

V2905

**1998 Ford Taurus
into a Load Cell Barrier
Test No. 980421-1**

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Table of Contents

<u>Section</u>	<u>Description</u>	<u>Page</u>
1.0	Purpose and Test Procedure	1-1
2.0	Frontal Barrier Impact Test Summary	2-1
3.0	FMVSS 208 Data	3-1
4.0	Vehicle, Occupant, and Camera Measurements	4-1
Appendix A	Photographs	A-1
Appendix B	Data Plots	B-1
Appendix C	Dummy Certification	C-1
Appendix D	Miscellaneous Test Information	D-1

List of Tables

<u>Number</u>	<u>Description</u>	<u>Page</u>
1	Crash Test Summary	2-5
2	Test Vehicle Information	2-7
3	Post-Impact Data	2-10
4	Vehicle Accelerometer Locations and Data Summary	2-14
5	Load Cell Barrier Data Summary	2-17
6	Dummy Injury Criteria	3-2
7	Impacted Vehicle Measurements	4-3
8	Dummy Measurement Data for Front Seat Occupants	4-6
9	Motion Picture Camera Locations	4-9

List of Figures

<u>Number</u>	<u>Description</u>	<u>Page</u>
1	Impact Velocity Measurement System	2-11
2	Vehicle Crush	2-12
3	Vehicle Accelerometer Placement	2-13
4	Load Cell Barrier Configuration	2-16
5	Pre-test and Post-test Measurement Points	4-2
6	Vehicle Target Locations	4-4
7	Dummy Measurement Locations for Front Seat Occupants	4-5
8	Camera Positions	4-7

List of Photographs

<u>Description</u>	<u>Figure</u>
Pre-Test Front View	A-1
Post-Test Front View	A-2
Pre-Test Left Side View	A-3
Post-Test Left Side View	A-4
Pre-Test Left Rear Three-Quarter View	A-5
Post-Test Left Rear Three-Quarter View	A-6
Pre-Test Rear View	A-7
Post-Test Rear View	A-8
Pre-Test Right Side View	A-9
Post-Test Right Side View	A-10
Pre-Test Right Front Three-Quarter View	A-11
Post-Test Right Front Three-Quarter View	A-12
Pre-Test Front Underbody View	A-13
Post-Test Front Underbody View	A-14
Pre-Test Rear Underbody View	A-15
Post-Test Rear Underbody View	A-16
Pre-Test Engine Compartment View	A-17
Post-Test Engine Compartment View	A-18
Pre-Test Windshield View	A-19
Post-Test Windshield - View 1	A-20
Post-Test Windshield - View 2	A-21
Pre-Test Fuel Filler Cap View	A-22
Post-Test Fuel Filler Cap View	A-23
Pre-Test Fuel Filler Neck View	A-24
Post-Test Fuel Filler Neck View	A-25
Pre-Test Fuel Tank View	A-26
Post-Test Fuel Tank View	A-27
Pre-Test Driver Dummy Position - View 1	A-28
Post-Test Driver Dummy Position - View 1	A-29

List of Photographs, Cont'd.

<u>Description</u>	<u>Figure</u>
Pre-Test Driver Dummy Position -View 2	A-30
Post-Test Driver Dummy Position - View 2	A-31
Pre-Test Driver Dummy Position -View 3	A-32
Post-Test Driver Dummy Position - View 3	A-33
Pre-Test Passenger Dummy Position - View 1	A-34
Post-Test Passenger Dummy Position - View 1	A-35
Pre-Test Passenger Dummy Position - View 2	A-36
Post-Test Passenger Dummy Position - View 2	A-37
Pre-Test Passenger Dummy Position - View 3	A-38
Post-Test Passenger Dummy Position - View 3	A-39
Pre-Test Driver Dummy Through Windshield View	A-40
Post-Test Driver Dummy Overall View	A-41
Post-Test Driver Dummy Head Contact - View 1	A-42
Post-Test Driver Dummy Head Contact - View 2	A-43
Post-Test Driver Dummy Head Contact - View 3	A-44
Post-Test Driver Dummy Knee Contact - View 1	A-45
Post-Test Driver Dummy Knee Contact - View 2	A-46
Pre-Test Passenger Dummy Through Windshield View	A-47
Post-Test Passenger Dummy Overall View	A-48
Post-Test Passenger Dummy Head Contact - View 1	A-49
Post-Test Passenger Dummy Head Contact - View 2	A-50
Post-Test Passenger Dummy Head Contact - View 3	A-51
Post-Test Passenger Dummy Knee Contact - View 1	A-52
Post-Test Passenger Dummy Knee Contact - View 2	A-53
Pre-Test Vehicle Certification Label View	A-54

Section 1.0

Purpose and Test Procedure

Purpose and Test Summary

This 30 mph flat frontal barrier impact test had the objective of investigating the performance of small female unbelted occupants in a full frontal 30 mph barrier test.

This test was conducted with a 1998 Ford Taurus that impacted a flat frontal load cell barrier. The test vehicle contained two instrumented Hybrid III 5th percentile adult female dummies.

Section 2.0

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 thirteen (13) accelerometers to measure longitudinal, lateral, and vertical axis accelerations. The vehicle was also instrumented with two (2) event circuits to measure squib current fire times in the airbag system. The vehicle's specified impact velocity range was 46.5 to 48.1 kph. The vehicle impacted a flat frontal load cell barrier instrumented with thirty-six (36) load cells.

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 February 2, 1998, draft SAE Hybrid III Small Female Dummy Positioning Procedure. The dummies were restrained by the airbag system.

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; upper neck load cells to measure forces and moments; and spine and sternum accelerometers to measure longitudinal accelerations. The driver dummy was also instrumented with pelvic accelerometers to measure longitudinal, lateral, and vertical accelerations.

The ninety-six (96) 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 sixteen (16) 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 dummy and vehicle data plots. Appendix C contains the dummy calibration information.

Test Results Summary

This frontal load cell barrier test was conducted at TRC on April 21, 1998.

The test vehicle, a 1998 Ford Taurus, was equipped with airbags at the driver's and right front passenger's seating positions. The vehicle's test weight was 1666.1 kilograms. The vehicle's impact speed was 47.2 kph. The vehicle's maximum static crush was 310 millimeters.

The driver's 36 millisecond HIC was 309. The driver's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 48.2 g. The driver's chest deflection was 35 millimeters. The driver's left and right femur maximum compressive forces were 3916 N and 4490 N, respectively.

The right front passenger's 36 millisecond HIC was 282. The right front passenger's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 39.6 g. The passenger's chest deflection measurement of 6 millimeters was questionable (See Data Acquisition Explanations). The right front passenger's left and right femur maximum compressive forces were 4969 N and 5878 N, respectively.

Data Acquisition Explanations

The driver dummy's neck X-axis moment load cell, NEKXM1, exceeded its data channel's full scale input at approximately 210 milliseconds and recorded questionable data after that.

The vehicle's left radiator X-axis acceleration data channel, RADXG1, exceeded its data channel's full scale input at approximately 120 milliseconds and recorded questionable data after that.

The vehicle's right radiator X-axis acceleration data channel, RADXG2, exceeded its data channel's full scale input at approximately 150 milliseconds and recorded questionable data after that.

The passenger dummy's chest deflection channel, CSTXD2, recorded questionable data. The data polarity is inconsistent with this transducer's expected negative output during chest compression.

Table 1 Crash Test Summary

Test type:	Load cell barrier impact
Test date:	04/21/98
Test time:	1458
Ambient temperature at impact area:	22° C
Vehicle year/make/ model/body style:	1998/Ford/Taurus/4-door LX
Vehicle test weight:	1666.1 kg
Impact angle ¹ :	0°
Impact velocity ² :	
Primary:	47.2 kph
Secondary:	47.2 kph
Maximum static crush:	310 mm
Average rebound:	1170 mm
Number of cameras:	
Real-time:	1
High-speed:	16
Door opening data:	
Left-front:	Slightly difficult
Right-front:	Slightly difficult

¹ With respect to tow track centerline.

² Speed trap measurement ($\pm .05$ mph accuracy)

Table 1 Crash Test Summary, Cont'd.

Dummies:	<u>Driver #289</u>	<u>Passenger #288</u>
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:	24	21
Front seat data:		
Seat track failure:	None	None
Seat back failure:	None	None
Visible dummy contact points:		
Head:	Airbag/headrest	Airbag/headrest
Chest:	Airbag	Airbag
Abdomen:	Lower steering wheel	None
Left knee:	Instrument panel	Instrument panel
Right knee:	Instrument panel	Instrument panel

Table 2 Test Vehicle Information

Vehicle year/make/ model/body style:	1998/Ford/Taurus/4-door LX		
Color:	White		
VIN:	1FAFP52U1WG145718		
Build date:	12/97		
Engine data:			
Placement:	Transverse/lateral		
Cylinders:	6		
Displacement:	3.0 liters		
Transmission data:	<u>3</u> speed,	<u> </u> manual,	<u> X </u> automatic, <u> X </u> overdrive
Final drive:	<u> X </u> fwd,	<u> </u> rwd,	<u> </u> 4wd
Date vehicle received:	04/16/98		
Odometer reading:	6		
Dealer's name and address:	N/A		

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Yes	Automatic speed control	No
Power seats	No	Tilting steering wheel	Yes
Power windows	Yes	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:	Ford Motor Company
Date of manufacture:	12/97
VIN:	1FAFP52U1WG145718
GVWR:	4687 lb
GAWR: Front:	2647 lb
Rear:	2065 lb

Table 2 Test Vehicle Information, Cont'd.

Size of tires on vehicle:	P205/65R15
Spare tire:	Space Saver
Type of front seats:	Bucket

Tire & capacity data from vehicle's label:

Recommended tire size:	P205/65R15
Recommended cold tire pressure:	
Front:	33 psi
Rear:	33 psi
Designated Seating Capacity:	
Front	3
Rear	3
Total	6
Vehicle Capacity Weight:	1100 lbs.

Test vehicle attitudes:

Delivered attitude:	LF: 718 mm	RF: 725 mm	LR: 692 mm	RR: 700 mm
Fully loaded attitude:	LF: 712 mm	RF: 716 mm	LR: 656 mm	RR: 666 mm
Pre-test attitude:	LF: 717 mm	RF: 720 mm	LR: 657 mm	RR: 658 mm
Post-test attitude:	LF: 708 mm	RF: 709 mm	LR: 655 mm	RR: 656 mm

Table 2 Test Vehicle Information, Cont'd.

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

Right front	482.2 kg	Right rear	252.7 kg
Left front	480.4 kg	Left rear	265.4 kg
Total front weight	962.6 kg	(65.0% of total vehicle weight)	
Total rear weight	518.1 kg	(35.0% of total vehicle weight)	
Total delivered weight	1480.7 kg		

Calculation of test vehicle's target test weight:

RCLW¹ = Rated Cargo and Luggage Weight

UDW = Unloaded Delivered Weight (1480.7 kg)

VCW = Vehicle Capacity Weight (499.0 kg)

DSC² = Designated Seating Capacity (6)

RCLW¹ = VCW - 68 (DSC) = 499.0 - 68 (6) = 91.0 kg

Target test weight = UDW + RCLW + (number of Hybrid III 5th Female Dummies x 47.6 kg per dummy)

Target test weight = 1480.7 + 91.0 + 95.2 = 1666.9 kg

Weight of test vehicle with required dummies and 90.2 kg of cargo weight:

Right front	500.8 kg	Right rear	329.8 kg
Left front	503.0 kg	Left rear	332.5 kg
Total front weight	1003.8 kg	(60.2% of total vehicle weight)	
Total rear weight	662.3 kg	(39.8% of total vehicle weight)	
Total test weight	1666.1 kg		

Weight of ballast secured in vehicle: None

Components removed to meet target test weight: Exhaust system

CG rearward of front wheel centerline: 1099.1 mm

Vehicle Wheelbase: 2765 mm

¹ Cargo weight for multi-purpose passenger vehicles, trucks, and buses is the vehicle's calculated cargo and luggage weight or 136.1 kg, whichever is less.

² The designated seating capacity is determined by counting the number of seat belts installed in the vehicle.

Table 3 Post-Impact Data

Test number: 980421-1
Test date: 04/21/98
Test time: 1458
Test type: Load cell barrier impact
Impact angle: 0°
Ambient temperature
at impact area: 22° C
Temperature in
occupant compartment: 22° C

Impact velocity:
Primary: 47.2 kph
Secondary: 47.2 kph
Specified range: 46.5 to 48.1 kph

Distance from vehicle to barrier:

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

Test vehicle static crush:

Overall length of test vehicle:

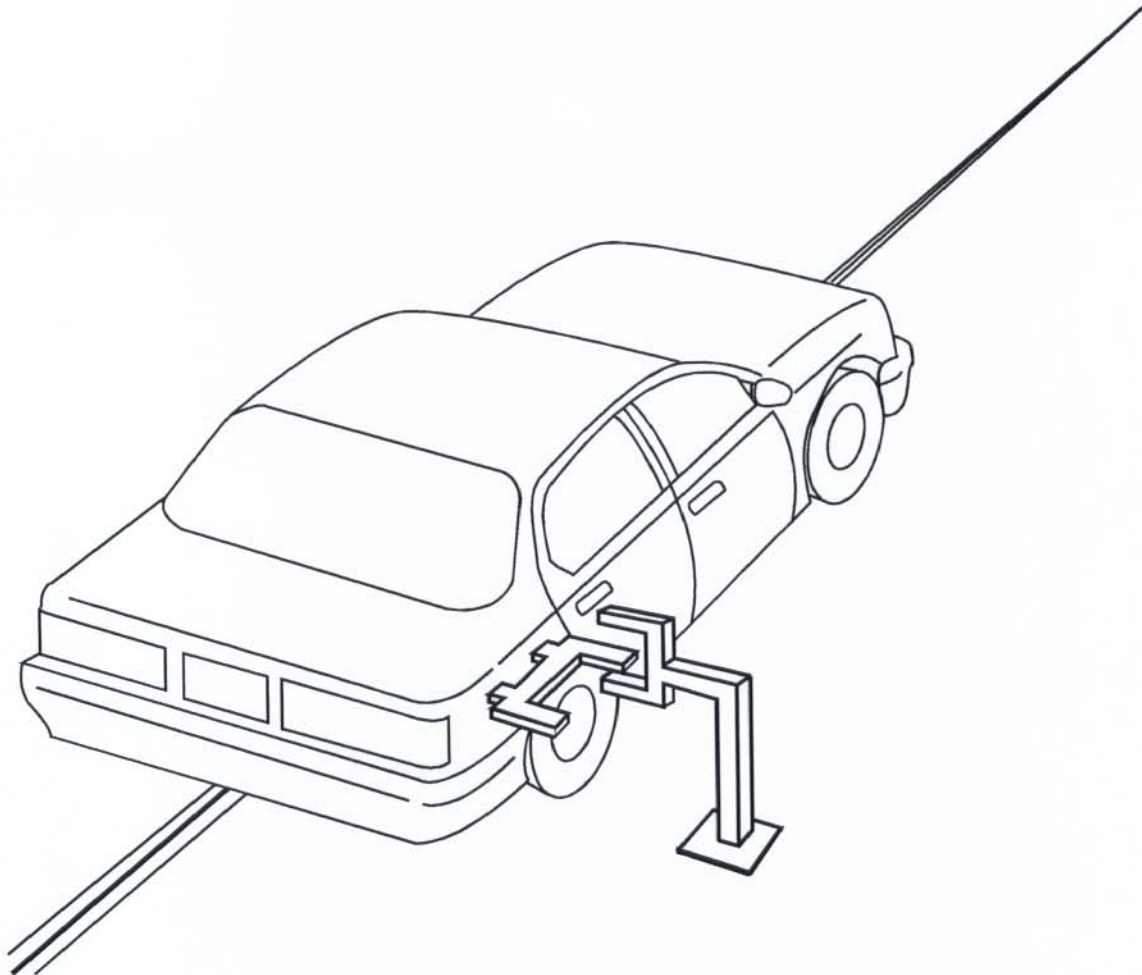
Pre-test:	L: 4812 mm	C: 5025 mm	R: 4807 mm
Post-test:	L: 4615 mm	C: 4715 mm	R: 4532 mm
Total crush:	L: 197 mm	C: 310 mm	R: 275 mm
Average crush:	257 mm		

Test vehicle rebound from flat barrier:

Distance from test vehicle to barrier:

Post-test:	L: 1163 mm	C: 1080 mm	R: 1267 mm
Average rebound:	1170 mm		

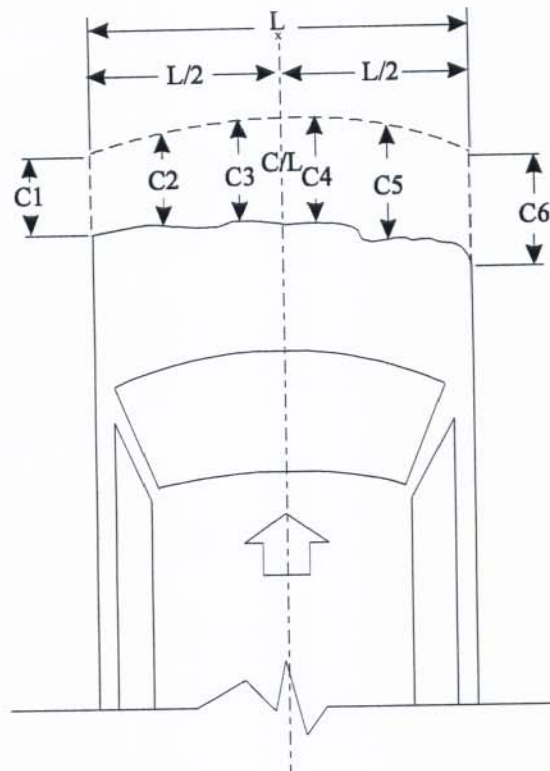
Figure 1 Impact Velocity Measurement System



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

The vanes have 305-millimeter spacing.

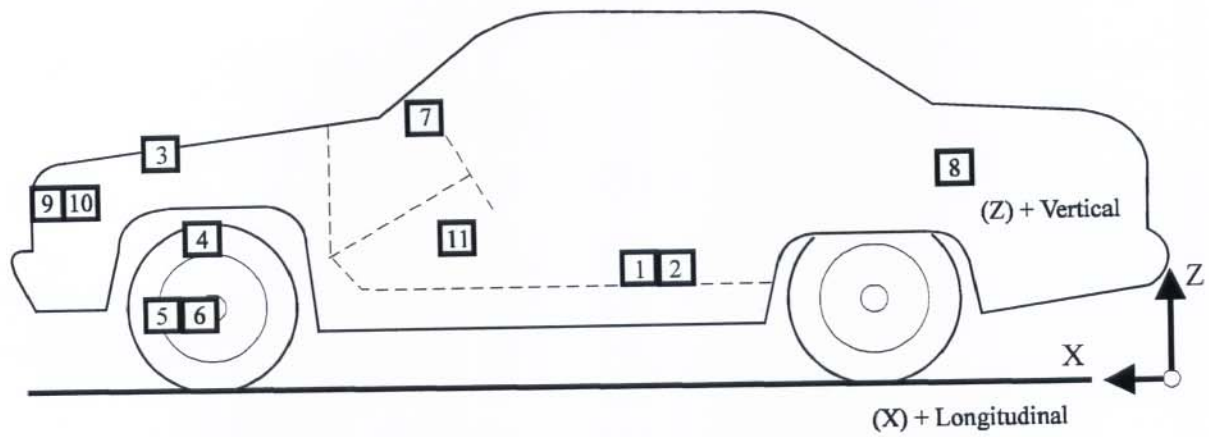
Figure 2 Vehicle Crush



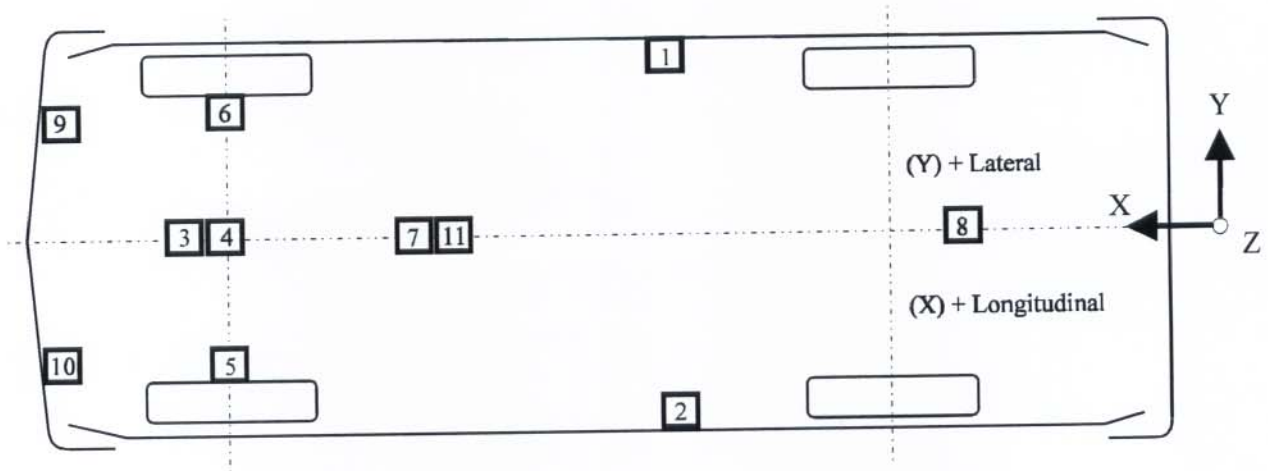
Notes: L is pre-test length of contact surface.
 C1 through C6 are spaced equally apart.
 CL is vehicle centerline.
 Measurements taken from a plane perpendicular
 to the vehicle centerline.

	Pre-test	Post-test	Crush
L	1524 mm		
C1	4812 mm	4615 mm	197 mm
C2	4963 mm	4692 mm	271 mm
C3	5011 mm	4718 mm	293 mm
C4	5013 mm	4706 mm	307 mm
C5	4960 mm	4652 mm	308 mm
C6	4807 mm	4532 mm	275 mm
CL	5025 mm	4715 mm	310 mm

Figure 3 Vehicle Accelerometer Placement



Side View



Bottom View

Table 4 Vehicle Accelerometer Locations and Data Summary

TEST NUMBER: 980421-1 No. LOCATION	X	Y	Z	POSITIVE DIRECTION	NEGATIVE DIRECTION
1 LEFT REAR SEAT CROSSMEMBER LONGITUDINAL	2092 mm	585 mm	255 mm	0.8 g @ 104.7 ms	25.3 g @ 44.4 ms
2 RIGHT REAR SEAT CROSSMEMBER LONGITUDINAL	2092 mm	-585 mm	255 mm	14.1 g @ 71.9 ms	26.5 g @ 57.9 ms
3 ENGINE TOP LONGITUDINAL	4103 mm	-180 mm	851 mm	12.3 g @ 60.2 ms	73.0 g @ 38.7 ms
4 ENGINE BOTTOM LONGITUDINAL	4205 mm	-45 mm	185 mm	8.5 g @ 56.4 ms	64.9 g @ 35.0 ms
5 RIGHT BRAKE CALIPER LONGITUDINAL	4080 mm	-685 mm	309 mm	36.0 g @ 71.4 ms	56.6 g @ 28.7 ms
6 LEFT BRAKE CALIPER LONGITUDINAL	4080 mm	685 mm	300 mm	28.8 g @ 73.7 ms	53.2 g @ 34.2 ms
7 INSTRUMENT PANEL CENTER LONGITUDINAL	3491 mm	45 mm	960 mm	3.1 g @ 94.9 ms	37.8 g @ 64.9 ms
8 REAR VEHICLE CENTERLINE VERTICAL	300 mm	0 mm	387 mm	12.9 g @ 71.6 ms	18.0 g @ 105.2 ms

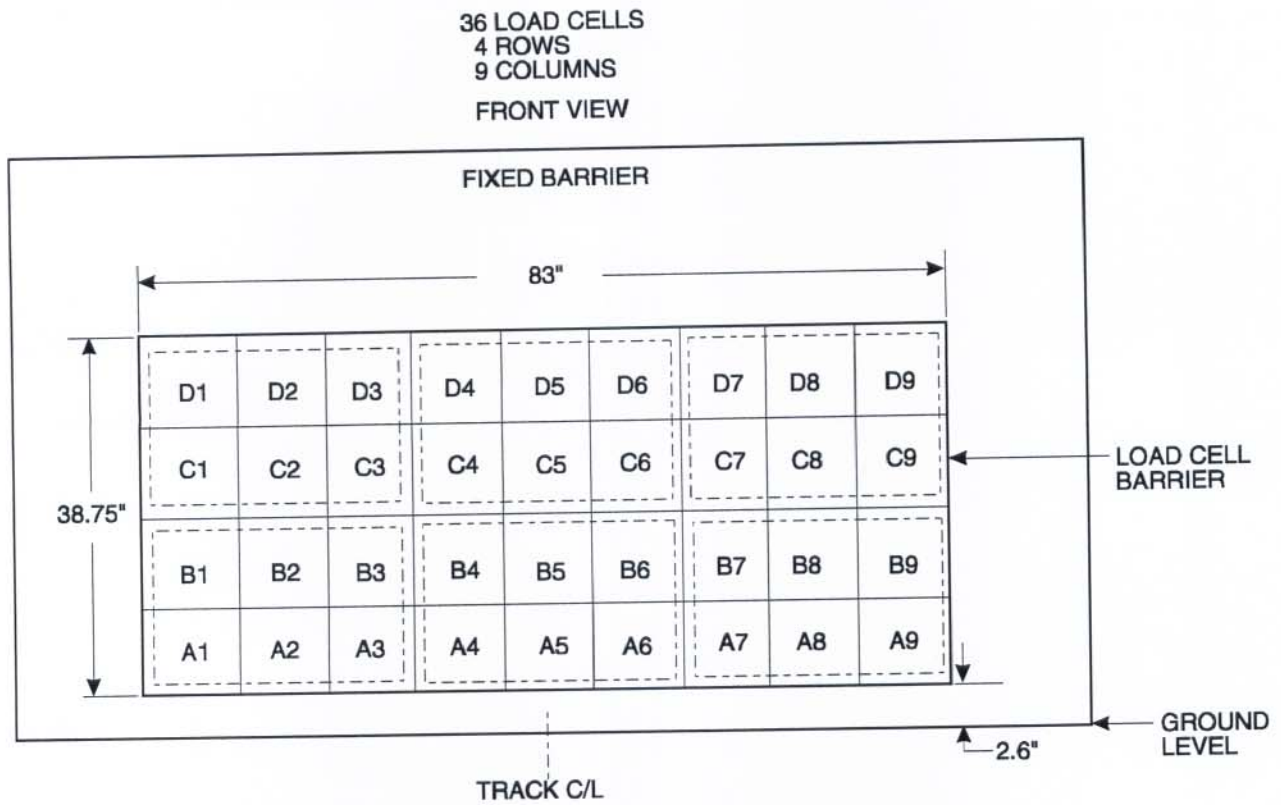
Table 4 Vehicle Accelerometer Locations and Data Summary, Cont'd.

TEST NUMBER: 980421 No. LOCATION	X	Y	Z	POSITIVE DIRECTION	NEGATIVE DIRECTION
9 LEFT RADIATOR LONGITUDINAL ¹	4550 mm	460 mm	659 mm	178.6 g @ 26.4 ms	1052.2 g @ 56.1 ms
10 RIGHT RADIATOR LONGITUDINAL ¹	4555 mm	-392 mm	622 mm	229.2 g @ 22.1 ms	276.8 g @ 16.9 ms
11 FLOOR TUNNEL LONGITUDINAL LATERAL VERTICAL RESULTANT	2173 mm	0 mm	310 mm	1.9 g @ 148.2 ms 2.6 g @ 47.0 ms 9.7 g @ 93.7 ms 33.2 g @ 73.5 ms	28.1 g @ 73.8 ms 4.5 g @ 63.4 ms 17.9 g @ 73.3 ms

REFERENCE: X: + FORWARD ACCELERATION
Y: + LEFT FROM VEHICLE CENTERLINE
Z: + UP FROM GROUND LEVEL

¹See DATA ACQUISITION EXPLANATIONS

Figure 4 Load Cell Barrier Configuration



Group 1: A1 through B3
Group 2: A4 through B6
Group 3: A7 through B9
Group 4: C1 through D3
Group 5: C4 through D6
Group 6: C7 through D9

Group A: A1 through A9
Group B: B1 through B9
Group C: C1 through C9
Group D: D1 through D9

Table 5 Load Cell Barrier Data Summary

Location	Positive direction				Negative direction			
Total group 1	2.3	kN	@	4.2 ms	119.3	kN	@	41.7 ms
Total group 2	0.0	kN	@	255.4 ms	129.3	kN	@	51.2 ms
Total group 3	1.8	kN	@	4.5 ms	148.9	kN	@	35.6 ms
Total group 4	1.5	kN	@	5.0 ms	40.5	kN	@	25.5 ms
Total group 5	0.1	kN	@	304.7 ms	61.1	kN	@	25.9 ms
Total group 6	0.5	kN	@	4.0 ms	35.5	kN	@	33.0 ms
Total load cell force	0.2	kN	@	238.0 ms	470.5	kN	@	40.8 ms

Tension is positive
Compression is negative

Table 5 Load Cell Barrier Data Summary, Cont'd.

Location	Positive direction	Negative direction
Total group A	4.1 kN @ 23.5 ms	54.0 kN @ 61.1 ms
Total group B	0.2 kN @ 202.8 ms	357.0 kN @ 40.2 ms
Total group C	0.2 kN @ 307.9 ms	106.1 kN @ 18.3 ms
Total group D	4.5 kN @ 15.0 ms	23.1 kN @ 26.0 ms

Section 3.0

FMVSS 208 Data

Table 6 Dummy Injury Criteria

<u>Maximum Acceleration</u>							
	<u>Head</u>				<u>Chest</u>		
	X	Y	Z	R	X	Y	Z
Driver	-48.4 g	6.5 g	8.9 g	49.3 g	-49.4 g	-8.2 g	9.1 g
Passenger	-94.3 g	-33.2 g	57.2 g	94.5 g	-36.0 g	6.0 g	-18.8 g

<u>Maximum Femur Compressive Force</u>		
	<u>Left Femur</u>	<u>Right Femur</u>
Driver	3916 N	4490 N
Passenger	4969 N	5878 N

<u>Head Injury Criteria¹</u>			
	<u>HIC</u>	<u>Time t₁</u>	<u>Time t₂</u>
Driver	309	46.6 ms	82.6 ms
Passenger	282	70.1 ms	106.1 ms

<u>Chest Maximum Resultant Acceleration²</u>			
	<u>Acceleration</u>	<u>Time t₁</u>	<u>Time t₂</u>
Driver	48.2 g	77.8 ms	80.8 ms
Passenger	39.6 g	91.7 ms	94.6 ms

<u>Maximum Chest Deflection</u>	
Driver	35 mm
Passenger ³	6 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 dummy's head and chest were restrained by the airbag. The dummy's head and upper torso rotated rearward as the dummy rebounded into the seat back. The dummy's head contacted the head restraint and upper seat back. The dummy's pelvis submarined slightly. The dummy translated forward again into the airbag. The driver dummy came to rest seated in the driver's seat. The dummy's head and shoulders were against the seat back.

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 dummy's head and chest were restrained by the airbag. The dummy's head and upper torso rotated rearward as the dummy rebounded into the seat back. The dummy's head contacted the head restraint. The dummy translated forward again into the airbag. The passenger dummy came to rest seated in the passenger's seat. The dummy's head and shoulders were slumped forward.

Section 4.0

Vehicle, Occupant, and Camera Measurements

Figure 5 Pre-test and Post-test Measurement Points

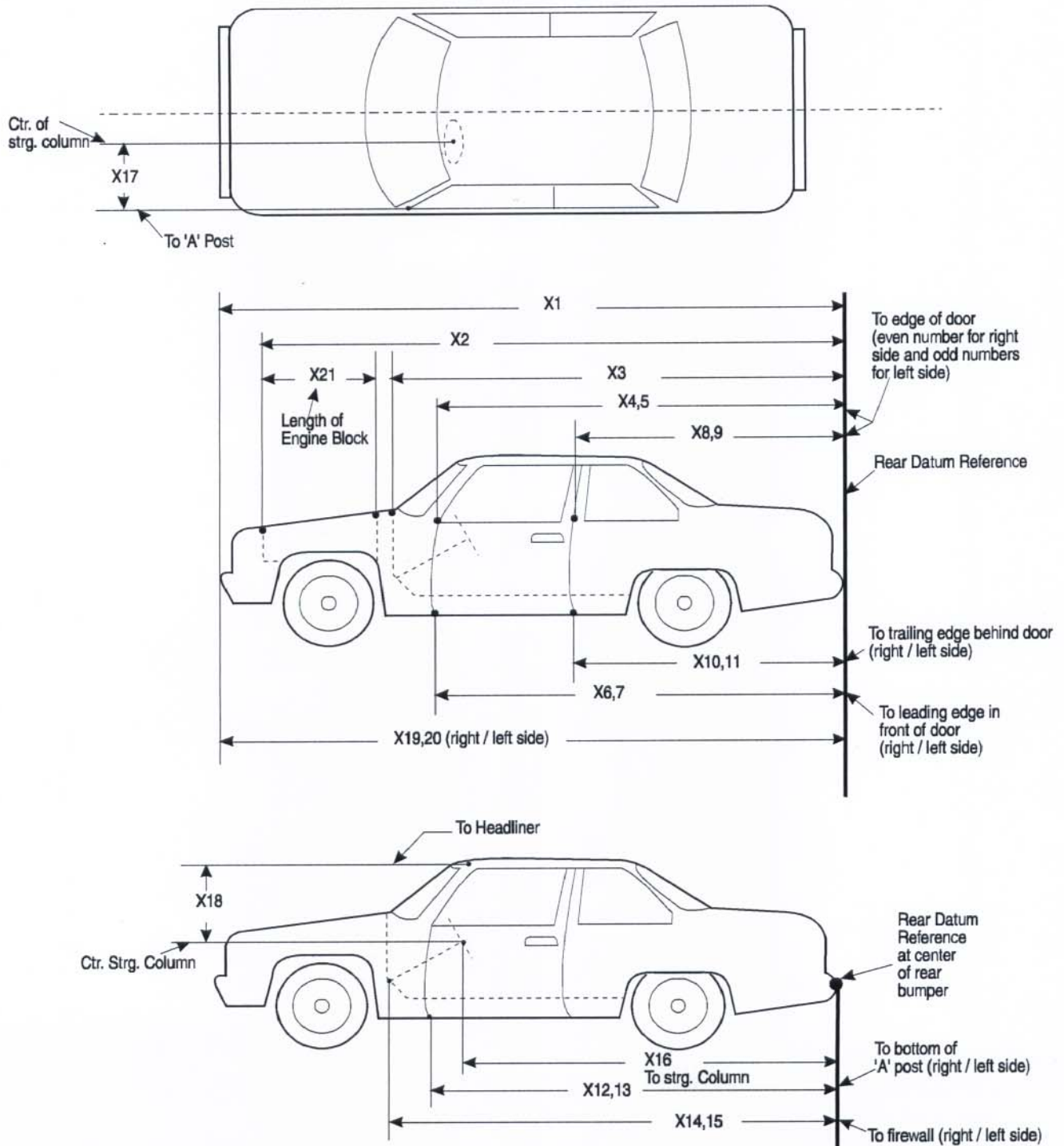


Table 7 Impacted Vehicle Measurements

Vehicle year/make/model/body style: 1998/Ford/Taurus/4-door LX

Test Number: 980421-1

No.	Type of measurement	Pre-test	Post-test	Difference
X1	Total Length of Veh. at Centerline	5025	4715	310
X2	Rear Surface of Veh. to Front of Engine Block	4415	4128	287
X3	Rear Surface of Veh. to Firewall	3885	3860	25
X4	Rear Surface of Veh. to Upper Leading Edge of Right Door	3437	3447	-10
X5	Rear Surface of Veh. to Upper Leading Edge of Left Door	3431	3425	6
X6	Rear Surface of Veh. to Lower Leading Edge of Right Door	3424	3415	9
X7	Rear Surface of Veh. to Lower Leading Edge of Left Door	3415	3405	10
X8	Rear Surface of Veh. to Upper Trailing Edge of Right Door	2425	2435	-10
X9	Rear Surface of Veh. to Upper Trailing Edge of Left Door	2421	2420	1
X10	Rear Surface of Veh. to Lower Trailing Edge of Right Door	2415	2412	3
X11	Rear Surface of Veh. to Lower Trailing Edge of Left Door	2410	2402	8
X12	Rear Surface of Veh. to Bottom of " A " Post on Right Side	3425	3426	-1
X13	Rear Surface of Veh. to Bottom of " A " Post on Left Side	3422	3422	0
X14	Rear Surface of Veh. to Firewall--Right Side	3661	3351	310
X15	Rear Surface of Veh. to Firewall--Left Side	3702	3385	317
X16	Rear Surface of Veh. to Steering Wheel Center	3045	3028	17
X17	Center of Steering Column to " A " Post	316	300	16
X18	Center of Steering Column to Headliner	415	410	5
X19	Rear Surface of Veh. to Right Side of Front Bumper	4807	4532	275
X20	Rear Surface of Veh. to Left Side of Front Bumper	4812	4615	197
X21	Length of Engine Block	345	345	0

Figure 6 Vehicle Target Locations

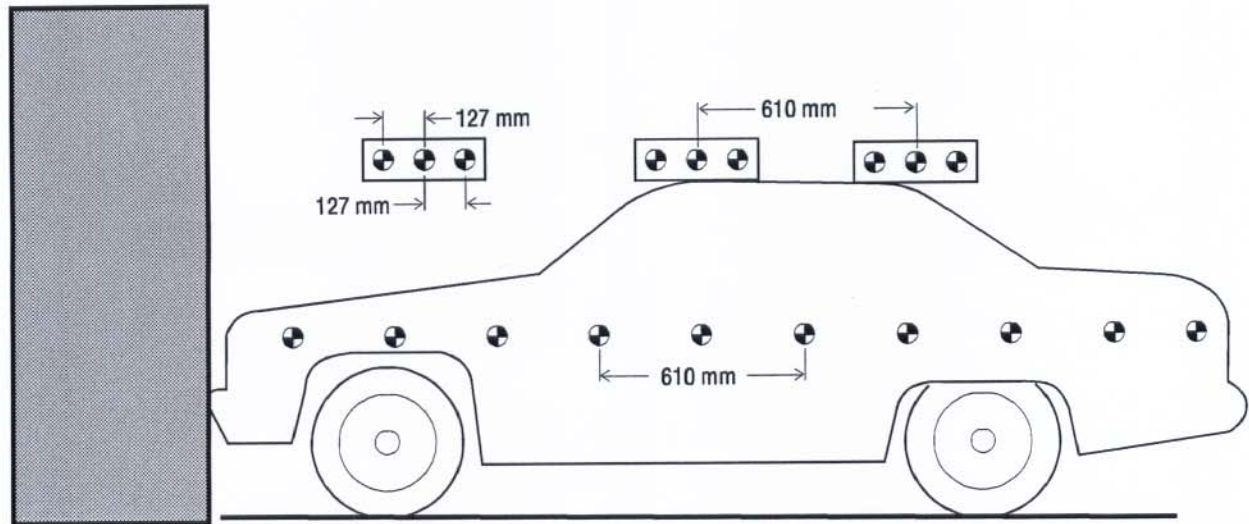


Figure 7 Dummy Measurement Locations for Front Seat Occupants

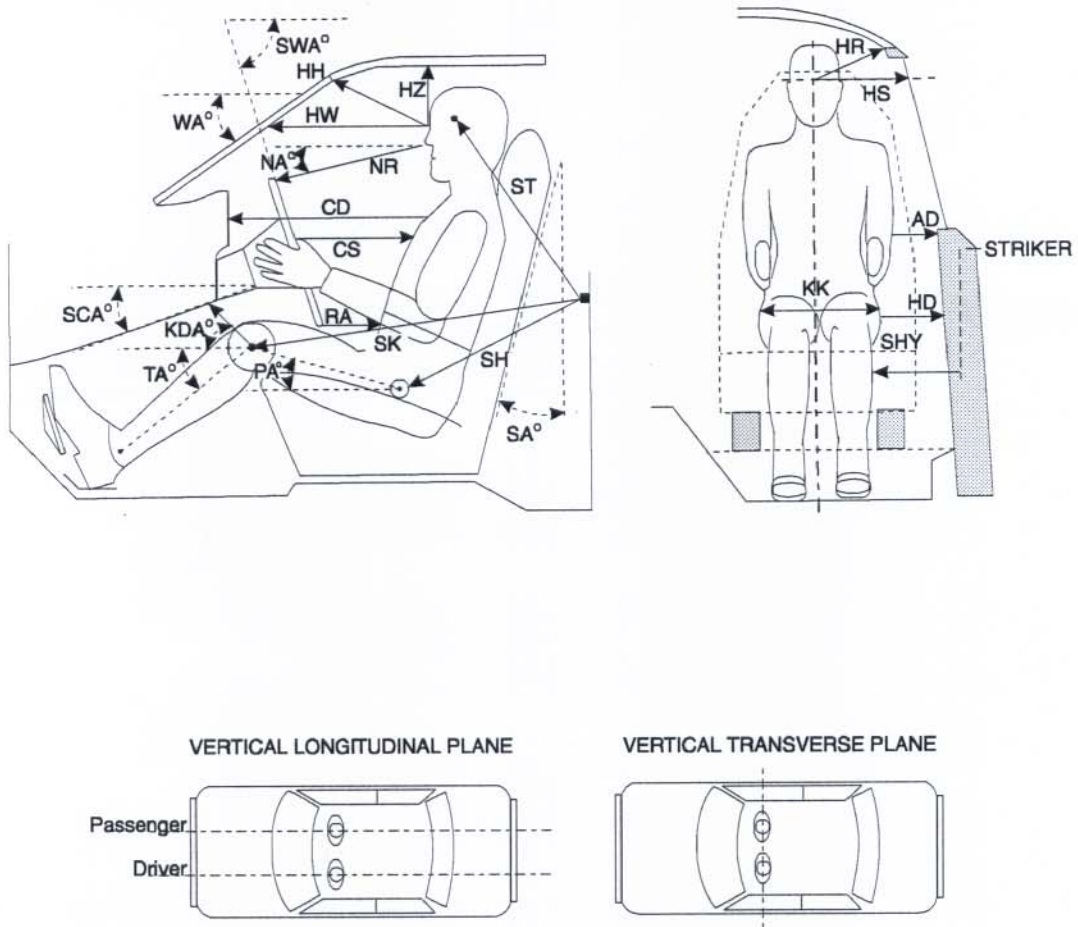


Table 8 Dummy Measurement Data For Front Seat Occupants

Designation	Type of Measurement	Driver (Serial #289)	Passenger (Serial #288)
WA	Windshield angle	25°	25°
SWA	Steering wheel angle	70°	NA
SCA	Steering column angle	20°	NA
SA ¹	Seat back angle	20°	24°
HZ	Head to roof	186 mm	180 mm
HH	Head to header	248 mm	247 mm
HW	Head to windshield	621 mm	617 mm
HR	Head to side header	251 mm	246 mm
NR	Nose to rim	237 mm	NA
NA	Nose to rim angle	4°	NA
CD	Chest to dash	433 mm	353 mm
CS	Steering wheel to chest	191 mm	NA
RA	Rim to abdomen	85 mm	NA
KDL	Left knee to dash	122 mm	104 mm
KDR	Right knee to dash	105 mm	128 mm
KDA	Outboard knee to dash angle	34°	25°
PA	Pelvic angle	22.3°	20°
TA	Tibial angle	48°	53°
KK	Knee to knee	291 mm	230 mm
ST ²	Striker to head	511 mm	534 mm
	Striker to head angle	-60°	-66°
SK	Striker to knee	675 mm	660 mm
	Striker to knee angle	2°	2°
SH	Striker to H-point	378 mm	351 mm
	Striker to H-point angle	13°	24°
SHY	Striker to H-point (Y dir.)	271 mm	309 mm
HS	Head to side window	357 mm	368 mm
HD	H-point to door	202 mm	188 mm
AD	Arm to door	163 mm	154 mm

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

¹ Passenger seat was deformed due to previous testing.

² A negative angle indicates the measurement point was above the striker.

The diagram illustrates the experimental setup for the car control task. A car is positioned on a track, with various components labeled for identification:

- 1:** Real-Time Panning (indicated by a curved arrow).
- Concrete Pad:** The base surface of the setup.
- Barrier:** A large rectangular structure on the left side of the track.
- Umbilical Cable:** A cable connecting the car to the external systems.
- Cable Support:** A structure supporting the umbilical cable.
- Tow Road:** The main driving area of the track.
- Monorail:** A track system on the right side of the setup.
- Tow Cable:** A cable connecting the car to the monorail.
- Overhead Steering Column Motion Targets:** A series of targets (labeled 11, 12, 13) positioned above the car's steering column.
- Targets:** Various numbered targets (2, 3, 4, 5, 6, 7, 8, 9, 10, 16, 17) are distributed around the car, some on the ground and some on the wall.

Figure 8 Camera Positions, Cont'd.

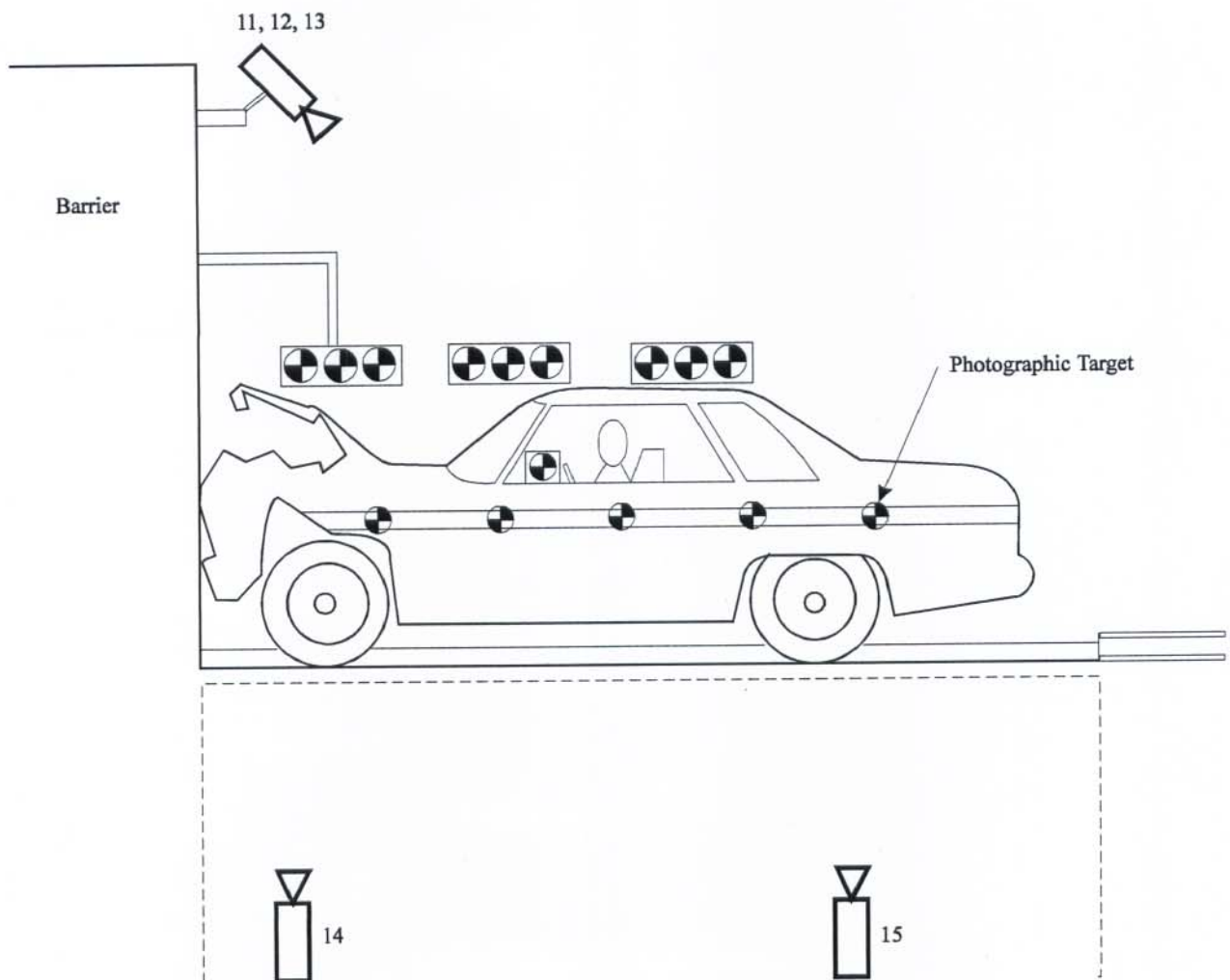


Table 9 Motion Picture Camera Locations

Vehicle year/make/model/body style: 1998/Ford/Taurus/4-door LX

Test number: 980421-1

Camera Number	View	Camera Positions ¹			Angle ²	Film Plane to Head Target	Lens	Film Speed
		X	Y	Z				
1	Real-time panning	NA	NA	NA	NA	NA	NA	24 frames/s
2	Left vehicle crush	-1054 mm	7493 mm	1118 mm	NA	NA	25 mm	1000 frames/s
3	Left windshield intrusion	-1346 mm	7859 mm	1074 mm	NA	NA	50 mm	1002 frames/s
4	Driver over shoulder	-3995 mm	2946 mm	2210 mm	NA	NA	25 mm	953 frames/s
5	Column movement - lower	2134 mm	7264 mm	1908 mm	NA	NA	25 mm	1000 frames/s
6	Column movement - upper	2134 mm	7264 mm	2616 mm	NA	NA	25 mm	1008 frames/s
7	Right side overall	-2065 mm	-6767 mm	942 mm	NA	NA	13 mm	992 frames/s
8	Right windshield intrusion	-968 mm	-7775 mm	1118 mm	NA	NA	50 mm	1000 frames/s
9	Passenger over shoulder	-3863 mm	-2946 mm	2210 mm	NA	NA	25 mm	1008 frames/s
10	Passenger A-pillar to B-pillar	-986 mm	-7442 mm	1151 mm	NA	NA	25 mm	1018 frames/s
11	Windshield - front view	-152 mm	0 mm	2040 mm	NA	NA	8.5 mm	1000 frames/s
12	Driver - front view	-173 mm	368 mm	2362 mm	NA	NA	17 mm	992 frames/s
13	Passenger - front view	-114 mm	-351 mm	2362 mm	NA	NA	17 mm	992 frames/s
14	Pit front position	-1283 mm	0 mm	-2347 mm	NA	NA	13 mm	945 frames/s
15	Pit rear position	-2522 mm	0 mm	-2515 mm	NA	NA	13 mm	1008 frames/s
16	Onboard driver	NA	NA	NA	NA	NA	8 mm	905 frames/s
17	Onboard passenger	NA	NA	NA	NA	NA	8 mm	925 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

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.

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 Left Rear Three-Quarter View



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



Figure A-7 Pre-Test Rear View

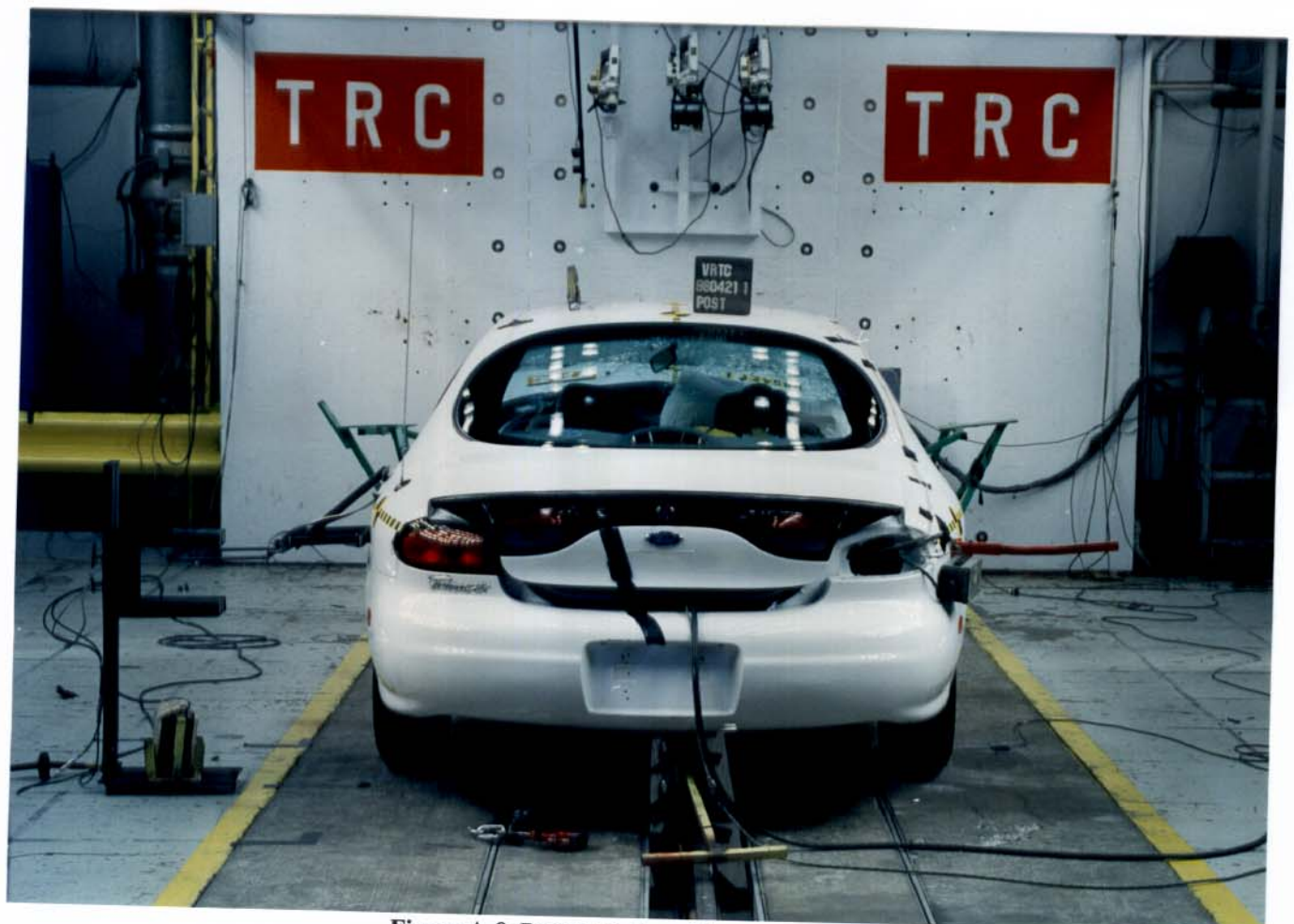


Figure A-8 Post-Test Rear View



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

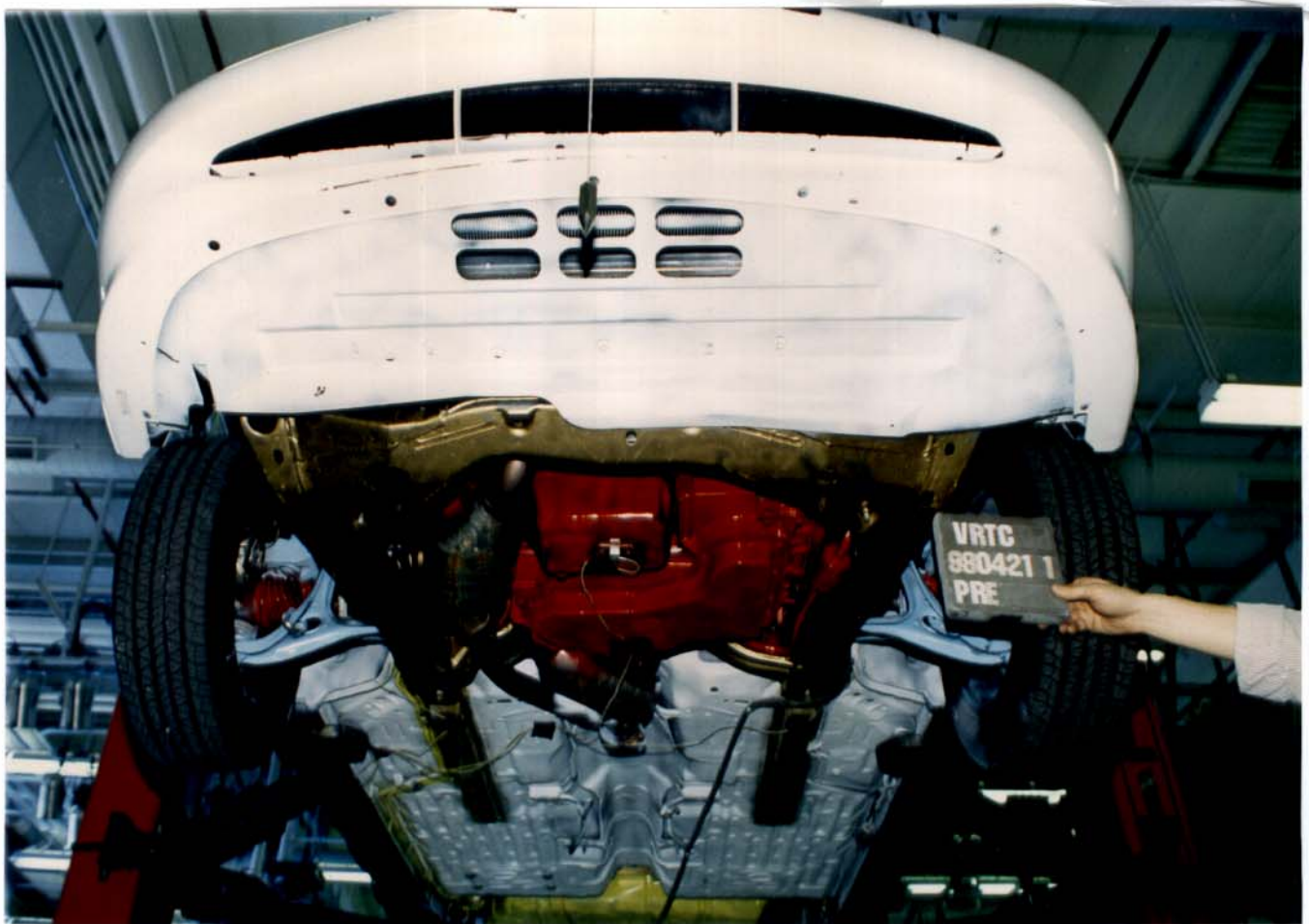


Figure A-13 Pre-Test Front Underbody View

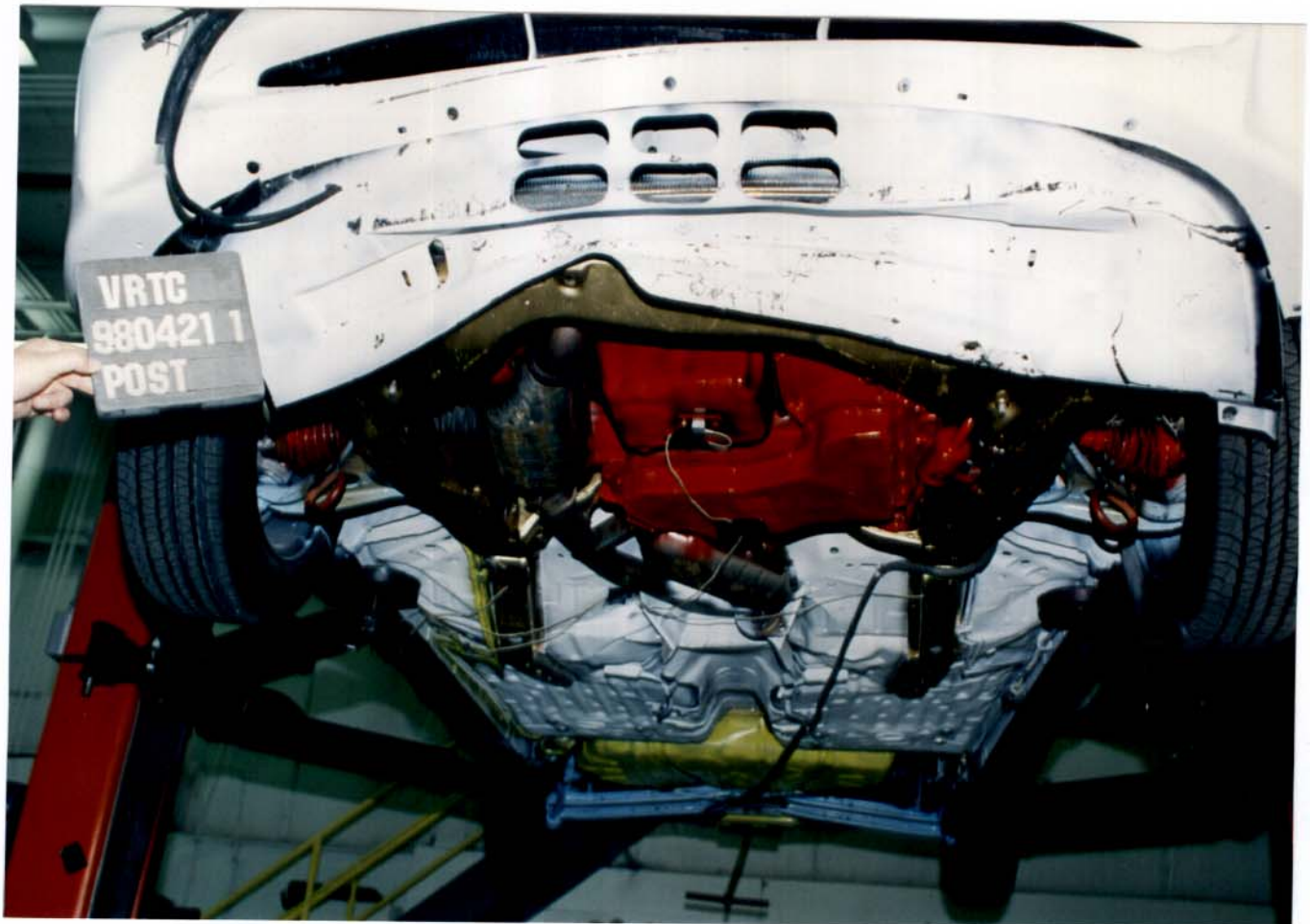


Figure A-14 Post-Test Front Underbody View

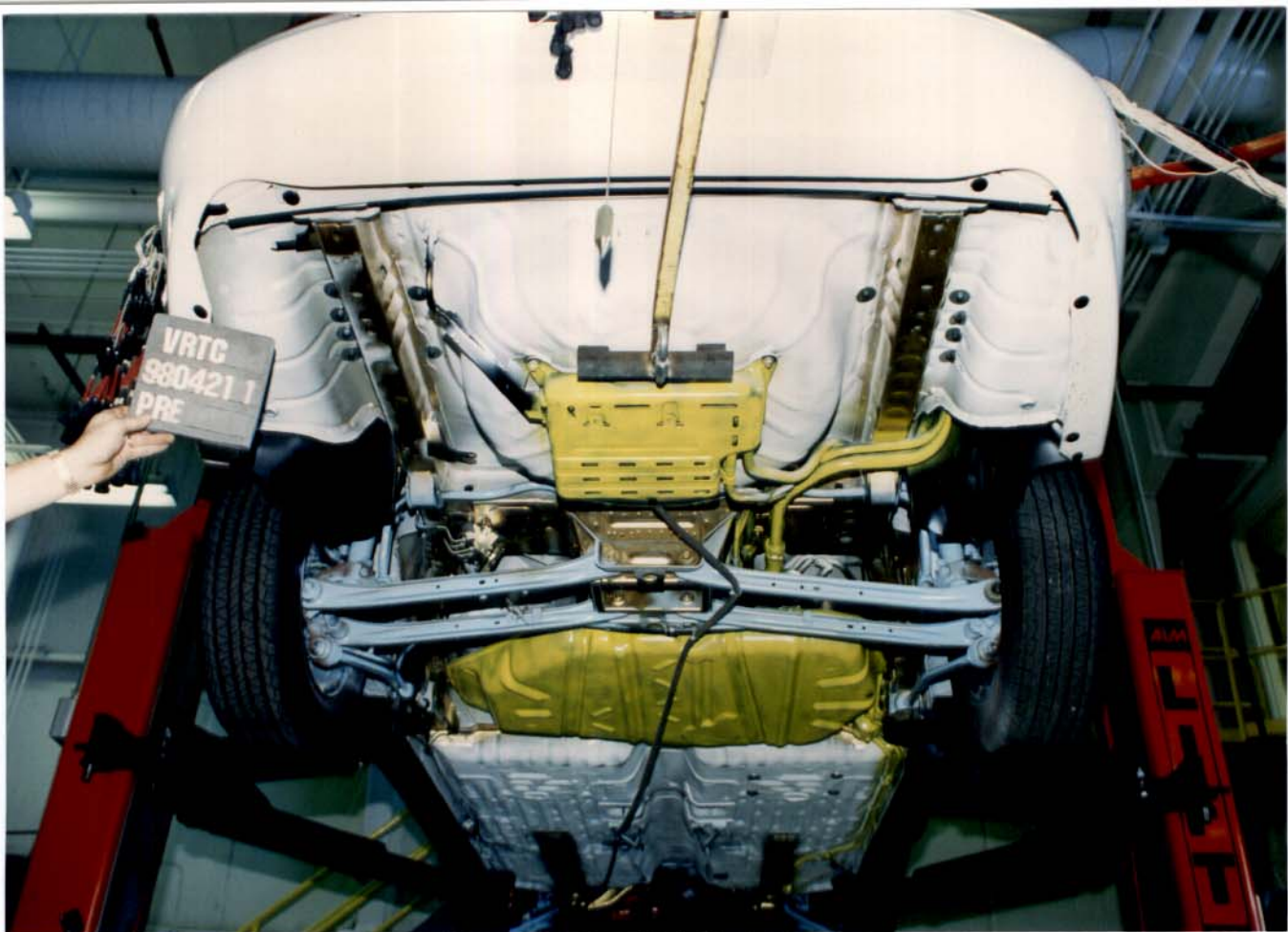


Figure A-15 Pre-Test Rear Underbody View

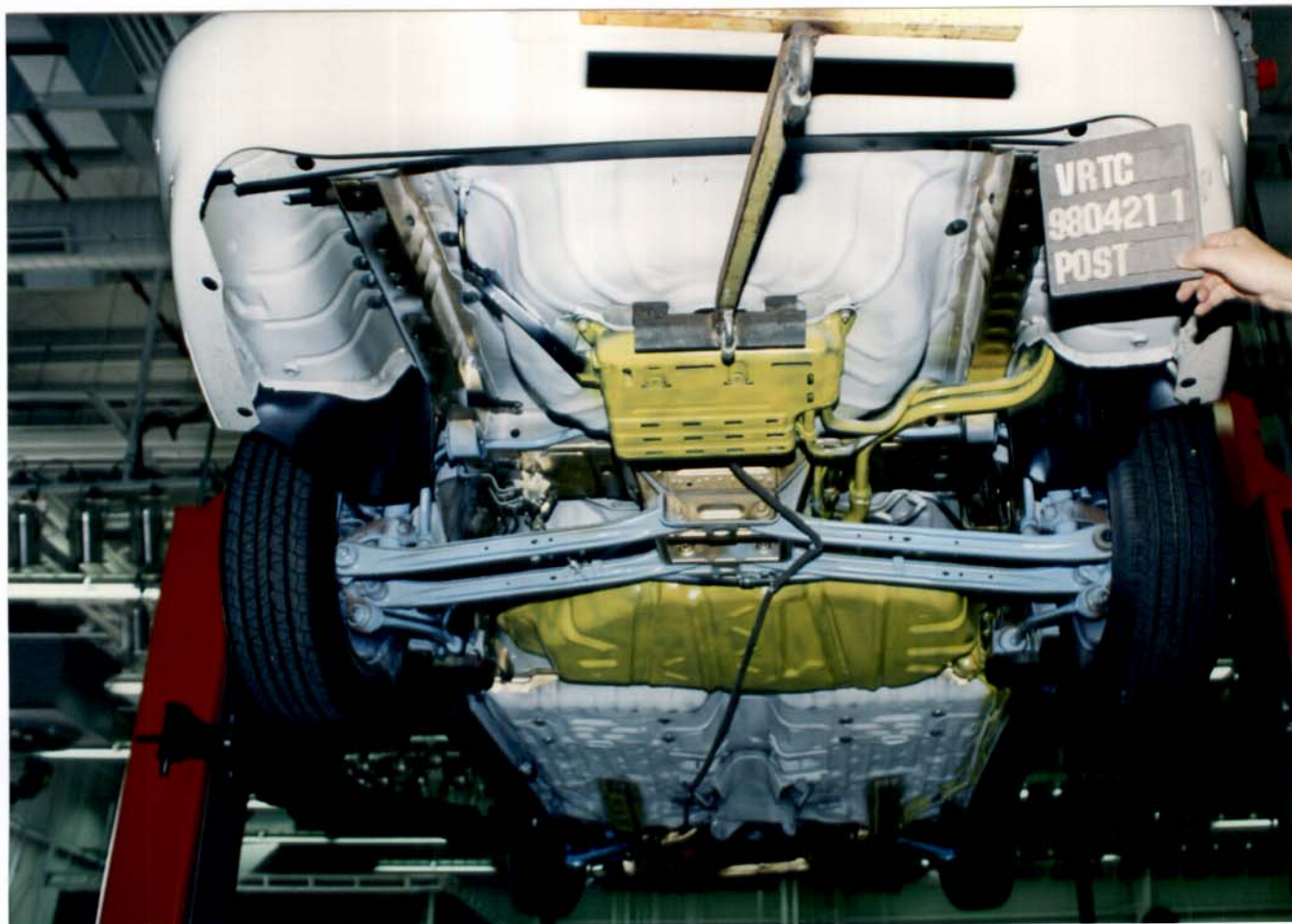


Figure A-16 Post-Test Rear Underbody View

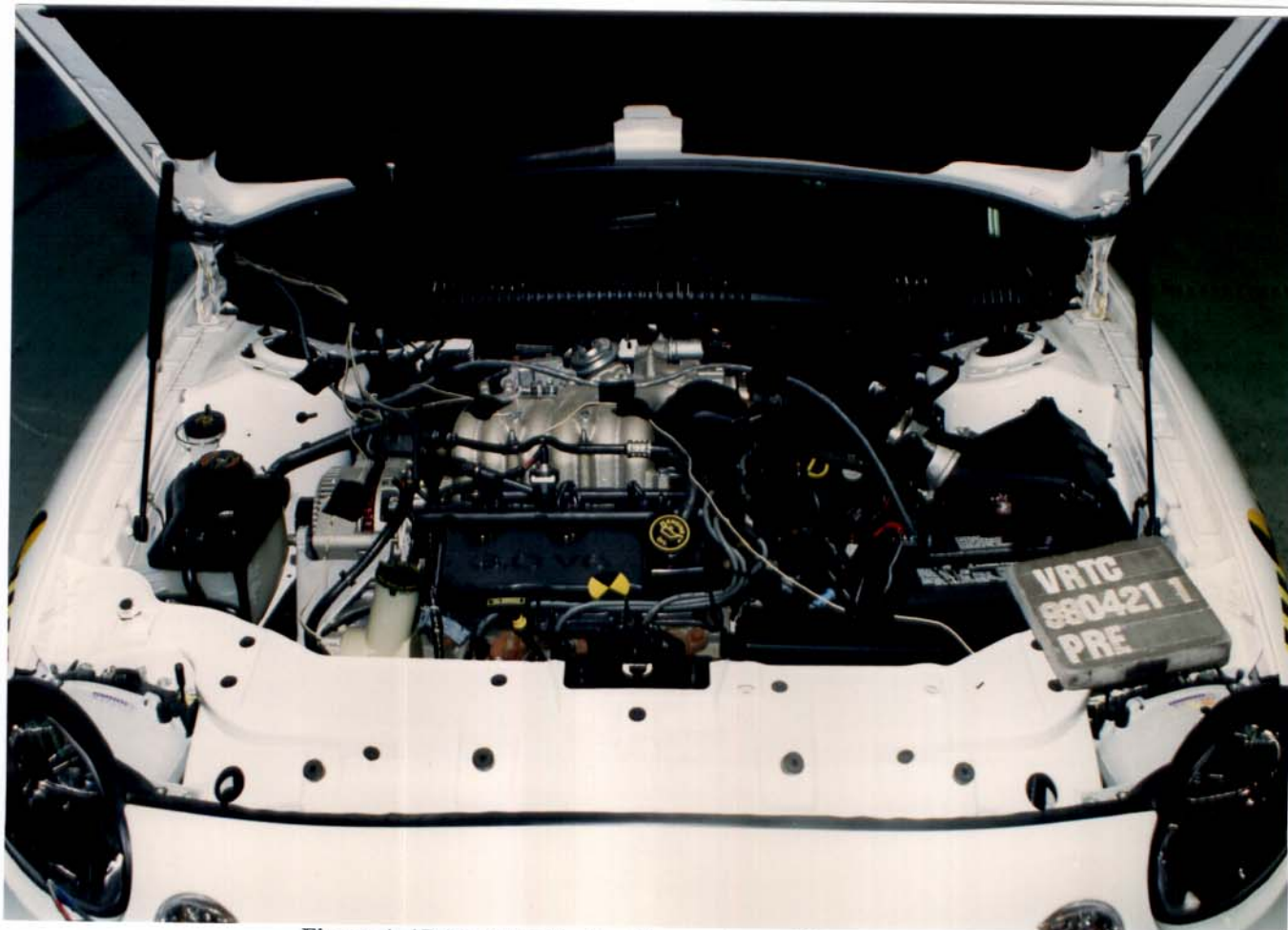


Figure A-17 Pre-Test Engine Compartment View



Figure A-18 Post-Test Engine Compartment View



Figure A-19 Pre-Test Windshield View



Figure A-20 Post-Test Windshield - View 1



Figure A-21 Post-Test Windshield - View 2

Intentionally Left Blank



Figure A-22 Pre-Test Fuel Filler Cap View



Figure A-23 Post-Test Fuel Filler Cap View

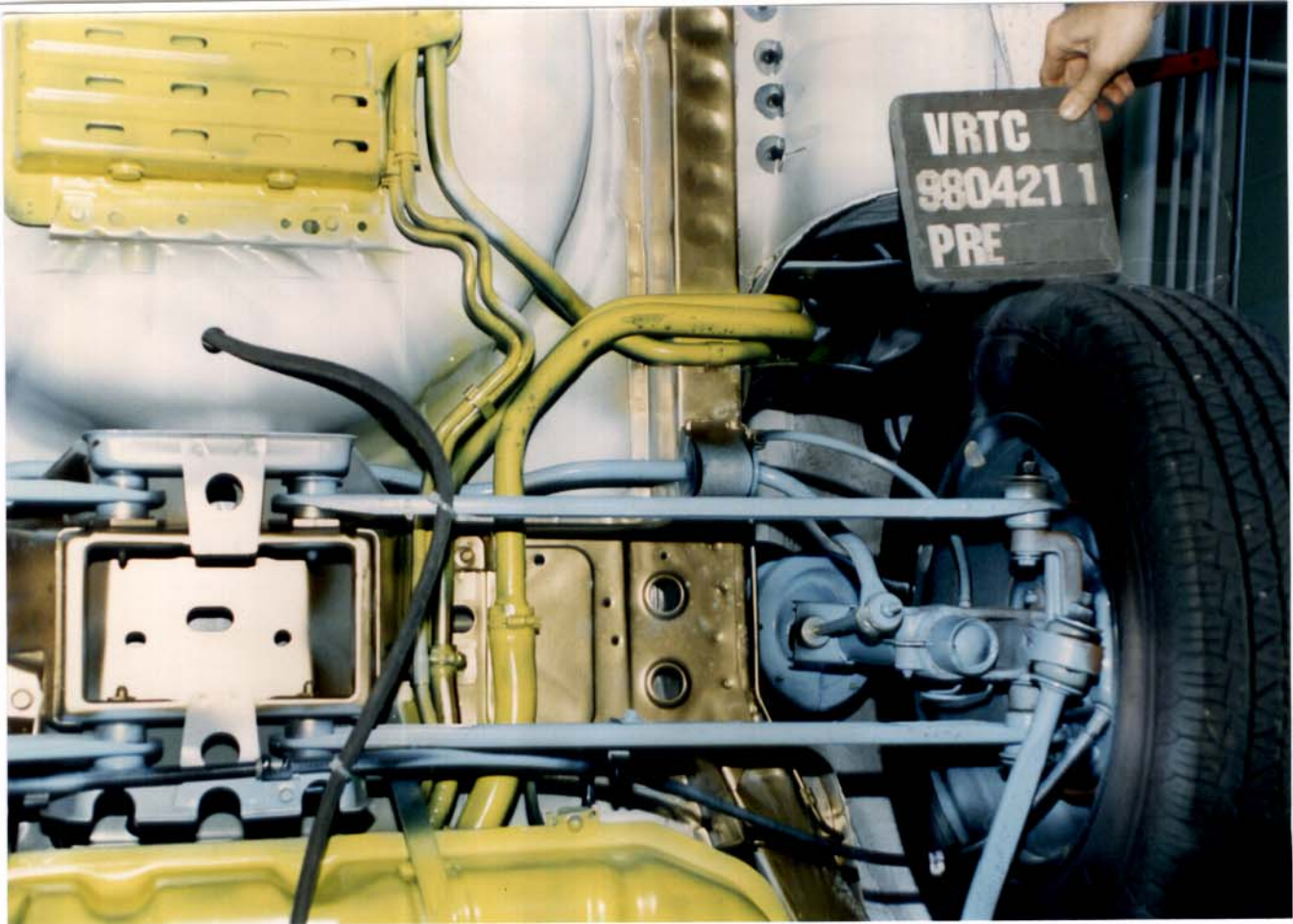


Figure A-24 Pre-Test Fuel Filler Neck View

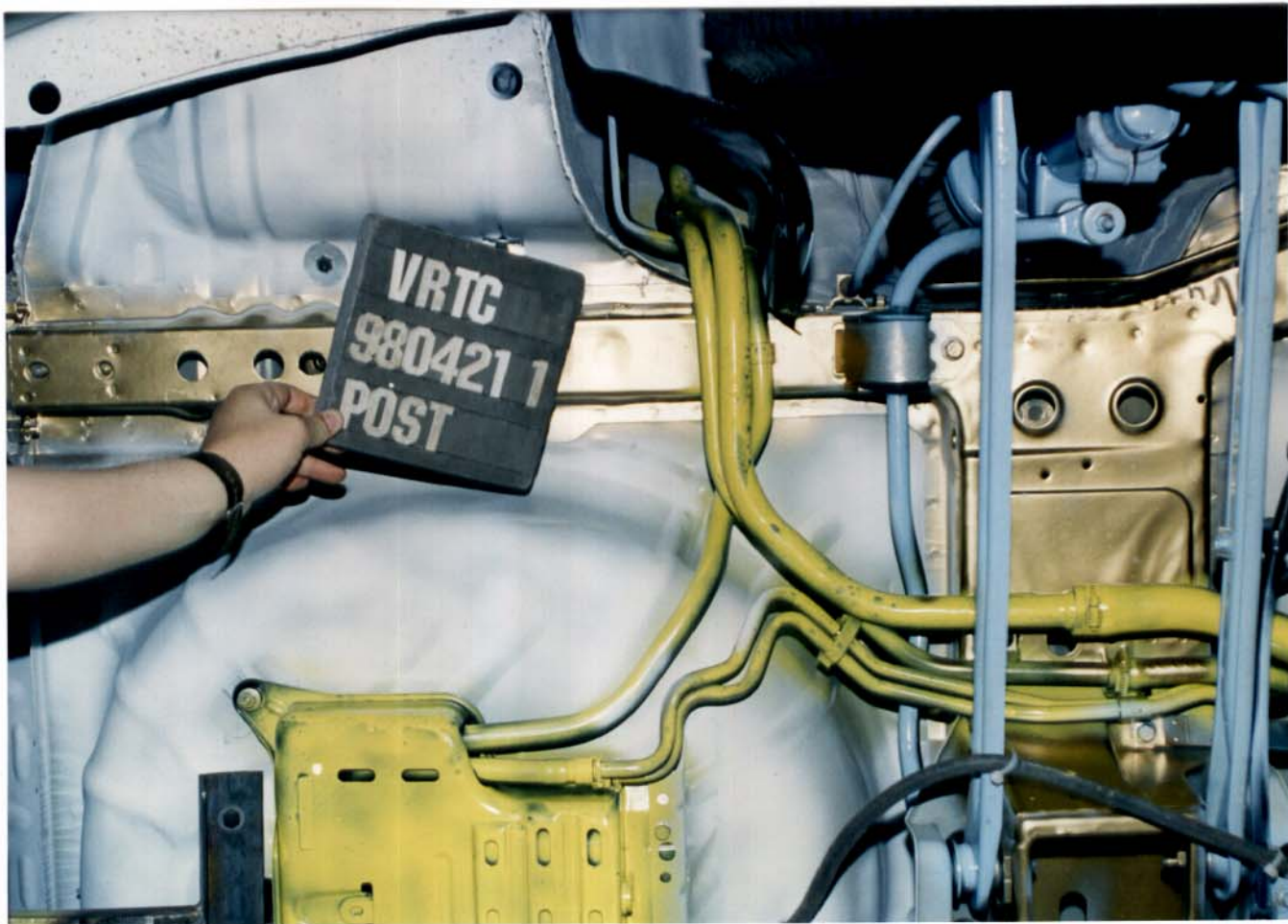


Figure A-25 Post-Test Fuel Filler Neck View

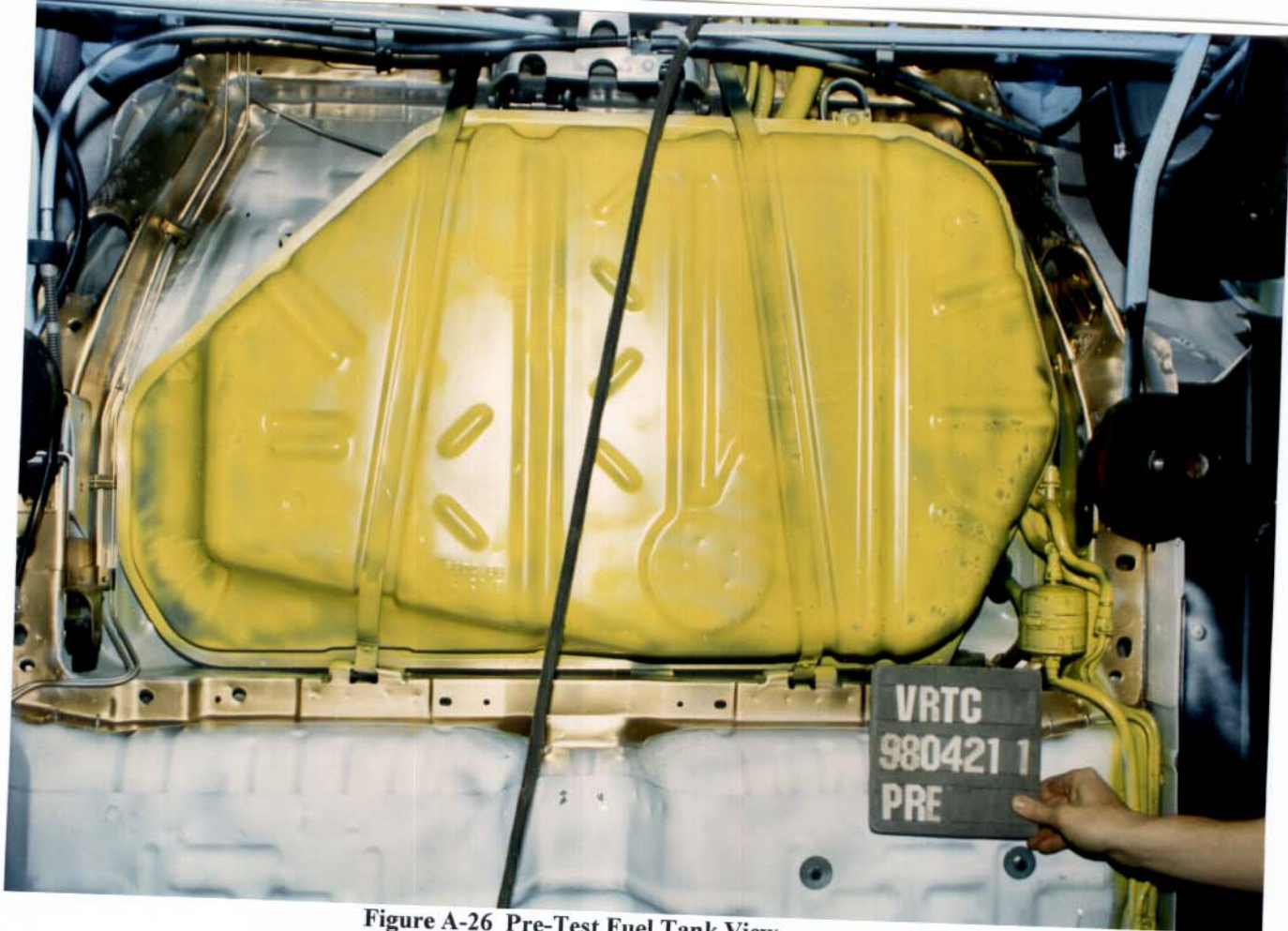


Figure A-26 Pre-Test Fuel Tank View

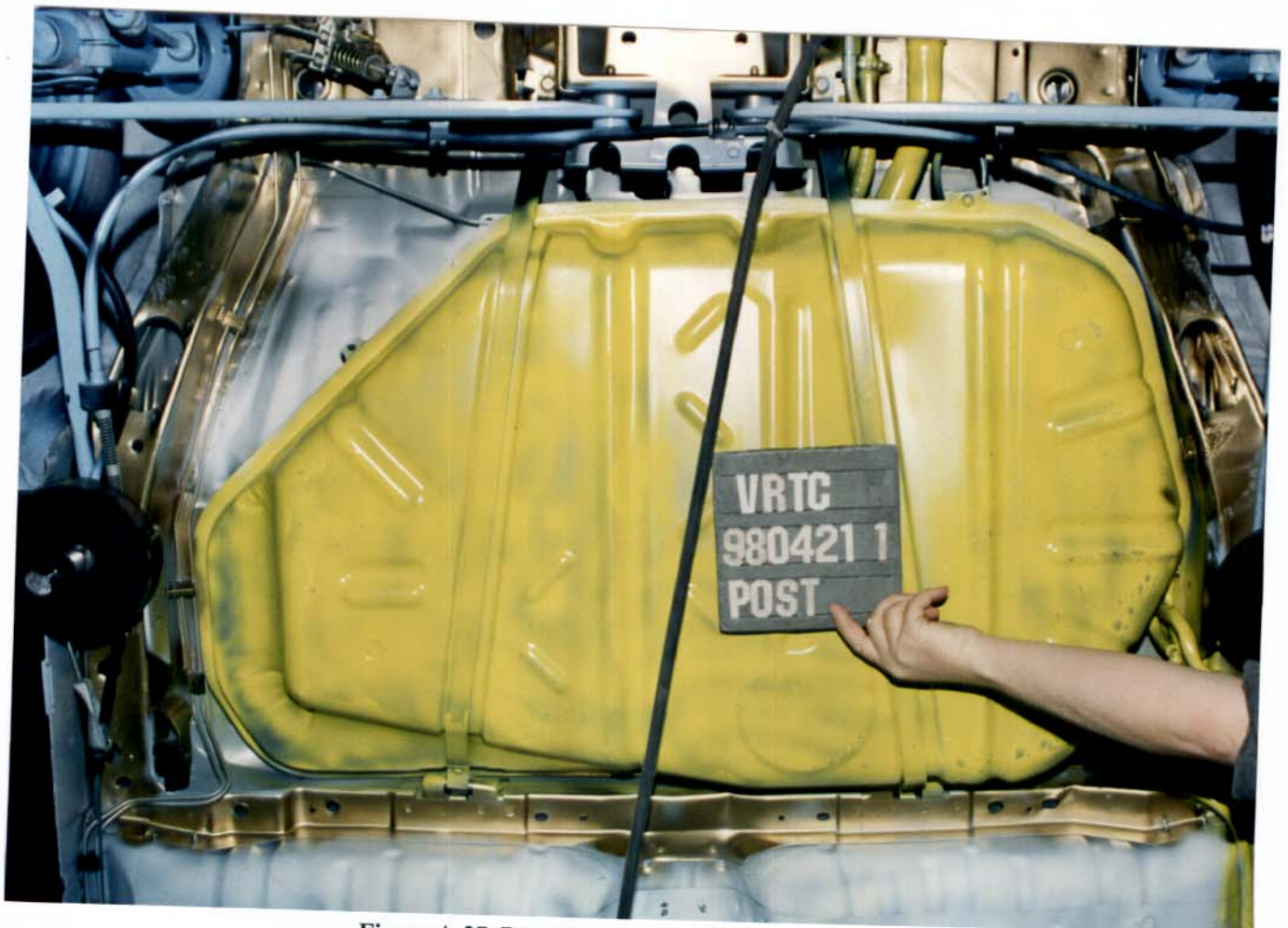


Figure A-27 Post-Test Fuel Tank View



Figure A-28 Pre-Test Driver Dummy Position - View 1



Figure A-29 Post-Test Driver Dummy Position - View 1



Figure A-30 Pre-Test Driver Dummy Position -View 2



Figure A-31 Post-Test Driver Dummy Position - View 2



Figure A-32 Pre-Test Driver Dummy Position -View 3



Figure A-33 Post-Test Driver Dummy Position - View 3



Figure A-34 Pre-Test Passenger Dummy Position - View 1



Figure A-35 Post-Test Passenger Dummy Position - View 1



Figure A-36 Pre-Test Passenger Dummy Position - View 2



Figure A-37 Post-Test Passenger Dummy Position - View 2



Figure A-38 Pre-Test Passenger Dummy Position - View 3



Figure A-39 Post-Test Passenger Dummy Position - View 3

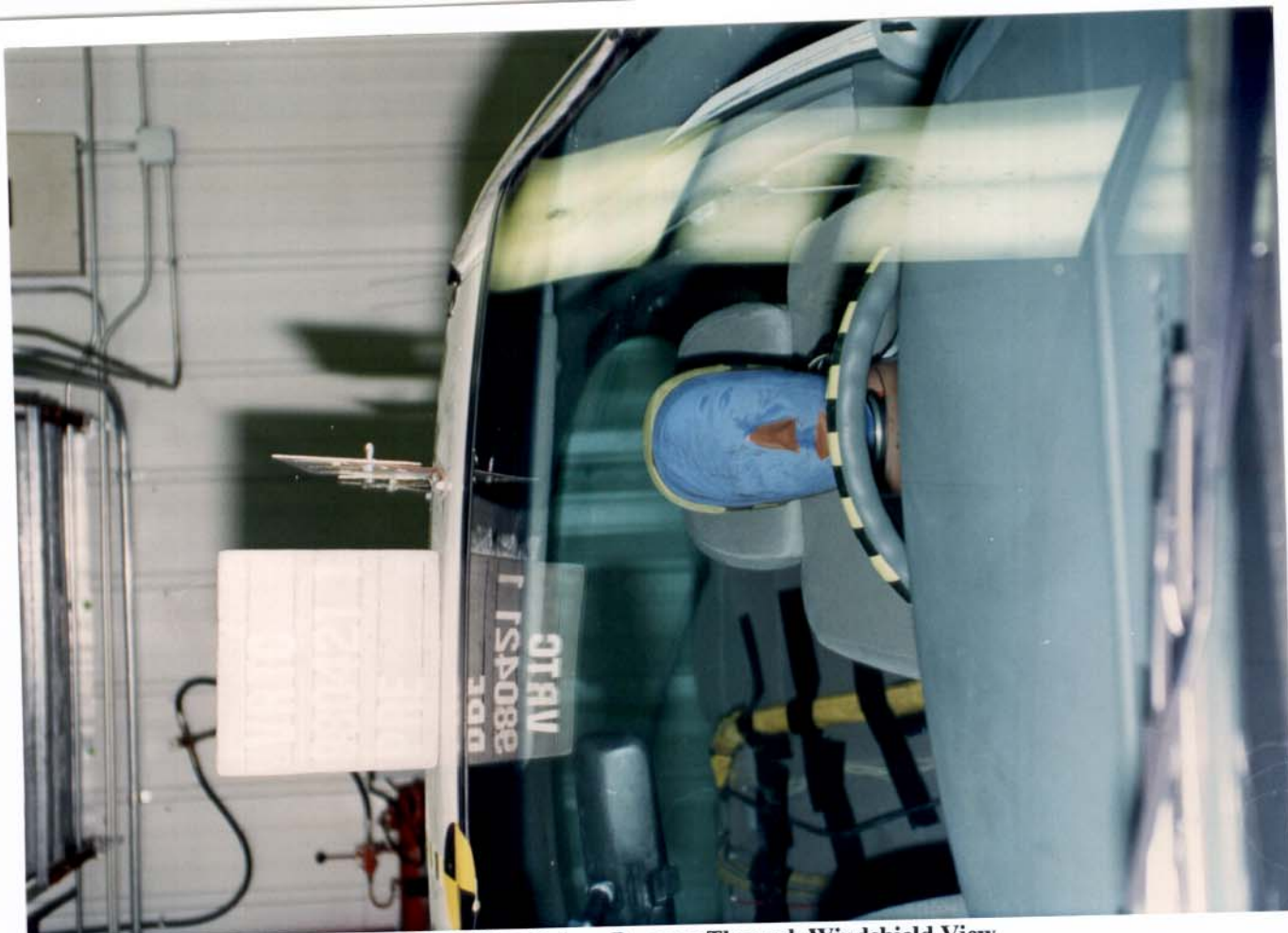


Figure A-40 Pre-Test Driver Dummy Through Windshield View



Figure A-41 Post-Test Driver Dummy Overall View



Figure A-42 Post-Test Driver Dummy Head Contact - View 1



Figure A-43 Post-Test Driver Dummy Head Contact - View 2



Figure A-44 Post-Test Driver Dummy Head Contact - View 3

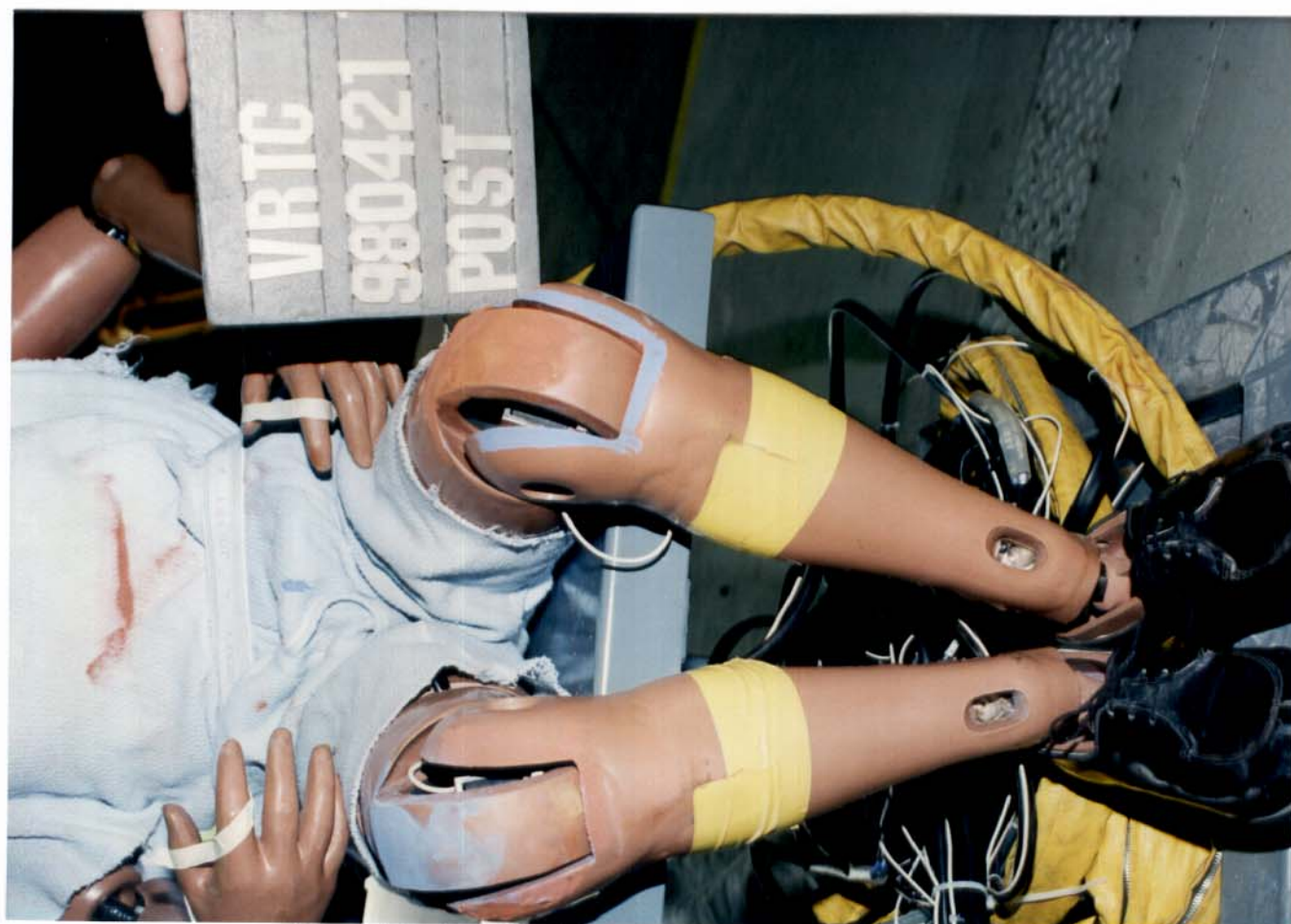


Figure A-45 Post-Test Driver Dummy Knee Contact - View 1



Figure A-46 Post-Test Driver Dummy Knee Contact - View 2



Figure A-47 Pre-Test Passenger Dummy Through Windshield View



Figure A-48 Post-Test Passenger Dummy Overall View

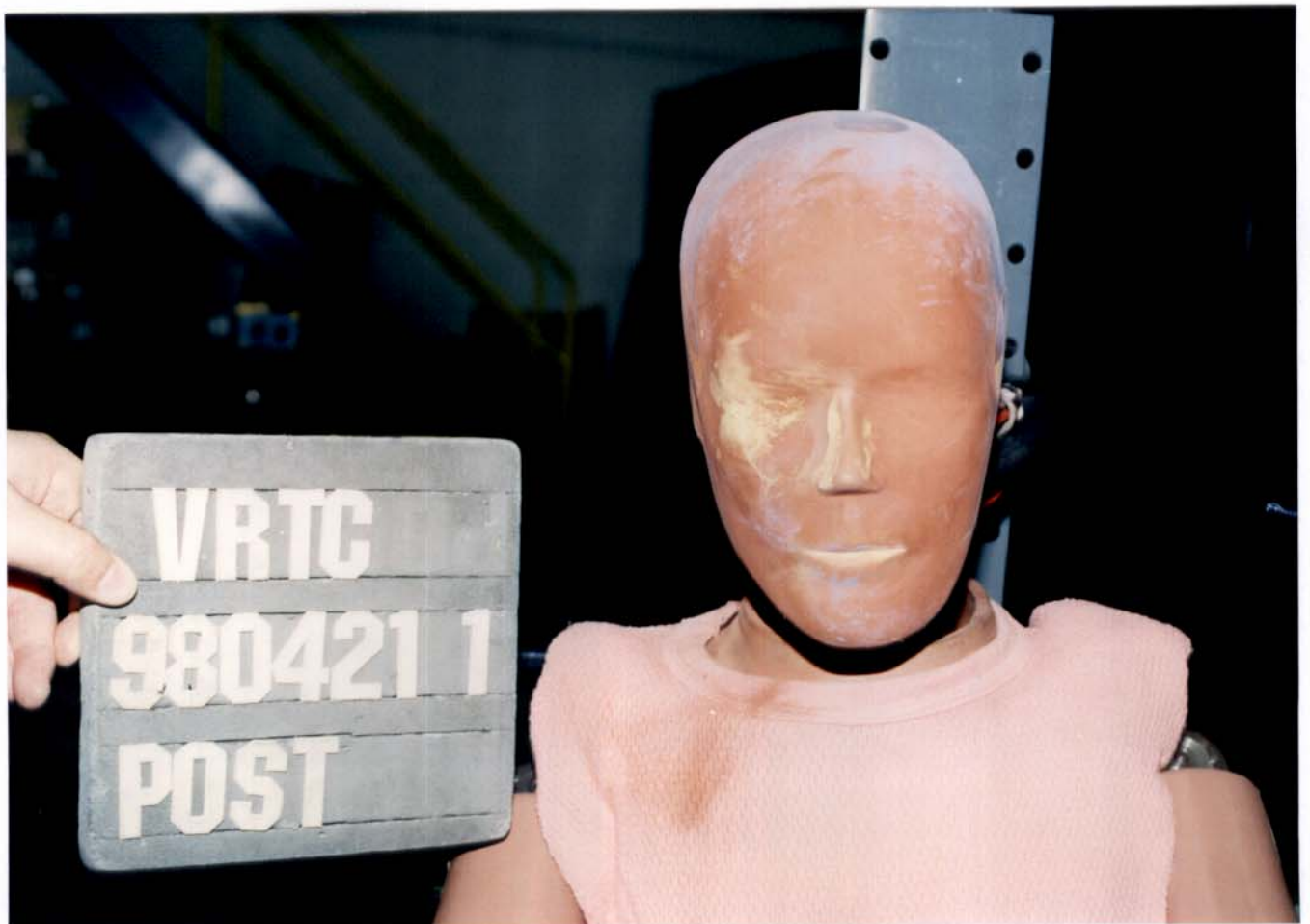


Figure A-49 Post-Test Passenger Dummy Head Contact - View 1



Figure A-50 Post-Test Passenger Dummy Head Contact - View 2



Figure A-51 Post-Test Passenger Dummy Head Contact - View 3



Figure A-52 Post-Test Passenger Dummy Knee Contact - View 1



Figure A-53 Post-Test Passenger Dummy Knee Contact - View 2

MFD. BY FORD MOTOR CO. IN U.S.A.
DATE: 12/97 GVWR: 4687LB/2125KG
FRONT GAWR: 2647LB 1200KG
REAR GAWR: 2065LB 936KG
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY, BUMPER, AND THEFT PREVENTION STANDARDS
IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.
VIN: 1FAFP52U1WG145718 F0173
TYPE: PASSENGER R0061



EXT PNT: WT RC: 47 DSO:
BRK INT TR TP/PS R AXLE TR SPR
A J2 H 3R X LLHH
UPC 7 F 60B-5420472-AA

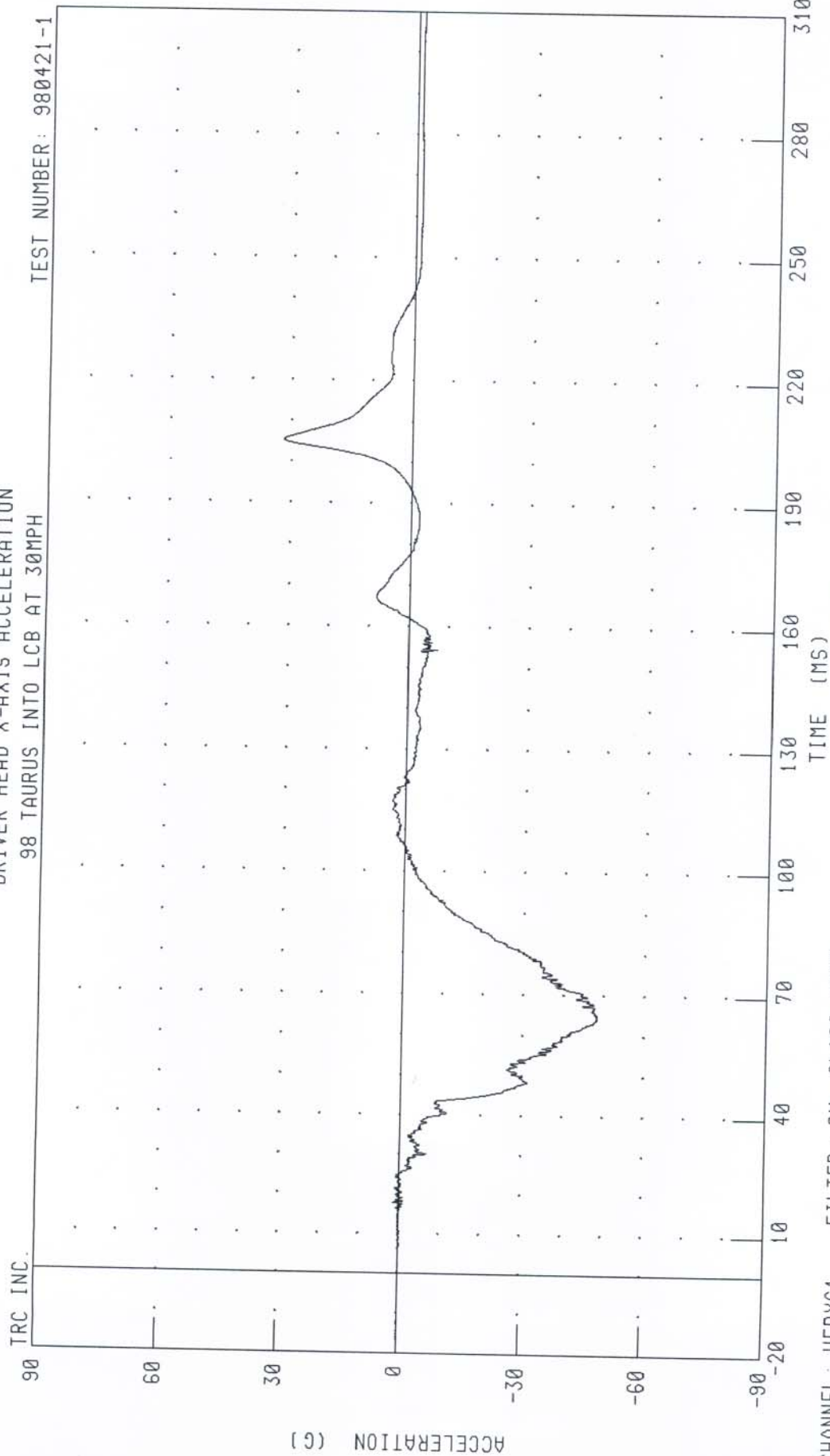
Figure A-54 Pre-Test Vehicle Certification Label View

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER HEAD X-AXIS ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: HEDXG1

FILTER: CH. CLASS 1000

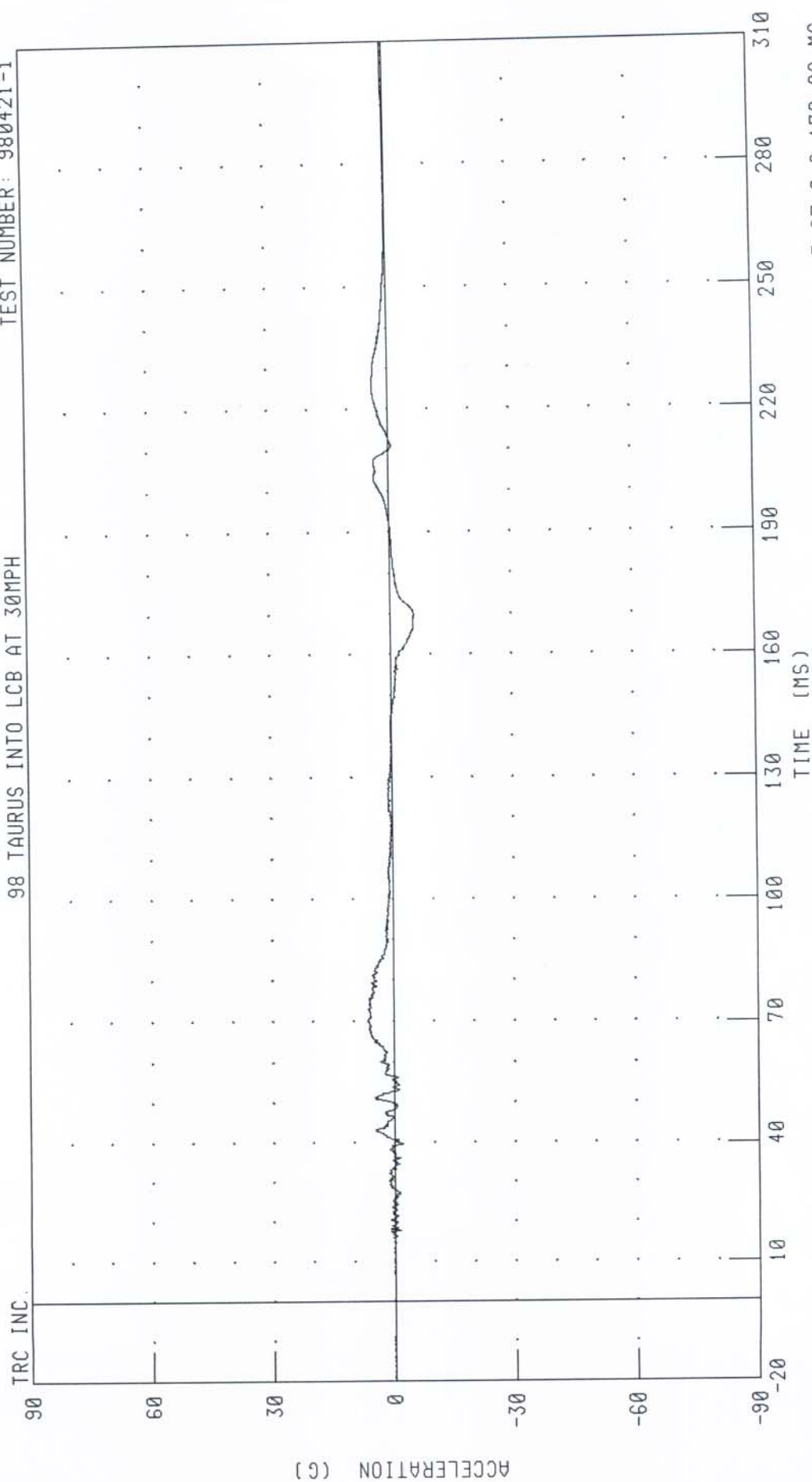
PEAK DATA: 31.87 G @ 205.44 MS, -48.42 G @ 63.92 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER HEAD Y-AXIS ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: HEDYG1 FILTER: CH. CLASS 1000

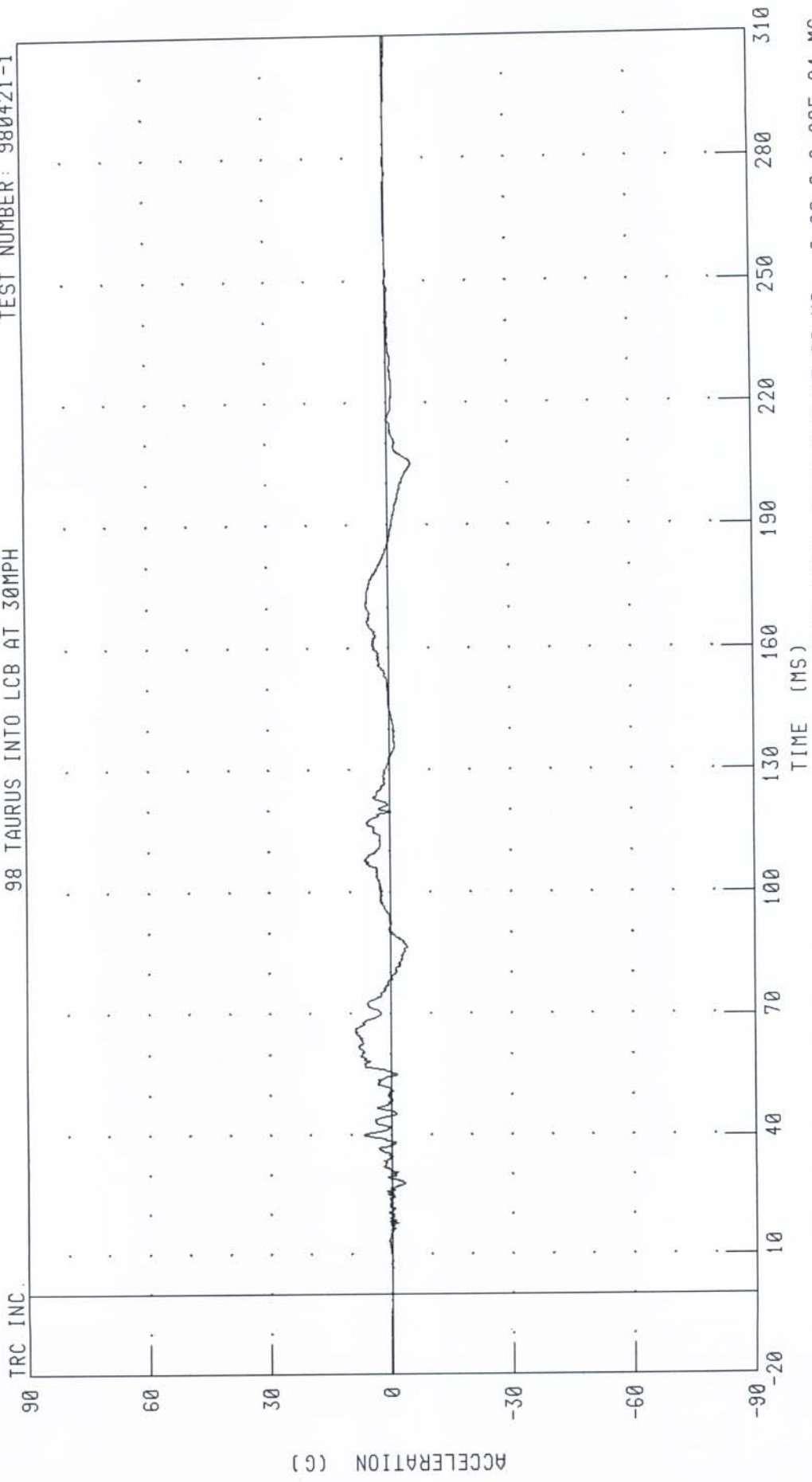
PEAK DATA: 6.46 G @ 70.08 MS, -5.97 G @ 170.08 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER HEAD Z-AXIS ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



PEAK DATA: 8.85 G @ 65.68 MS, -6.00 G @ 205.04 MS

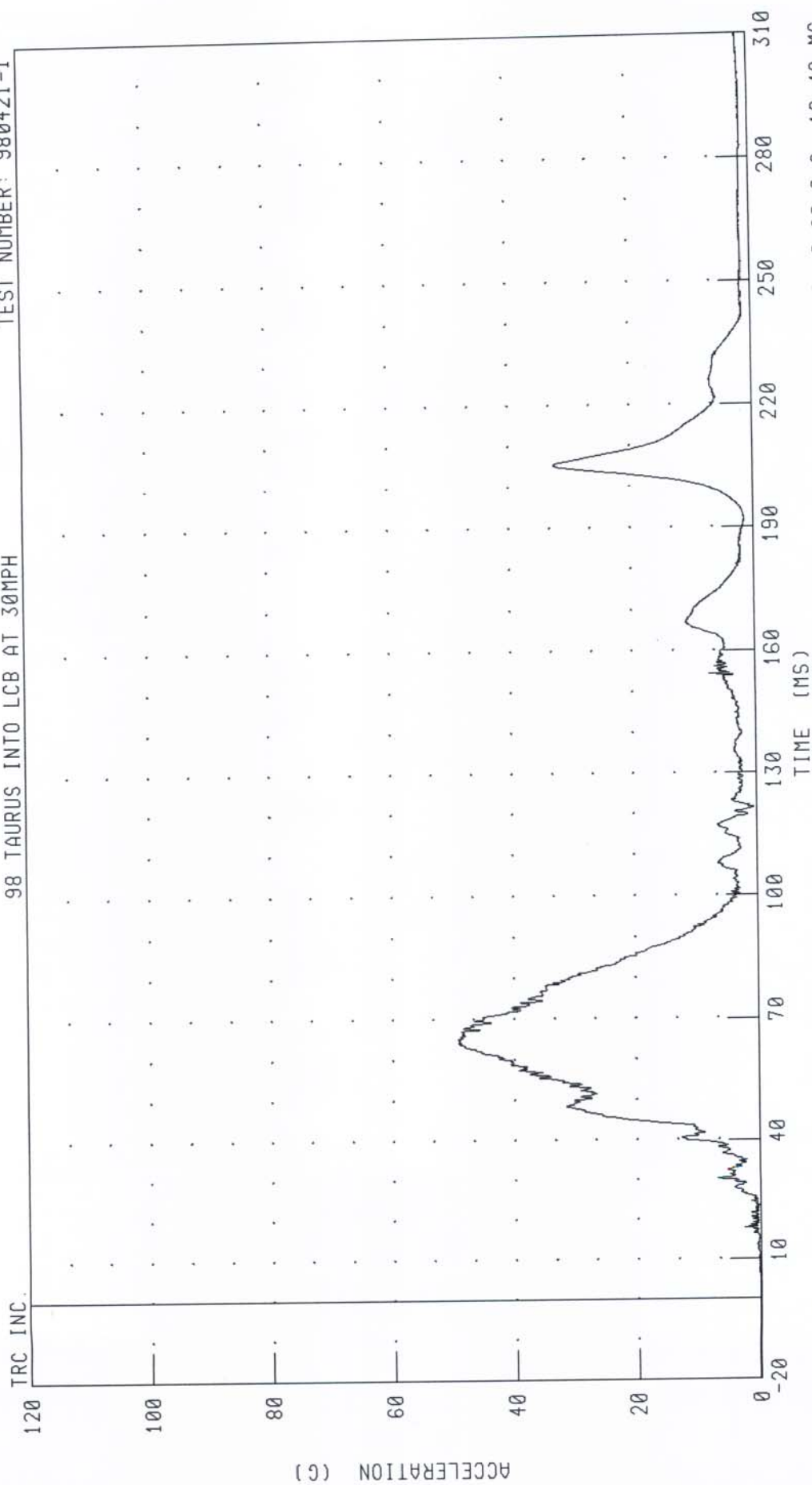
CHANNEL: HEDZG1 FILTER: CH. CLASS 1000

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER HEAD RESULTANT ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: HEDRG1 FILTER: CH. CLASS 1000

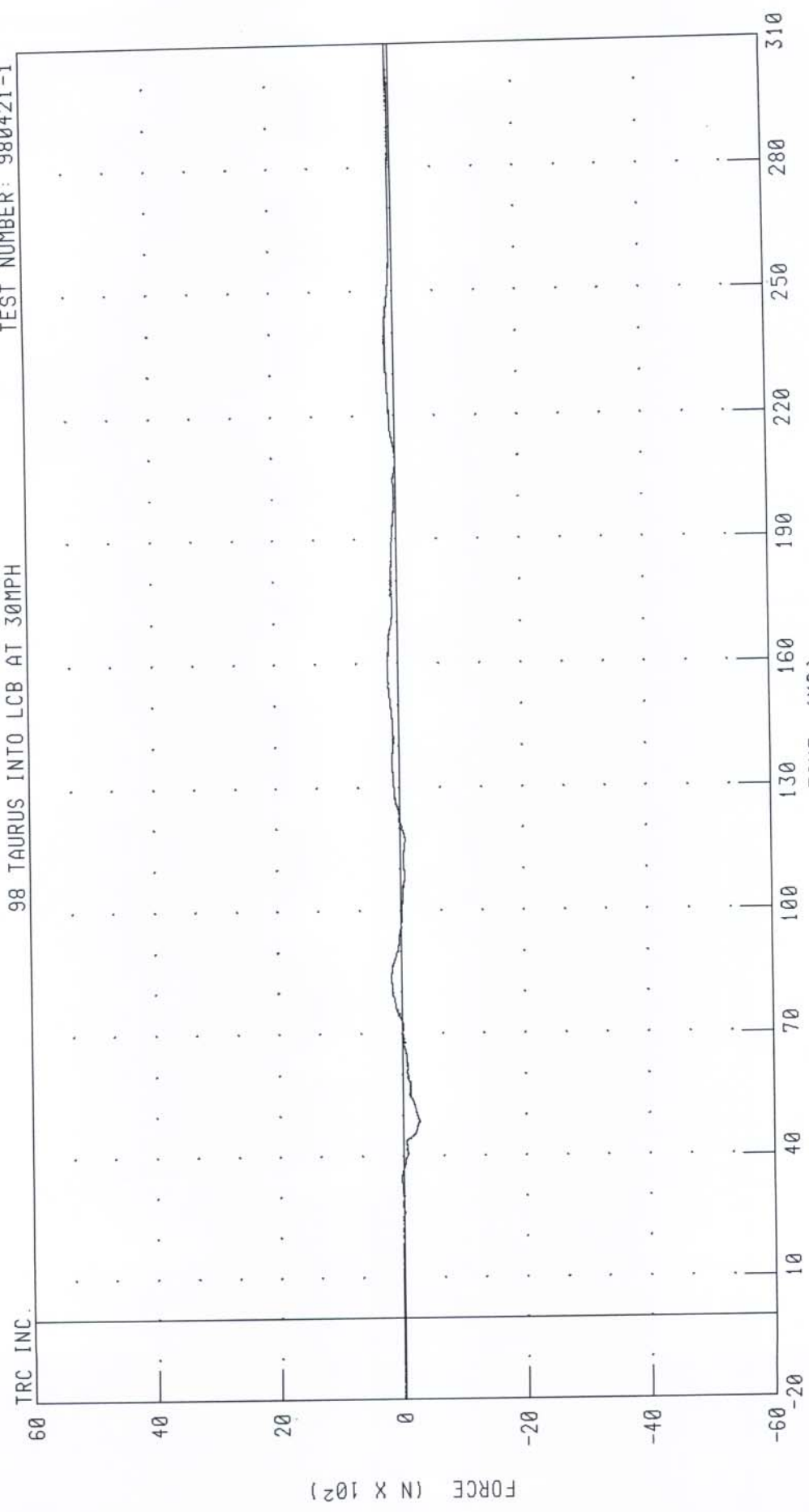
PEAK DATA: 49.29 G @ 65.12 MS, 0.06 G @ -16.40 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER NECK X-AXIS SHEAR FORCE

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



TIME (MS)

PEAK DATA: 165.00 N @ 83.04 MS, -269.91 N @ 48.56 MS

CHANNEL: NEKXF1 FILTER: CH. CLASS 1000

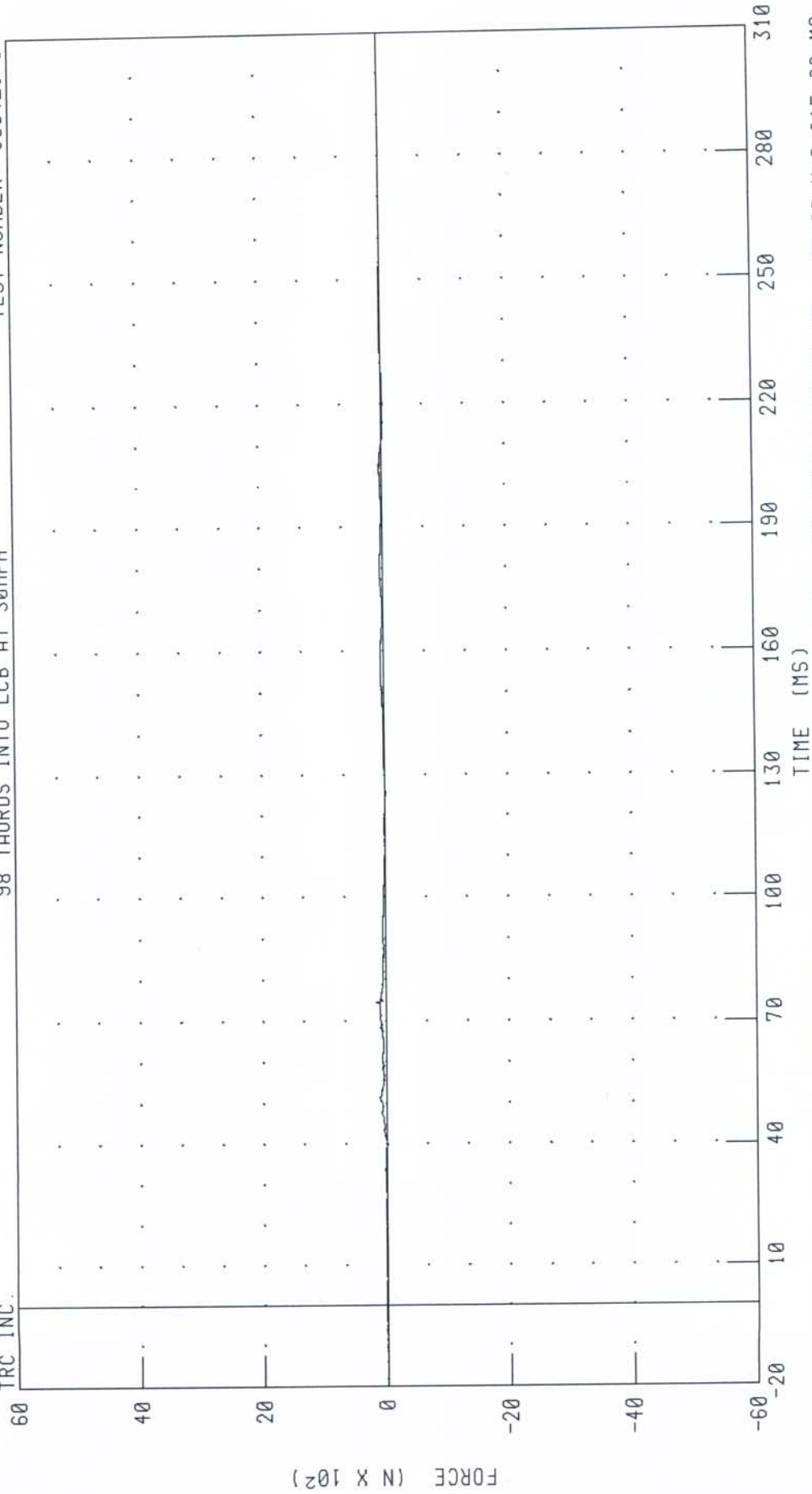
1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER NECK Y-AXIS SHEAR FORCE

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH

TRC INC.



CHANNEL: NEKYF1 FILTER: CH. CLASS 1000

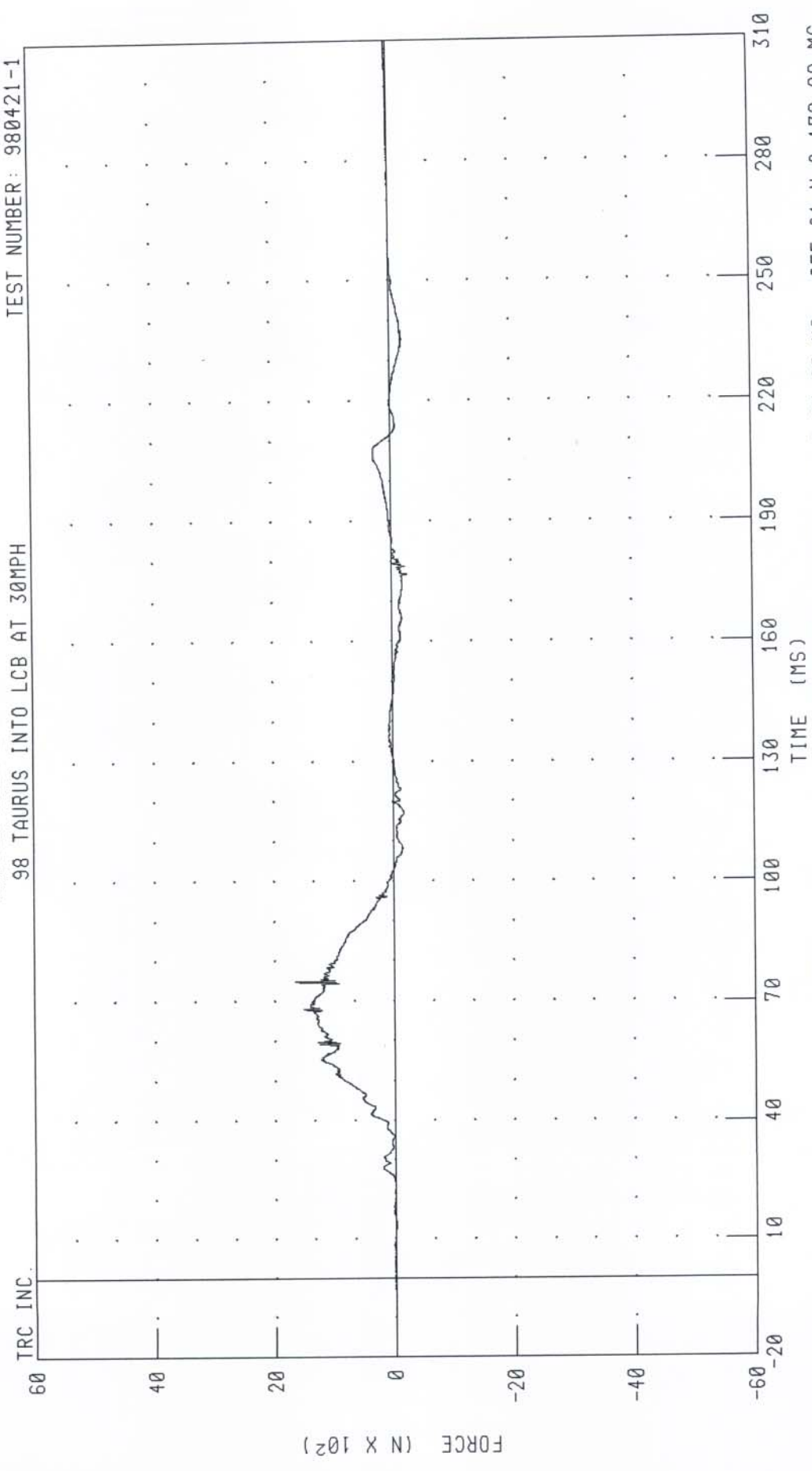
PEAK DATA: 154.36 N @ 74.64 MS; -36.80 N @ 215.60 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER NECK Z-AXIS AXIAL FORCE

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



PEAK DATA: 1648.24 N @ 74.88 MS; -255.01 N @ 176.88 MS

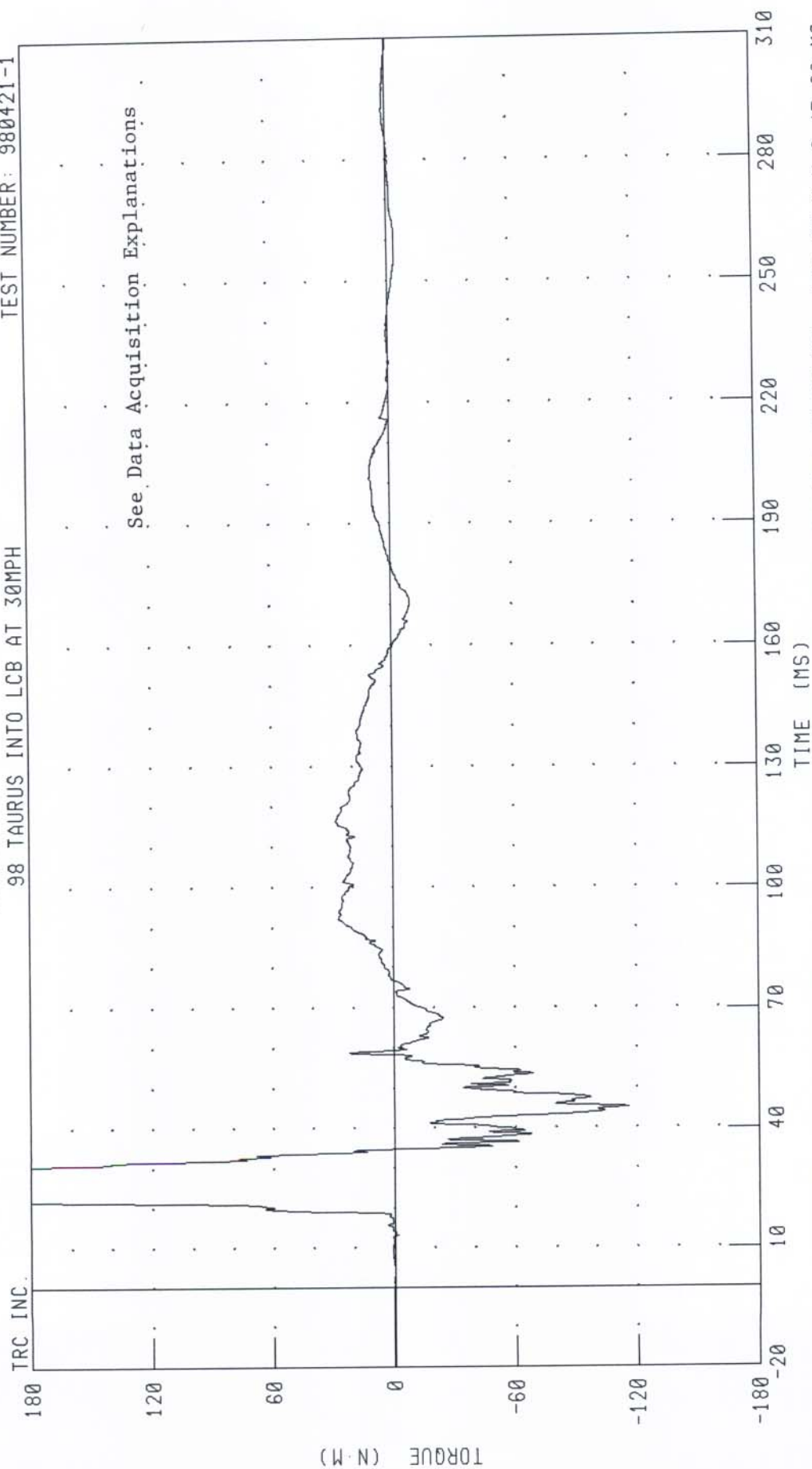
CHANNEL: NEKZF1 FILTER: CH. CLASS 1000

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER NECK MOMENT ABOUT X AXIS

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: NEKX11 FILTER: CH. CLASS 600

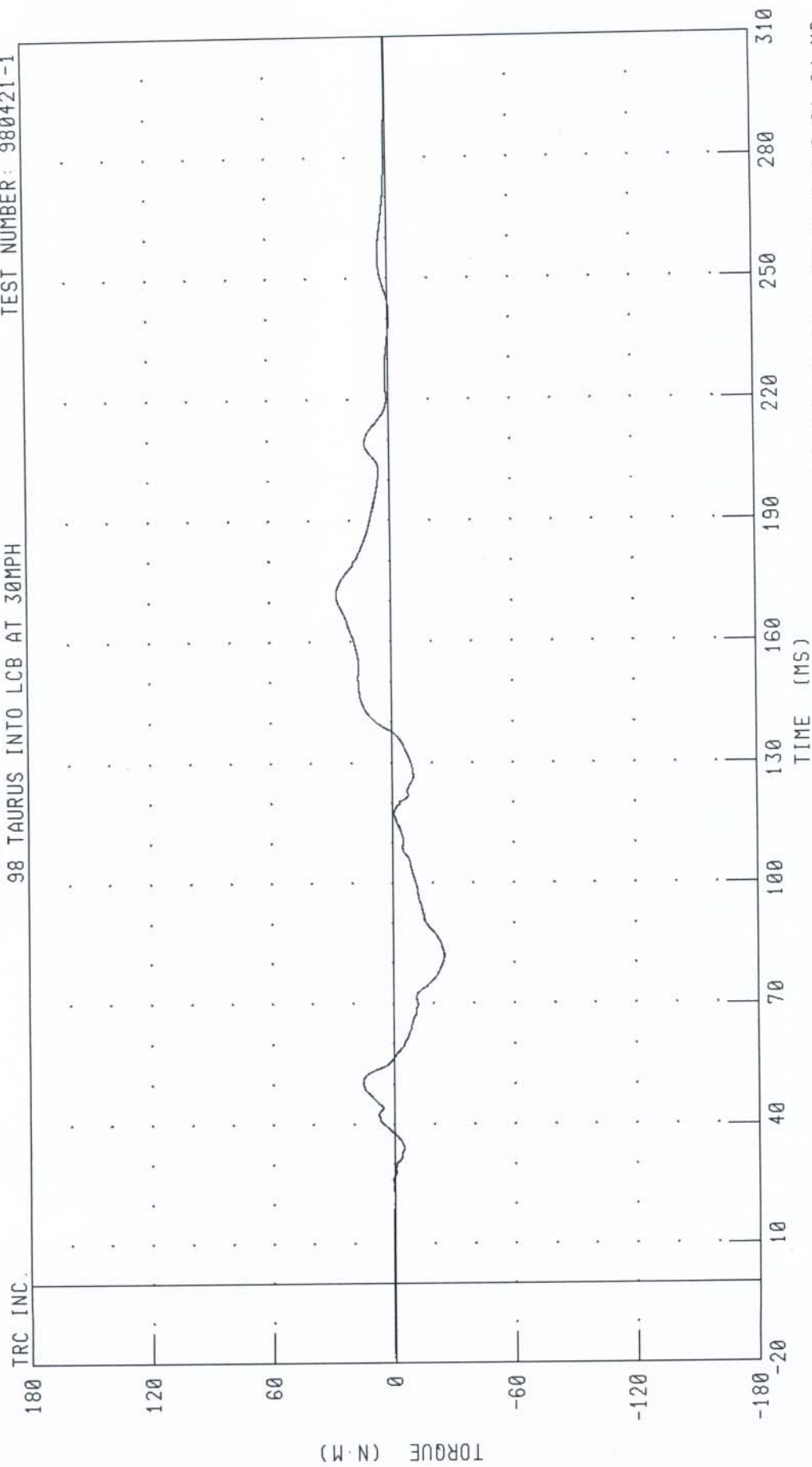
PEAK DATA: 286.23 N·M @ 29.68 MS, -116.20 N·M @ 45.28 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER NECK MOMENT ABOUT Y AXIS

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: NEKYM1 FILTER: CH. CLASS 600

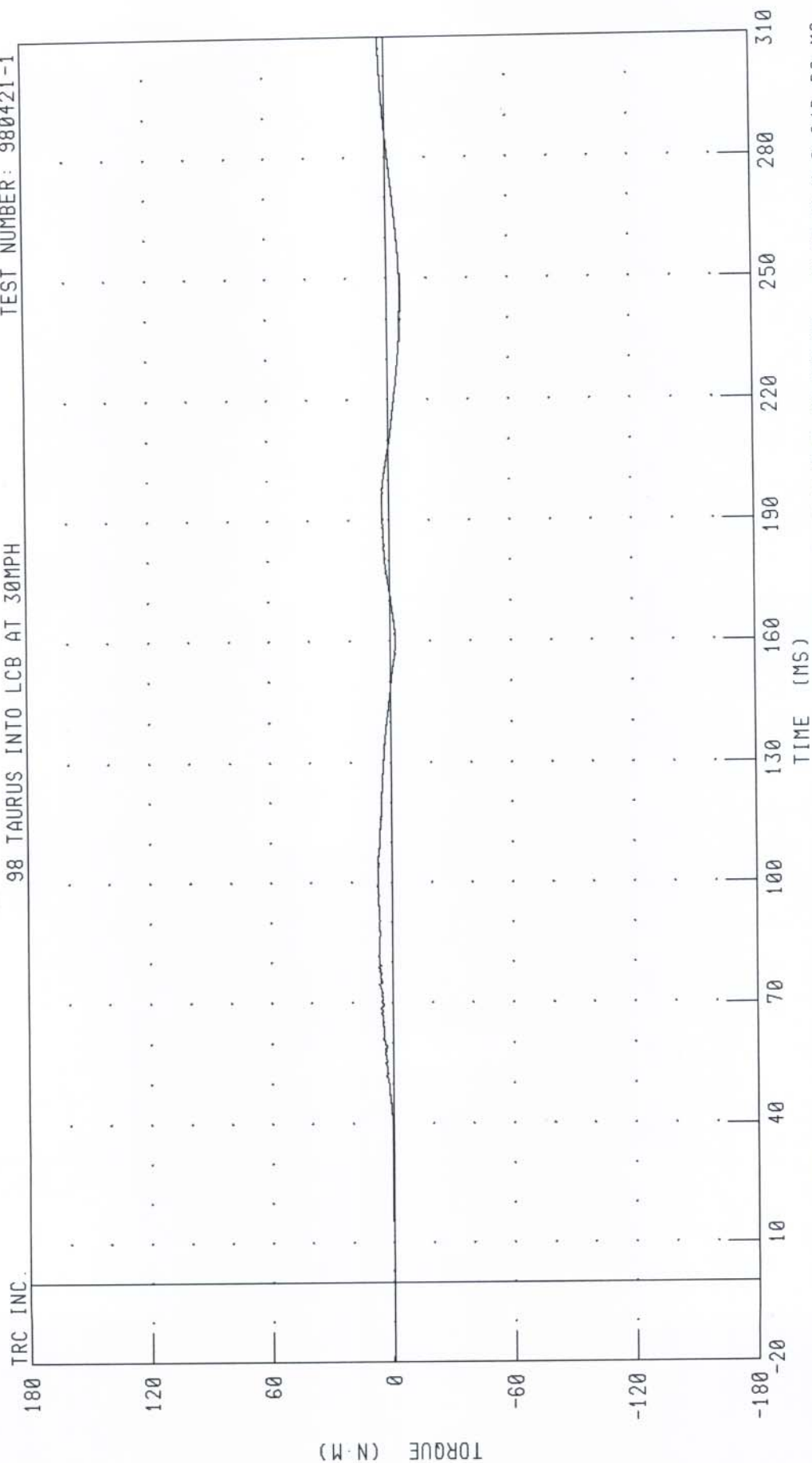
PEAK DATA: 26.72 N·M @ 172.24 MS, -25.44 N·M @ 81.84 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER NECK MOMENT ABOUT Z AXIS

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: NEKZM1 FILTER: CH. CLASS 600

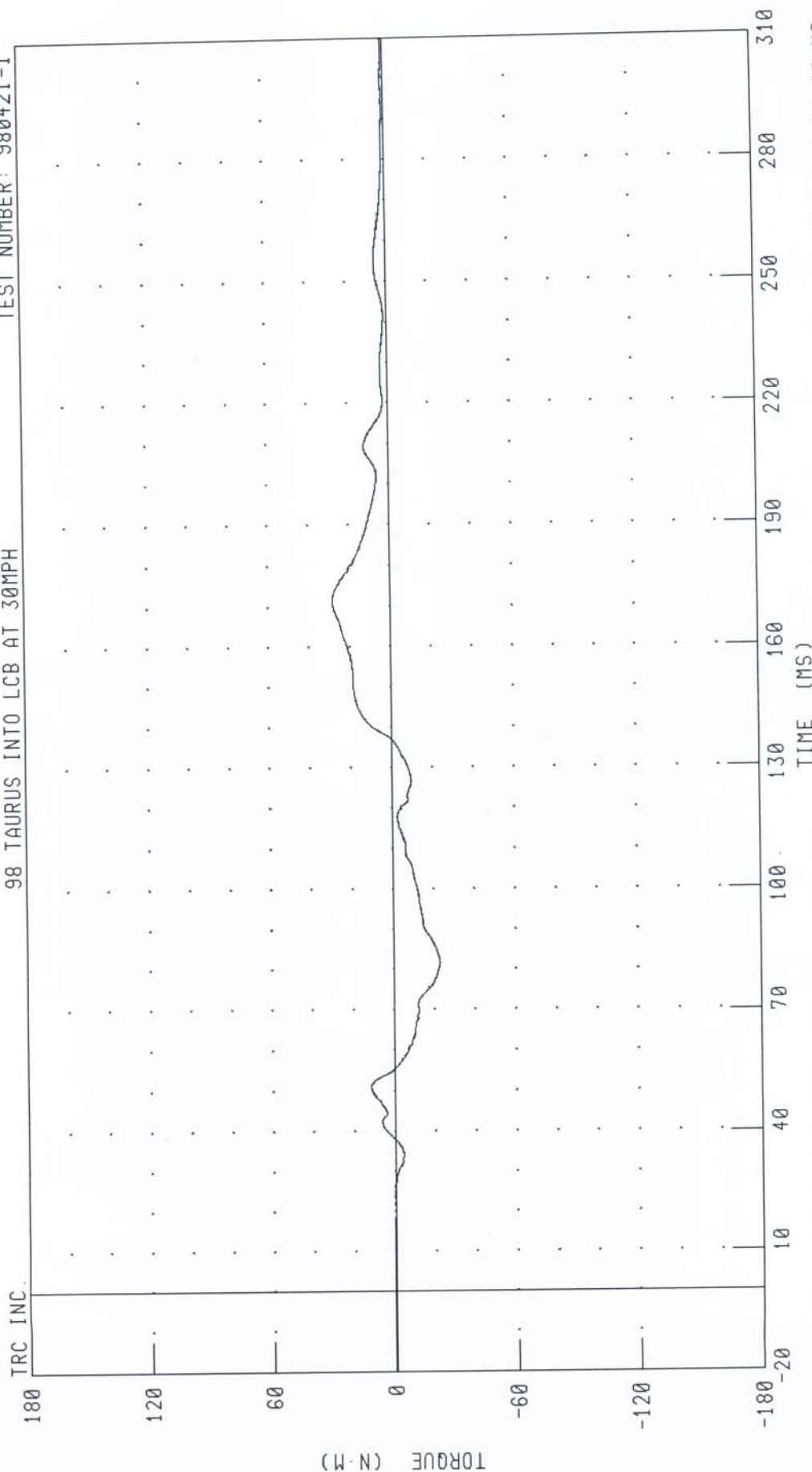
PEAK DATA: 7.18 N·M @ 99.28 MS; -6.77 N·M @ 246.08 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER NECK OCCIPITAL CONDYLE ABOUT Y AXIS

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: NEKOM1 FILTER: CH. CLASS 600

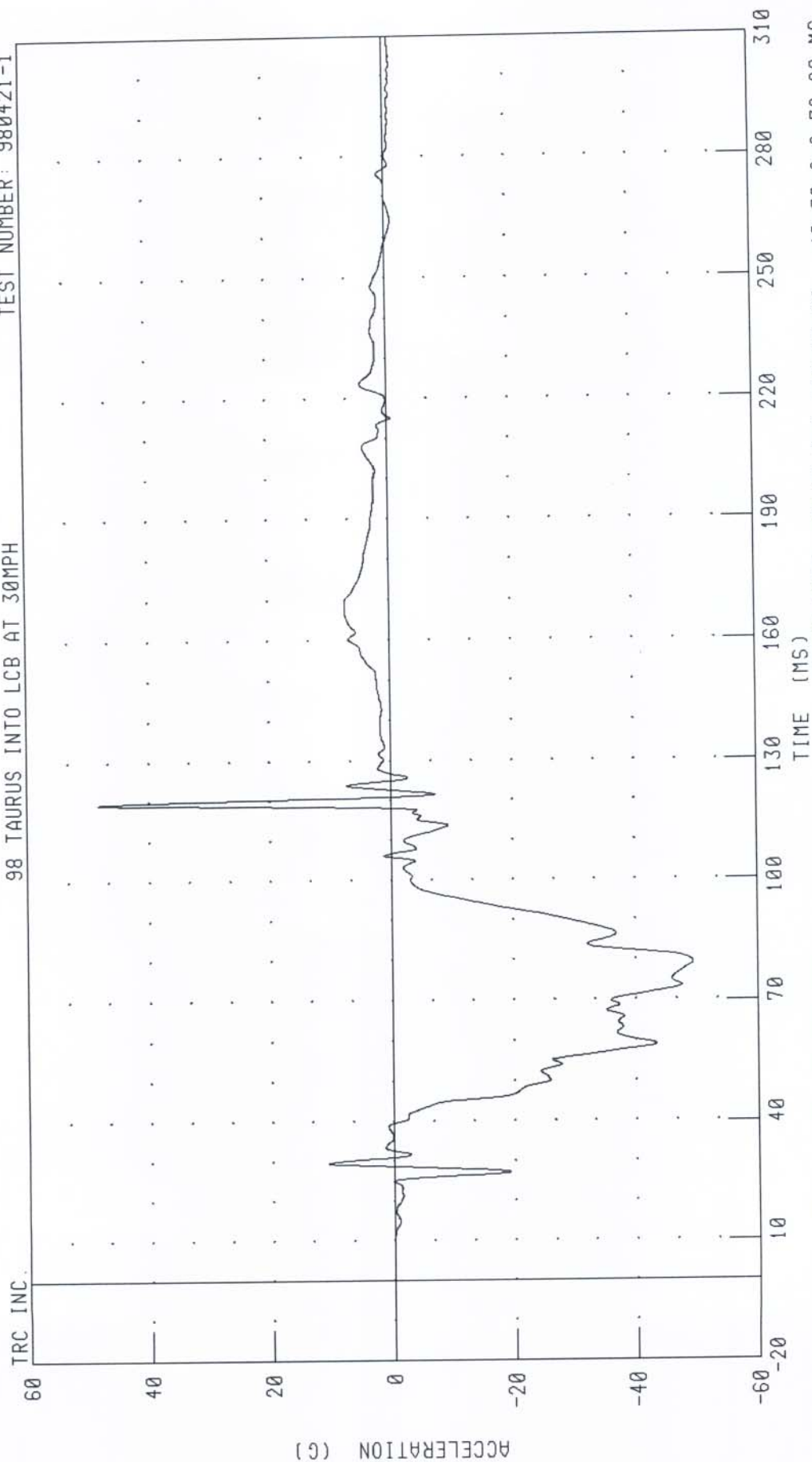
PEAK DATA: 28.28 N·M @ 171.36 MS; -22.87 N·M @ 81.92 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER CHEST X-AXIS ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



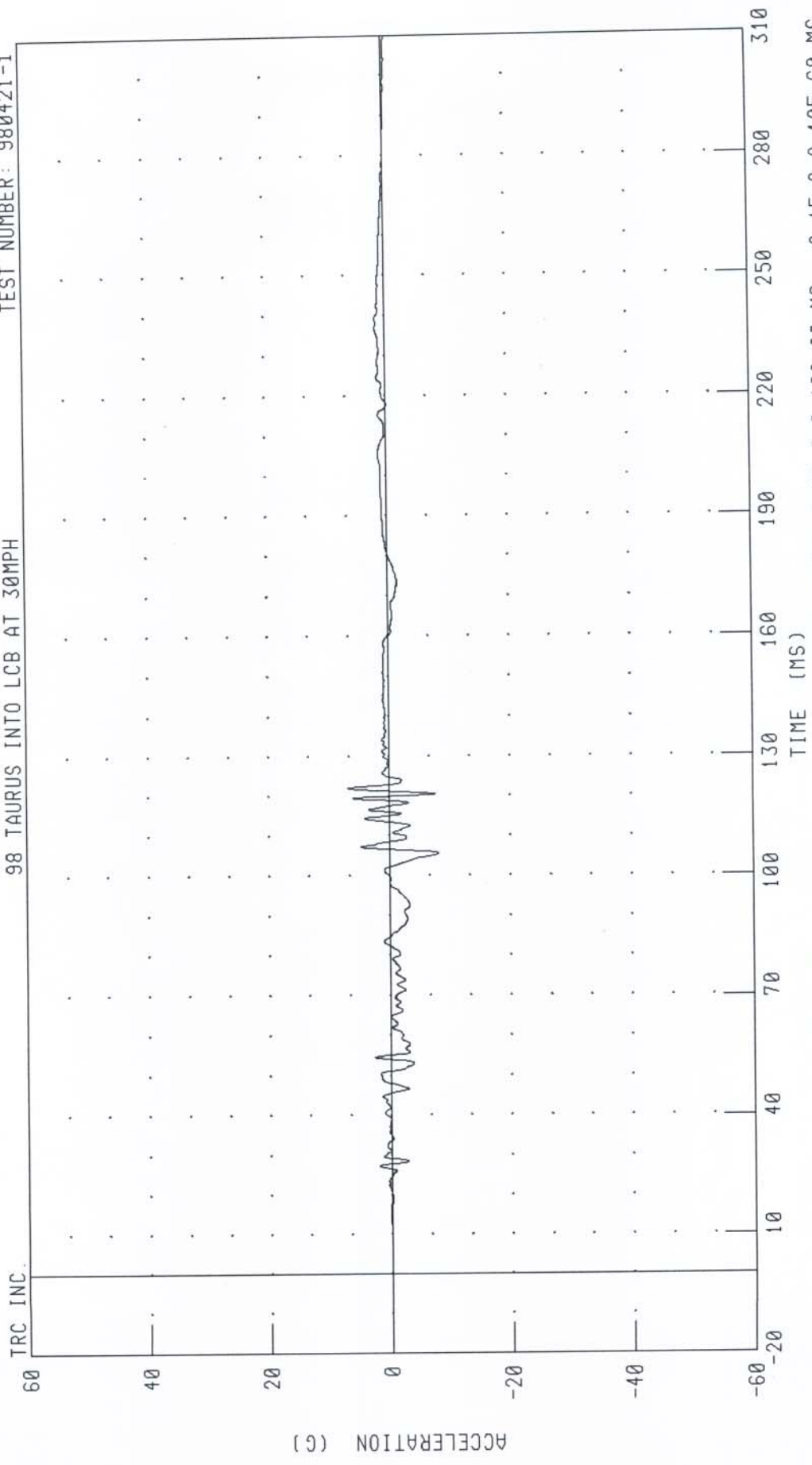
CHANNEL: CSTXG1 FILTER: CH. CLASS 180

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER CHEST Y-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: CSTYG1 FILTER: CH. CLASS 180

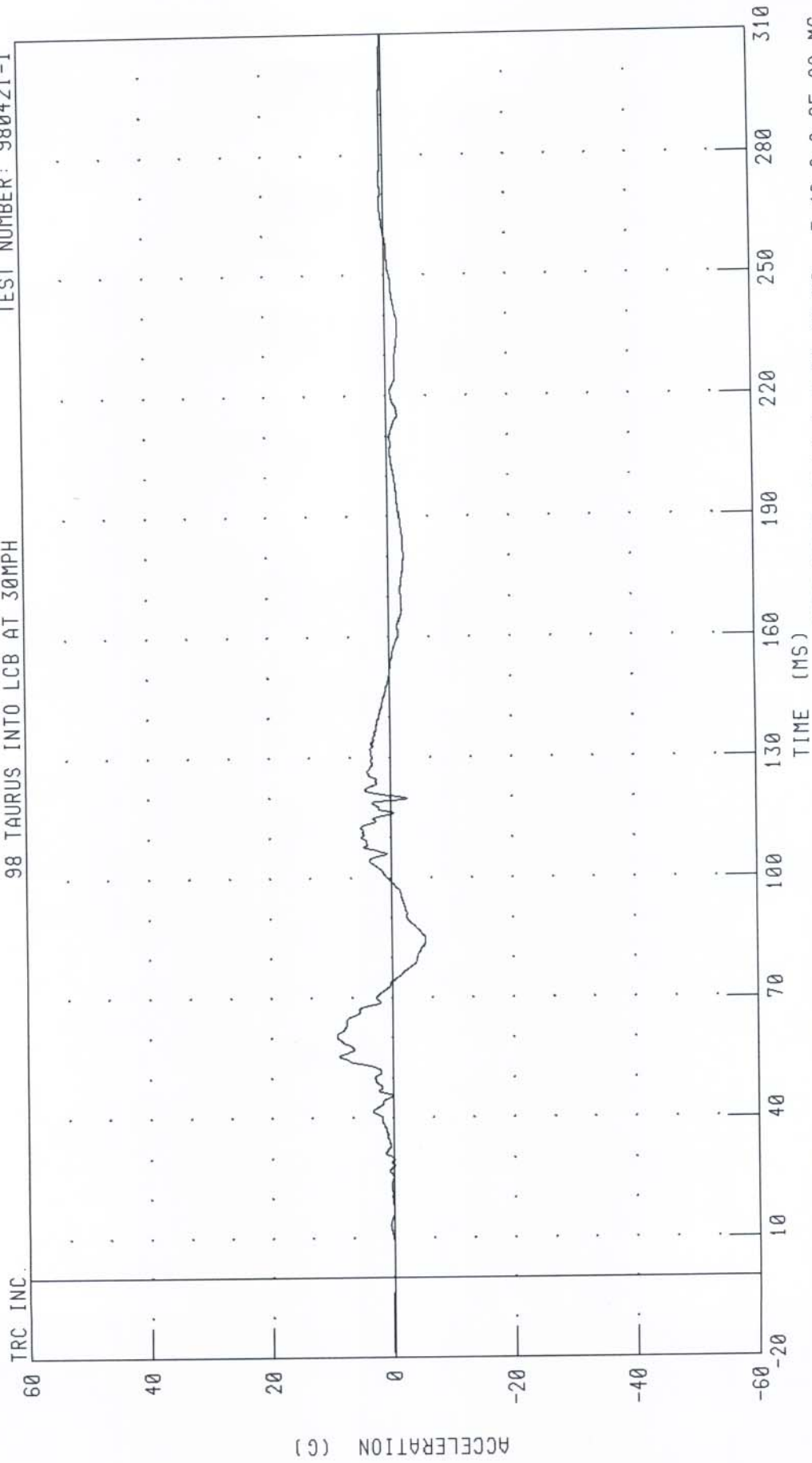
PEAK DATA: 6.82 G @ 122.08 MS; -8.15 G @ 105.60 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER CHEST Z-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



PEAK DATA: 9.11 G @ 60.40 MS, -5.49 G @ 85.28 MS

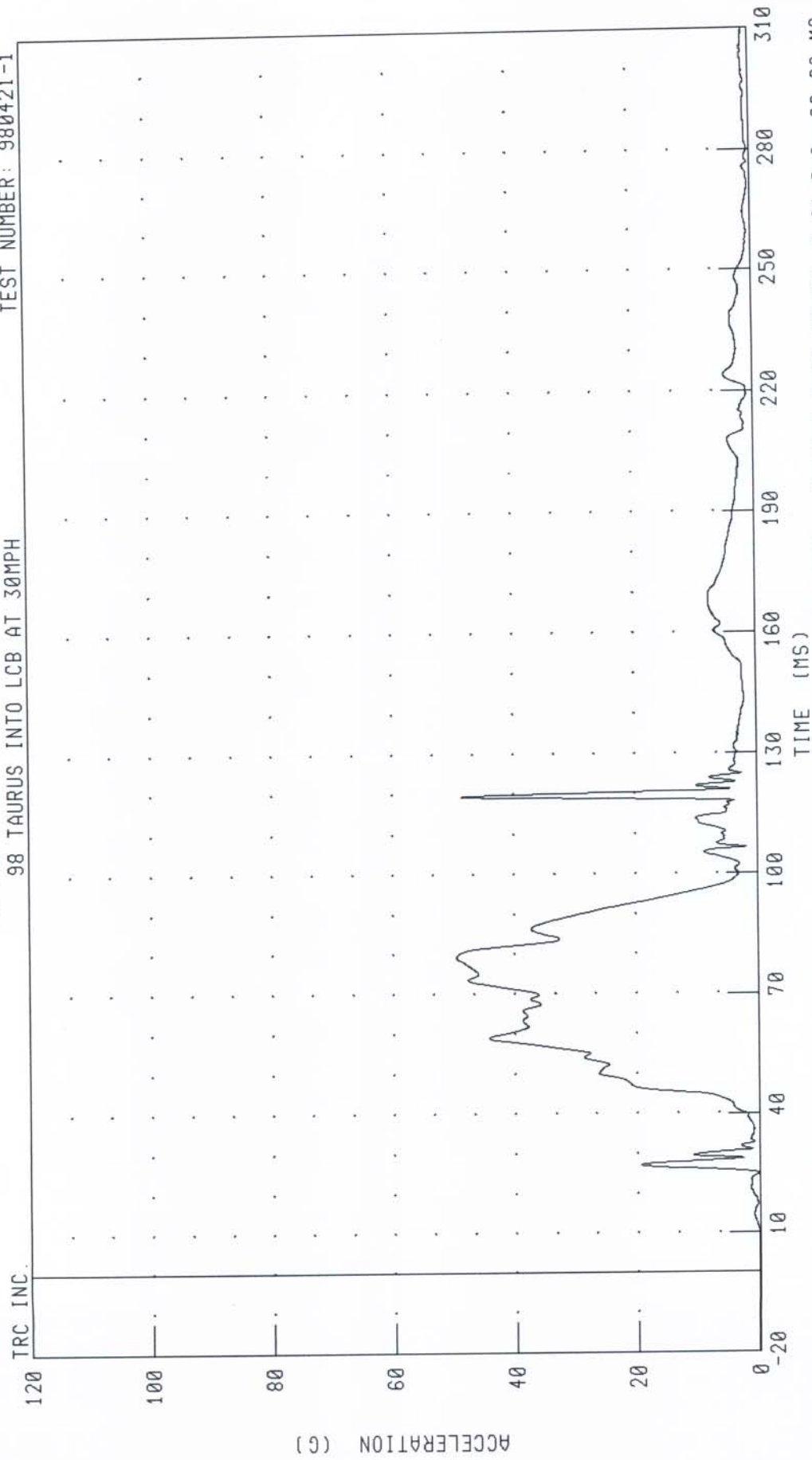
CHANNEL: CSTZG1 FILTER: CH. CLASS 180

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER CHEST RESULTANT ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: CSTR01 FILTER: CH. CLASS 180

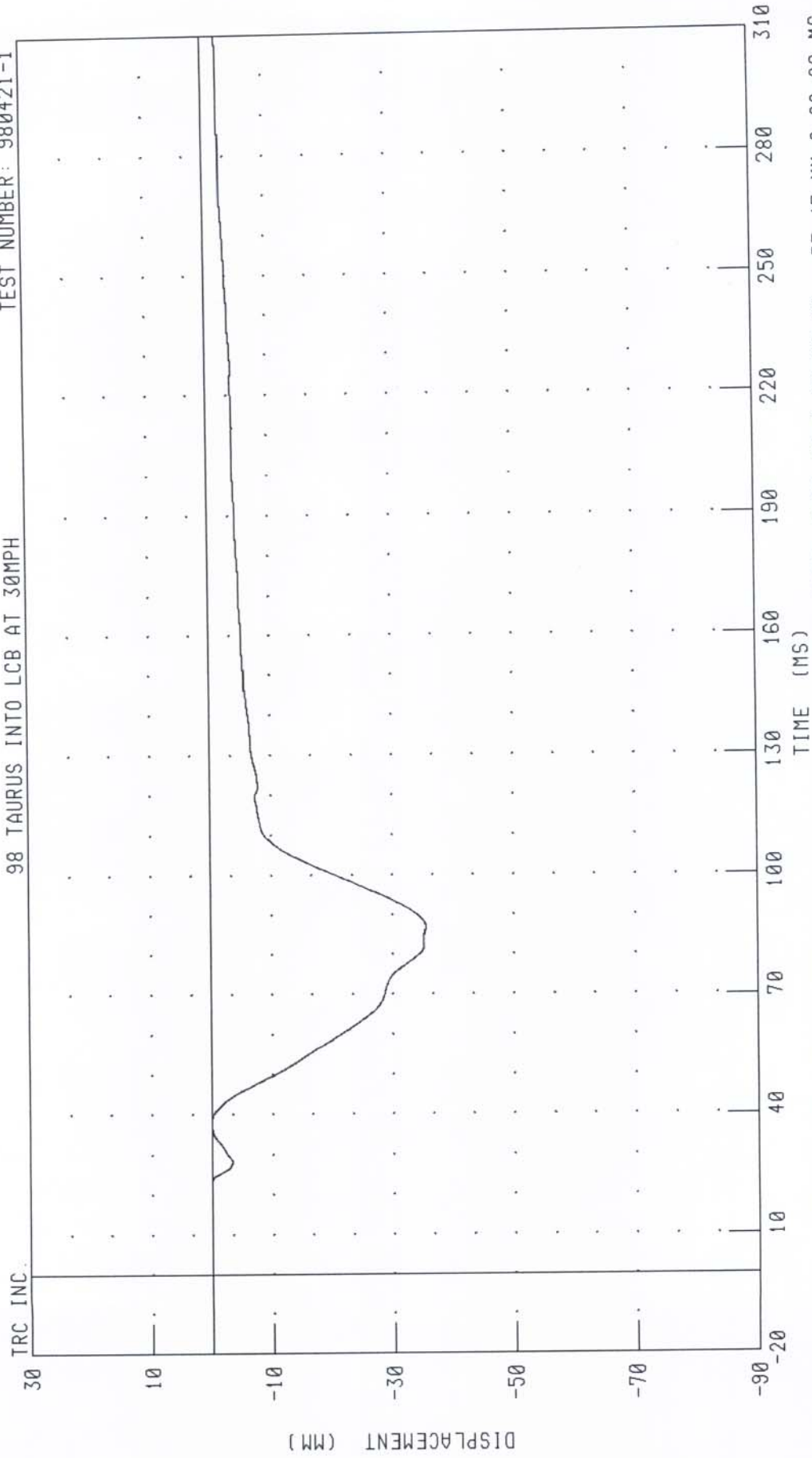
PEAK DATA: 49.56 G @ 79.28 MS; 0.01 G @ -20.00 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER CHEST DEFLECTION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



PEAK DATA: 0.09 MM @ 38.08 MS; -35.47 MM @ 86.96 MS

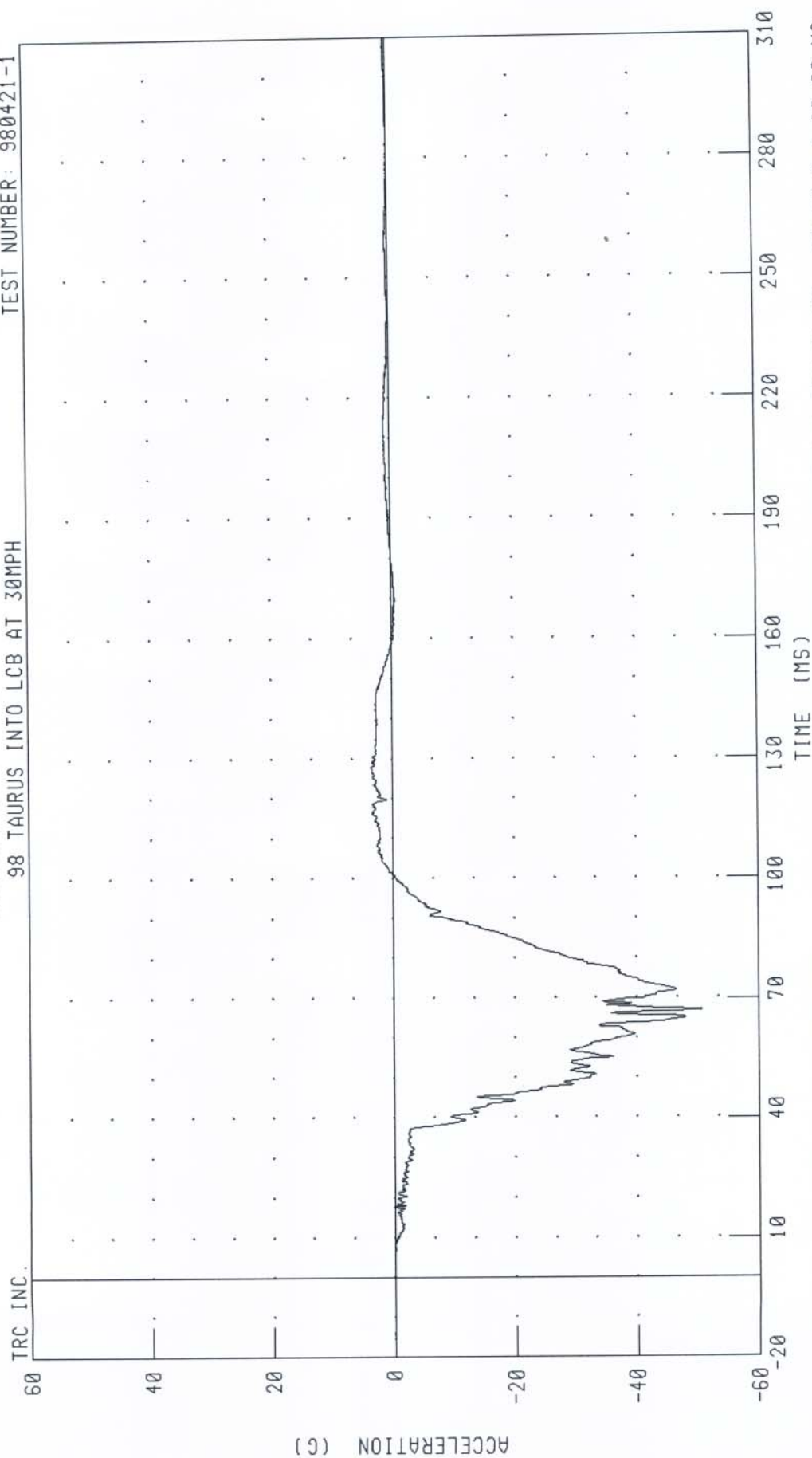
CHANNEL: CSTXD1 FILTER: CH. CLASS 180

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER PELVIS X-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



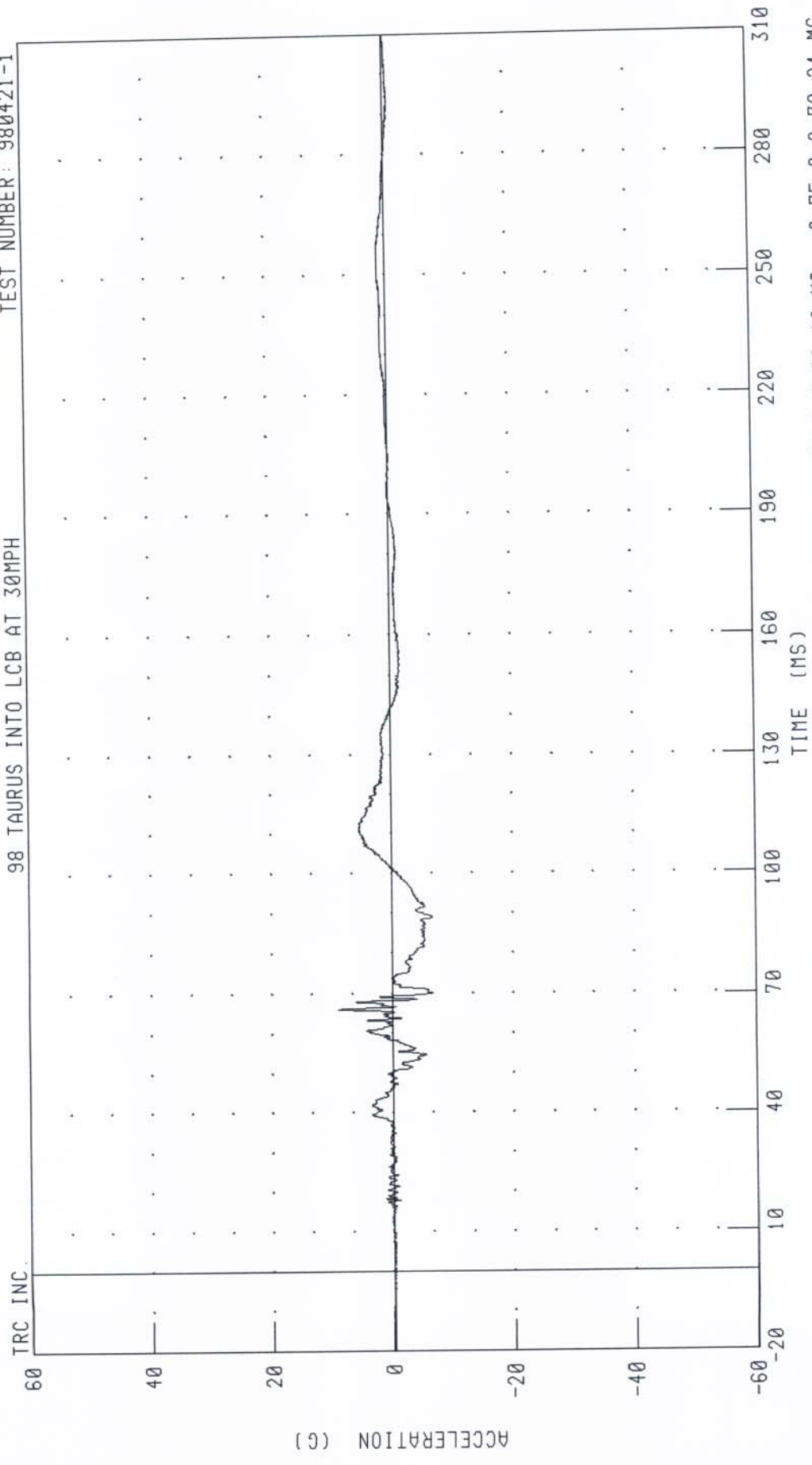
CHANNEL: PEVXG1 FILTER: CH. CLASS 1000

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER PELVIS Y-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



PEAK DATA: 8.84 G @ 66.16 MS; -6.75 G @ 70.24 MS

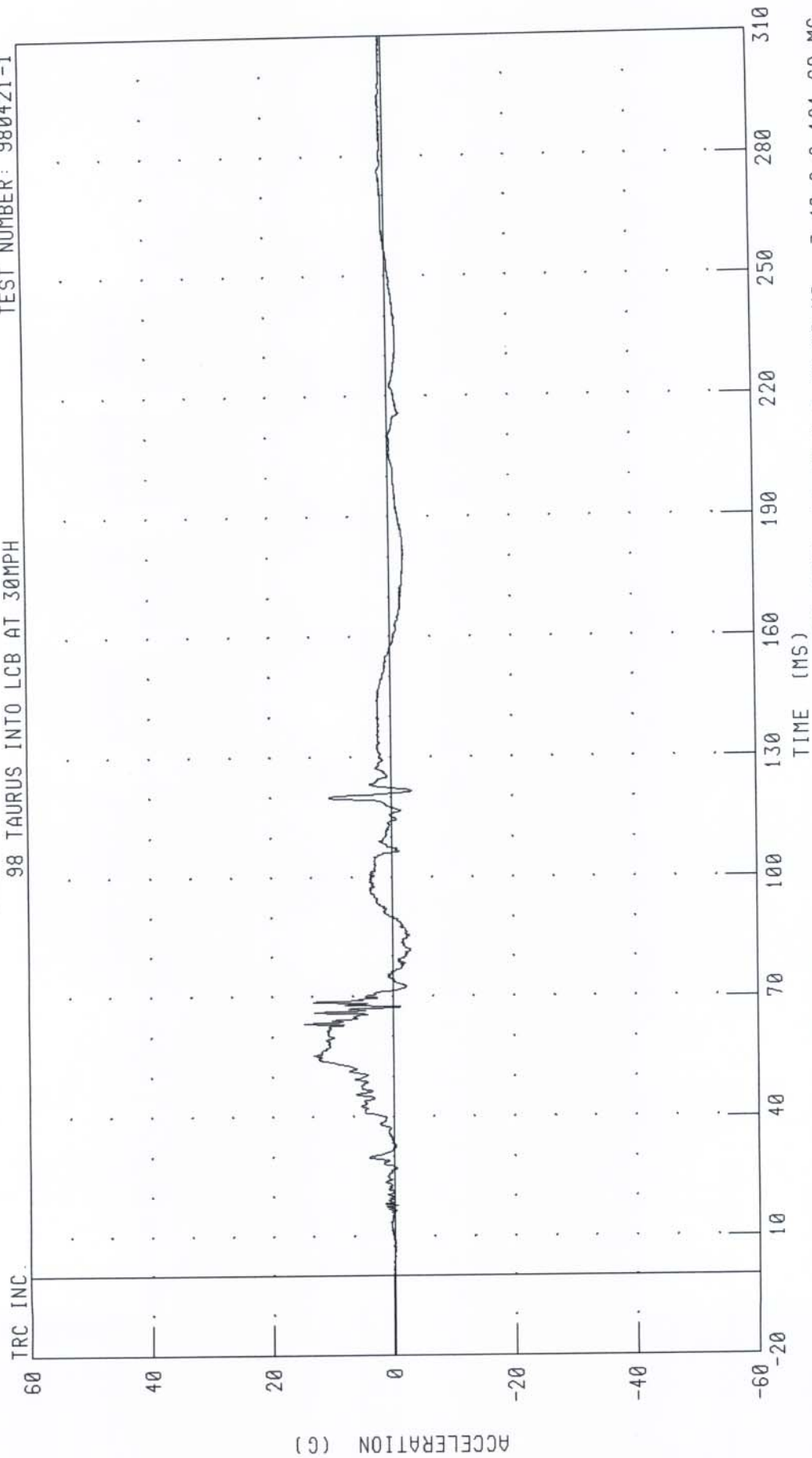
CHANNEL: PEVYG1 FILTER: CH. CLASS 1000

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER PELVIS Z-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: PEVZG1 FILTER: CH. CLASS 1000

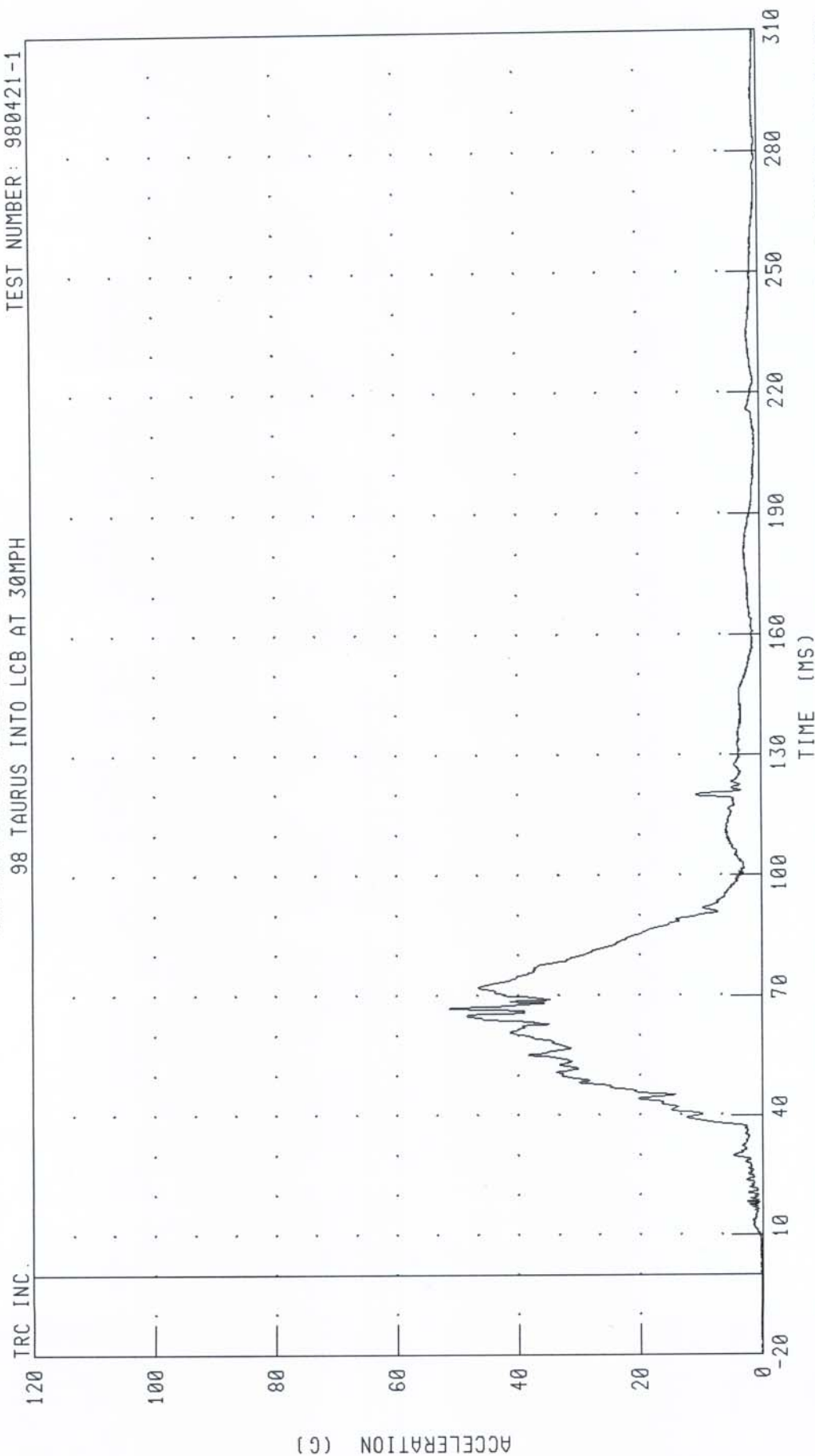
PEAK DATA: 14.68 G @ 63.28 MS, -3.40 G @ 121.68 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER PELVIS RESULTANT ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: PEVRG1 FILTER: CH. CLASS 1000

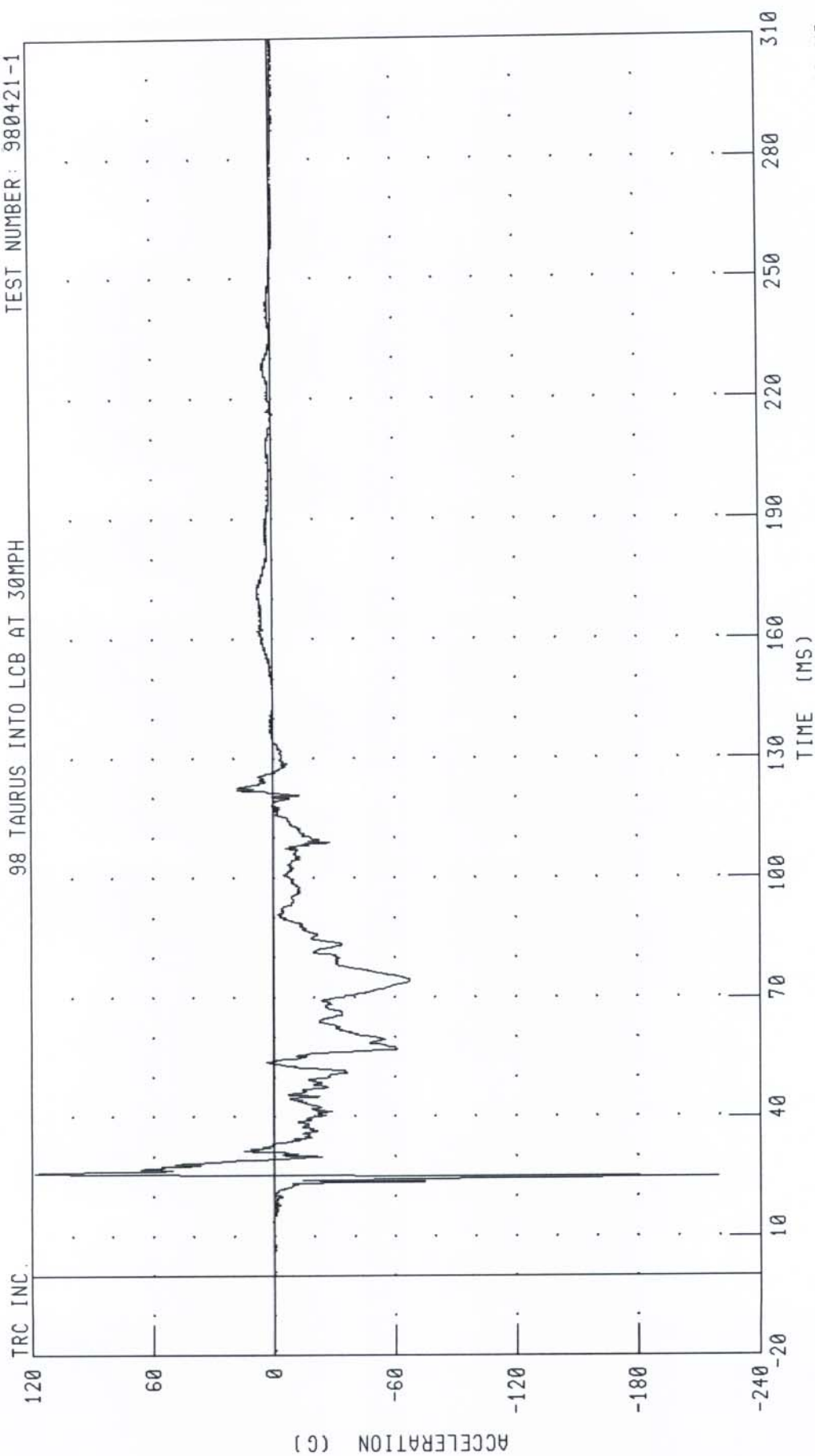
PEAK DATA: 51.26 G @ 66.88 MS; 0.05 G @ -15.44 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER STERNUM TOP X-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



PEAK DATA: 118.63 G @ 26.00 MS, -219.47 G @ 24.96 MS

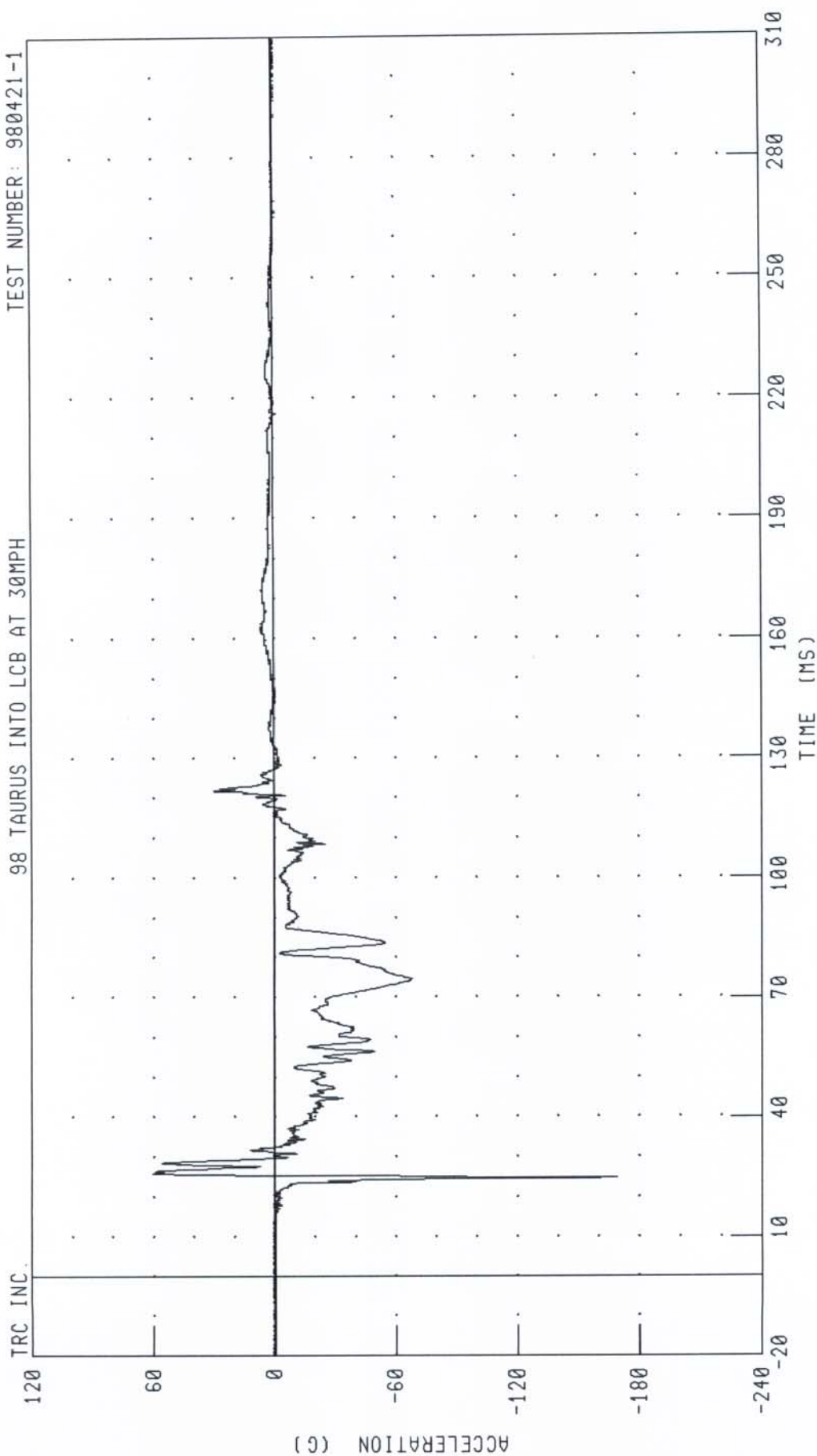
CHANNEL: STTXG1 FILTER: CH CLASS 1000

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER STERNUM MIDDLE X-AXIS ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: STMXG1 FILTER: CH. CLASS 1000

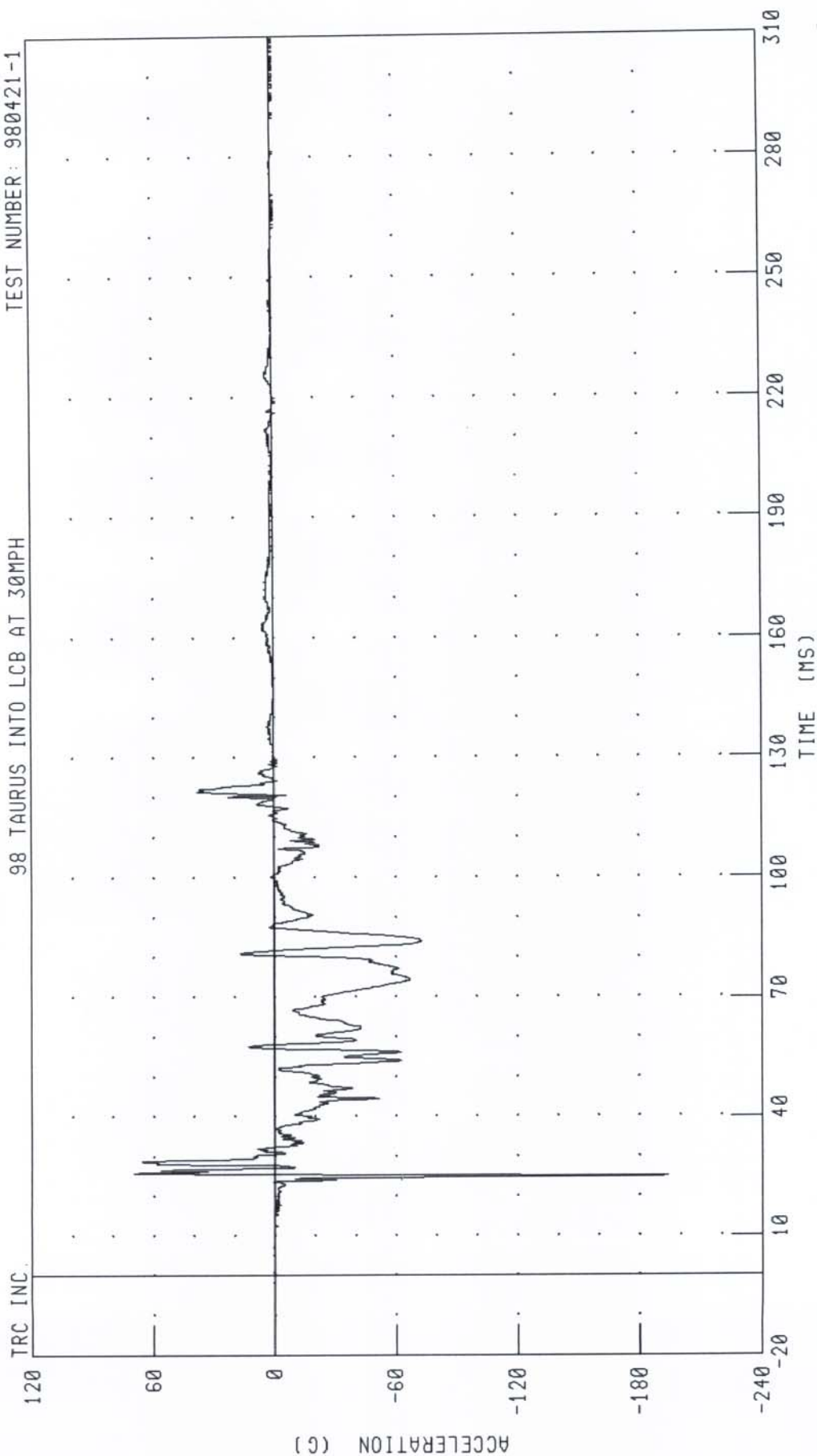
PEAK DATA: 60.89 G @ 26.00 MS, -169.14 G @ 24.80 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER STERNUM BOTTOM X-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: STBXC1 FILTER: CH. CLASS 1000

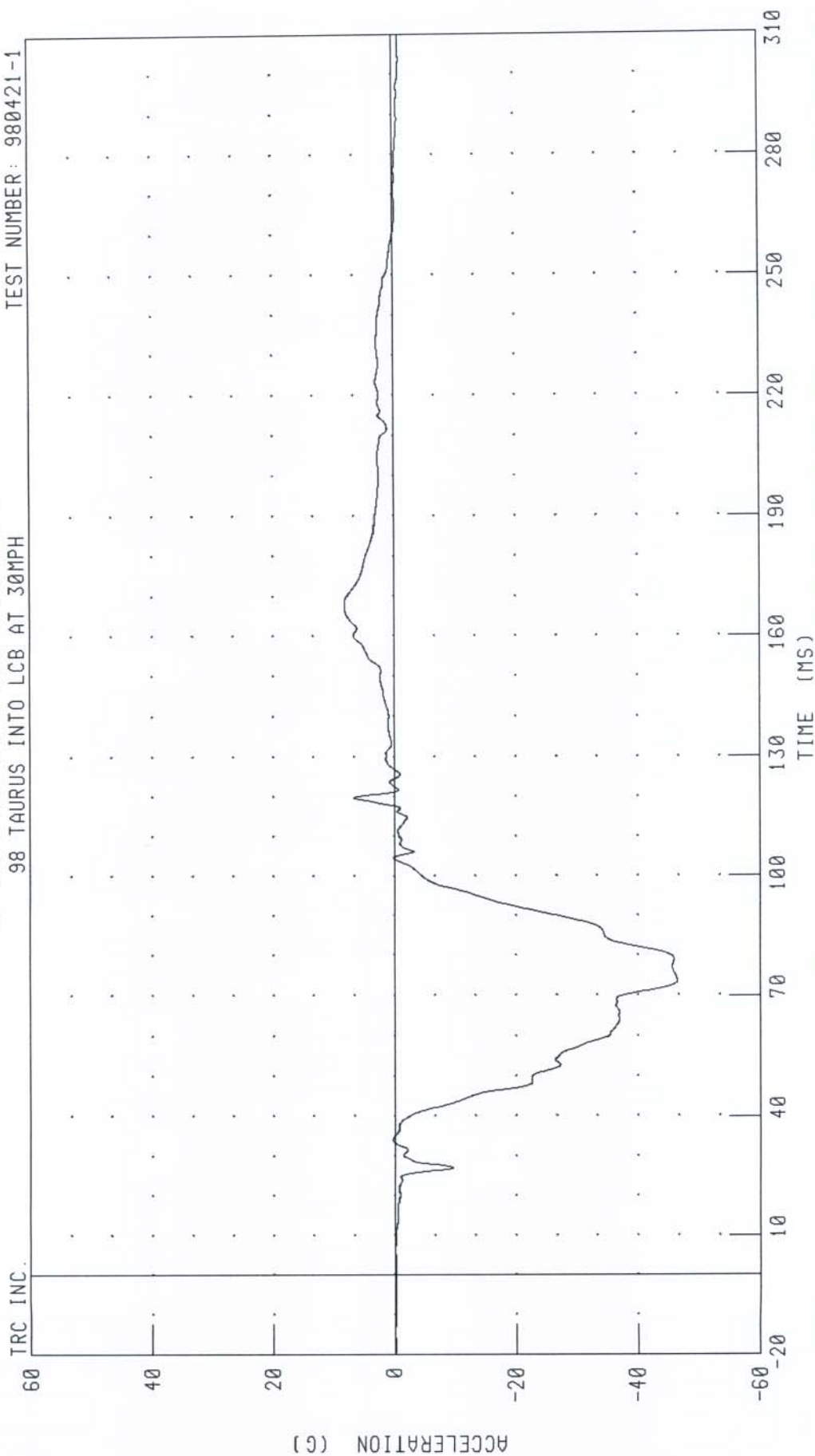
PEAK DATA: 69.64 G @ 26.00 MS; -193.88 G @ 25.12 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER SPINE TOP X-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH

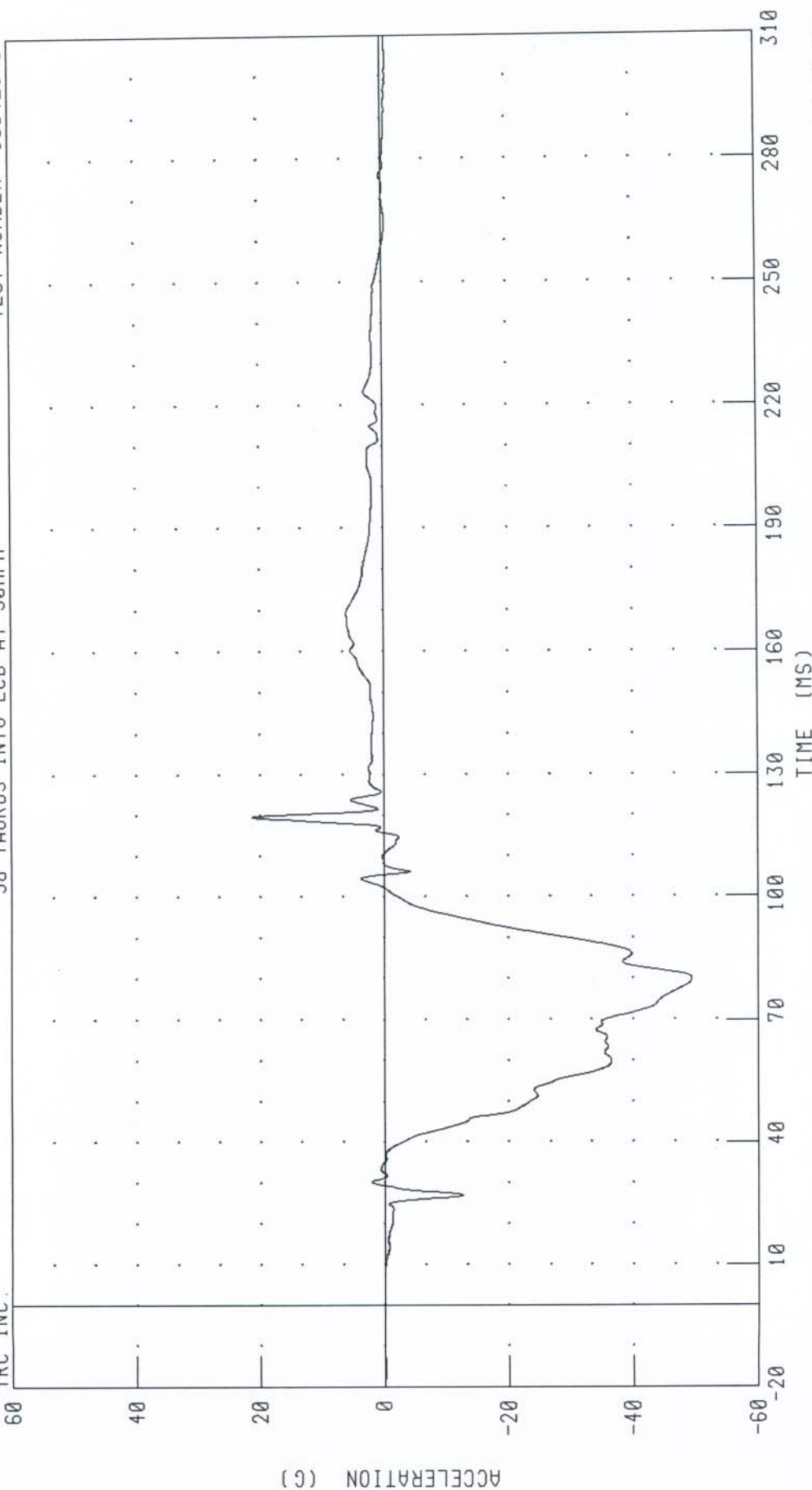


CHANNEL: SPTXG1 FILTER: CH. CLASS 180

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH
DRIVER SPINE MIDDLE X-AXIS ACCELERATION
98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1

TRC INC.



CHANNEL: SPMXG1 FILTER: CH CLASS 180

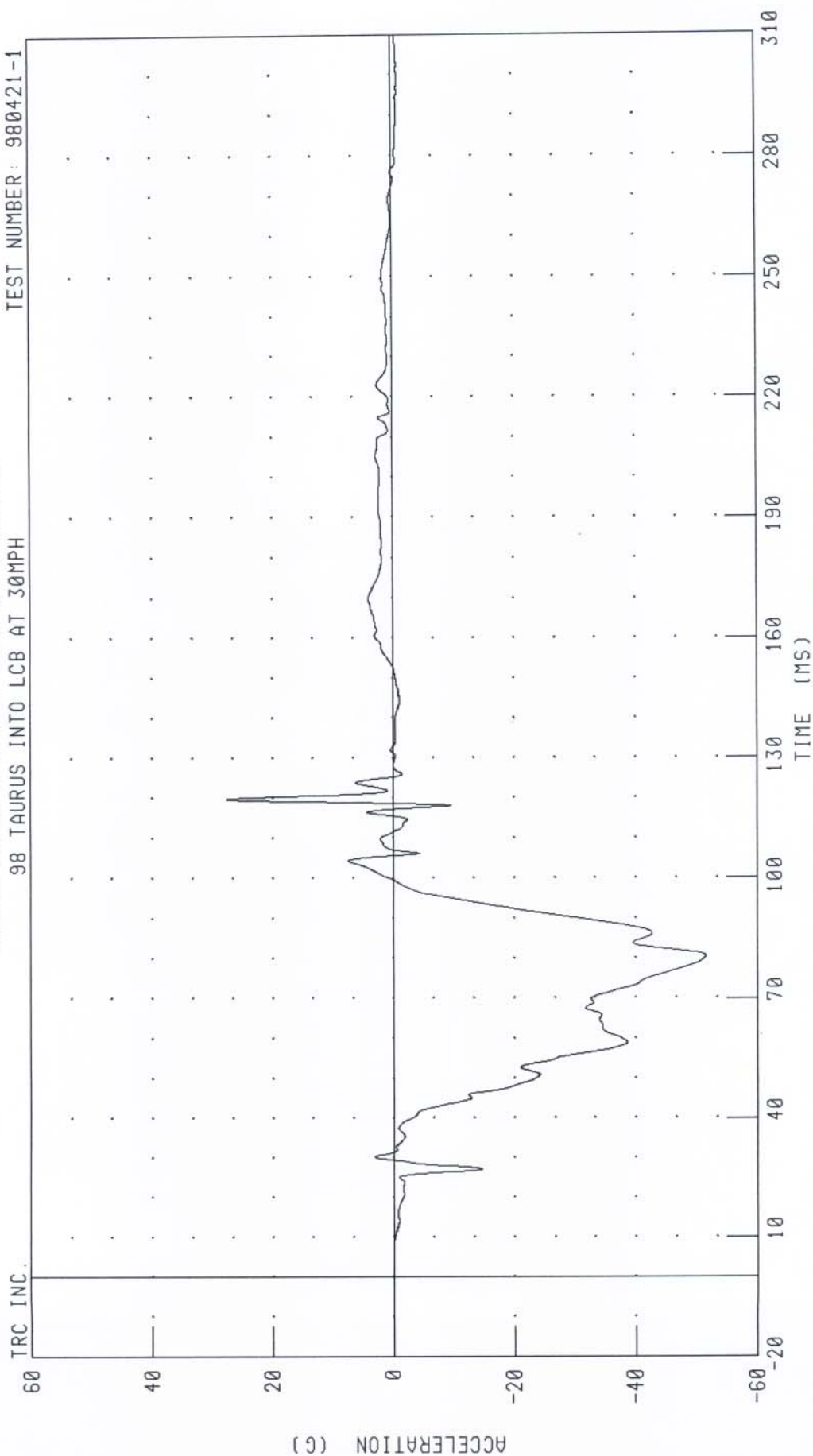
PEAK DATA: 21.28 G @ 119.76 MS; -49.42 G @ 80.08 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER SPINE BOTTOM X-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: SPBXG1 FILTER: CH. CLASS 180

PEAK DATA: 27.53 G @ 119.76 MS; -51.54 G @ 80.64 MS

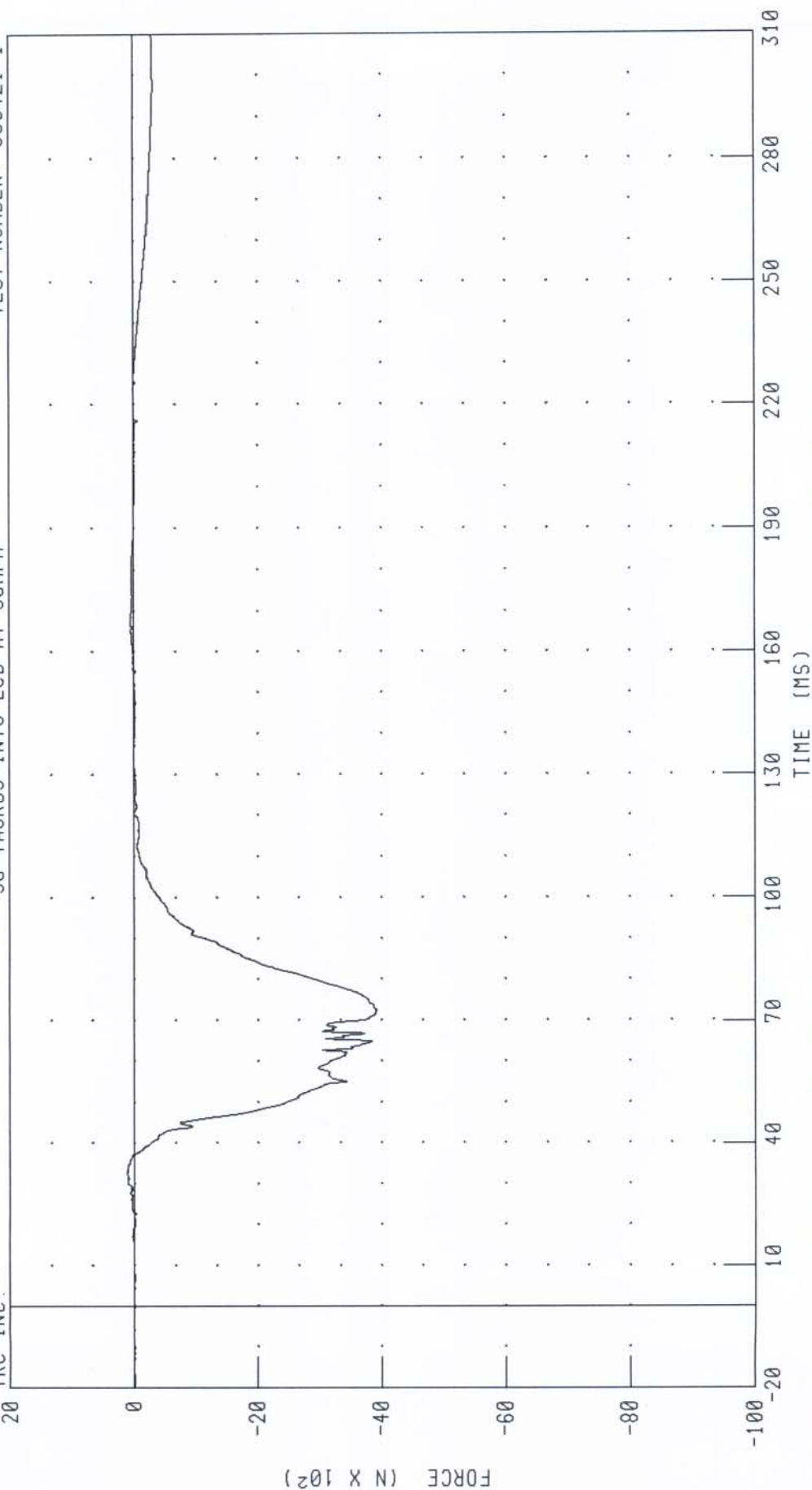
1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER LEFT FEMUR FORCE

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1

TRC INC.



CHANNEL: LFMF1 FILTER: CH. CLASS 600

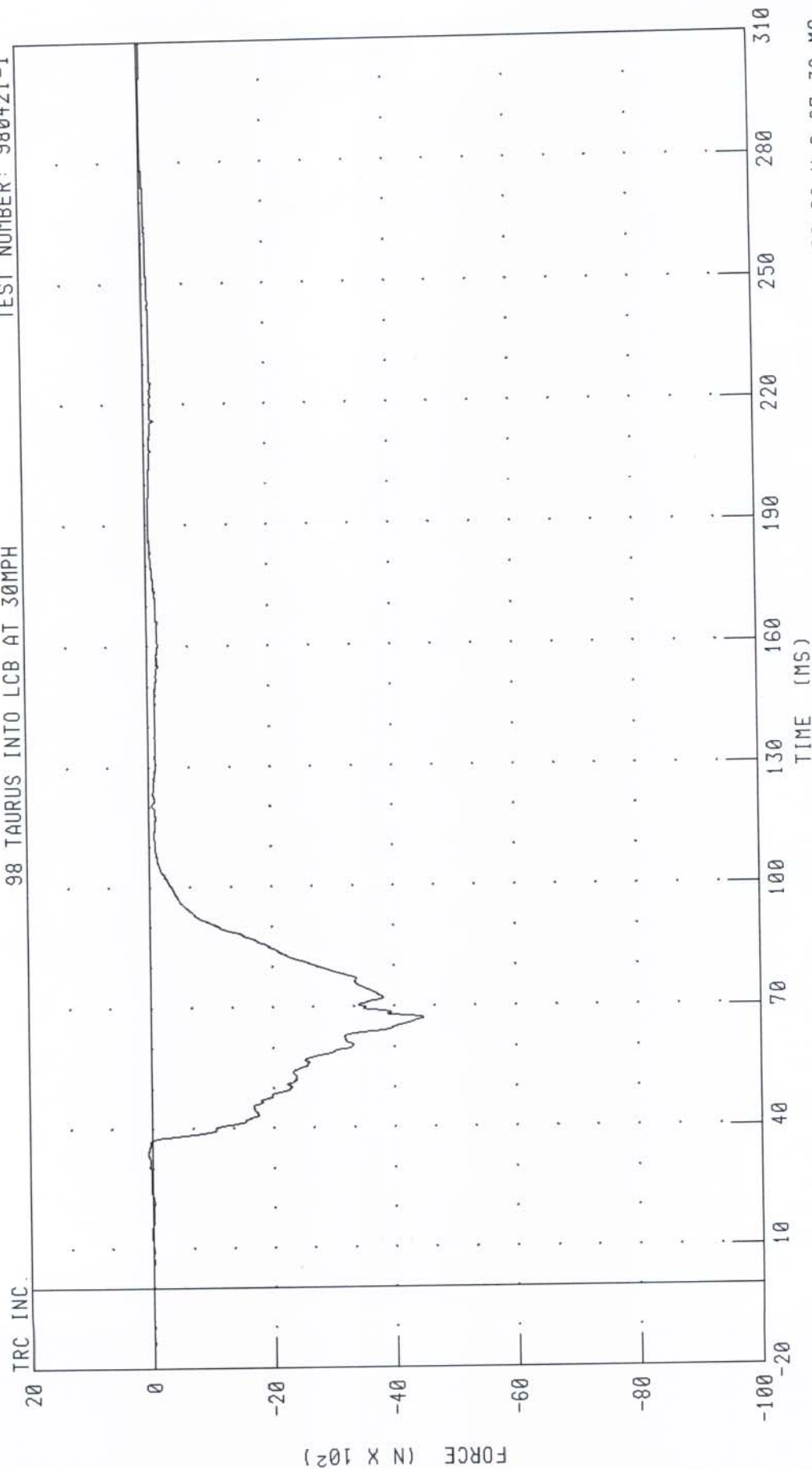
PEAK DATA: 124.77 N @ 32.80 MS; -3916.22 N @ 72.56 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

DRIVER RIGHT FEMUR FORCE

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



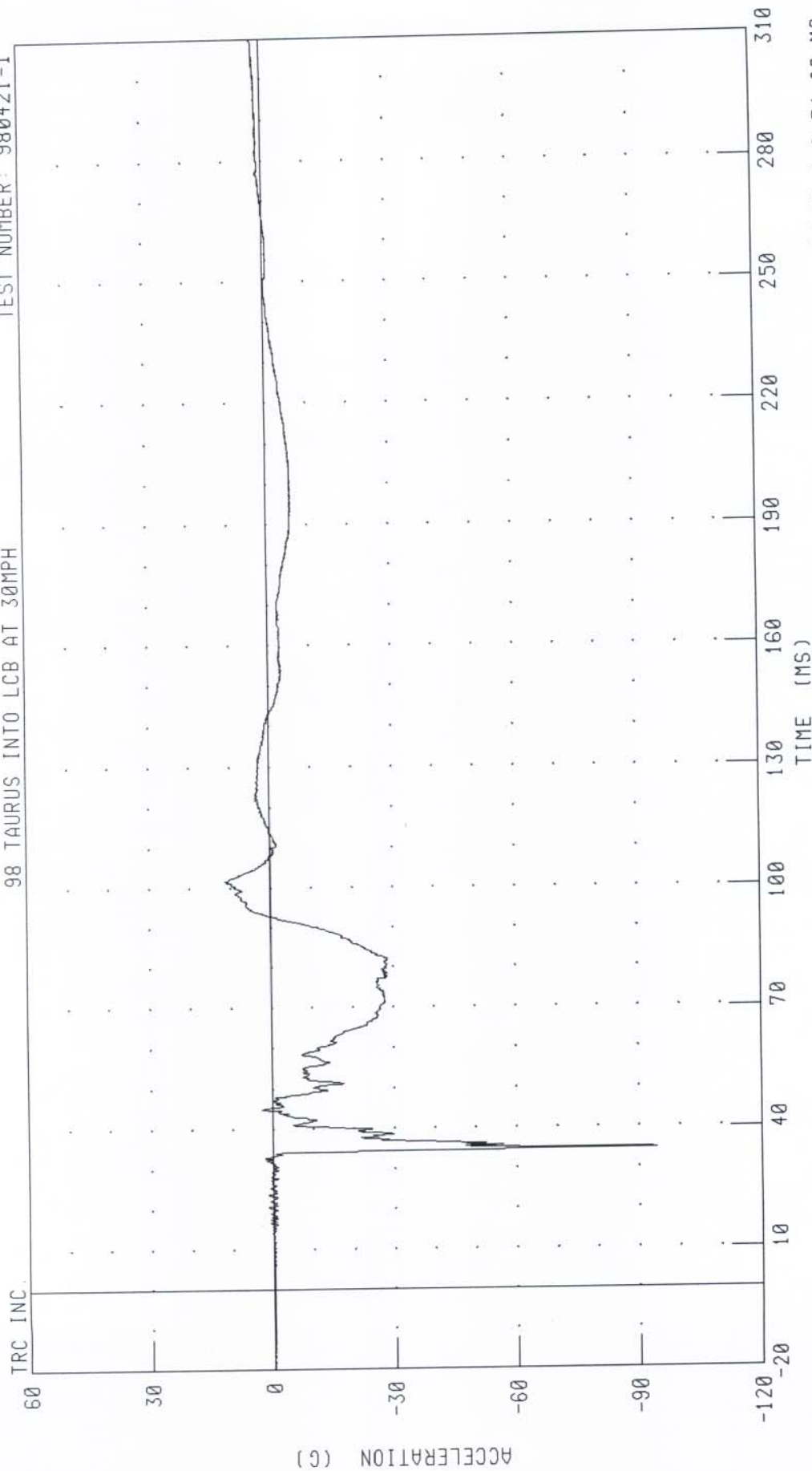
CHANNEL: RFMF1 FILTER: CH. CLASS 600

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER HEAD X-AXIS ACCELERATION

98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



PEAK DATA: 11.22 G @ 101.84 MS, -94.25 G @ 34.88 MS

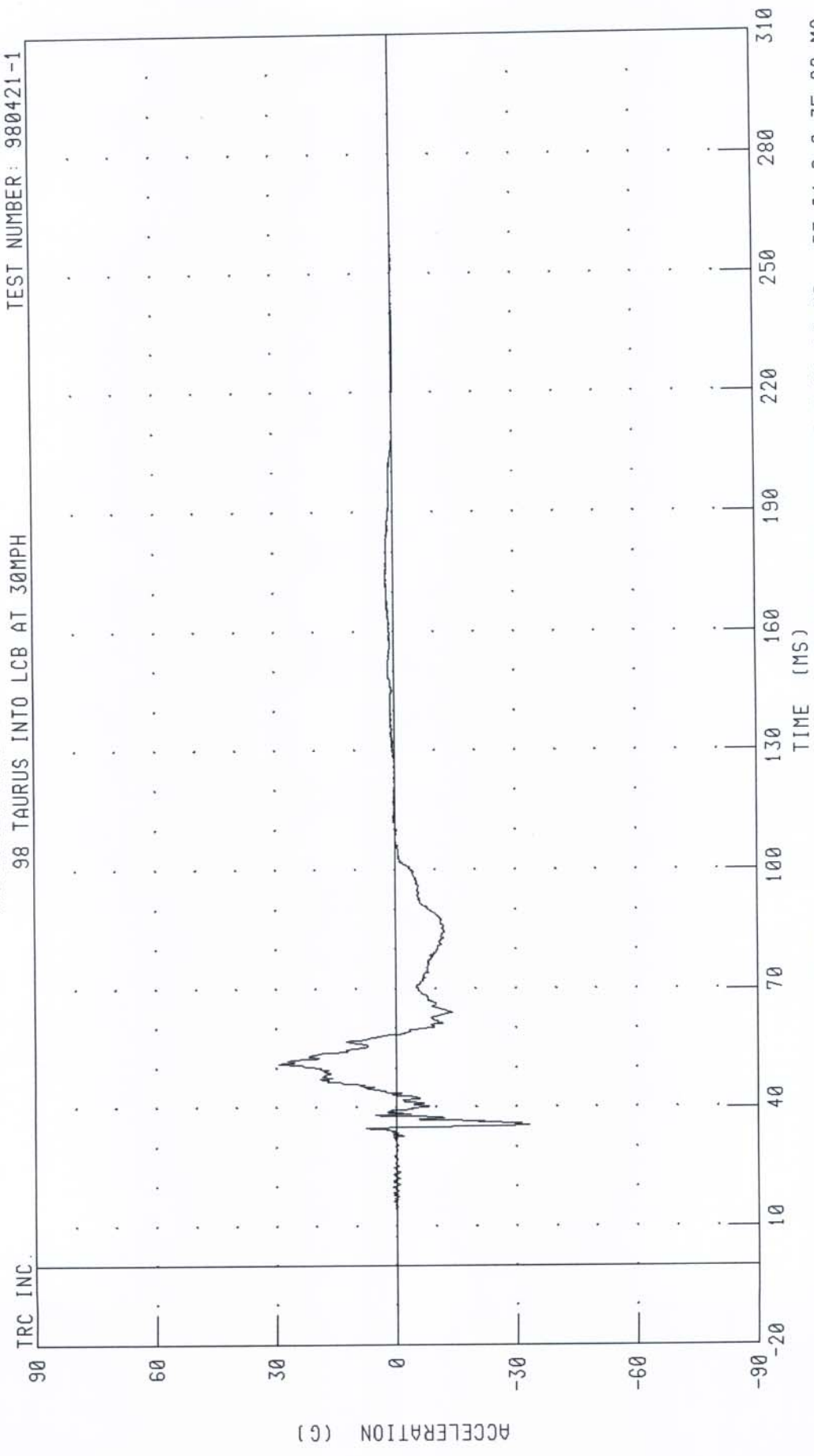
CHANNEL: HEDXC2 FILTER: CH, CLASS 1000

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER HEAD Y-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: HEDYC2 FILTER: CH. CLASS 1000

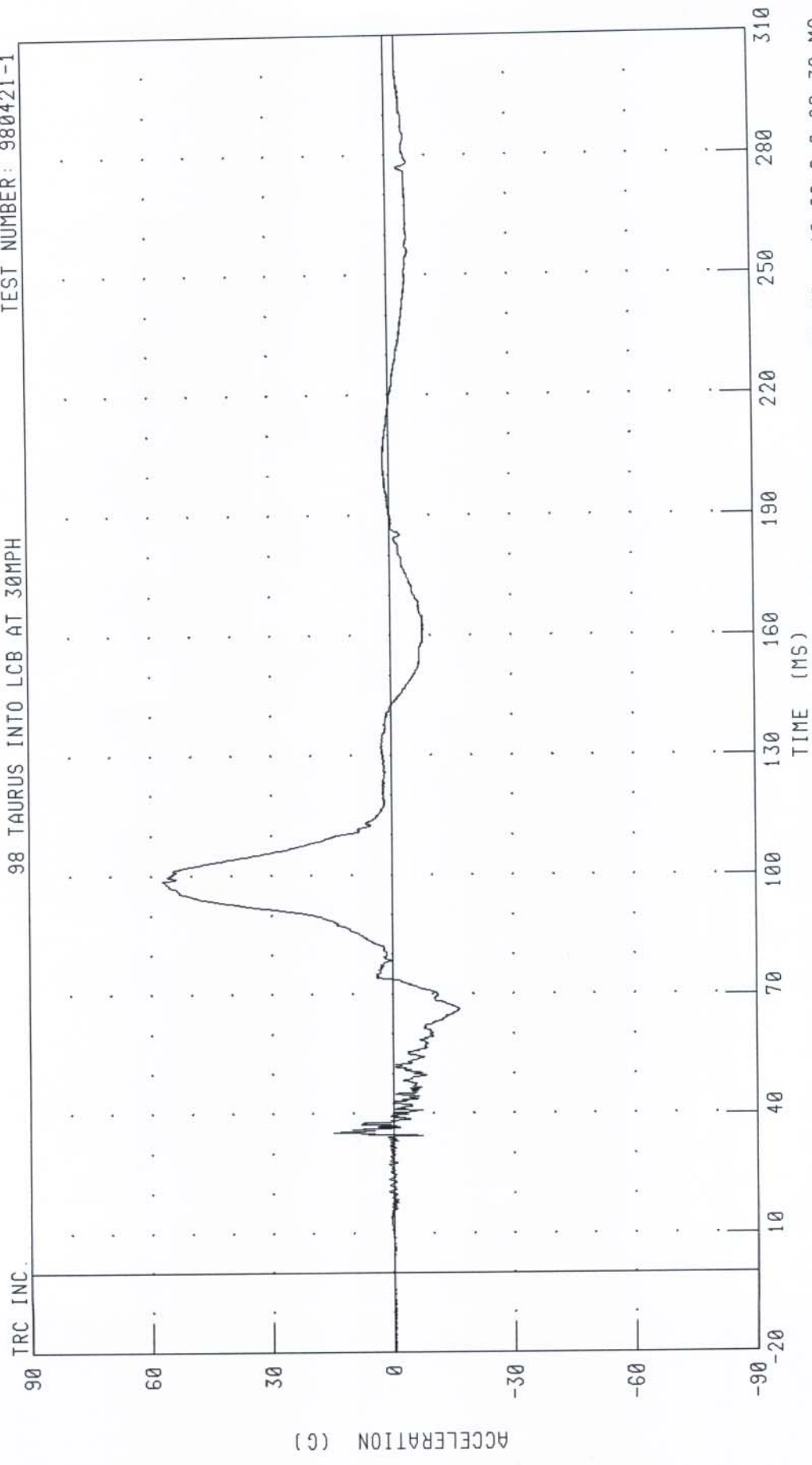
PEAK DATA: 29.31 G @ 51.12 MS, -33.24 G @ 35.60 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER HEAD Z-AXIS ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



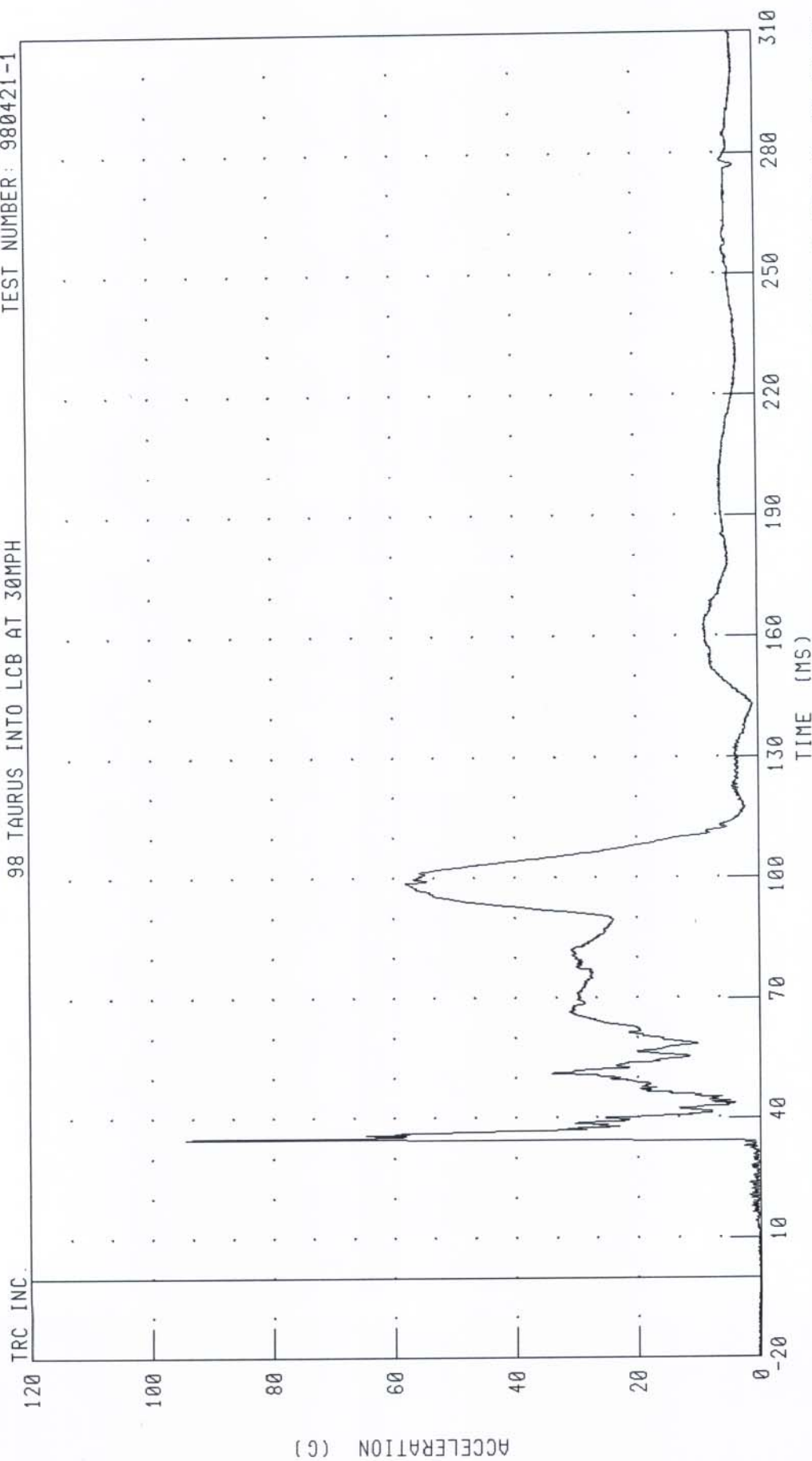
CHANNEL: HEDZG2 FILTER: CH. CLASS 1000 PEAK DATA: 57.16 G @ 98.72 MS; -16.68 G @ 66.32 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER HEAD RESULTANT ACCELERATION

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: HEDRC2 FILTER: CH. CLASS 1000

PEAK DATA: 94.49 G @ 34.88 MS; 0.10 G @ -20.00 MS

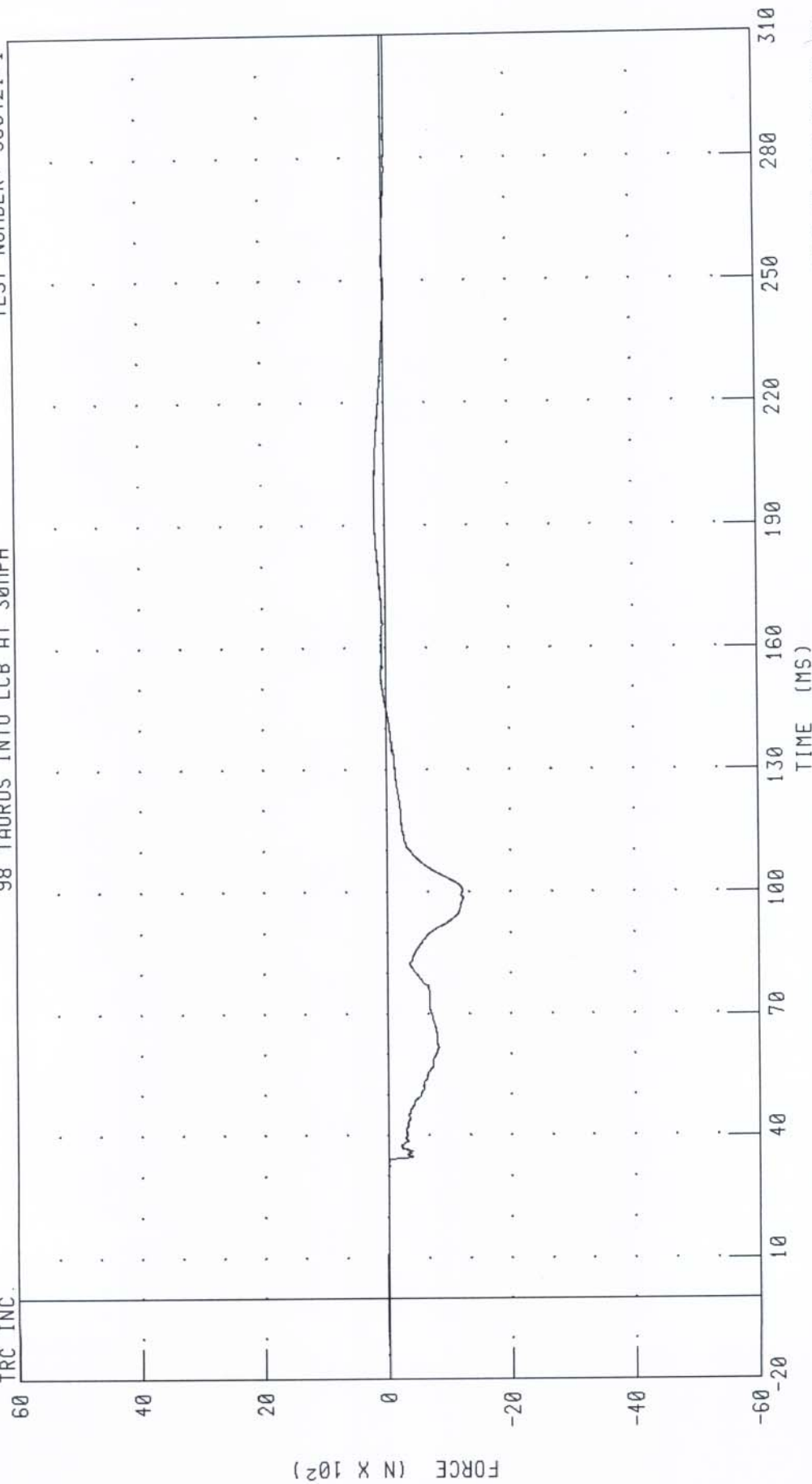
1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER NECK X-AXIS SHEAR FORCE

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH

TRC INC.



CHANNEL: NEKXF2 FILTER: CH. CLASS 1000

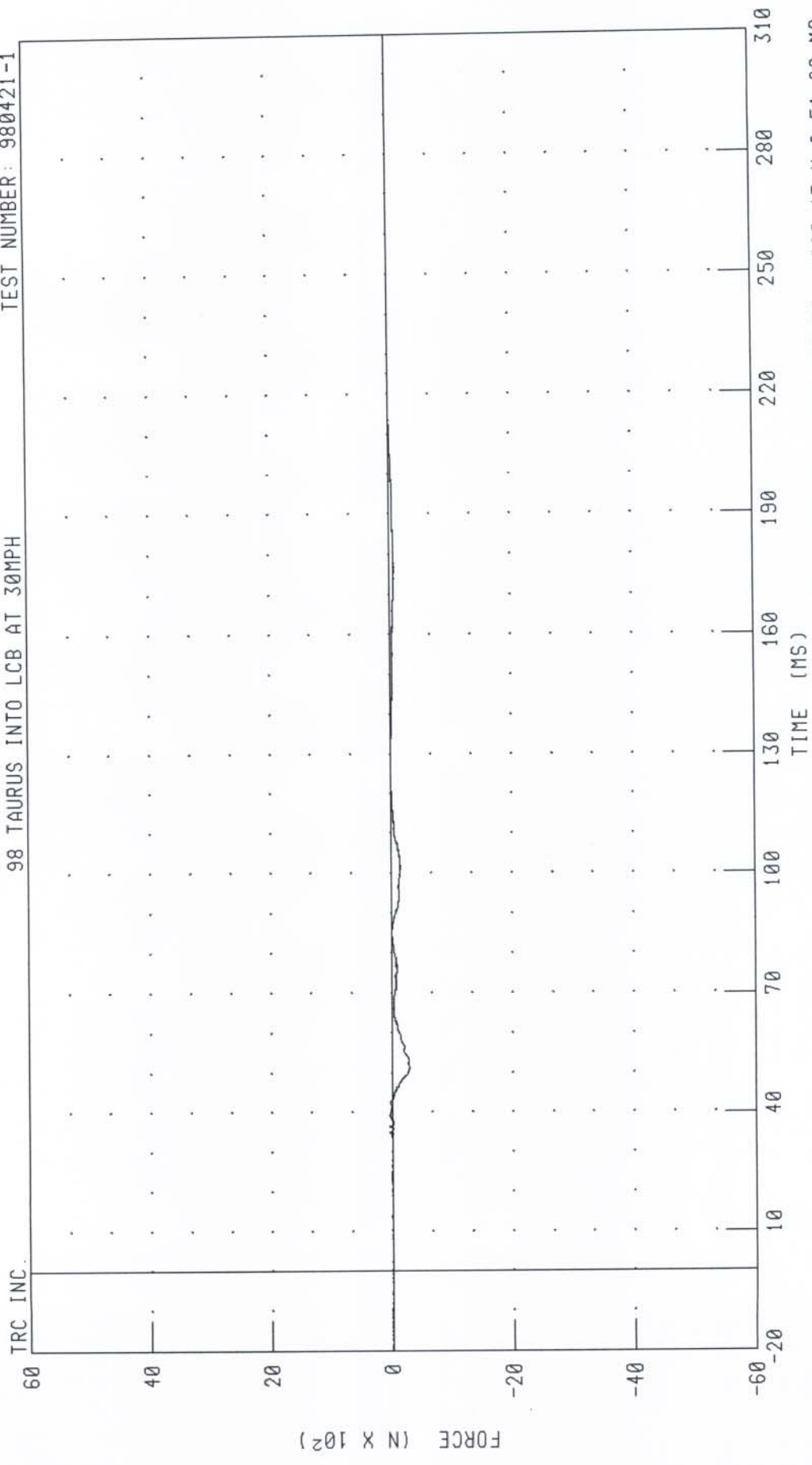
PEAK DATA: 164.74 N @ 191.28 MS; -1238.91 N @ 98.64 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER NECK Y-AXIS SHEAR FORCE

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



PEAK DATA: 42.70 N @ 34.88 MS, -292.15 N @ 51.28 MS

CHANNEL: NEKYF2 FILTER: CH. CLASS 1000

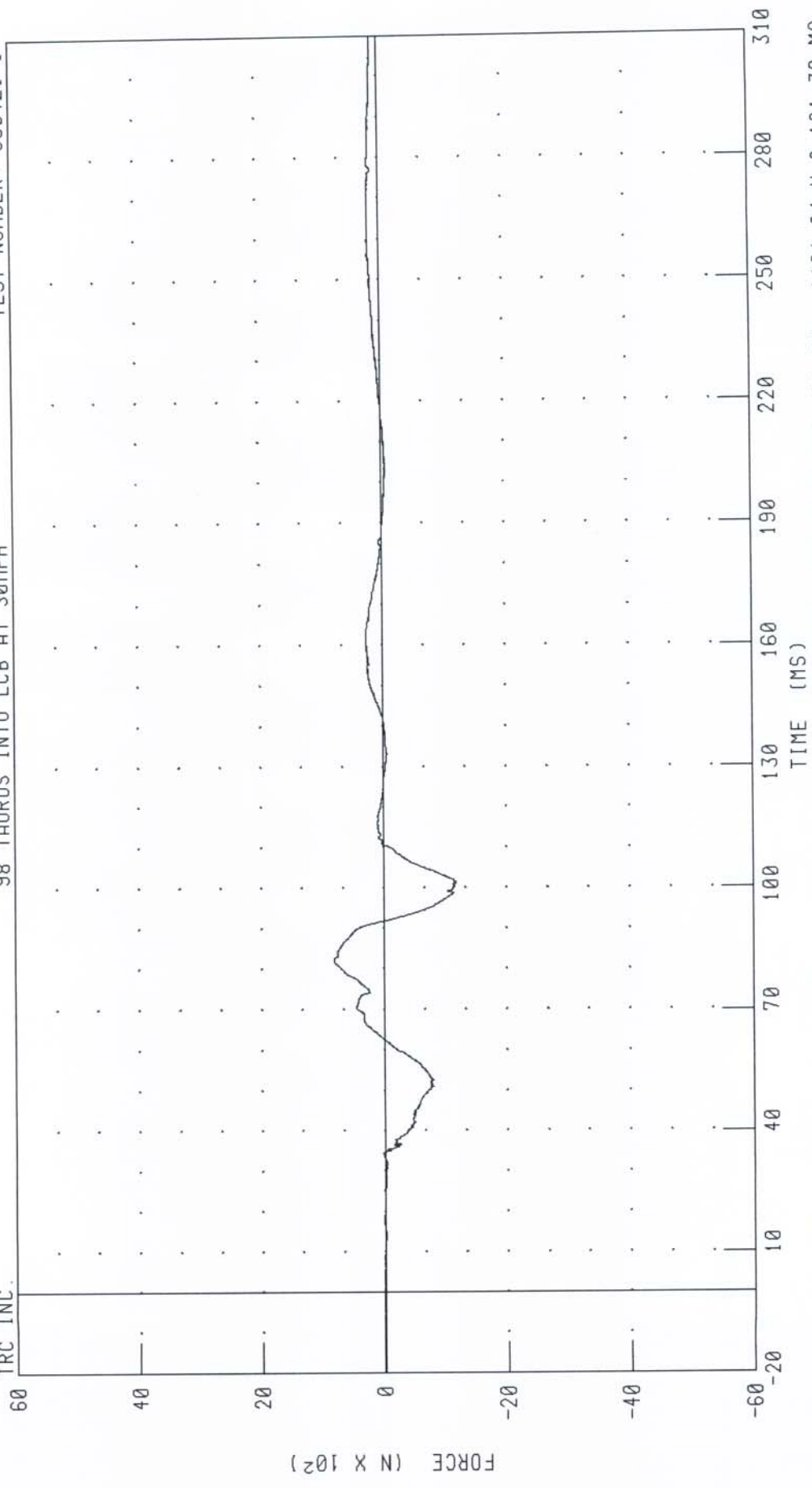
1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER NECK Z-AXIS AXIAL FORCE

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH

TRC INC.



PEAK DATA: 807.27 N @ 81.92 MS; -1181.64 N @ 101.36 MS

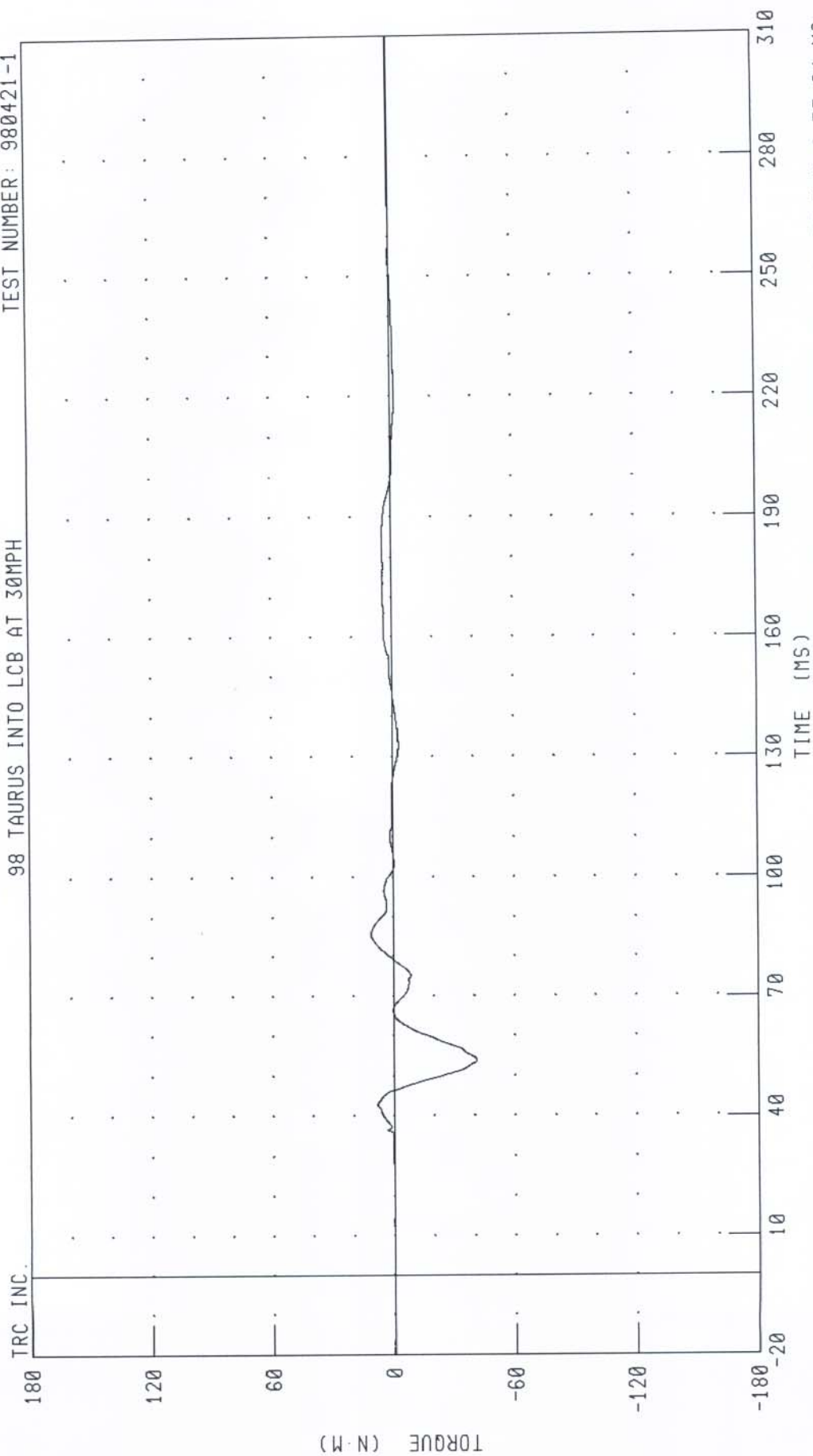
CHANNEL: NEKZF2 FILTER: CH CLASS 1000

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER NECK MOMENT ABOUT X AXIS

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH



CHANNEL: NEKX12 FILTER: CH. CLASS 600

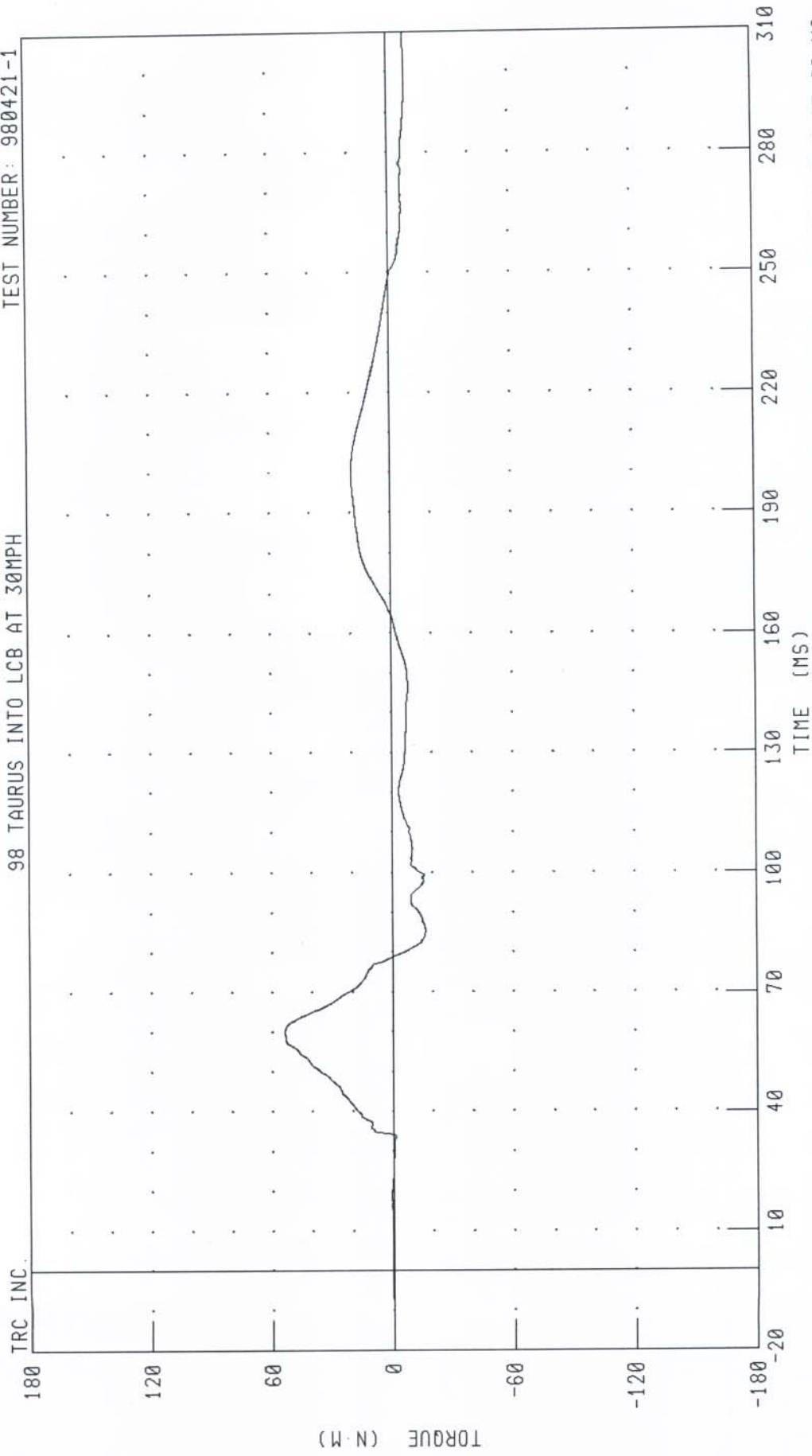
PEAK DATA: 10.92 N·M @ 85.68 MS; -41.00 N·M @ 53.84 MS

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH

PASSENGER NECK MOMENT ABOUT Y AXIS

TEST NUMBER: 980421-1

98 TAURUS INTO LCB AT 30MPH

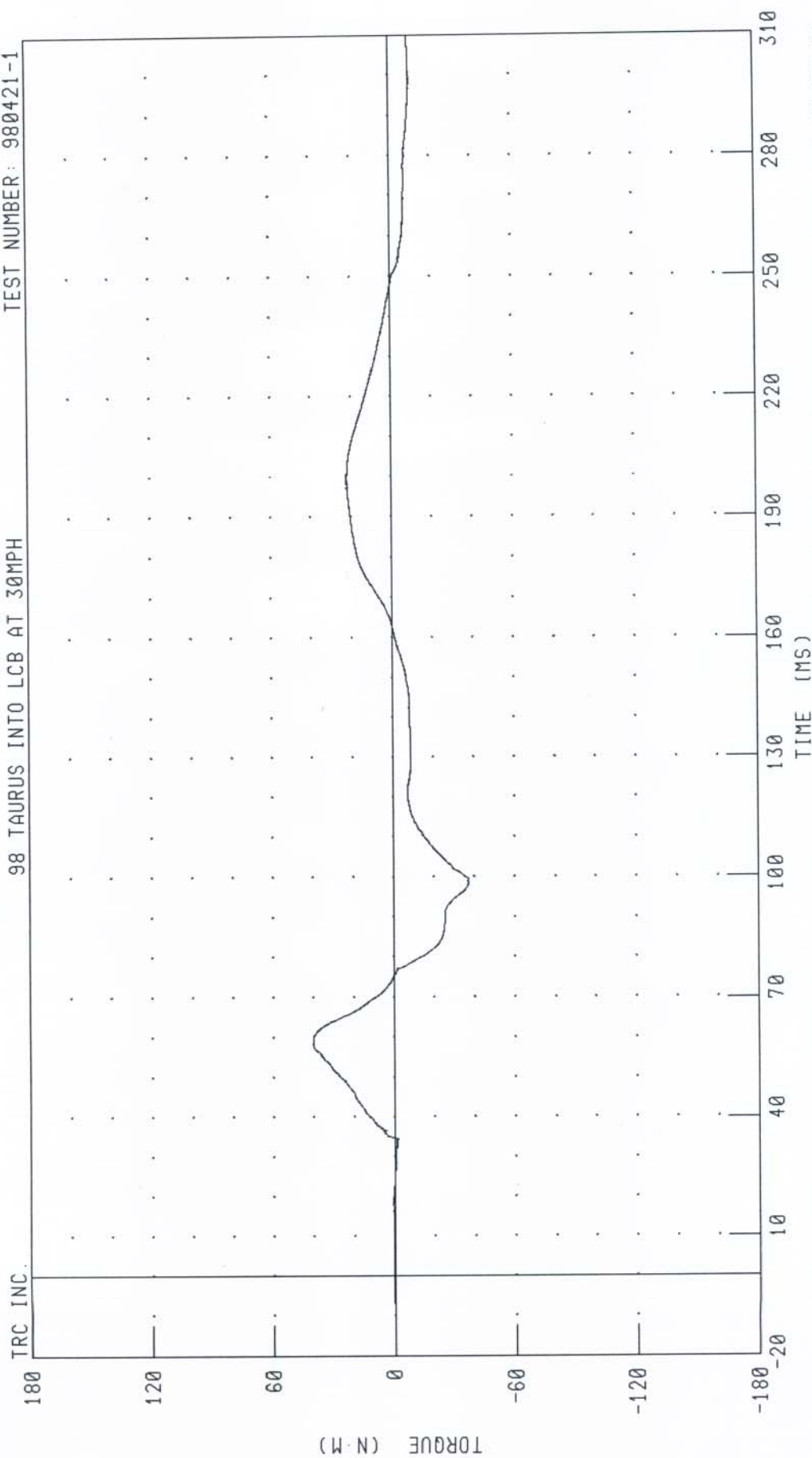


PEAK DATA: 53.73 N·M @ 60.24 MS; -16.28 N·M @ 85.60 MS

CHANNEL: NEKYM2 FILTER: CH. CLASS 600

1998 FORD TAURUS WITH SMALL FEMALE DUMMIES INTO 0 DEG LOAD CELL BARRIER AT 30MPH
PASSENGER NECK OCCIPITAL CONDYLE ABOUT Y AXIS
98 TAURUS INTO LCB AT 30MPH

TEST NUMBER: 980421-1



CHANNEL: NEKOM2 FILTER: CH. CLASS 600

PEAK DATA: 40.28 N-M @ 58.48 MS; -37.37 N-M @ 99.52 MS