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U.S. Department
of Transportation

National Highway
Traffic Safety
Administration

DOT HS 808 253

August 1994

Final Report

Final Report of a 1991 Ford F150 Pickup Frontal Impact CNG Fuel Tank Integrity

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 808 253		

4. Title and Subtitle	5. Report Date
Final Report Of A 1991 Ford F150 pickup Frontal Impact CNG Fuel Tank Integrity	August 1994
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
C. A. Markusic, Senior Project Engineer, TRC	940711
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)\
National Highway Traffic Safety Admin. Vehicle Research and Test Center P. O. Box 37 East Liberty, OH 43319	11. Contract or Grant No. DTNH22-88-C-07292
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U. S. Department of Transportation National Highway Traffic Safety Administration 400 Seventh St., S.W. Washington, DC 20590	Final Report July - August 1994
	14. Sponsoring agency Code DOT/NHTSA/VRTC

DEPARTMENT OF TRANSPORTATION
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15. Supplemental Notes

16. Abstract

A gasoline-powered vehicle was converted to operate as a dual fueled (gasoline/CNG) vehicle. The conversion met the minimum standards of National Fire Protection Association Procedure Number 52 (NFPA 52). The purpose of this test was to evaluate the suitability of NFPA 52 for ensuring adequate safety in vehicles converted to CNG after first sale.

This 48 kph frontal barrier impact test was conducted at the Transportation Research Center Inc. on July 11, 1994. The subject vehicle, a 1991 Ford F-150 pickup, VIN 1FTDF15Y8MLA77319, was tested according to the frontal barrier impact test procedures prescribed in FMVSS 303. The actual impact speed was 48.3 kph. In the hour following the impact, a pressure increase of 44 kPa was recorded, which is well within the requirements specified in FMVSS 303 for OEM vehicles.

17. Key Words	18. Distribution Statement
CNG Fuel System Intrgrity Frontal Barrier Impact	Document is available to the public through the National Technical Information Service. Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. Number of Pages	22. Price
Unclassified	Unclassified	72	

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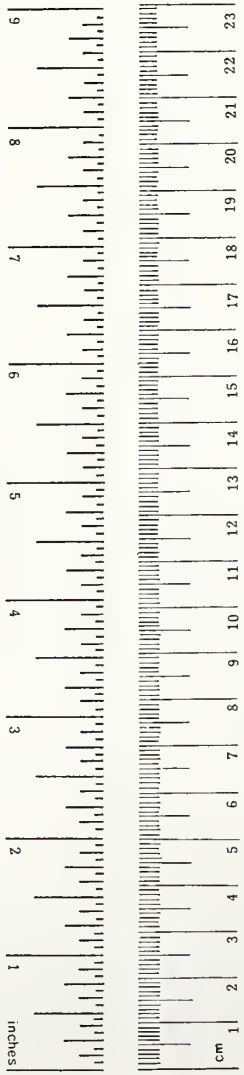
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

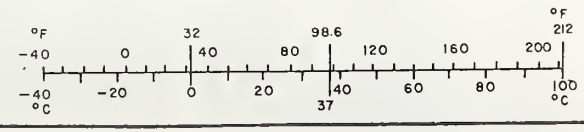
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2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

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



Approximate Conversions from Metric Measures

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



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Section 1.0

Purpose and Test Procedure

Purpose

This 48 kph flat frontal barrier impact test was conducted for Vehicle Research and Test Center by Transportation Research Center Inc. (TRC). The purpose of this test was to evaluate the suitability of National Fire Protection Association Procedure Number 52 (NFPA 52) for ensuring adequate safety in vehicles converted to CNG after first sale. The subject vehicle for this test was a 1991 Ford F150 pickup.

Test Procedure

This test was conducted in accordance with the applicable portions of NHTSA's Office of Vehicle Safety Compliance (OVSC) Laboratory Test Procedure No. TP-301-00, with the addition of vehicle accelerometers. Data was obtained relative to fuel system integrity.

The test vehicle was instrumented with seven (7) accelerometers to measure longitudinal, lateral, and vertical axis accelerations, one (1) thermocouple to measure ambient temperature, and a pressure transducer to measure fuel system pressure. The vehicle impacted the flat barrier in the specified impact velocity range of 47.5 to 49.1 kph.

The test vehicle contained tow (2) uninstrumented Part 572 B 50th percentile adult anthropomorphic test devices (dummies) positioned in the front outboard designated seating positions. The fuel system was filled with nitrogen gas at 20,684 kPa at 21° C.

The seven (7) acceleration data channels were multiplexed and recorded on a 14-track tape drive. The acceleration data was digitally sampled at 12,500 samples per second and processed according to SAE J211 OCT88. The pressure and temperature data was recorded by a Fluke 2625A Data Logger The data logger sampled the data at 2.7 sec/sample.

The crash event was recorded by one (1) real-time panning motion picture camera and five (5) high-speed motion picture cameras.

The vehicle impact data are presented in Section 2.0. Appendix A contains the still photographic prints. Appendix B contains the vehicle data plots. Appendix C contains miscellaneous test information.

Section 2.0

Frontal Impact Test Summary

Test Results Summary

The 48 kph frontal barrier impact test was conducted at Transportation Research Center Inc. on July 11, 1994.

The test vehicle, a 1991 Ford F150 pickup truck, appeared to comply with the proposed performance requirements of FMVSS 303 in the frontal impact mode. The pressure transducer recorded a pressure increase of 44 kPa during the one-hour period immediately following the impact.

The test vehicle was equipped with a 4.9-liter inline engine, manual transmission, power steering, and power brakes. The vehicle's test weight was 2375 kilograms. The vehicle's maximum static crush was 605 millimeters. The vehicle's imapct speed was 48.3 kph.

Data Acquisition Explanations

The right frame rail X-axis accelerometer, RSRXG, did not return to zero following the impact event. The data not returning to zero affected the velocity and displacement calculations.

Table 1 Crash Test Summary

Test type:	Frontal Barrier Impact	
Test date:	07/11/94	
Test time:	1333	
Ambient temperature:	24° C	
Vehicle year/make/ model/body style:	1991/Ford/F150/pickup	
Vehicle test weight:	2375 kg	
Impact angle[1]:	0°	
Impact velocity[2]:	Primary = 48.3 kph Secondary = 48.3 kph	
Maximum static crush:	605 mm	
Dummies:	Driver #258	Passenger #259
Type:	Part 572 B	Part 572 B
Location:	Left front	Right front
Restraint:	3-point unibelt	3-point unibelt
Number of data channels:	7	
Number of cameras:	High-speed 5 Real-time 1	

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

Table 2 Test Vehicle Information

Vehicle year/make/ model/body style:	1991/Ford/F150/pickup			
Color:	Red and White			
VIN:	1FTDF15Y8MLA77319			
Engine data:				
Placement:	Inline			
Cylinders:	6			
Displacement	4.9 liters			
Transmission data:	_4_speed,	_X_manual,	__automatic,	__overdrive
	__FWD,	_X_RWD,	__4WD	
Date vehicle received:	07/08/94			
Odometer reading:	15,657			
Dealer's name and address:	NA			

Accessories:

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

Certification data from vehicle's label:

Vehicle manufactured by:	Ford Motor Company
Date of manufacture:	06/91
VIN:	1FTDF15Y8MLA77319
GVWR:	2472 kg
GAWR: Front:	1202 kg
Rear:	1436 kg

Table 2 Test Vehicle Information, Cont'd.

Size of tires:	P235/75R15
Tire pressure with maximum capacity vehicle load:	
Front:	240 kPa
Rear:	240 kPa
Spare tire:	None
Type of front seats:	Bench

Tire & capacity data from vehicle's label:

Recommended tire size:	P215/75R15 SL
Recommended cold tire pressure:	
Front:	240 kPa
Rear:	240 kPa
Designated seating capacity:	
Front	NA
Rear	NA
Total	NA
Vehicle capacity weight:	NA

Test vehicle attitude:

Delivered attitude:	LF	805 mm;	RF	807 mm;	LR	839 mm;	RR	855 mm
Pre-test attitude:	LF	755 mm;	RF	765 mm;	LR	755 mm;	RR	783 mm
Post-test attitude:	LF	687 mm;	RF	739 mm;	LR	820 mm;	RR	854 mm

Table 2 Test Vehicle Information Cont'd

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

Right front	563	kg	Right rear	485	kg
Left front	548	kg	Left rear	494	kg
Total front weight	1111	kg	(53.2% of total vehicle weight)		
Total rear weight	979	kg	(46.8% of total vehicle weight)		
Total delivered weight	2090	kg			

Calculation of test vehicle's target test weight:

RCLW[1] = Rated cargo and luggage weight

UDW = Unloaded delivered weight (2090 kg)

VCW = Vehicle capacity weight (NA kg)

DSC = Designated seating capacity (NA)

RCLW[1] = VCW - 68 (DSC) =136 kg

Target test weight=UDW + RCLW[1] + (Number of Hybrid II dummies x 76 kg/dummy)

Target test weight = 2090 + 136 + 152

Target test weight = 2378 kg

Weight of test vehicle with required dummies and 133 kg of cargo weight:

Right front	591	kg	Right rear	580	kg
Left front	584	kg	Left rear	620	kg
Total front weight	1175	kg	(49.5% of total vehicle weight)		
Total rear weight	1200	kg	(50.5% of total vehicle weight)		
Total test weight	2375	kg	(3 kg under target test weight)		

Weight of ballast secured in vehicle: 96 kg

Components removed to meet target test weight: None

CG rearward of front wheel centerline: 1707 mm

Vehicle wheelbase: 3378 mm

[1] Cargo weight for multi-purpose passenger vehicles, trucks, and buses is the vehicle's rated cargo and luggage weight from the vehicle's label or 136 kg, whichever is less.

Table 3 Post-Impact Data

Test number:	940711
Test date:	07/11/94
Test time:	1333
Test type:	Frontal barrier impact
Impact angle:	0°
Ambient temperature at impact area:	24° C
Impact velocity:	
Primary	48.3 kph
Secondary	48.3 kph
Specified range	47.5 to 49.1 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:

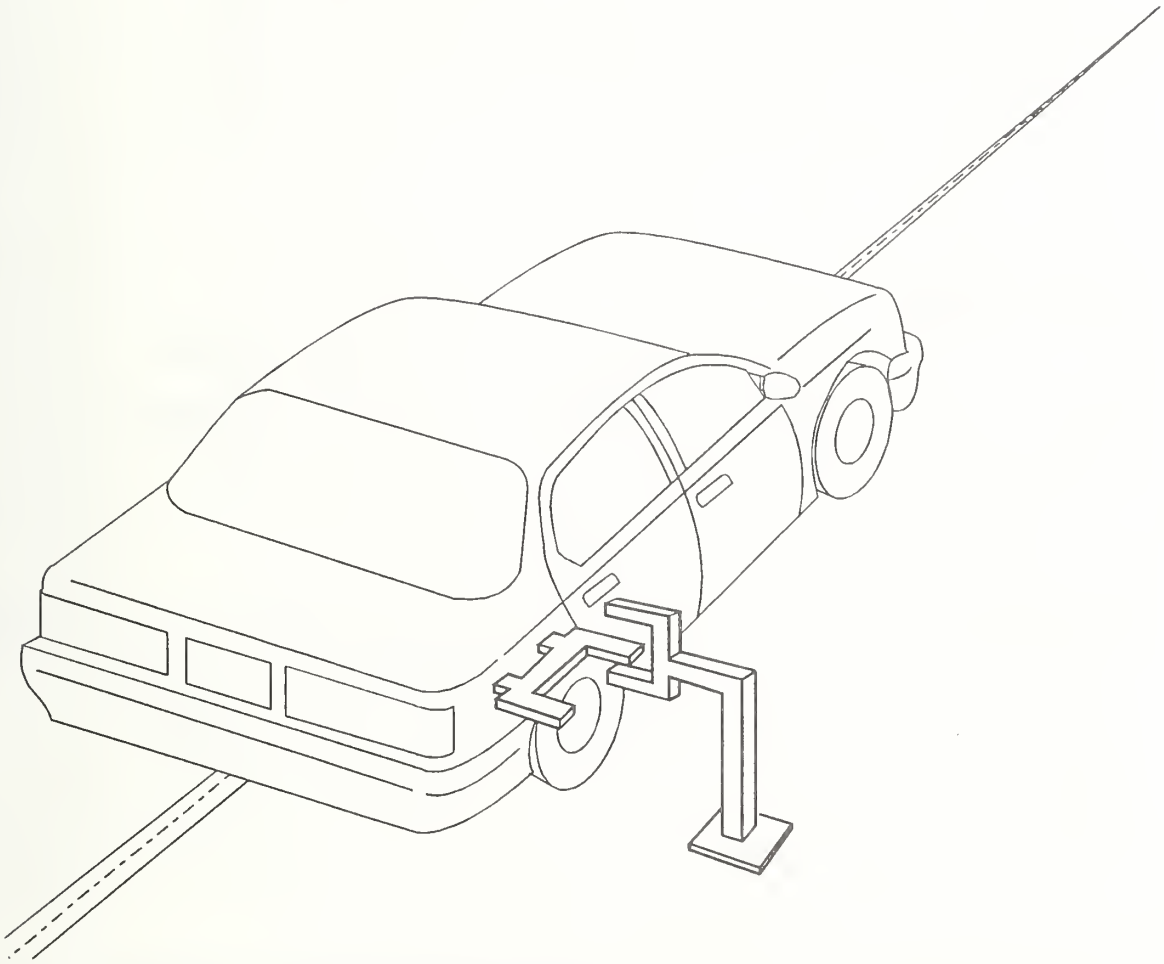
Pre-test:	L	5431 mm;	C	5485 mm;	R	5420 mm
Post-test:	L	4826 mm;	C	4928 mm;	R	4943 mm
Total crush:	L	605 mm;	C	557 mm;	R	477 mm
Average crush:	546 mm					

Test vehicle rebound from flat barrier:

Distance from test vehicle to barrier:

Post-test:	L	339 mm;	C	299 mm;	R	294 mm
Average rebound	311 mm					

Figure 1 Impact Velocity Measurement System



The final vane clears emitter/receiver pair two inches before impact.

The vanes have one-foot spacing.

Table 4 Post-Impact Dummy/Vehicle Data

Visible Dummy Contact Points:

	Driver #258	Passenger #259
Head	NA	NA
Chest	NA	NA
Abdomen	NA	NA
Left knee	NA	NA
Right knee	NA	NA

Door Opening:

	Left	Right
Front	Difficult	Difficult
Rear	NA	NA

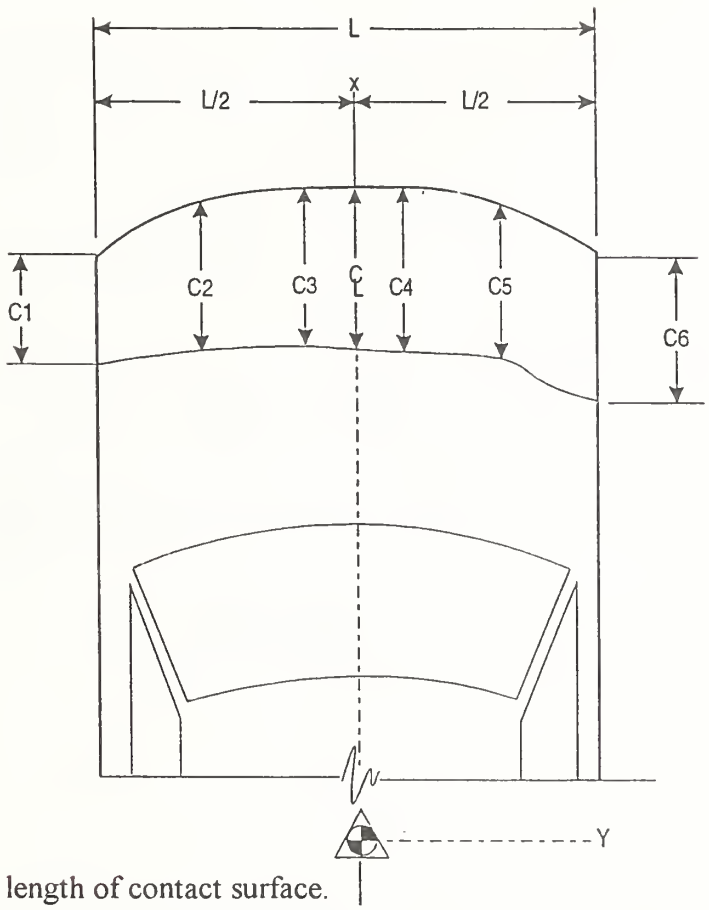
Seat Movement:

	Seat Back Failure	Seat Shift
Front	None	None
Rear	NA	NA

Glazing Damage: The entire windshield cracked upon impact.

Other Notable Impact Effects: Both front tires deflated on impact.

Figure 2 Vehicle Crush



Notes: L is pre-test length of contact surface.

C1 through C6 are spaced equally apart.

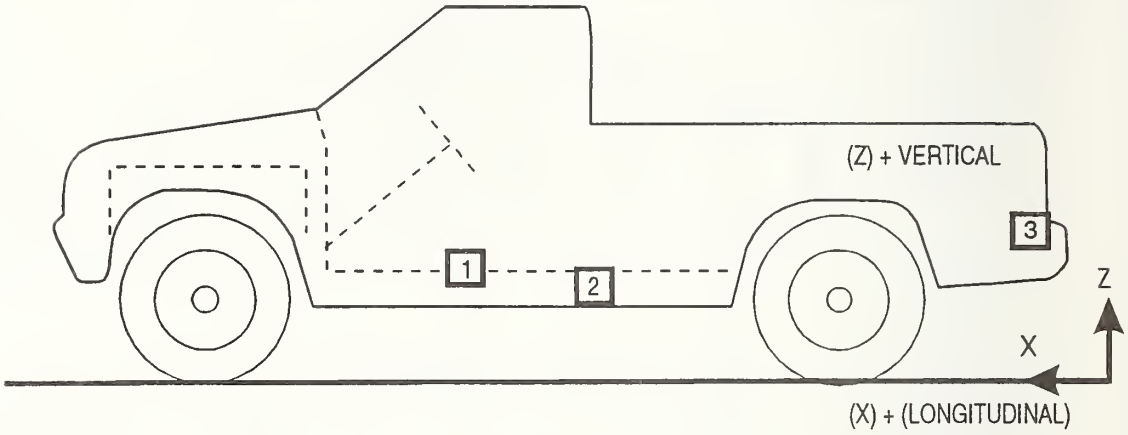
CL is vehicle centerline.

All measurements are in inches.

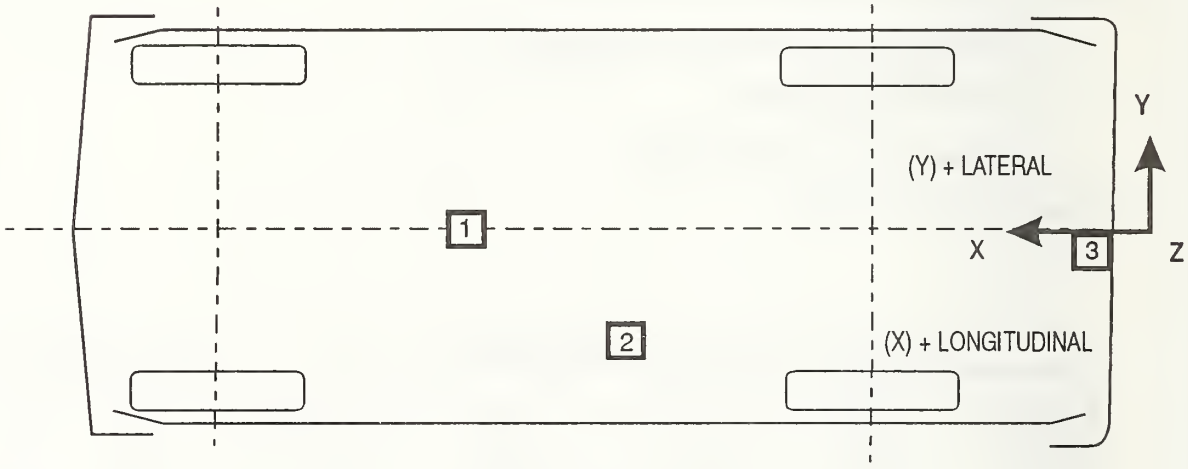
Vehicle: Ford F150 pickup

Pre-test		Post-test		Crush	
L	1855				
C1	5431	C1	4826	C1	605
C2	5470	C2	4883	C2	587
C3	5475	C3	4909	C3	566
C4	5476	C4	4928	C4	548
C5	5460	C5	4915	C5	545
C6	5420	C6	4943	C6	477
CL	5485	CL	4928	CL	557

Figure 3 Vehicle Accelerometer Placement



SIDE VIEW



BOTTOM VIEW

Table 5 Vehicle Accelerometer Locations and Data Summary

TEST NUMBER: 940711 No. LOCATION	X	Y	Z	POSITIVE DIRECTION		NEGATIVE DIRECTION	
1 VEHICLE CENTER OF GRAVITY	2953 mm	0 mm	673 mm				
LONGITUDINAL				61.9 g	@ 71.2 ms	80.4 g	@ 50.8 ms
LATERAL				16.7 g	@ 43.8 ms	9.3 g	@ 51.4 ms
VERTICAL				29.4 g	@ 101.4 ms	59.9 g	@ 53.5 ms
RESULTANT				85.0 g	@ 51.9 ms		
2 RIGHT FRAME RAIL	2437 mm	-805 mm	381 mm				
LONGITUDINAL[1]				36.1 g	@ 11.0 ms	87.5 g	@ 57.8 ms
VERICAL				23.8 g	@ 82.1 ms	60.4 g	@ 58.4 ms
3 REAR FRAME CROSSMEMBER	303 mm	0 mm	617 mm				
LONGITUDINAL				3.8 g	@ 21.4 ms	26.3 g	@ 47.1 ms
VERTICAL				26.0 g	@ 55.9 ms	22.5 g	@ 11.6 ms

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

[1] See DATA ACQUISITION EXPLANATIONS

Table 6 Fuel System Data

Make/Model: Ford F150/pickup

Fuel Tank Capacity: 114.5 liters total

Actual Test Pressures and Temperatures:

Time following impact (sec)	Tank pressure (kPa)	Ambient temperature (° C)
168	21,330	24.7
1068	21,345	24.4
1968	21,360	24.3
2868	21,374	24.8
3768	21,374	24.8

Rated Service Pressure: 20,684 kPa at 21° C

Test Gas Type: Nitrogen

Details of fuel system:

One fuel tank was located at the front of the bed. The second fuel tank was located under the vehicle directly behind the cab and outboard of the right frame rail. The fuel lines ran along the left frame rail to the front. The fuel filler was located on the left side.

Fuel injection: Yes

Does electric fuel pump operate with ignition switch "ON" and the engine not operating? No

Section 3.0

Camera Information

Figure 4 Camera Positions

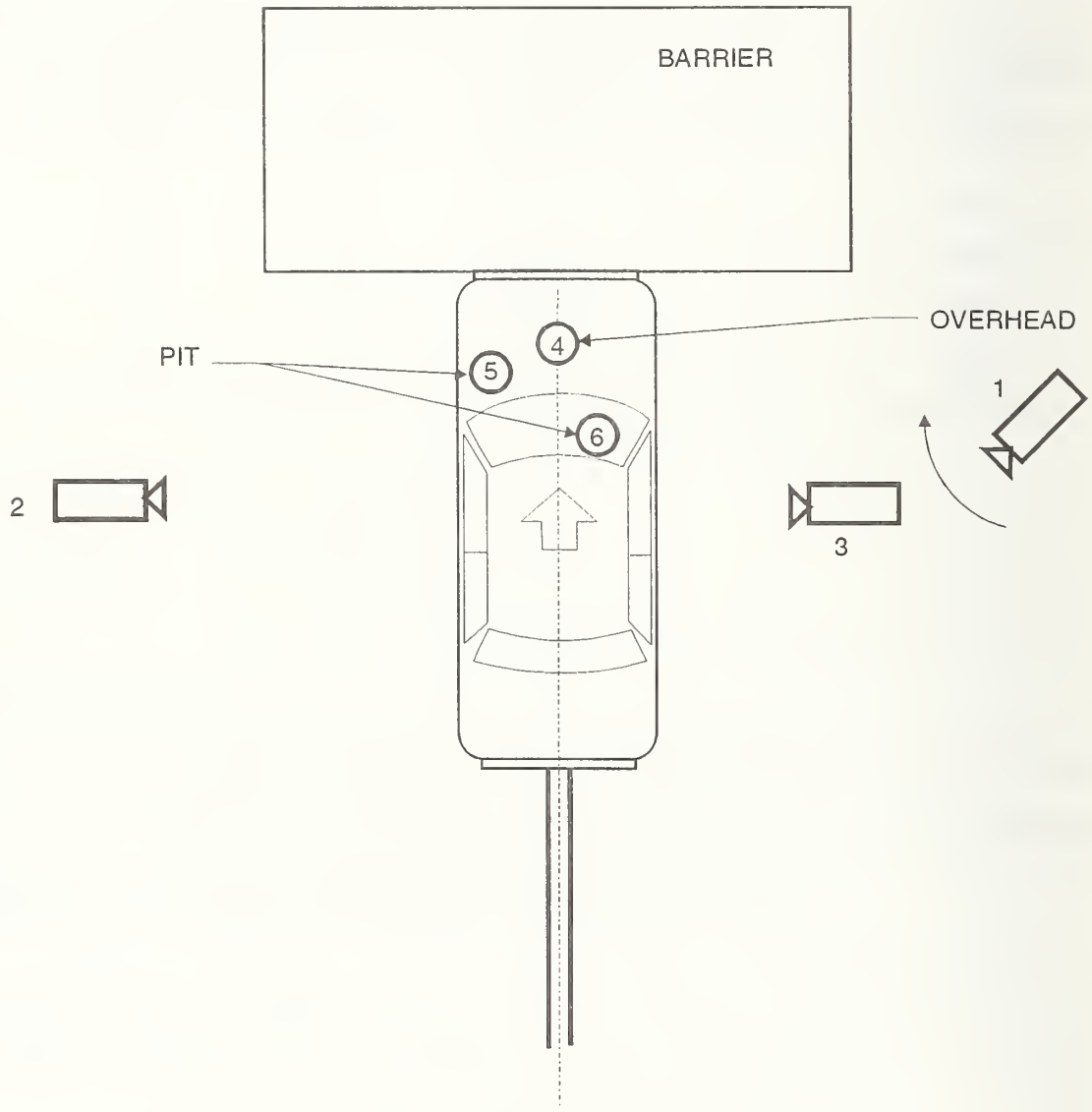


Table 7 Motion Picture Camera Information

Camera Number	Location	Type of Camera	Lens (mm)	Speed (fps)	Purpose of camera
1	Panning	Bolex	120	24	Documentary
2	Left wide	Photosonic	13	500	Vehicle crush
3	Right wide	Photosonic	13	500	Vehicle crush
4	Overhead wide	Photosonic	13	510	Vehicle crush
5	Pit - front	Photosonic	13	1012	Fuel system
6	Pit - Rear	Photosonic	13	1000	Fuel system

Appendix A

Photographs

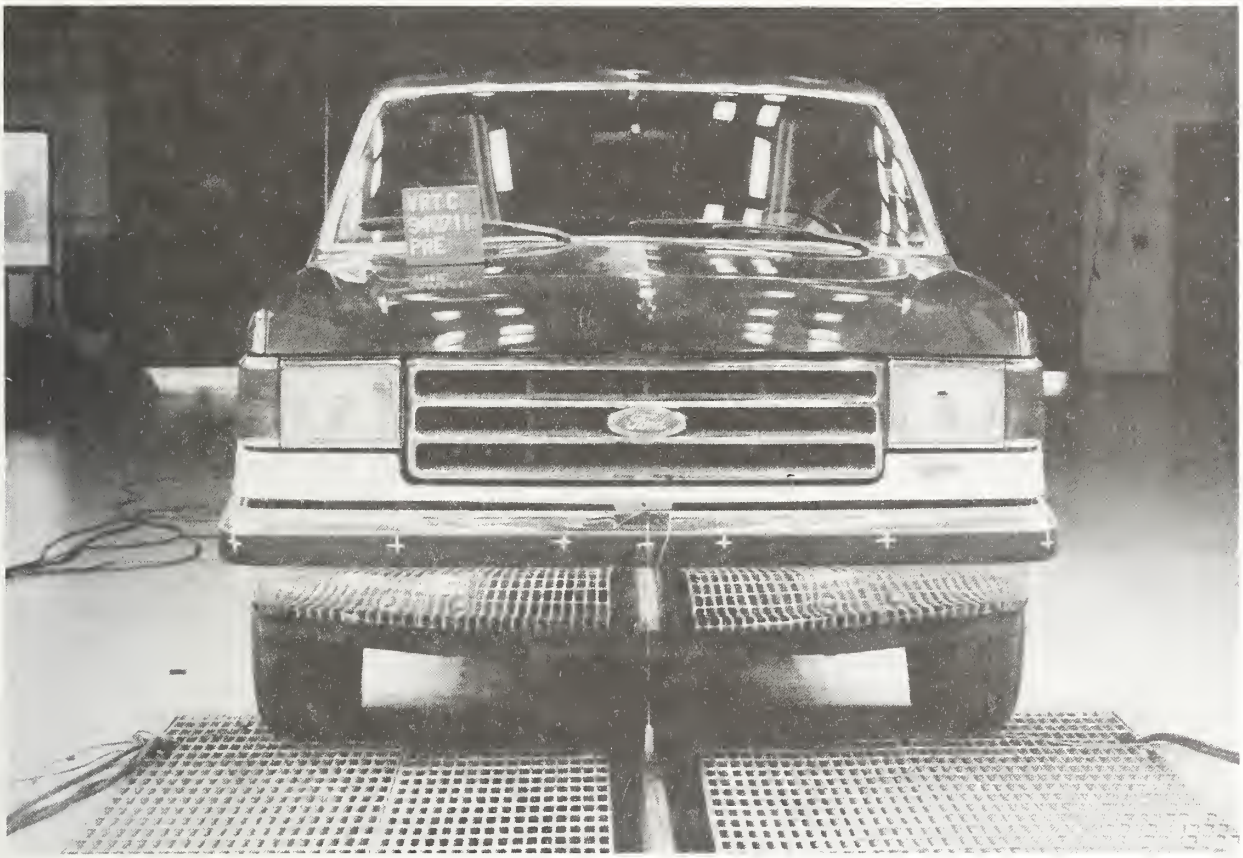


Figure A-1 Pre-Test Front View

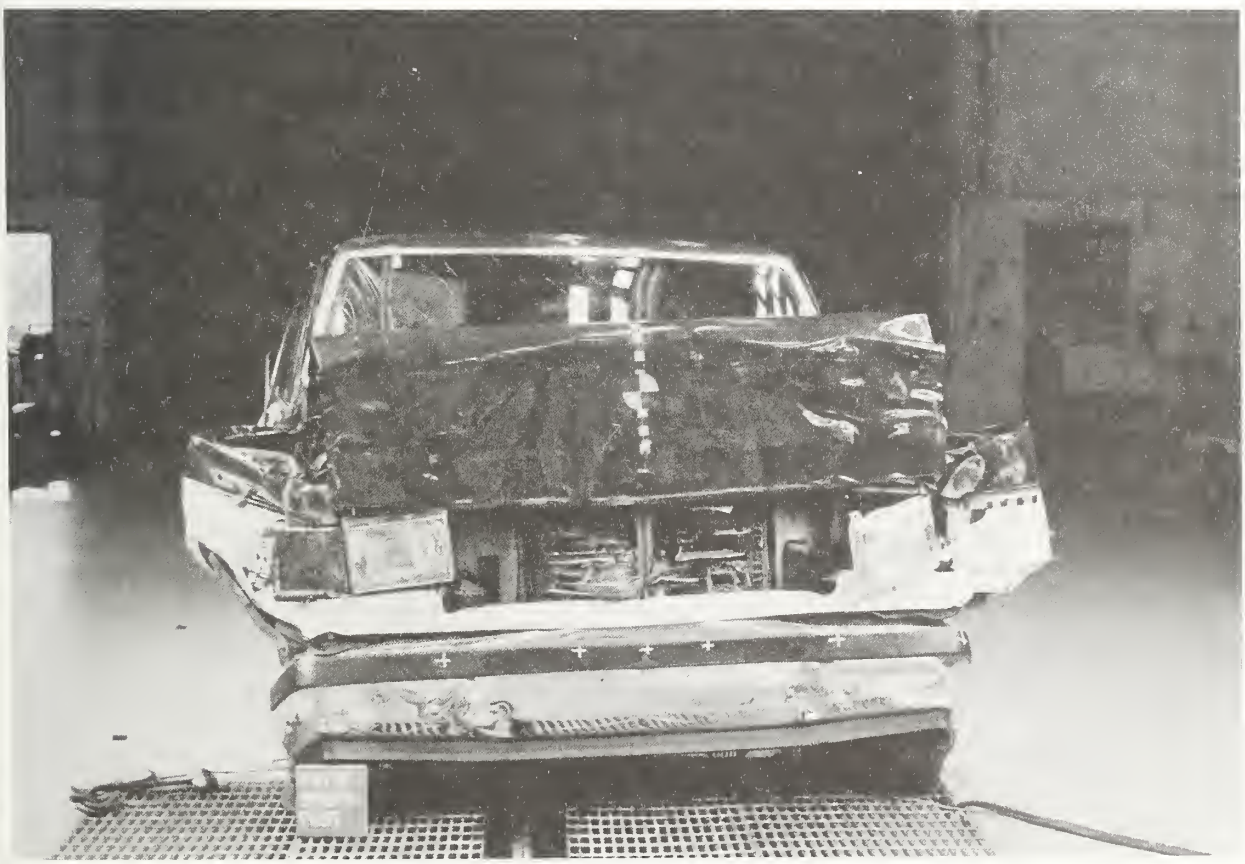


Figure A-2 Post-Test Front View

Figure A-3 Pre-Test Left Side View

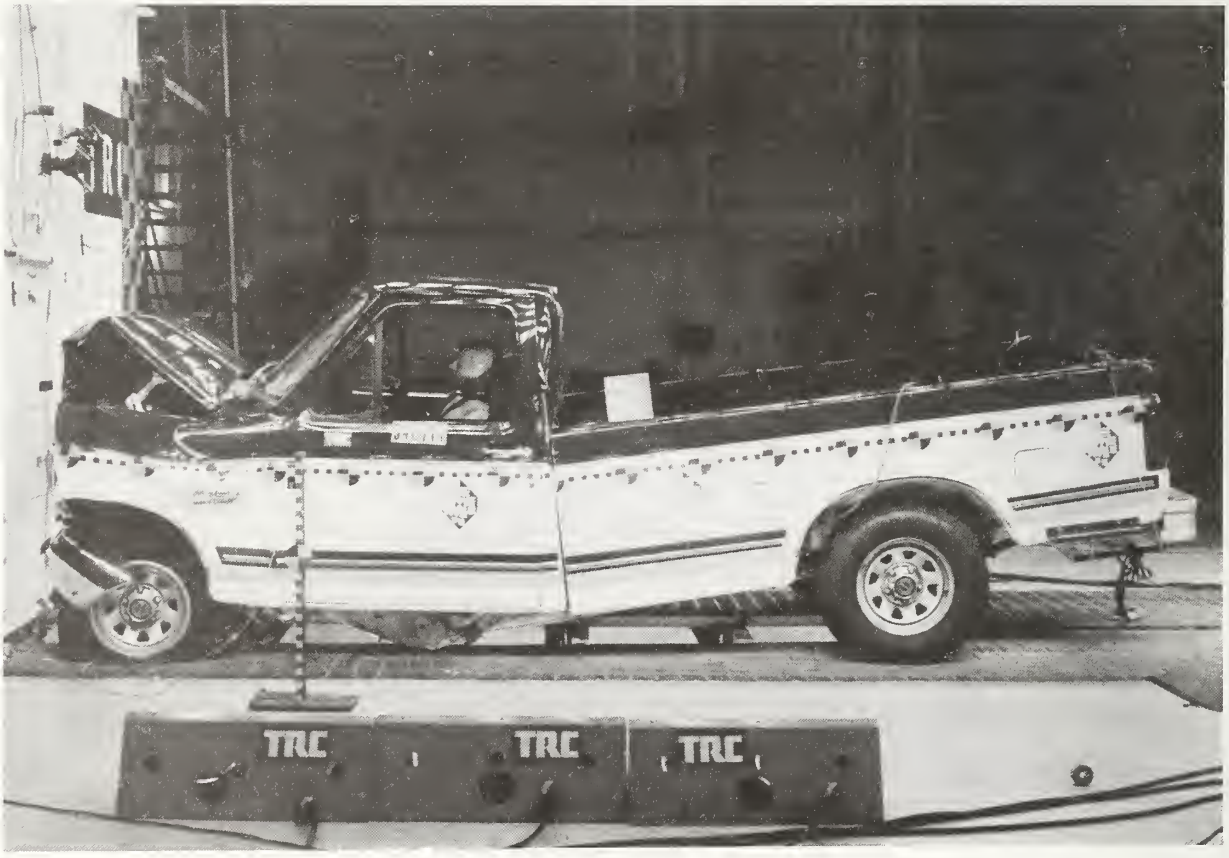


Figure A-4 Post-Test Left Side View

Figure A-5 Pre-Test Rear View

Figure A-6 Post-Test Rear View

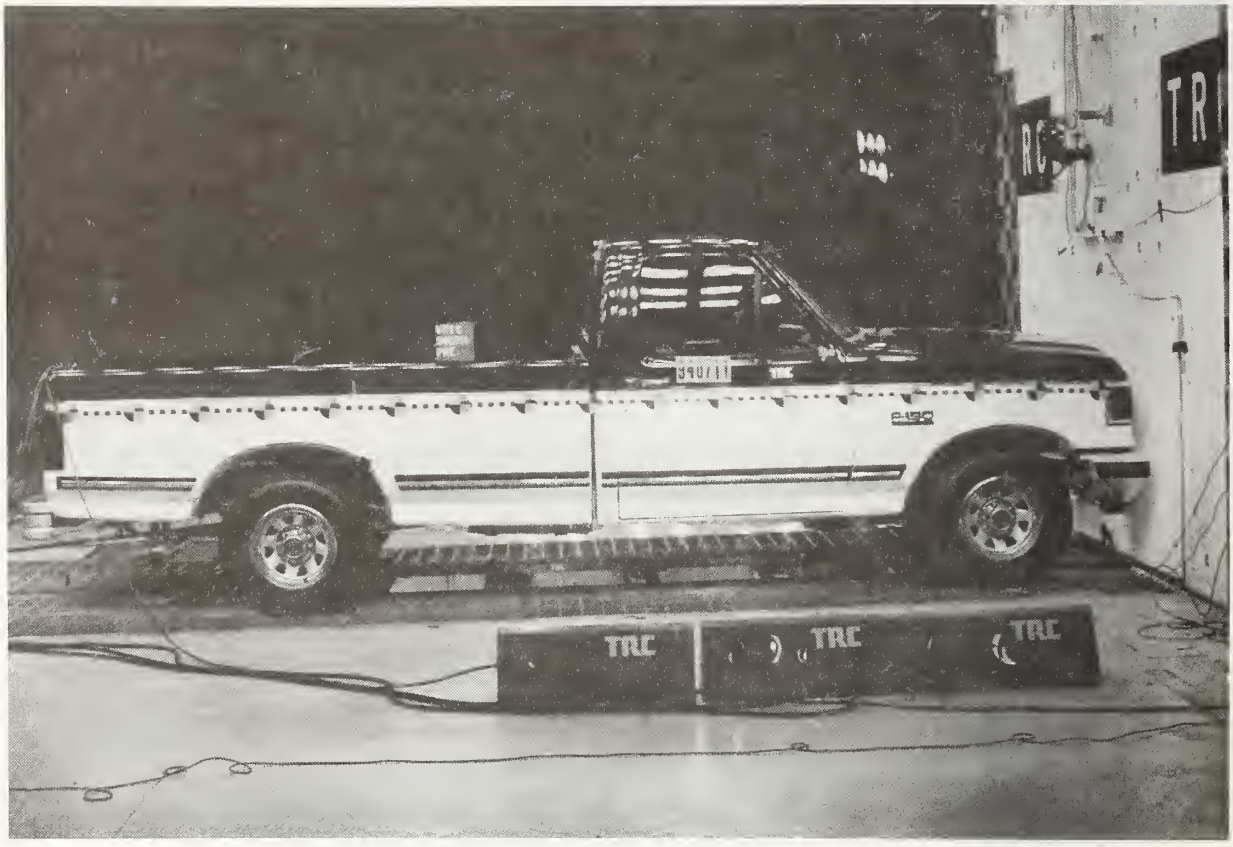


Figure A-7 Pre-Test Right Side View

Figure A-8 Post-Test Right Side View

Figure A-9 Pre-Test Right Front Three-Quarter View

Figure A-10 Post-Test Right Front Three-Quarter View

Figure A-11 Pre-Test Left Rear Three-Quarter View

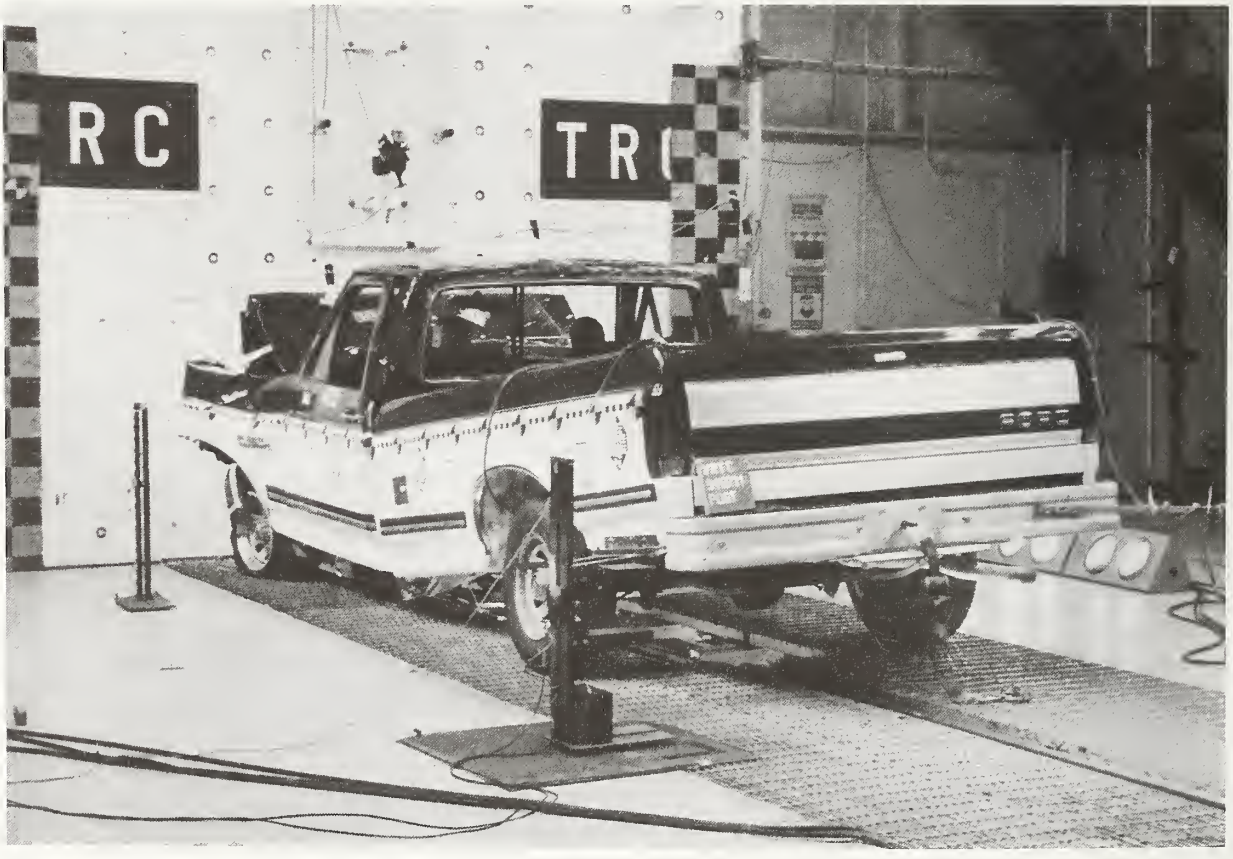


Figure A-12 Post-Test Left Rear Three-Quarter View

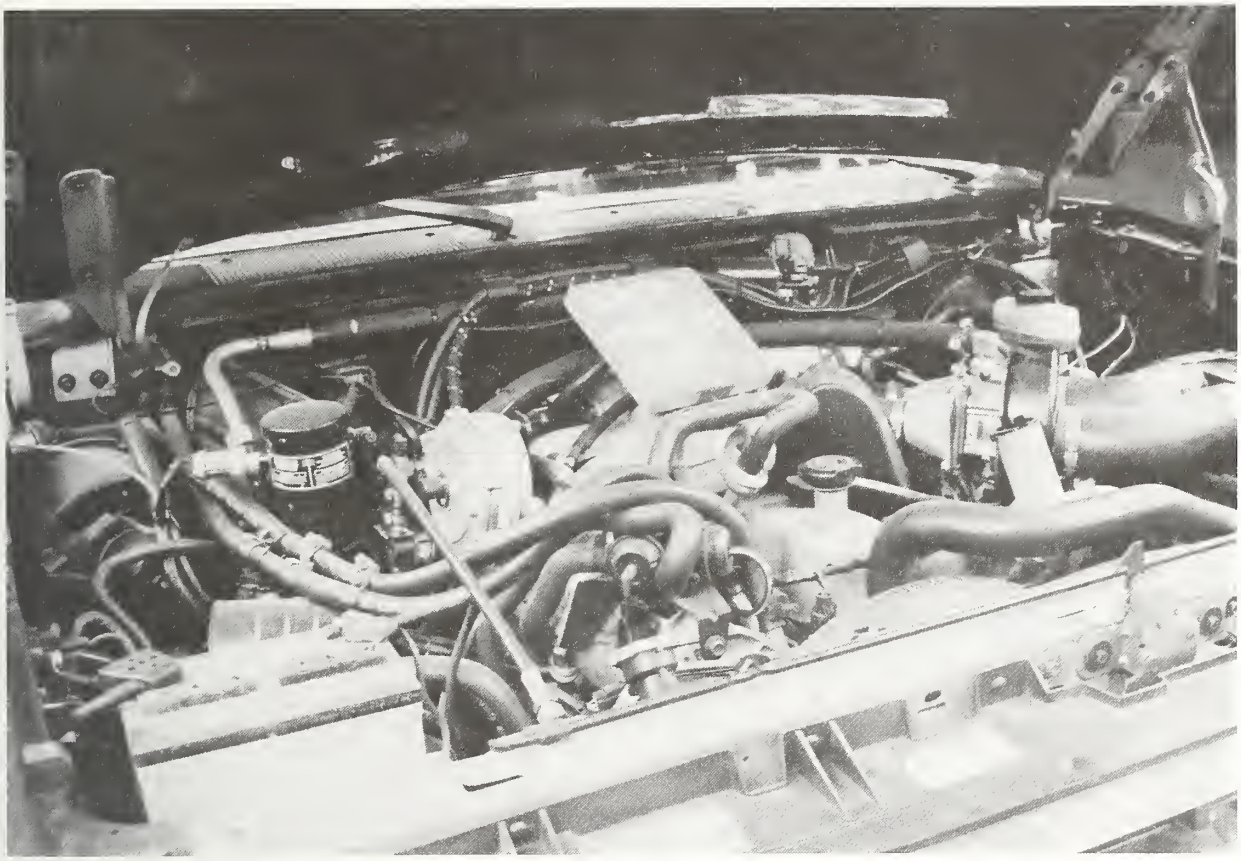


Figure A-13 Pre-Test Engine Compartment View

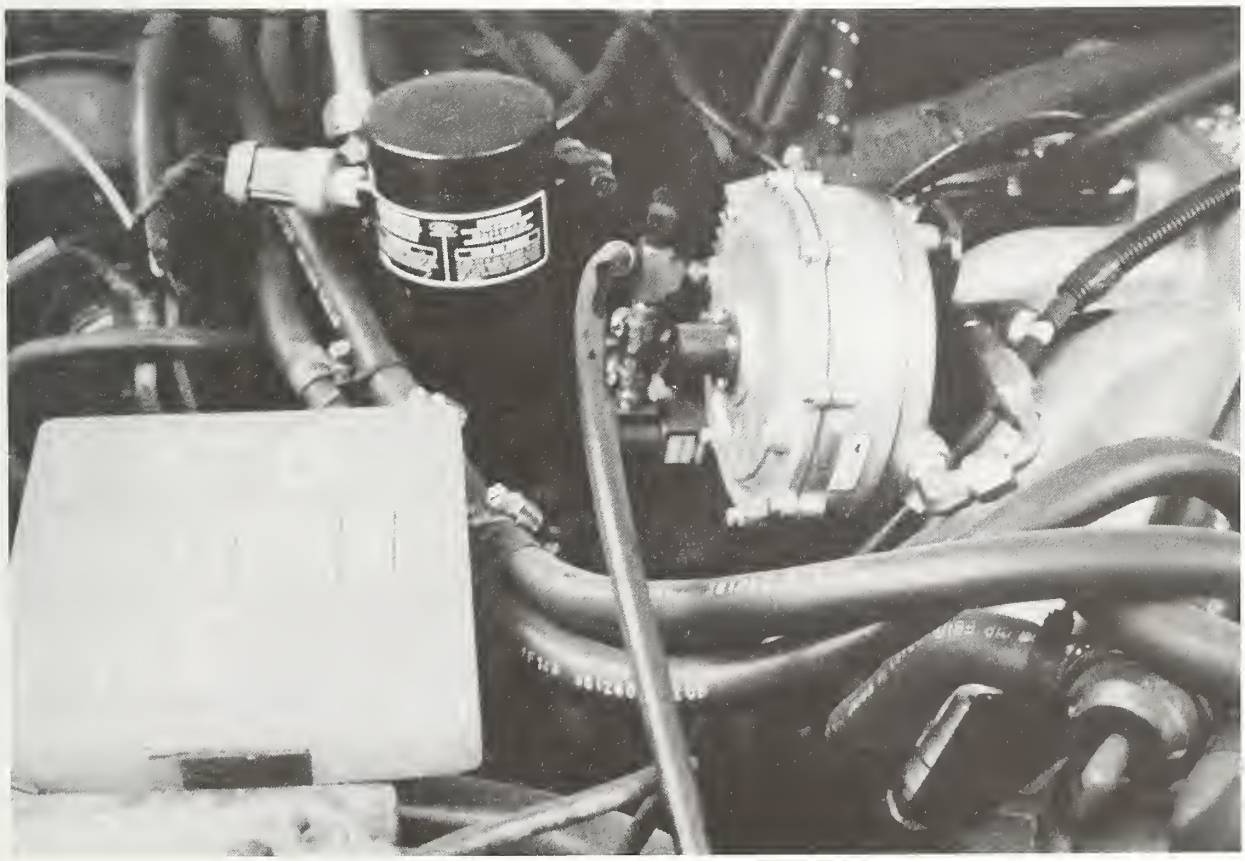


Figure A-14 Pre-Test Engine Compartment Closeup - View 1

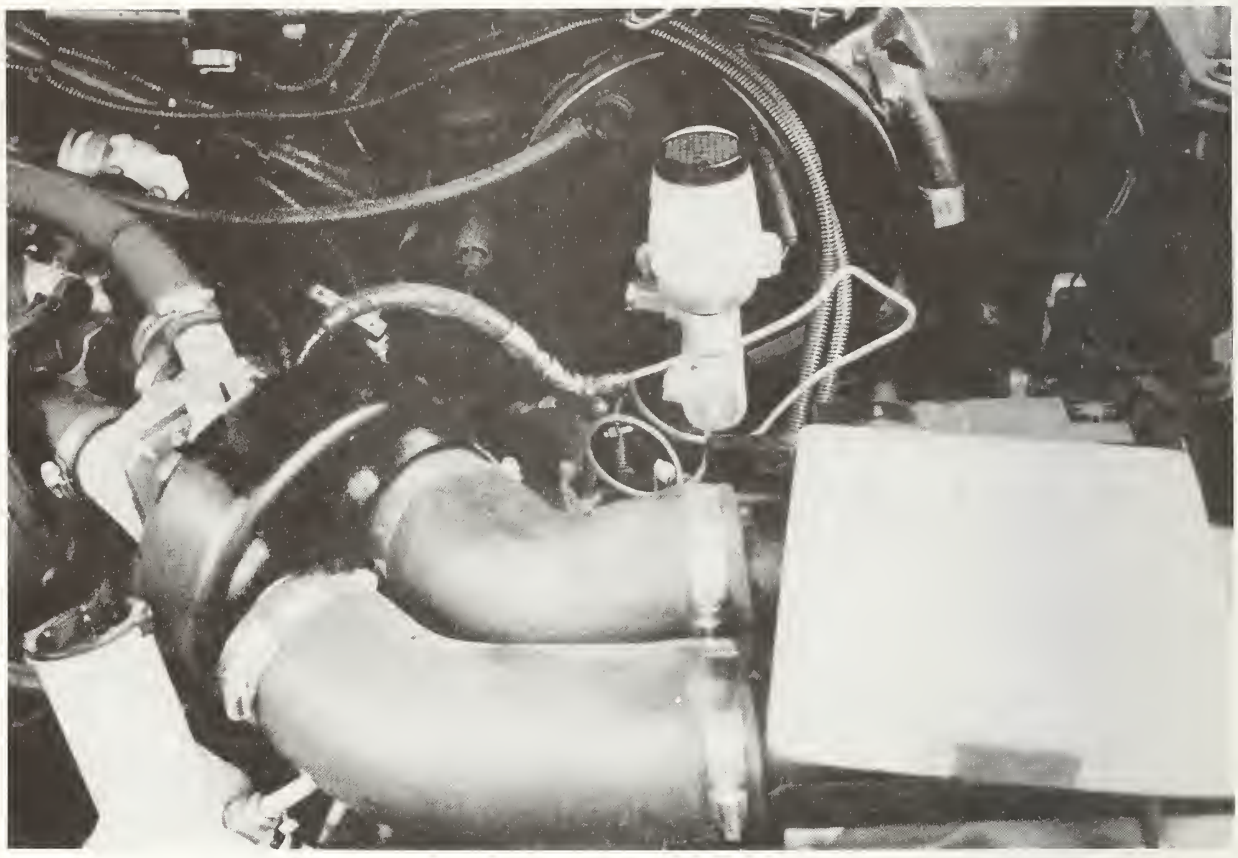


Figure A-15 Pre-Test Engine Compartment Closeup - View 2

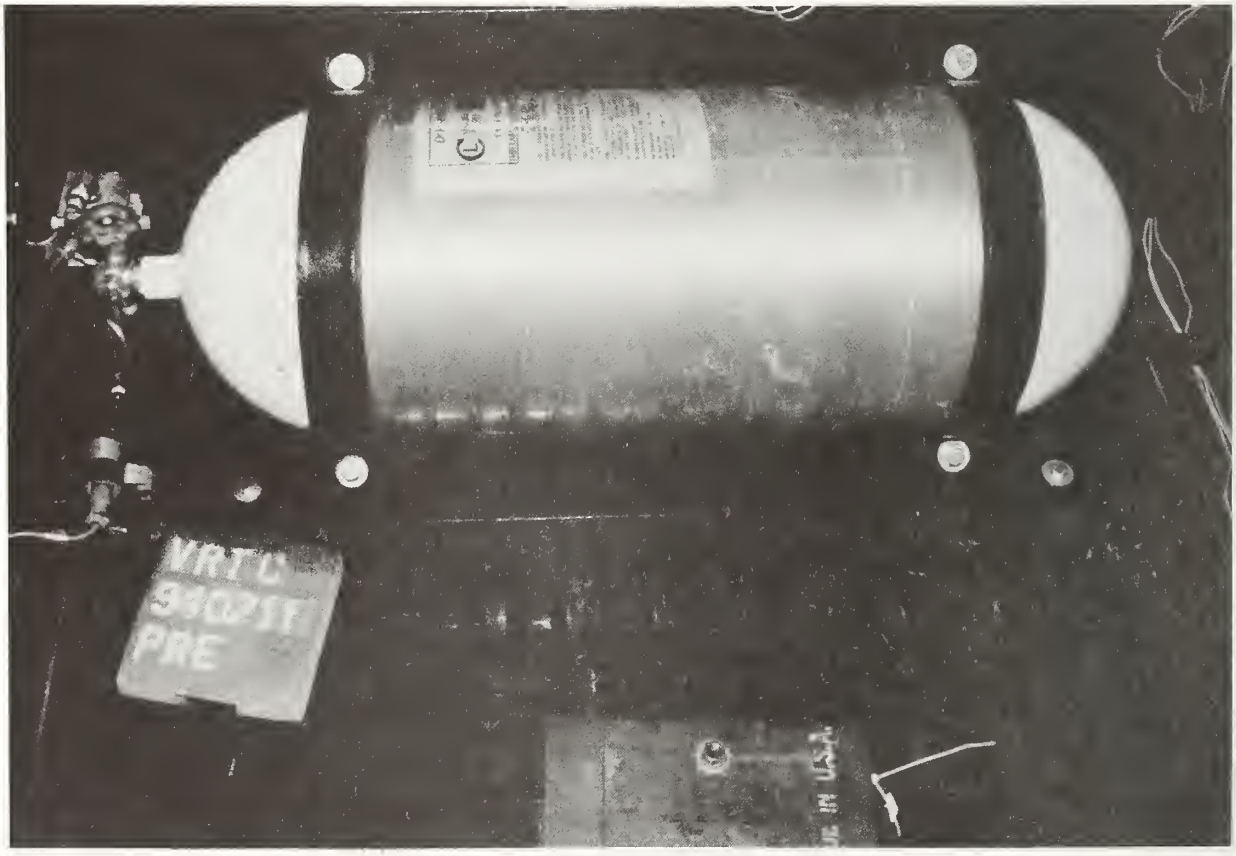


Figure A-16 Pre-Test Bed Mounted Fuel Tank View

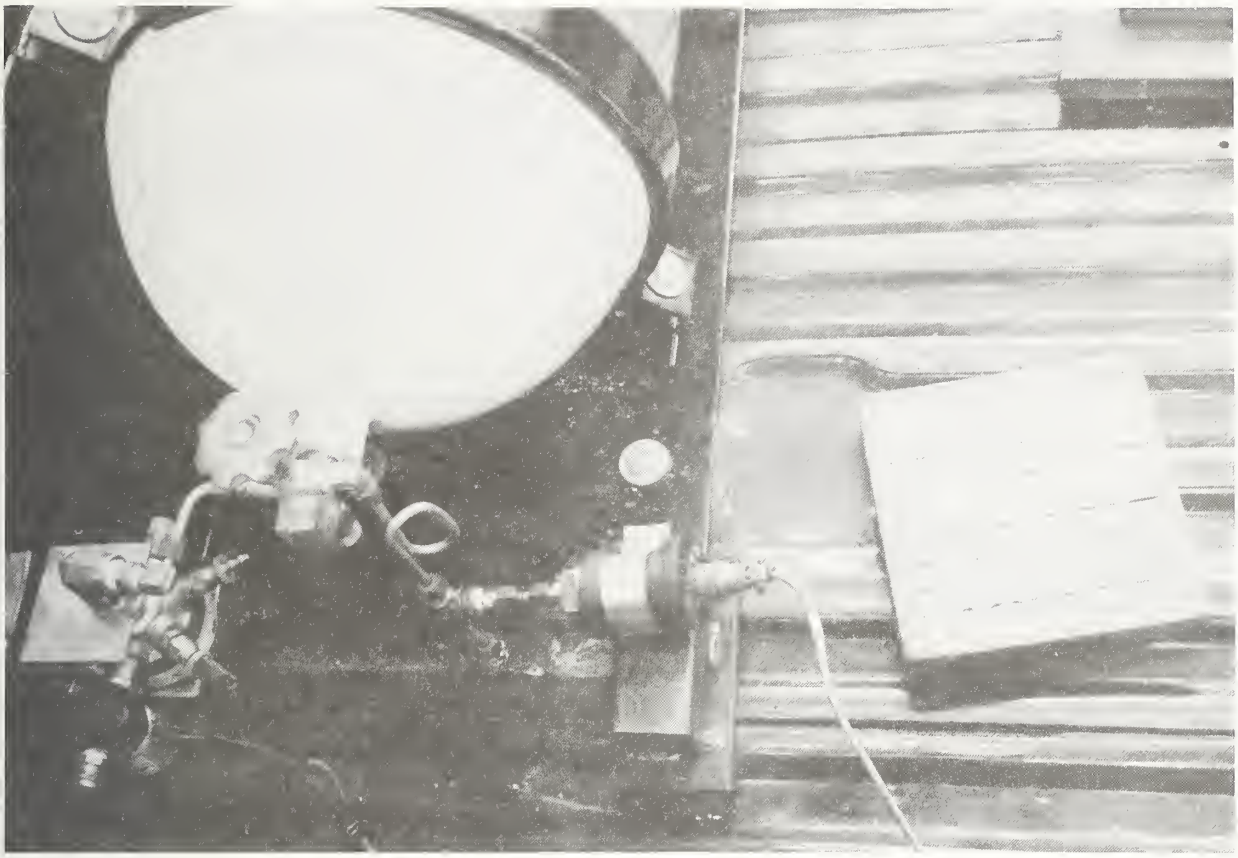


Figure A-17 Pre-Test Bed Mounted Fuel Tank Closeup View

Figure A-18 Pre-Test Underbody Fuel Tank View

Figure A-19 Pre-Test Underbody Fuel Tank Closeup View

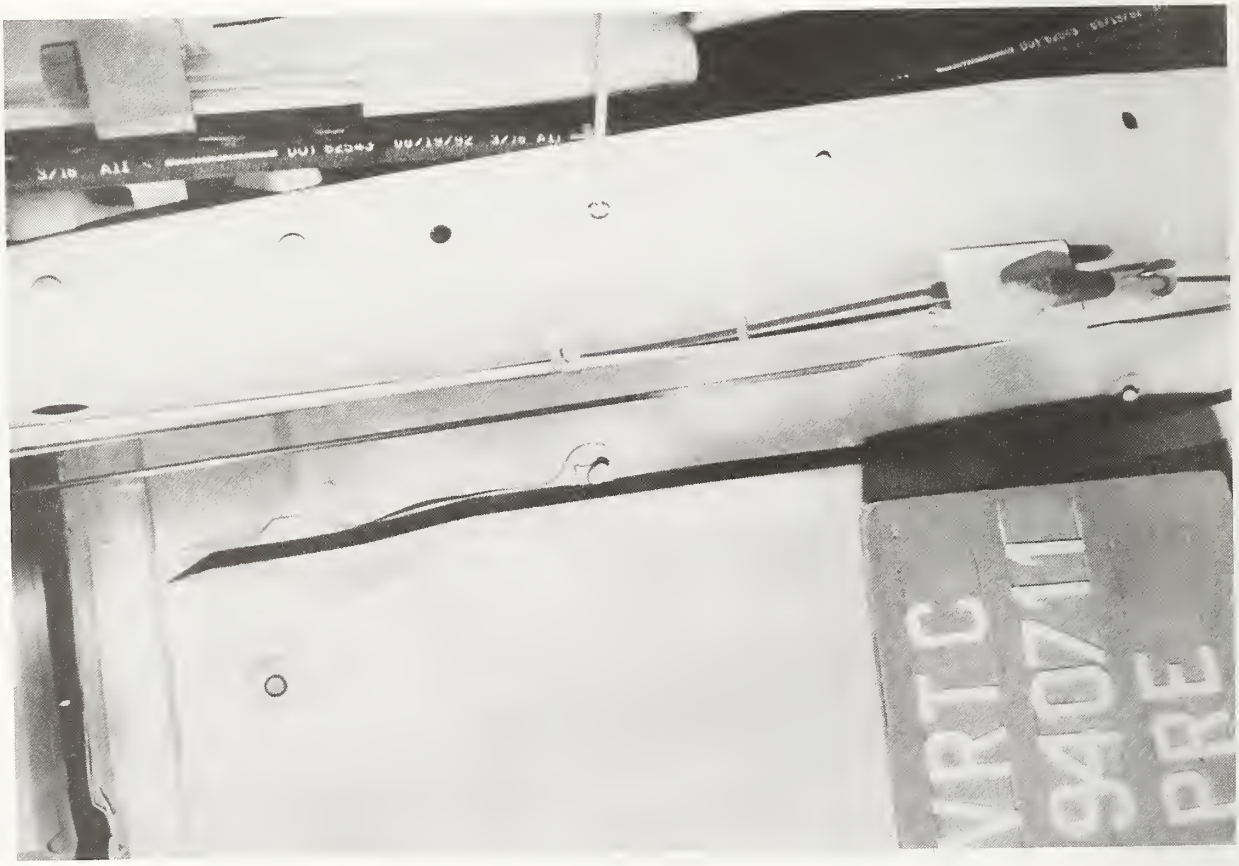


Figure A-20 Pre-Test Fuel Lines - View 1

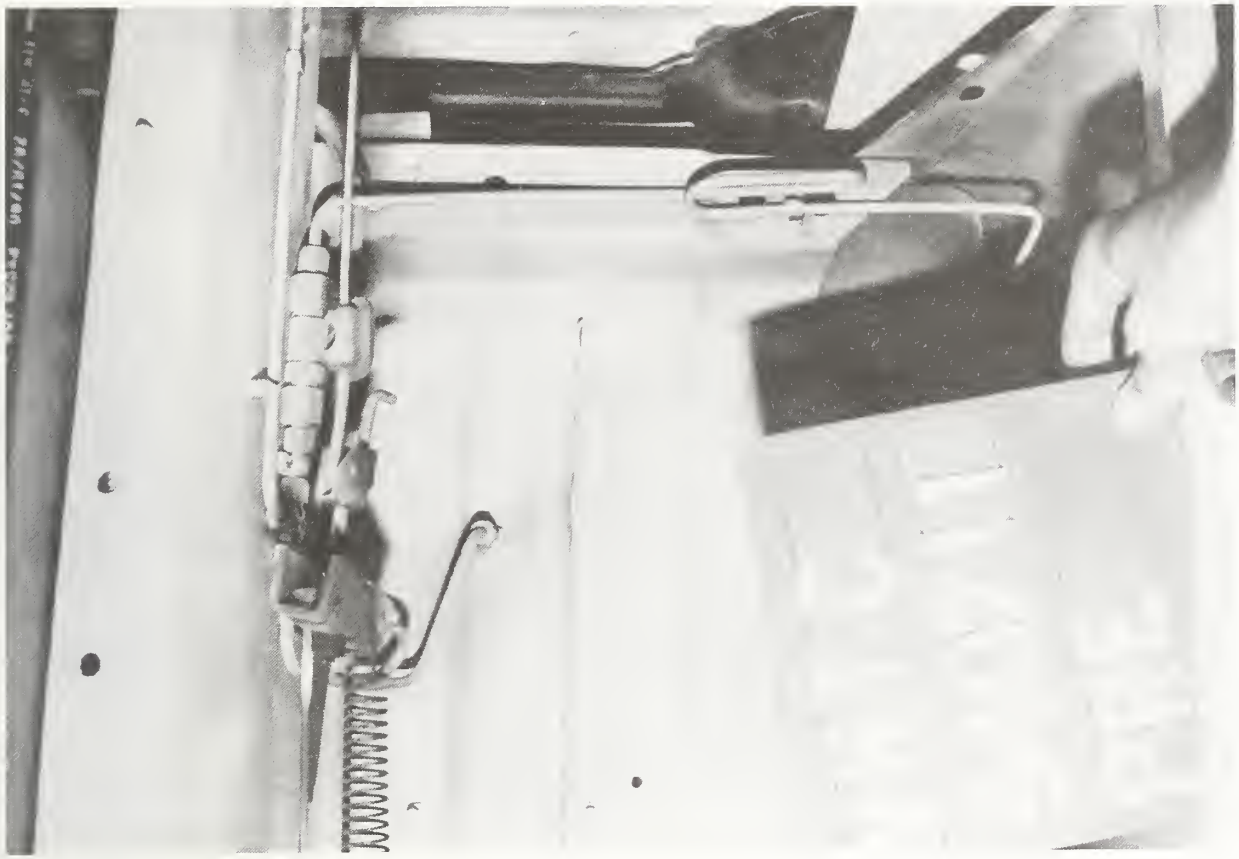


Figure A-21 Pre-Test Fuel Lines - View 2

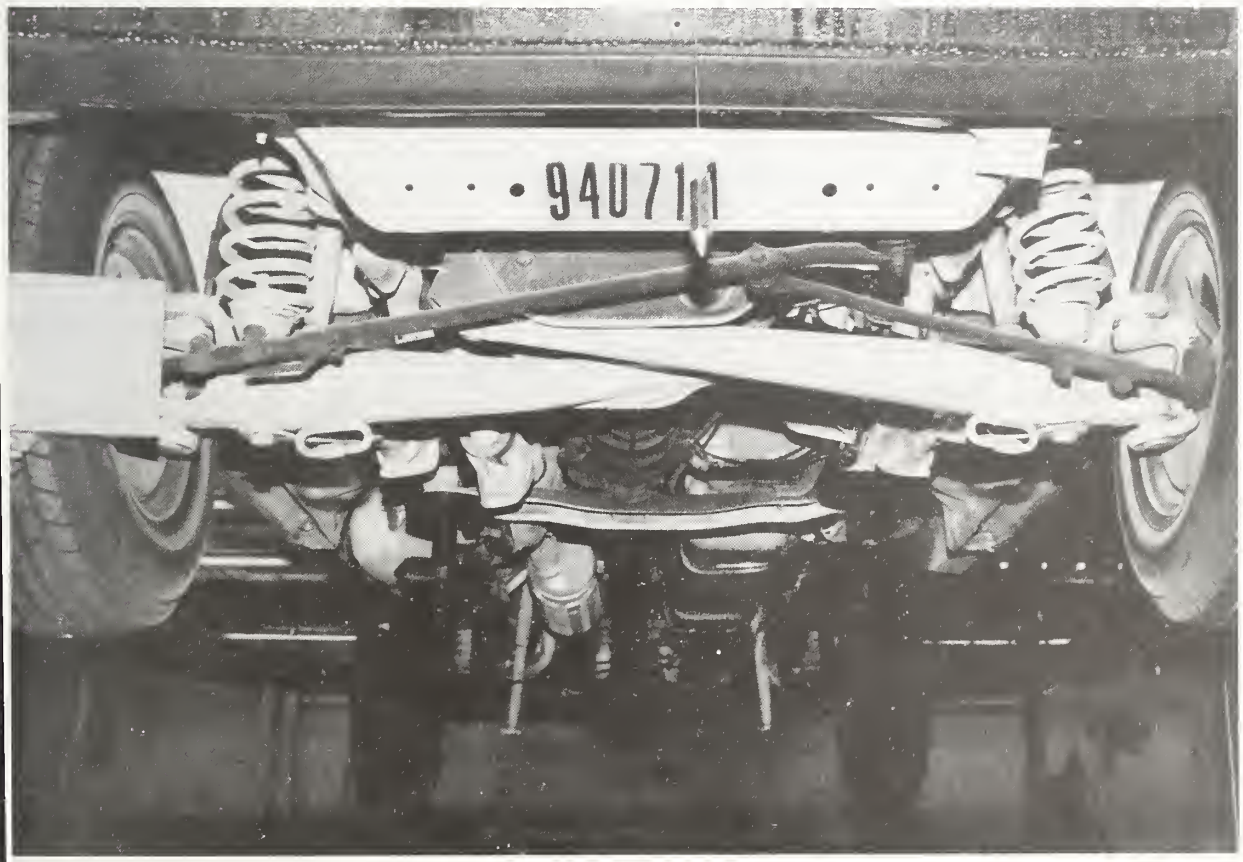


Figure A-22 Pre-Test Front Underbody View

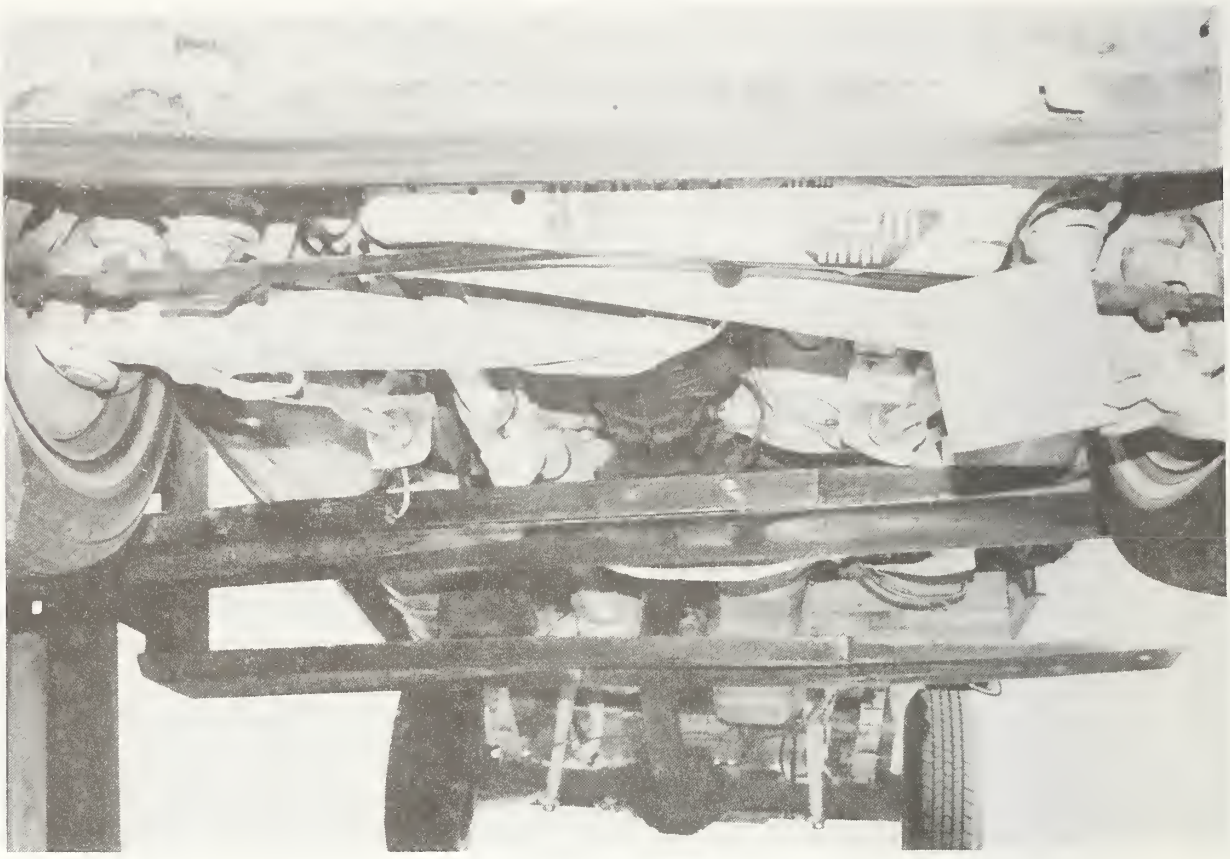


Figure A-23 Post-Test Front Underbody View

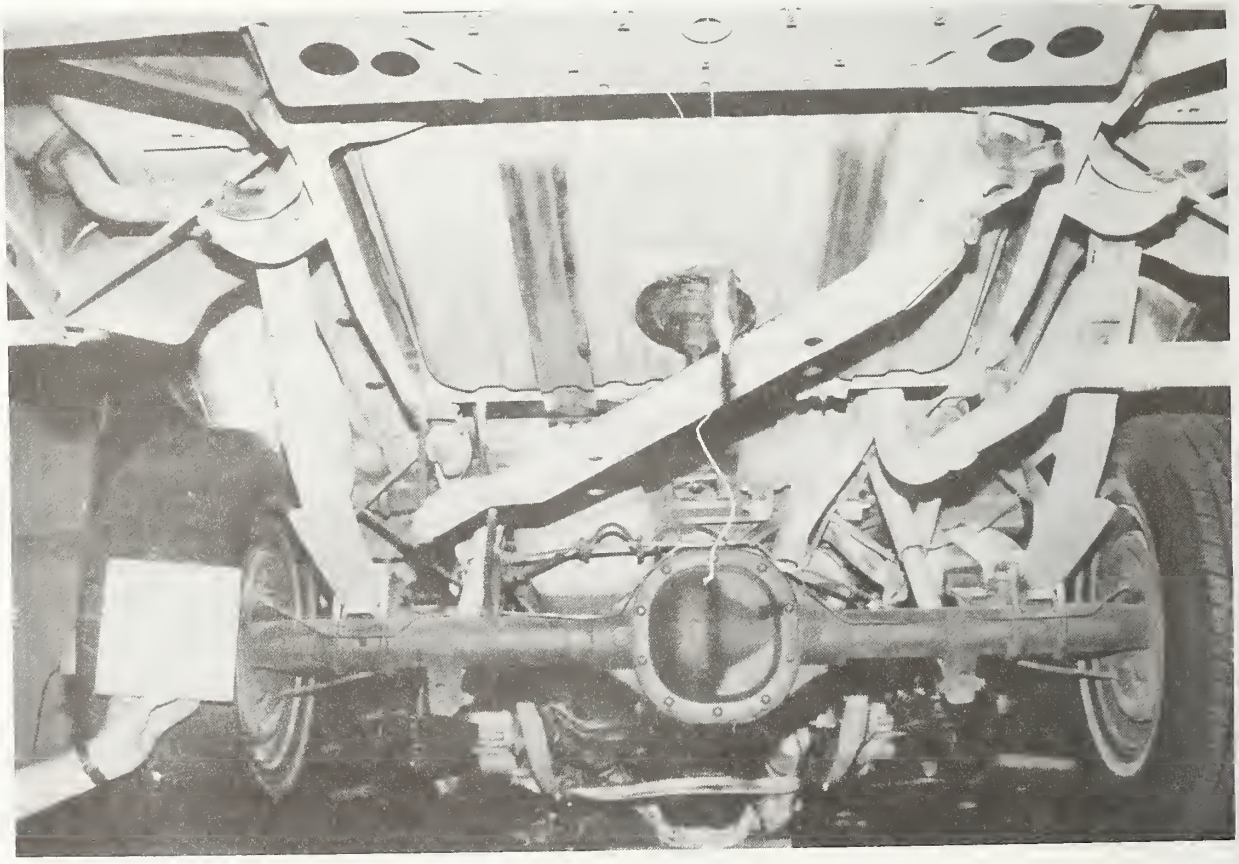


Figure A-24 Pre-Test Rear Underbody View

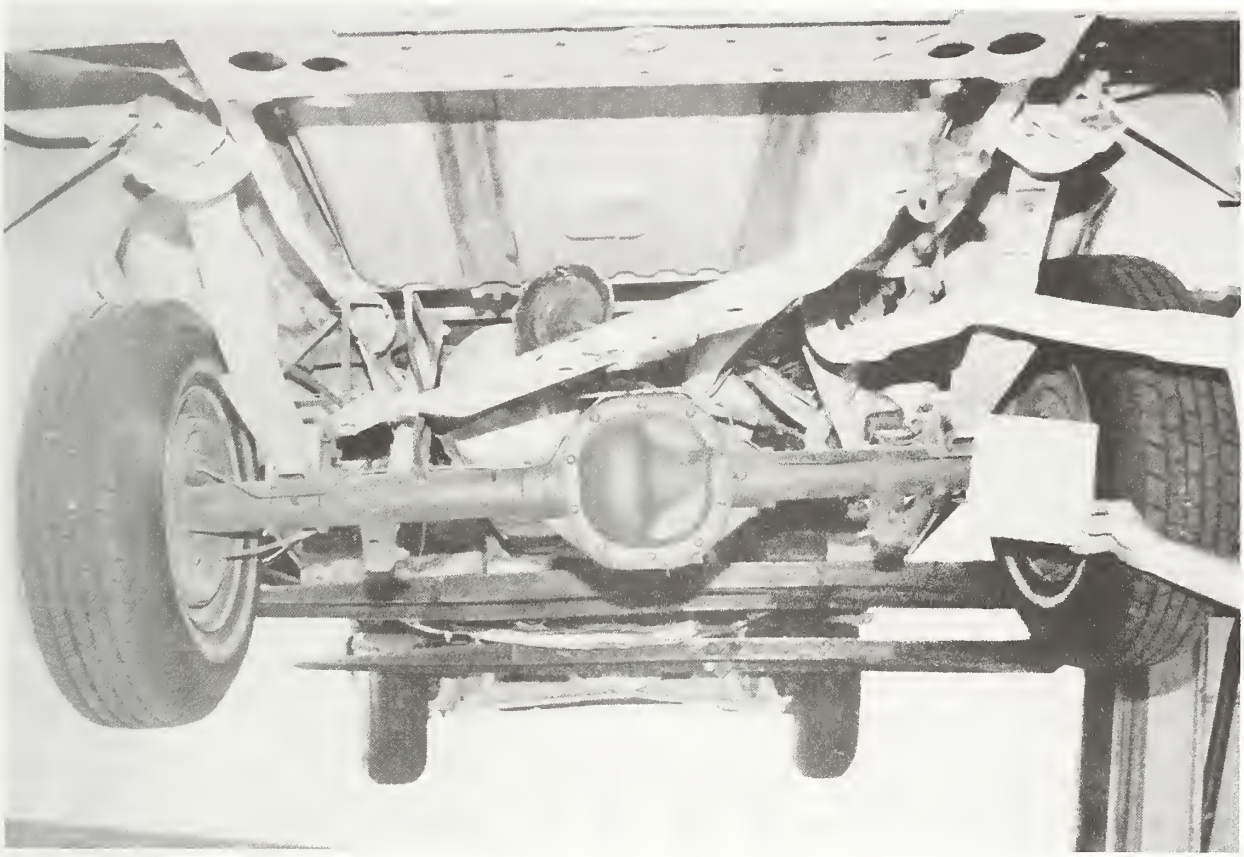


Figure A-25 Post-Test Rear Underbody View

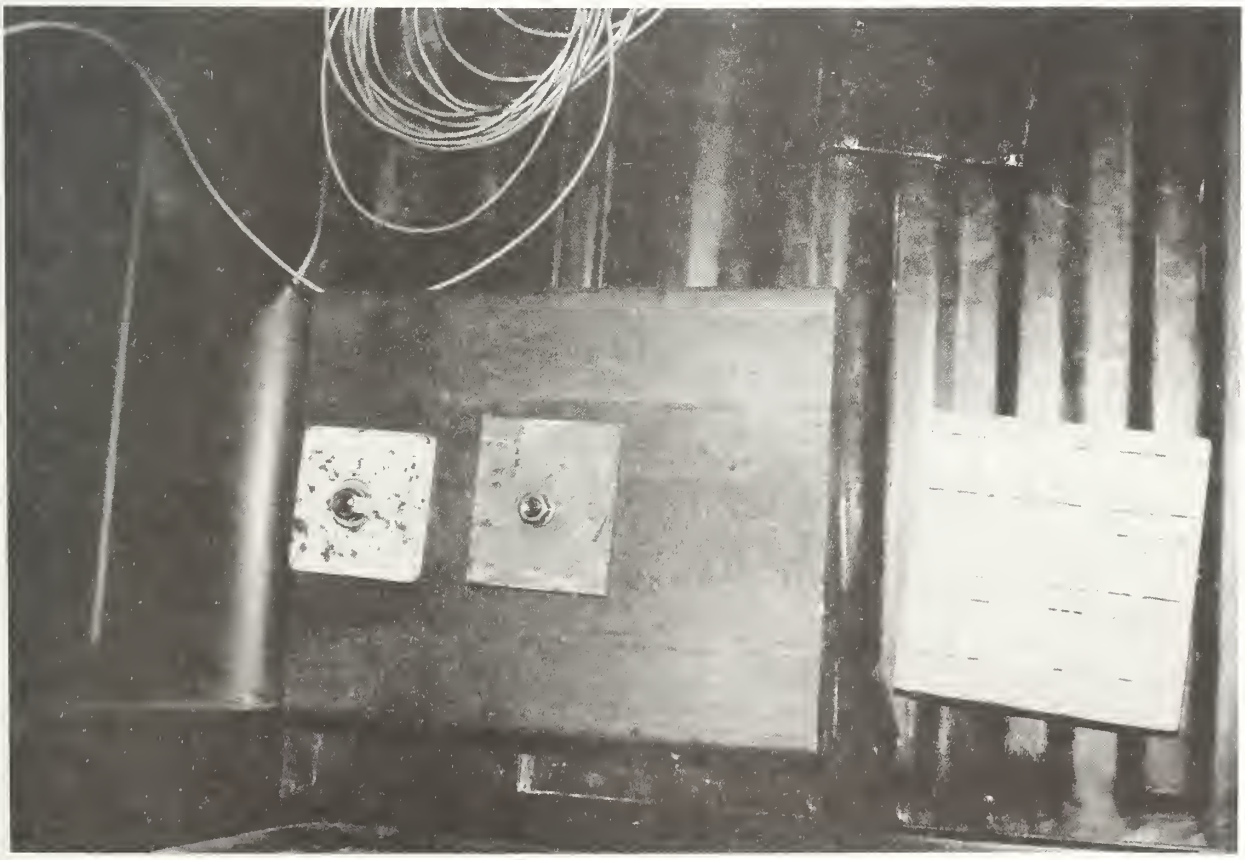


Figure A-26 Pre-Test Ballast Location - View 1

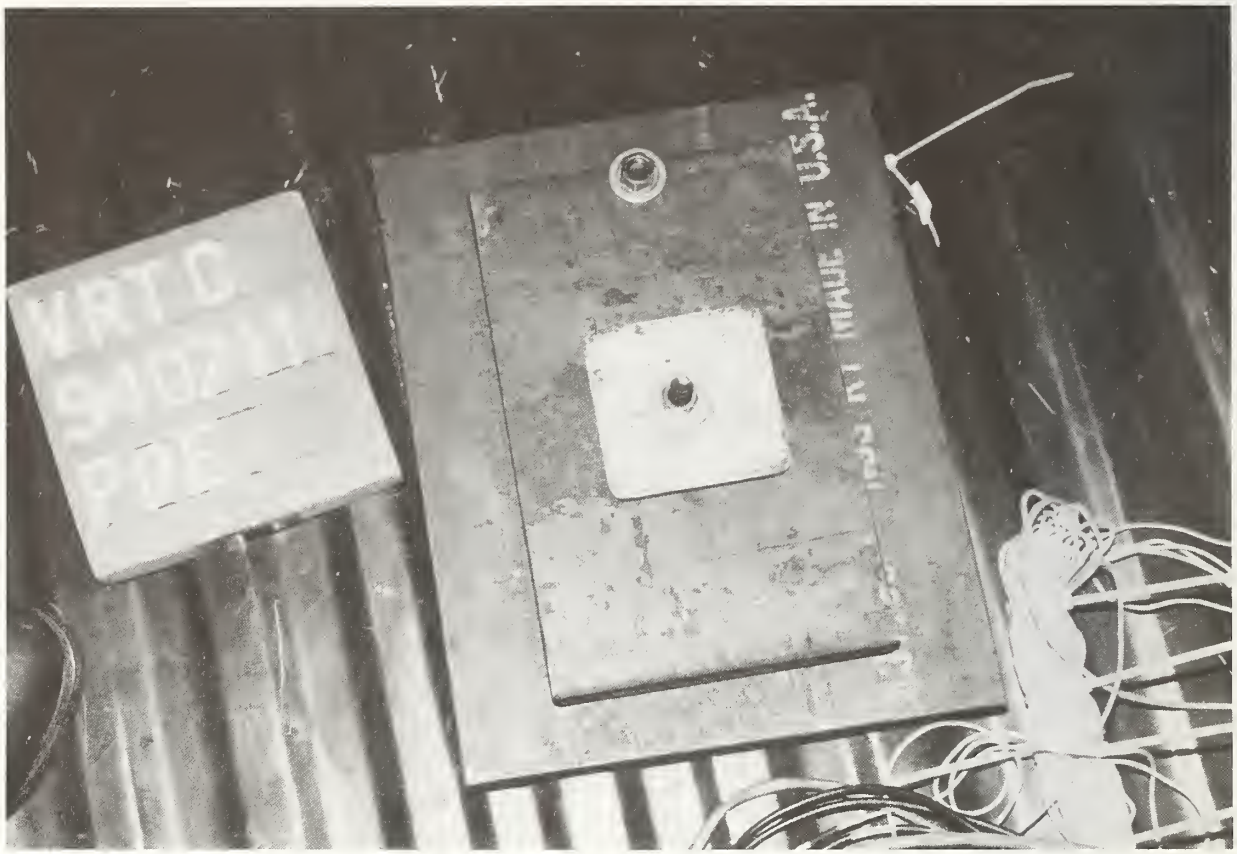
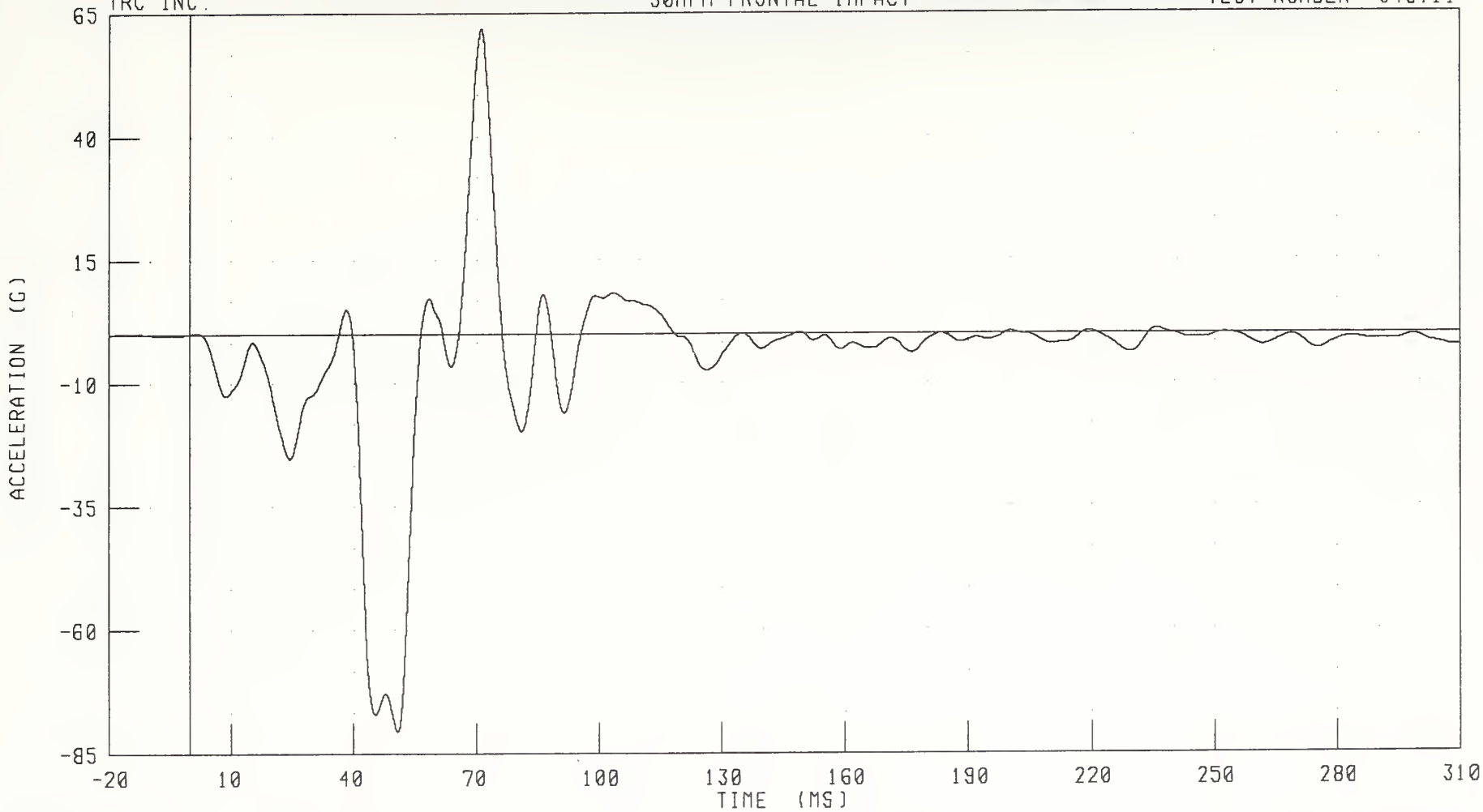


Figure A-27 Pre-Test Ballast Location - View 2

Appendix B

Data Plots

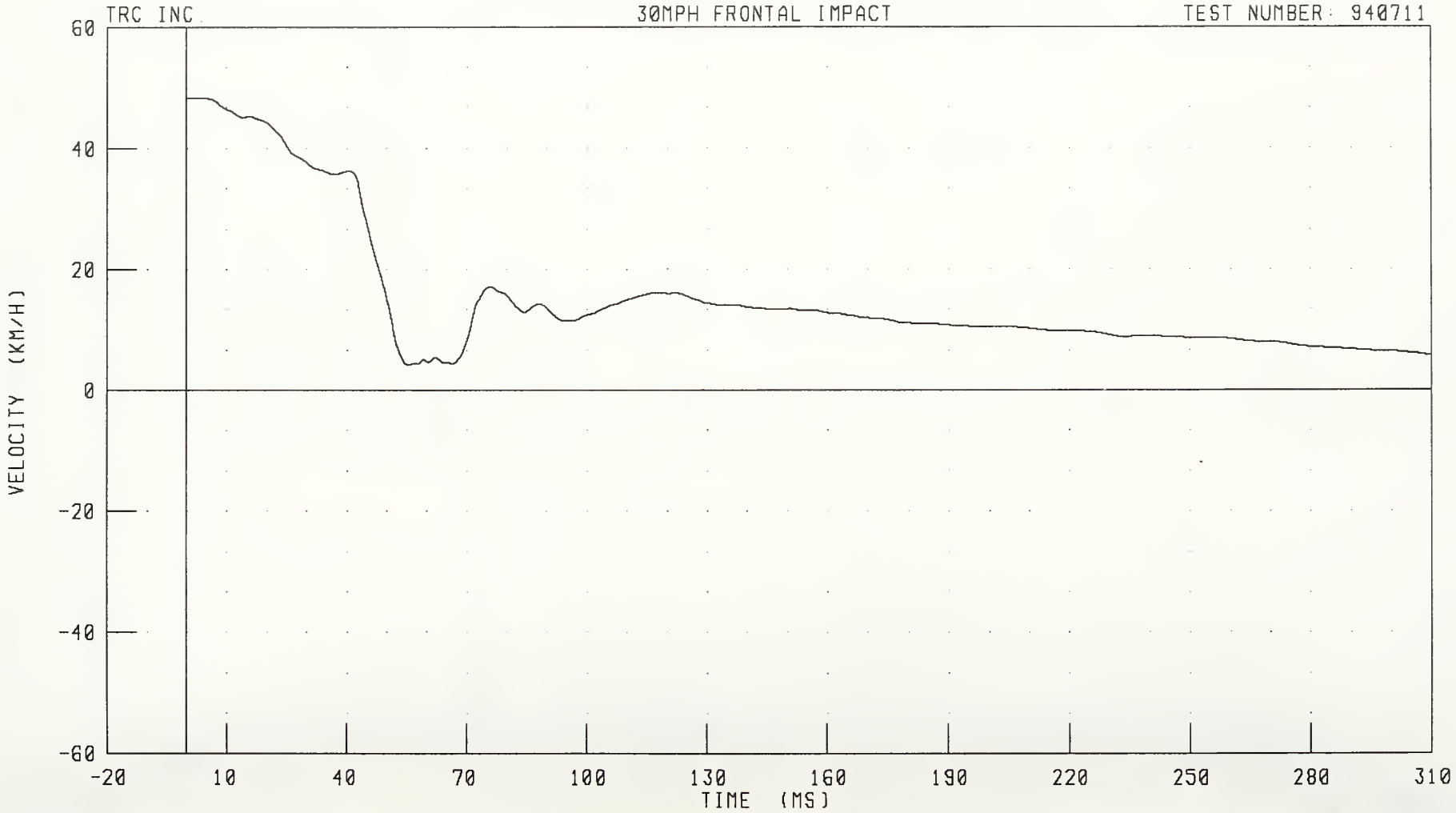
1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY X-AXIS ACCELERATION
TRC INC. 30MPH FRONTAL IMPACT TEST NUMBER 940711



CHANNEL: VCGXG FILTER: CH. CLASS 60 PEAK DATA: 61.85 G @ 71.20 MS, -80.45 G @ 50.80 MS

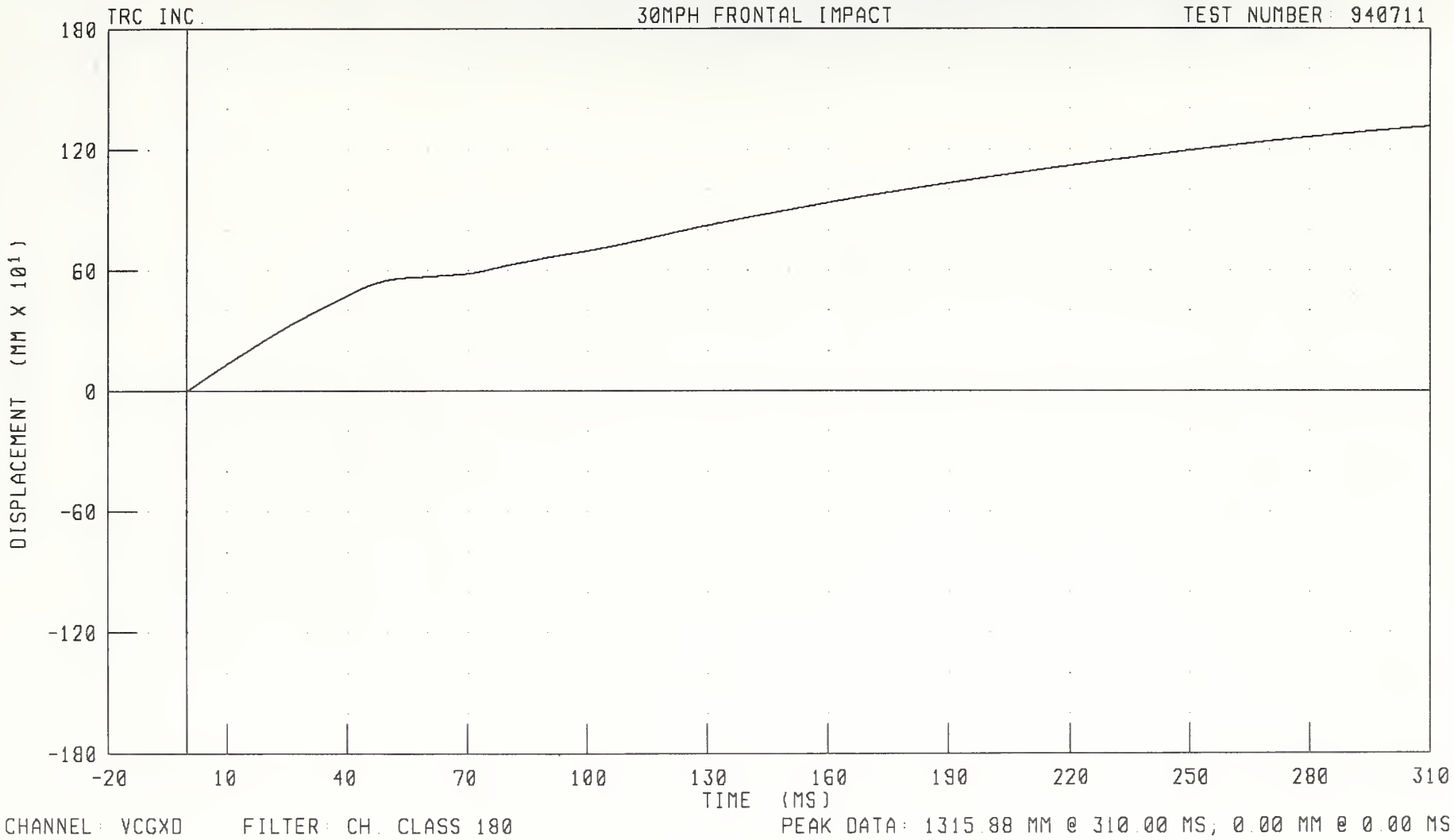
1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY X-AXIS VELOCITY

TRC INC 30MPH FRONTAL IMPACT TEST NUMBER: 940711



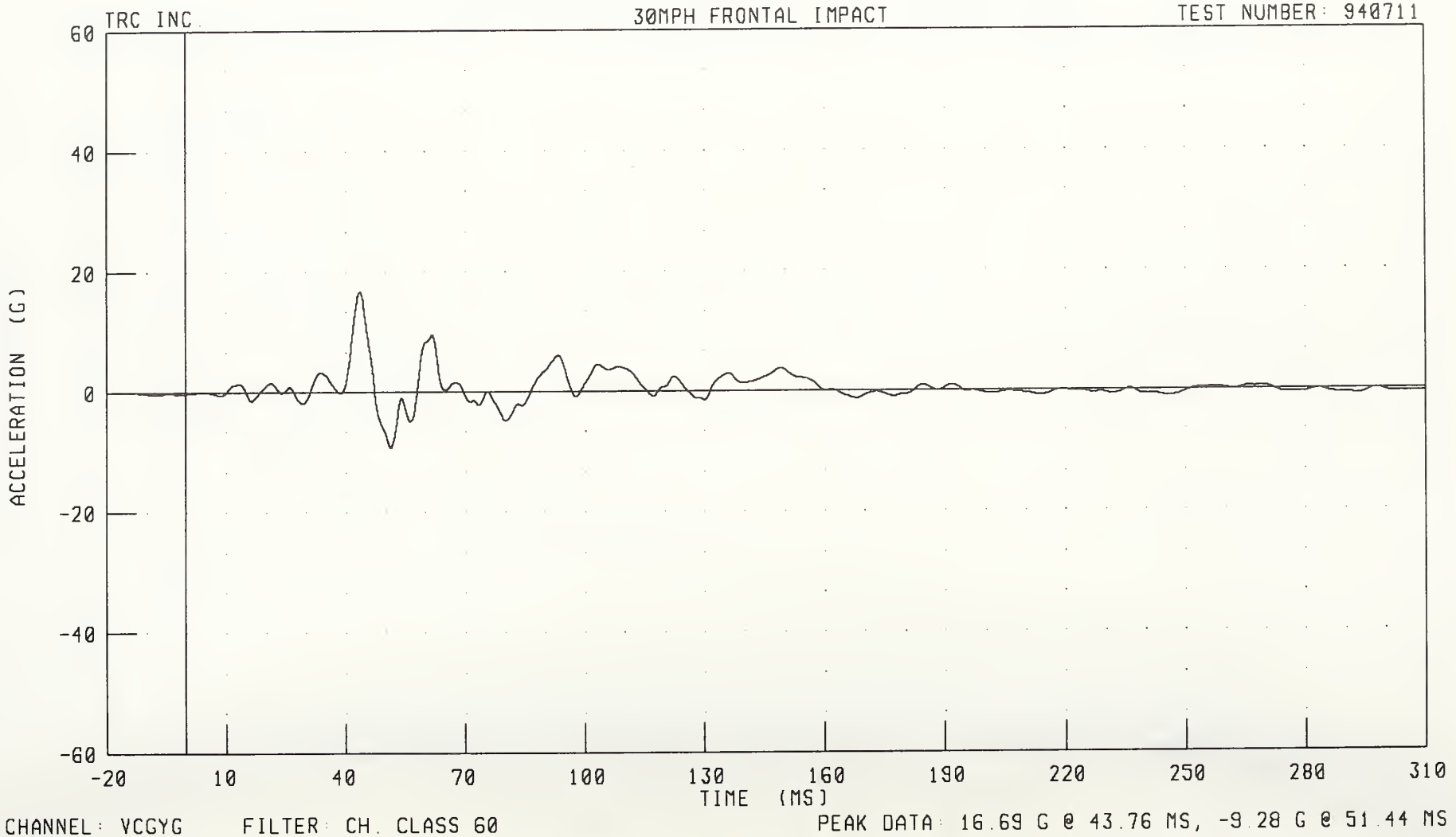
CHANNEL: VCGXV FILTER: CH. CLASS 180 PEAK DATA: 48.30 KM/H @ 0.00 MS; 4.26 KM/H @ 55.60 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY X-AXIS DISPLACEMENT



CHANNEL: VCGXD FILTER: CH. CLASS 180 PEAK DATA: 1315.88 MM @ 310.00 MS, 0.00 MM @ 0.00 MS

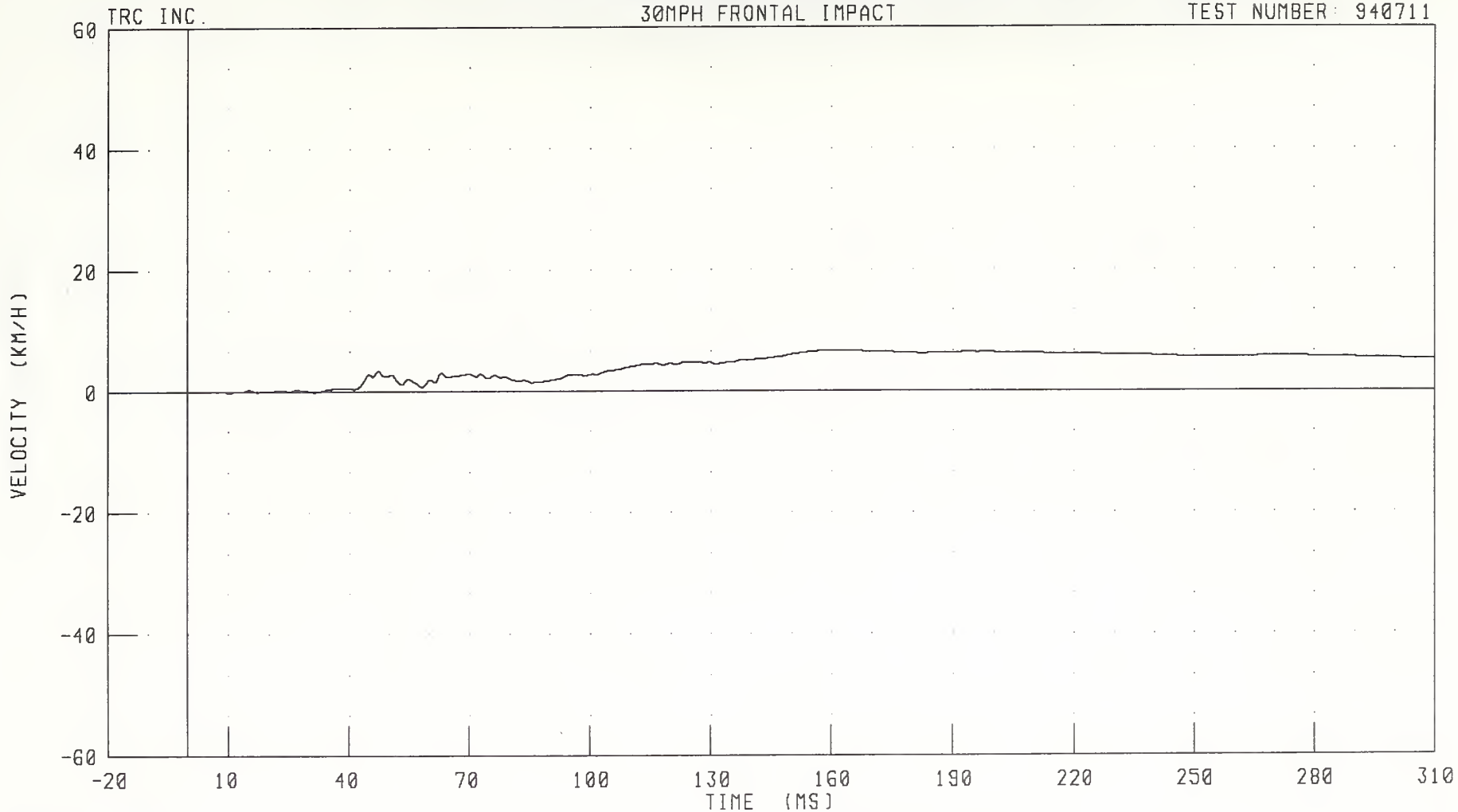
1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY Y-AXIS ACCELERATION
30MPH FRONTAL IMPACT



CHANNEL: VCGYG FILTER: CH. CLASS 60 PEAK DATA: 16.69 G @ 43.76 MS, -9.28 G @ 51.44 MS

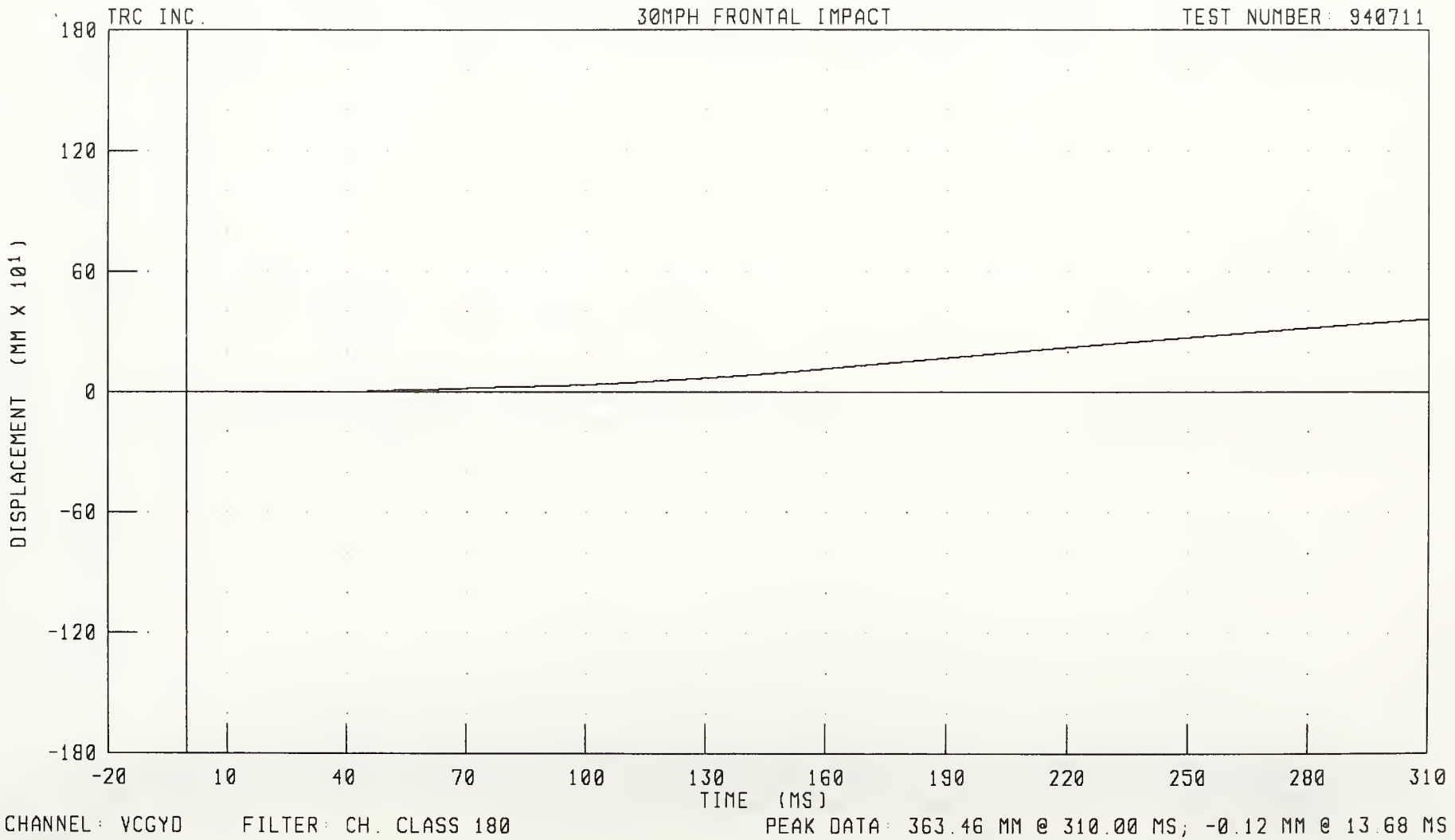
1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY Y-AXIS VELOCITY

TRC INC. 30MPH FRONTAL IMPACT TEST NUMBER: 940711

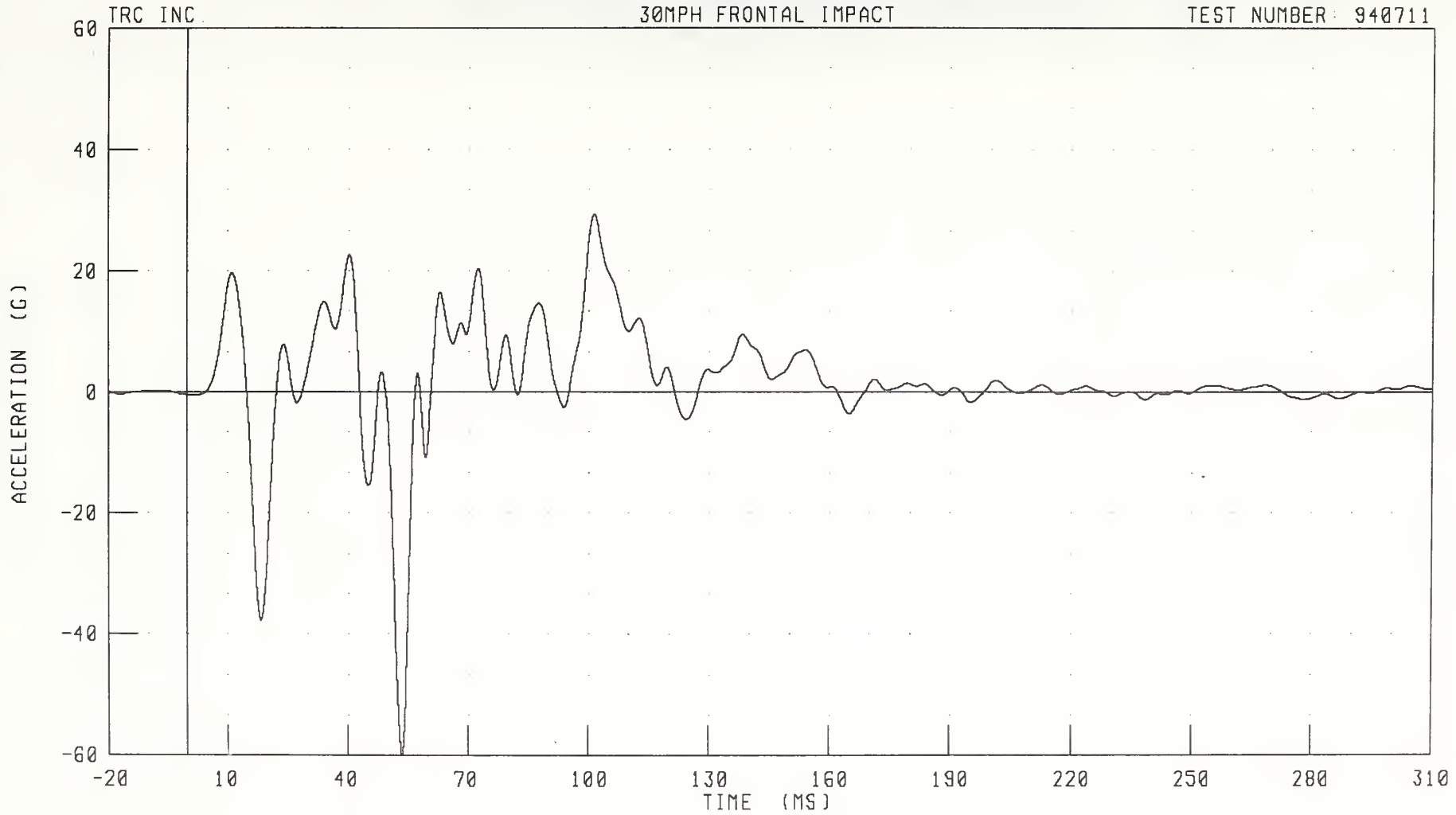


CHANNEL: VCGYV FILTER: CH. CLASS 180 PEAK DATA: 6.67 KM/H @ 163.44 MS, -0.14 KM/H @ 10.40 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY Y-AXIS DISPLACEMENT

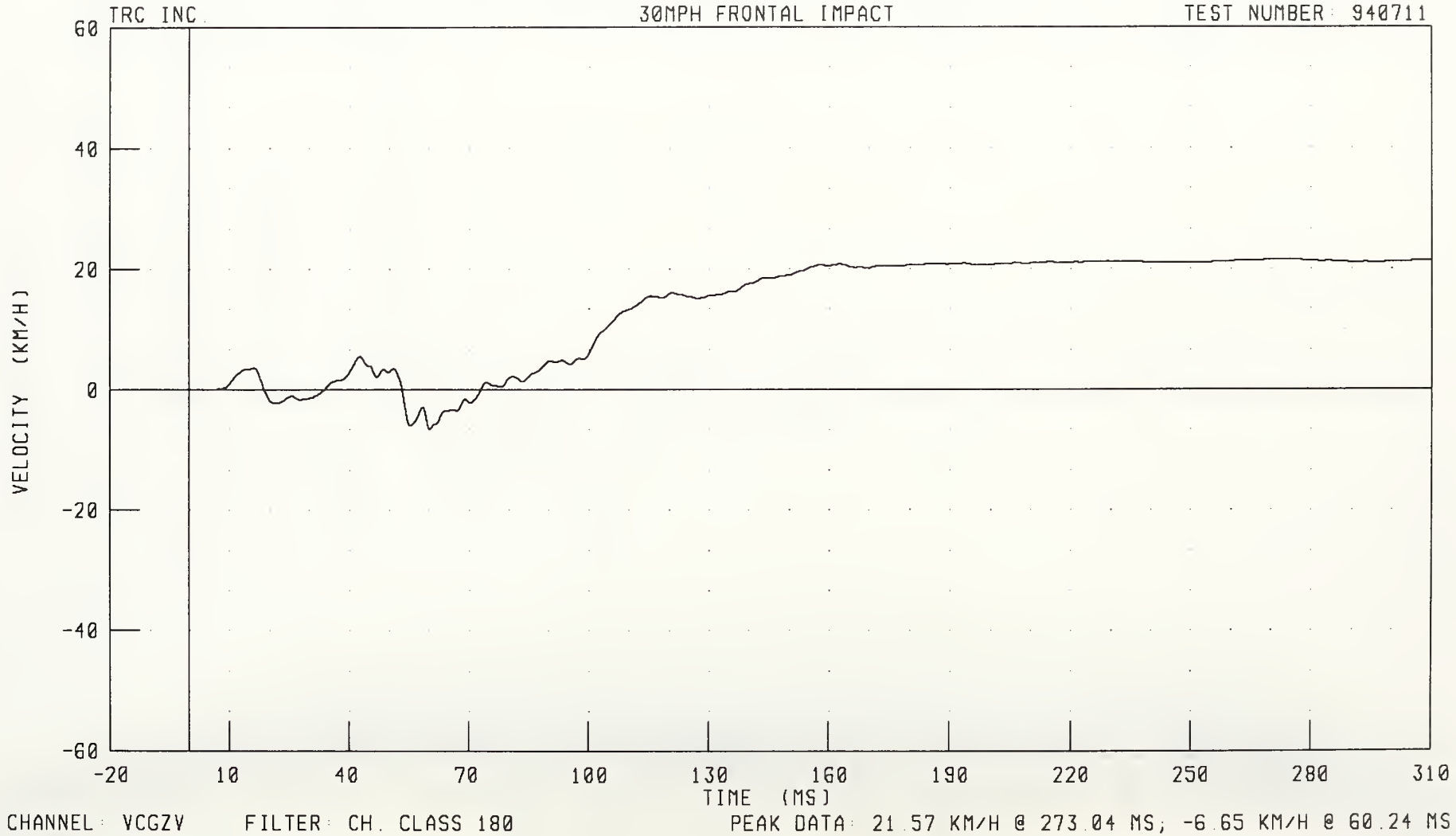


1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY Z-AXIS ACCELERATION



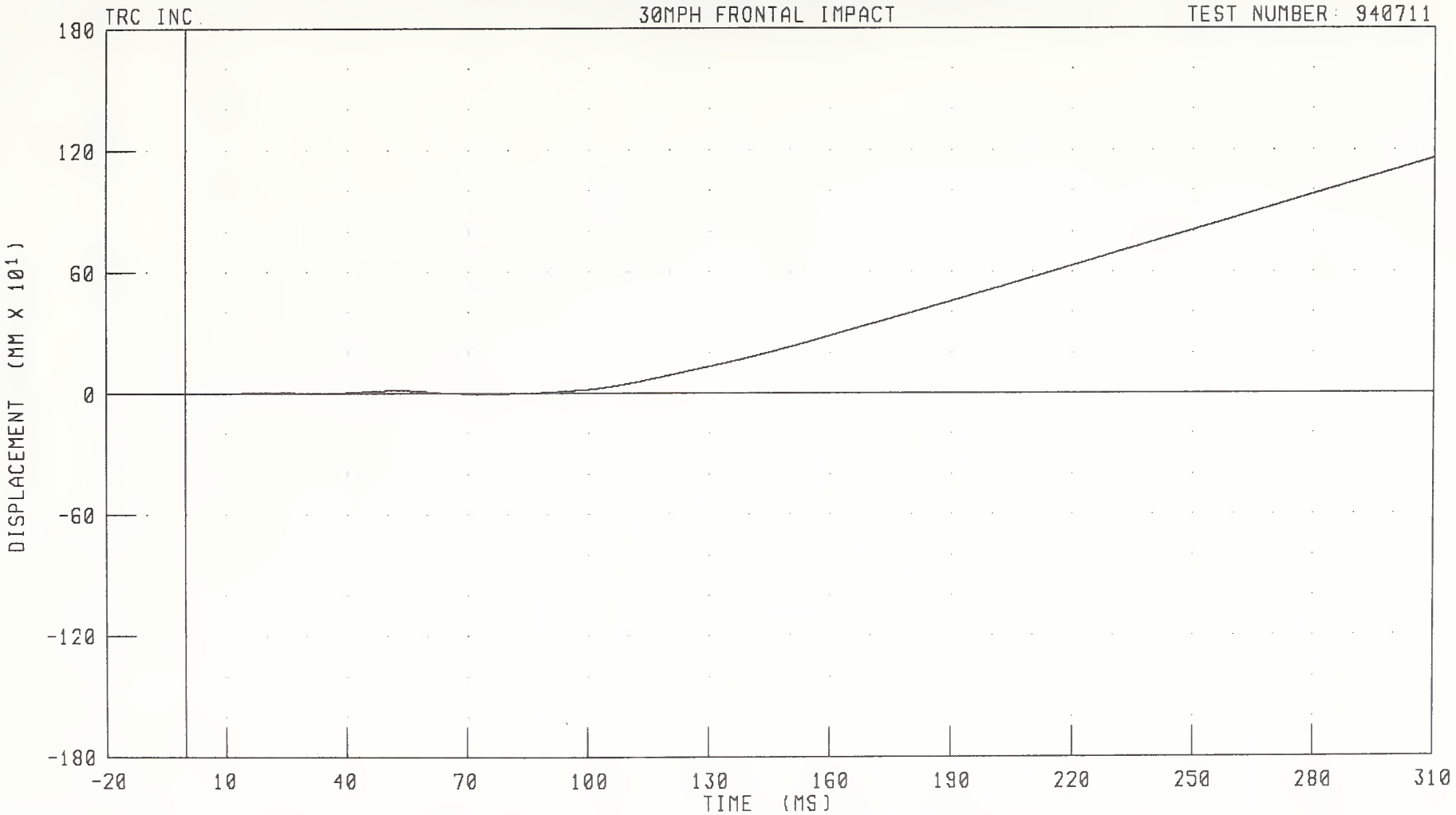
CHANNEL: VCGZG FILTER: CH. CLASS 60 PEAK DATA: 29.37 G @ 101.44 MS; -59.95 G @ 53.52 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY Z-AXIS VELOCITY



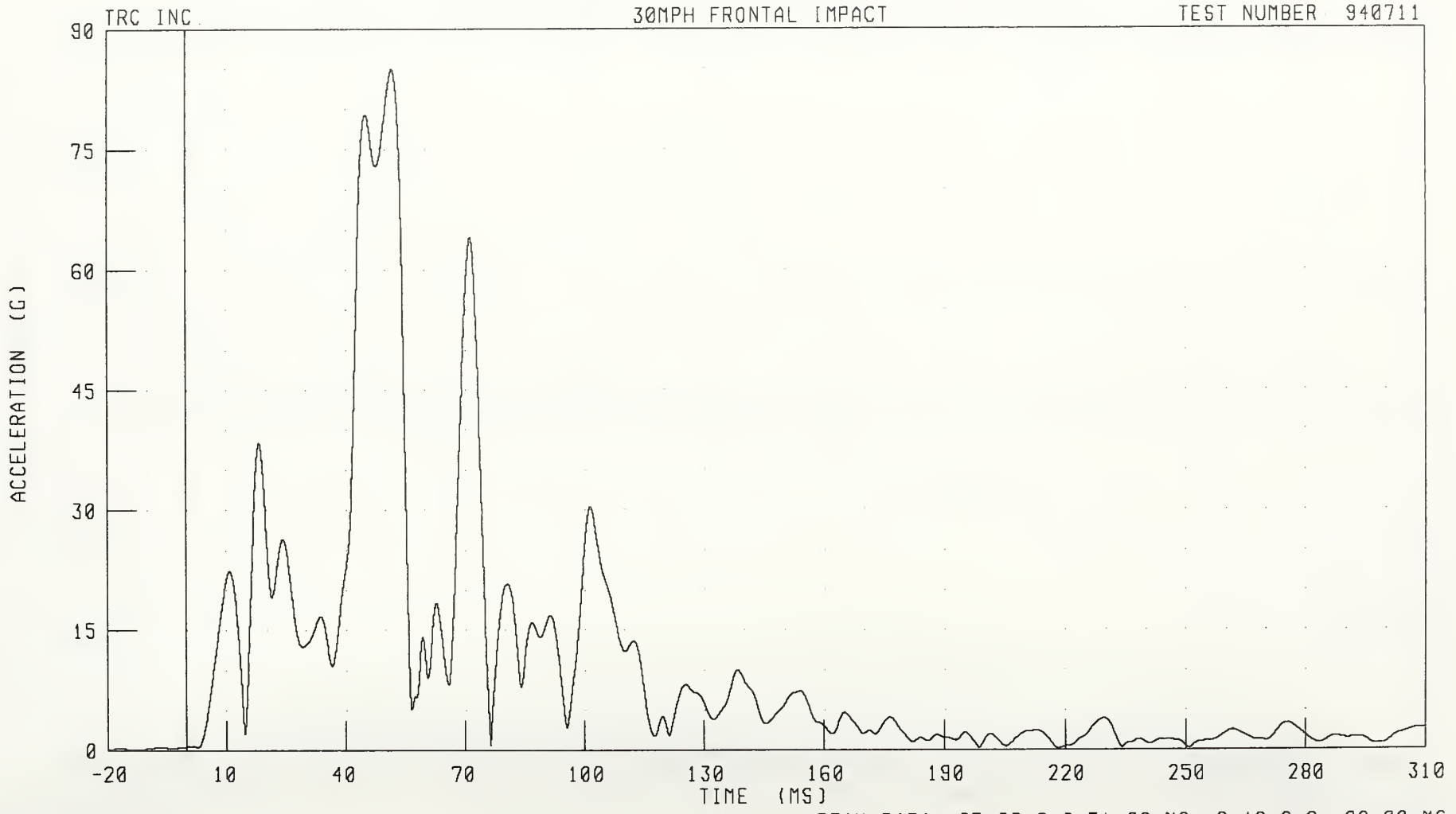
CHANNEL: VCGZV FILTER: CH. CLASS 180 PEAK DATA: 21.57 KM/H @ 273.04 MS; -6.65 KM/H @ 60.24 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY Z-AXIS DISPLACEMENT



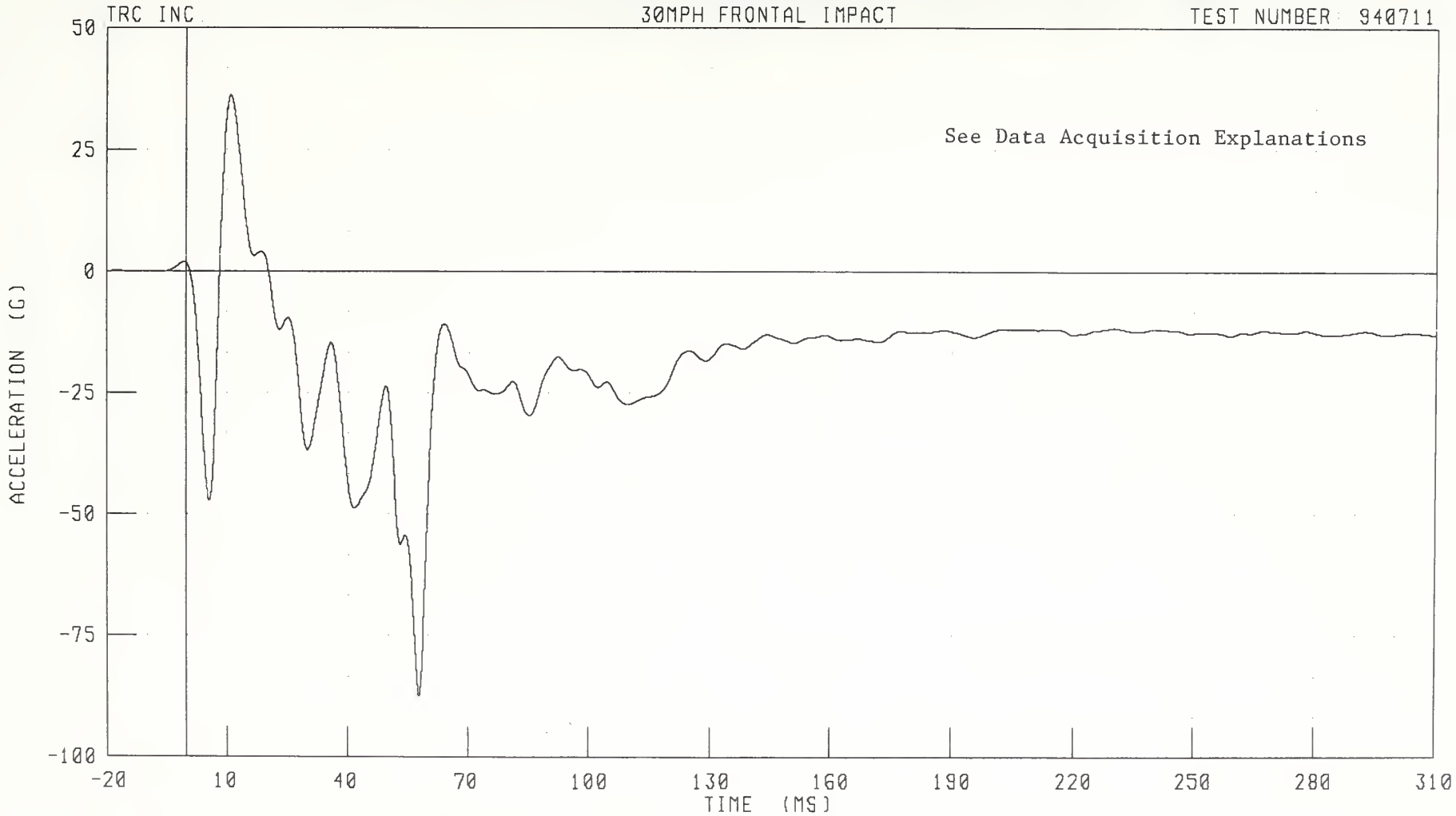
CHANNEL: VCGZD FILTER: CH. CLASS 180 PEAK DATA: 1158.52 MM @ 310.00 MS; -4.19 MM @ 73.04 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
VEHICLE CENTER OF GRAVITY RESULTANT ACCELERATION



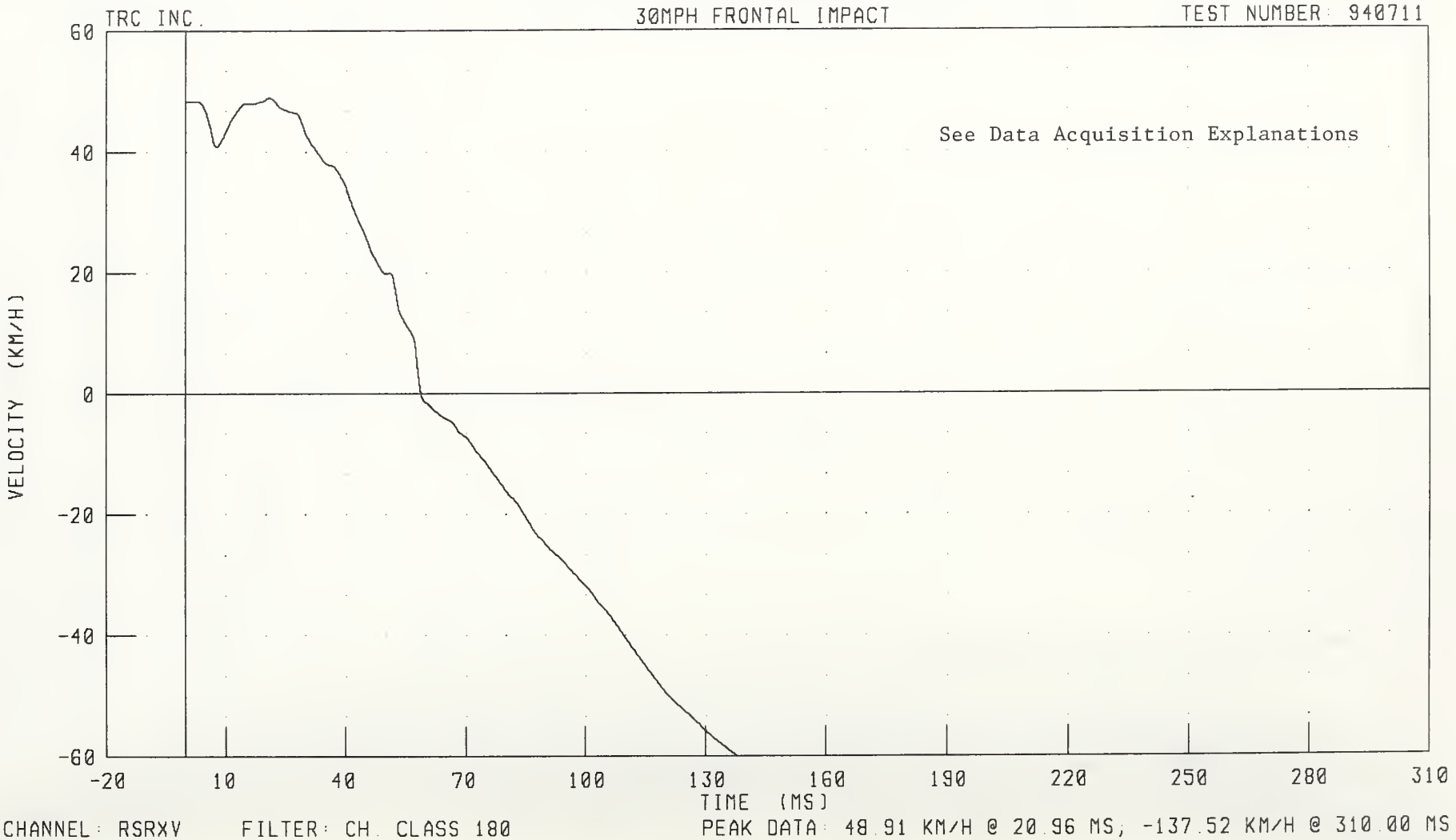
CHANNEL VCGRG FILTER CH CLASS 60 PEAK DATA 85.03 G @ 51.92 MS, 0.10 G @ -20.00 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
RIGHT FRAME RAIL MID X-AXIS ACCELERATION



CHANNEL: RSRXG FILTER: CH. CLASS 60 PEAK DATA: 36.13 G @ 10.96 MS; -87.46 G @ 57.76 MS

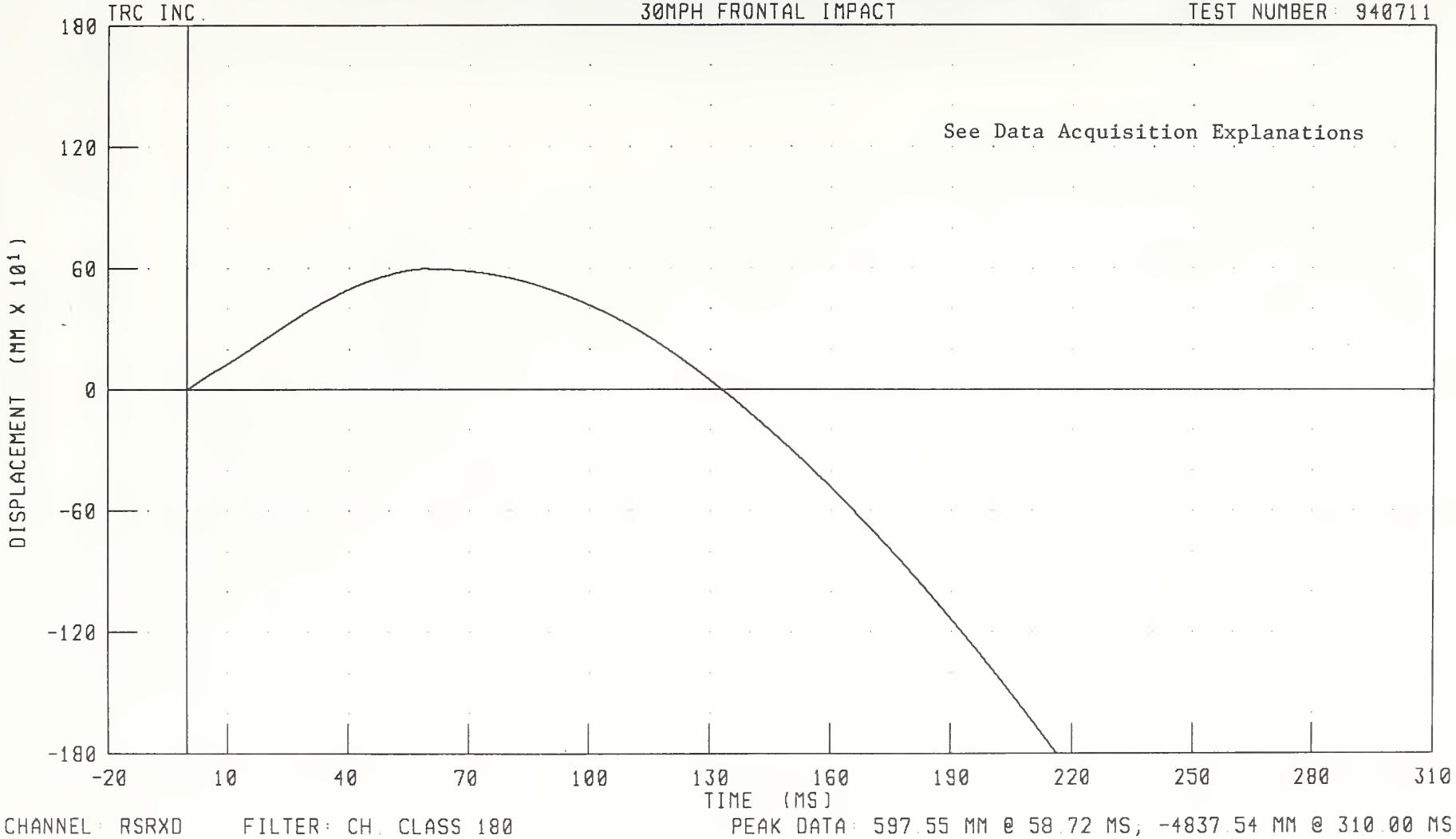
1991 FORD F150 INTO FLAT FRONTAL BARRIER
RIGHT FRAME RAIL MID X-AXIS VELOCITY
30MPH FRONTAL IMPACT



CHANNEL: RSRXV FILTER: CH CLASS 180 PEAK DATA: 48.91 KM/H @ 20.96 MS, -137.52 KM/H @ 310.00 MS

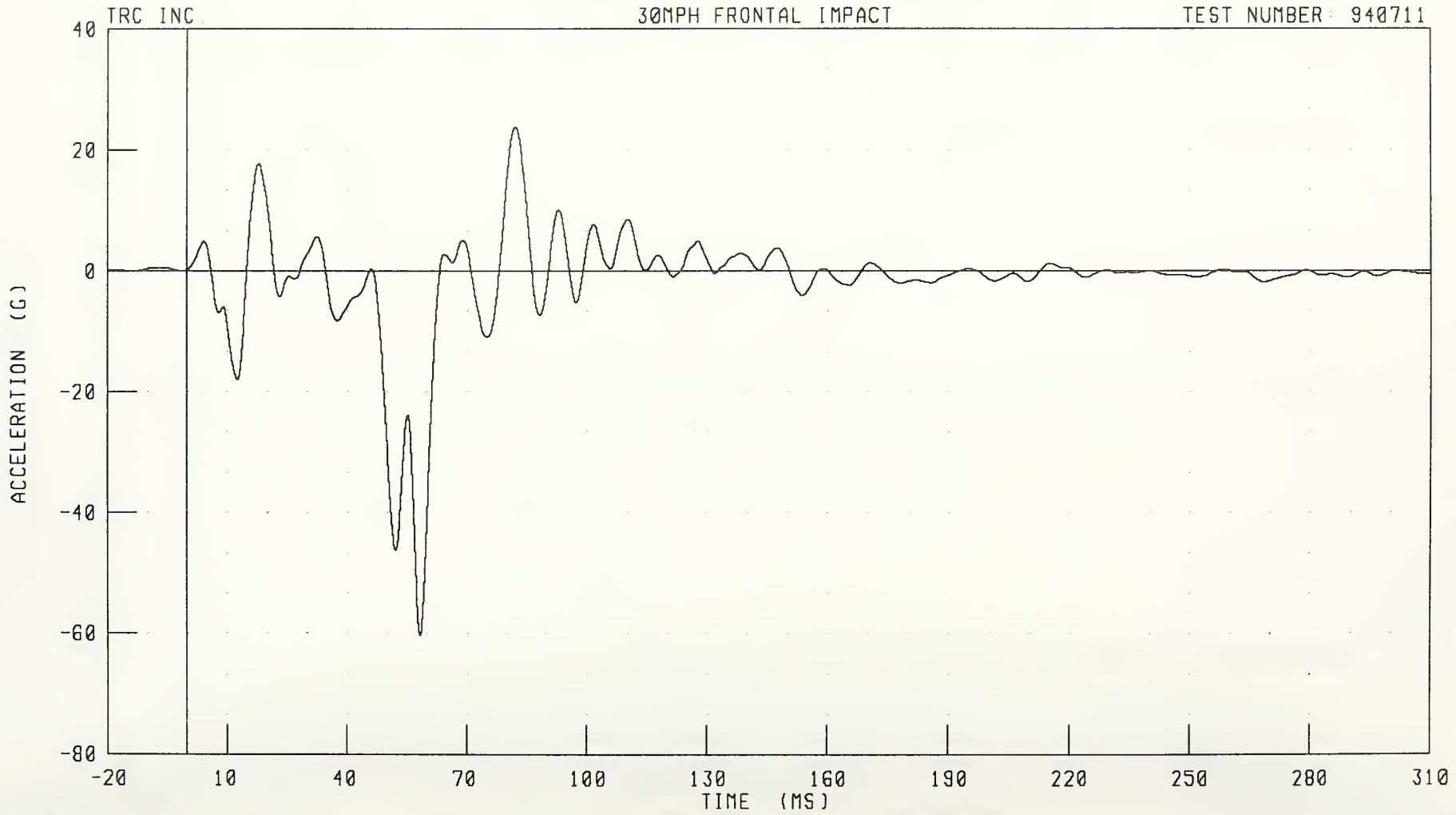
1991 FORD F150 INTO FLAT FRONTAL BARRIER
RIGHT FRAME RAIL MID X-AXIS DISPLACEMENT

TRC INC. 30MPH FRONTAL IMPACT TEST NUMBER: 940711



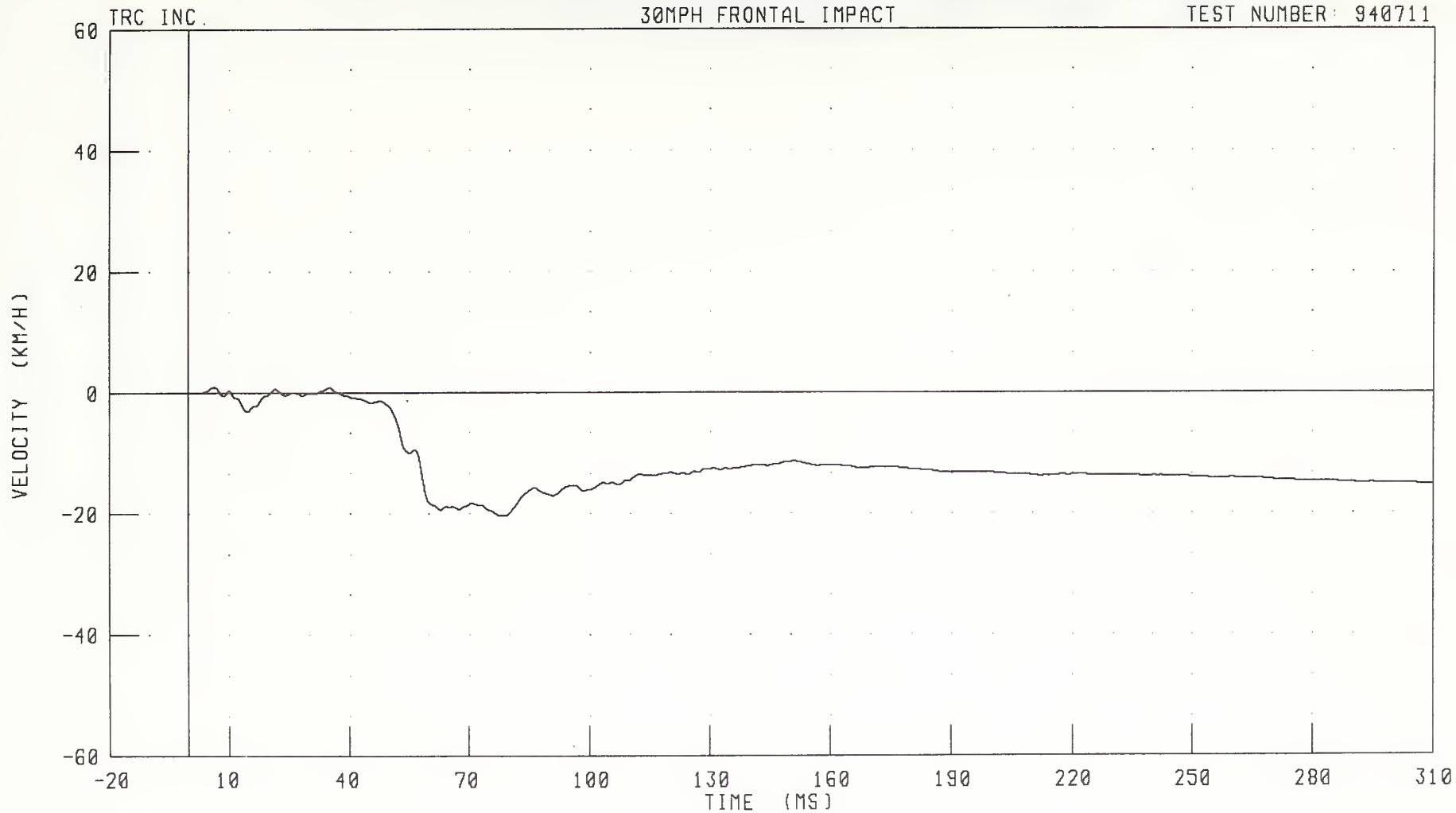
CHANNEL: RSRXD FILTER: CH. CLASS 180 PEAK DATA: 597.55 MM @ 58.72 MS, -4837.54 MM @ 310.00 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
RIGHT FRAME RAIL MID Z-AXIS ACCELERATION



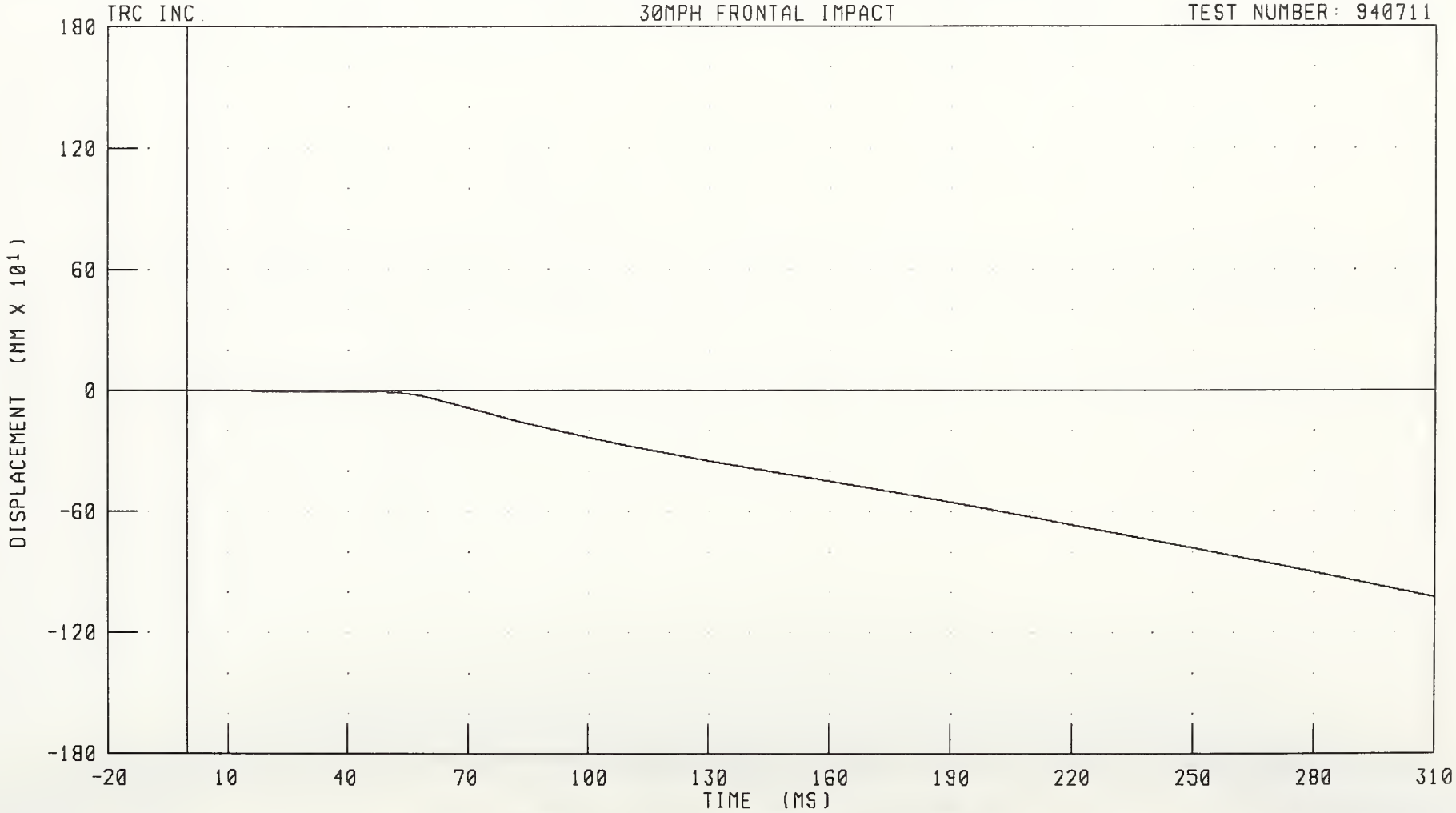
CHANNEL: RSRZG FILTER: CH CLASS 60 PEAK DATA: 23.79 G @ 82.08 MS, -60.35 G @ 58.40 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
RIGHT FRAME RAIL MID Z-AXIS VELOCITY



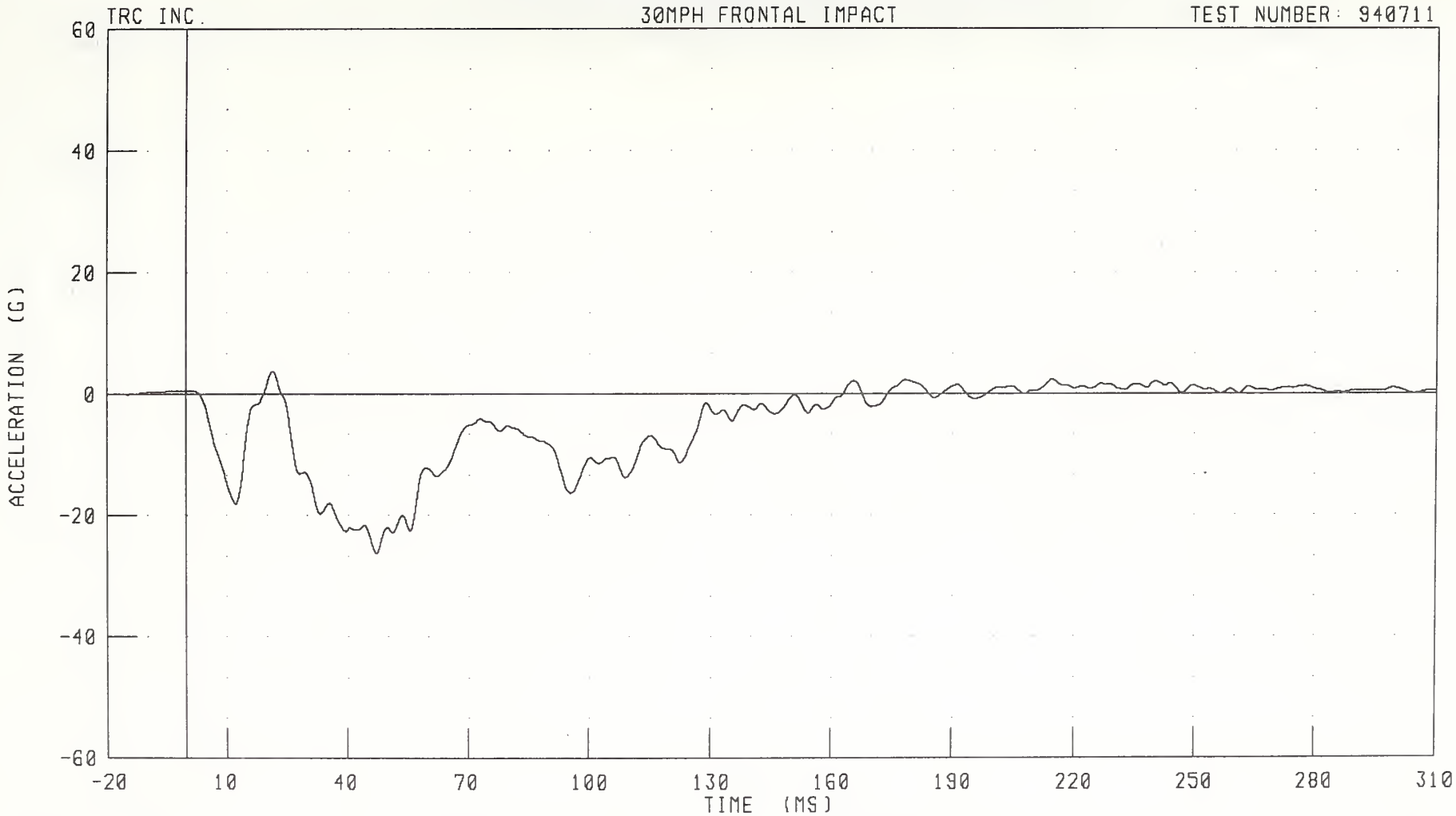
CHANNEL: RSRZV FILTER: CH. CLASS 180 PEAK DATA: 0.95 KM/H @ 6.32 MS; -20.34 KM/H @ 79.04 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
RIGHT FRAME RAIL MID Z-AXIS DISPLACEMENT



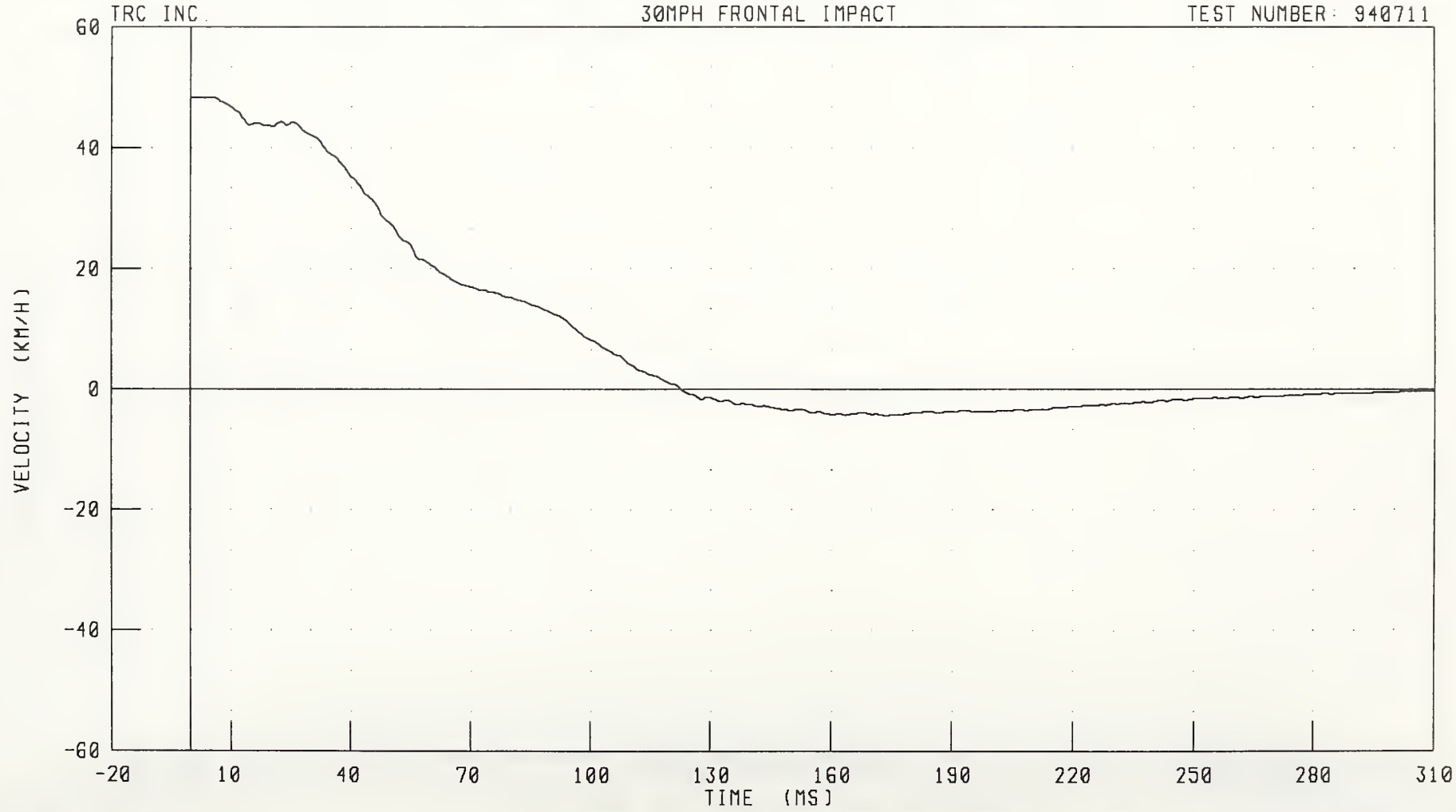
CHANNEL: RSRZD FILTER: CH. CLASS 180 PEAK DATA: 0.63 MM @ 7.76 MS; -1024.89 MM @ 310.00 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
REAR FRAME CROSSMEMBER X-AXIS ACCELERATION
30MPH FRONTAL IMPACT



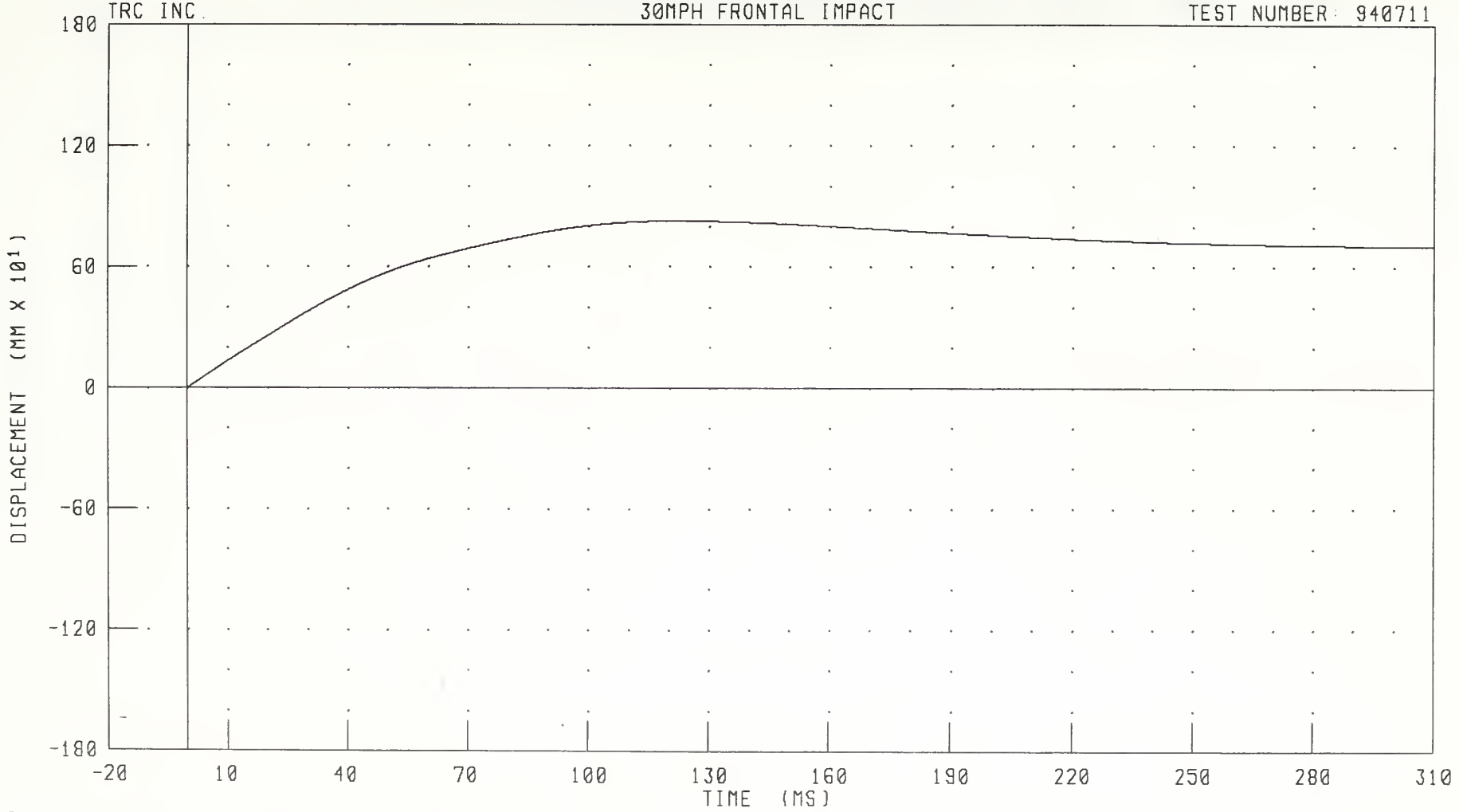
CHANNEL: RFCXG FILTER: CH. CLASS 60 PEAK DATA: 3.82 G @ 21.36 MS; -26.28 G @ 47.12 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
REAR FRAME CROSSMEMBER X-AXIS VELOCITY



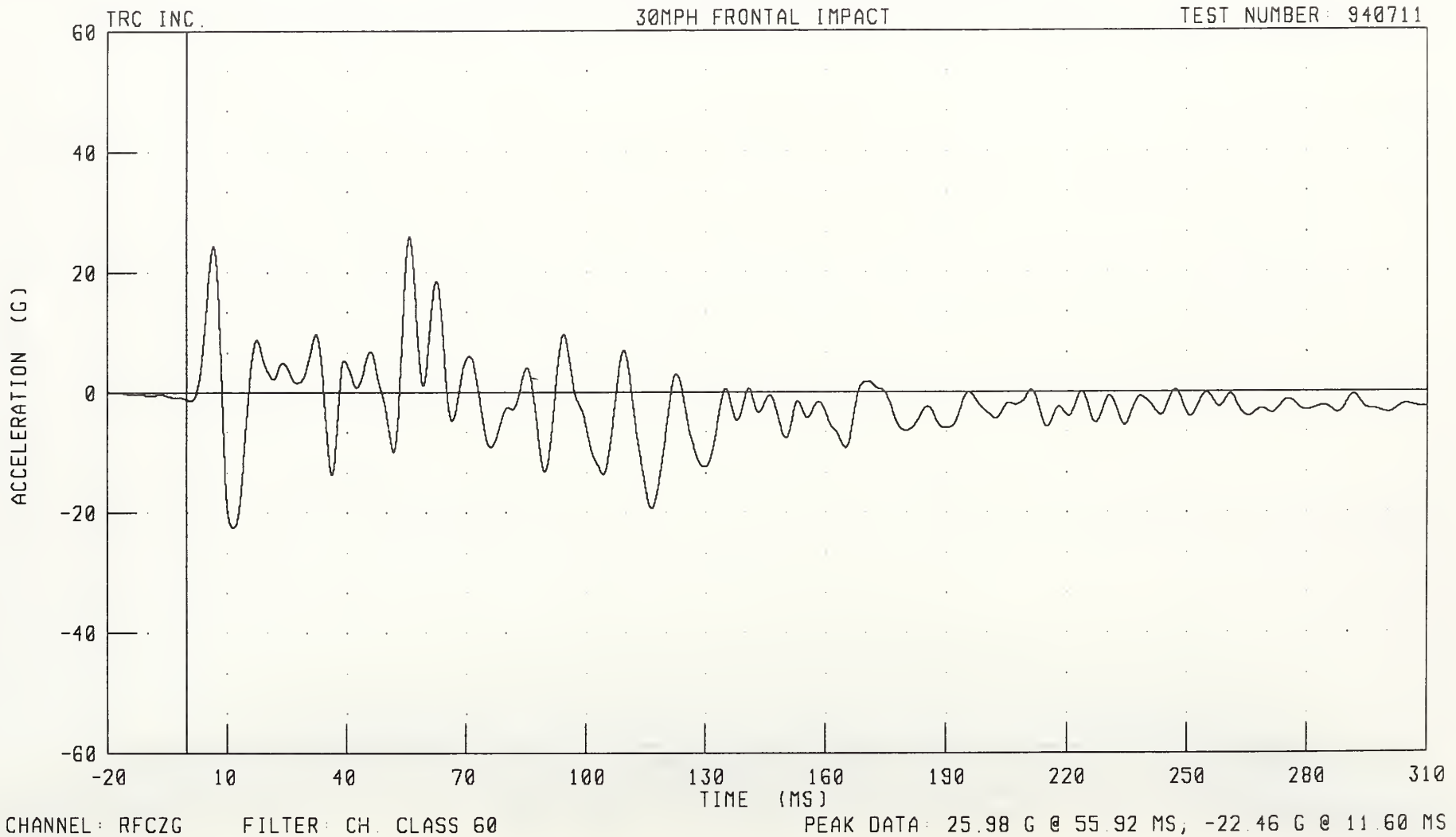
CHANNEL: RFCXV FILTER: CH. CLASS 180 PEAK DATA: 48.33 KM/H @ 5.12 MS, -4.34 KM/H @ 173.68 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
REAR FRAME CROSSMEMBER X-AXIS DISPLACEMENT



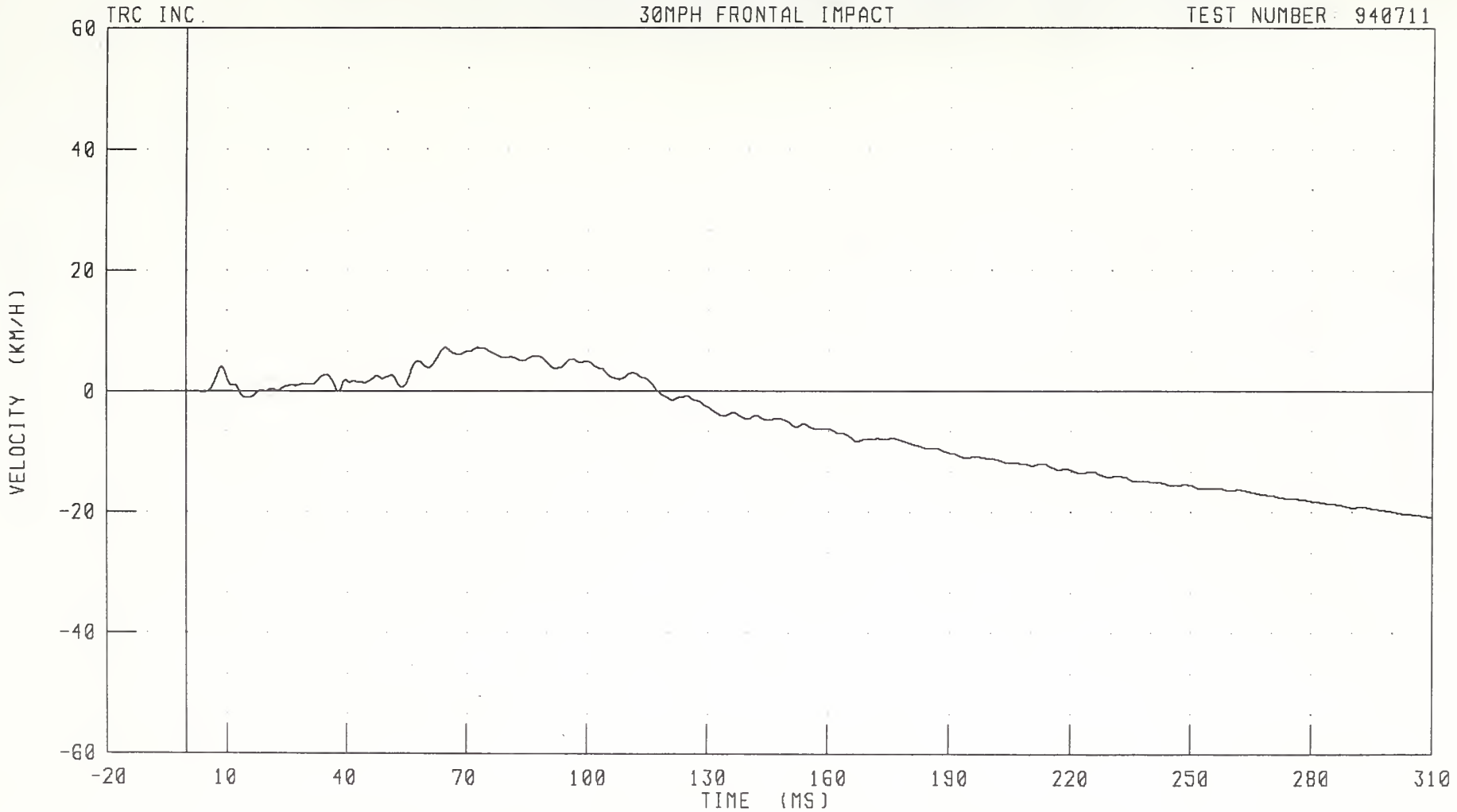
CHANNEL: RFCXD FILTER: CH. CLASS 180 PEAK DATA: 829.00 MM @ 122.64 MS, 0.00 MM @ 0.00 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
REAR FRAME CROSSMEMBER Z-AXIS ACCELERATION

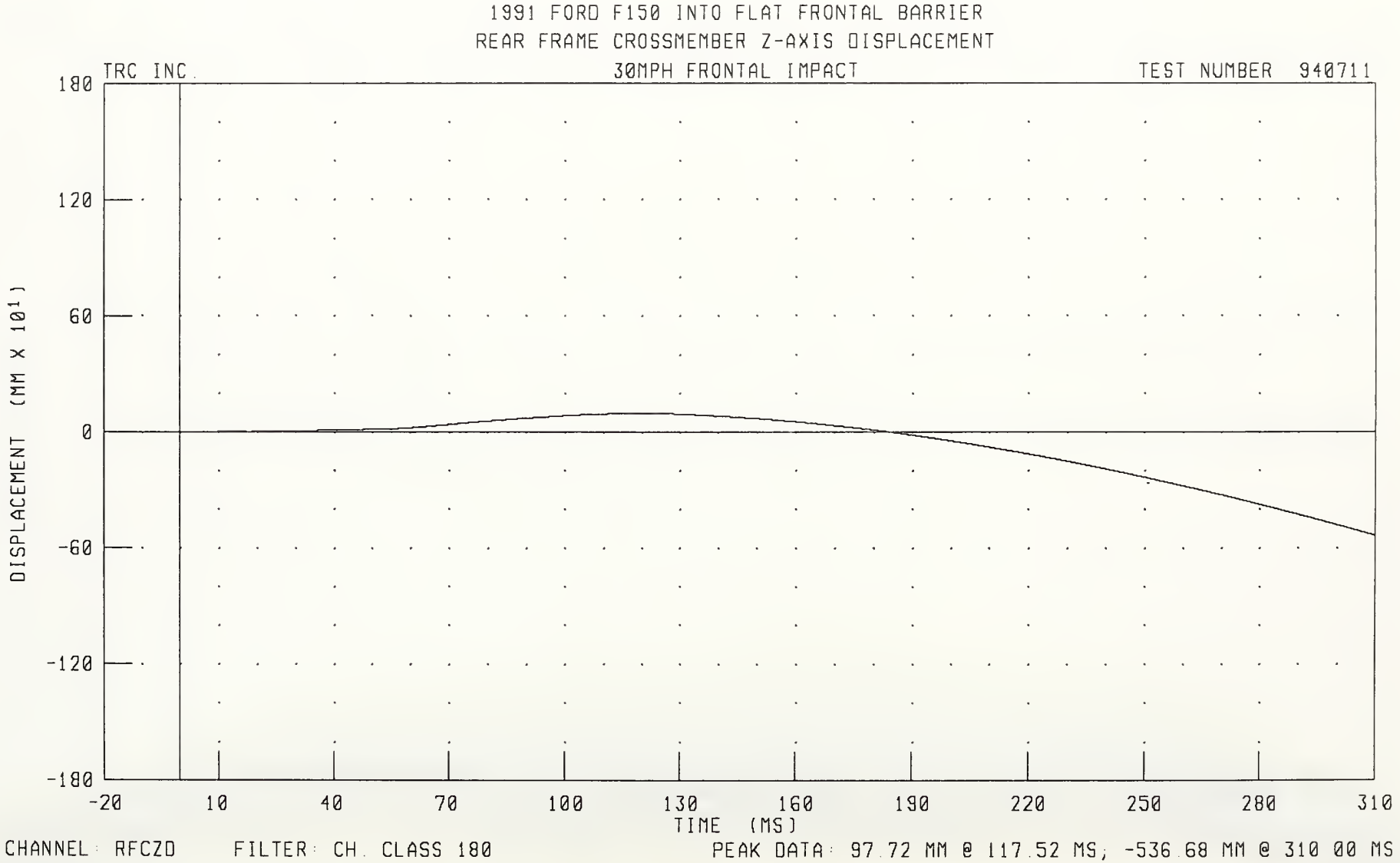


CHANNEL: RFCZG FILTER: CH. CLASS 60 PEAK DATA: 25.98 G @ 55.92 MS, -22.46 G @ 11.60 MS

1991 FORD F150 INTO FLAT FRONTAL BARRIER
REAR FRAME CROSSMEMBER Z-AXIS VELOCITY



CHANNEL: RFCZV FILTER: CH. CLASS 180 PEAK DATA: 7.28 KM/H @ 64.64 MS, -20.82 KM/H @ 310.00 MS


1991 FORD F150 INTO FLAT FRONTAL BARRIER
REAR FRAME CROSSMEMBER Z-AXIS DISPLACEMENT
TRC INC.
30MPH FRONTAL IMPACT
TEST NUMBER 940711
180
120
60
0
-60
-120
-180
DISPLACEMENT (MM X 10¹)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL: RFCZD
FILTER: CH. CLASS 180
PEAK DATA: 97.72 MM @ 117.52 MS; -536.68 MM @ 310.00 MS

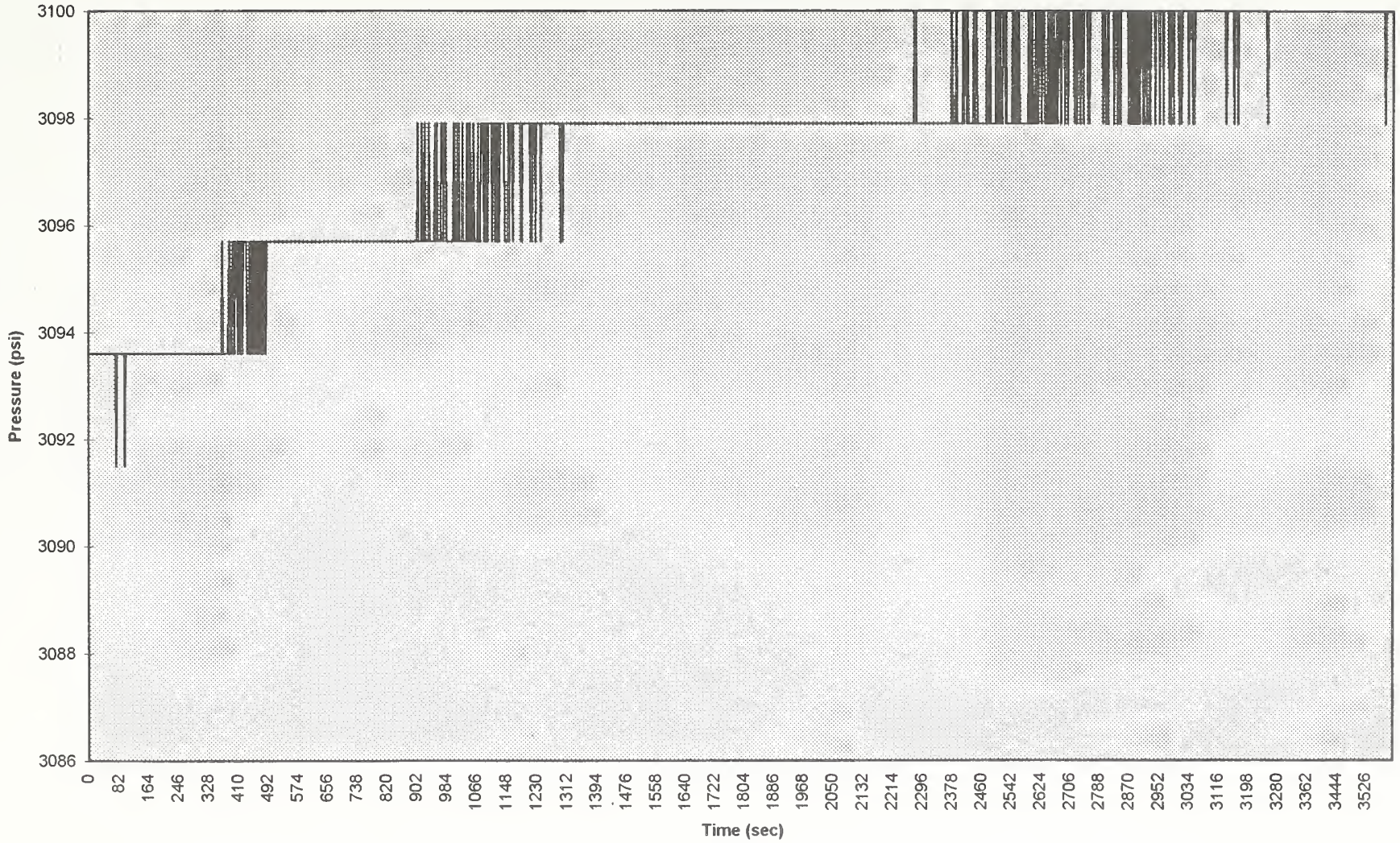
Appendix C

Miscellaneous Test Information

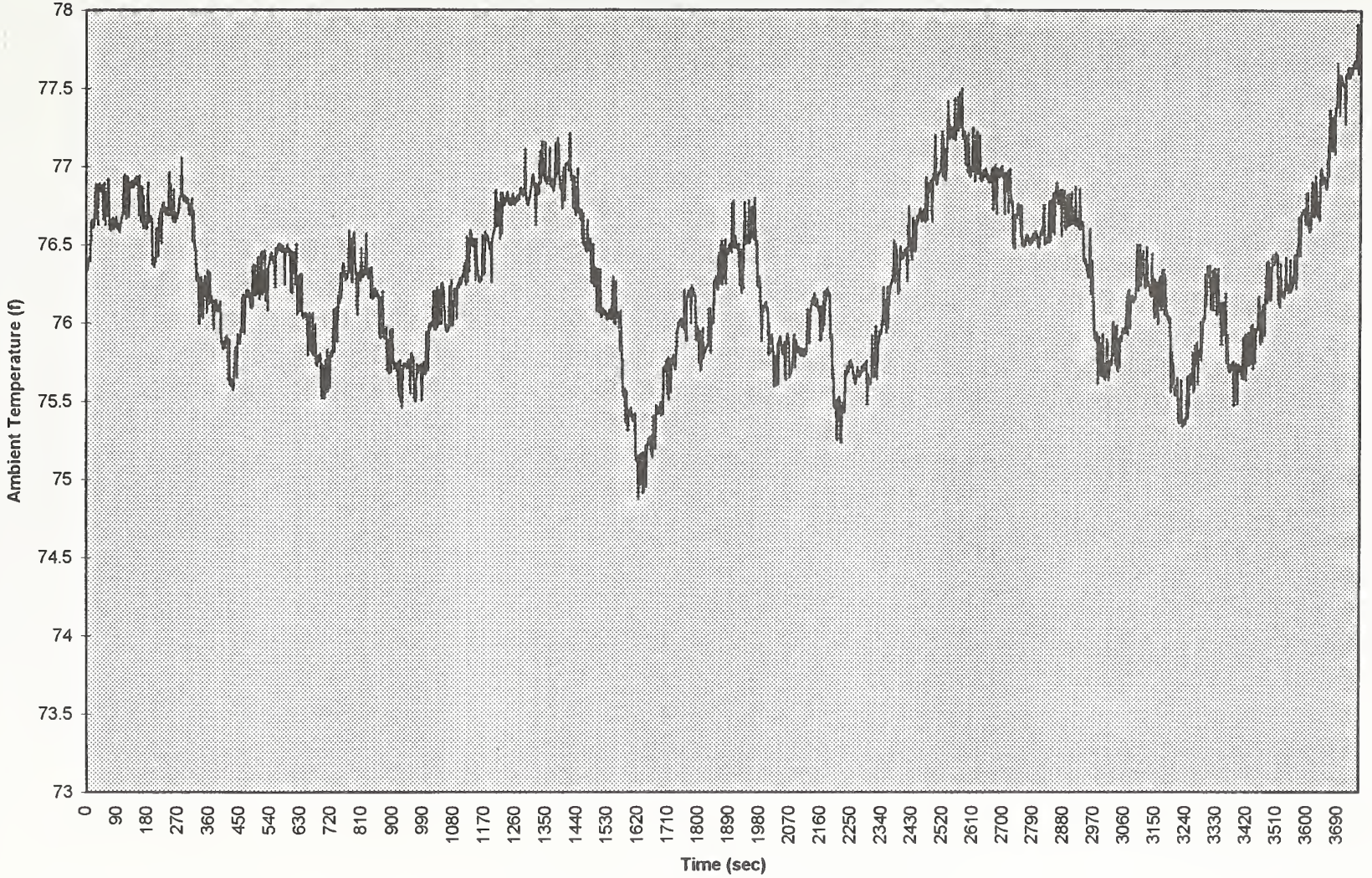
Vehicle Instrumentation Information

No.	Location	Axis	Mfr.	Model	S/N	Orientation (+ Sensing)
1	Vehicle center of gravity	X	Endevco	7264	BH14J	Front
		Y	Endevco	7264	BN09J	Left
		Z	Endevco	7264	EJ60J	Up
2	Right frame rail	X	Endevco	7264	BF24J	Rear
		Z	Endevco	7264	BH37J	Down
3	Rear frame crossmember	X	Endevco	7264	AZ67	Rear
		Z	Endevco	7264	BA46	Up

VRTC CNG TEST 7/11/94



VRTC CNG TEST 7/11/94



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