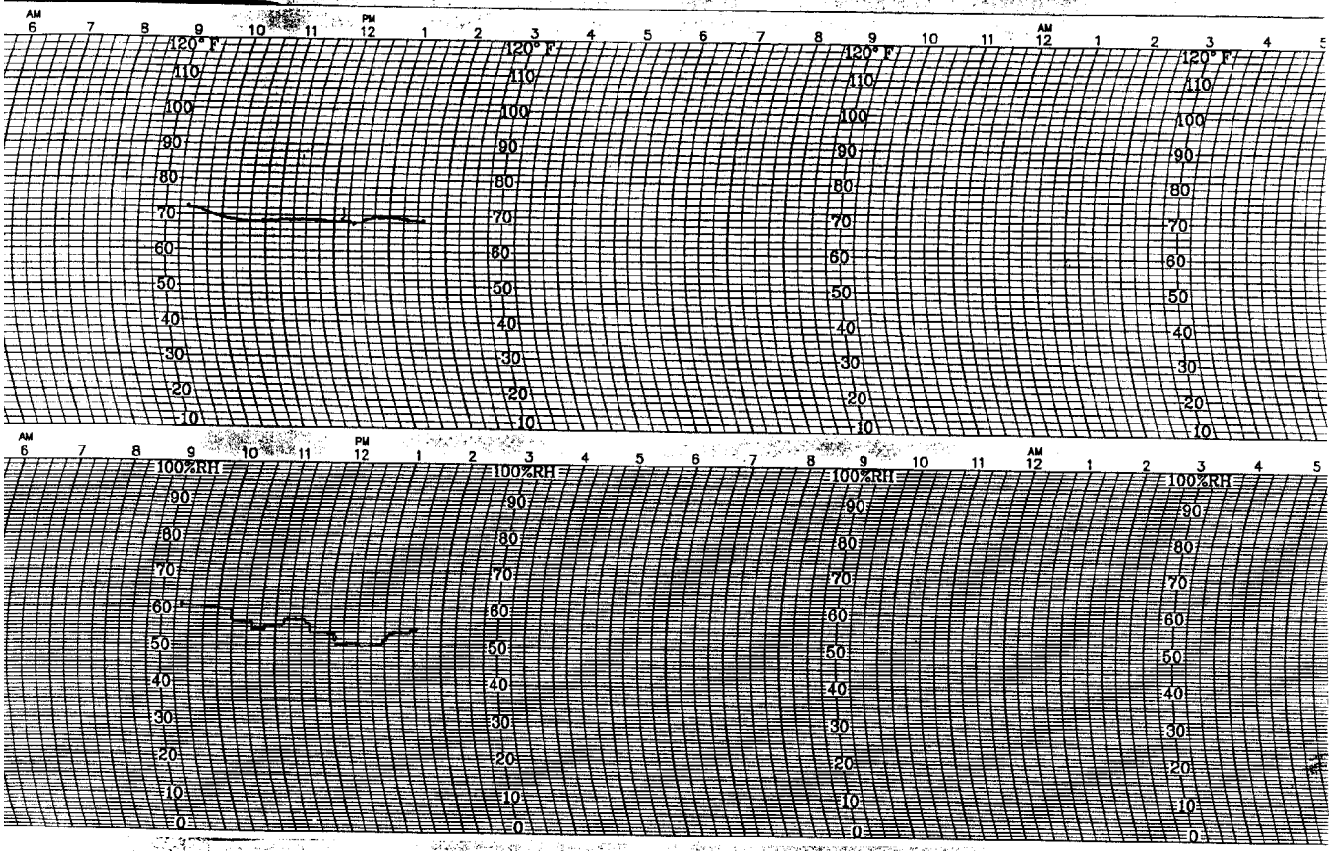
The timing marks appear on the film as small red marks on the right edge of the film. Round marks are left by the Photo-Sonics and Stalex cameras while horizontal bars are left by the Hycam, Locam, and Fastax II cameras.

The timing generator puts out a pulse for every millisecond plus it generates additional pulses for hundredths and tenths of seconds. To explain this further, we can use an example of a camera running at 1000 frames per second.

1. Every frame will have **one** LED appear in it. This indicates a *millisecond* pulse.

2. Every ten frames will have **two** LEDs appear in it. These indicate a *millisecond* pulse plus a *hundredth of a second* pulse.

3. Every one hundred frames will have **three** LEDs appear in it. These indicate a *millisecond* pulse, a *hundredth of a second* pulse, and a *tenth of a second* pulse.


AM
6 7 8 9 10 11
PM
12 1 2 3 4 5 6 7 8 9 10 11
AM
12 1 2 3 4 5
120° F
110
100
90
80
70
60
50
40
30
20
10
100%RH
90
80
70
60
50
40
30
20
10
0