V1802

HEAVY TRUCK UNDERRIDE PROTECTION

1993 SATURN SL

INTO HEAVY TRUCK REAR UNDERRIDE GUARD

WITH .75-INCH MOUNTING BOLTS

TRC TEST NO. 921106

PREPARED BY:

TRANSPORTATION RESEARCH CENTER INC.

10820 STATE ROUTE 347

EAST LIBERTY, OH 43319

NOVEMBER - DECEMBER 1992

FINAL REPORT

PREPARED FOR:

VEHICLE RESEARCH AND TEST CENTER

BLDG. 60, LOGAN COUNTY

10820 STATE ROUTE 347

EAST LIBERTY, OHIO 43319

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REPORT PREPARED BY:

Craig A. Markusic Date 12/7/92
Craig A. Markusic
Project Engineer

REPORT APPROVED BY:

John C. Stultz Date 12-7-92
John C. Stultz
Chief Engineer Impact Laboratory
Transportation Research Center Inc.

Walter J. Sutterlin Date 12-8-92
Walter J. Sutterlin
Project Manager
Vehicle Research & Test Center

FINAL REPORT ACCEPTED BY:

Michael W. Monk Date 12 21 92
Michael W. Monk
Project Manager
Vehicle Research & Test Center

Jeffrey C. Elias Date 12/9/92
Jeff Elias
Project Engineer
Vehicle Research & Test Center

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16. Abstract

A 1993 Saturn SL 4-door sedan was impacted into a heavy truck rear underride guard at the Transportation Research Center Inc. on November 6, 1992. This test was conducted to determine the performance of the underride guard with .75-inch mounting bolts in the 0°, 30 mph impact mode. The actual test speed was 30.0 mph. The vehicle's maximum static crush was 1.4 inches. The ambient temperature was 66° F.

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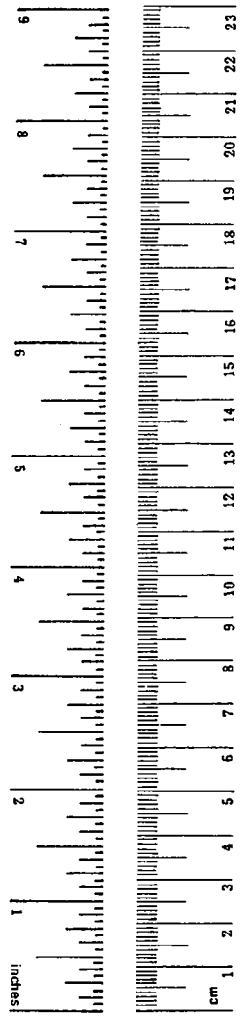
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

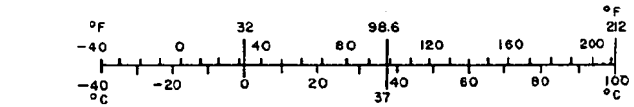
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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 & TEST PROCEDURE

PURPOSE

This heavy truck rear underride guard impact test was conducted for the Vehicle Research & Test Center (VRTC) by the Transportation Research Center Inc. (TRC).

A rear underride guard was developed to minimally meet the proposed Federal regulatory standards for height, geometry, and static force/deflection requirements. This test was conducted to determine the effectiveness of this design in preventing excessive rear underride (intrusion into the passenger compartment of the test vehicle) in a 0°, 30 mph impact mode.

TEST PROCEDURE

The test vehicle was instrumented with seven (7) accelerometers to measure longitudinal, lateral, and vertical axis accelerations. Each seat belt was instrumented with a load cell to measure shoulder belt force. The vehicle's specified impact velocity range was 29.5 to 30.5 mph. The vehicle impacted the heavy truck rear underride guard mounted with .75-inch mounting bolts onto a heavy truck frame surrogate attached to the rigid barrier at the Transportation Research Center Inc.

The test vehicle contained two (2) Part 572 E 50th percentile adult male anthropomorphic test devices (dummies). The dummies were positioned in the front outboard designated seating positions according to the dummy placement procedure specified in Appendix B and Optional Appendix C of NHTSA Laboratory Test Procedure TP-208-08.

Both dummies were instrumented with head, chest, and pelvis accelerometers to measure longitudinal, lateral, and vertical accelerations; six-axis neck load cells to measure neck moments and forces; and with left and right femur load cells to measure axial forces. Each Part 572 E dummy's instrumentation also included a chest potentiometer to measure longitudinal deflection.

The forty-five (45) data channels were multiplexed and recorded on a 14-track tape drive. The data was digitally sampled at 8000 samples per second and processed per sections 12.8 and 12.9 of the Laboratory Test Procedure.

The crash event was recorded by one (1) real-time panning motion picture camera and fourteen (14) high-speed motion picture cameras.

The heavy truck underride guard data are summarized in Section 2.0. The occupant, vehicle, & camera measurements are presented in Section 3.0. Appendix A contains the still photographic prints. Appendix B contains the data plots. Appendix C contains dummy certification data. Appendix D contains miscellaneous test information.

SECTION 2.0

HEAVY TRUCK REAR UNDERRIDE GUARD IMPACT TEST SUMMARY

TEST RESULTS SUMMARY

This heavy truck rear underride guard impact test was conducted at TRC on November 6, 1992.

The test vehicle, a 1993 Saturn SL 4-door sedan, was equipped with a 1.9 liter, transverse engine, manual transmission, power steering, and power brakes. The vehicle's test weight was 2738 pounds. The vehicle's impact speed was 30.0 mph. The vehicle's crush was 1.4 inches.

The driver's head injury criteria (HIC) was 360. The driver's maximum chest resultant acceleration with three (3) milliseconds minimum duration was 18.5 g. The driver's chest deflection was 1.0 inches. The driver's maximum left and right femur forces were 515 pounds and 609 pounds, respectively (See TEST ANOMALIES).

The right front passenger's head injury criteria (HIC) was 858. The right front passenger's maximum chest resultant acceleration with three (3) milliseconds minimum duration was 23.7 g. The right front passenger's chest deflection was 1.1 inches. The right front passenger's maximum left and right femur forces were 586 pounds and 798 pounds, respectively.

TEST ANOMALIES

The driver dummy's right femur load cell, RFMF1, recorded anomalous data spikes at 82, 86, and 109 milliseconds.

The right front passenger's pelvis X-, Y-, and Z-axis accelerometers, PEVXG2, PEVYG2, and PEVZG2, recorded an anomlous data spike at 92 milliseconds. This data spike affected the right front passenger's pelvis resultant acceleration calculation, PEVRG2.

TABLE 1 CRASH TEST SUMMARY

TEST TYPE: Heavy Truck Rear Underride Guard

TEST DATE: 11/06/92 TEST TIME: 1452 AMBIENT TEMP. (°F): 66

VEHICLE YEAR/MAKE/MODEL/BODY STYLE: 1993/Saturn/SL/4-door sedan

VEHICLE TEST WEIGHT (LBS): 2738

IMPACT ANGLE (DEG)*: 0

IMPACT VELOCITY (MPH)**: PRIMARY = 30.0 SECONDARY = 30.0

MAXIMUM STATIC CRUSH (IN): 1.4

DUMMIES:	Driver #048	Passenger #043
TYPE:	Part 572 E	Part 572 E
LOCATION:	Left front	Right front
RESTRAINT:	2-point passive belt and airbag	2-point passive belt

NUMBER OF DATA CHANNELS: 45

NUMBER OF CAMERAS: HIGH-SPEED 14 REAL-TIME 1

*With respect to tow track centerline.

**Speed trap measurement (± .05 mph accuracy). The velocity measurement system contains two (2) independent photo emitter/receiver pairs (See Figure 1) which each measure the impact velocity.

TABLE 2 TEST VEHICLE INFORMATION

VEHICLE MANUFACTURER: Saturn Corporation

MAKE/MODEL: Saturn/SL VIN: 1G8ZF5592PZ131943

BODY STYLE: 4-door sedan MODEL YEAR: 1993

COLOR: Red

ENGINE DATA: TYPE: transverse CYLINDERS: 4 DISPLACEMENT: 1.9 liter

TRANSMISSION DATA: _5_SPEED, _X_MANUAL, ___AUTOMATIC, _X_FWD, ___RWD,___4WD

DATE VEHICLE RECEIVED: 10/30/92 ODOMETER READING: 167.0

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	Yes
POWER WINDOWS	No	TELESCOPING STEERING WHEEL	No
TINTED GLASS	Yes	AIR CONDITIONING	No
RADIO	Yes	ANTI-SKID BRAKE	No
CLOCK	Yes	REAR WINDOW DEFROSTER	Yes
OTHER	Airbag		

REMARKS:

1. IS THE VEHICLE STOCK THROUGHOUT? Yes
2. DOES VEHICLE SHOW EVIDENCE OF PRIOR ACCIDENT HISTORY? No
3. DOES VEHICLE SHOW ANY SIGNIFICANT CORROSION? No
4. CONDITION OF THE FRONT/REAR BUMPER AND FRAME: Good

CERTIFICATION DATA FROM VEHICLE'S LABEL:

VEHICLE MANUFACTURED BY: Saturn Corporation

DATE OF MANUFACTURE: 09/92 VIN: 1G8ZF5592PZ131943

GVWR: 3244 LBS

GAWR: FRONT: 1644 LBS., REAR: 1600 LBS.

TABLE 2 TEST VEHICLE INFORMATION CONT'D

TIRES ON VEHICLE (MFR., LINE, SIZE): Firestone, FR480, 175/70R14

TIRE PRESSURE WITH MAXIMUM CAPACITY VEHICLE LOAD: FRONT: 35 PSI
REAR: 35 PSI

SPARE TIRE (MFR., LINE, SIZE): Firestone, Temporary, T115/70R14

TYPE OF SEATS: FRONT: Bucket
REAR: Bench

TYPE OF FRONT SEAT BACKS: Manually-adjustable

MAXIMUM WIDTH: 65.5 INCHES

WHEELBASE: 102.4 INCHES

LOCATION OF LABEL STATING TIRE & CAPACITY DATA:
The label was located on the trunk lid.

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: 2 FRONT 3 REAR 5 TOTAL

VEHICLE CAPACITY WEIGHT: 864 LBS.

TEST VEHICLE ATTITUDE
(MEASURED AT THE TOP CENTER OF THE WHEEL WELL OPENING) *

DELIVERED ATTITUDE:	LF	26.4;	RF	26.6;	LR	26.6;	RR	26.6
PRE-TEST ATTITUDE**:	LF	25.2;	RF	25.7;	LR	28.1;	RR	28.4
POST-TEST ATTITUDE:	LF	22.8;	RF	25.4;	LR	25.4;	RR	25.8

TEST VEHICLE ATTITUDE
(MEASURED AT FRONT AND REAR BUMPER CENTERLINE) *

DELIVERED ATTITUDE:	FRONT	14.9	REAR	22.0
PRE-TEST ATTITUDE:	FRONT	12.8	REAR	24.5

*It was determined by VRTC that under heavy braking the front of the test vehicle lowered by 2.1 to 2.2 inches measured at the front bumper centerline and the rear of the test vehicle raised 2.5 to 2.8 inches measured at the rear bumper centerline. The pre-test attitudes of the test vehicle were modified to simulate these conditions.
All measurements are in inches.

TABLE 2 TEST VEHICLE INFORMATION CONT'D

WEIGHT OF TEST VEHICLE AS RECEIVED (WITH MAXIMUM FLUIDS):

RIGHT FRONT	697 LBS.	RIGHT REAR	441 LBS.
LEFT FRONT	694 LBS.	LEFT REAR	444 LBS.
TOTAL FRONT WEIGHT	1391 LBS.	(61.1% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	885 LBS.	(38.9% OF TOTAL VEHICLE WEIGHT)	

TOTAL DELIVERED WEIGHT 2276 LBS.

CALCULATION OF TEST VEHICLE'S TARGET TEST WEIGHT:

RCLW = RATED CARGO AND LUGGAGE WEIGHT*

UDW = UNLOADED DELIVERED WEIGHT (2276 LBS)

VCW = VEHICLE CAPACITY WEIGHT (864 LBS)

DSC = DESIGNATED SEATING CAPACITY (5)

RCLW*= VCW - 150 (DSC) = 114

TARGET TEST WEIGHT = UDW + RCLW*+ (NO. OF HYBRID III DUMMIES X 167 LBS PER DUMMY)

TARGET TEST WEIGHT = 2276 + 114 + 334

TARGET TEST WEIGHT = 2724 LBS

WEIGHT OF TEST VEHICLE WITH REQUIRED DUMMIES AND 128 LBS. OF CARGO WEIGHT:

RIGHT FRONT	776 LBS.	RIGHT REAR	647 LBS.
LEFT FRONT	739 LBS.	LEFT REAR	576 LBS.
TOTAL FRONT WEIGHT	1515 LBS.	(55.3% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	1223 LBS.	(44.7% OF TOTAL VEHICLE WEIGHT)	
TOTAL TEST WEIGHT	2738 LBS.	(0.5% OVER TARGET TEST WEIGHT)	

WEIGHT OF BALLAST SECURED IN VEHICLE CARGO AREA: 0

COMPONENTS REMOVED TO MEET TARGET TEST WEIGHT: Rear bumper

CG = 45.7 INCHES REARWARD OF FRONT WHEEL CENTERLINE

*Cargo weight for multi-purpose passenger vehicles, trucks, and buses is the vehicle's calculated cargo and luggage weight or 300 pounds, whichever is less.

TABLE 3 POST-IMPACT DATA

TEST NUMBER: 921106

TEST DATE: 11/06/92 TEST TIME: 1452

TEST TYPE: Heavy truck rear underride guard IMPACT ANGLE: 0

AMBIENT TEMPERATURE AT IMPACT AREA: 66° F

TEMPERATURE IN OCCUPANT COMPARTMENT: 69° F

IMPACT VELOCITY*: PRIMARY = 30.0 MPH SECONDARY = 30.0 MPH

(SPECIFIED RANGE = 29.5 TO 30.5 MPH)

DISTANCE FROM VEHICLE TO BARRIER: ENTERING VELOCITY TRAP = 26.0 IN.

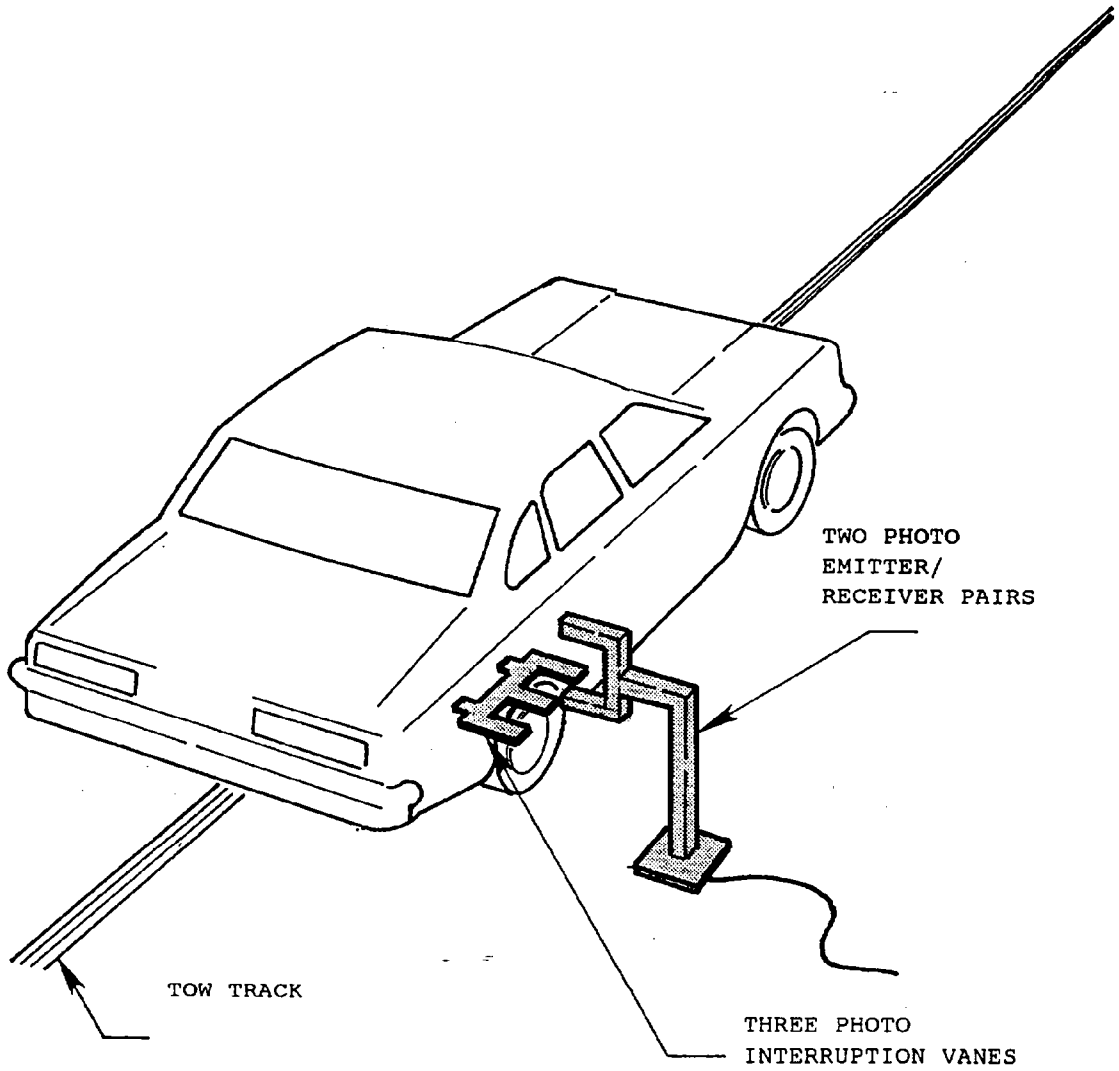
EXITING VELOCITY TRAP = 2.0 IN.

TEST VEHICLE STATIC CRUSH (ALL MEASUREMENTS ARE IN INCHES):

OVERALL LENGTH OF TEST VEHICLE:	PRE-TEST:	L	170.8;	C	176.5;	R	171.2
	POST-TEST:	L	169.8;	C	176.1;	R	169.8
	TOTAL CRUSH:	L	1.0;	C	0.4;	R	1.4
	AVERAGE CRUSH:	0.9					

*The velocity measurement system contains two (2) independent photo emitter/receiver pairs (See Figure 1) which each measure the impact velocity.

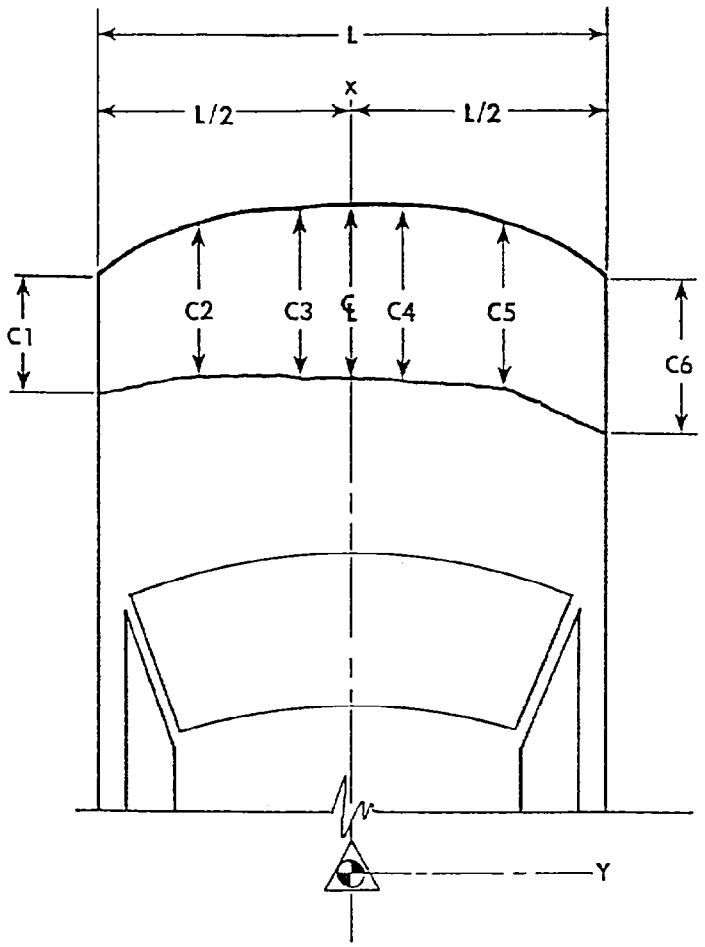
FIGURE 1 IMPACT VELOCITY MEASUREMENT SYSTEM



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

The vanes have one foot spacing.

FIGURE 2 VEHICLE CRUSH



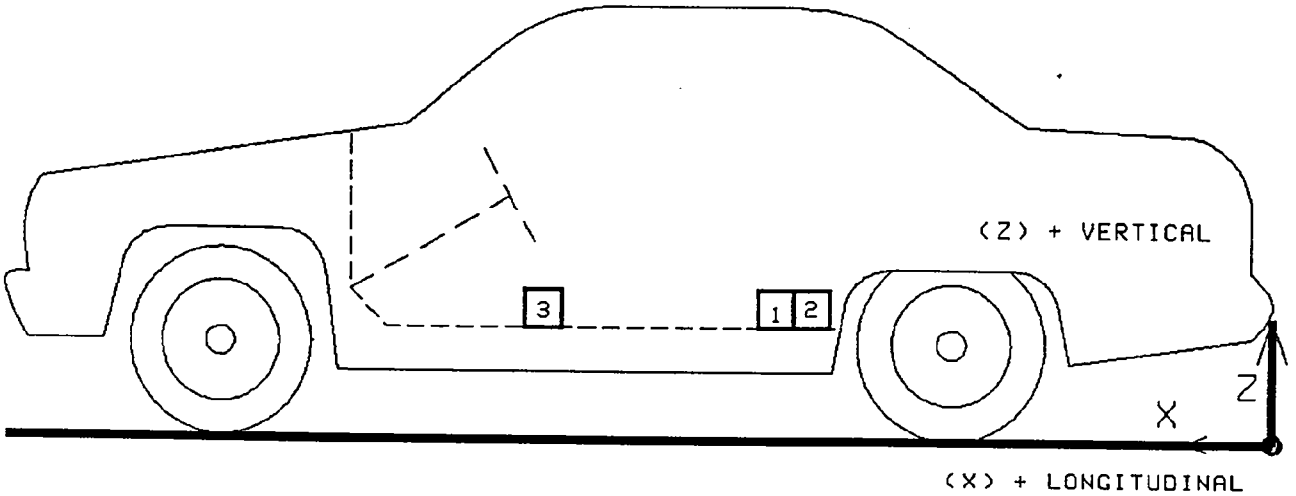
NOTES: L is pre-test length of contact surface.
C1 through C6 are spaced equally apart.
CL is vehicle centerline.
All measurements are in inches.

Vehicle Saturn SL

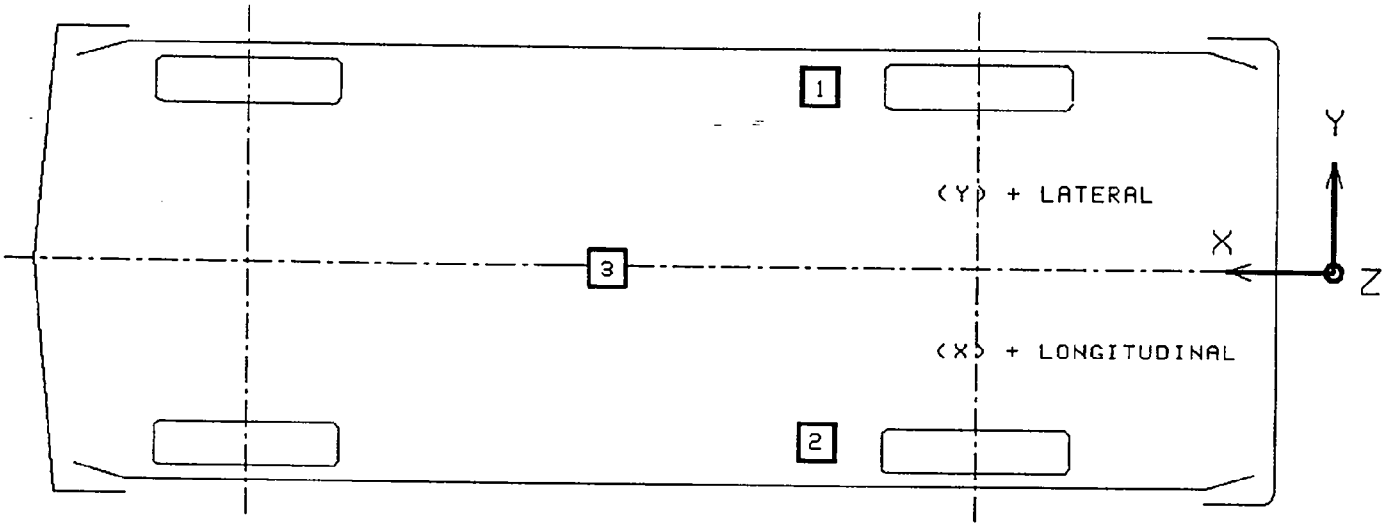
	PRE-TEST		POST-TEST		CRUSH
L	50.0				
C1	170.8	C1	169.8	C1	1.0
C2	174.6	C2	173.9	C2	0.7
C3	176.1	C3	175.6	C3	0.5
C4	176.2	C4	175.9	C4	0.3
C5	174.6	C5	174.1	C5	0.5
C6	171.2	C6	169.8	C6	1.4
CL	176.5	CL	176.1	CL	0.4

FIGURE 3

VEHICLE ACCELEROMETER PLACEMENT



SIDE VIEW



BOTTOM VIEW

TABLE 4

VEHICLE ACCELEROMETER LOCATIONS AND DATA SUMMARY

TEST NUMBER 921106

No.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION MAX G	POSITIVE DIRECTION MSEC	NEGATIVE DIRECTION MAX G	NEGATIVE DIRECTION MSEC
1	LEFT REAR SEAT CROSSMEMBER	62.8	16.2	14.5				
	LONGITUDINAL				5.5	97.1	16.5	64.5
	LATERAL				2.6	242.8	3.8	111.4
2	RIGHT REAR SEAT CROSSMEMBER	62.8	-16.2	14.8				
	LONGITUDINAL				6.5	104.0	18.8	63.0
	LATERAL				2.8	134.8	3.9	112.0
3	VEHICLE CENTER OF GRAVITY	92.8	0.0	14.8				
	LONGITUDINAL				6.7	97.1	17.3	63.4
	LATERAL				22.3	96.6	4.2	83.0
	VERTICAL				17.4	93.0	9.5	65.1
	RESULTANT				26.5	96.6		

* ALL MEASUREMENTS OF ACCELEROMETER LOCATIONS ARE IN INCHES.

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

SECTION 3.0

OCCUPANT, VEHICLE, & CAMERA INFORMATION

TABLE 5

DUMMY DATA SUMMARY

TEST NUMBER 921106

	DRIVER DUMMY SN: 48				PASSENGER DUMMY SN: 43			
	POSITIVE DIRECTION		NEGATIVE DIRECTION		POSITIVE DIRECTION		NEGATIVE DIRECTION	
	MAX	MSEC	MAX	MSEC	MAX	MSEC	MAX	MSEC
HEAD ACCELERATION (g)								
LONGITUDINAL	12.4	246.6	83.8	233.0	26.0	250.3	164.7	223.3
LATERAL	8.7	238.8	41.2	232.6	15.7	226.3	18.5	222.0
VERTICAL	6.5	234.8	24.2	240.8	26.8	226.5	62.3	223.3
RESULTANT	93.5	232.5			176.6	223.3		
HIC	360 FROM 230.0 TO 237.5				858 FROM 221.8 TO 225.8			
NECK FORCE (lb)								
LONGITUDINAL	85.1	129.9	290.7	240.6	110.4	127.3	367.4	225.3
LATERAL	36.9	254.5	122.7	236.3	136.2	241.8	620.8	226.0
VERTICAL	108.3	96.6	576.6	234.8	154.4	277.8	268.5	225.1
NECK MOMENT (in-lb)								
ABOUT X	100.1	254.1	437.5	238.4	176.1	339.1	500.9	227.4
ABOUT Y	1004.9	241.8	86.5	285.8	1412.5	229.4	248.0	245.5
ABOUT Z	141.4	290.1	63.5	71.8	164.1	277.8	24.9	140.5
CHEST ACCELERATION (g)								
LONGITUDINAL	2.1	160.3	18.9	241.0	1.7	168.8	21.9	226.4
LATERAL	3.9	91.0	4.1	240.8	6.3	257.3	4.1	113.8
VERTICAL	6.5	241.6	6.2	234.5	8.2	259.0	24.0	225.5
RESULTANT	20.3	241.1			31.4	225.8		
3 MSEC	18.5				23.7			
CHEST DEFLECTION (in)								
LONGITUDINAL	0.0	22.1	1.0	104.9	0.0	4.3	1.1	112.9
PELVIS ACCELERATION (g)								
LONGITUDINAL	5.3	151.5	21.7	88.4	5.6	171.5 γ	22.8	104.4γ
LATERAL	7.1	89.3	3.3	170.6	4.8	318.4 γ	5.2	91.5γ
VERTICAL	9.7	254.1	2.4	23.8	16.3	250.3 γ	10.4	226.3γ
RESULTANT	22.2	91.3			25.8	253.0 γ		
FEMUR LOAD (lb)								
LEFT	131.5	42.3	514.8	91.4	77.3	42.8	585.7	249.0
RIGHT	83.6	42.2 γ	608.7	92.1γ	37.5	149.9	798.3	92.4

POSITIVE DIRECTION

LONGITUDINAL:	FORWARD
LATERAL:	LEFTWARD
VERTICAL:	UPWARD
FORCE:	TENSION

NEGATIVE DIRECTION

LONGITUDINAL:	REARWARD
LATERAL:	RIGHTWARD
VERTICAL:	DOWNWARD
FORCE:	COMPRESSION

γ See TEST ANOMALIES

TABLE 6 POST-IMPACT DUMMY/VEHICLE DATA

VISIBLE DUMMY CONTACT POINTS:

	DRIVER #048	PASSENGER #043
HEAD	Airbag/header	Header
CHEST	Airbag	None
ABDOMEN	None	None
LEFT KNEE	Instrument panel	Instrument panel
RIGHT KNEE	Instrument panel	Instrument panel

DOOR OPENING:

	LEFT	RIGHT
FRONT	Easy	Easy
REAR	Easy	Easy

SEAT MOVEMENT:

	SEAT BACK FAILURE	SEAT SHIFT
FRONT	None	None
REAR	NA	NA

GLAZING DAMAGE:

The entire windshield cracked and lost most of its retention along the upper edge and along both A-pillars. The rear window shattered on impact.

OTHER NOTABLE IMPACT EFFECTS:

None

DUMMY KINEMATIC SUMMARY

DRIVER DUMMY

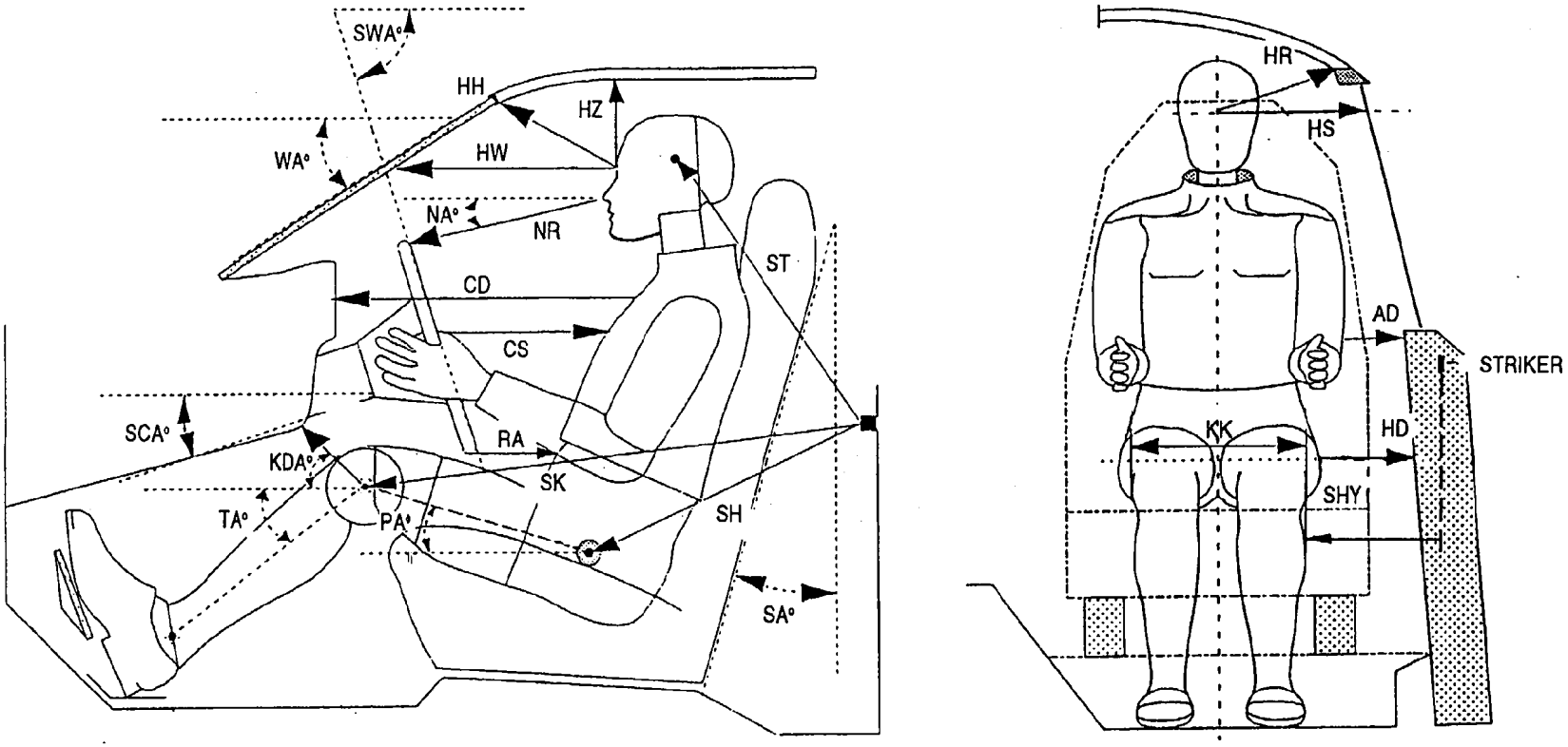
Upon impact, the driver dummy translated forward on the seat impacting both knees into the instrument panel. The dummy's head and chest then impacted the airbag. The dummy then rebounded rearward slightly. The driver dummy was restrained by the two-point passive belt and airbag. The dummy's head then impacted the header. The driver dummy came to rest in the driver's seat restrained by the two-point passive belt.

PASSENGER DUMMY

Upon impact, the right front passenger dummy translated forward on the seat impacting both knees into the instrument panel. The dummy's head then rotated slightly downward. The right front passenger dummy was restrained by the two-point passive belt. The dummy then rebounded rearward into the seat back followed by the dummy's head impacting the header. The right front passenger dummy came to rest in the right front passenger's seat restrained by the two-point passive belt.

FIGURE 4

DUMMY MEASUREMENT LOCATIONS FOR FRONT SEAT OCCUPANTS



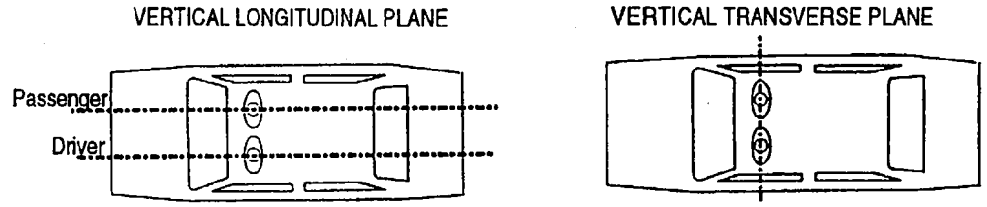


TABLE 7 DUMMY MEASUREMENT DATA FOR FRONT SEAT OCCUPANTS

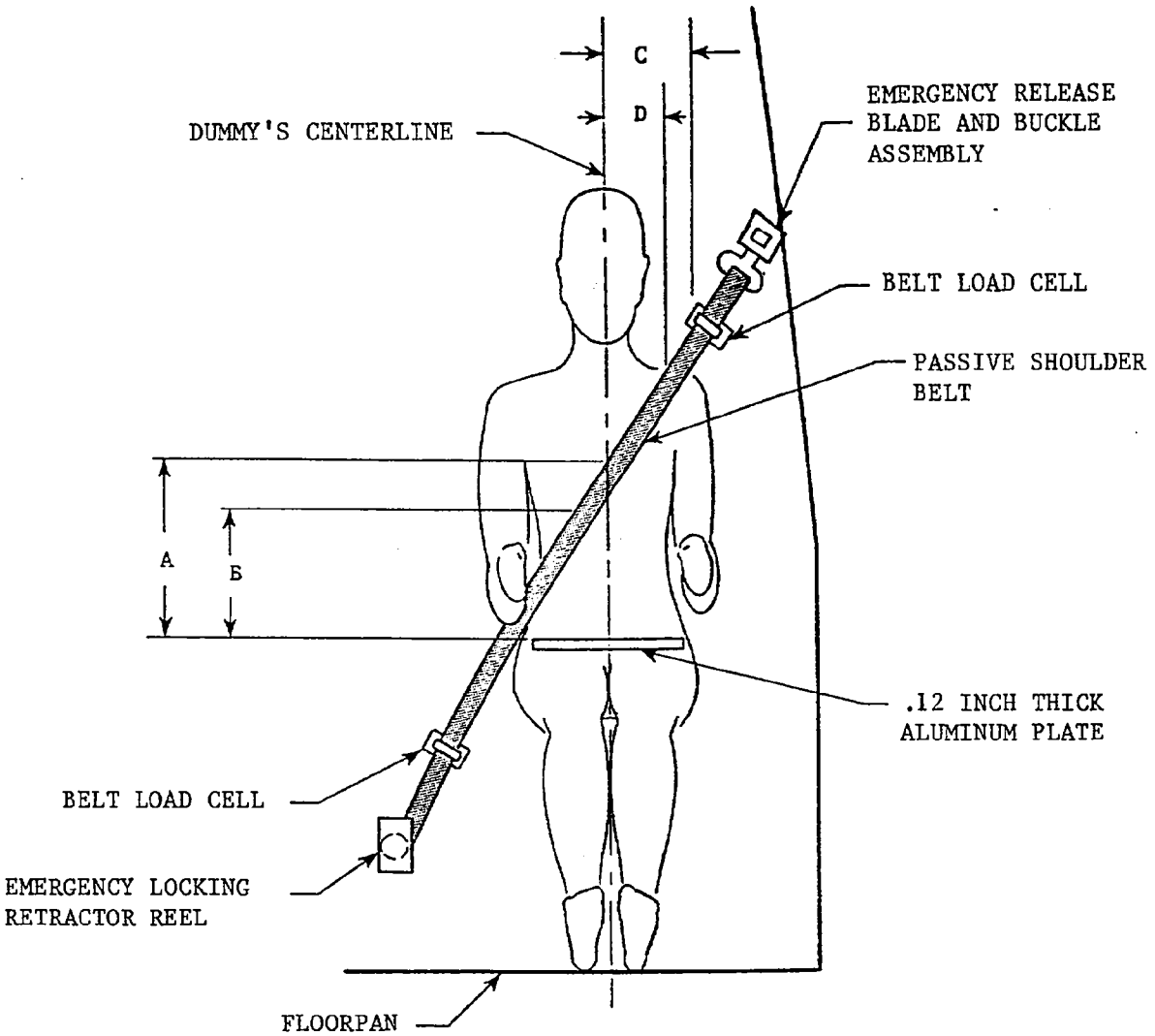
DESIGNATION	TYPE OF MEASUREMENT	DRIVER (SERIAL #048)	PASSENGER (SERIAL #043)
WA°	WINDSHIELD ANGLE	28°	28°
SWA°	STEERING WHEEL ANGLE	67°	NA
SCA°	STEERING COLUMN ANGLE	23°	NA
SA°	SEAT BACK ANGLE	10°	10°
HZ	HEAD TO ROOF	8.0	7.5
HH	HEAD TO HEADER	16.1	15.5
HW	HEAD TO WINDSHIELD	25.0	24.6
HR	HEAD TO SIDE HEADER	8.2	7.5
NR	NOSE TO RIM	15.1	NA
NA	NOSE TO RIM ANGLE	NA	NA
CD	CHEST TO DASH	20.1	21.0
CS	STEERING WHEEL TO CHEST	10.4	NA
RA	RIM TO ABDOMEN	7.8	NA
KDL	LEFT KNEE TO DASH	7.2	7.1
KDR	RIGHT KNEE TO DASH	7.2	6.6
KDA	OUTBOARD KNEE TO DASH ANGLE	44°	39°
PA°	PELVIC ANGLE	25°	23°
TA°	TIBIAL ANGLE	42°	38°
KK	KNEE TO KNEE	9.9	9.0
ST*	STRIKER TO HEAD	17.8	19.6
	STRIKER TO HEAD ANGLE	-79°	-84°
SK*	STRIKER TO KNEE	22.2	23.0
	STRIKER TO KNEE ANGLE	9°	6°
SH*	STRIKER TO H-POINT	5.6	6.1
	STRIKER TO H-POINT ANGLE	-54°	-53°
SHY	STRIKER TO H-POINT (Y DIR.)	8.0	8.2
HS	HEAD TO SIDE WINDOW	13.1	12.7
HD	H-POINT TO DOOR	5.1	5.8
AD	ARM TO DOOR	3.8	4.6

THE SEAT BACK ANGLE (SA°) IS MEASURED RELATIVE TO VERTICAL, ALL OTHER ANGLES ARE MEASURED RELATIVE TO HORIZONTAL.

*A negative angle indicates the measurement point was located above the striker.

ALL DISTANCE MEASUREMENTS ARE IN INCHES.

FIGURE 5 SEAT BELT POSITIONING DATA



	DRIVER DUMMY	PASSENGER DUMMY
A - TOP SURFACE OF ALUM. PLATE TO BELT UPPER EDGE	13.0	12.6
B - TOP SURFACE OF ALUM. PLATE TO BELT LOWER EDGE	10.4	10.0
C - DUMMY CENTERLINE TO OUTER EDGE OF BELT AT CHEST FLESH TOP	5.9	6.6
D - DUMMY CENTERLINE TO INNER EDGE OF BELT AT CHEST FLESH TOP	3.2	4.0

ALL DISTANCE MEASUREMENTS ARE IN INCHES.

FIGURE 6

PRE-TEST AND POST-TEST MEASUREMENT POINTS

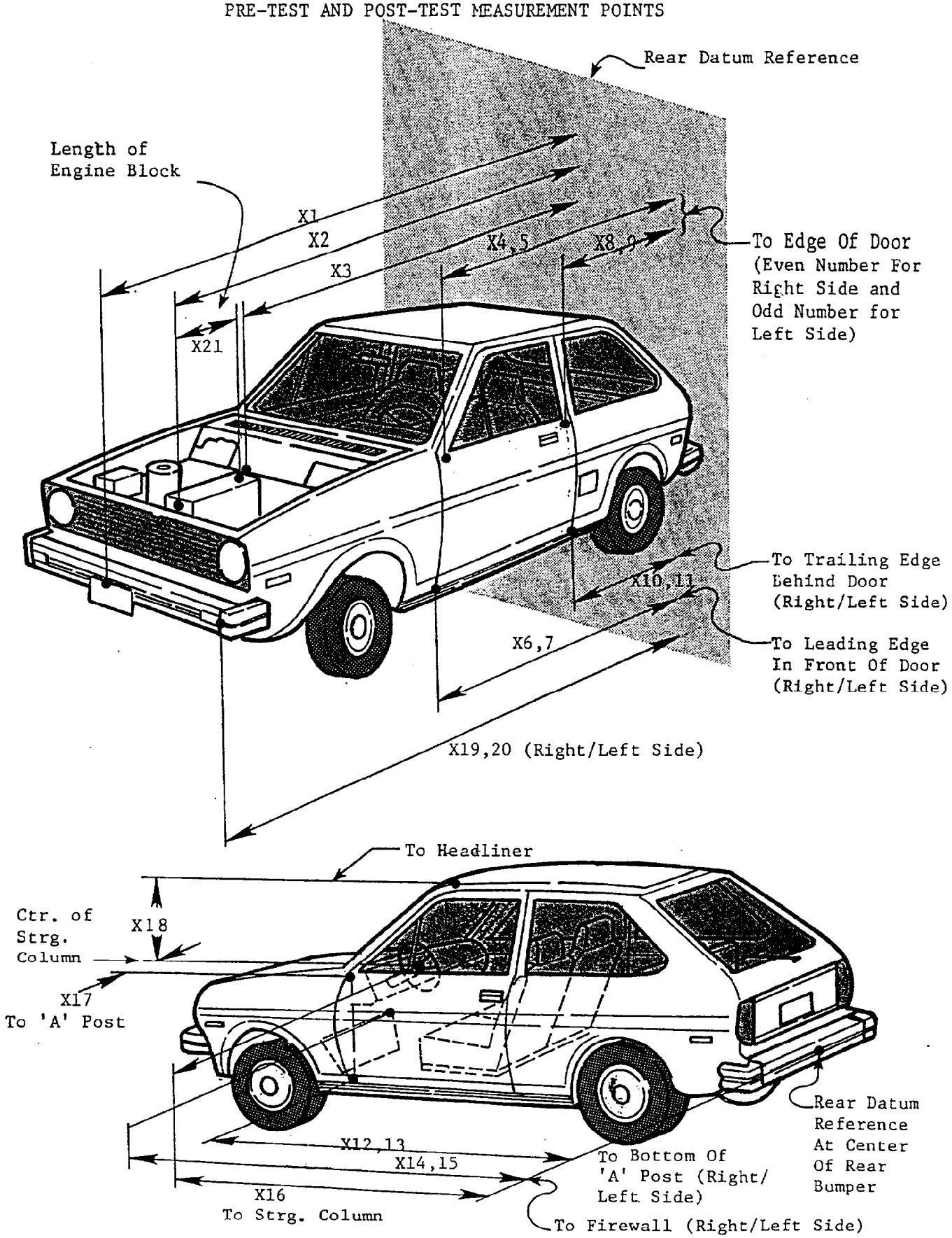


TABLE 8 IMPACTED VEHICLE MEASUREMENTS

VEHICLE MAKE/MODEL: Saturn/SL TEST NUMBER: 921106

ALL MEASUREMENTS ARE IN INCHES

NO.	TYPE OF MEASUREMENT	PRE-TEST	POST-TEST	DIFF.
X1	TOTAL LENGTH OF VEHICLE AT CENTERLINE	176.5	176.1	0.4
X2	REAR SURFACE OF VEHICLE TO FRONT OF ENGINE BLOCK	147.0	147.1	-0.1
X3	REAR SURFACE OF VEHICLE TO FIREWALL	130.0	129.4	0.6
X4	REAR SURFACE OF VEHICLE TO UPPER LEADING EDGE OF RIGHT DOOR	116.5	115.9	0.6
X5	REAR SURFACE OF VEHICLE TO UPPER LEADING EDGE OF LEFT DOOR	116.7	116.2	0.5
X6	REAR SURFACE OF VEHICLE TO LOWER LEADING EDGE OF RIGHT DOOR	116.3	116.1	0.2
X7	REAR SURFACE OF VEHICLE TO LOWER LEADING EDGE OF LEFT DOOR	116.8	116.5	0.3
X8	REAR SURFACE OF VEHICLE TO UPPER TRAILING EDGE OF RIGHT DOOR	76.1	75.9	0.2
X9	REAR SURFACE OF VEHICLE TO UPPER TRAILING EDGE OF LEFT DOOR	76.4	76.0	0.4
X10	REAR SURFACE OF VEHICLE TO LOWER TRAILING EDGE OF RIGHT DOOR	77.6	77.0	0.6
X11	REAR SURFACE OF VEHICLE TO LOWER TRAILING EDGE OF LEFT DOOR	77.9	77.5	0.4
X12	REAR SURFACE OF VEHICLE TO BOTTOM OF "A" POST ON RIGHT SIDE	116.2	116.4	-0.2
X13	REAR SURFACE OF VEHICLE TO BOTTOM OF "A" POST ON LEFT SIDE	116.3	115.9	0.4
X14	REAR SURFACE OF VEHICLE TO FIREWALL - RIGHT SIDE	130.9	129.6	1.3
X15	REAR SURFACE OF VEHICLE TO FIREWALL - LEFT SIDE	130.4	129.4	1.0
X16	REAR SURFACE OF VEHICLE TO STEERING WHEEL CENTER	97.5	96.4	1.1
X17	CENTER OF STEERING COLUMN TO "A" POST	10.8	11.1	-0.3
X18	CENTER OF STEERING COLUMN TO HEADLINER	17.2	12.1	5.1
X19	REAR SURFACE OF VEHICLE TO RIGHT SIDE OF FRONT BUMPER	171.2	169.8	1.4
X20	REAR SURFACE OF VEHICLE TO LEFT SIDE OF FRONT BUMPER	170.8	169.8	1.0
X21	LENGTH OF ENGINE BLOCK	16.5	16.5	0.0

FIGURE 7 CAMERA POSITIONS

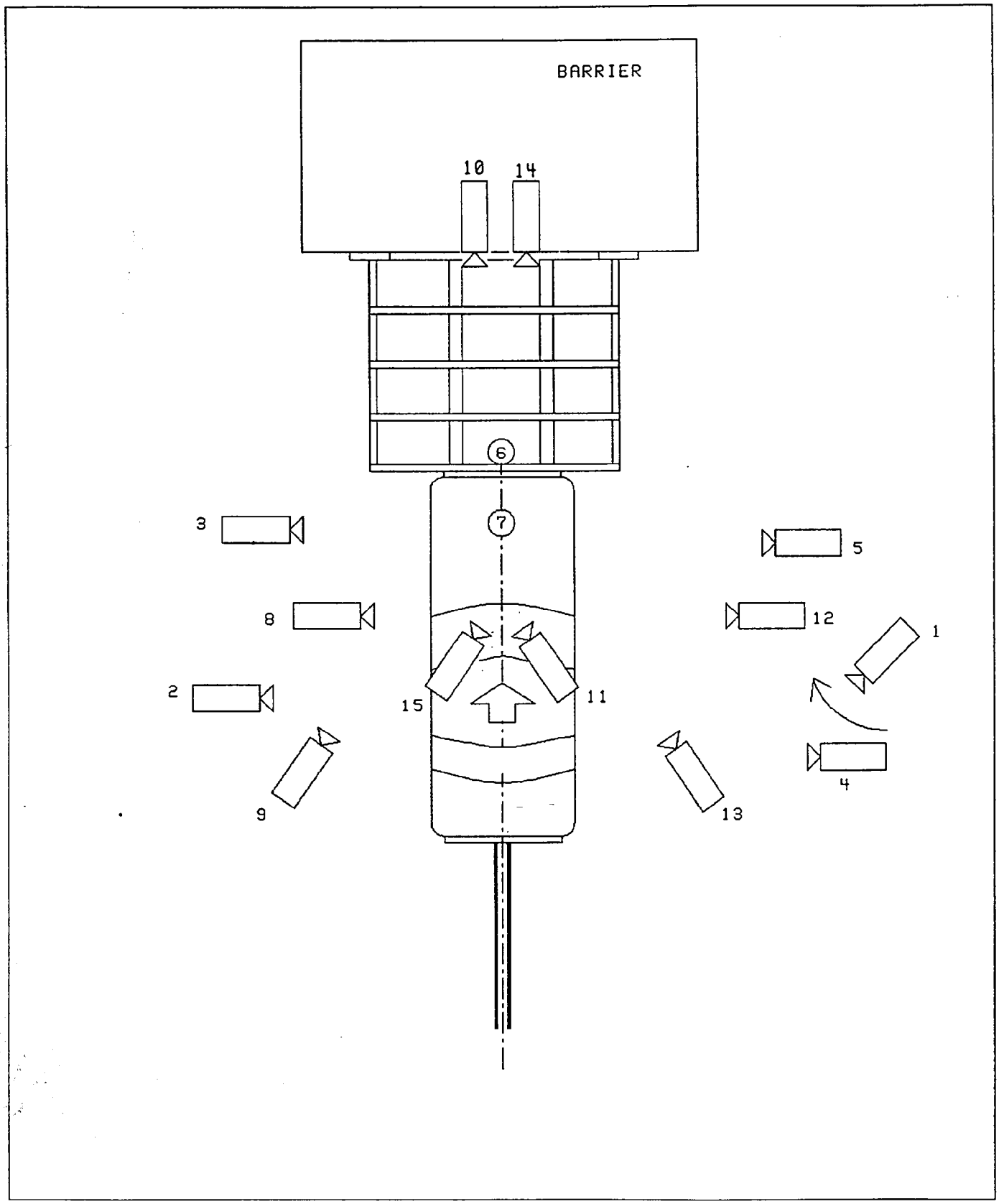


TABLE 9 CAMERA INFORMATION

CAMERA NO.	LOCATION	TYPE	LENS (mm)	SPEED (fps)	PURPOSE OF CAMERA DATA
1	Panning	Bolex	12-120	24	Vehicle dynamics
2	Left wide	Stalex	13	498	Barrier deformation/crush
3	Left front close-up	Stalex	50	498	Barrier deformation/crush
4	Right wide	Photosonic	13	500	Barrier deformation/crush
5	Right front close-up	Stalex	50	513	Barrier deformation/crush
6	Overhead tight	Photosonic	25	508	Barrier deformation/crush
7	Pit-front close-up	Photosonic	13	500	Barrier deformation/crush
8	Left medium tight	Stalex	25	495	Dummy kinematics
9	Driver angle view	Photosonic	25	500	Dummy kinematics
10	Driver barrier view	Photosonic	17	495	Dummy kinematics
11	Onboard driver	Photosonic	8	500	Dummy kinematics
12	Right medium tight	Hycam	25	520	Dummy kinematics
13	Passenger angle view	Photosonic	25	500	Dummy kinematics
14	Passenger barrier view	Photosonic	17	505	Dummy kinematics
15	Onboard passenger view	Photosonic	8	500	Dummy kinematics

APPENDIX A

PHOTOGRAPHS

Figure A-1. PRE-TEST FRONT VIEW

Figure A-2. POST-TEST FRONT VIEW

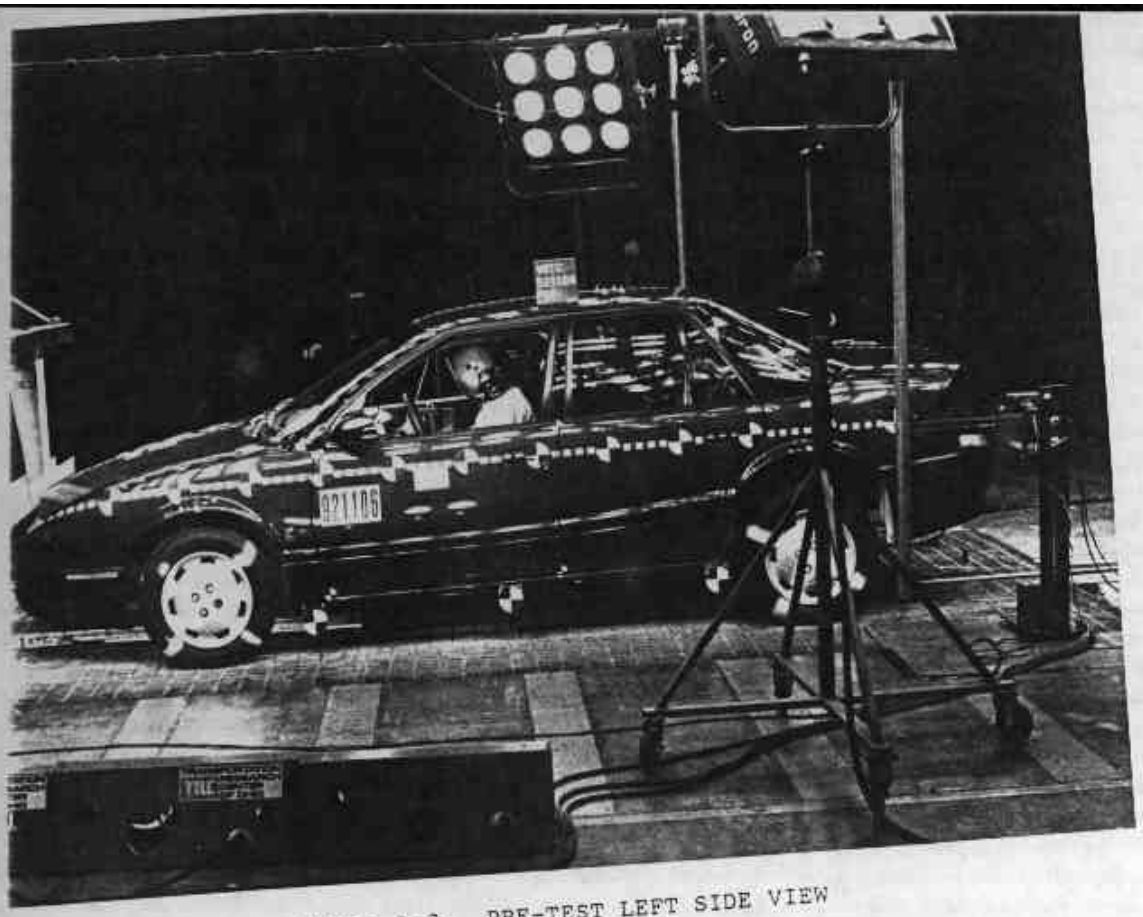


Figure A-3. PRE-TEST LEFT SIDE VIEW

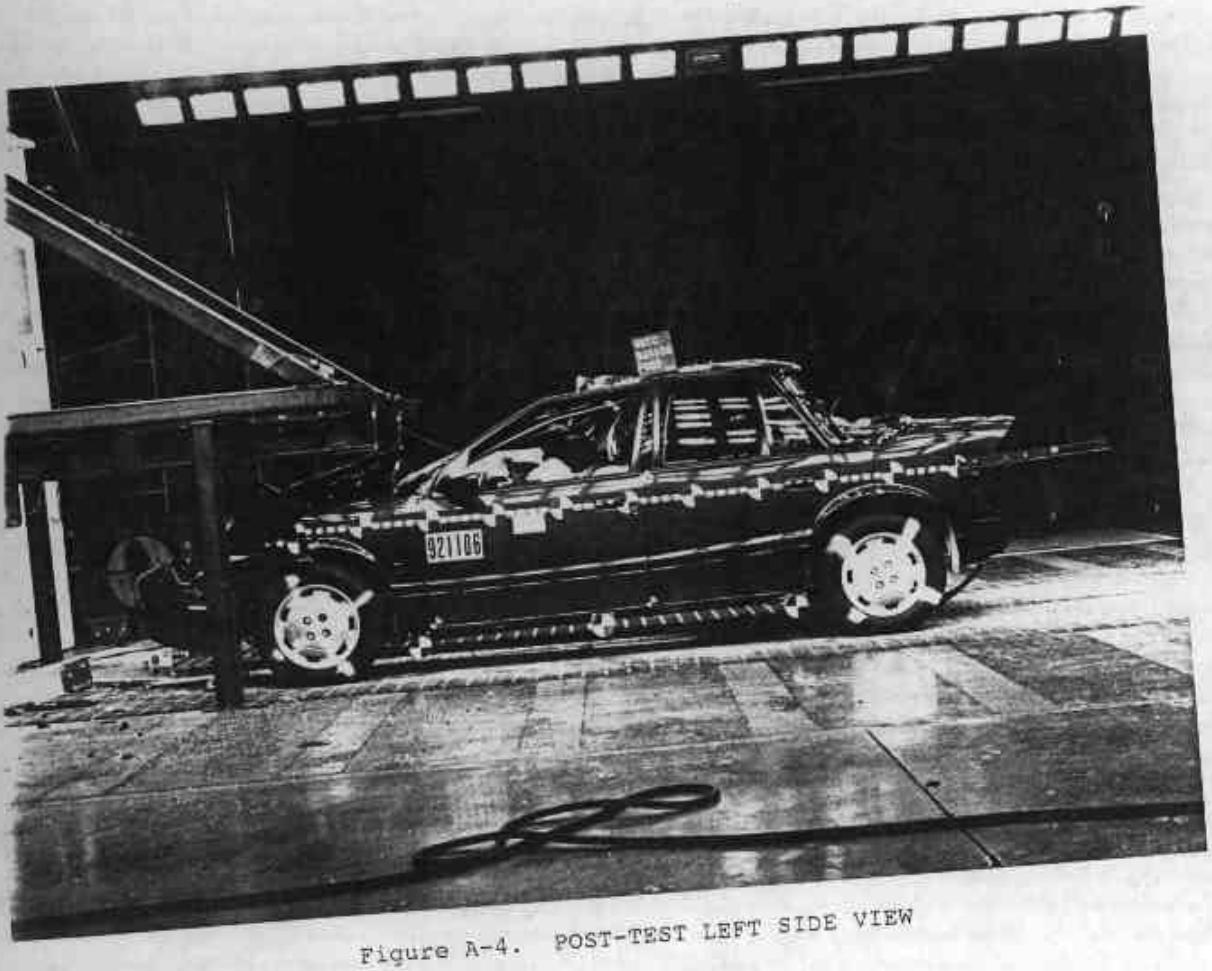


Figure A-4. POST-TEST LEFT SIDE VIEW

Figure A-5. PRE-TEST REAR VIEW

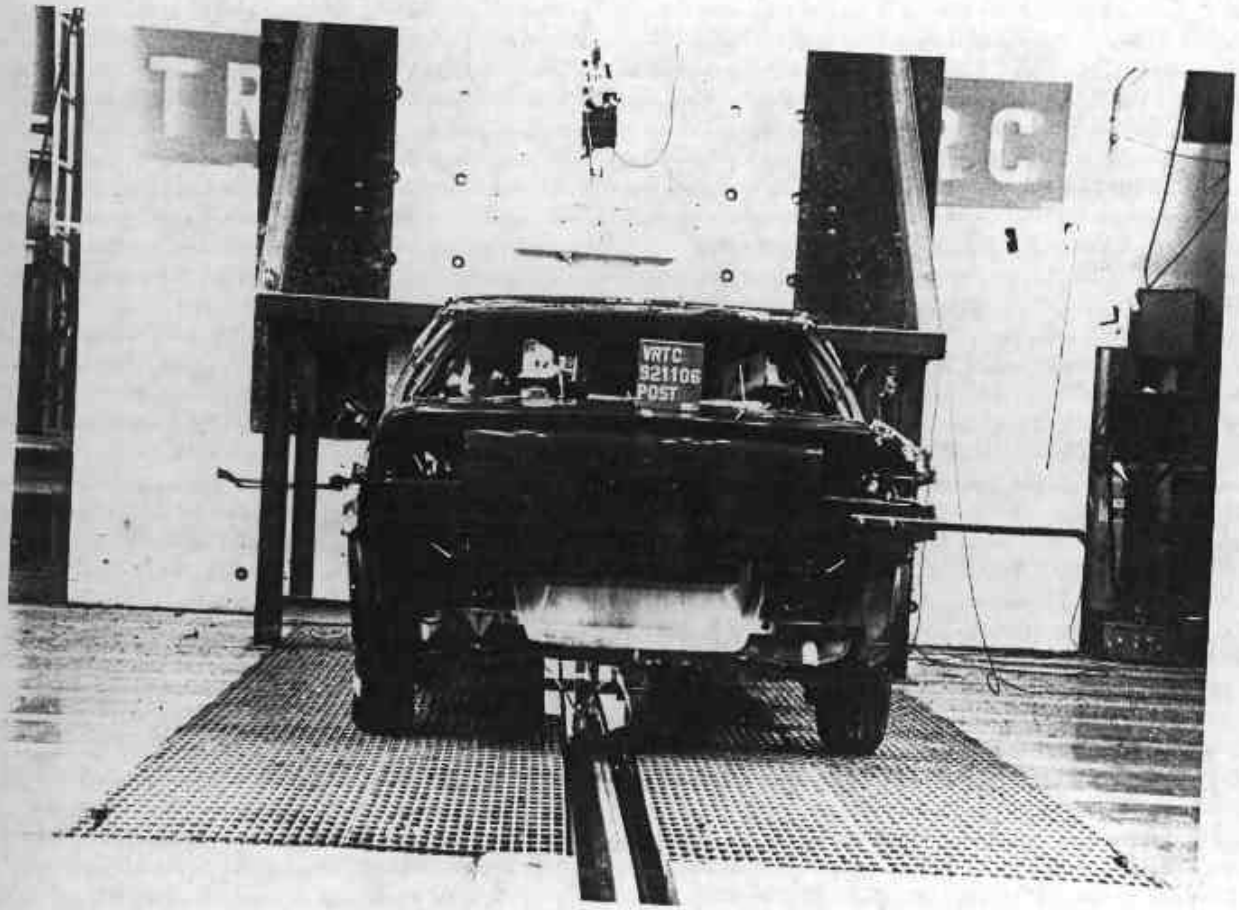


Figure A-6. POST-TEST REAR VIEW

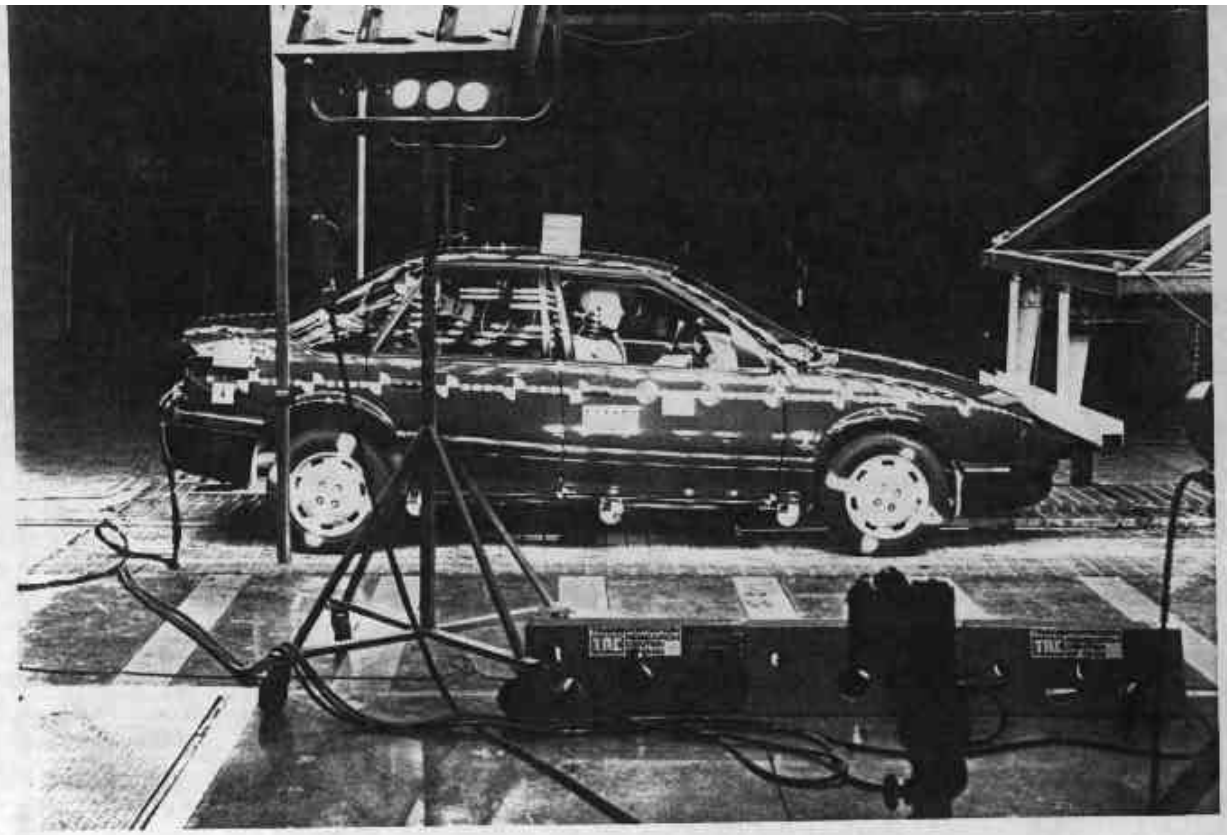


Figure A-7. PRE-TEST RIGHT SIDE VIEW

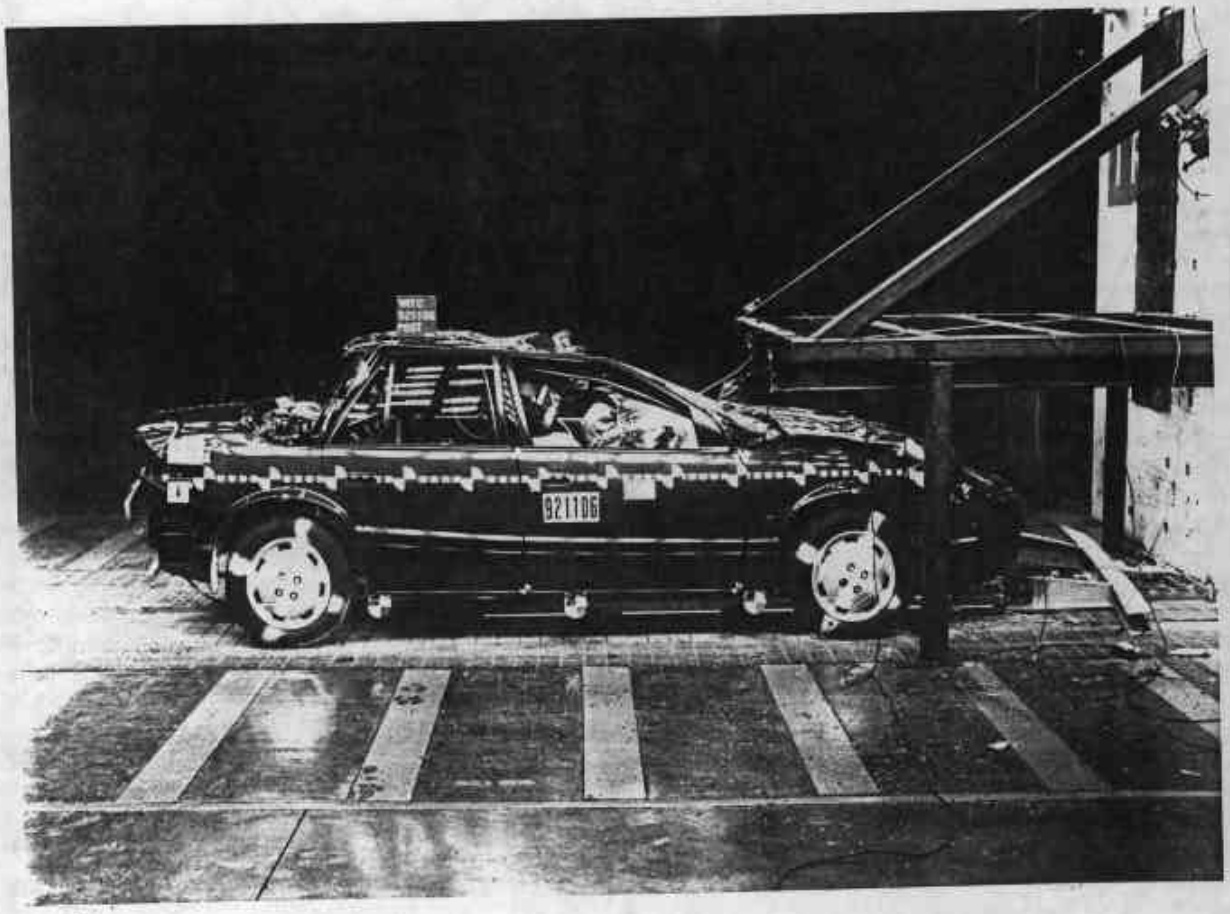


Figure A-8. POST-TEST RIGHT SIDE VIEW

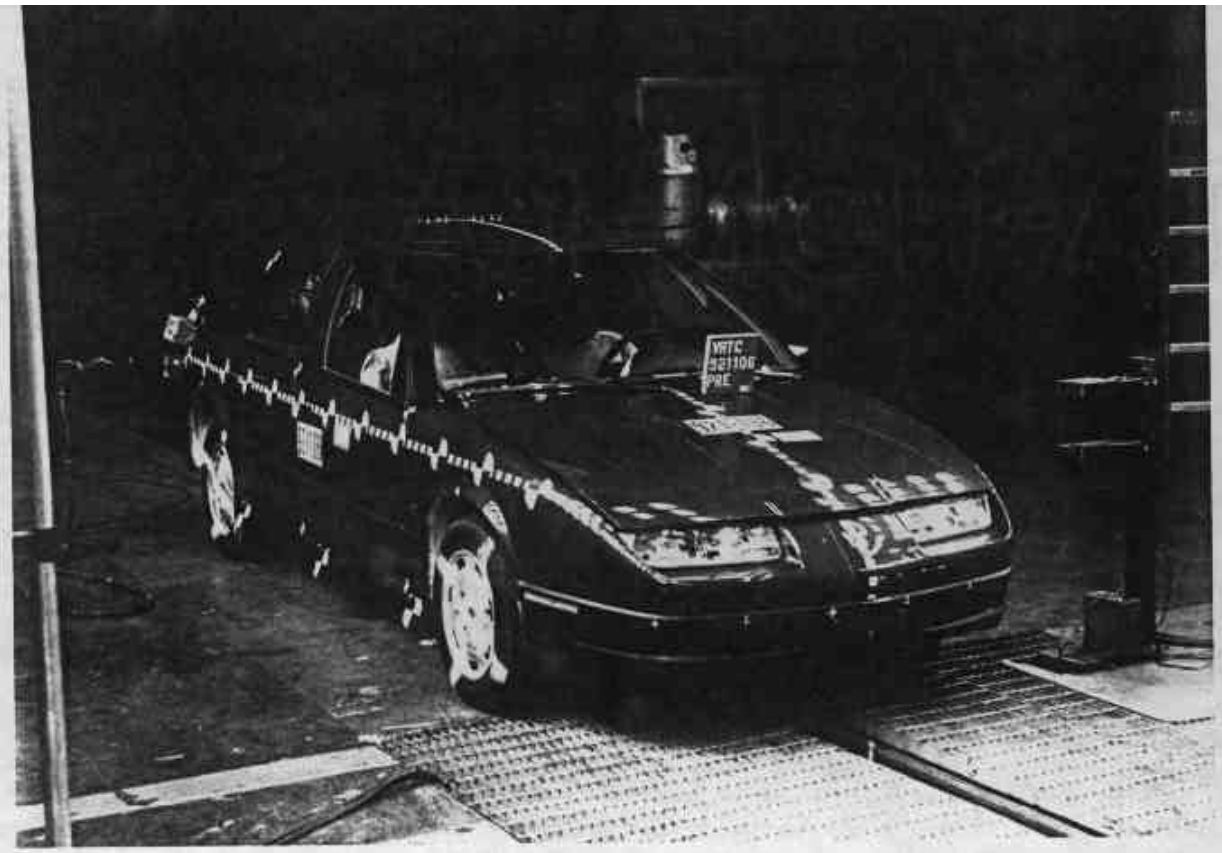


Figure A-9. PRE-TEST RIGHT FRONT THREE-QUARTER VIEW

Figure A-10. POST-TEST RIGHT FRONT THREE-QUARTER VIEW

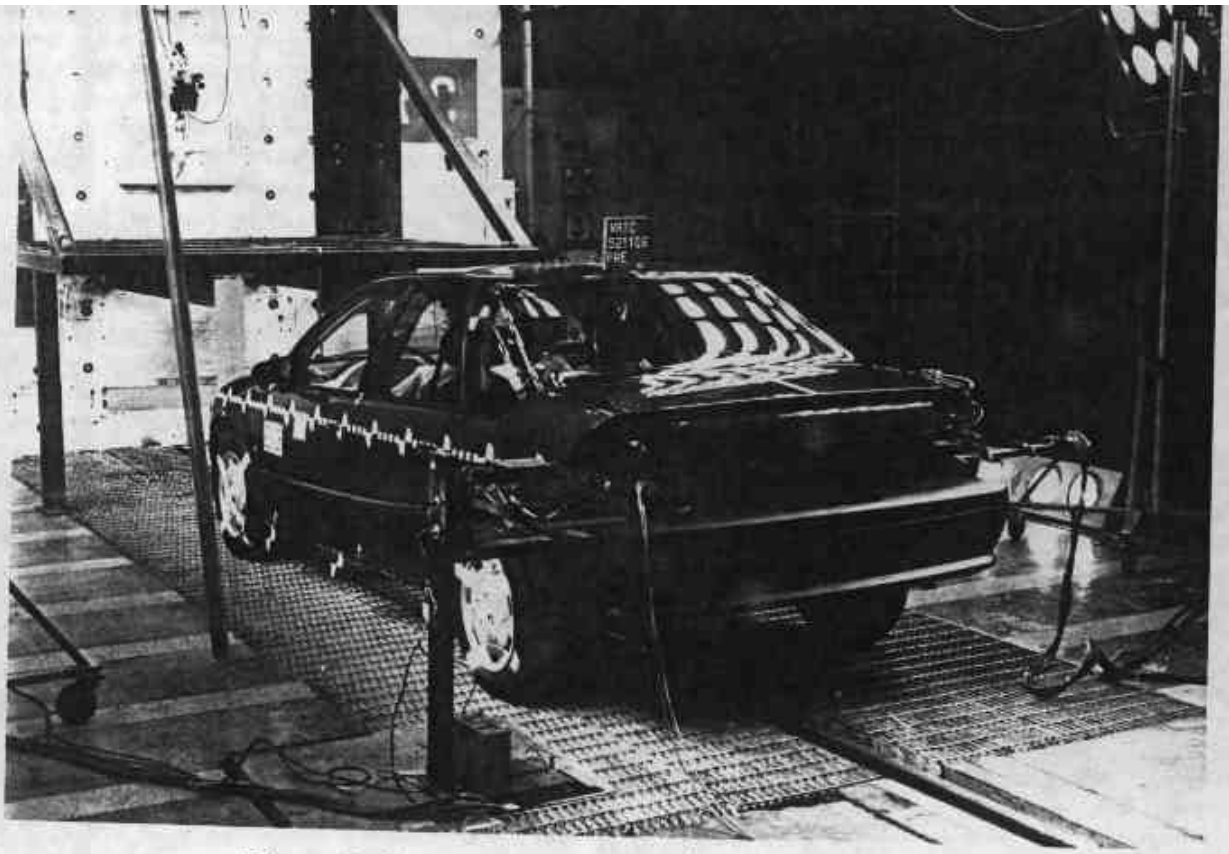


Figure A-11. PRE-TEST LEFT REAR THREE-QUARTER VIEW

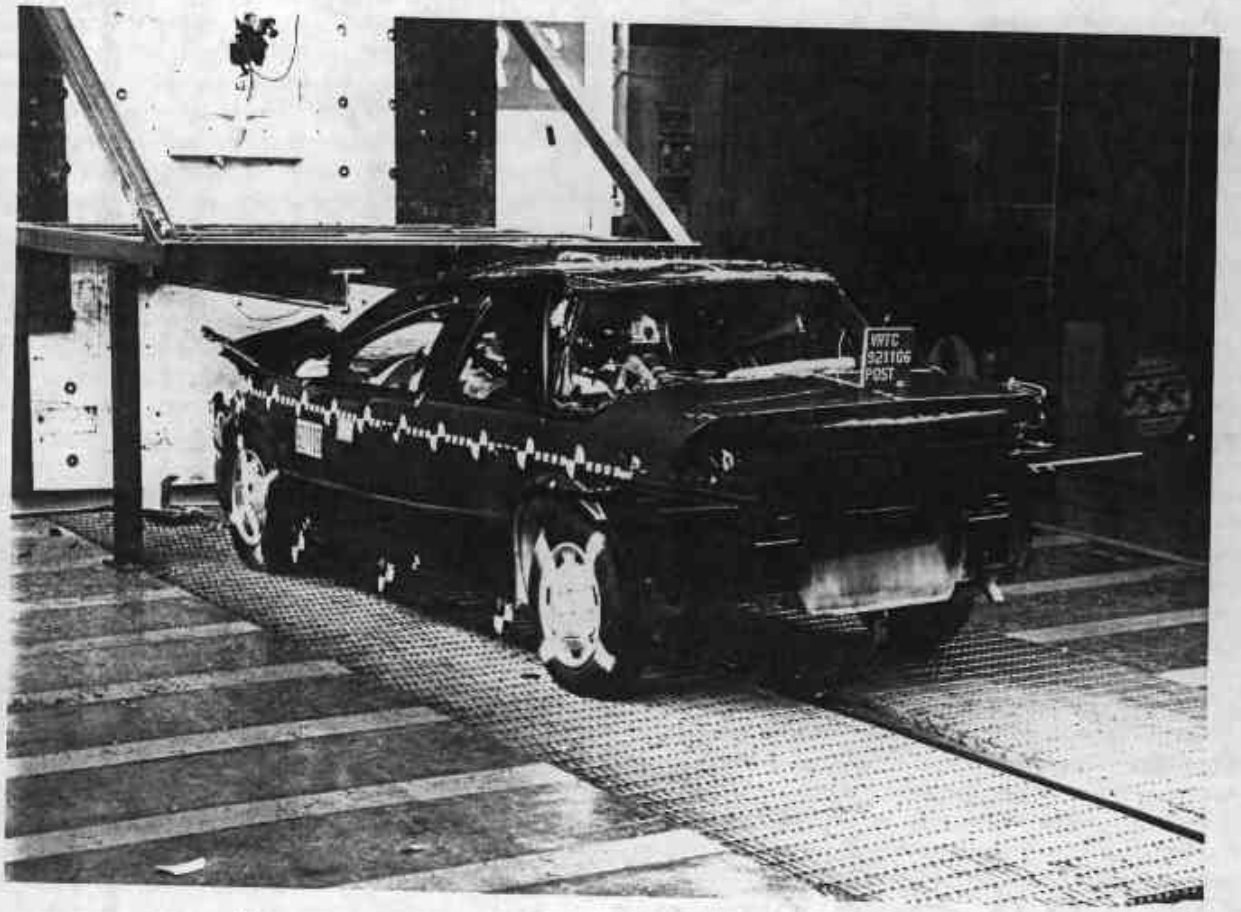


Figure A-12. POST-TEST LEFT REAR THREE-QUARTER VIEW

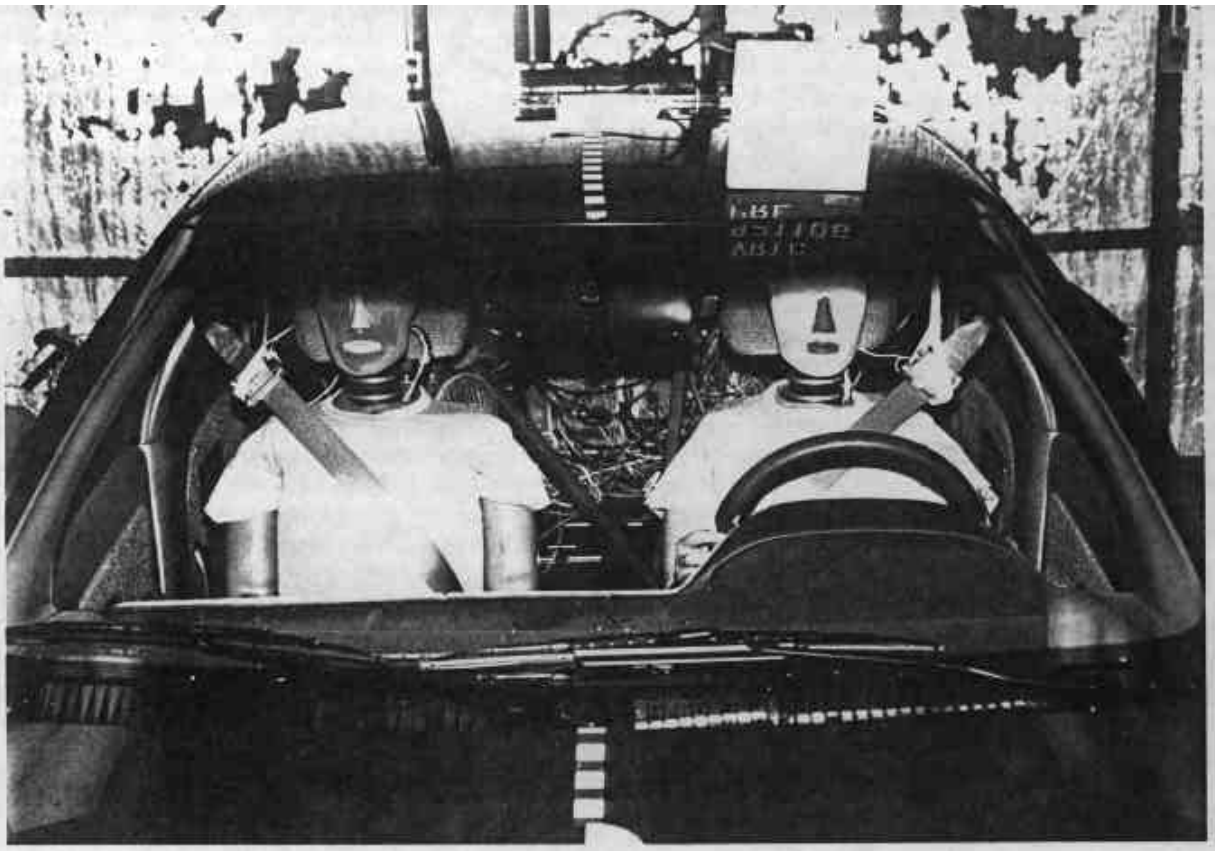


Figure A-13. PRE-TEST WINDSHIELD VIEW

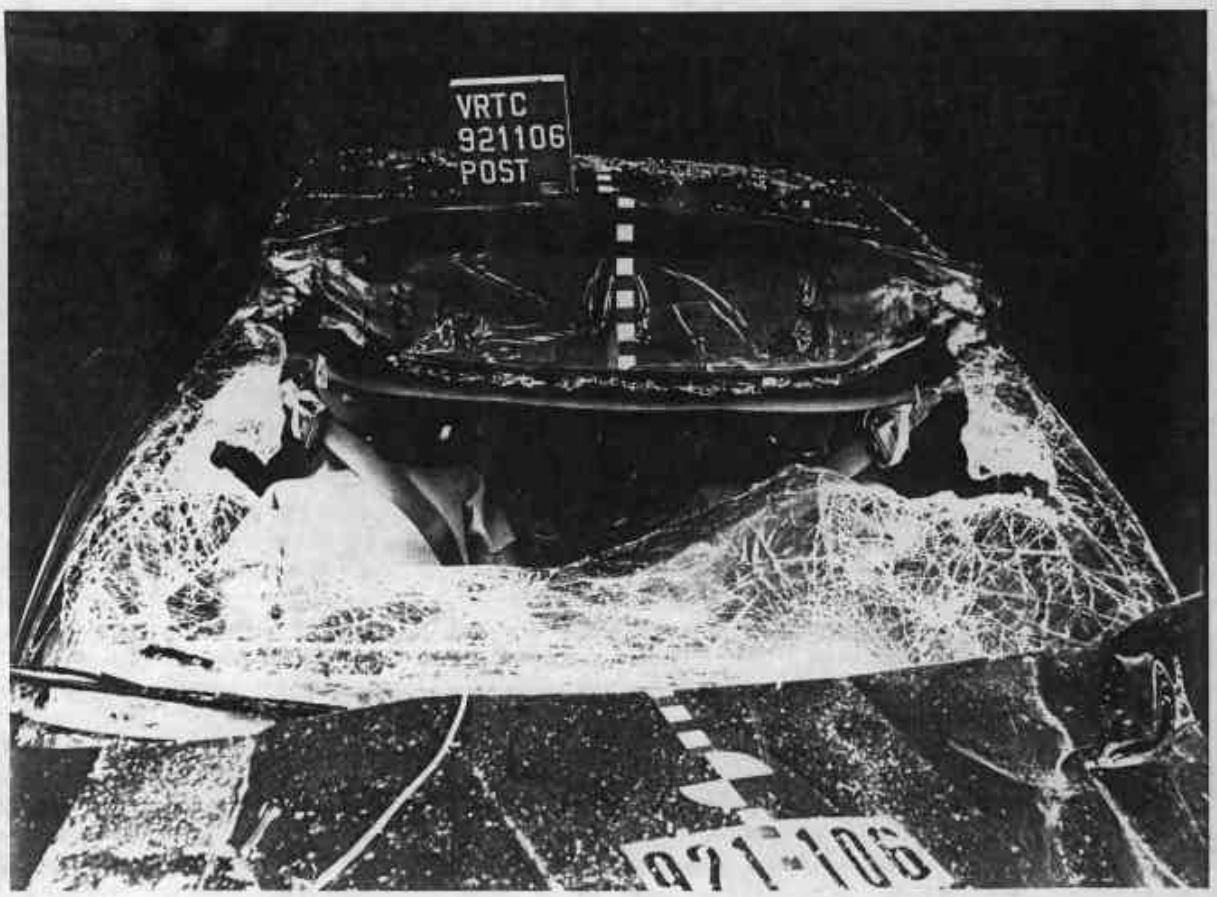


Figure A-14. POST-TEST WINDSHIELD - VIEW 1

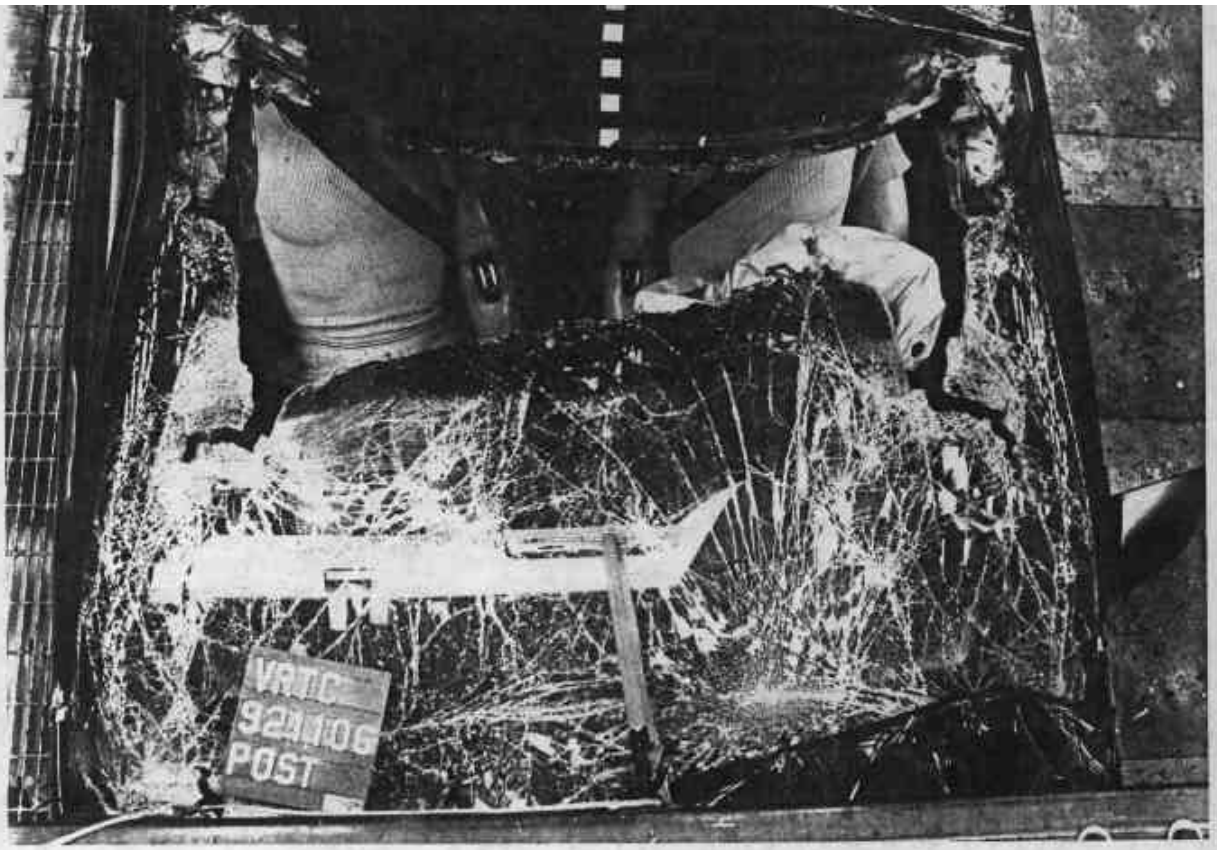


Figure A-15. POST-TEST WINDSHIELD - VIEW 2

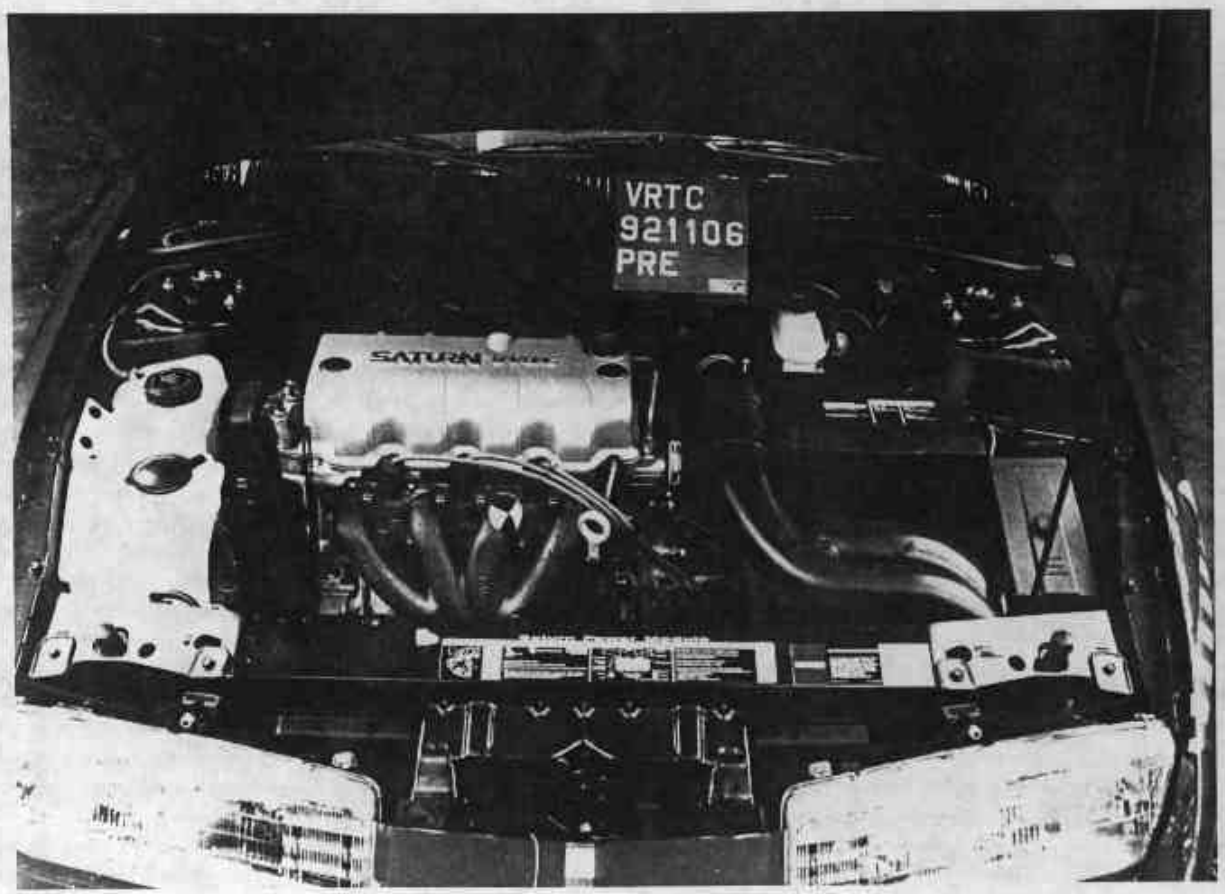


Figure A-16. PRE-TEST ENGINE COMPARTMENT VIEW

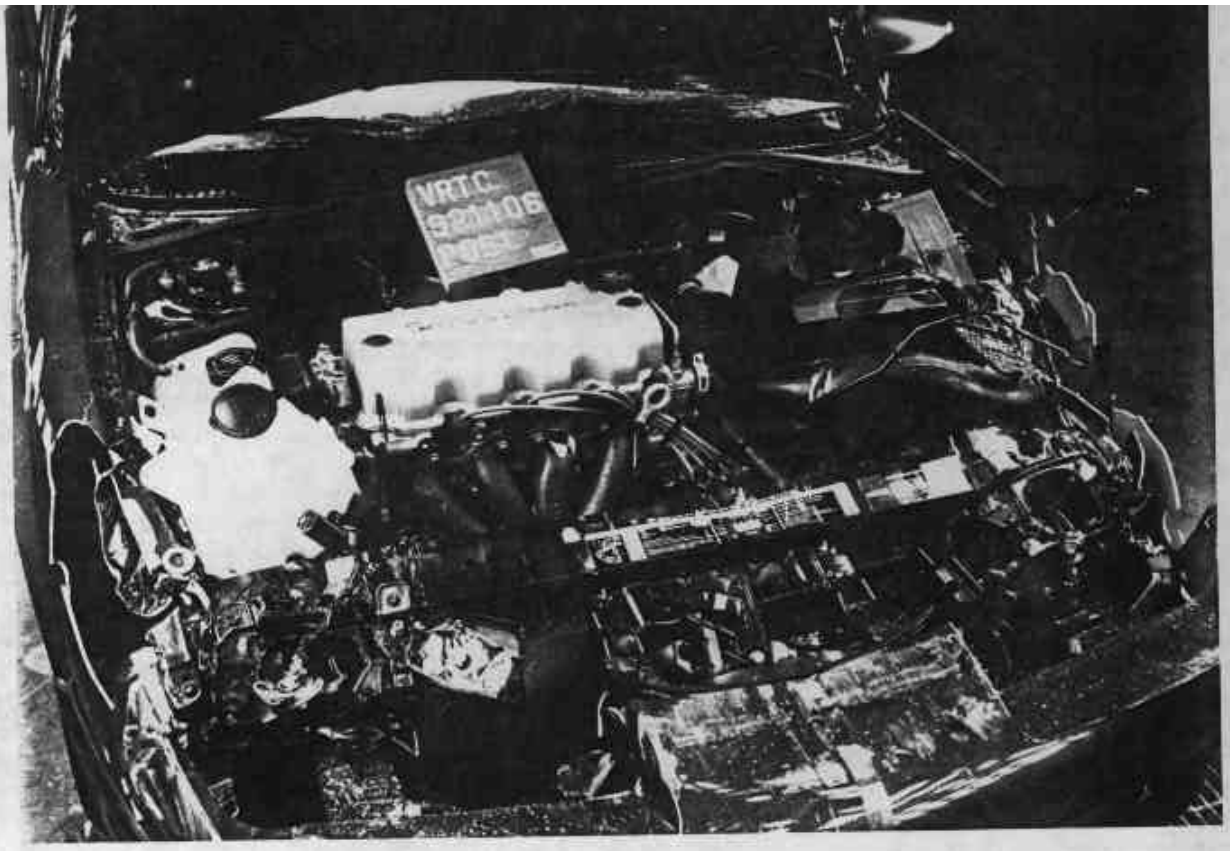


Figure A-17. POST-TEST ENGINE COMPARTMENT VIEW

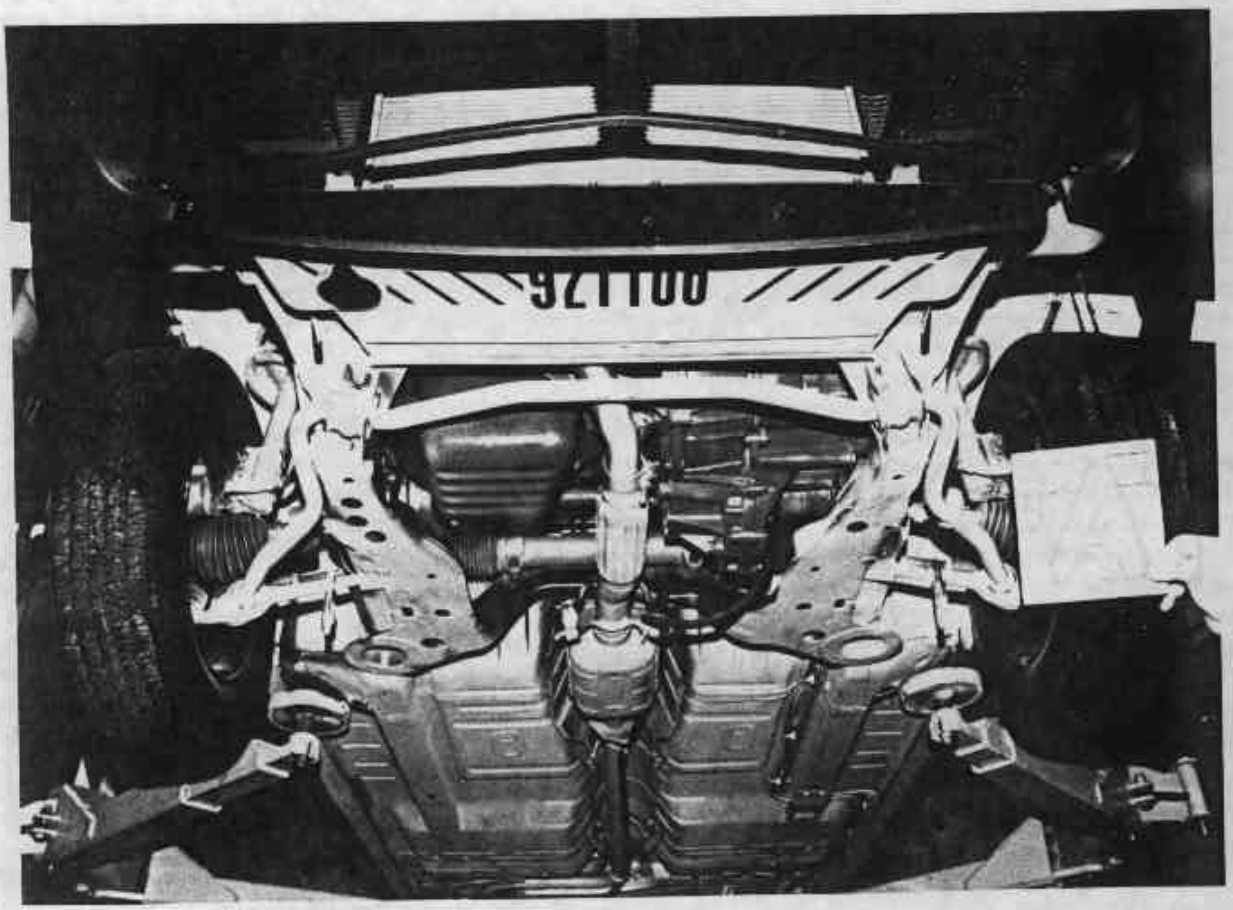


Figure A-18. PRE-TEST FRONT UNDERBODY VIEW

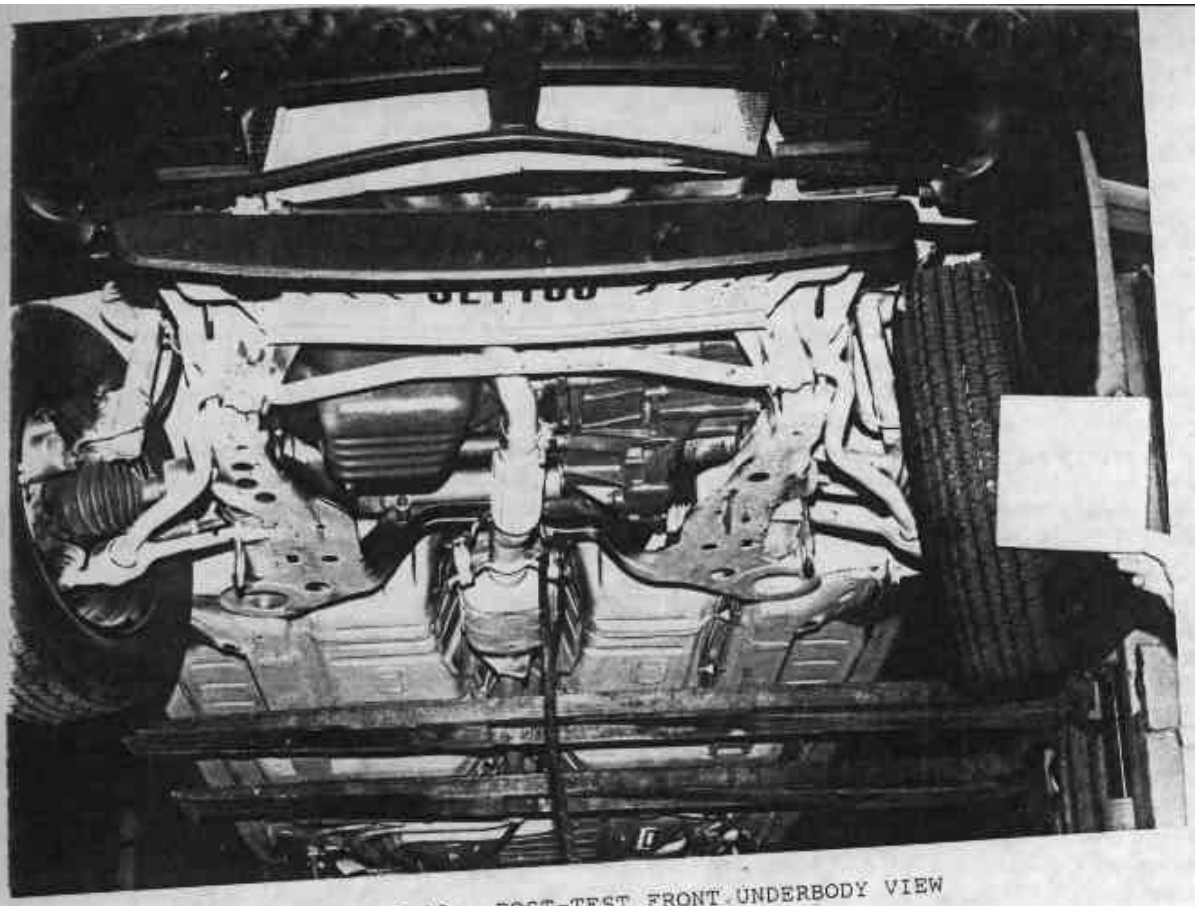


Figure A-19. POST-TEST FRONT UNDERBODY VIEW

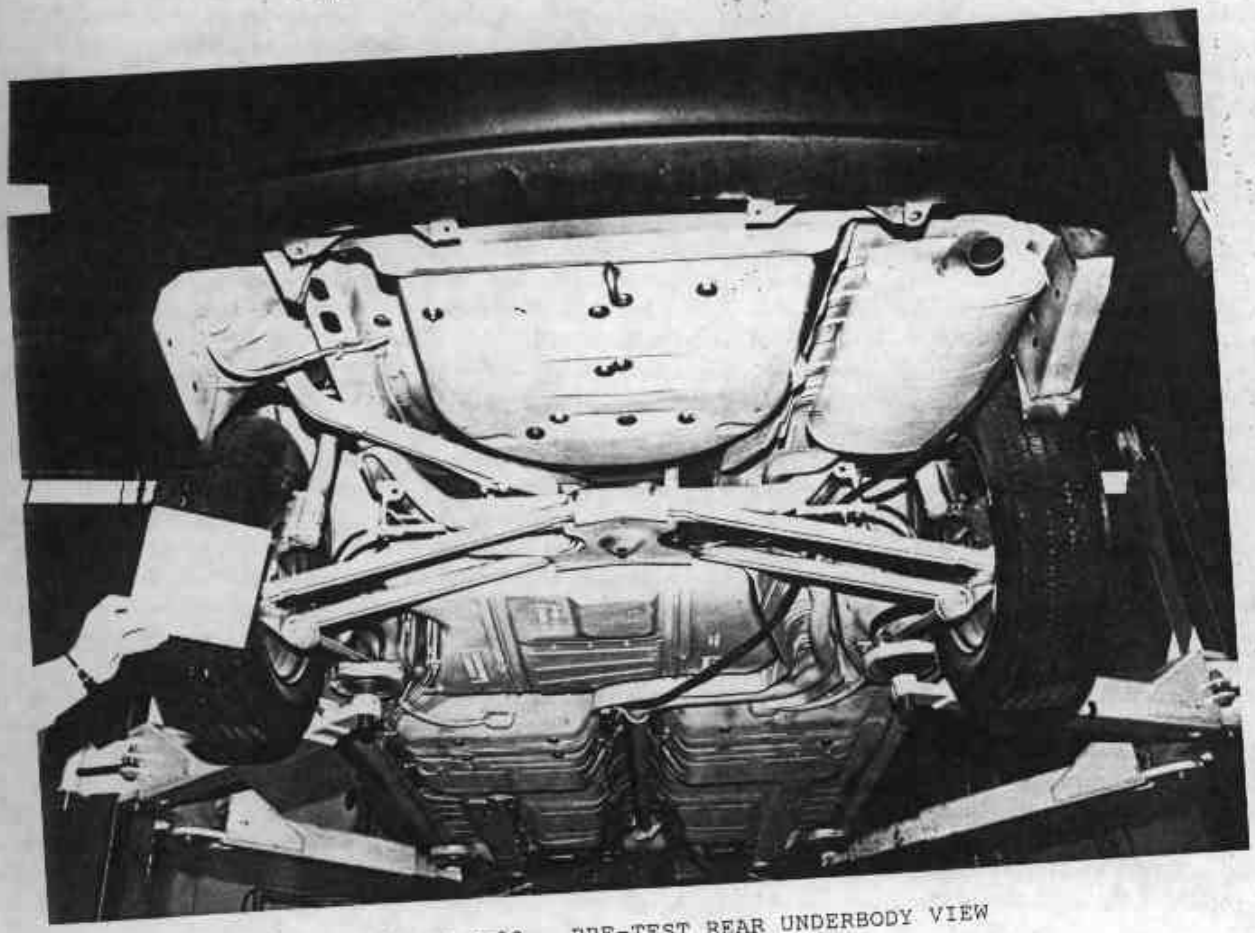


Figure A-20. PRE-TEST REAR UNDERBODY VIEW

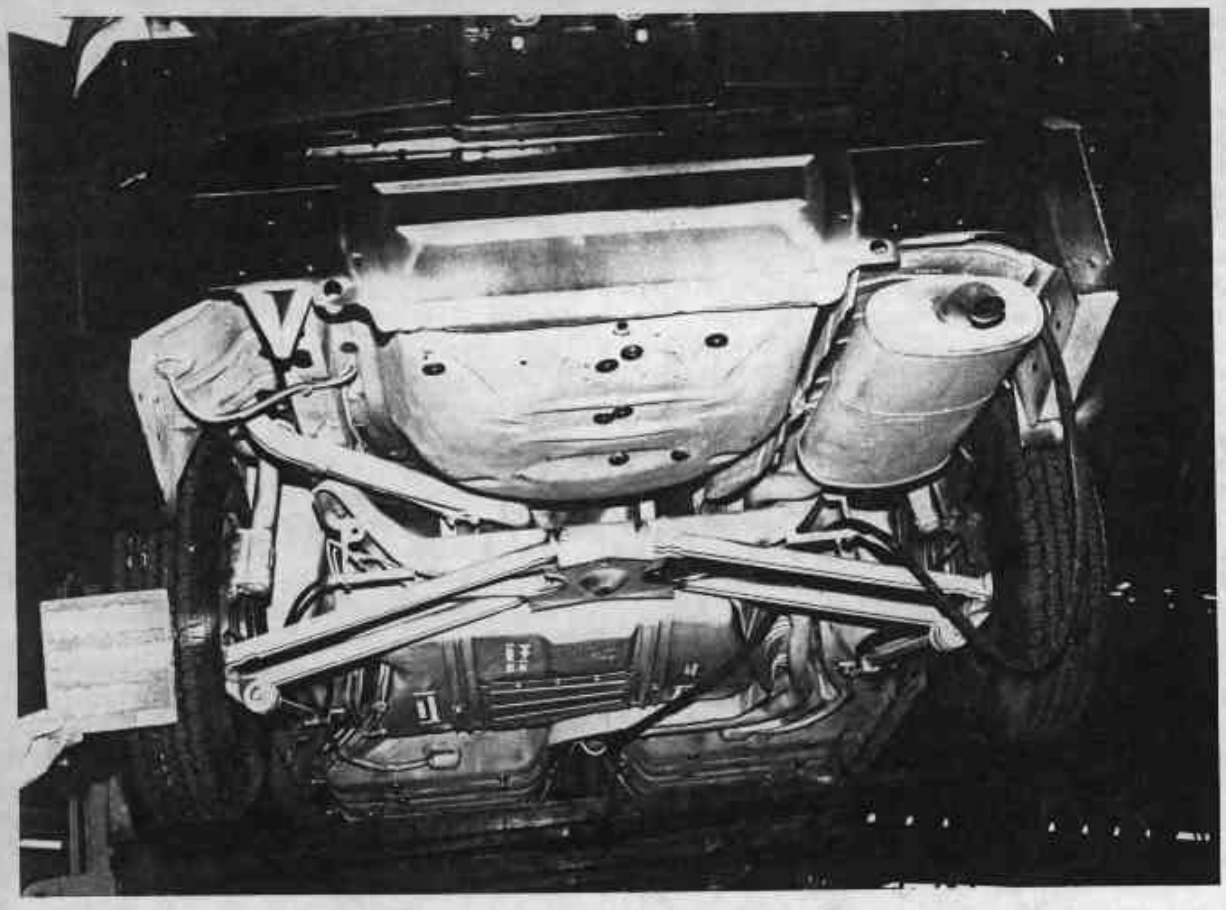


Figure A-21. POST-TEST REAR UNDERBODY VIEW

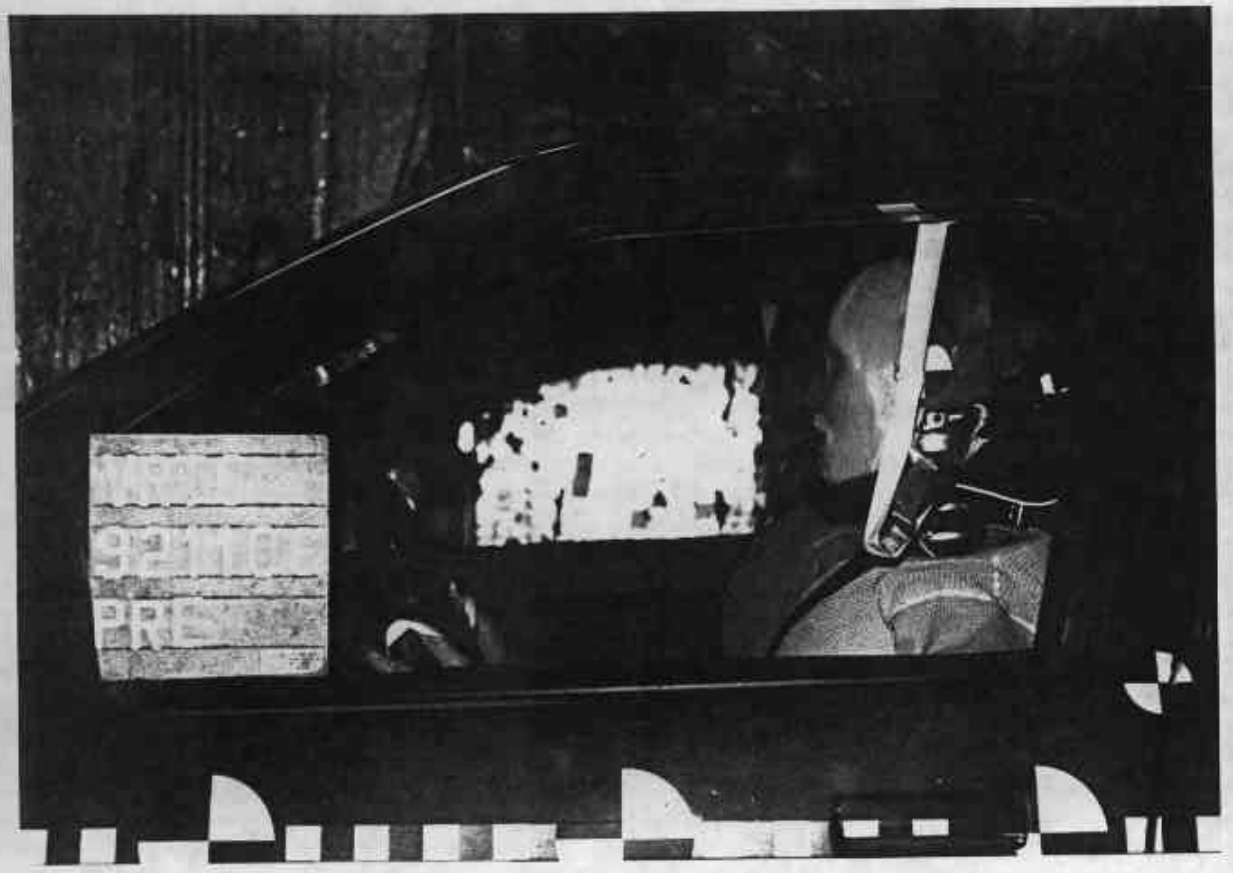


Figure A-22. PRE-TEST DRIVER DUMMY POSITION VIEW

Figure A-23. POST-TEST DRIVER DUMMY POSITION VIEW

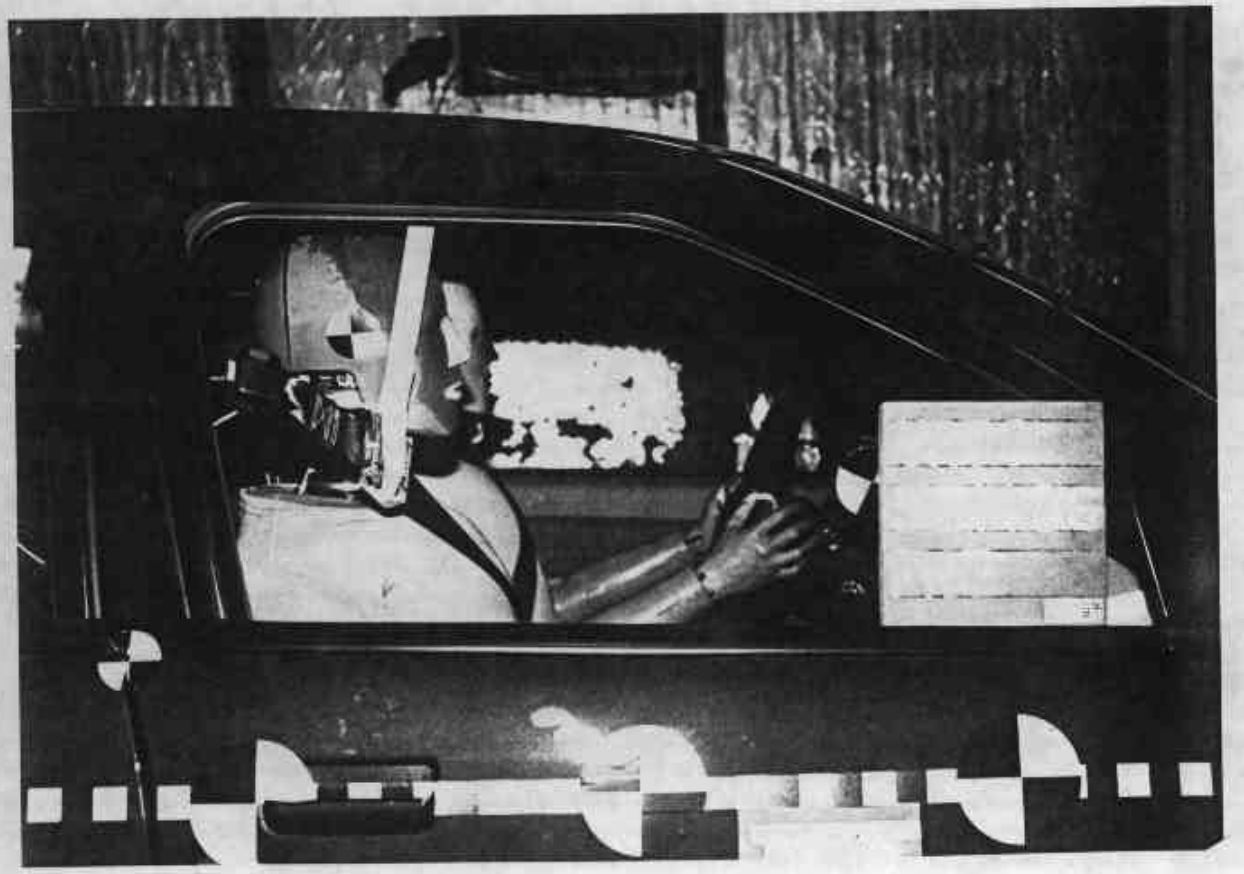


Figure A-24. PRE-TEST PASSENGER DUMMY POSITION VIEW

Figure A-25. POST-TEST PASSENGER DUMMY POSITION VIEW

Figure A-26. PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 1

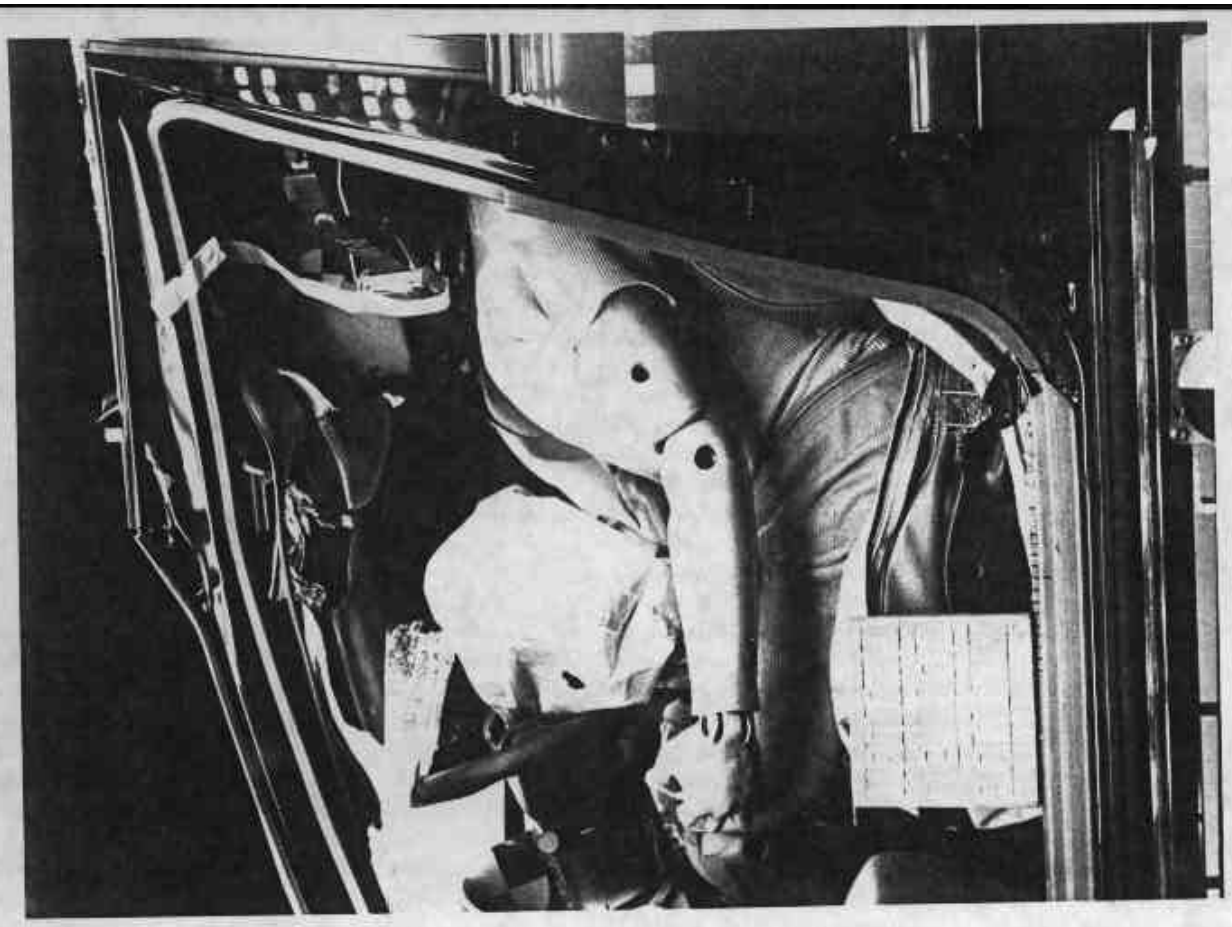


Figure A-27. POST-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 1

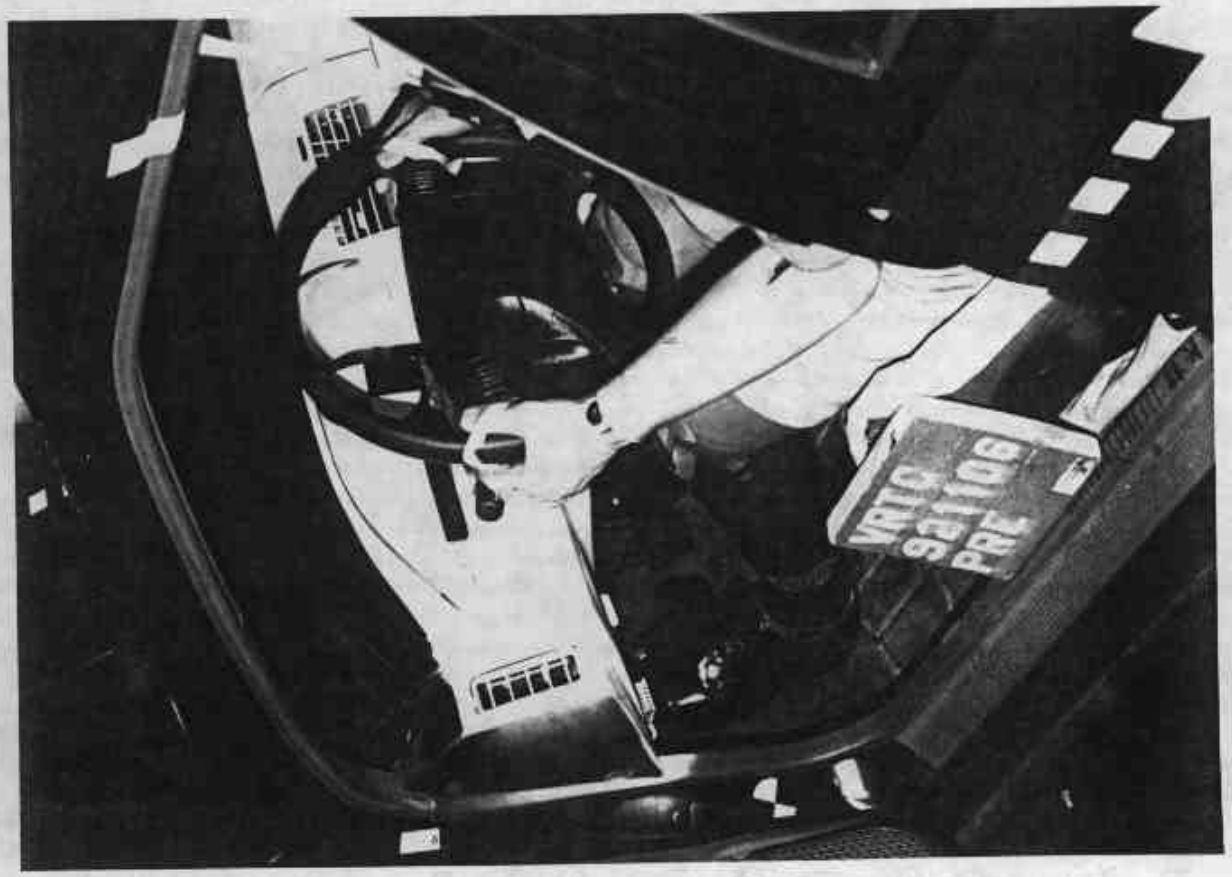


Figure A-28. PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 2

Figure A-29. POST-TEST DRIVER DUMMY AND VEHICLE INTERIOR - VIEW 2

Figure A-30. POST-TEST DRIVER DUMMY AND VEHICLE INTERIOR - VIEW 3

Figure A-31. PRE-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 1

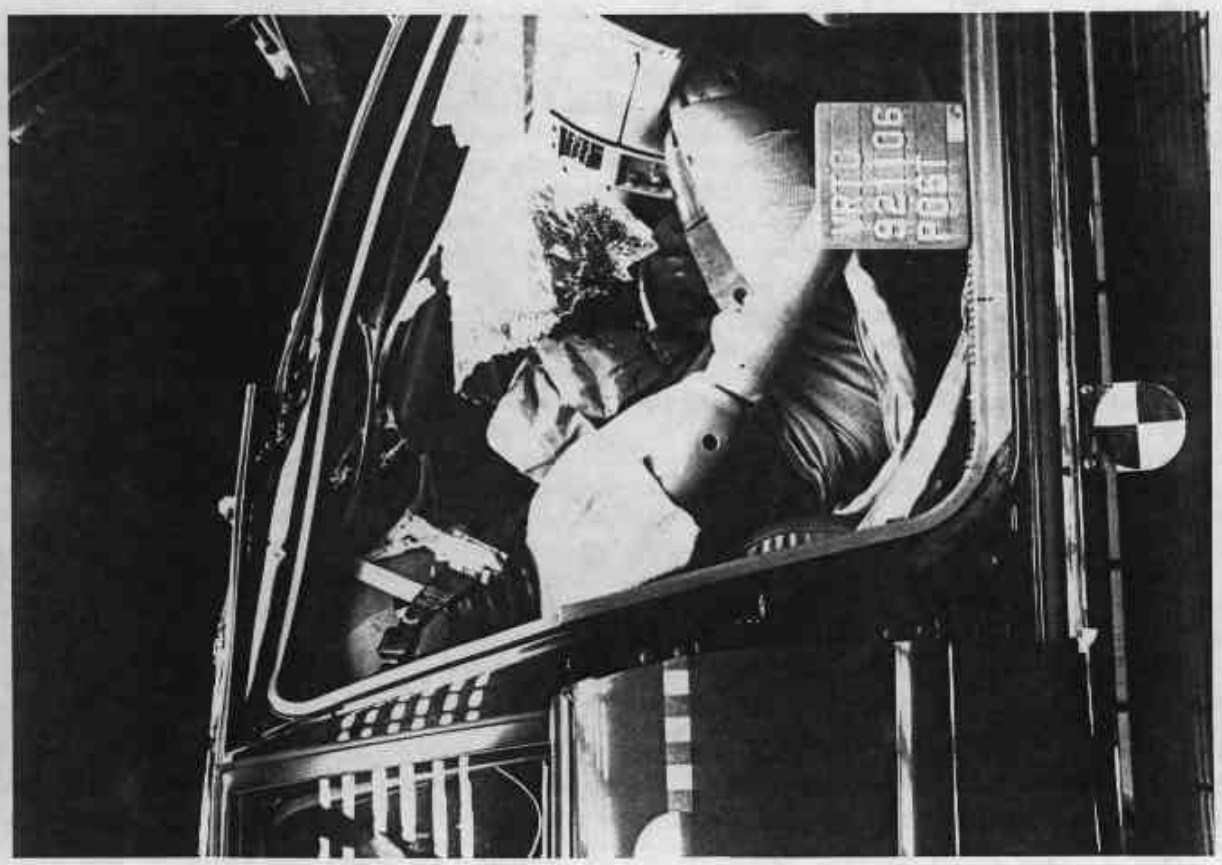


Figure A-32. POST-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 1

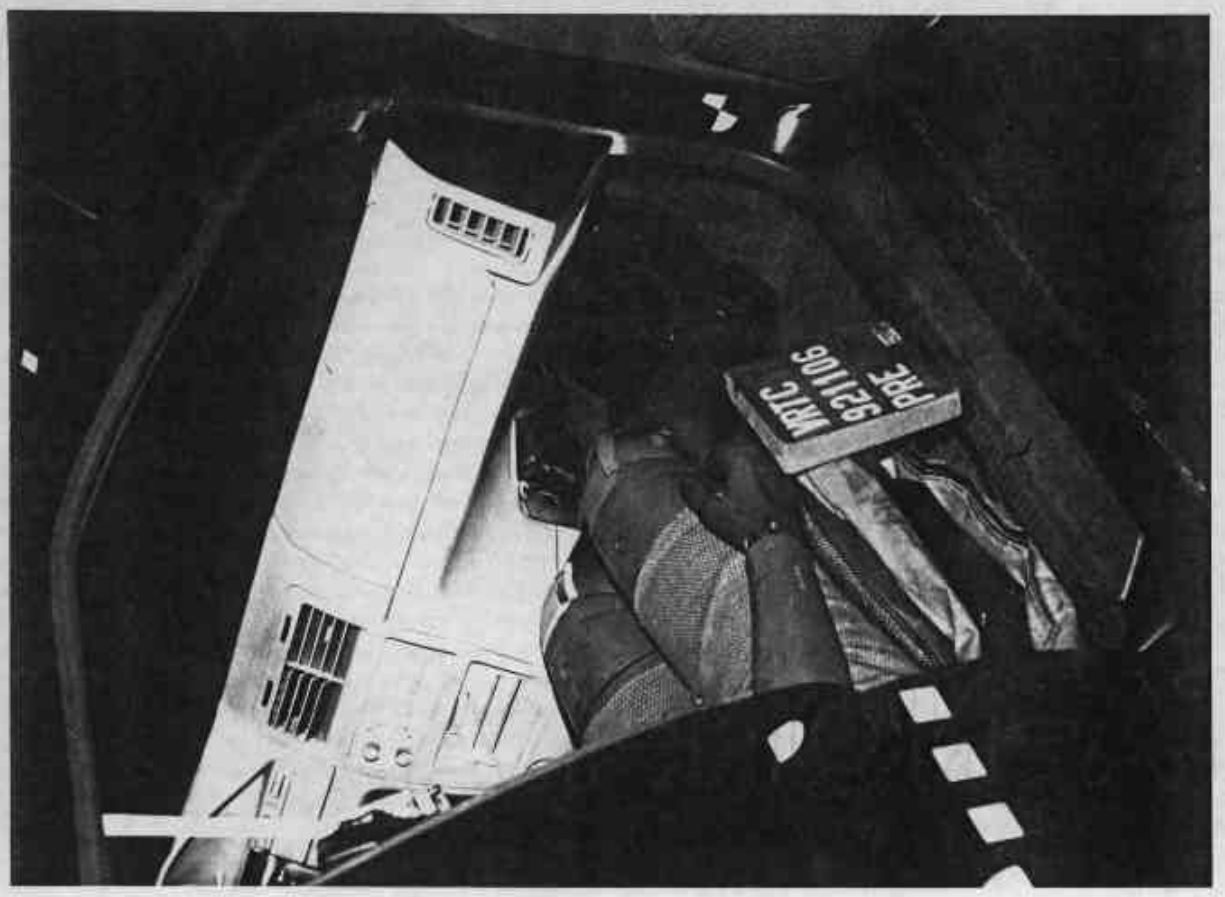


Figure A-33. PRE-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 2

Figure A-34. POST-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 2

Figure A-35. POST-TEST DRIVER DUMMY HEAD CONTACT - VIEW 1

Figure A-36. POST-TEST DRIVER DUMMY HEAD CONTACT - VIEW 2

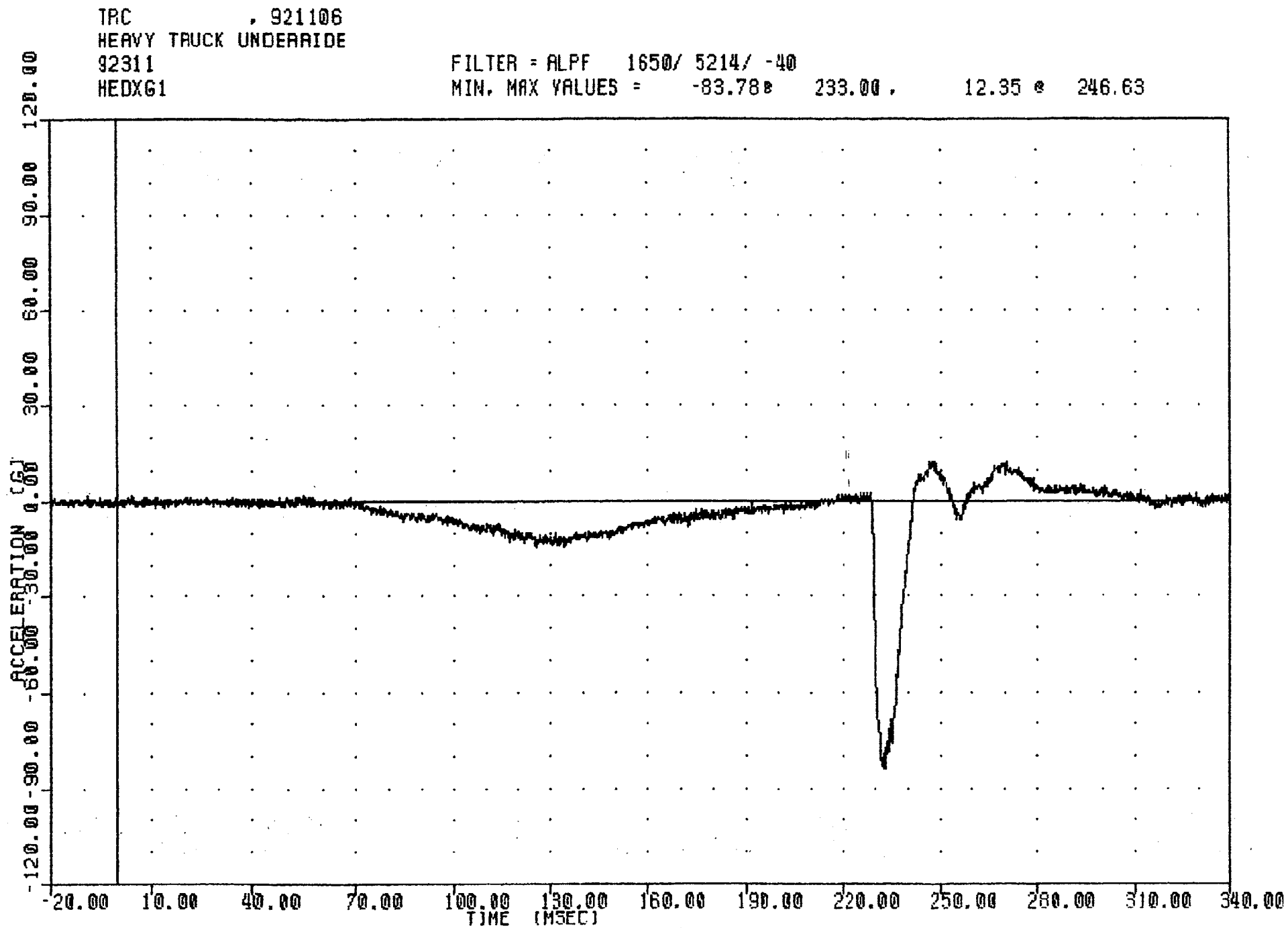
Figure A-37. POST-TEST DRIVER DUMMY KNEE CONTACT VIEW

Figure A-38. POST-TEST PASSENGER DUMMY HEAD CONTACT VIEW

Figure A-39. POST-TEST PASSENGER DUMMY KNEE CONTACT VIEW

APPENDIX B

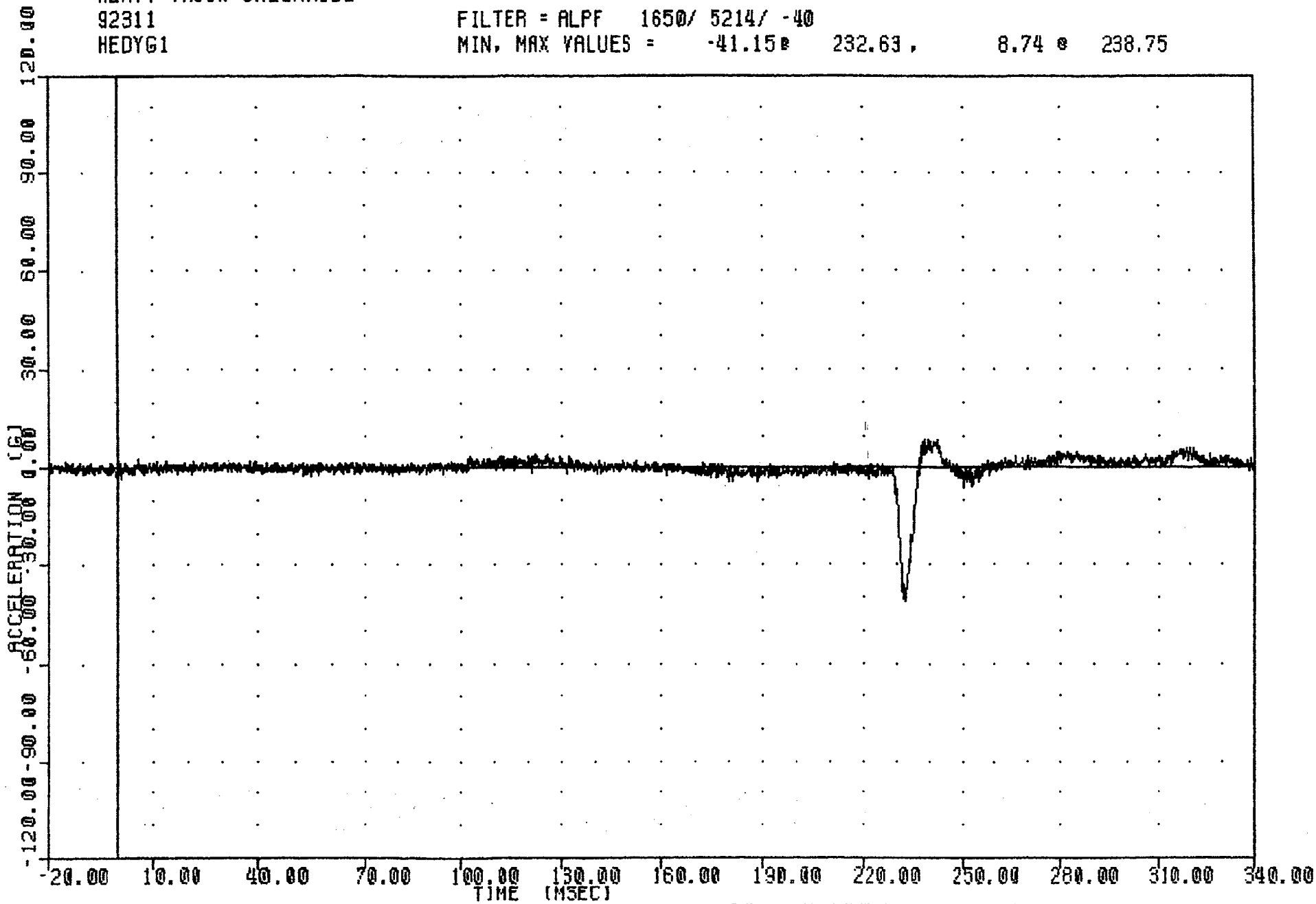
DATA PLOTS



1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER HEAD X-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
HEDYG1

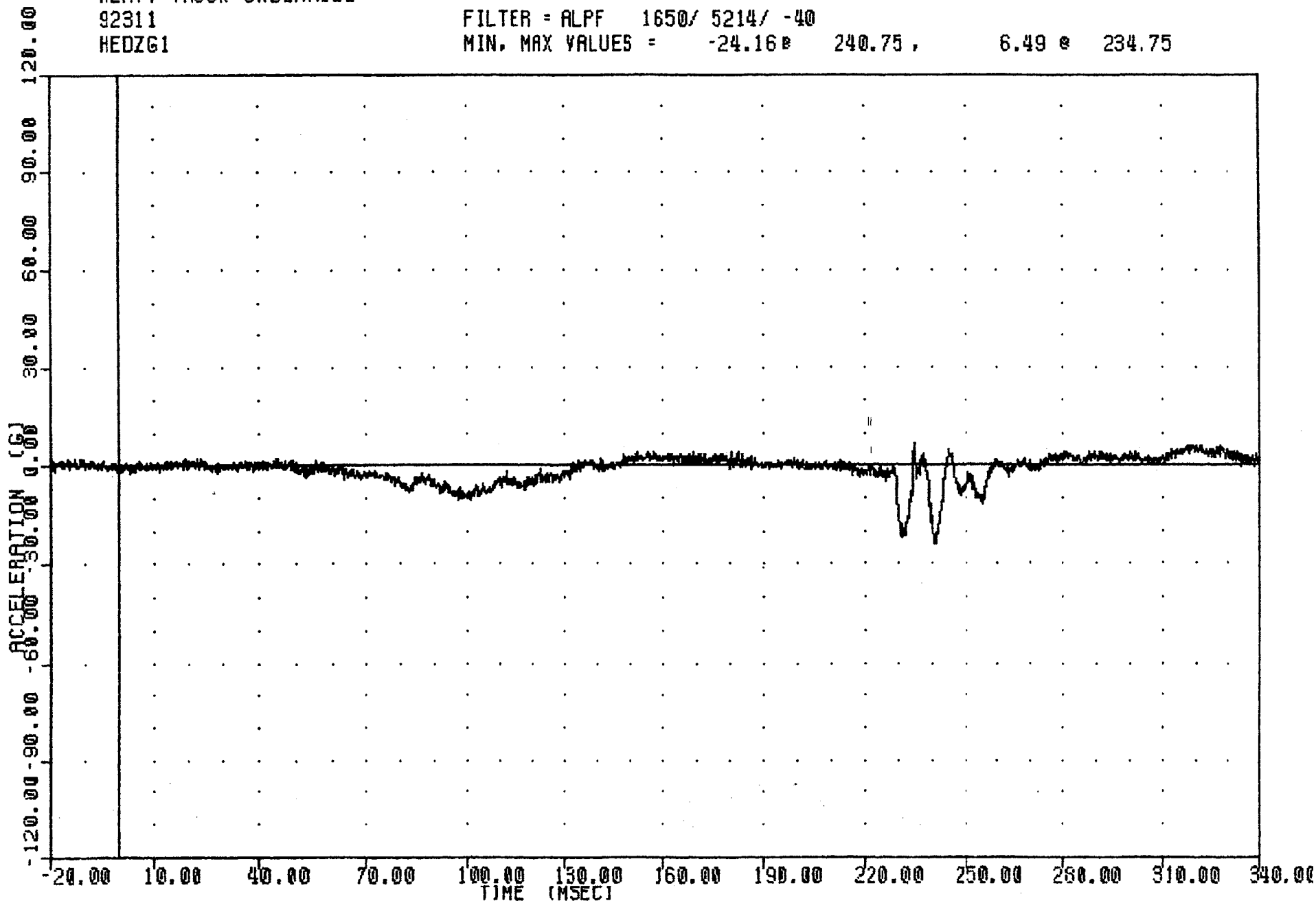
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -41.15 @ 232.63 , 8.74 @ 238.75



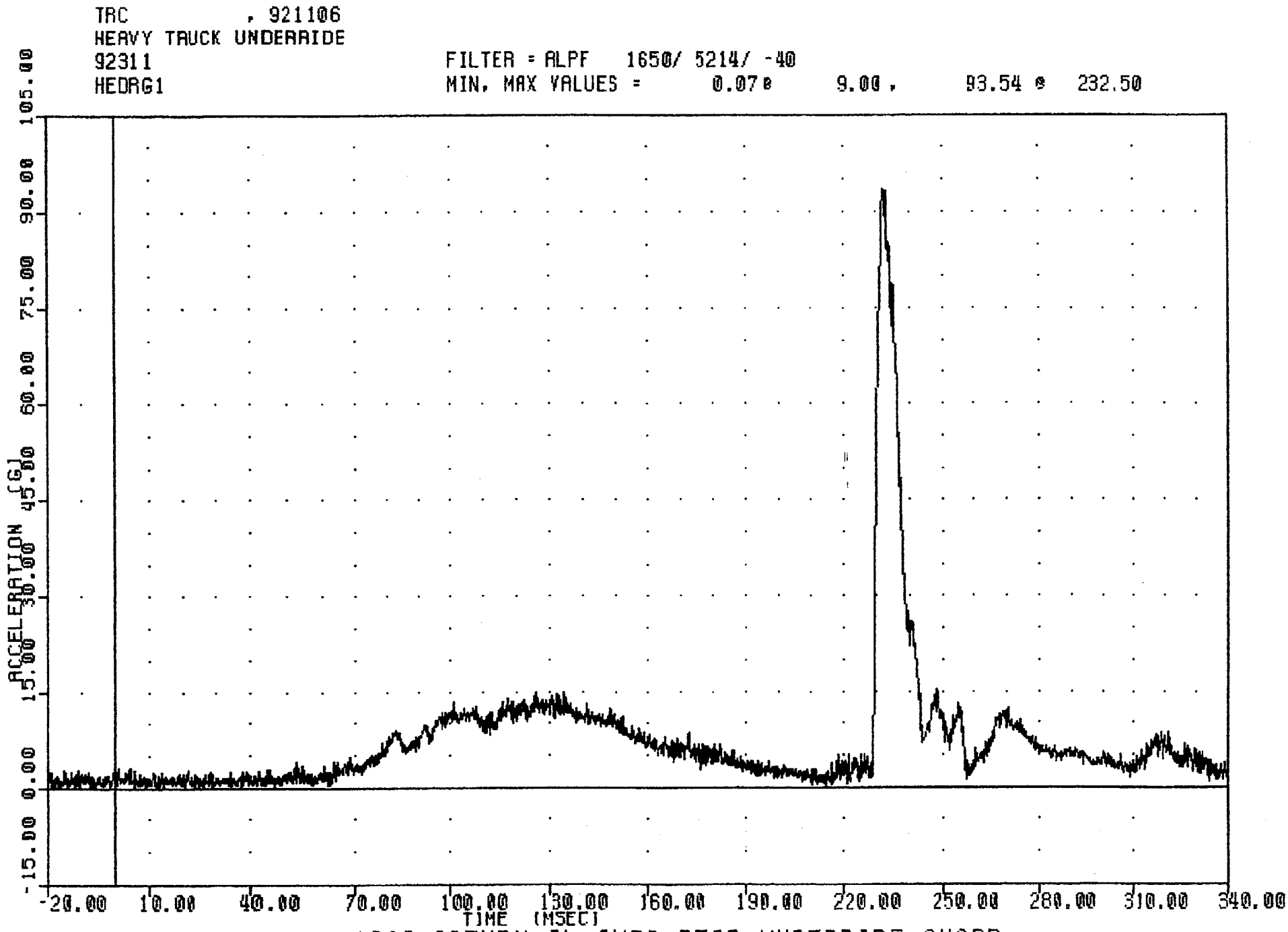
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER HEAD Y-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
HEDZG1

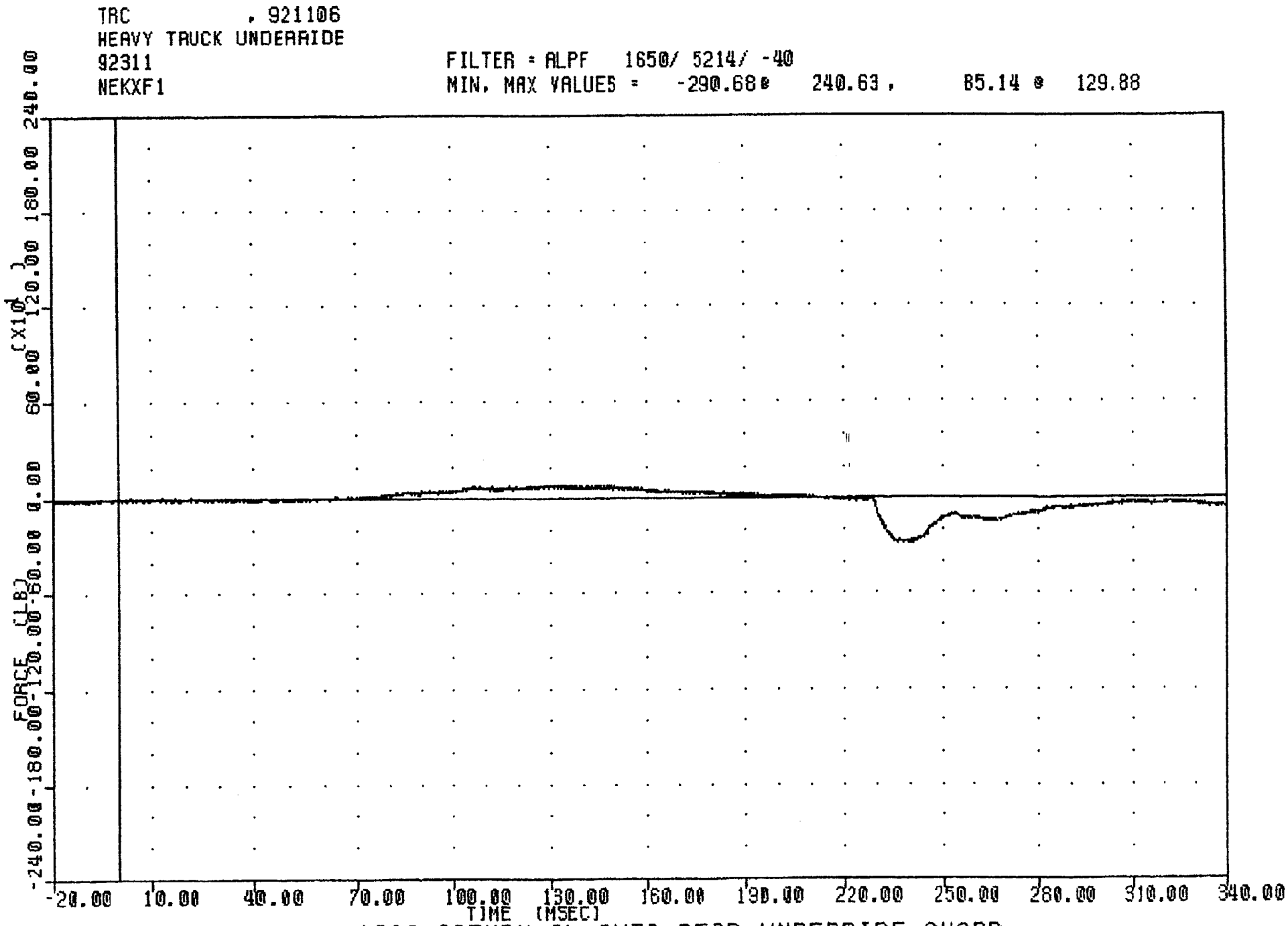
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -24.16 @ 240.75 , 6.49 @ 234.75



1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER HEAD Z-AXIS ACCELERATION



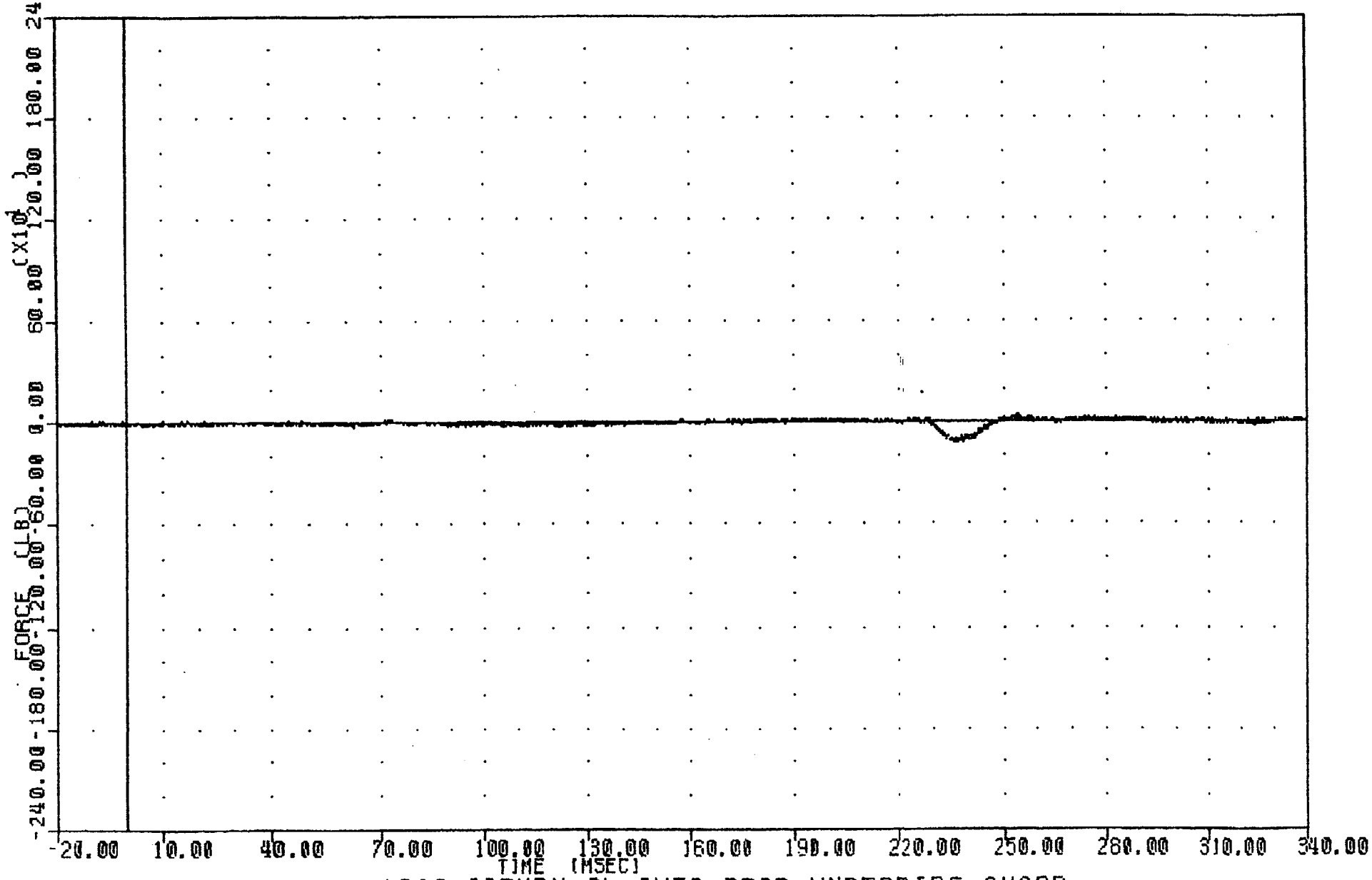
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER HEAD RESULTANT ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER NECK X-AXIS SHEAR FORCE

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKYF1

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -122.67 @ 236.25 , 36.86 @ 254.50



1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER NECK Y-AXIS SHEAR FORCE

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKZF1

FILTER = ALPF 1650/ 5214/ -40
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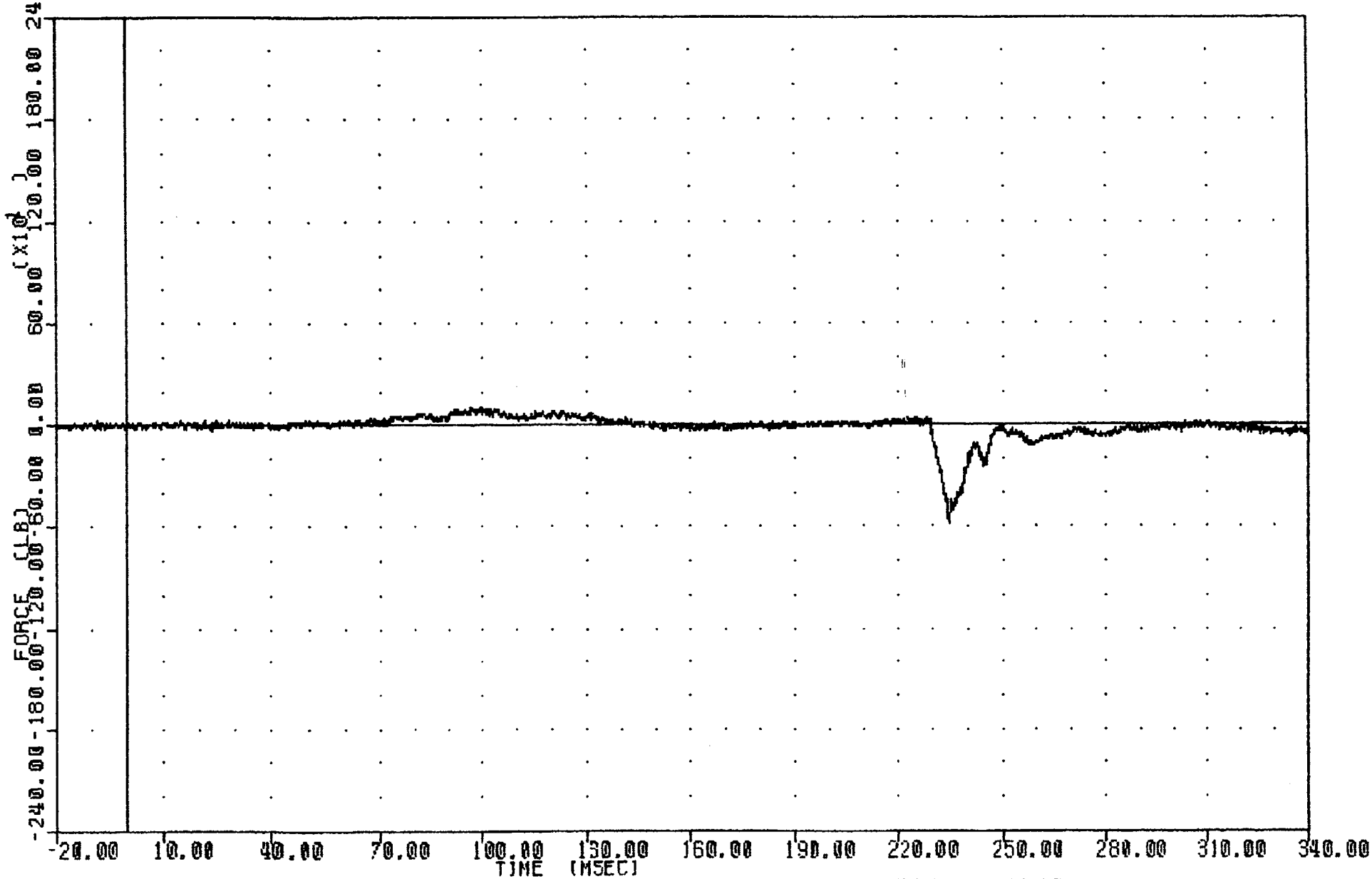
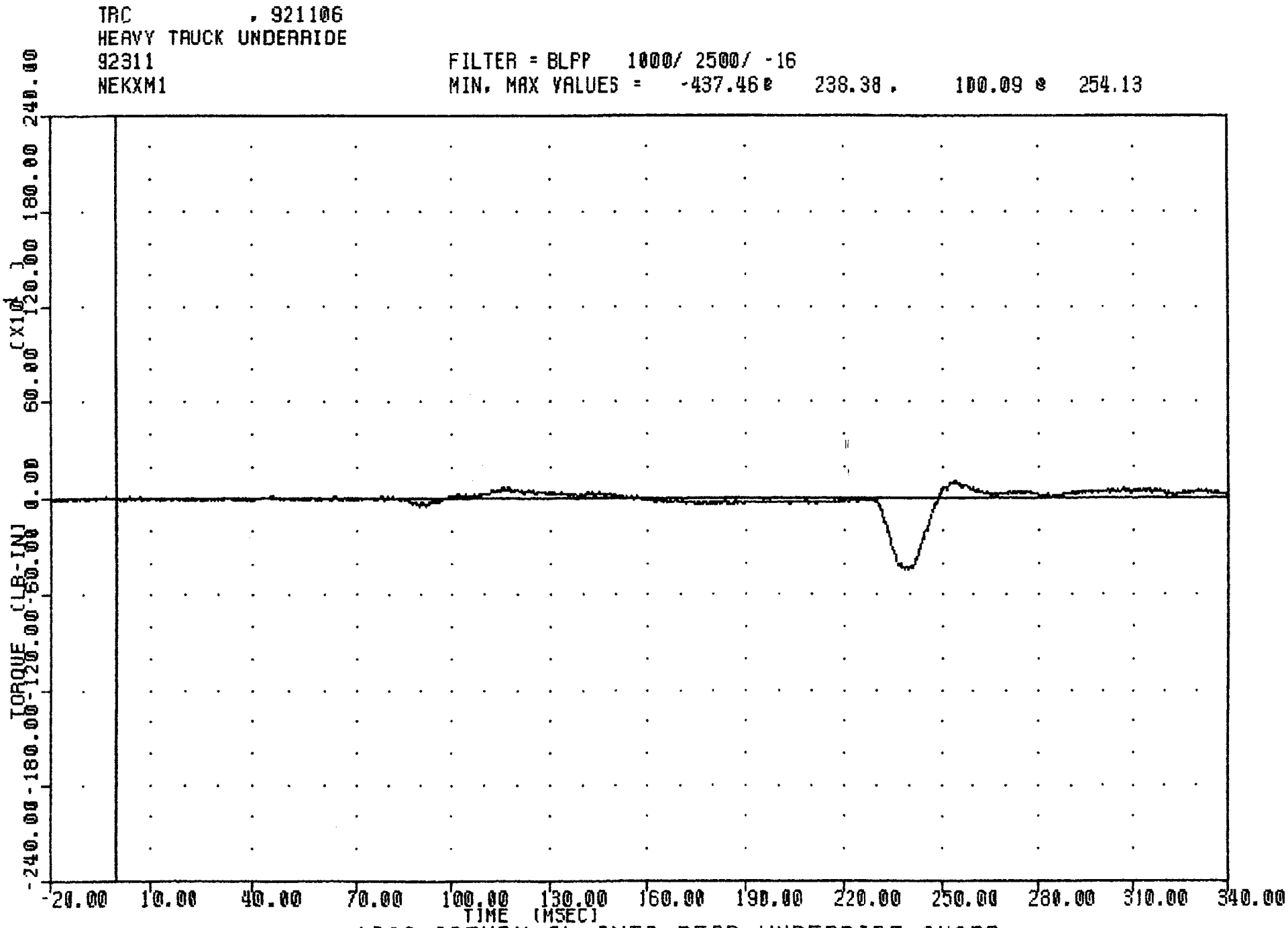


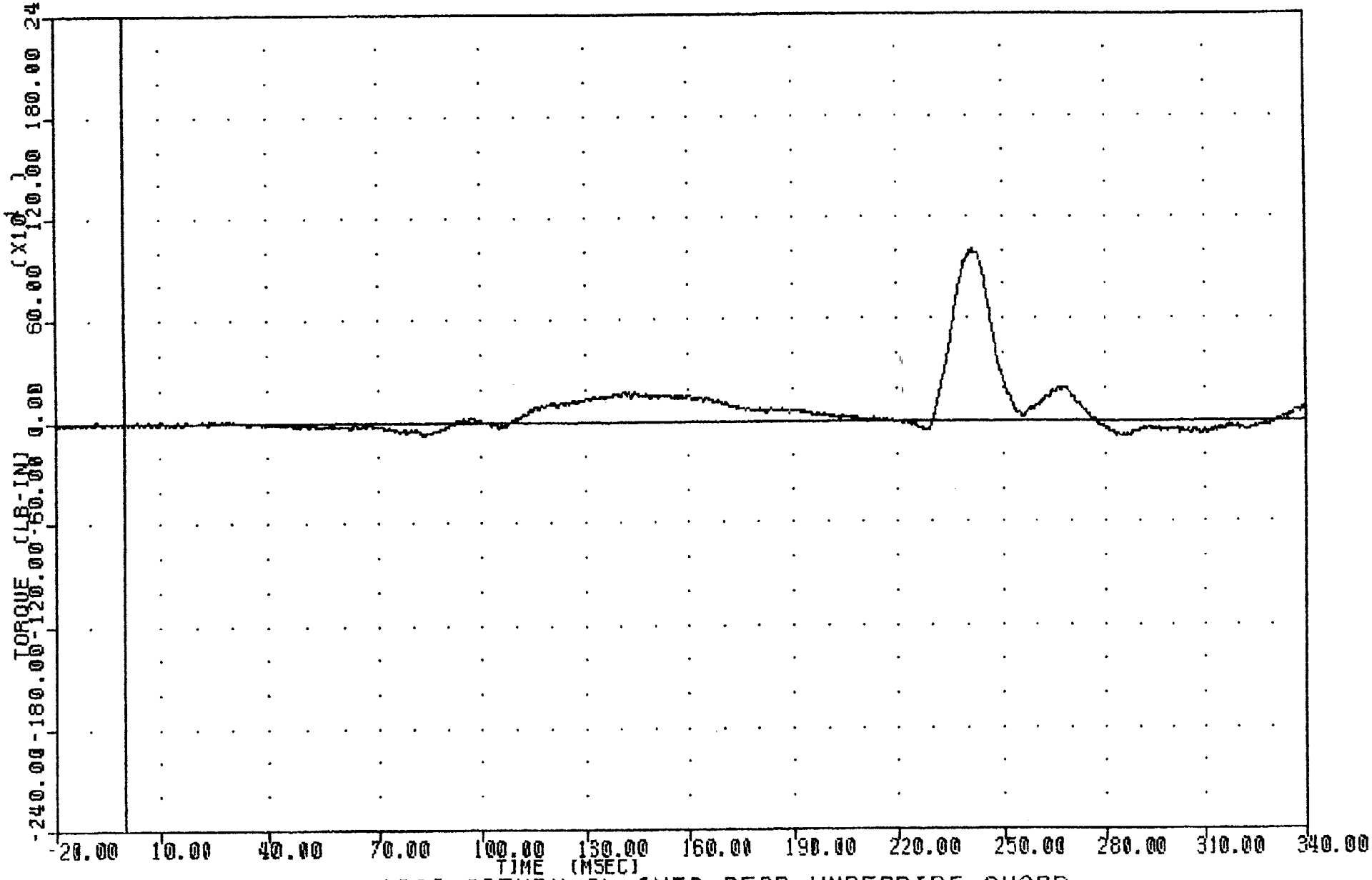
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER NECK Z-AXIS AXIAL FORCE



1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER NECK MOMENT ABOUT X AXIS

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKYM1

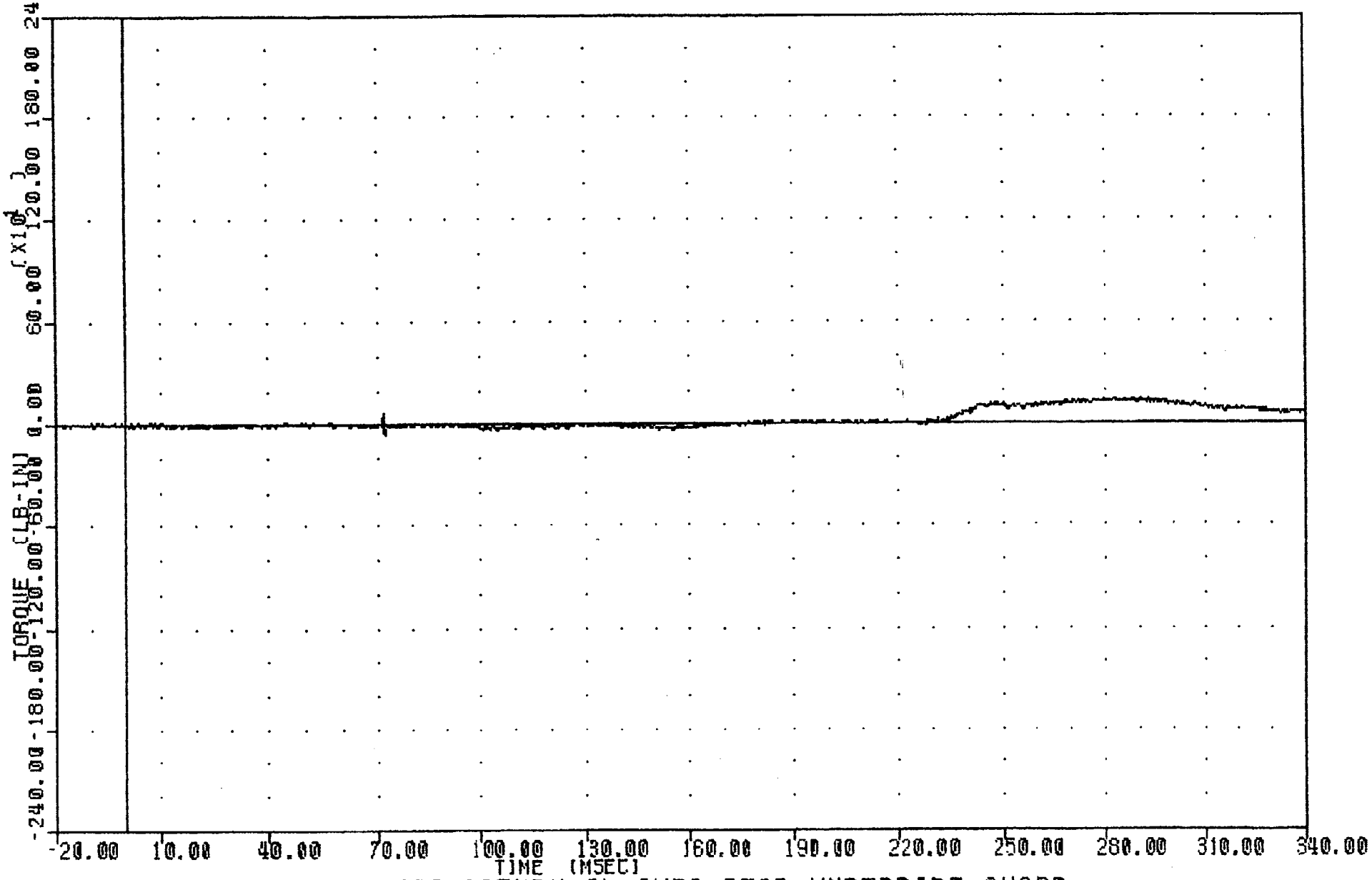
FILTER = BLPP 1000/ 2500/ -16
MIN, MAX VALUES = -86.48 @ 285.75 , 1004.90 @ 241.75



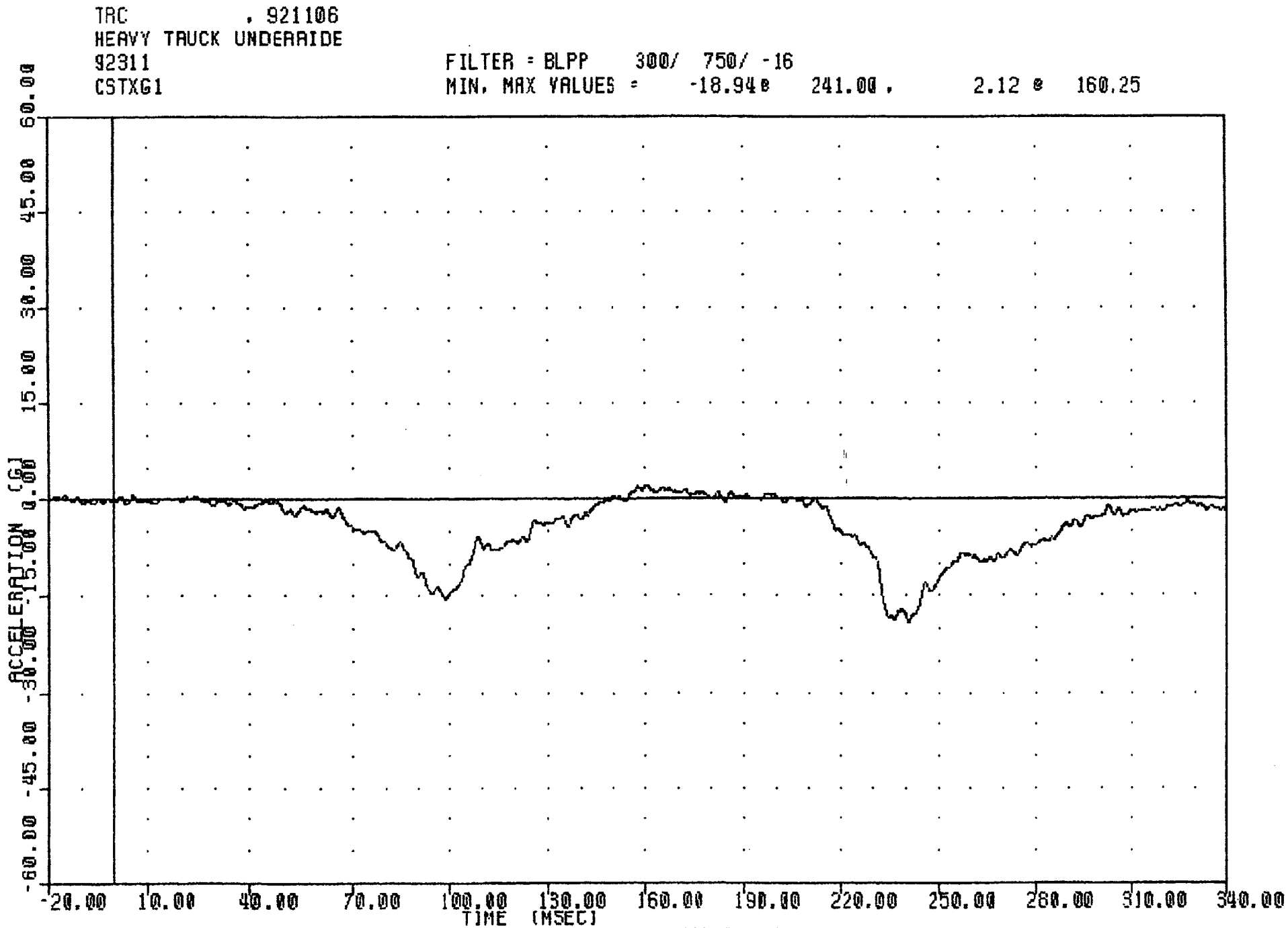
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER NECK MOMENT ABOUT Y AXIS

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKZM1

FILTER = BLPP 1000/ 2500/ -16
MIN. MAX VALUES = -63.55 @ 71.75 , 141.35 @ 290.13



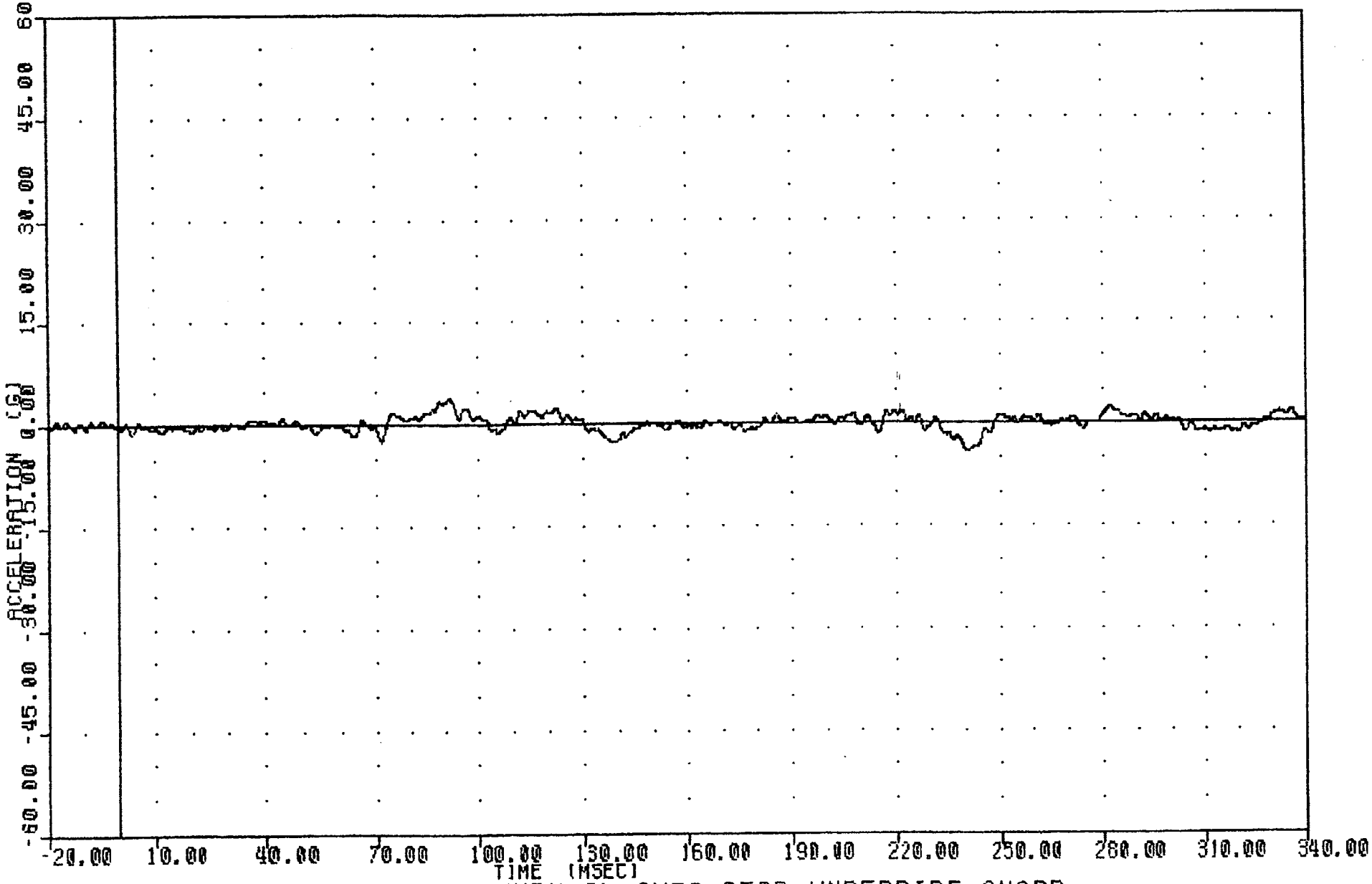
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER NECK MOMENT ABOUT Z AXIS



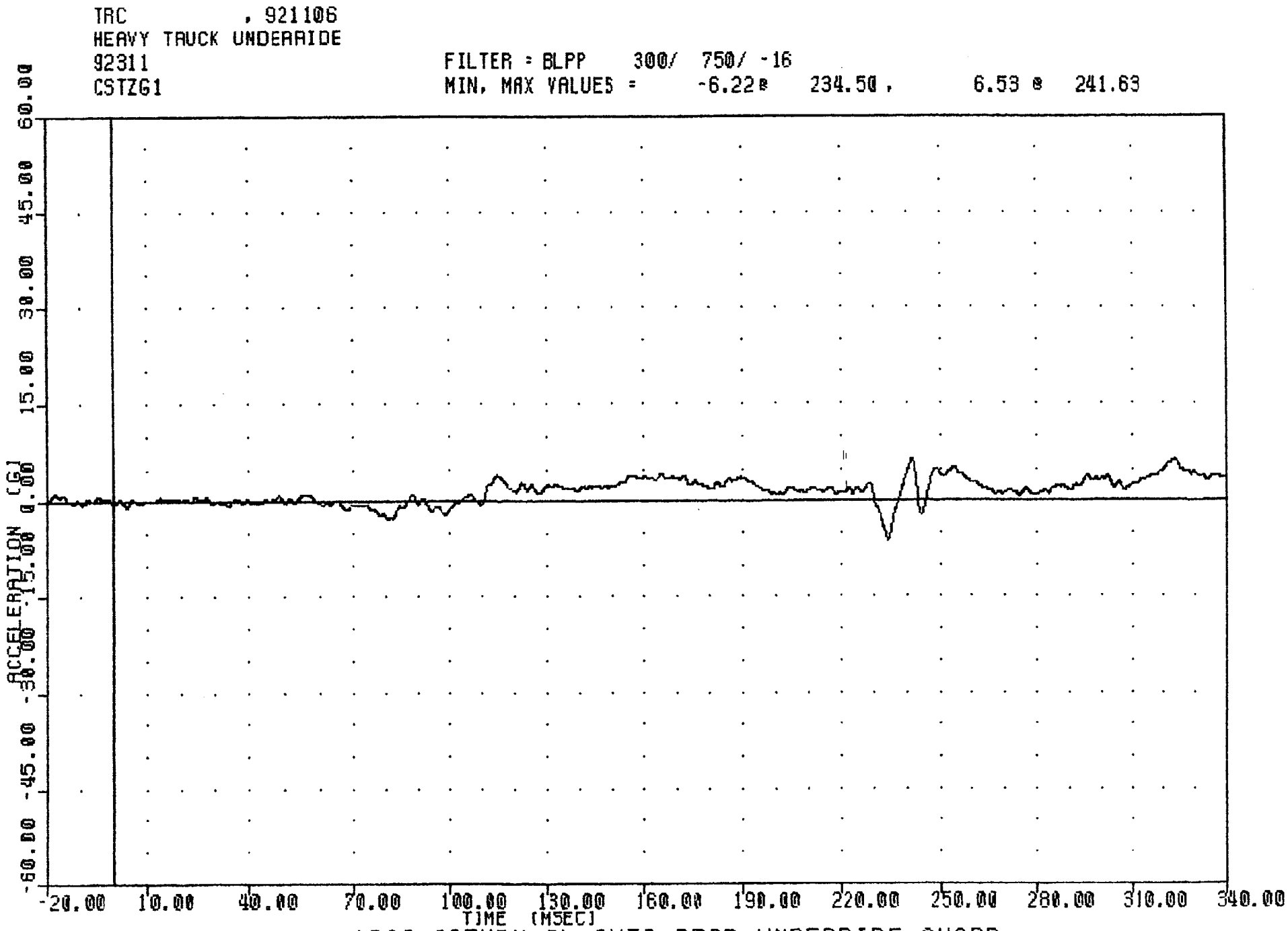
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER CHEST X-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
CSTYG1

FILTER = BLPP 300/ 750/ -16
MIN, MAX VALUES = -4.08 @ 240.75 , 3.90 @ 91.00



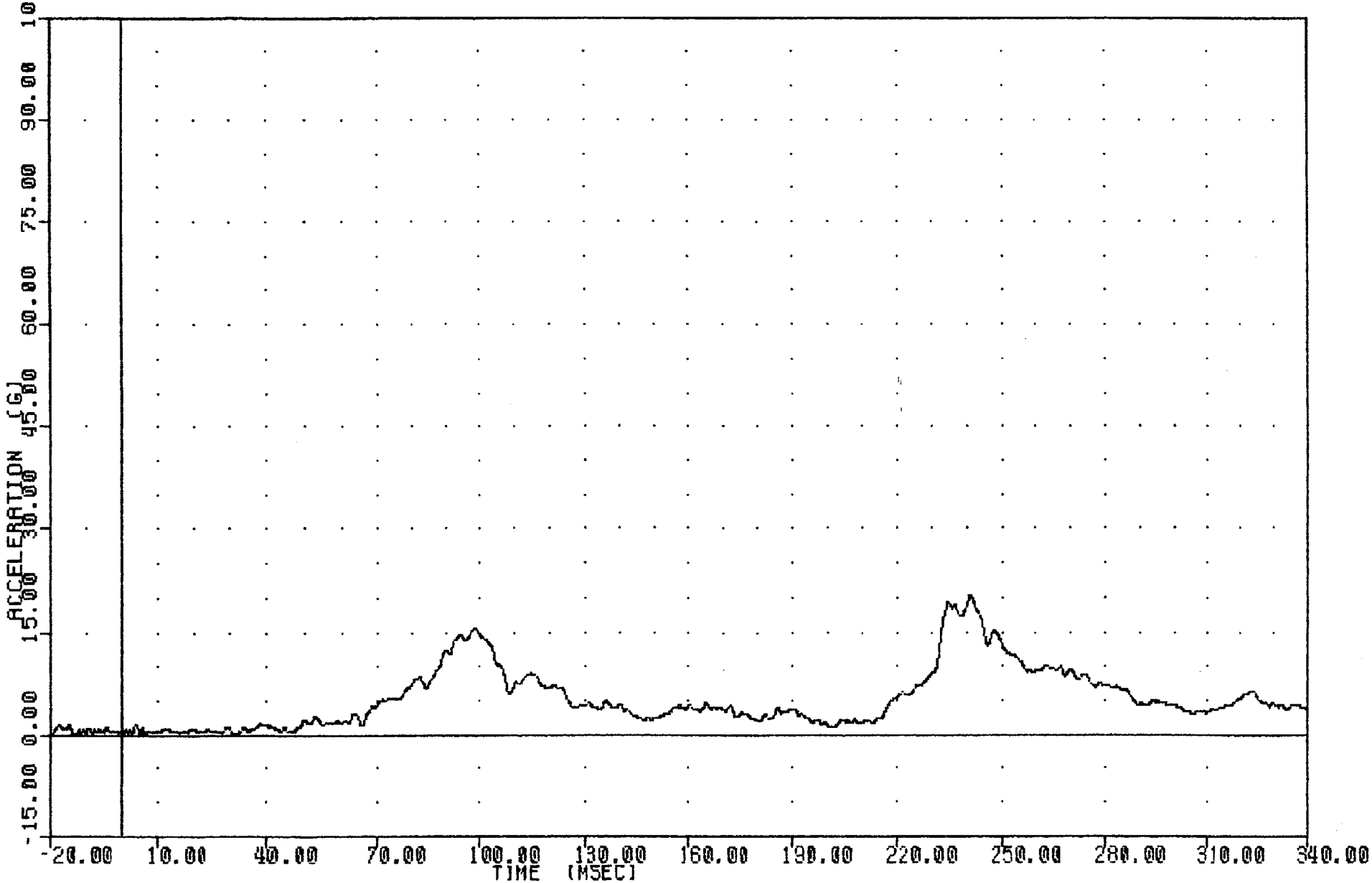
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER CHEST Y-AXIS ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER CHEST Z-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
CSTRG1

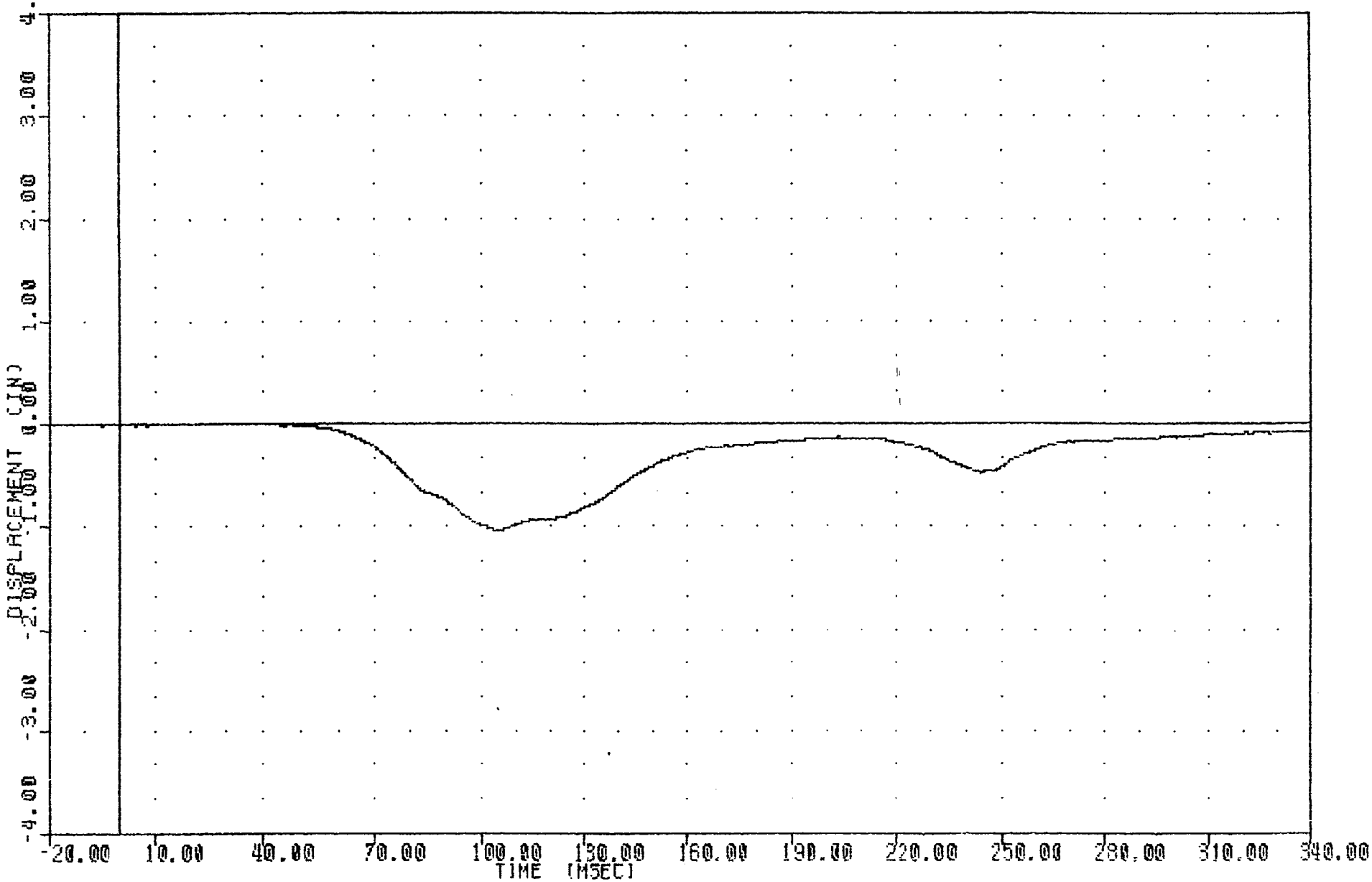
FILTER = BLPP 300/ 750/ -16
MIN, MAX VALUES = 0.05 @ -20.00 , 20.26 @ 241.13



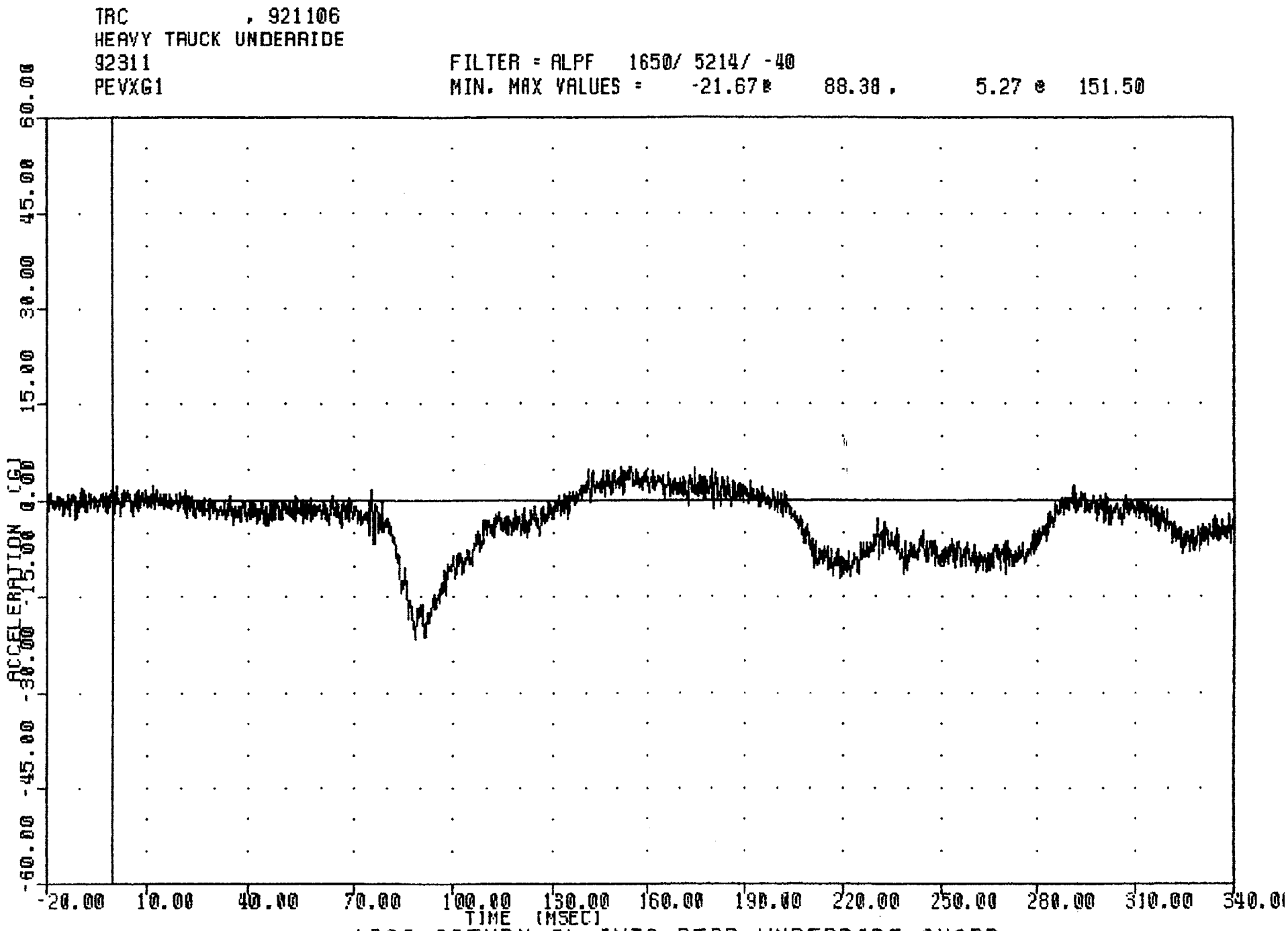
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER CHEST RESULTANT ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
CSTXD1

FILTER = BLPF 300/ 750/ -16
MIN, MAX VALUES = -1.03 @ 104.88 , 0.00 @ 22.13



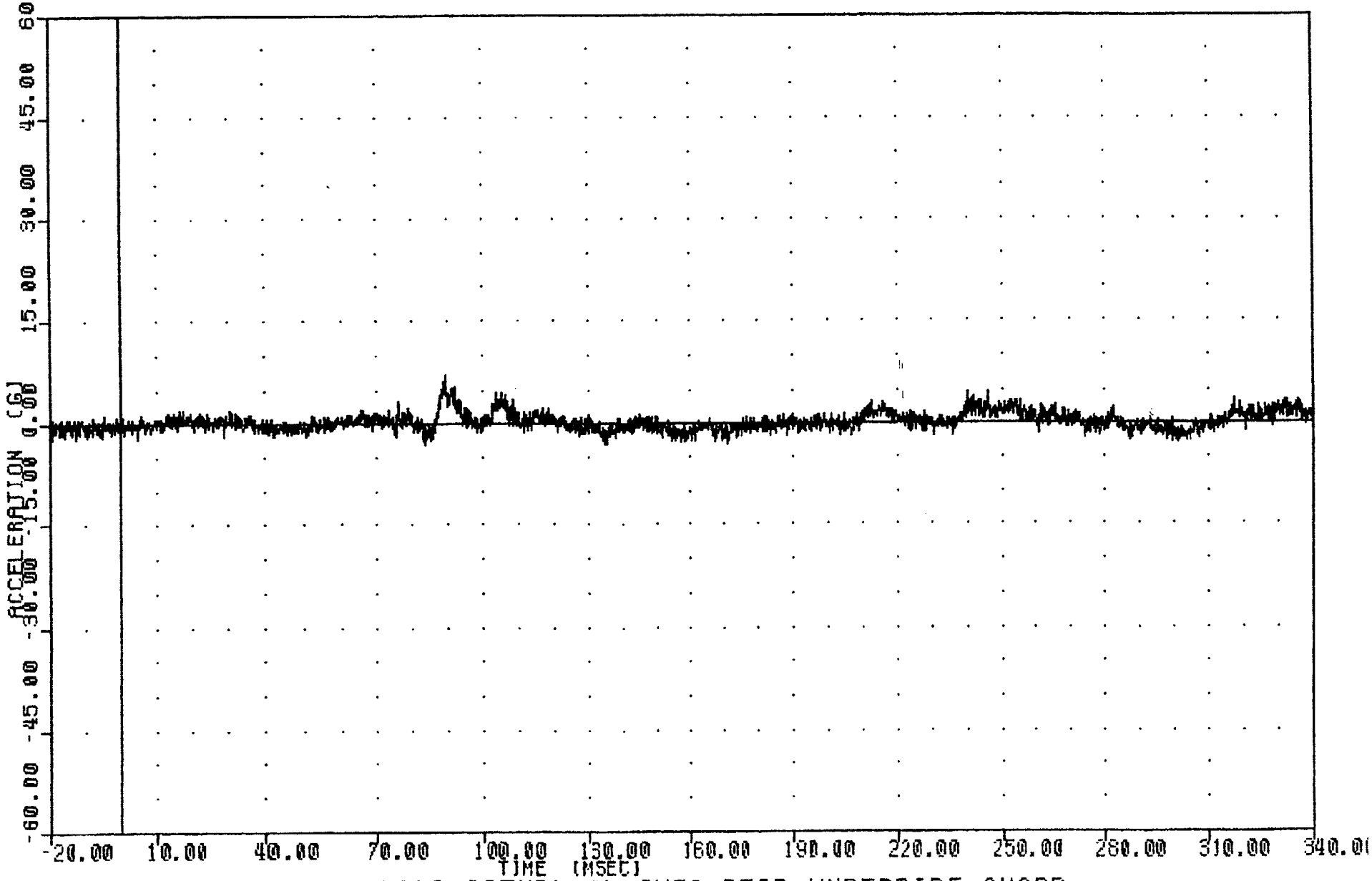
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER CHEST DEFLECTION



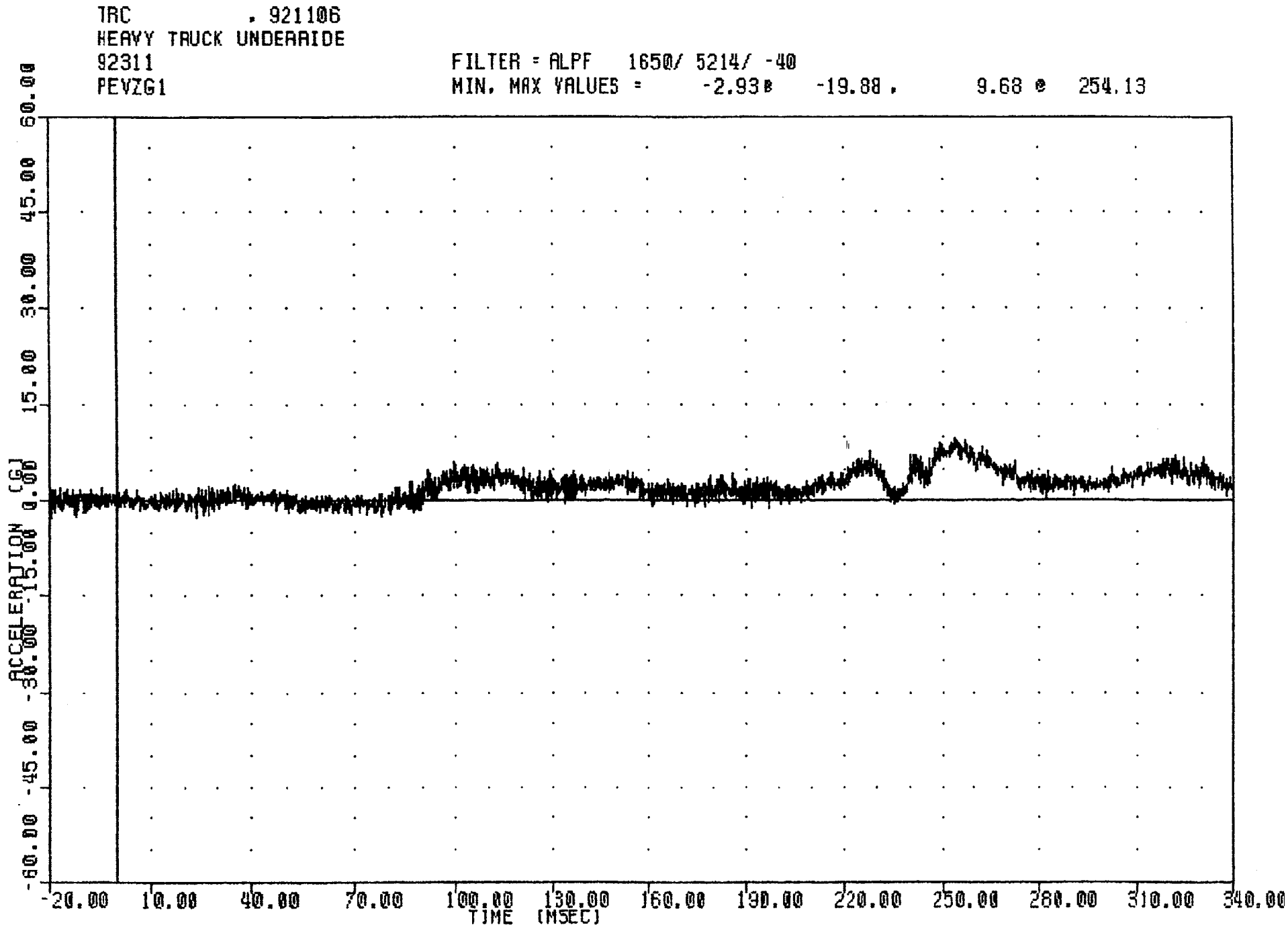
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER PELVIS X-AXIS ACCELERATION

TRC . 921106
HEAVY TRUCK UNDERRIDE
92311
PEVYG1

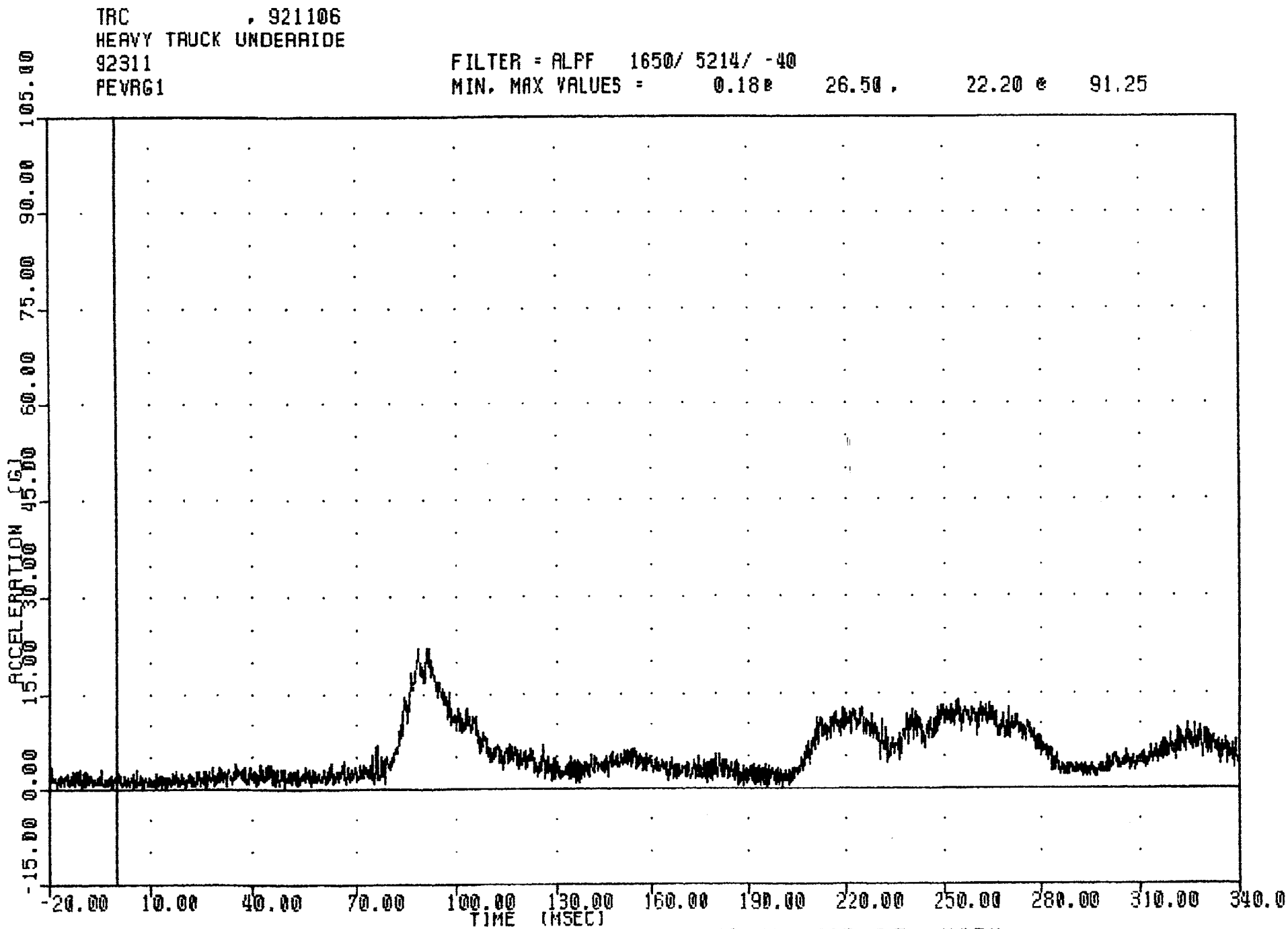
FILTER = ALPF 1650/ 5214/ -40
MIN. MAX VALUES = -3.26 @ 170.63 , 7.13 @ 89.25



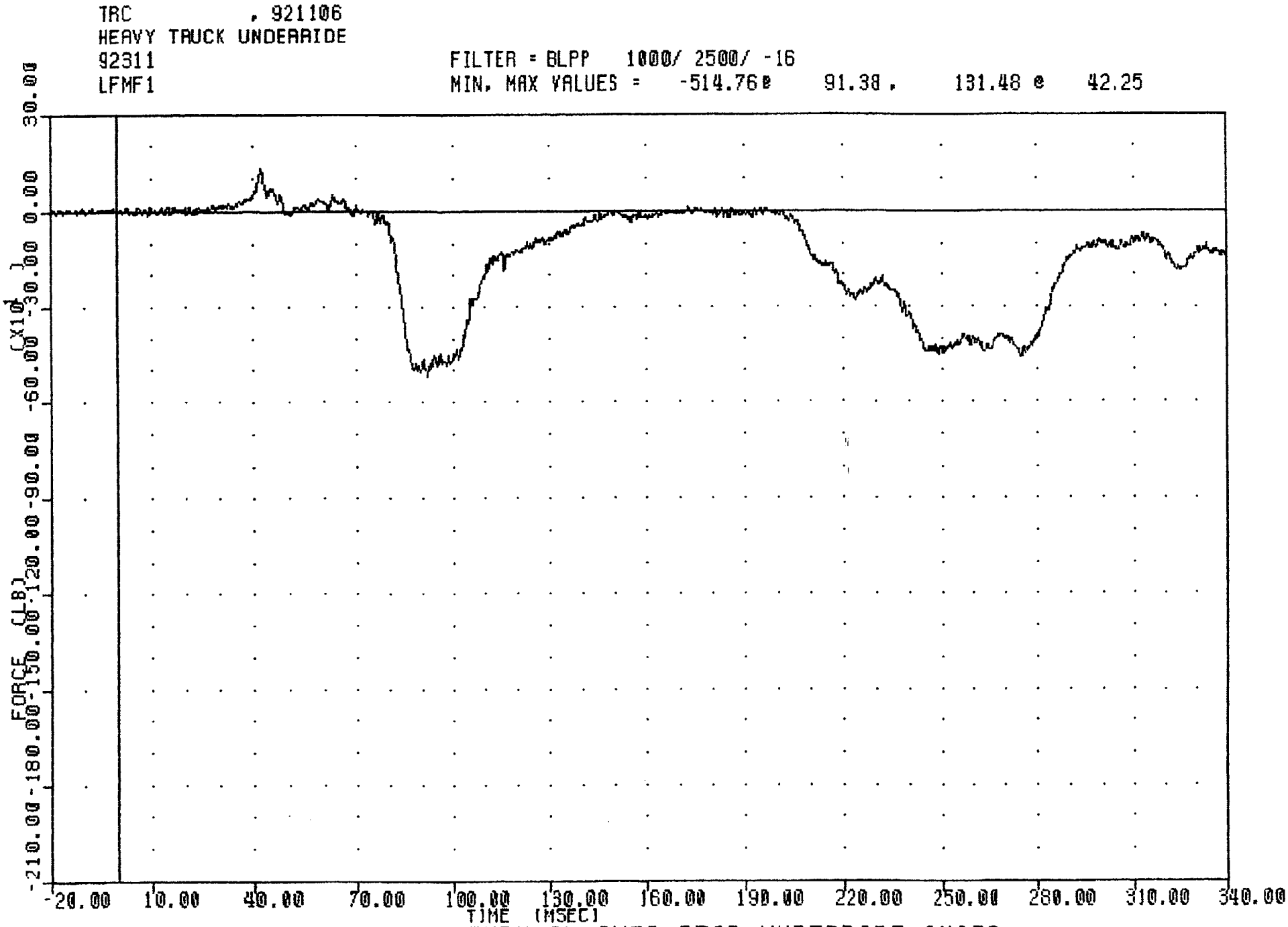
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER PELVIS Y-AXIS ACCELERATION



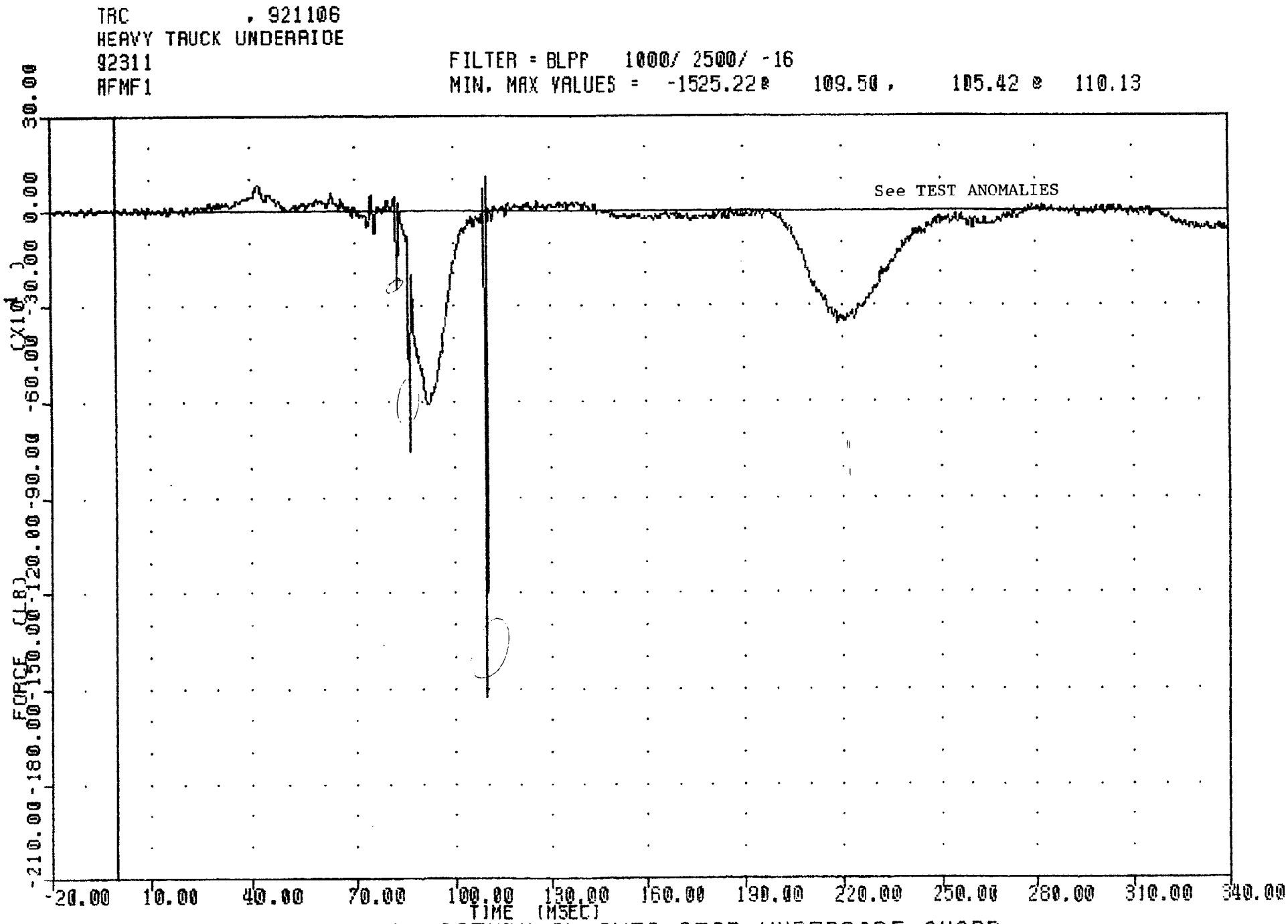
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER PELVIS Z-AXIS ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER PELVIS RESULTANT ACCELERATION



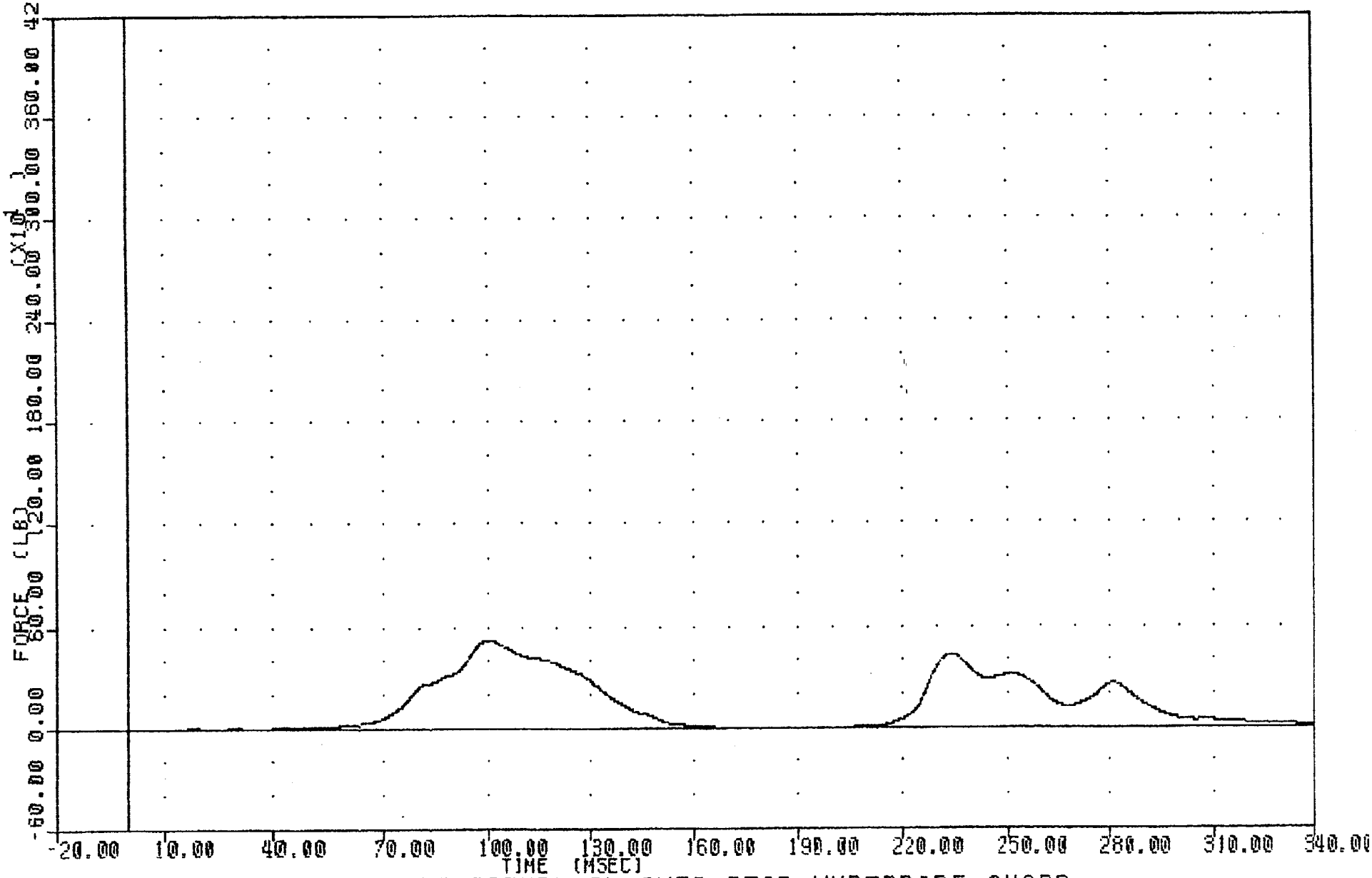
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER LEFT FEMUR FORCE



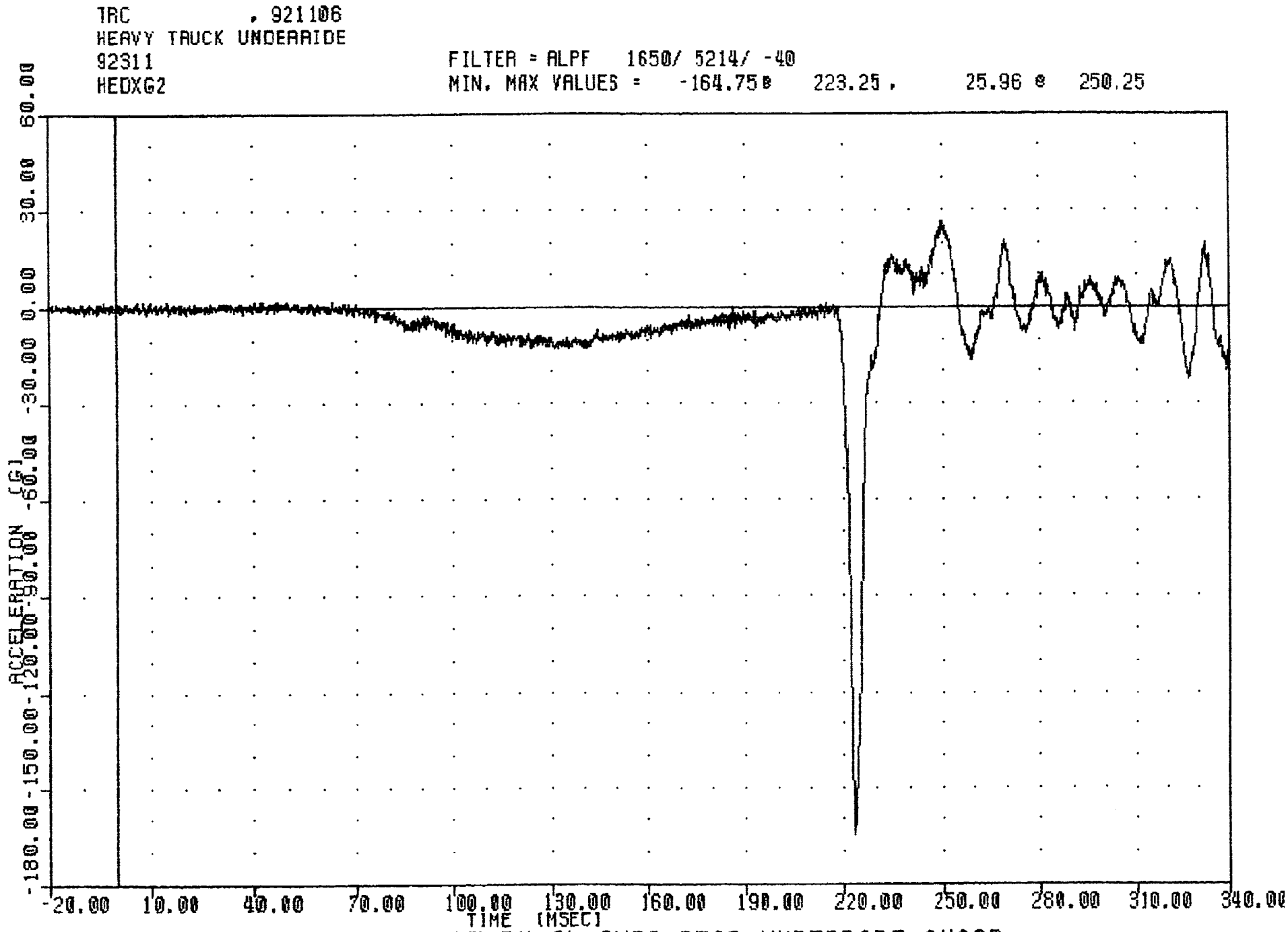
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER RIGHT FEMUR FORCE

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
SHBF1

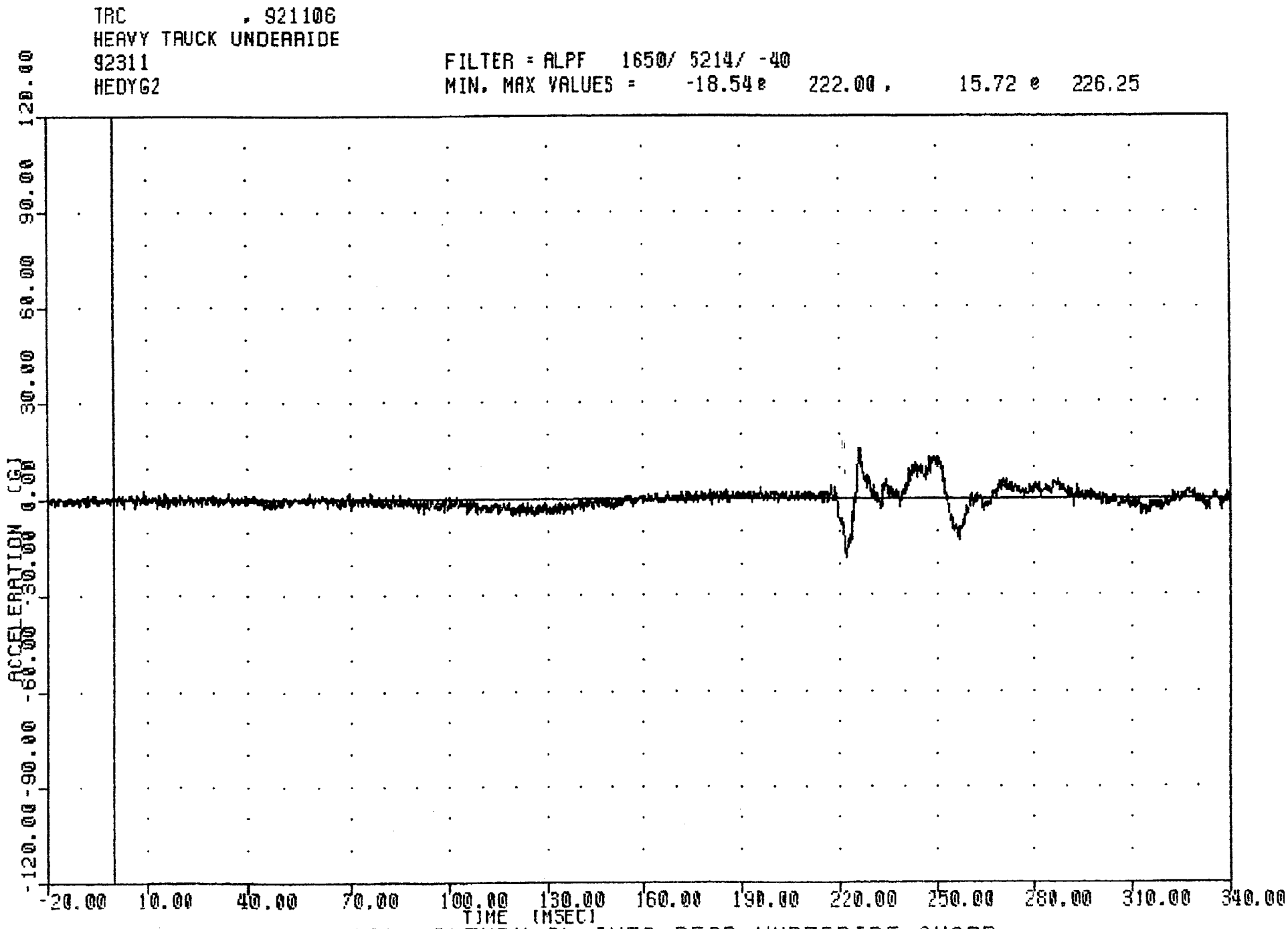
FILTER = BLPP 100/ 250/ -16
MIN. MAX VALUES = -5.43 @ 185.38 , 522.50 @ 100.13



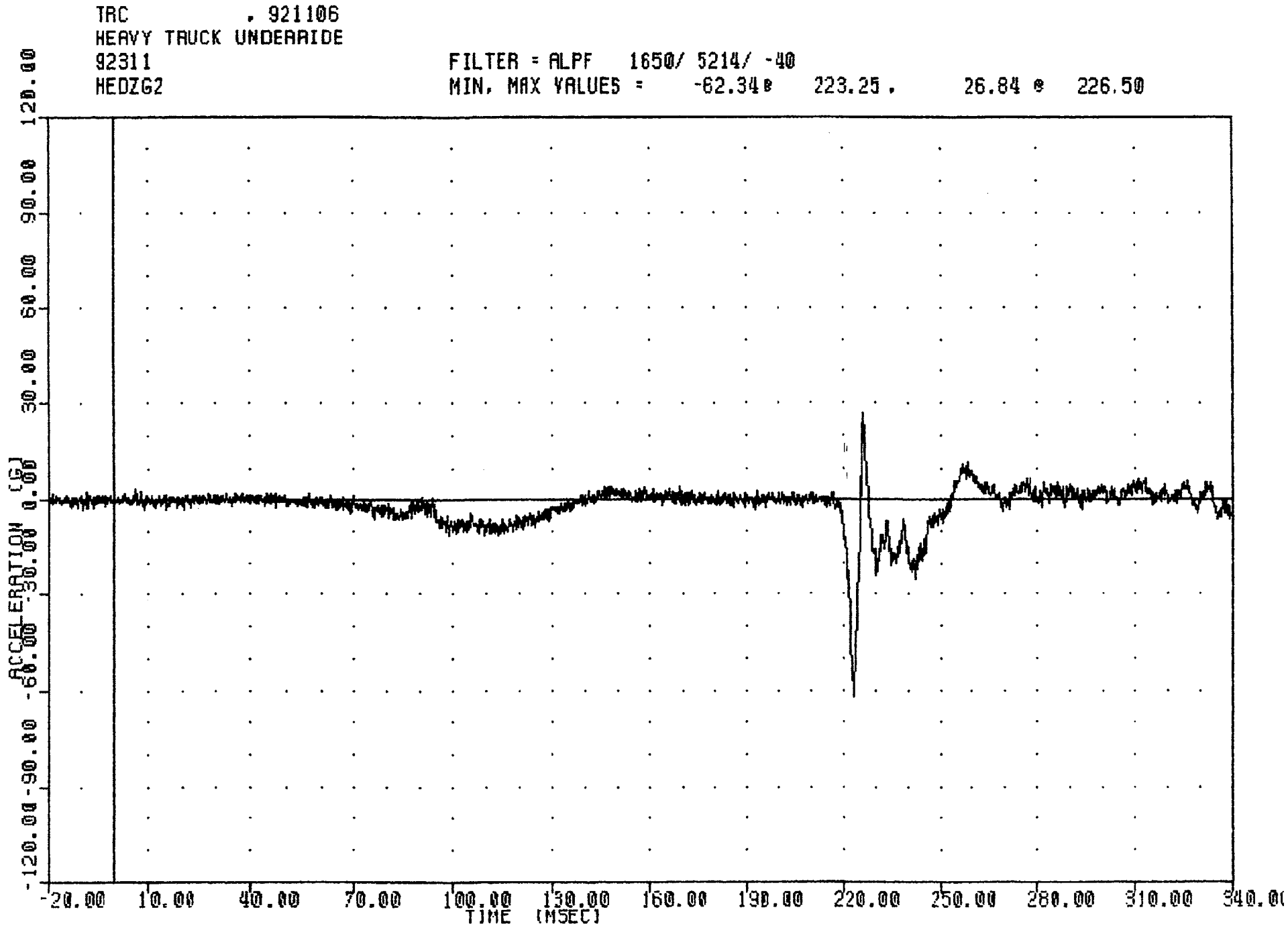
1993 SATURN SL INTO REAR UNDERRIDE GUARD
DRIVER SHOULDER BELT FORCE



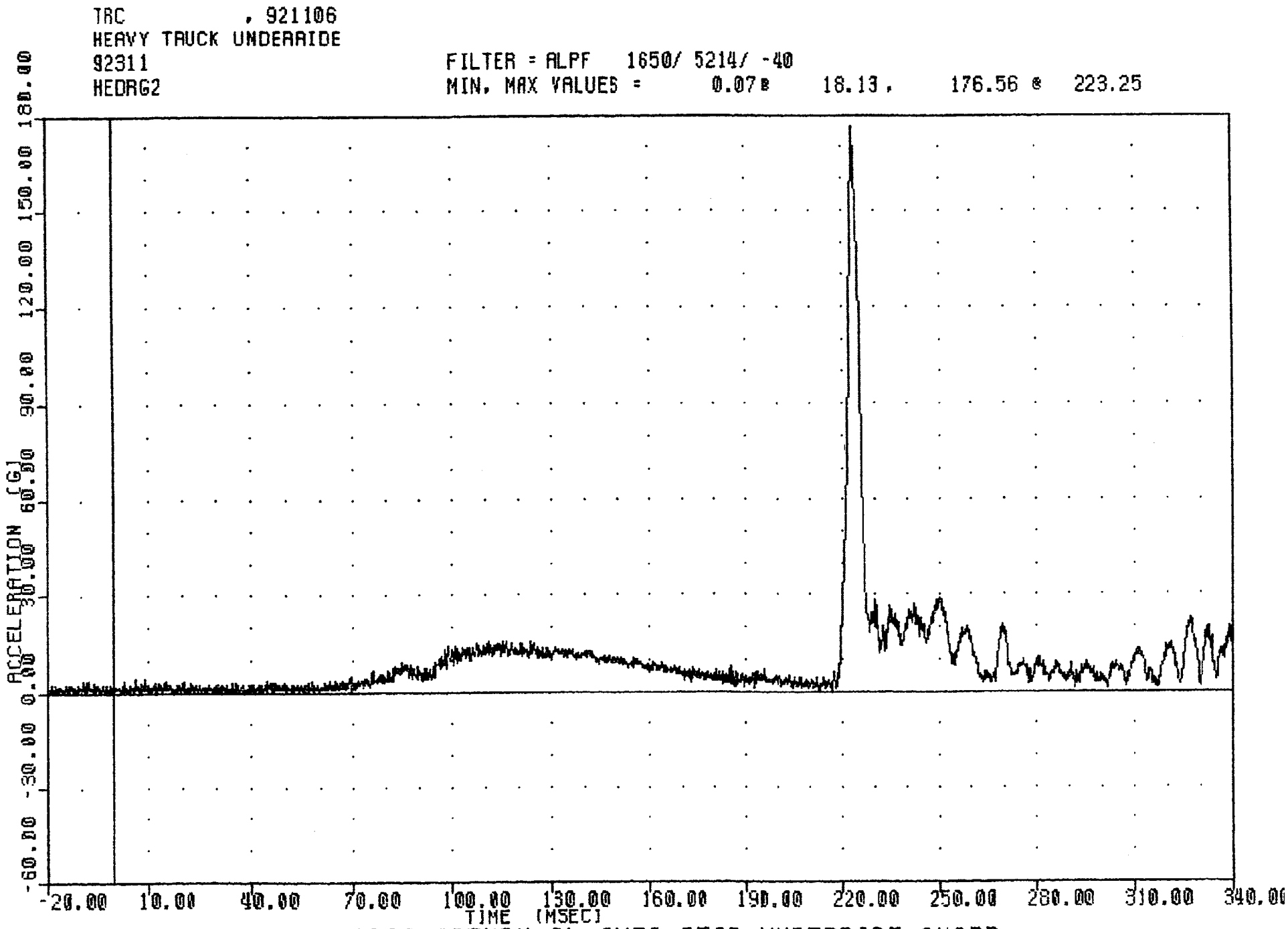
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER HEAD X-AXIS ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER HEAD Y-AXIS ACCELERATION



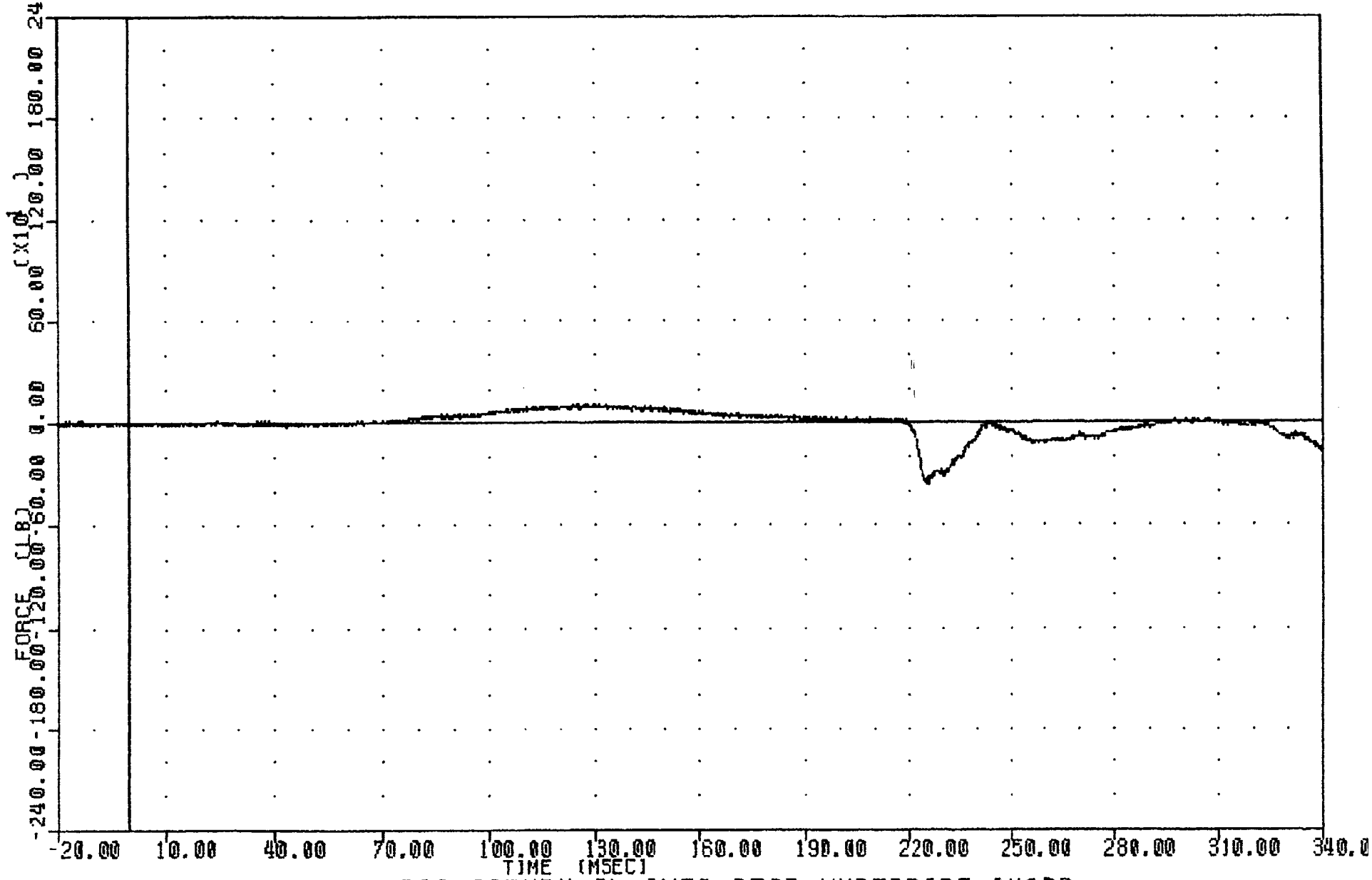
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER HEAD Z-AXIS ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER HEAD RESULTANT ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKXF2

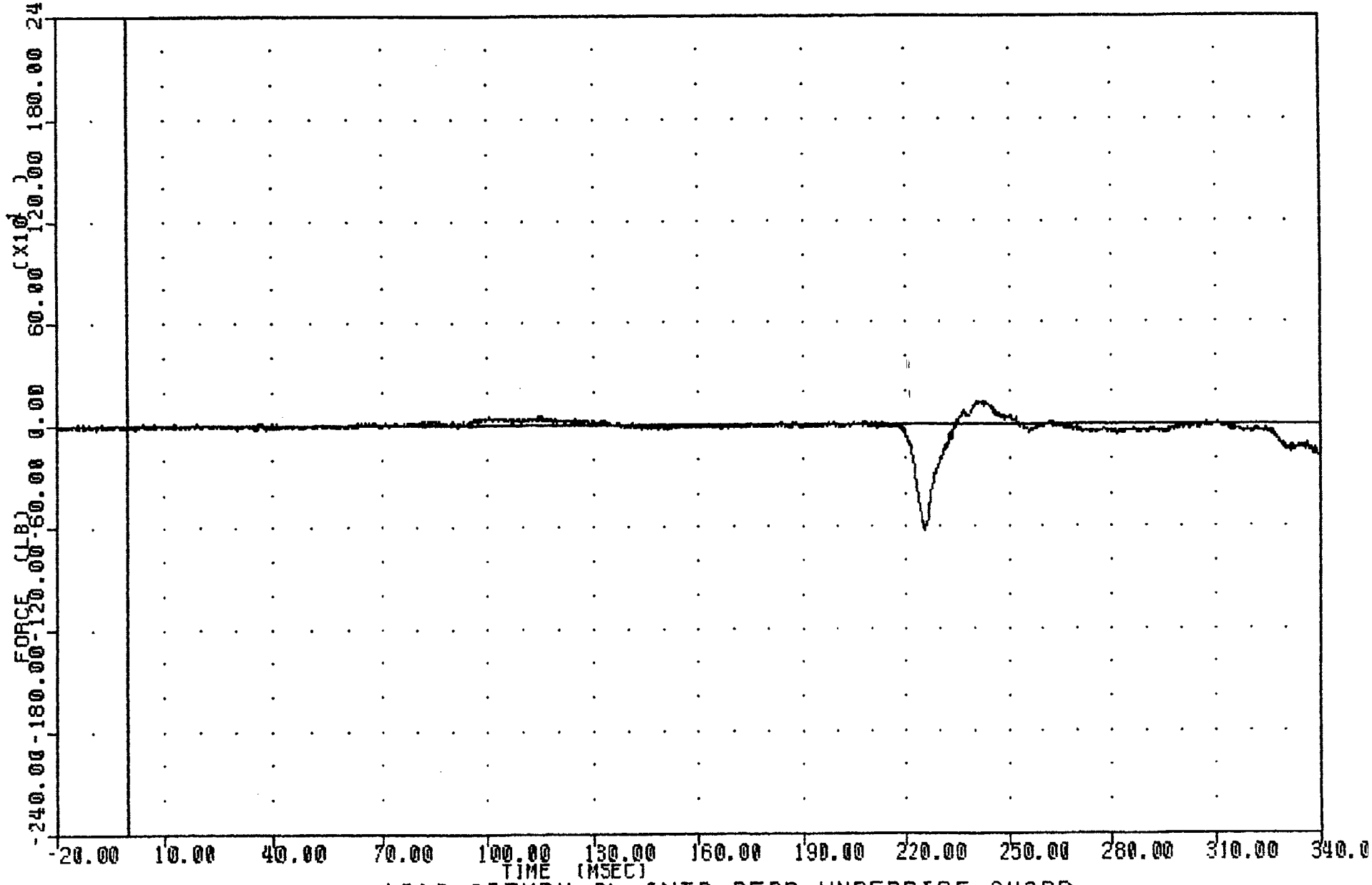
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -367.44 @ 225.25 , 110.41 @ 127.25



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK X-AXIS SHEAR FORCE

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKYF2

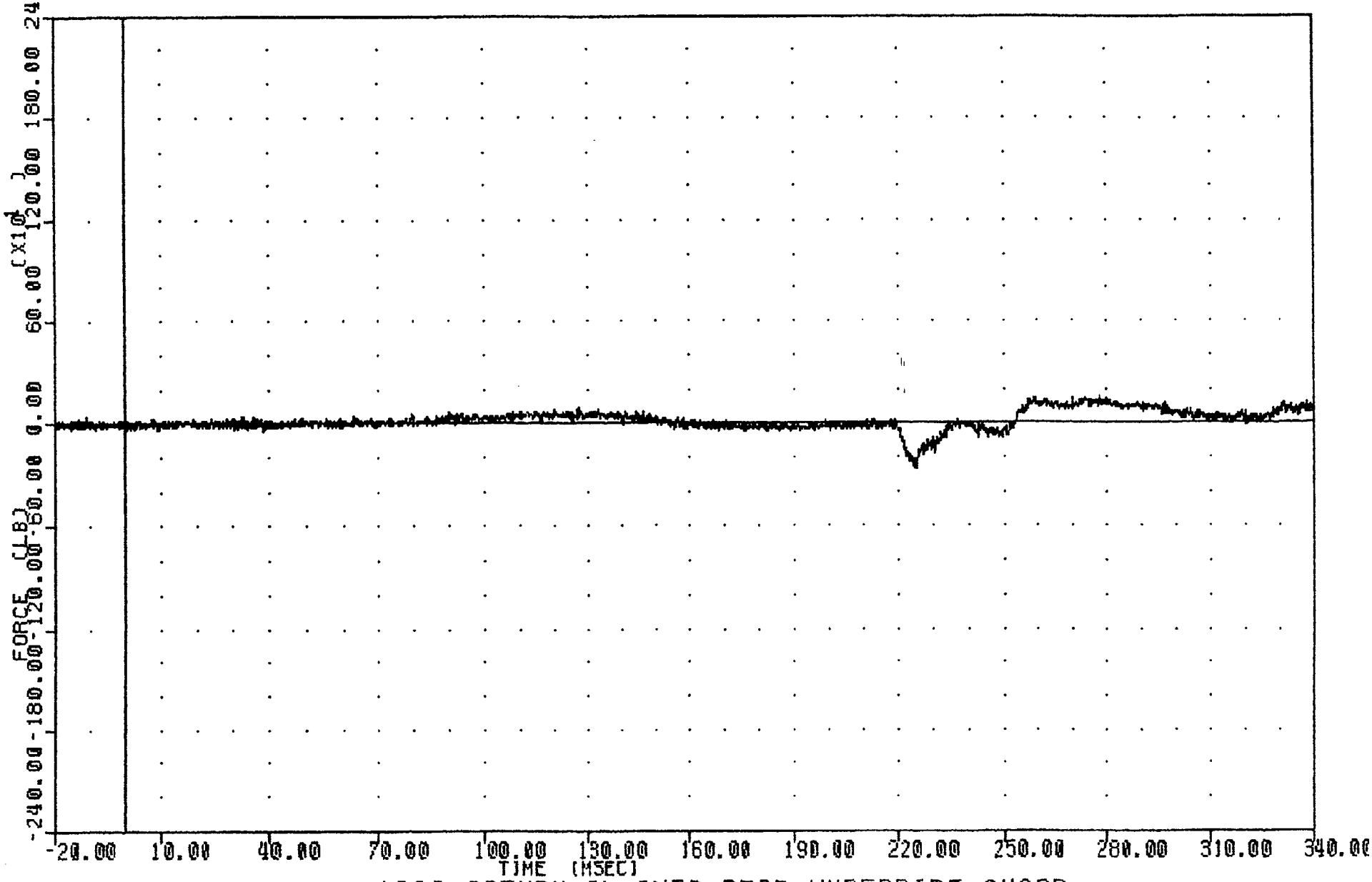
FILTER = ALPF 1650/ 5214/ -40
MIN. MAX VALUES = -620.83 @ 226.00 , 136.21 @ 241.75



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK Y-AXIS SHEAR FORCE

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKZF2

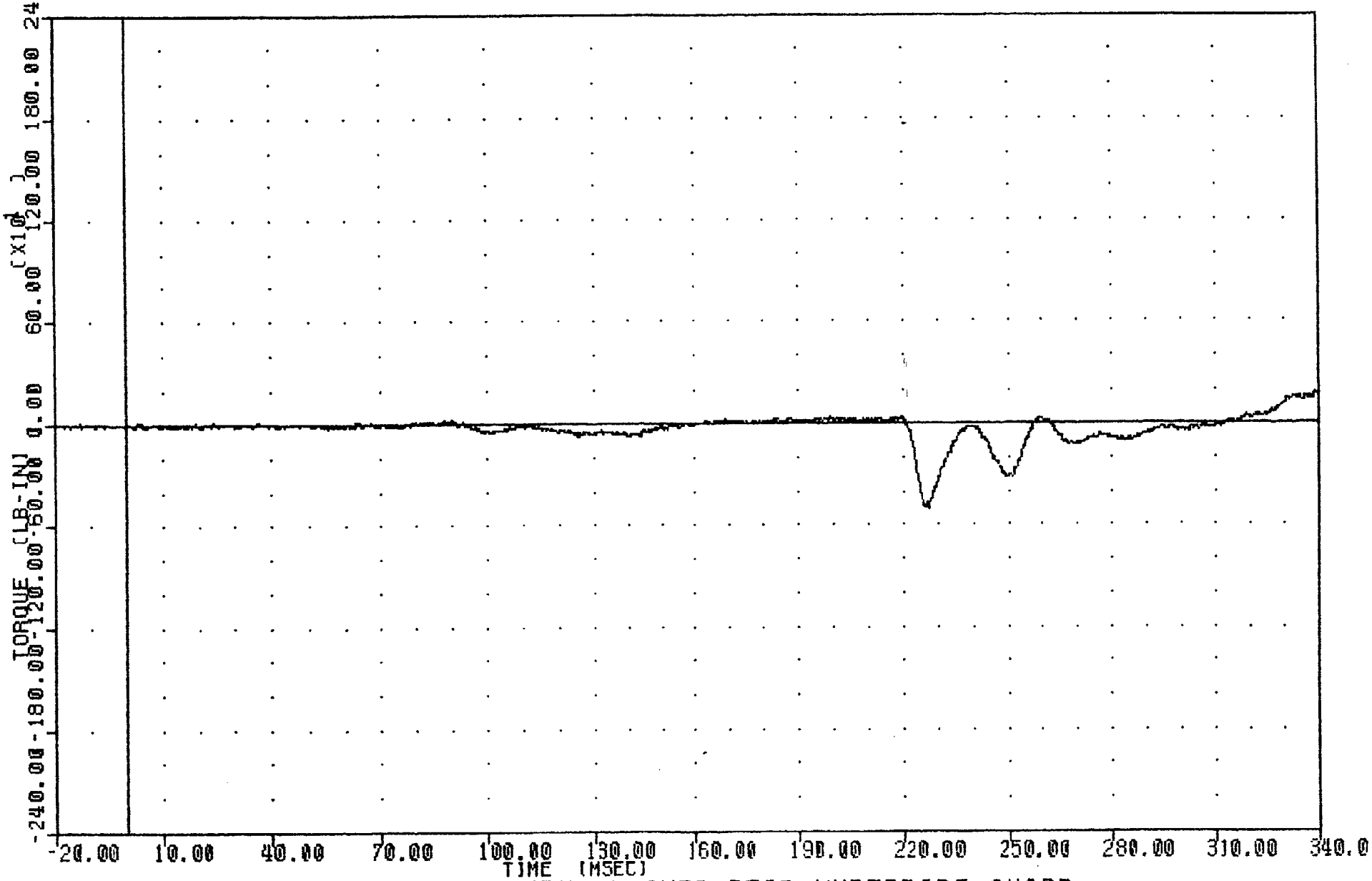
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -268.53 @ 225.13 , 154.38 @ 277.75



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK Z-AXIS AXIAL FORCE

TRC . 921106
HEAVY TRUCK UNDERRIDE
92311
NEKXM2

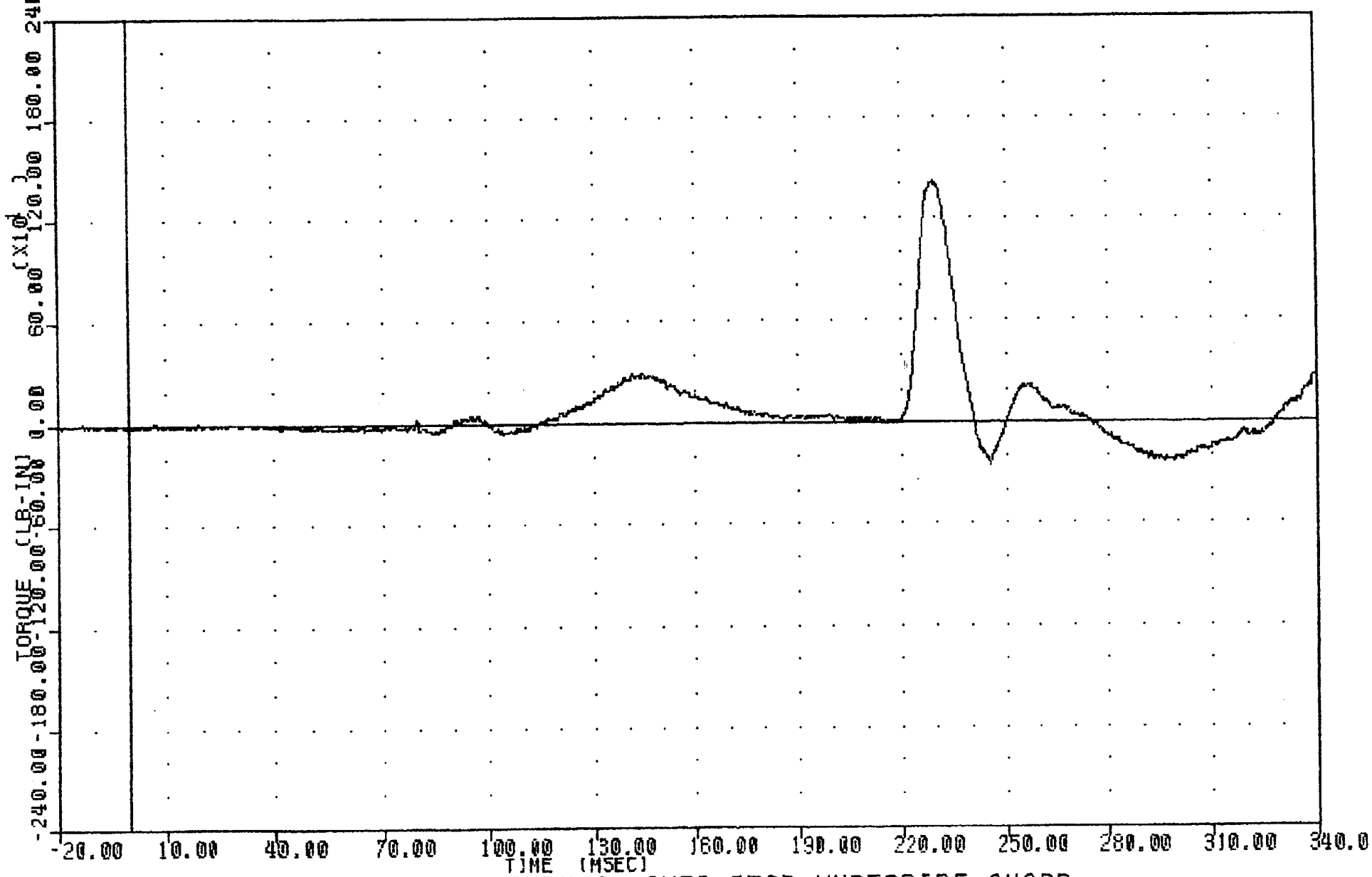
FILTER = BLPP 1000/ 2500/ -16
MIN, MAX VALUES = -500.89 @ 227.38 , 176.14 @ 339.13



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK MOMENT ABOUT X AXIS

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKYM2

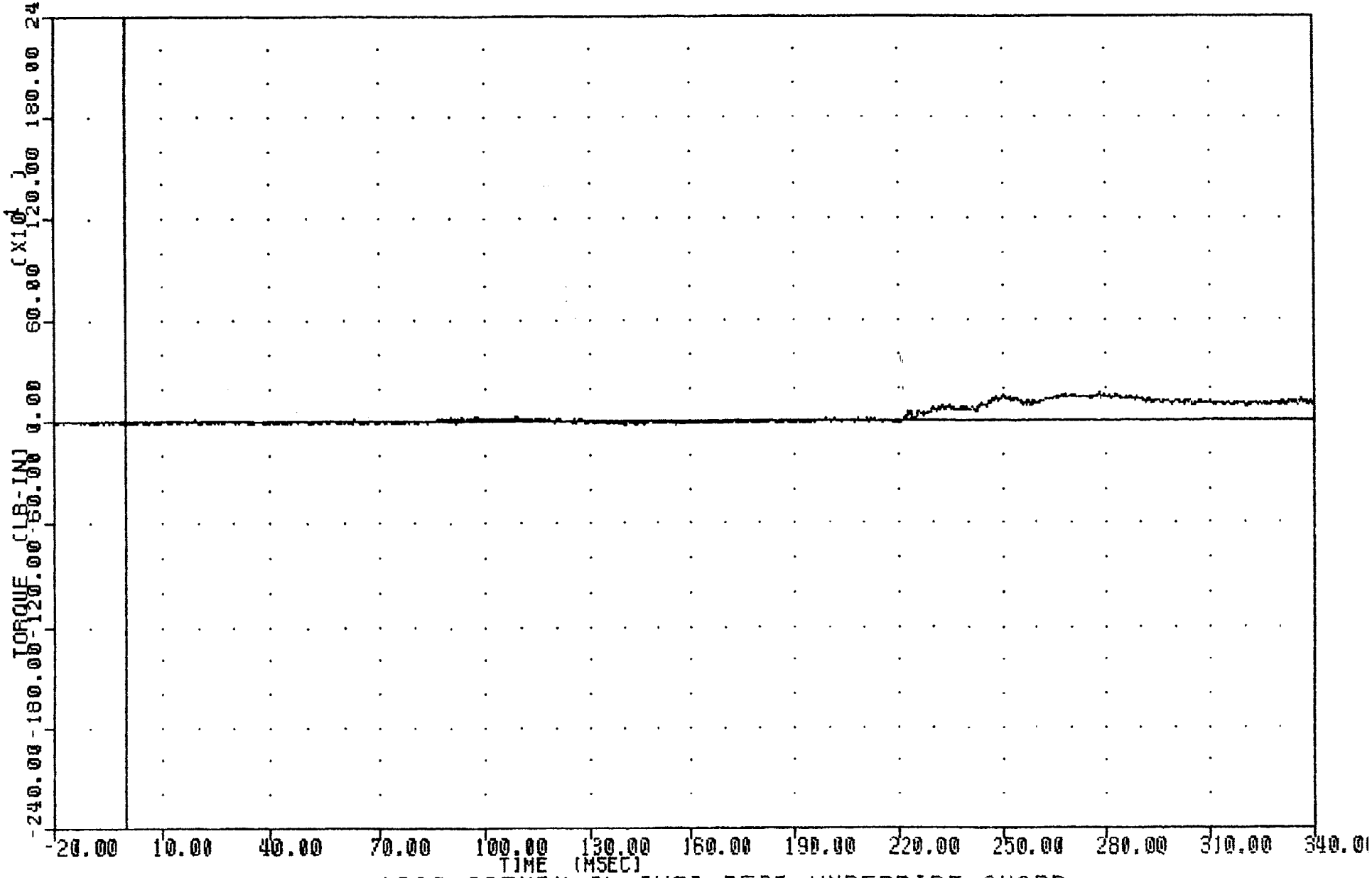
FILTER = BLPP 1000/ 2500/ -16
MIN, MAX VALUES = -248.01 @ 245.50 , 1412.48 @ 229.38



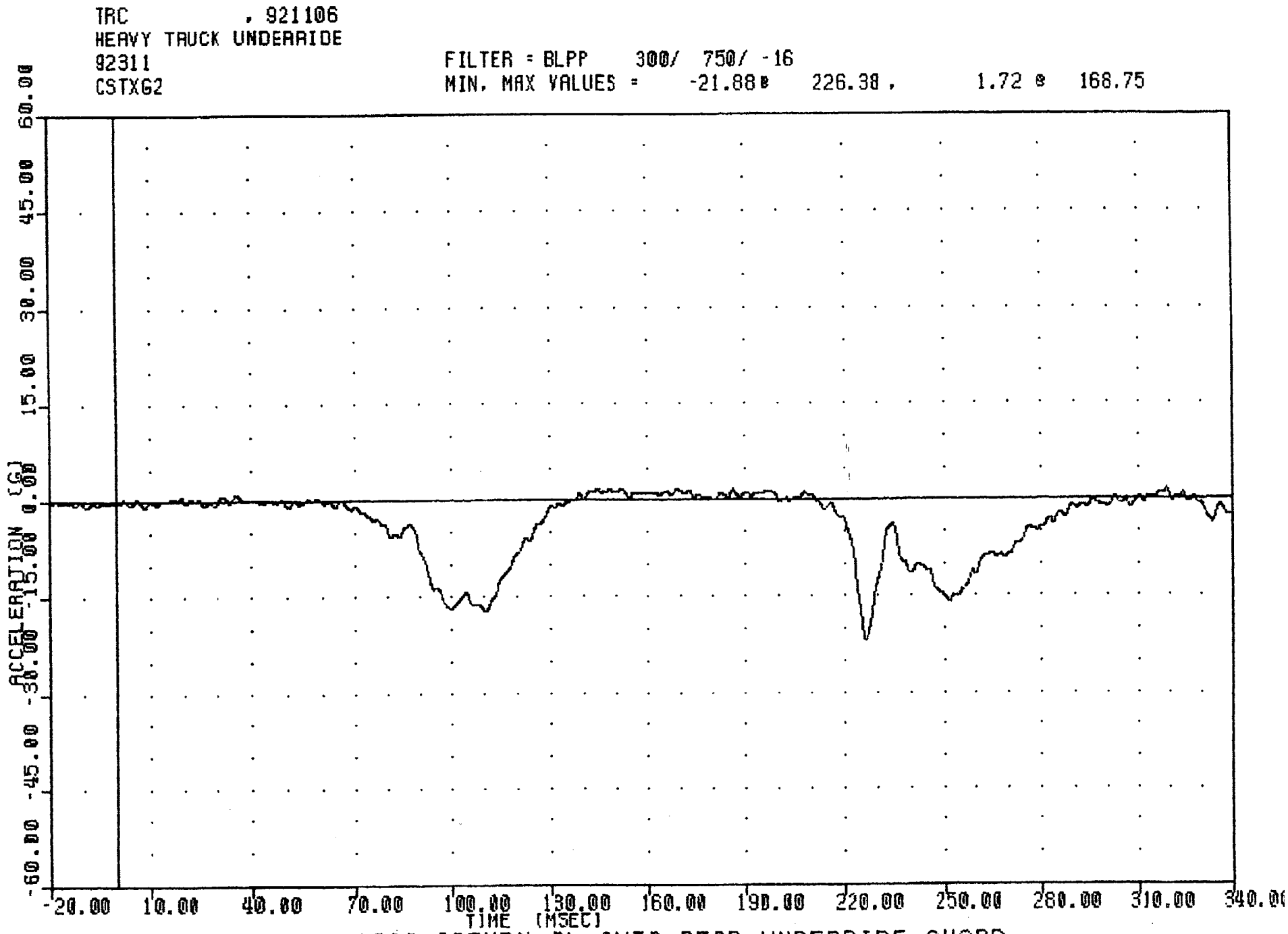
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK MOMENT ABOUT Y AXIS

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
NEKZM2

FILTER = BLPP 1000/ 2500/ -16
MIN, MAX VALUES = -24.93 @ 140.50 , 164.09 @ 277.75



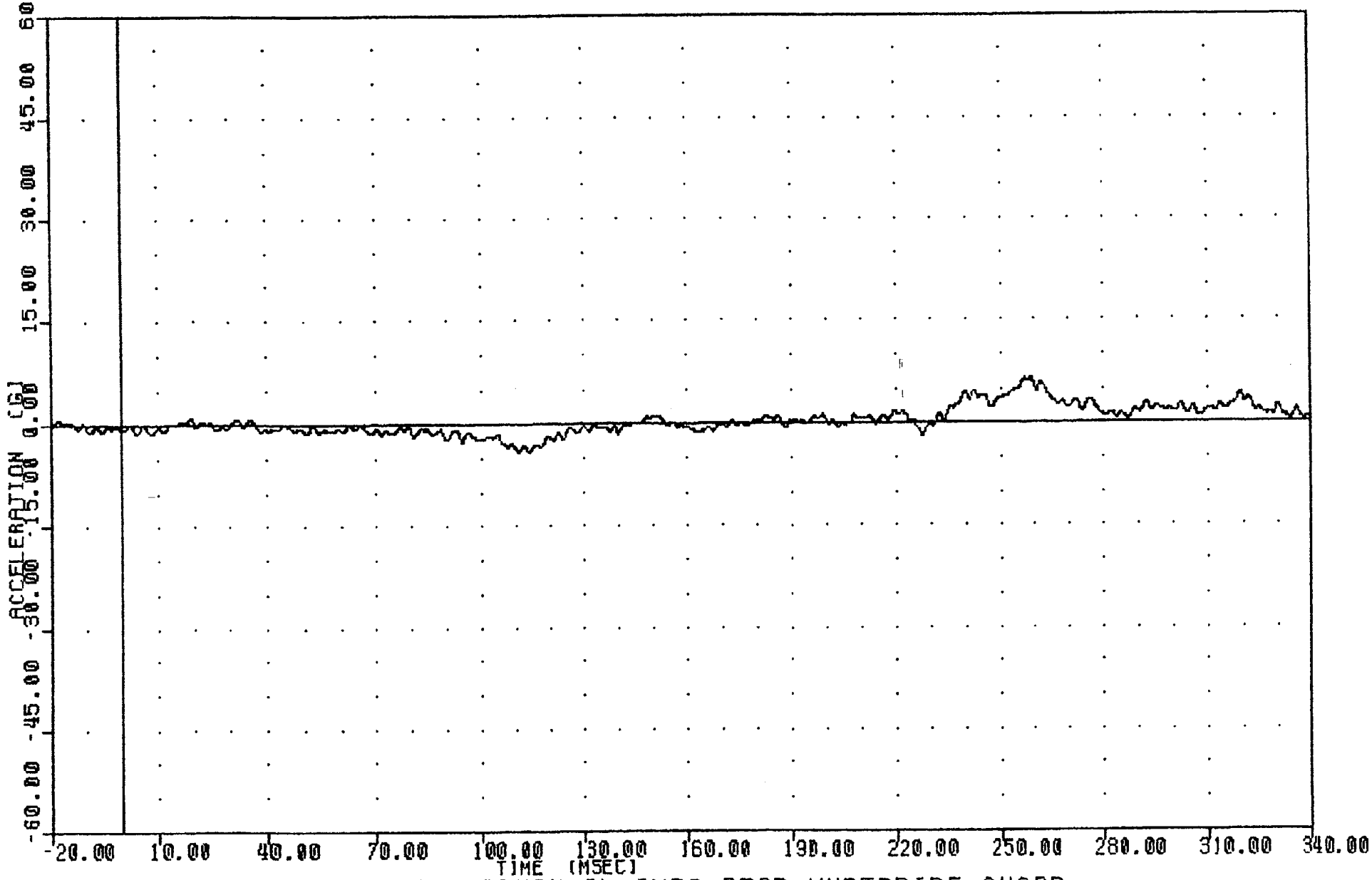
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK MOMENT ABOUT Z AXIS



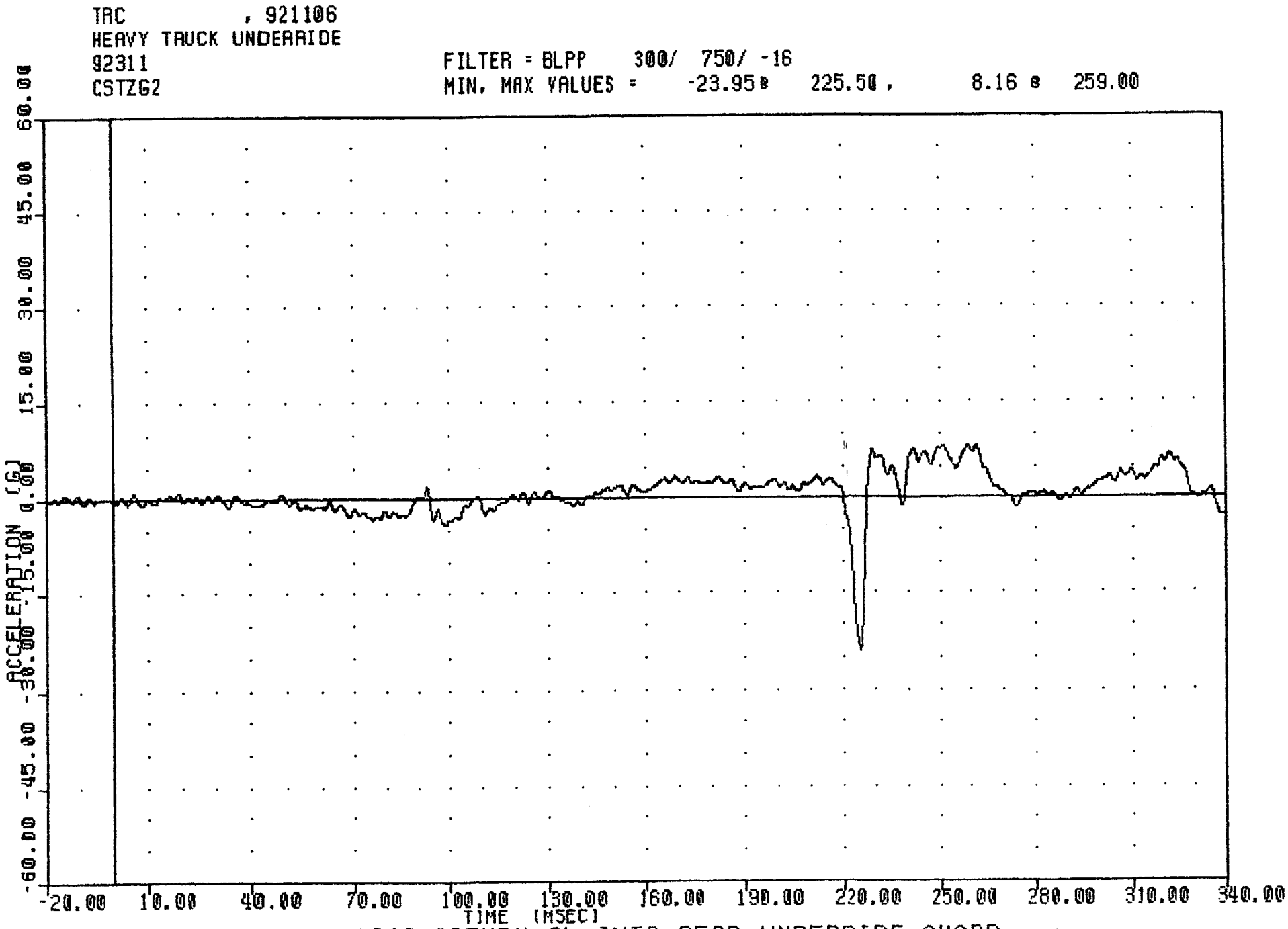
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER CHEST X-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
CSTYG2

FILTER = BLPP 300/ 750/ -16
MIN, MAX VALUES = -4.11 @ 113.75 , 6.32 @ 257.25



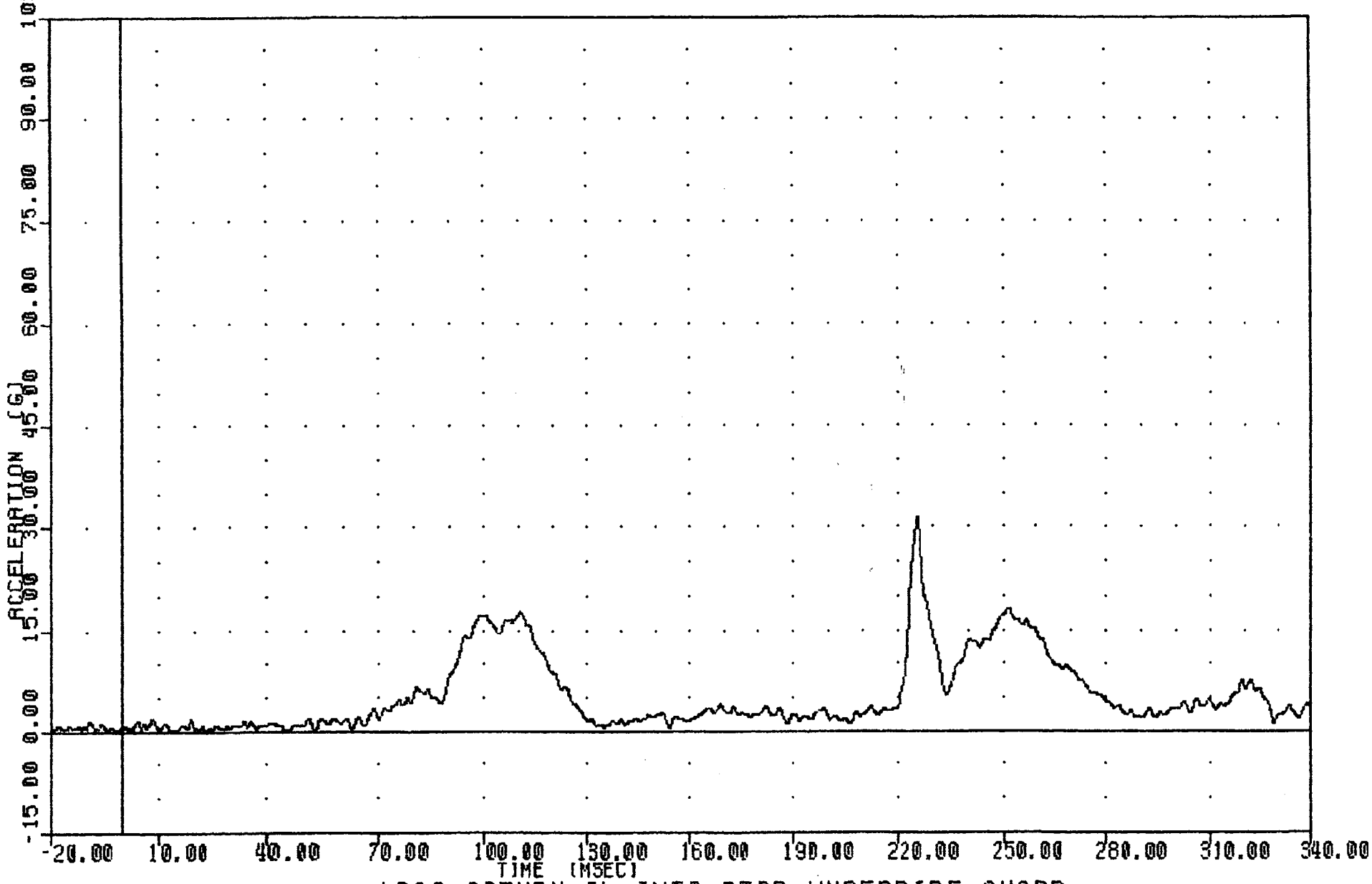
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER CHEST Y-AXIS ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER CHEST Z-AXIS ACCELERATION

TRC . 921106
HEAVY TRUCK UNDERRIDE
92311
CSTRG2

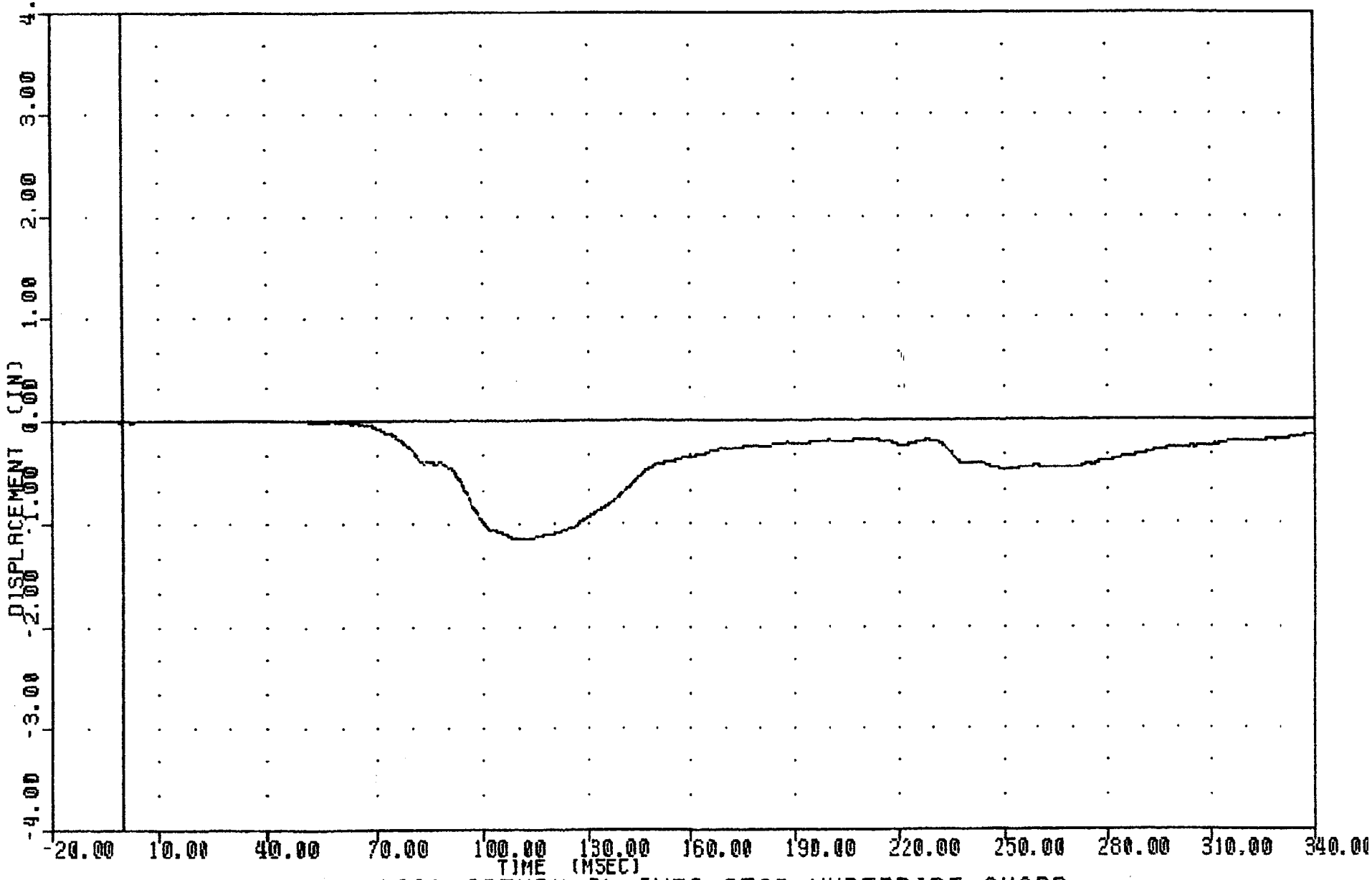
FILTER = BLPP 300/ 750/ -16
MIN, MAX VALUES = 0.04 @ 21.13 , 31.38 @ 225.75



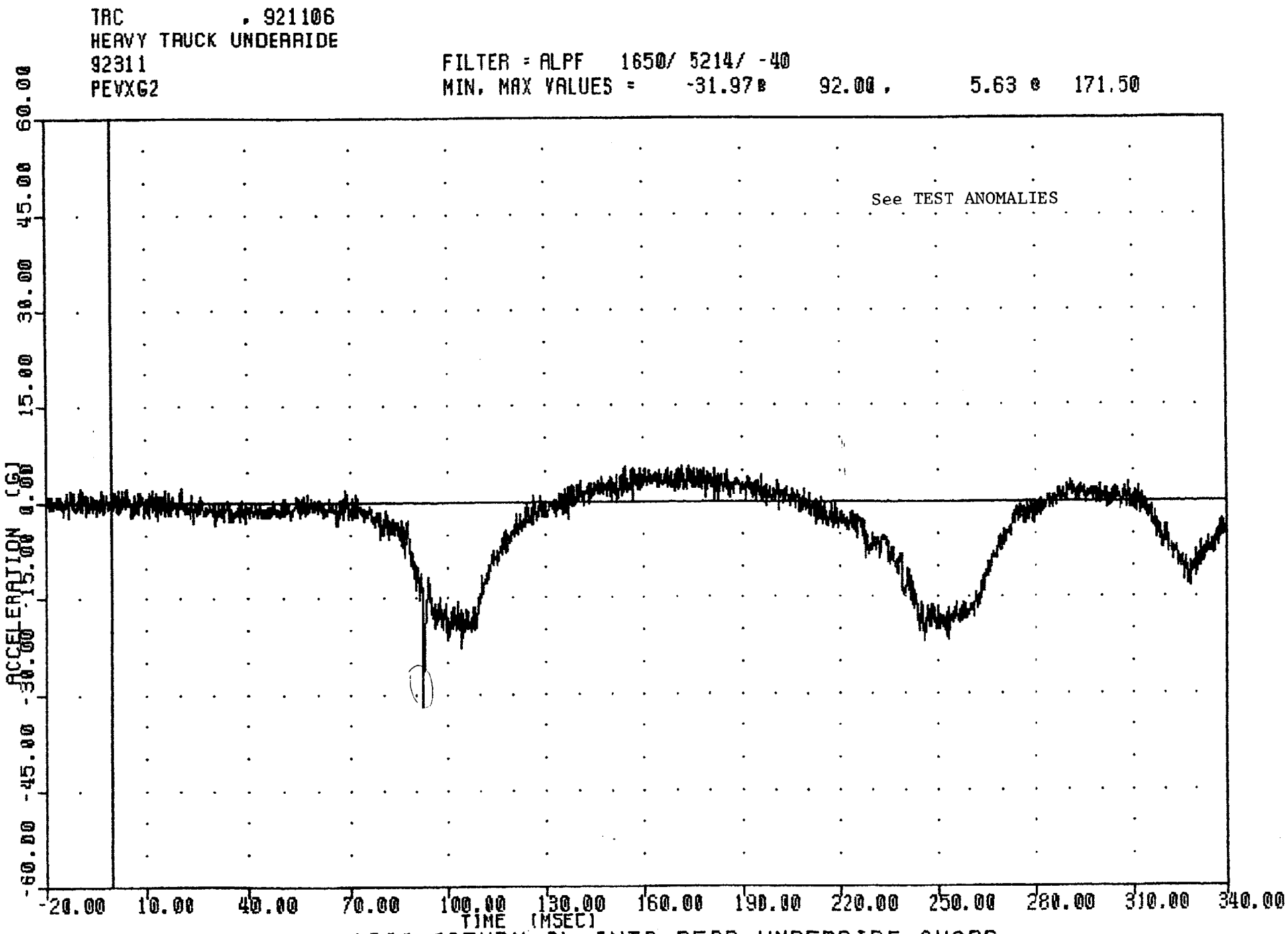
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER CHEST RESULTANT ACCELERATION

TRC . 921106
HEAVY TRUCK UNDERRIDE
92311
CSTXD2

FILTER = BLPF 300/ 750/ -16
MIN, MAX VALUES = -1.14 @ 112.88 , 0.01 @ 4.25



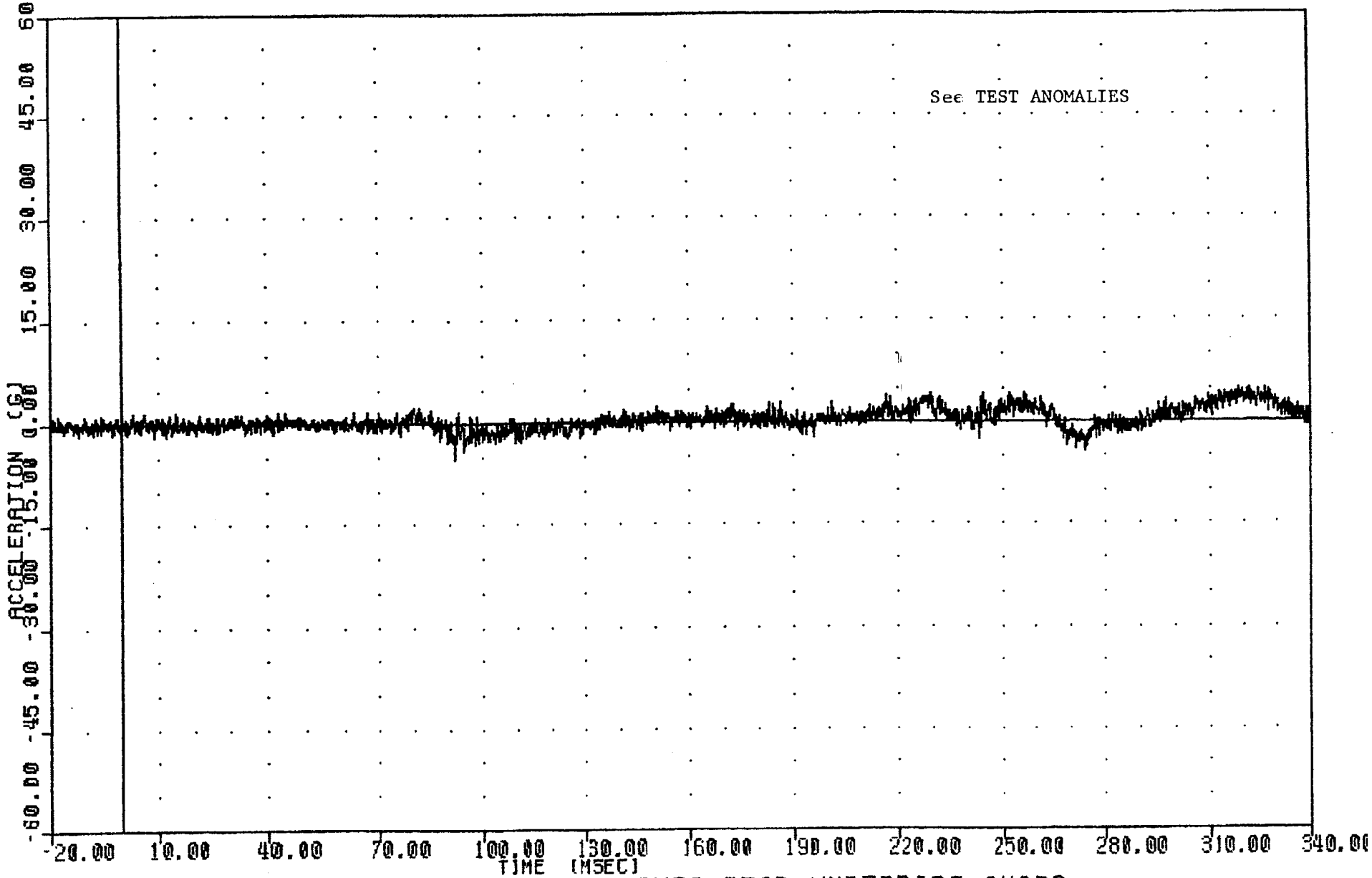
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER CHEST DEFLECTION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER PELVIS X-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
PEVYG2

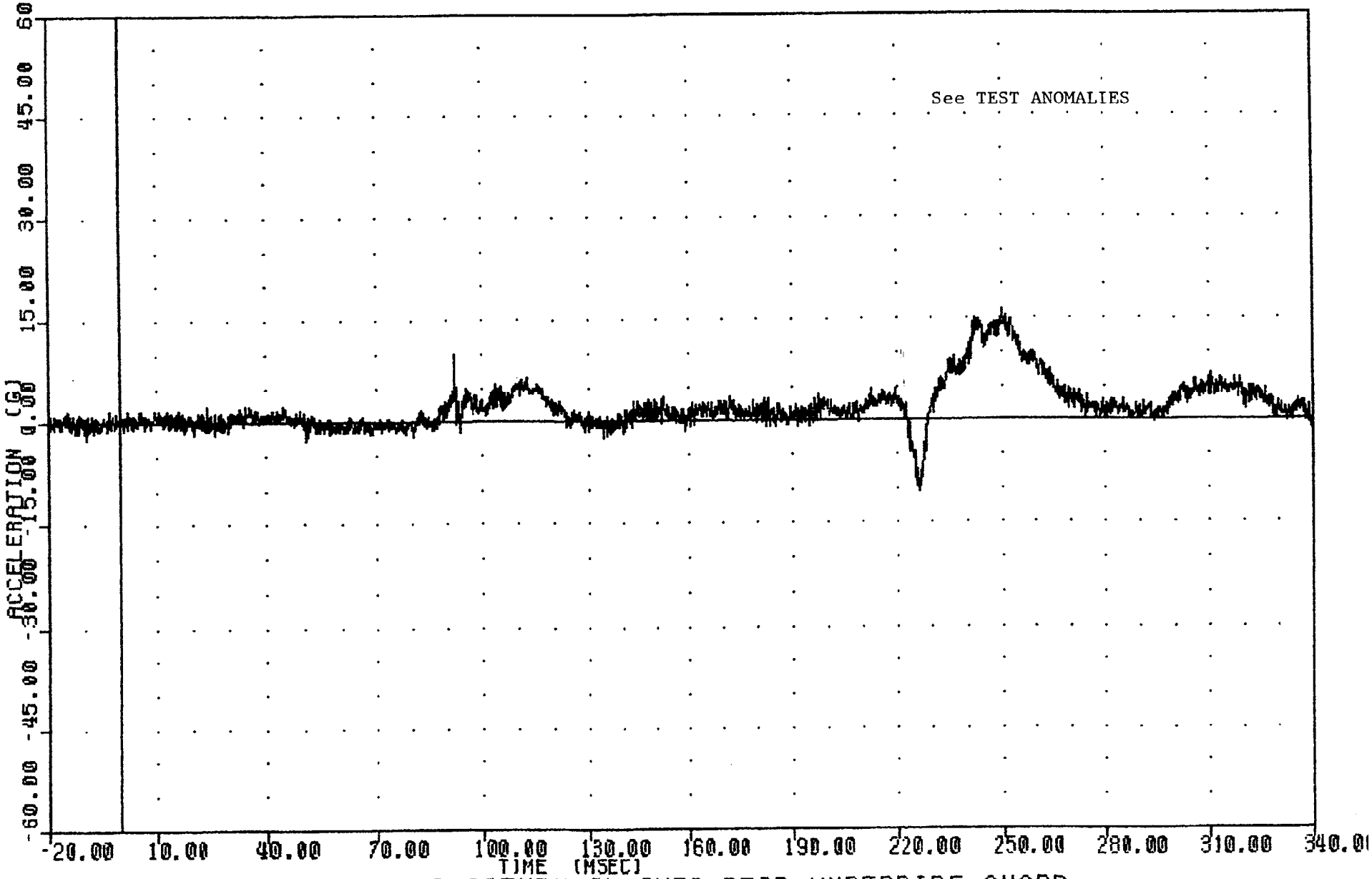
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -5.17 @ 91.50 , 4.84 @ 318.36



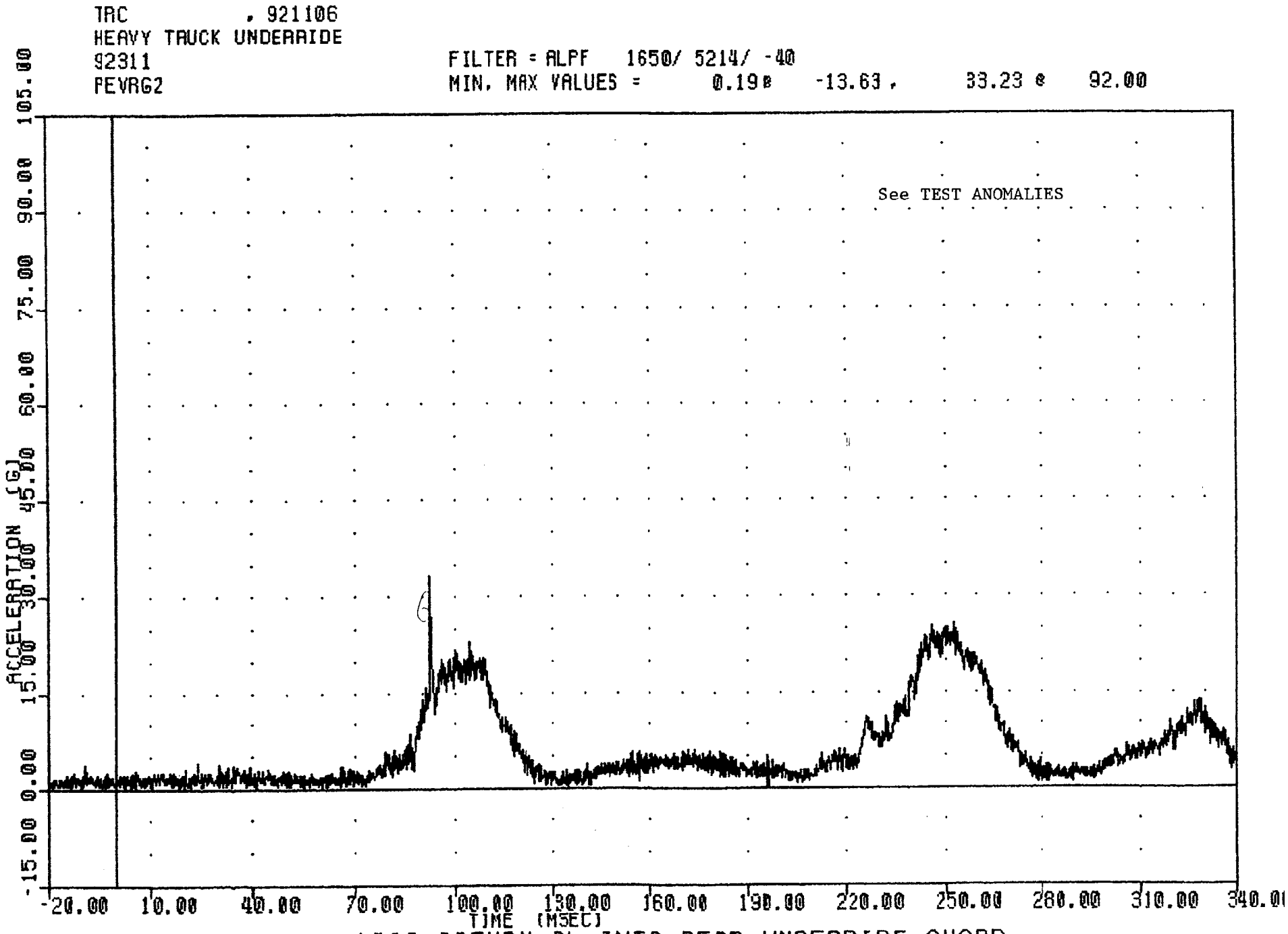
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER PELVIS Y-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
PEVZG2

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -10.35 @ 226.25 , 16.34 @ 250.25



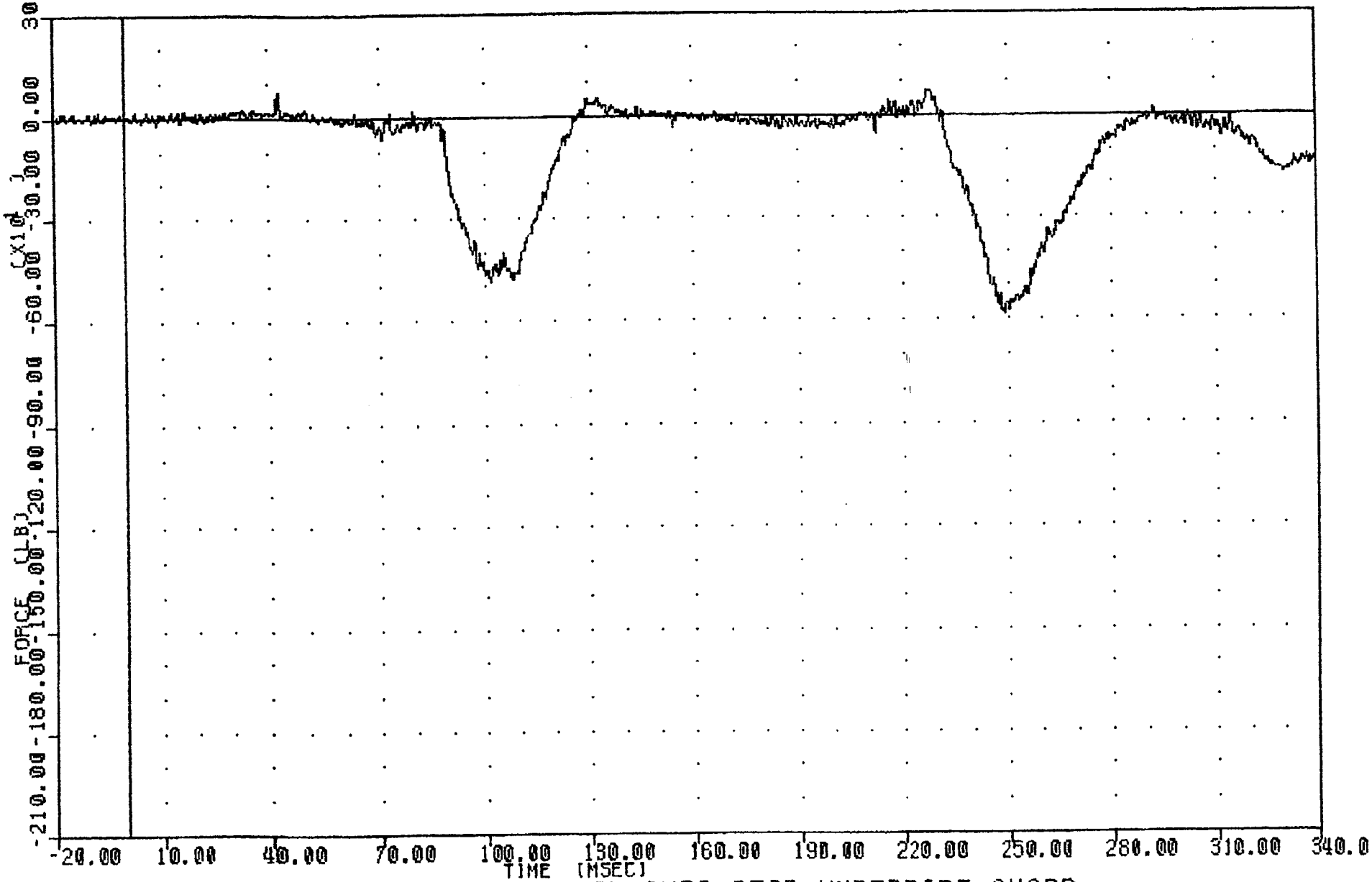
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER PELVIS Z-AXIS ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER PELVIS RESULTANT ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
LFMF2

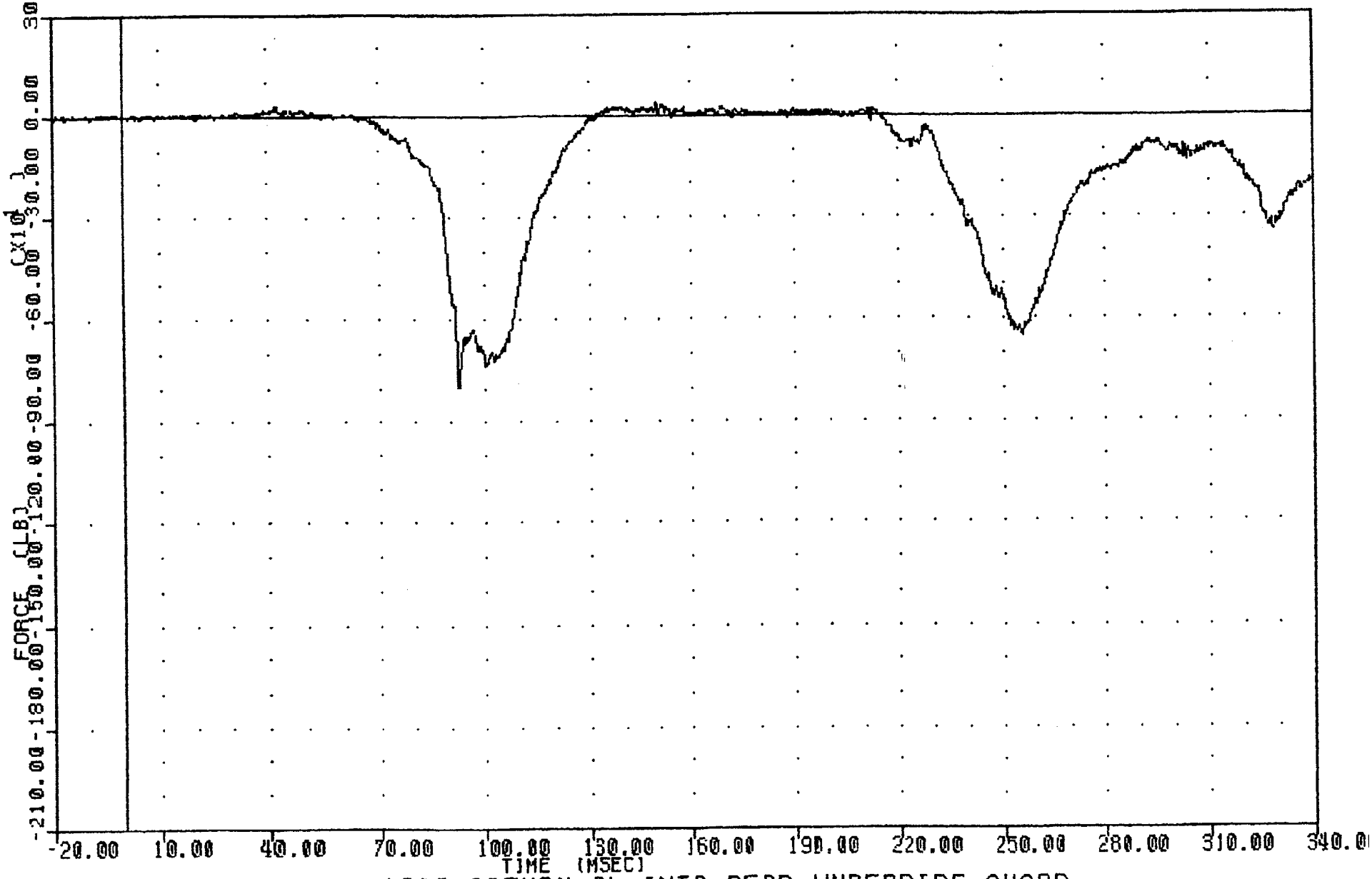
FILTER = BLPP 1000/ 2500/ -16
MIN. MAX VALUES = -585.66 @ 249.00 , 77.26 @ 42.75



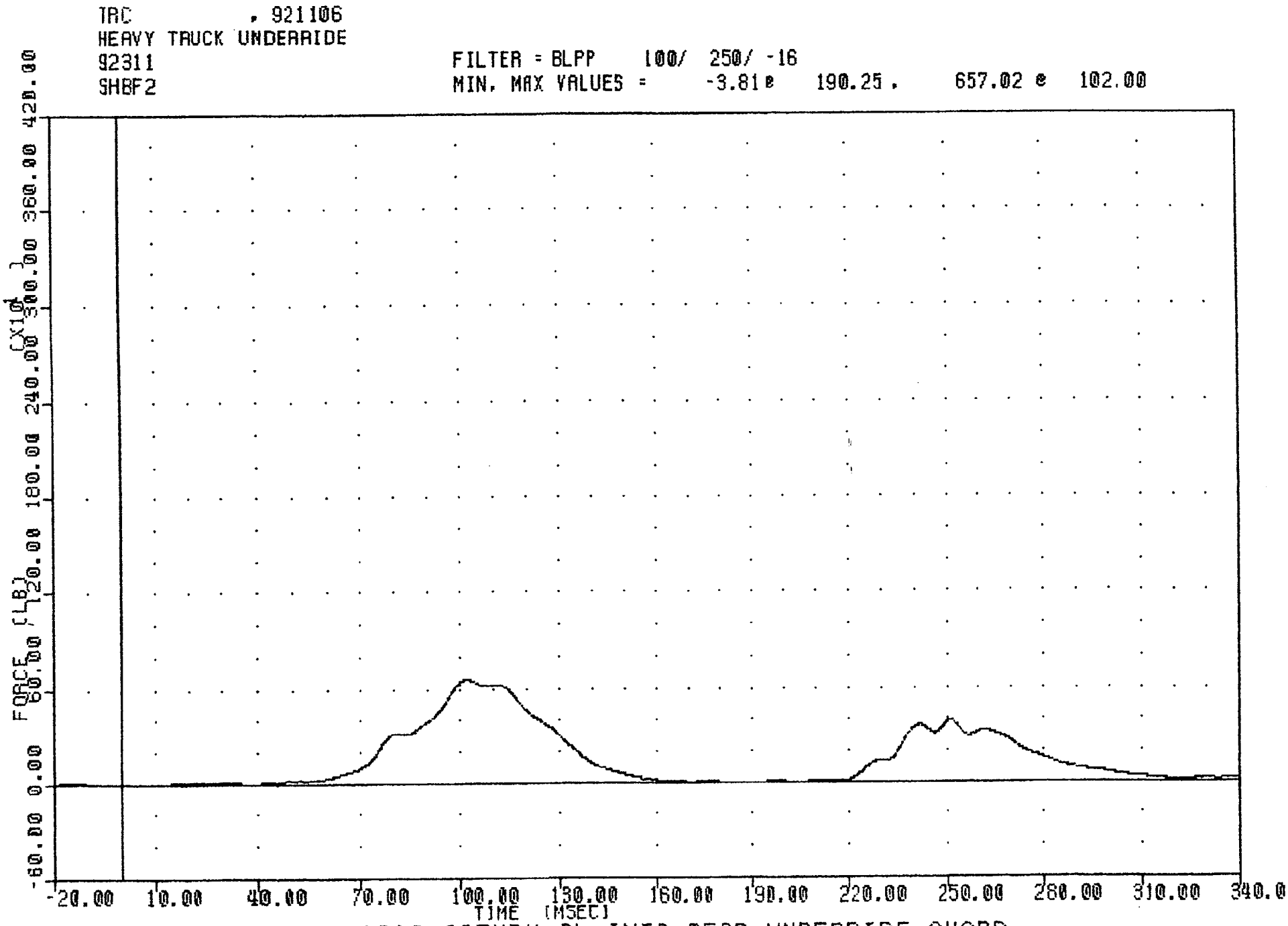
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER LEFT FEMUR FORCE

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
RFMF2

FILTER = BLPP 1000/ 2500/ -16
MIN, MAX VALUES = -798.30 @ 92.38 , 37.53 @ 149.88



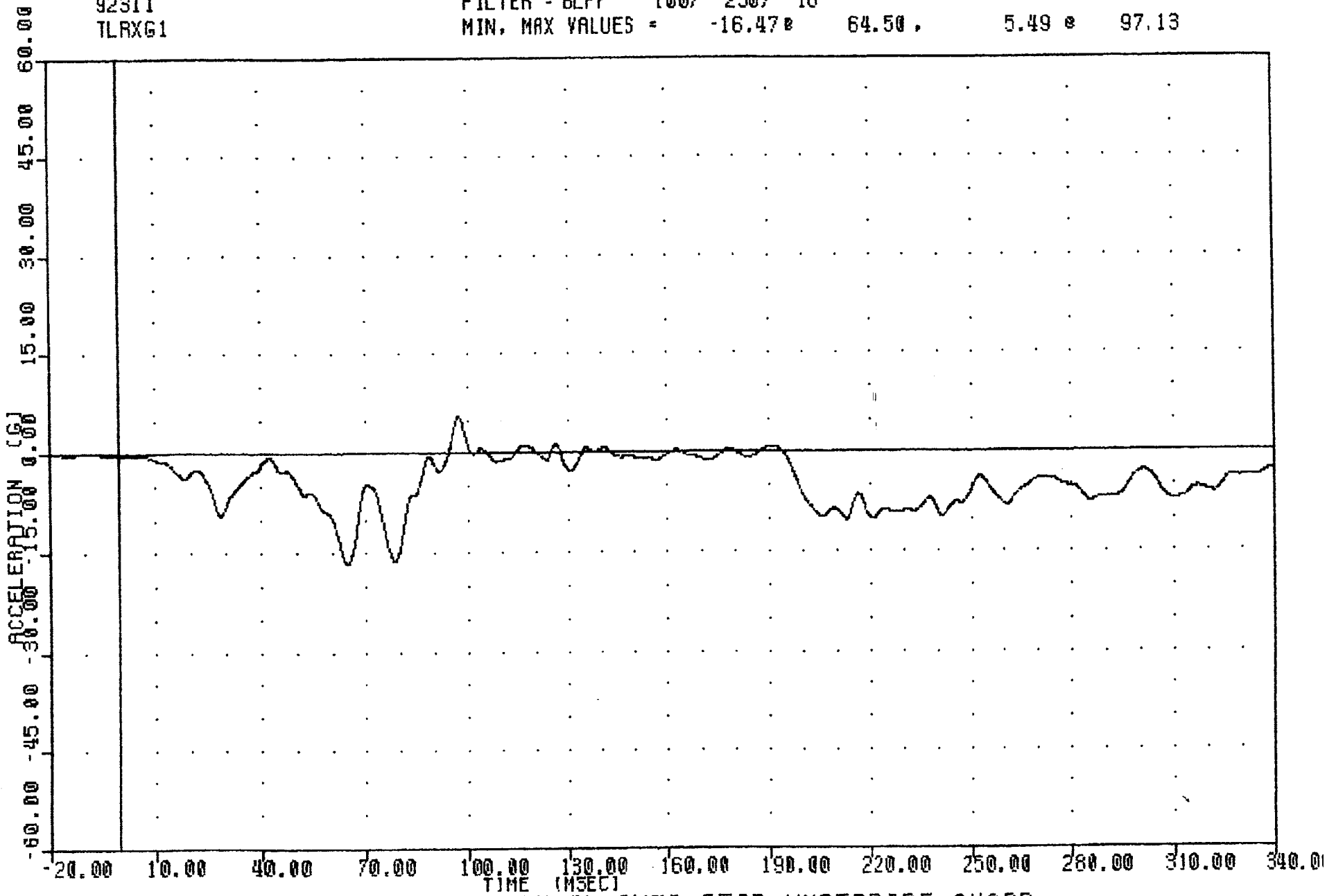
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER RIGHT FEMUR FORCE



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT FRONT PASSENGER SHOULDER BELT FORCE

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
TLRXG1

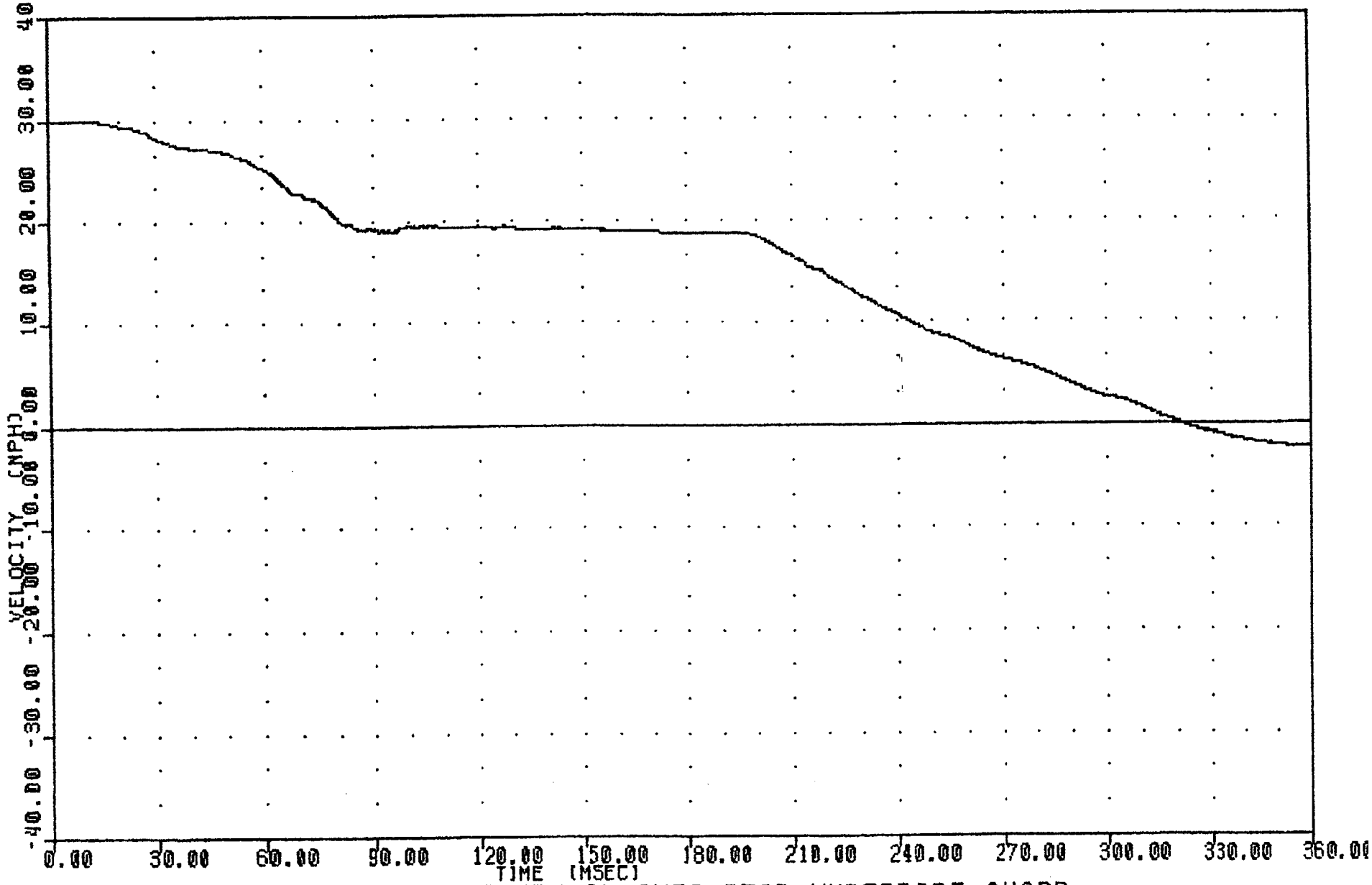
FILTER = BLPP 100/ 250/ -16
MIN, MAX VALUES = -16.47 @ 64.50 , 5.49 @ 97.13



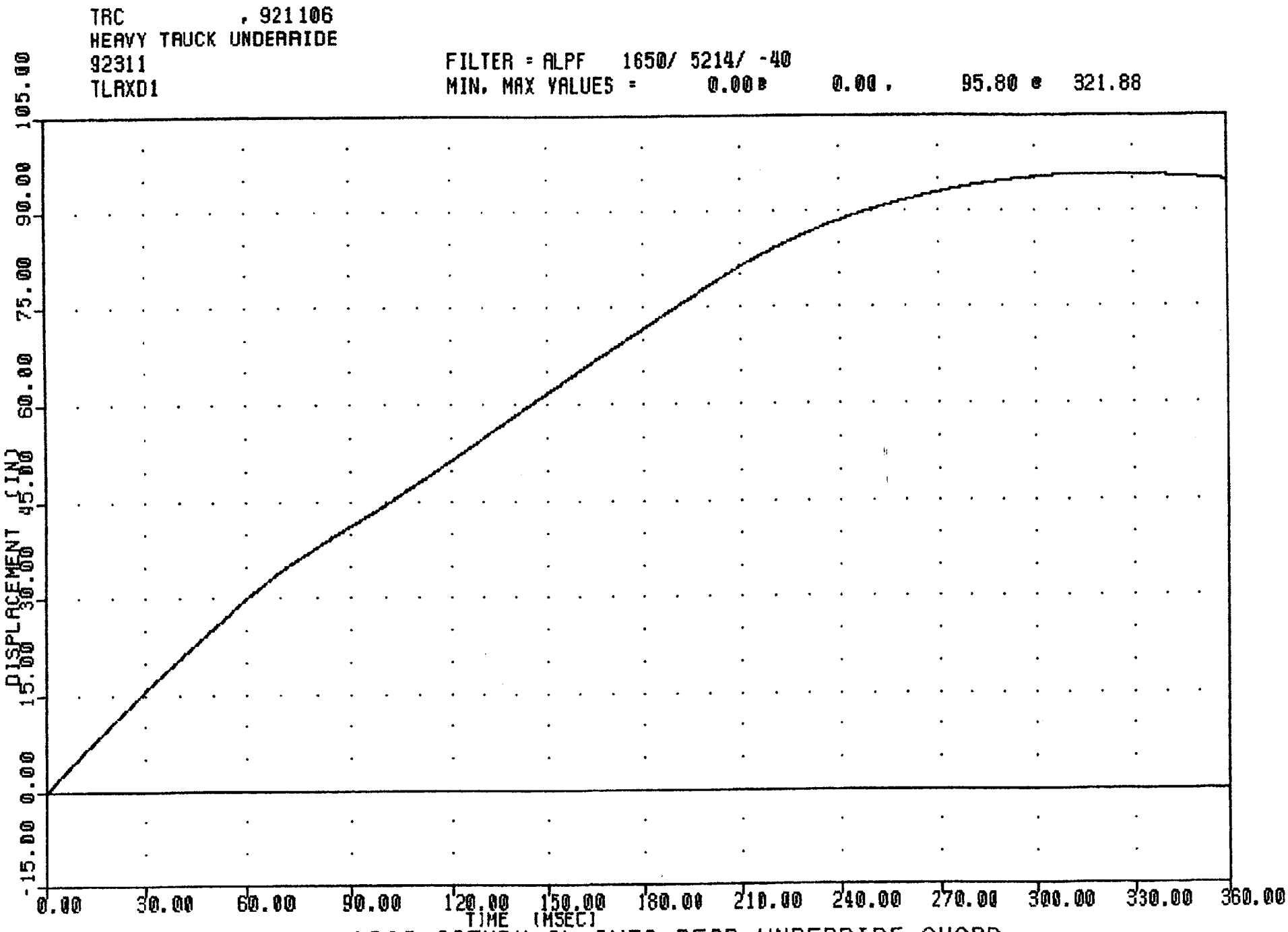
1993 SATURN SL INTO REAR UNDERRIDE GUARD
LEFT REAR SEAT X-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
TLRXV1

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -2.30 @ 359.88 , 30.00 @ 0.75



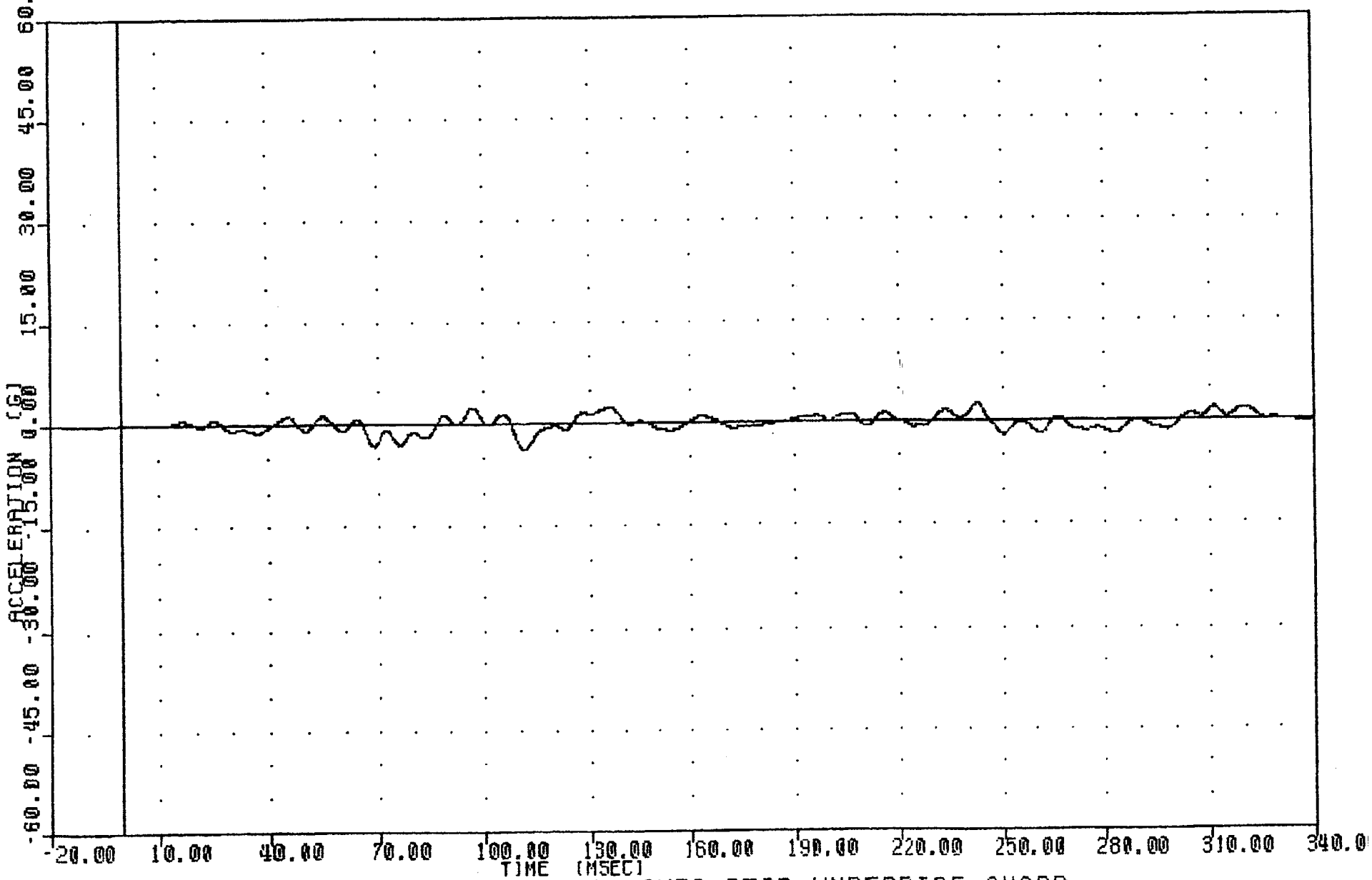
1993 SATURN SL INTO REAR UNDERRIDE GUARD
LEFT REAR SEAT X-AXIS VELOCITY



1993 SATURN SL INTO REAR UNDERRIDE GUARD
LEFT REAR SEAT X-AXIS DISPLACEMENT

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
TLRYG1

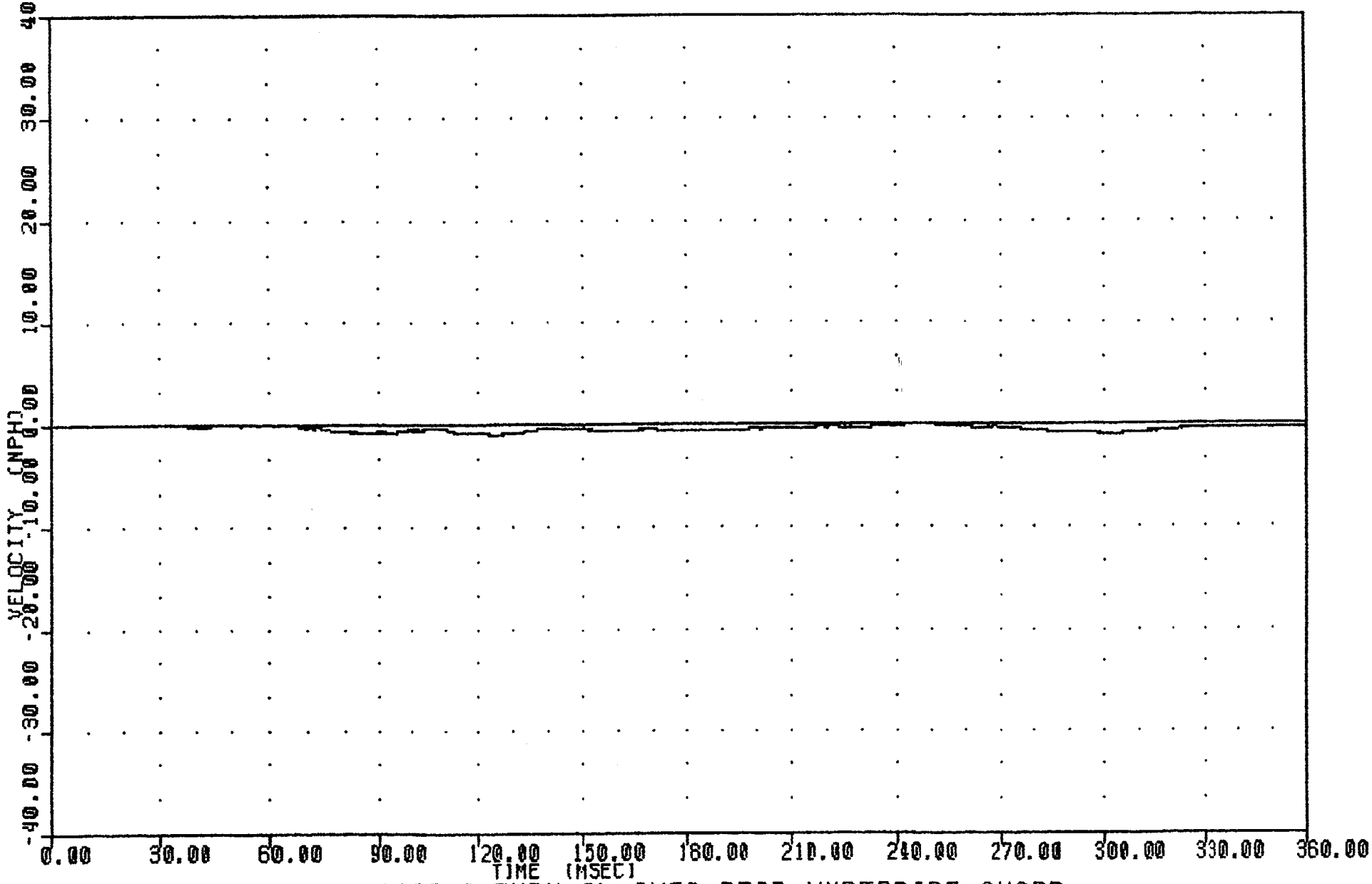
FILTER = BLPF 100/ 250/ -16
MIN, MAX VALUES = -3.82 @ 111.38 , 2.58 @ 242.75



1993 SATURN SL INTO REAR UNDERRIDE GUARD
LEFT REAR SEAT Y-AXIS ACCELERATION

TRC . 921106
HEAVY TRUCK UNDERRIDE
92311
TLRYV1

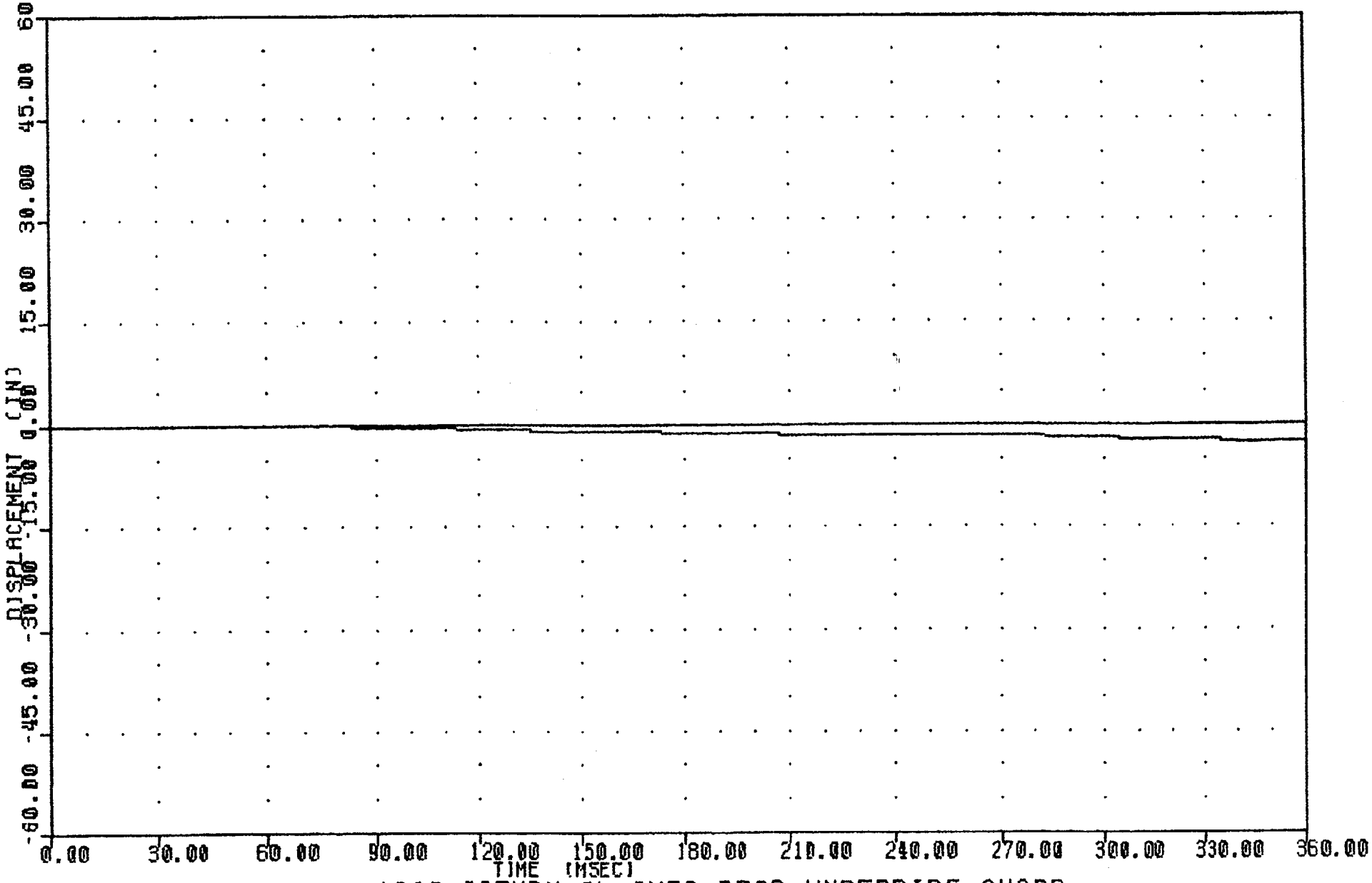
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -1.00 @ 303.00 , 0.14 @ 244.88



1993 SATURN SL INTO REAR UNDERRIDE GUARD
LEFT REAR SEAT Y-AXIS VELOCITY

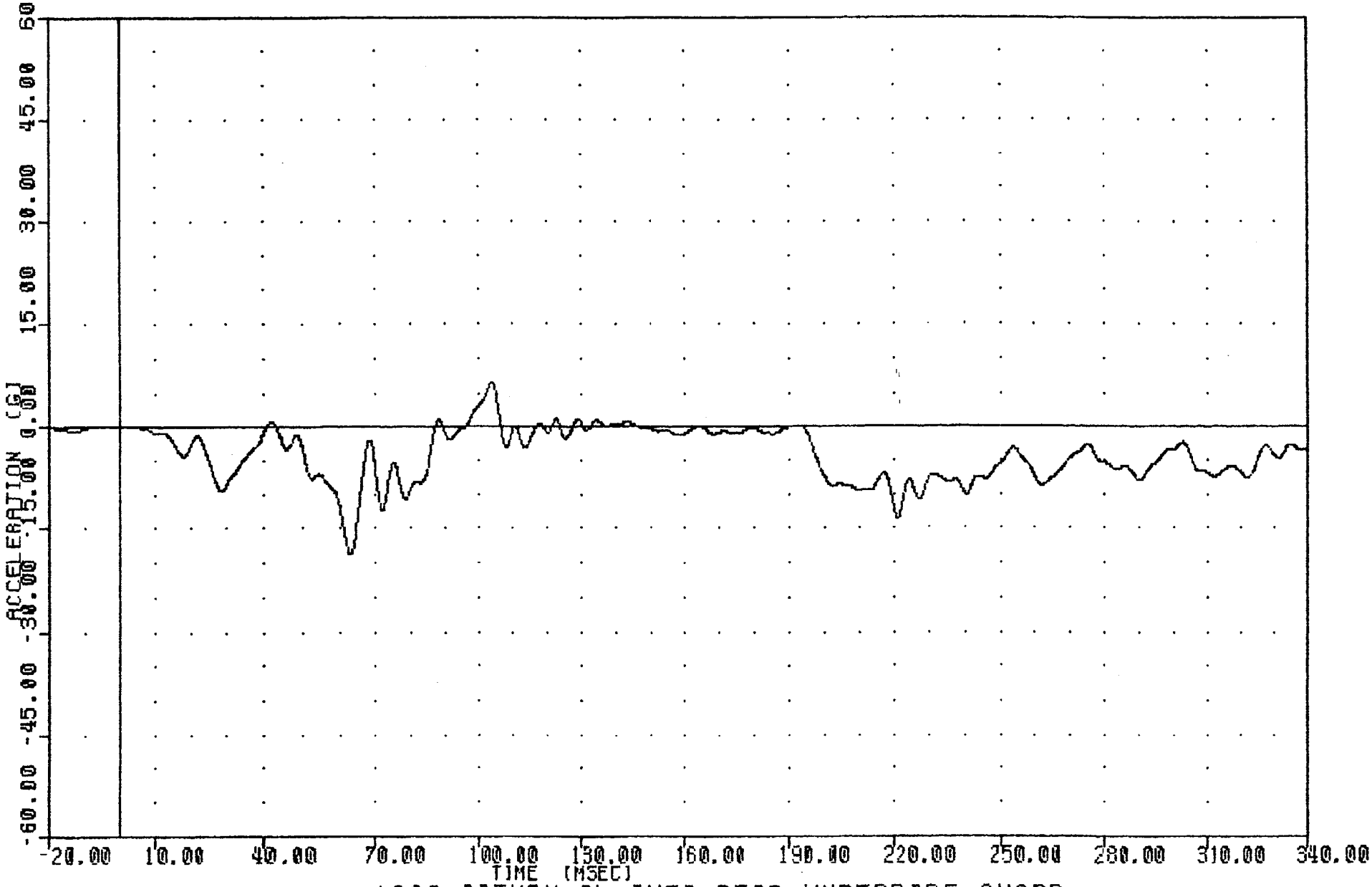
TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
TLRYD1

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -2.48 @ 360.00 , 0.03 @ 37.13



1993 SATURN SL INTO REAR UNDERRIDE GUARD
LEFT REAR SEAT Y-AXIS DISPLACEMENT

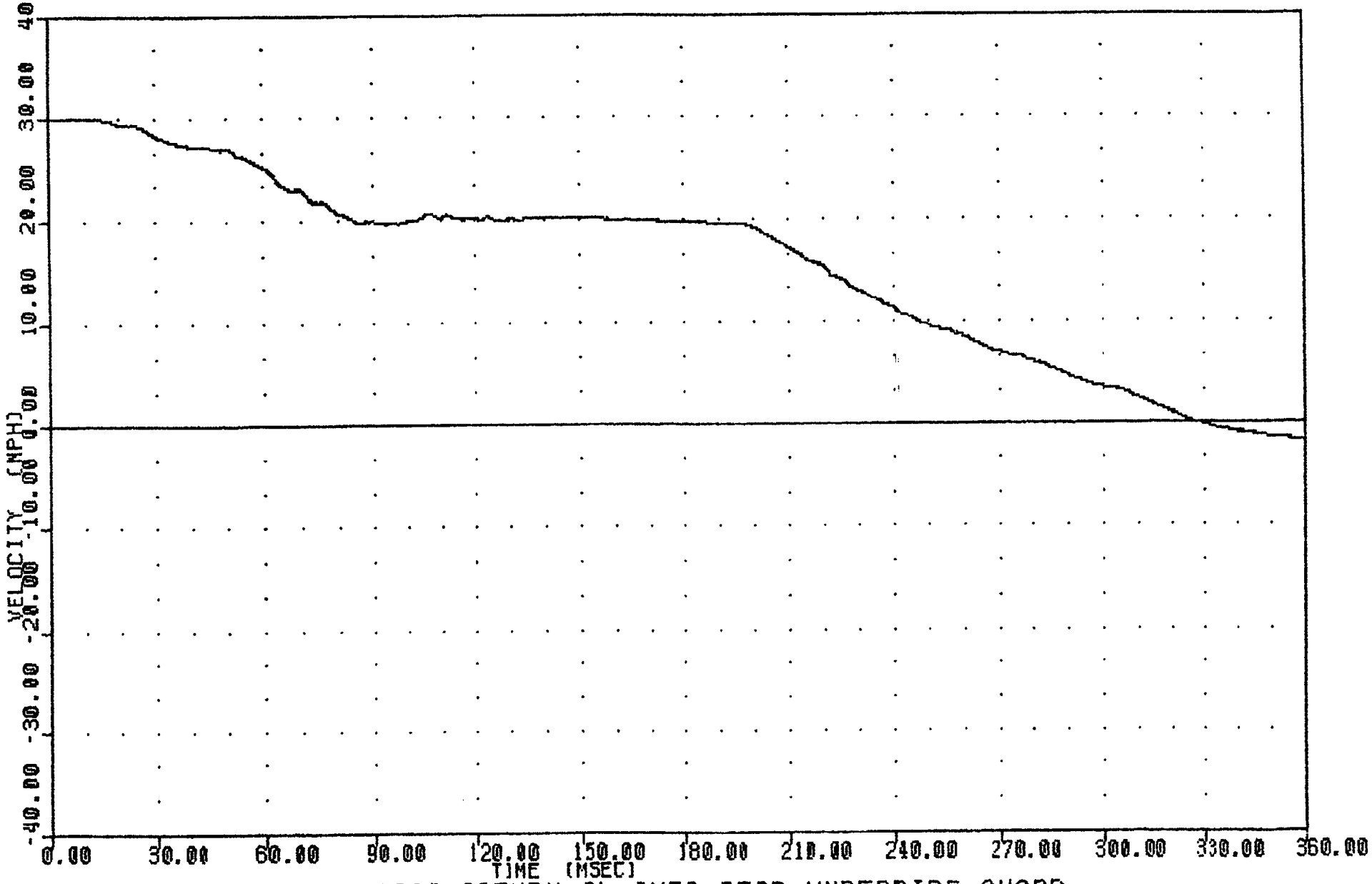
TRC . 921106
HEAVY TRUCK UNDERRIDE
92311 FILTER = BLPP 100/ 250/ -16
TRRXG1 , MIN, MAX VALUES = -18.78 @ 63.00 , 6.50 @ 104.00



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT REAR SEAT X-AXIS ACCELERATION

TRC . 921106
HEAVY TRUCK UNDERRIDE
92311
TRRXV1

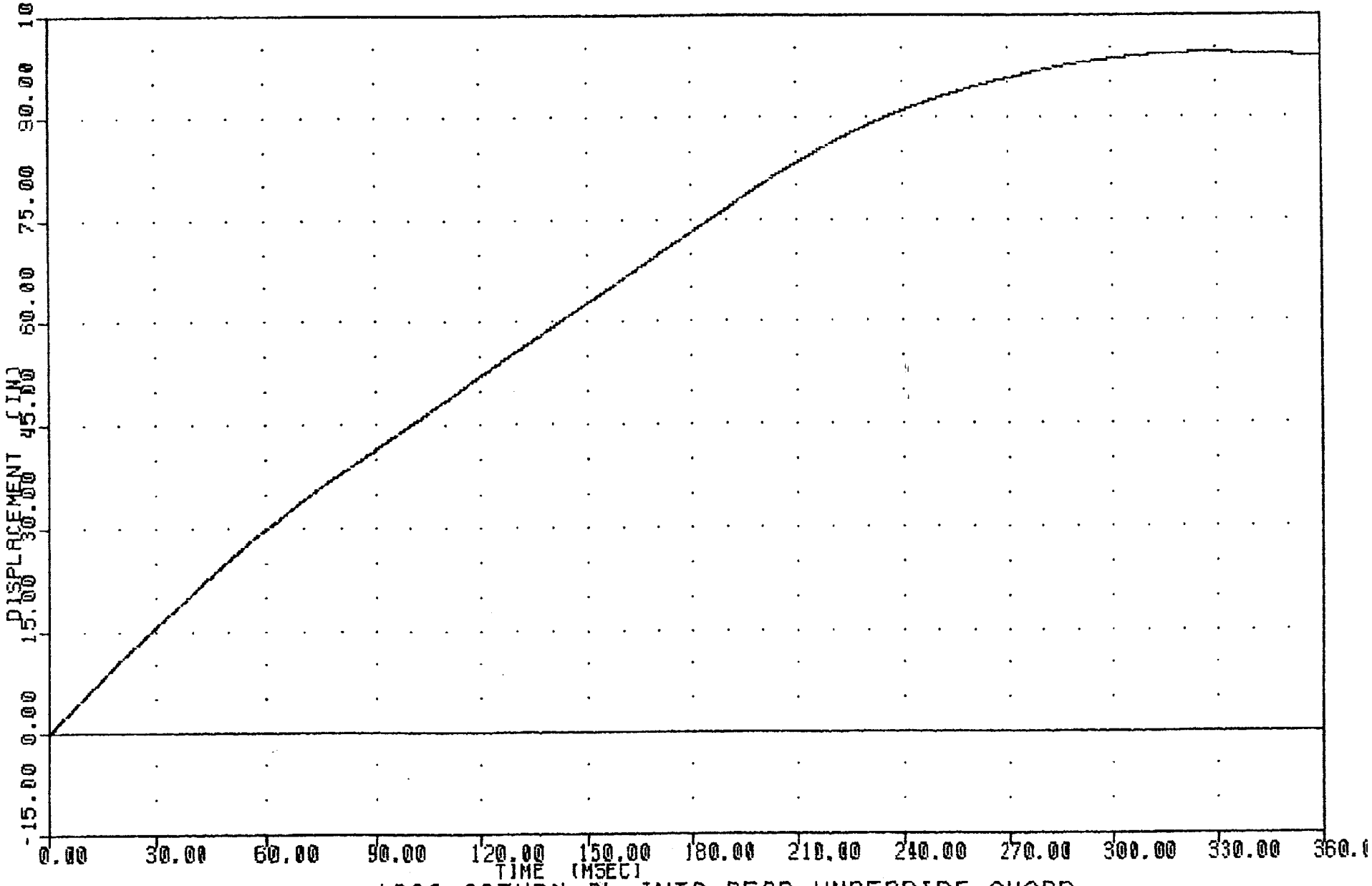
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -1.63 @ 357.88 , 30.01 @ 5.13



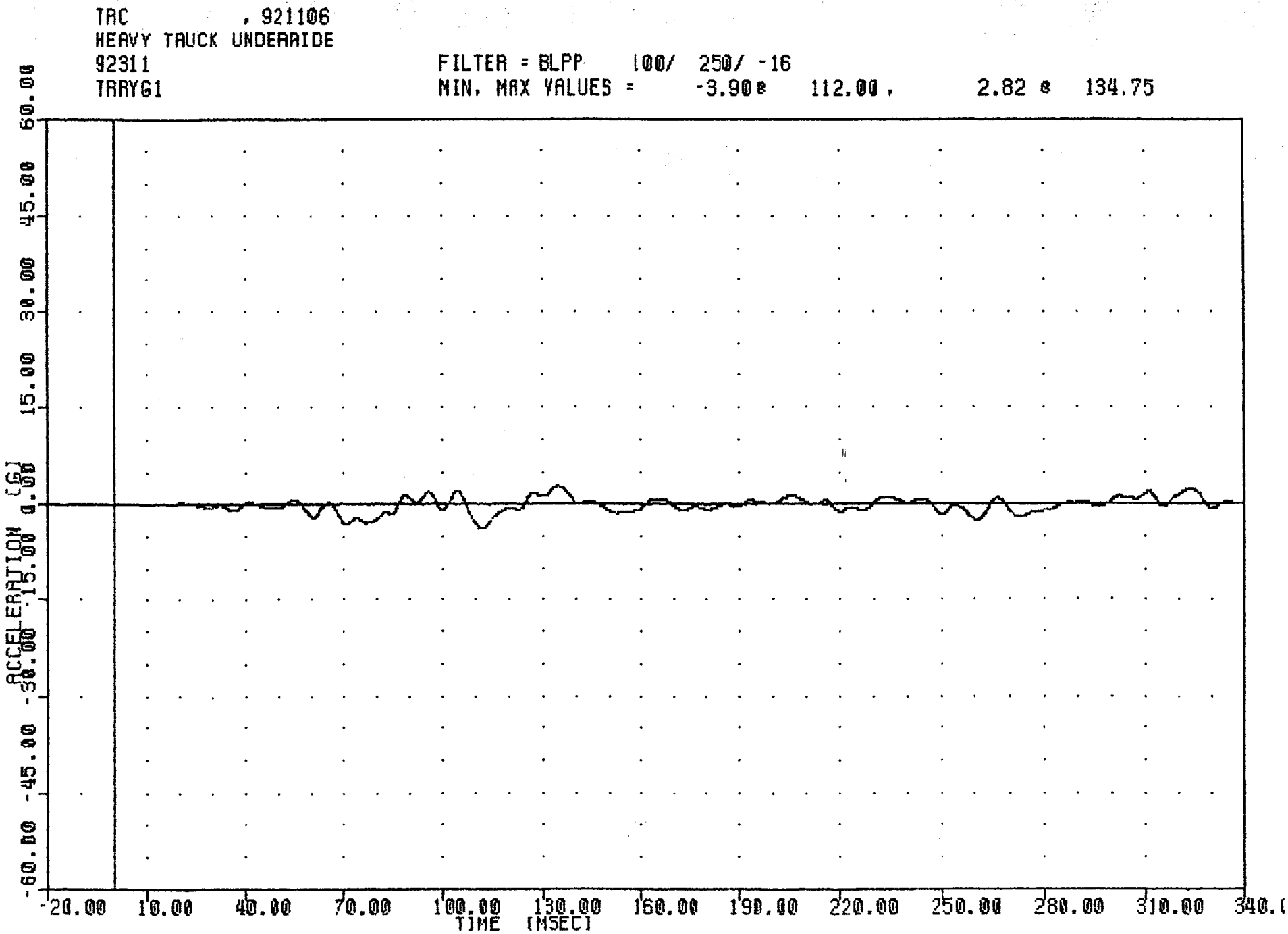
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT REAR SEAT X-AXIS VELOCITY

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
TRRXD1

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = 0.00 @ 0.00 , 99.35 @ 328.88



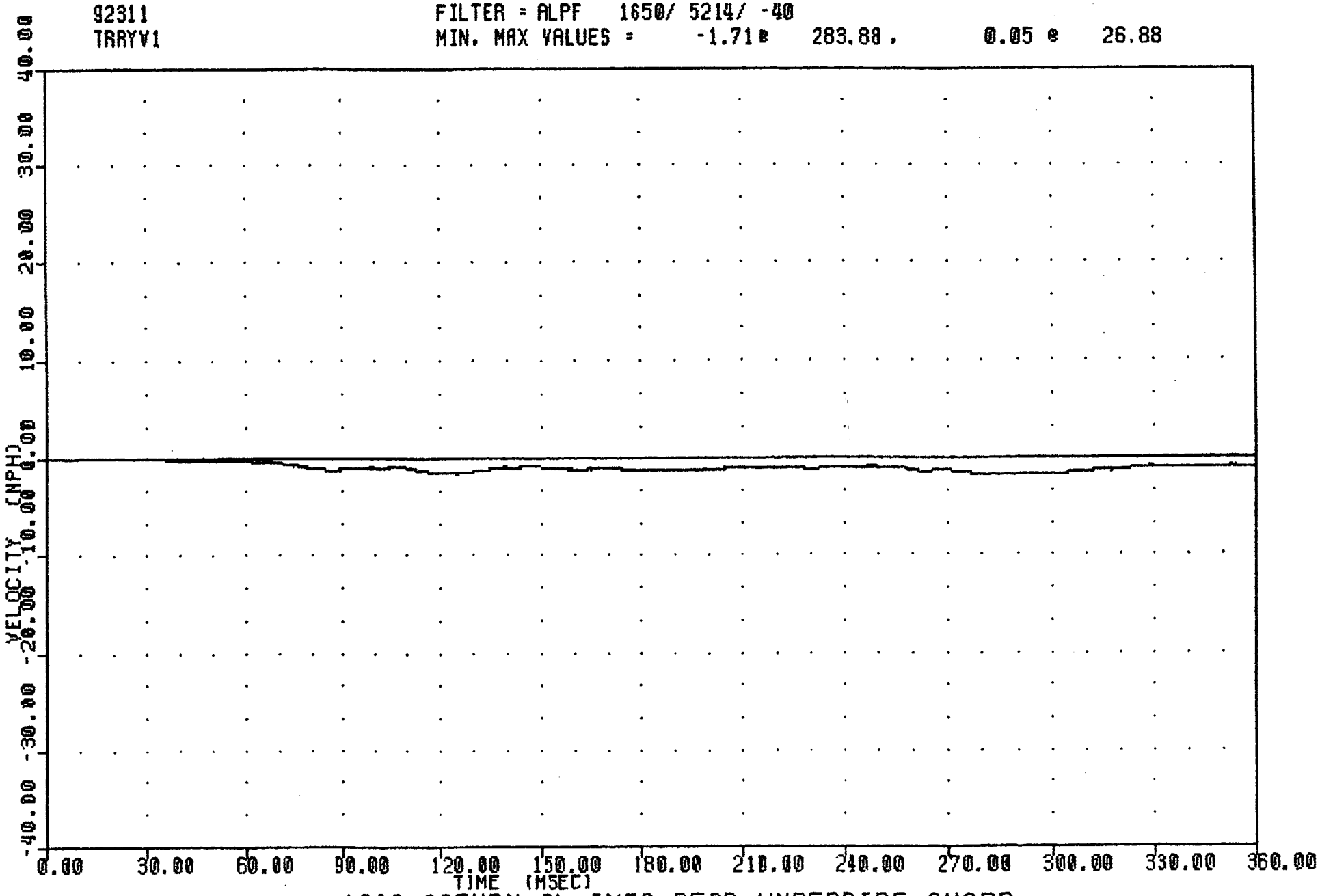
1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT REAR SEAT X-AXIS DISPLACEMENT



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT REAR SEAT Y-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
TRRYV1

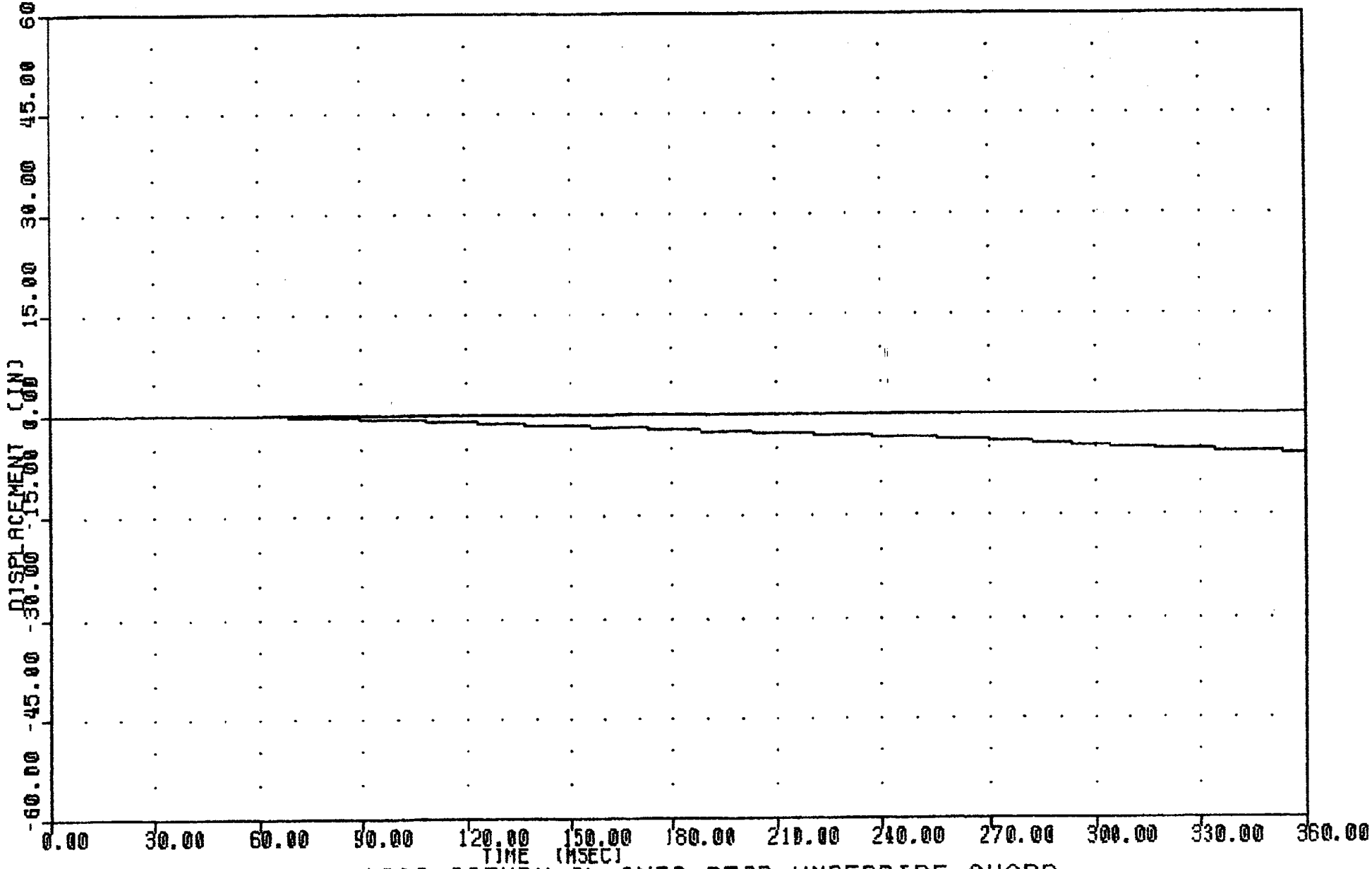
FILTER = ALPF 1650/ 5214/ -40
MIN. MAX VALUES = -1.71 @ 283.88 , 0.05 @ 26.88



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT REAR SEAT Y-AXIS VELOCITY

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
TRRYD1

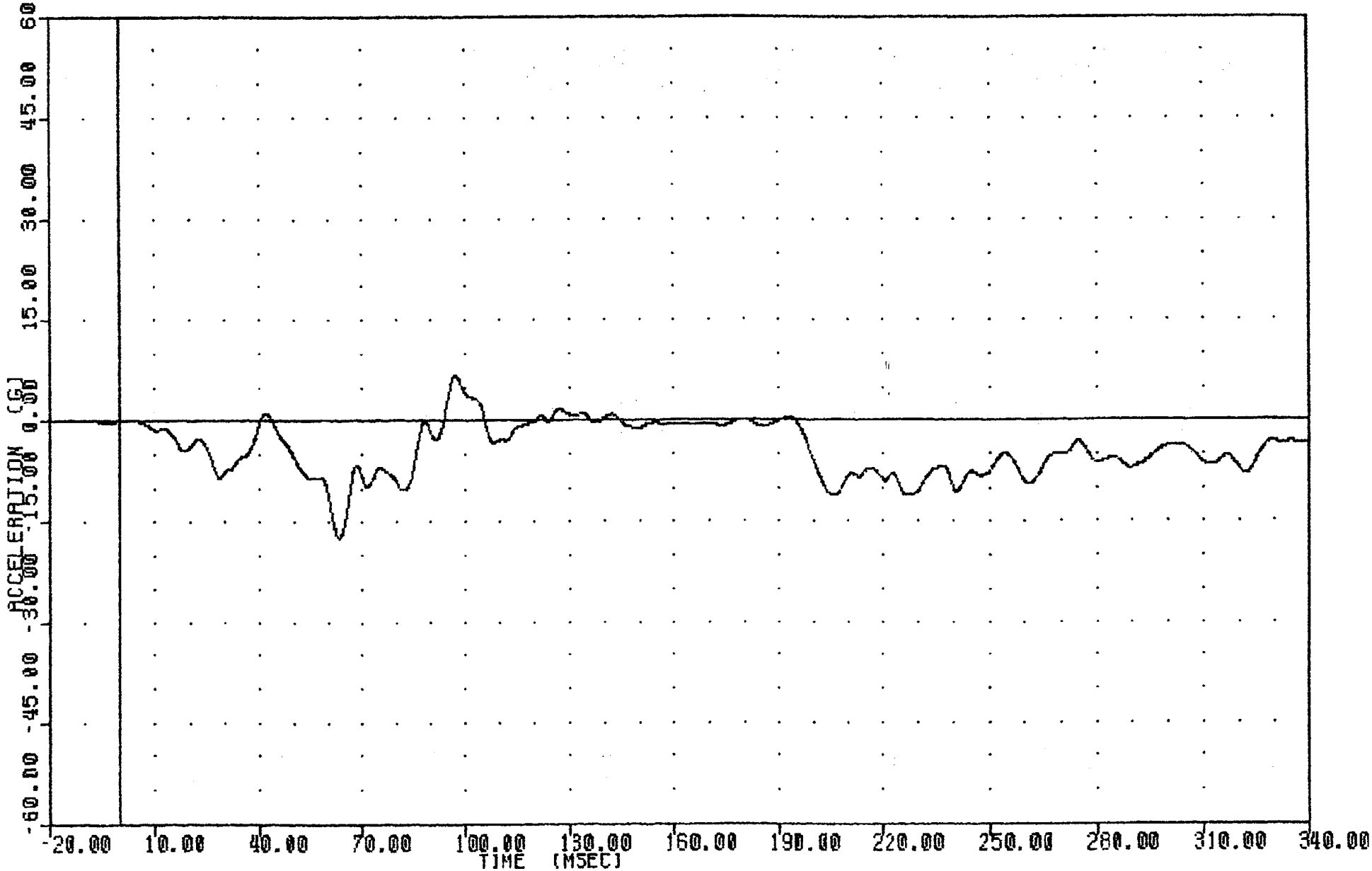
FILTER = RLPF 1650/ 5214/ -40
MIN, MAX VALUES = -5.92 @ 360.00 , 0.01 @ 28.50



1993 SATURN SL INTO REAR UNDERRIDE GUARD
RIGHT REAR SEAT Y-AXIS DISPLACEMENT

TRC . 921106
HEAVY TRUCK UNDERRIDE
92311
YCGXG1

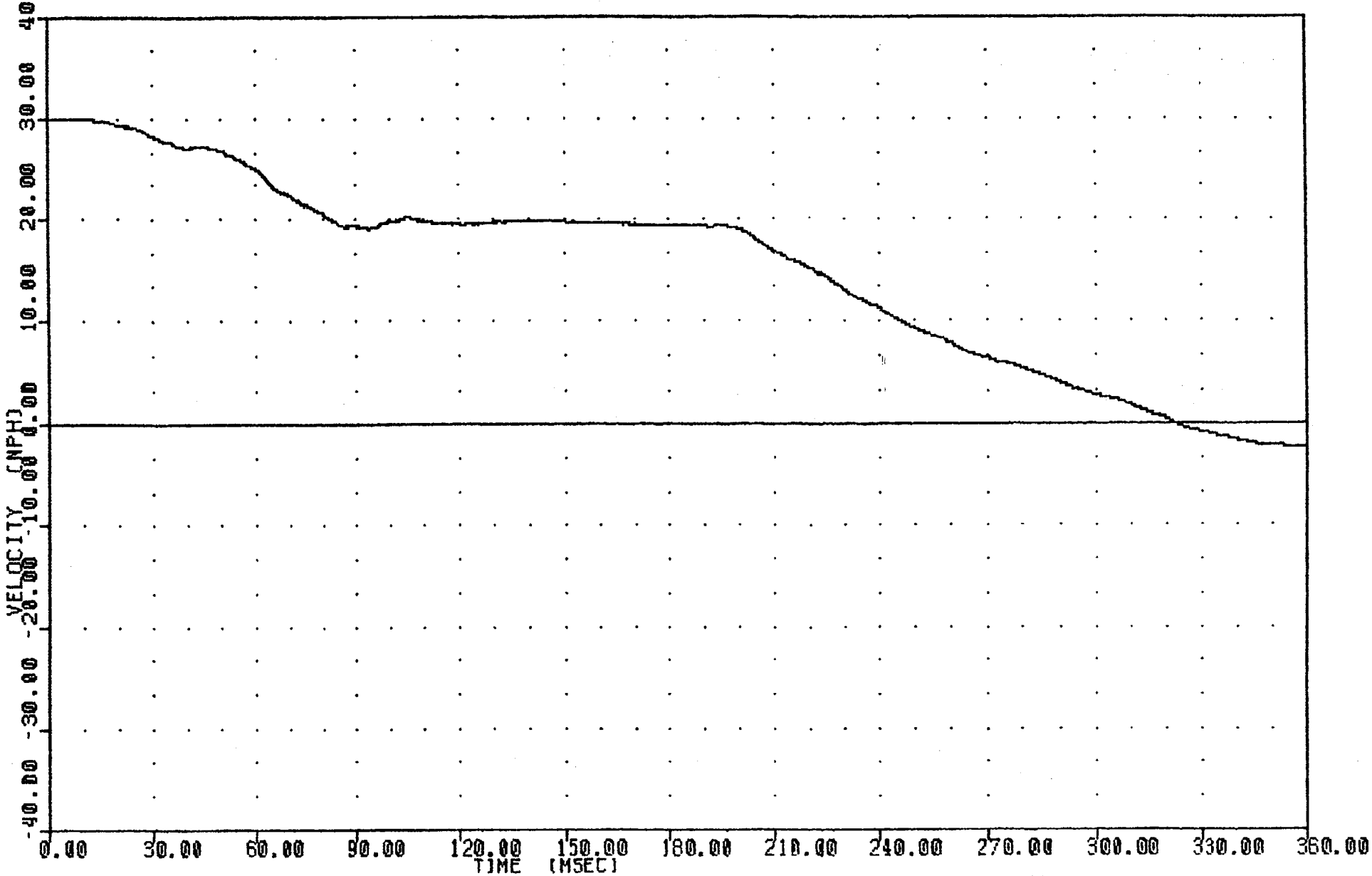
FILTER = BLPP 100/ 250/ -16
MIN, MAX VALUES = -17.30 @ 63.38 , 6.74 @ 97.13



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY X-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
YCGXV1

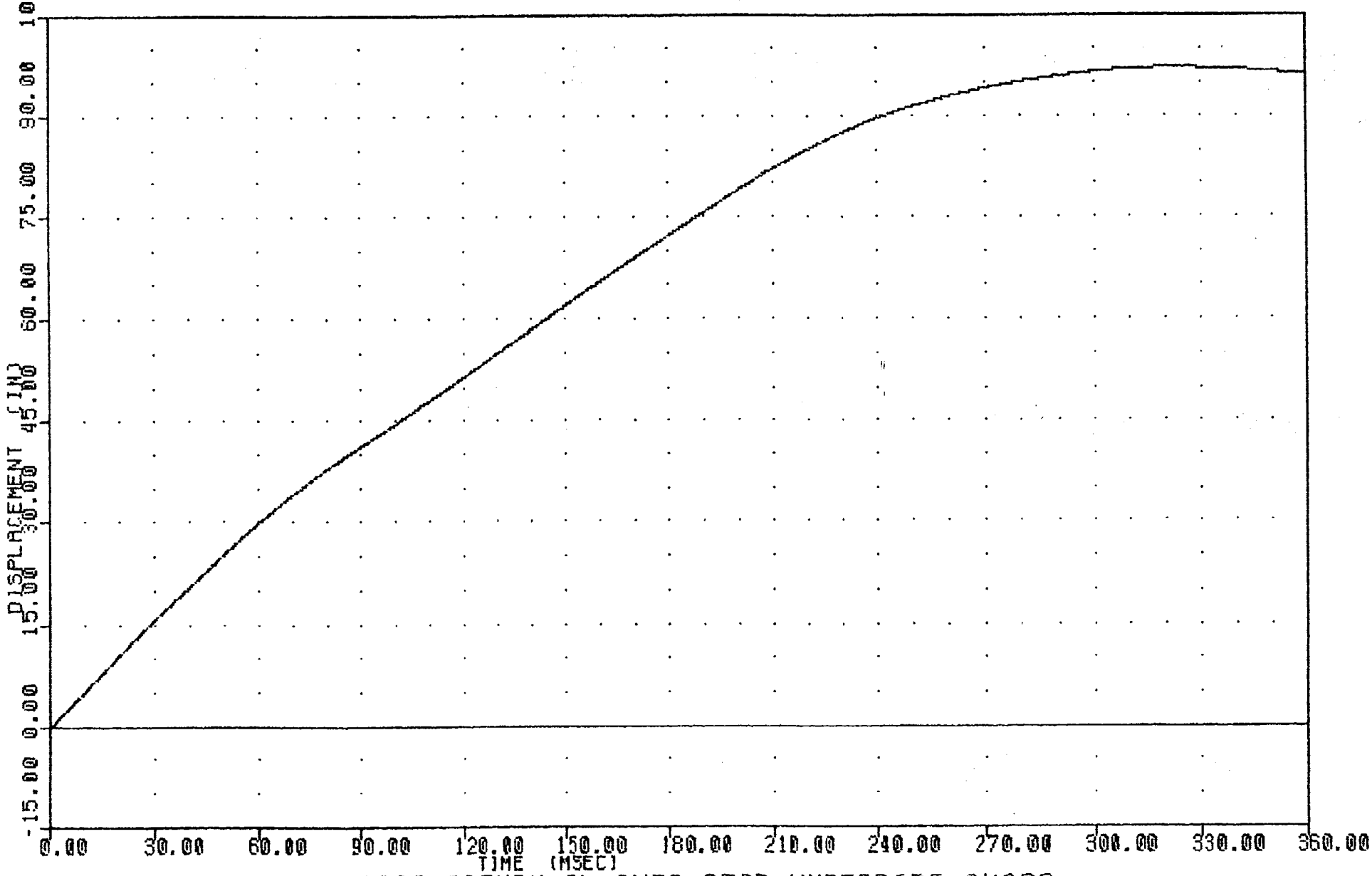
FILTER = ALPF 1650/ 5214/ -40
MIN. MAX VALUES = -2.21 @ 355.25 , 30.01 @ 5.38



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY X-AXIS VELOCITY

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
VCGXD1

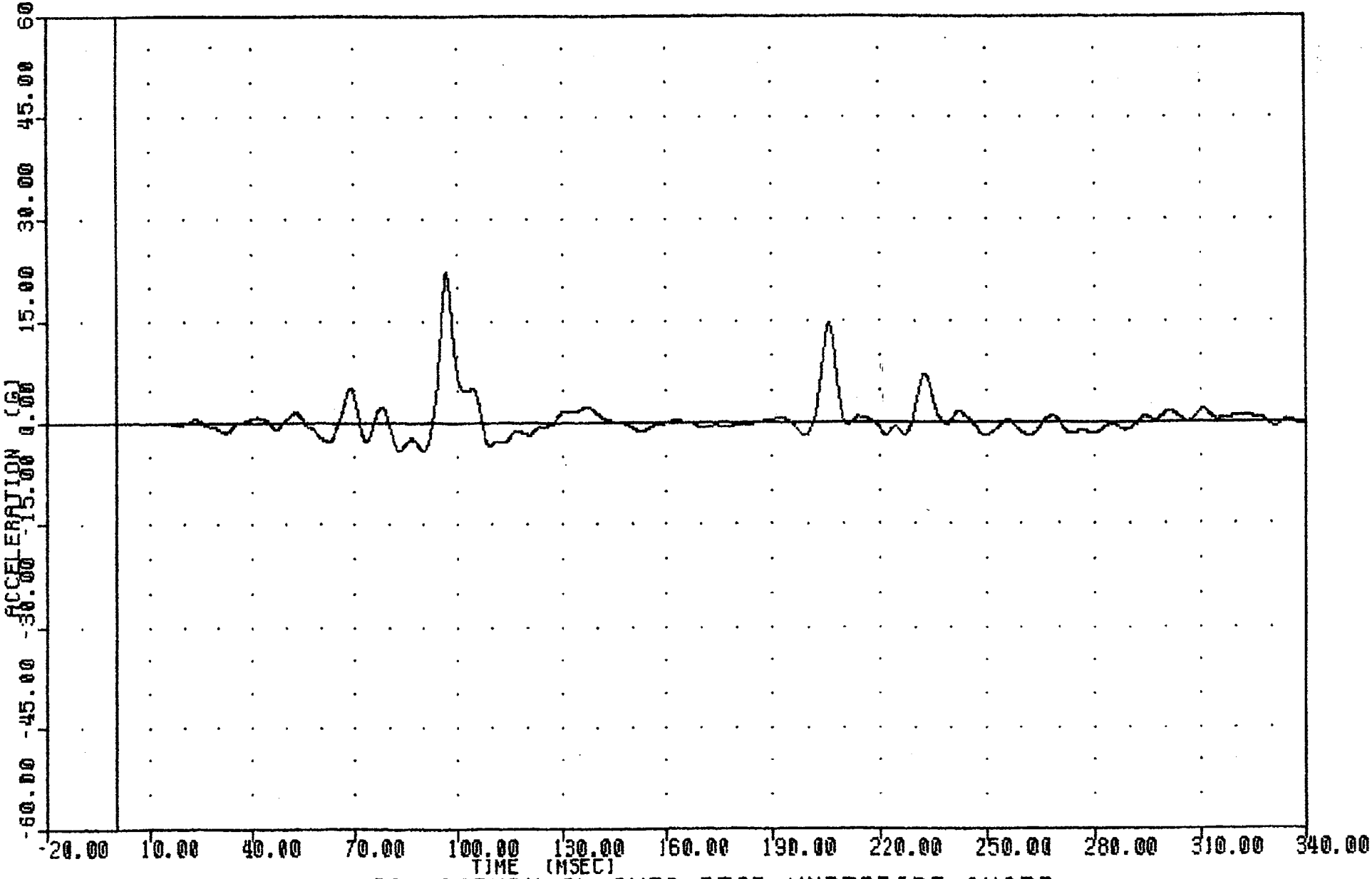
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = 0.00 @ 0.00 , 97.14 @ 322.63



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY X-AXIS DISPLACEMENT

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
VCGYG1

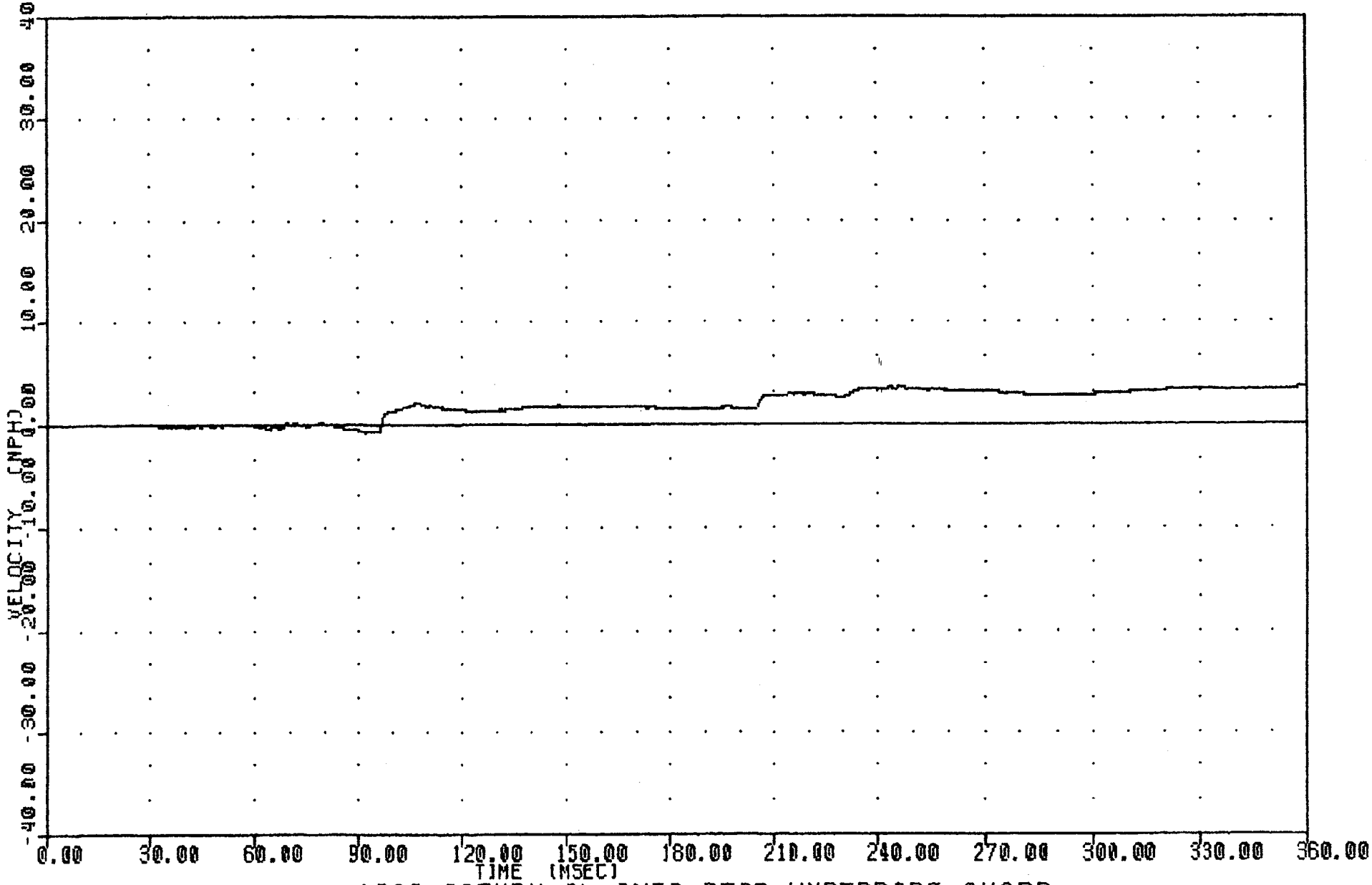
FILTER = BLPP 100/ 250/ -16
MIN, MAX VALUES = -4.21 @ 83.00 , 22.28 @ 96.63



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY Y-AXIS ACCELERATION

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
VCGYV1

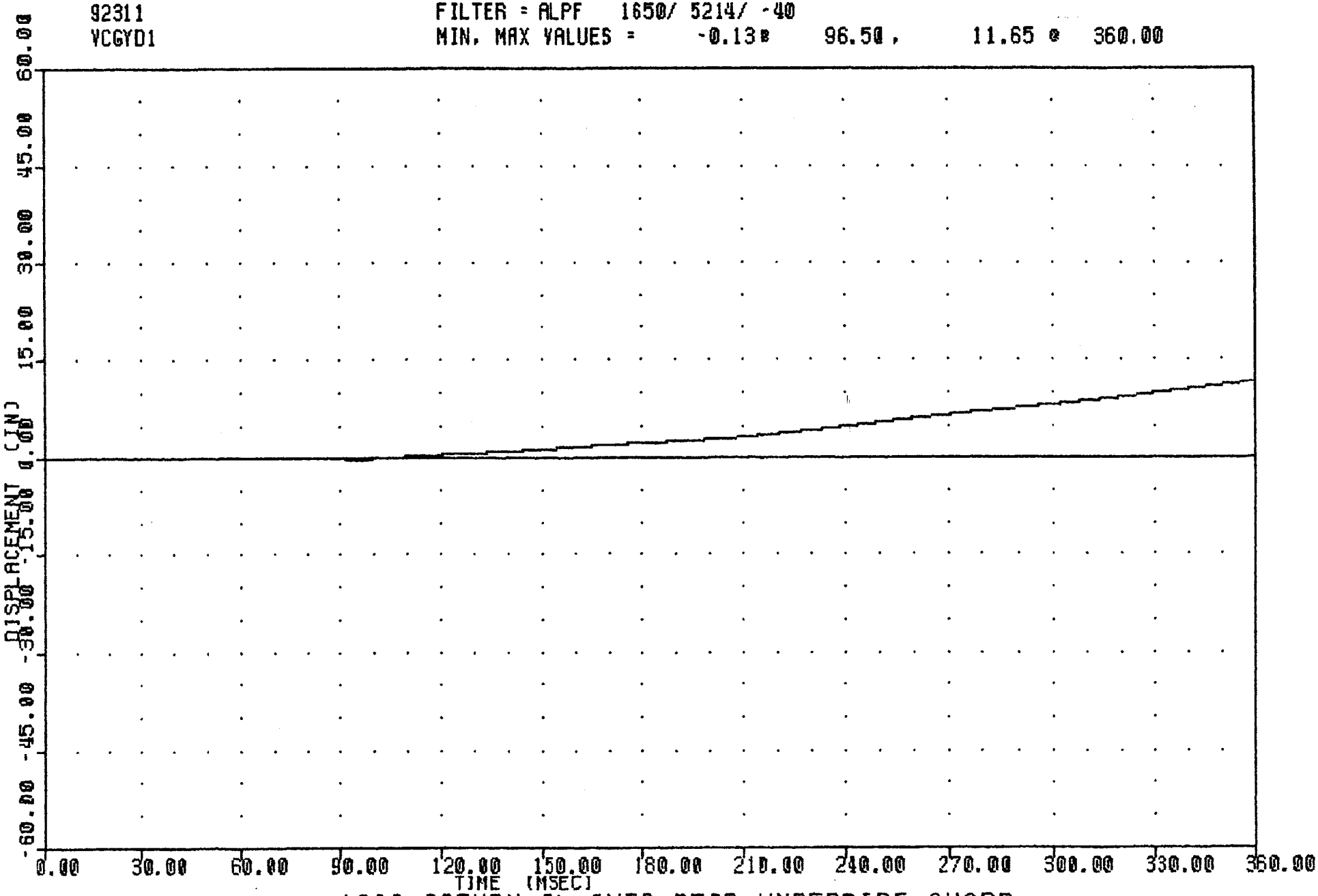
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -0.69 @ 91.88 , 3.60 @ 247.25



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY Y-AXIS VELOCITY

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
YCGYD1

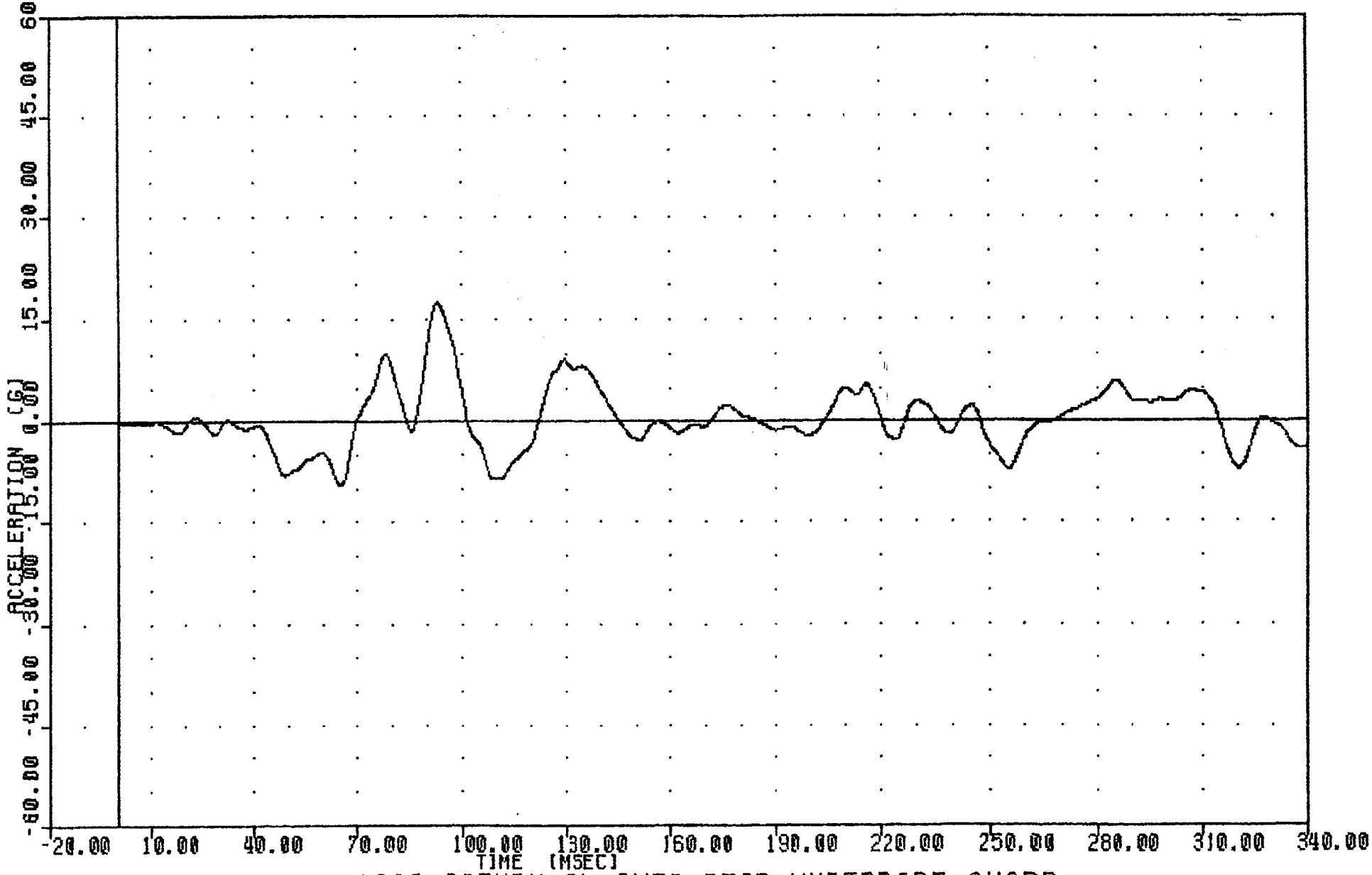
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -0.13 @ 96.50 , 11.65 @ 360.00



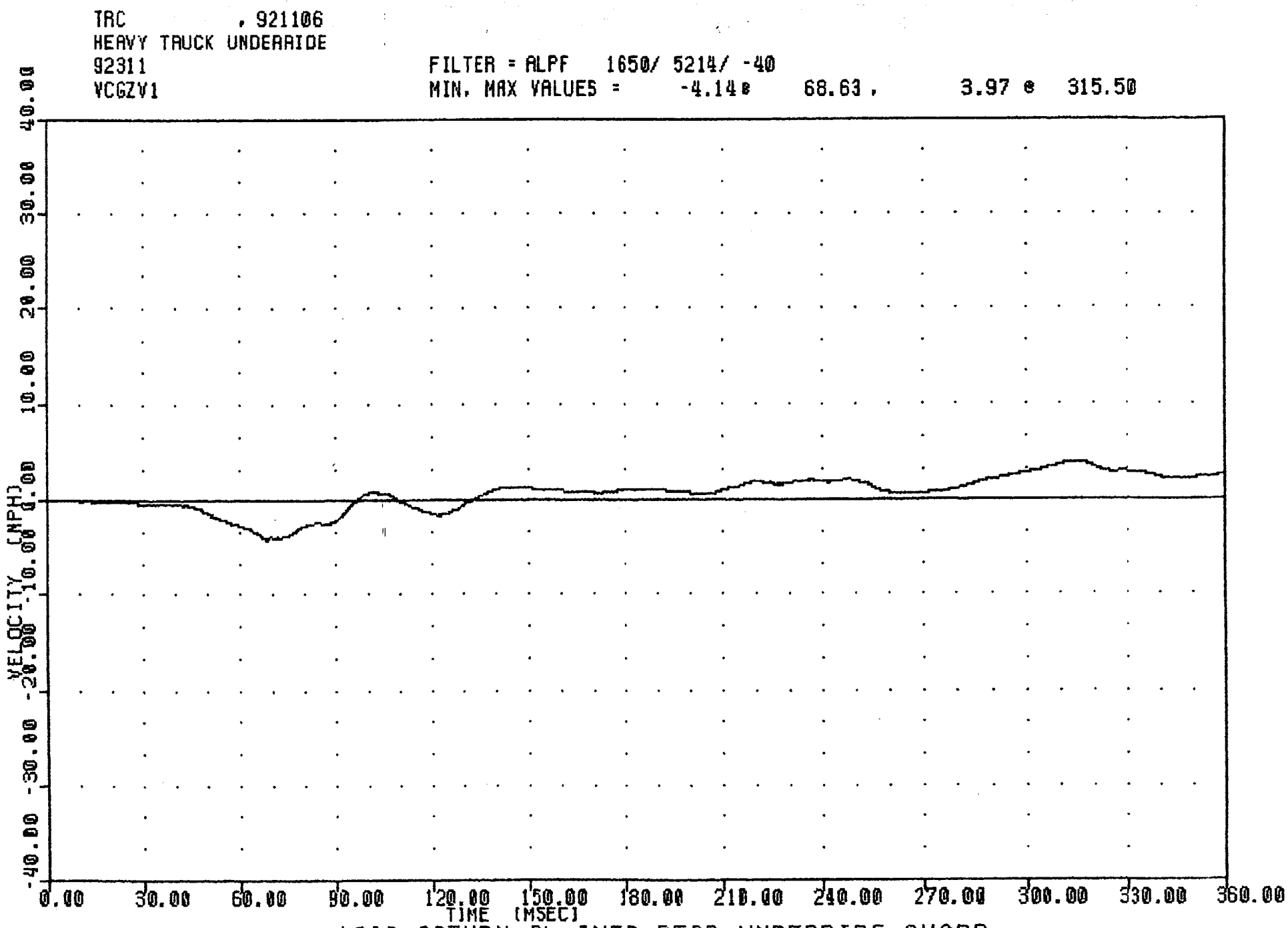
1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY Y-AXIS DISPLACEMENT

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
VCGZG1

FILTER = BLPP 100/ 250/ -16
MIN. MAX VALUES = -9.48 @ 65.13 , 17.43 @ 93.00



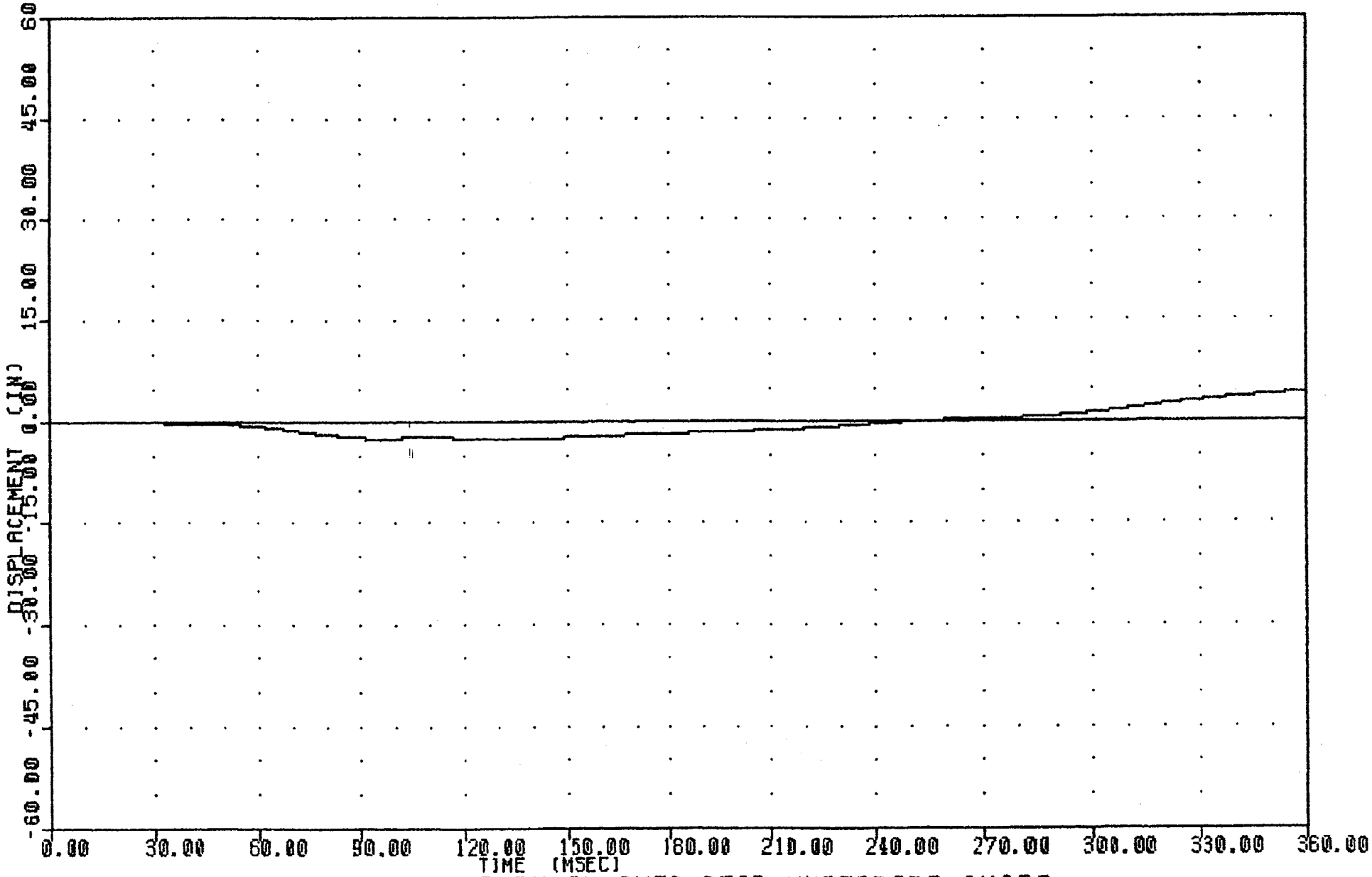
1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY Z-AXIS ACCELERATION



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY Z-AXIS VELOCITY

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
VCGZD1

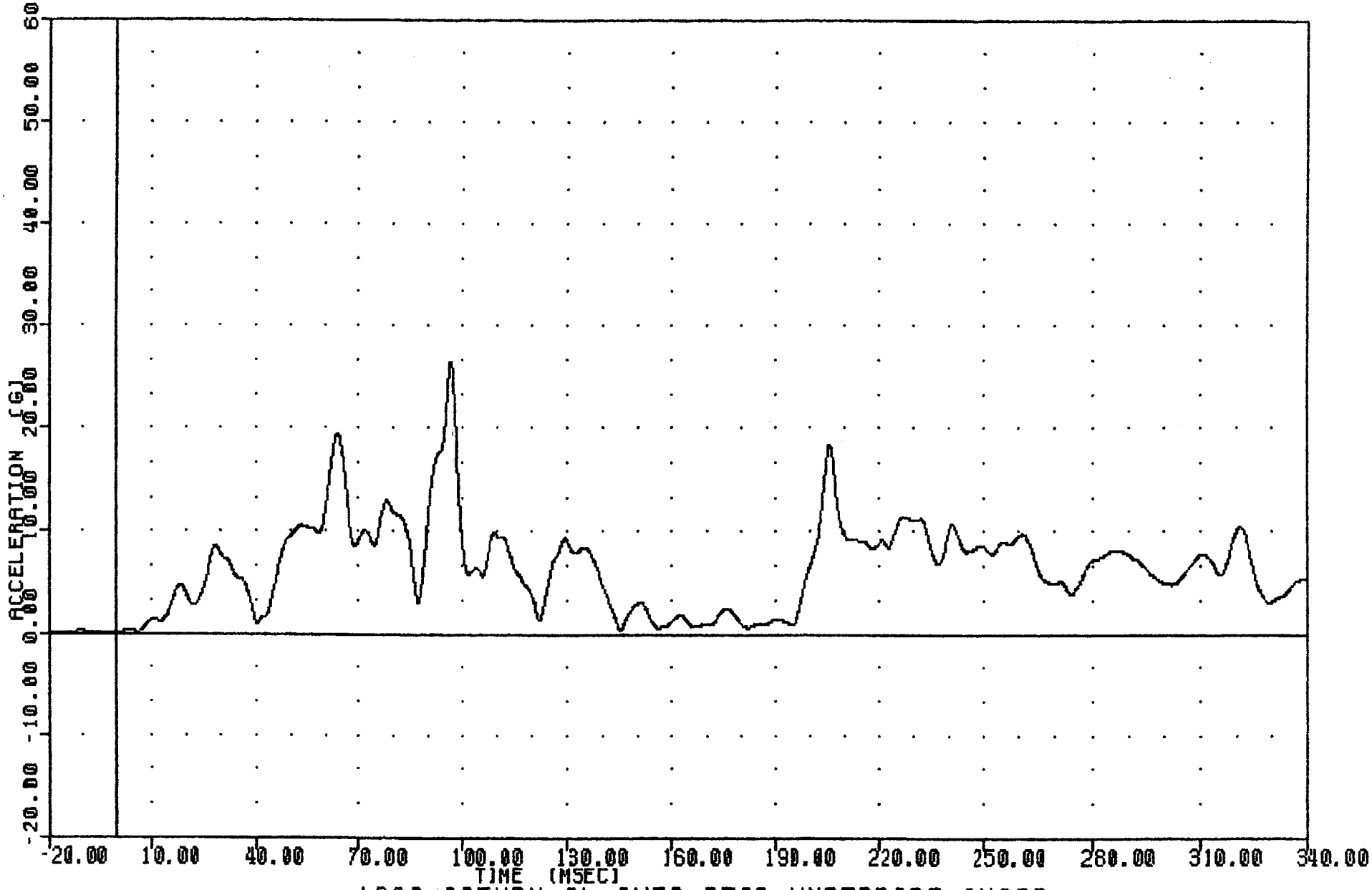
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -2.60 @ 132.88 , 4.33 @ 360.00



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY Z-AXIS DISPLACEMENT

TRC , 921106
HEAVY TRUCK UNDERRIDE
92311
YCGRG1

FILTER = BLPP 100/ 250/ -16
MIN, MAX VALUES = 0.02@ -19.25 , 26.50 @ 96.63



1993 SATURN SL INTO REAR UNDERRIDE GUARD
CAR CENTER OF GRAVITY RESULTANT ACCELERATION

APPENDIX C

DUMMY CERTIFICATION DATA

PRE-TEST CERTIFICATION DATA

DRIVER DUMMY S/N 048

TRANSPORTATION RESEARCH CENTER OF OHIO
HYBRID III EXTERNAL DIMENSIONS
HUMANOID 048

19-AUG-92

TRC 48C3ED1 572E SN048 EXT. DIMENSION CAL03

TEST PARAMETER	(DIMEN.)	SPECIFICATION	TEST RESULTS
TEMPERATURE			70.0 DEG. F
RELATIVE HUMIDITY			56.0 %
LOCATION FOR CHEST CIRCUMFERENCE	(AA)	16.9-17.1 IN	17.0 IN
LOCATION FOR WAIST CIRCUMFERENCE	(BB)	8.9- 9.1 IN	9.0 IN
CHEST CIRCUMFERENCE	(Y)	38.2-39.4 IN	38.8 IN
WAIST CIRCUMFERENCE	(Z)	32.9-34.1 IN	33.5 IN
CHEST DEPTH	(O)	8.4- 9.0 IN	8.6 IN
H-POINT HEIGHT	(C)	3.3- 3.5 IN	3.4 IN
H-POINT FROM SEATBACK	(D)	5.3- 5.5 IN	5.4 IN
SKULL CAP TO BACKLINE	(H)	1.6- 1.8 IN	1.7 IN
TOTAL SITTING HEIGHT	(A)	34.6-35.0 IN	34.8 IN
THIGH CLEARANCE	(F)	5.5- 6.1 IN	6.1 IN
BUTTOCK KNEE LENGTH	(K)	22.8-23.8 IN	23.5 IN
BUTTOCK POPLITEAL LENGTH	(N)	17.8-18.8 IN	18.5 IN
POPLITEAL HEIGHT	(L)	16.9-17.9 IN	17.0 IN
KNEE PIVOT HEIGHT	(M)	19.1-19.7 IN	19.4 IN
FOOT LENGTH	(P)	9.9-10.5 IN	10.2 IN
FOOT BREADTH	(W)	3.6- 4.2 IN	3.9 IN
SHOULDER PIVOT FROM BACKLINE	(E)	3.3- 3.7 IN	3.6 IN
SHOULDER BREADTH	(V)	16.6-17.2 IN	16.8 IN
SHOULDER PIVOT HEIGHT	(B)	19.9-20.5 IN	20.1 IN
ELBOW REST HEIGHT	(J)	7.5- 8.3 IN	8.0 IN
SHOULDER-ELBOW LENGTH	(I)	13.0-13.6 IN	13.5 IN
BACK OF ELBOW TO WRIST PIVOT	(G)	11.4-12.0 IN	11.6 IN

TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fonts

TRANSPORTATION RESEARCH CENTER OF OHIO

HEAD DROP TEST

HYBRID III

29-OCT-92

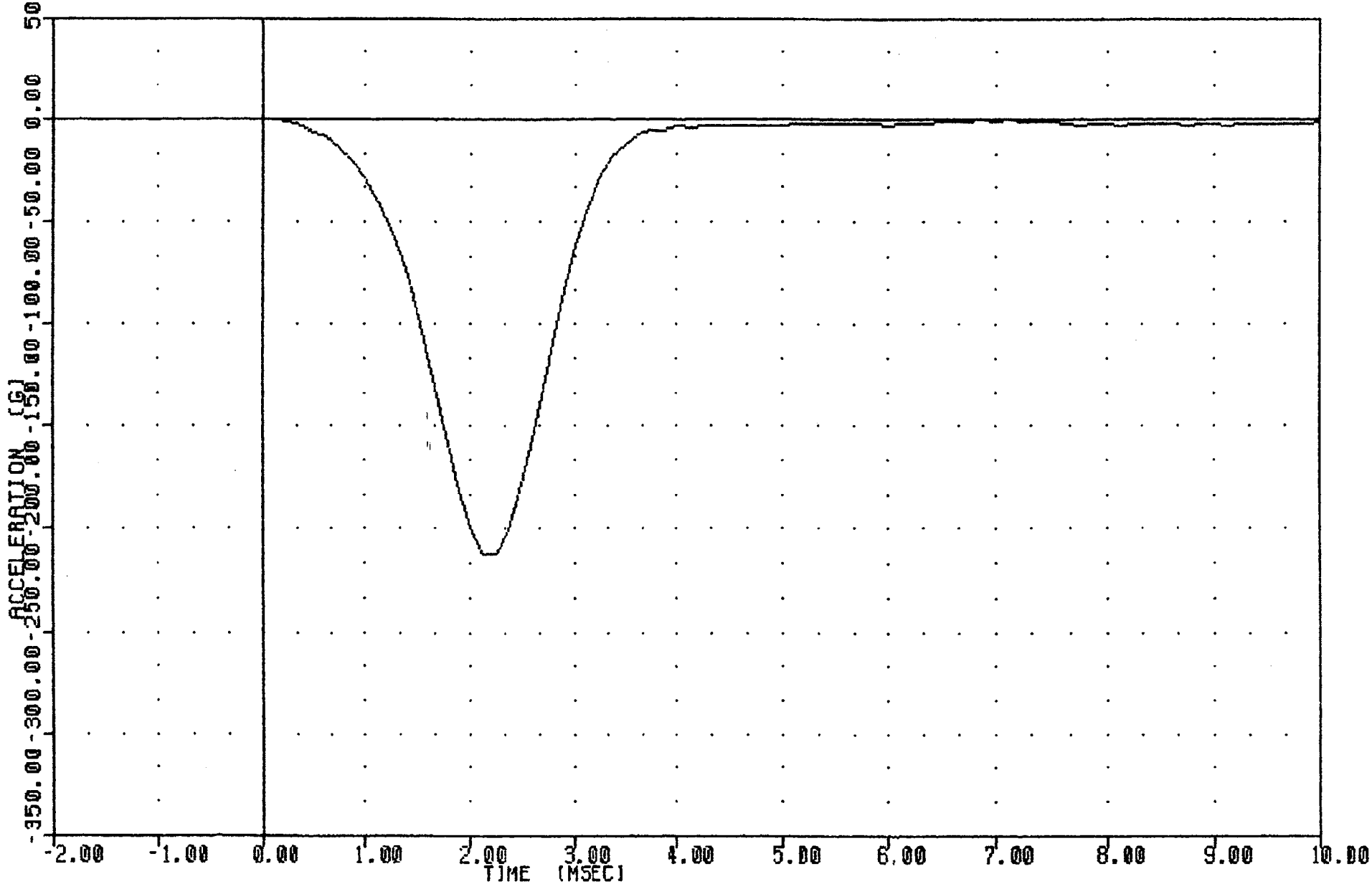
TRC 48C3HD2 572E SN48 HEAD DROP CAL 03

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	71.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PEAK RESULTANT ACCELERATION	225 - 275 G	244.09 G
PEAK LATERAL ACCELERATION	15 G MAX	-5.09 G
IS ACCELERATION CURVE UNIMODAL?	YES	YES

TEST MEETS SPECIFICATIONS

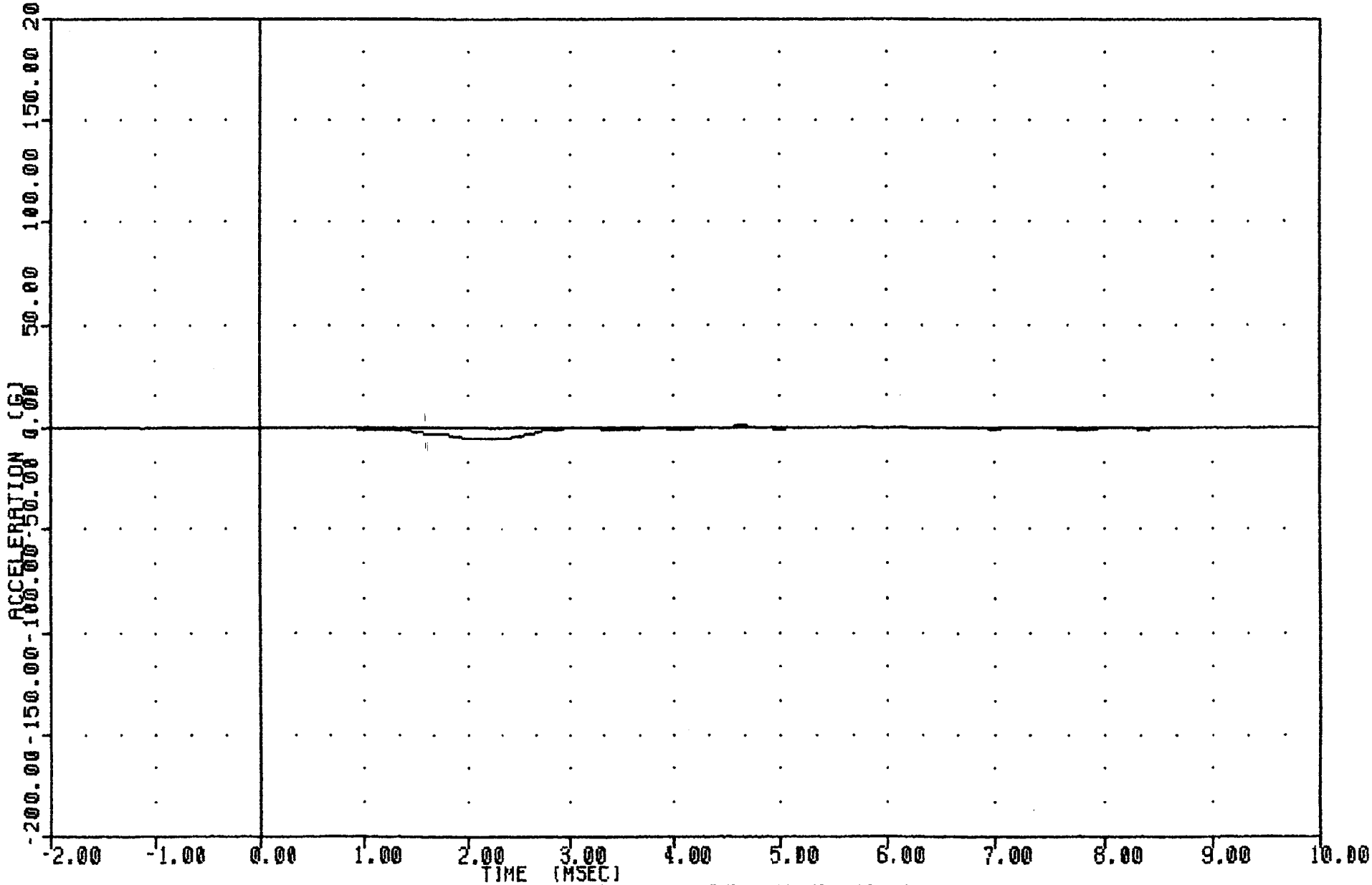
TECHNICIAN Pete Tant

TRC , 48C3HD2
572E SN48 HEAD DROP CAL 03
92303 FILTER = ALPF 1650/ 5214/ -40
HEDXG MIN. MAX VALUES = -212.68 @ 2.25 , 0.00 @ -2.00



PART 572-E HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Y AXIS

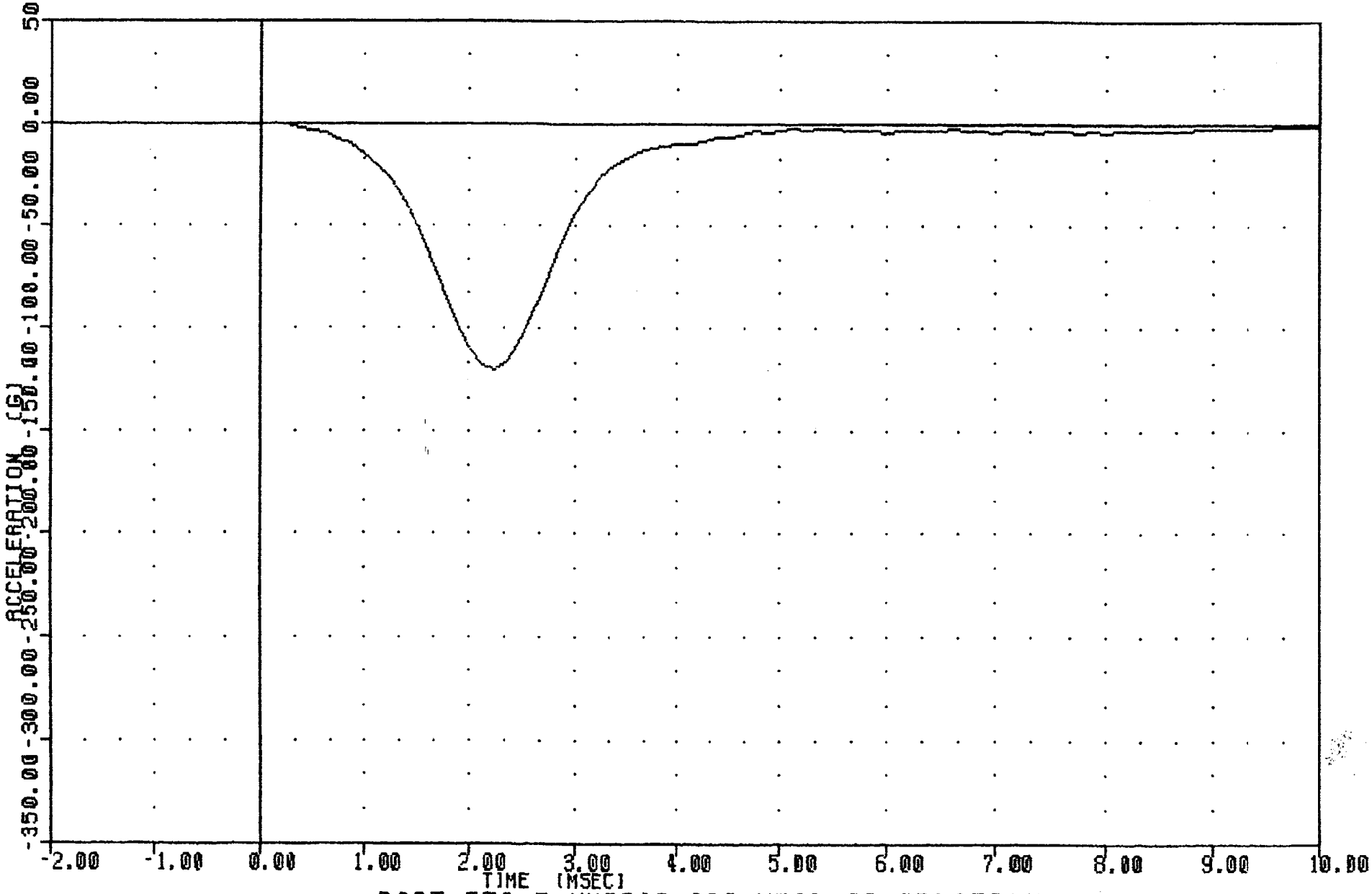
TRC , 48C3HD2
572E SN40 HEAD DROP CAL 03
92303 FILTER = ALPF 1650/ 5214/ -40
HEDYG MIN, MAX VALUES = -5.10 @ 2.25 , 0.82 @ 4.63



PART 572-E HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Y AXIS

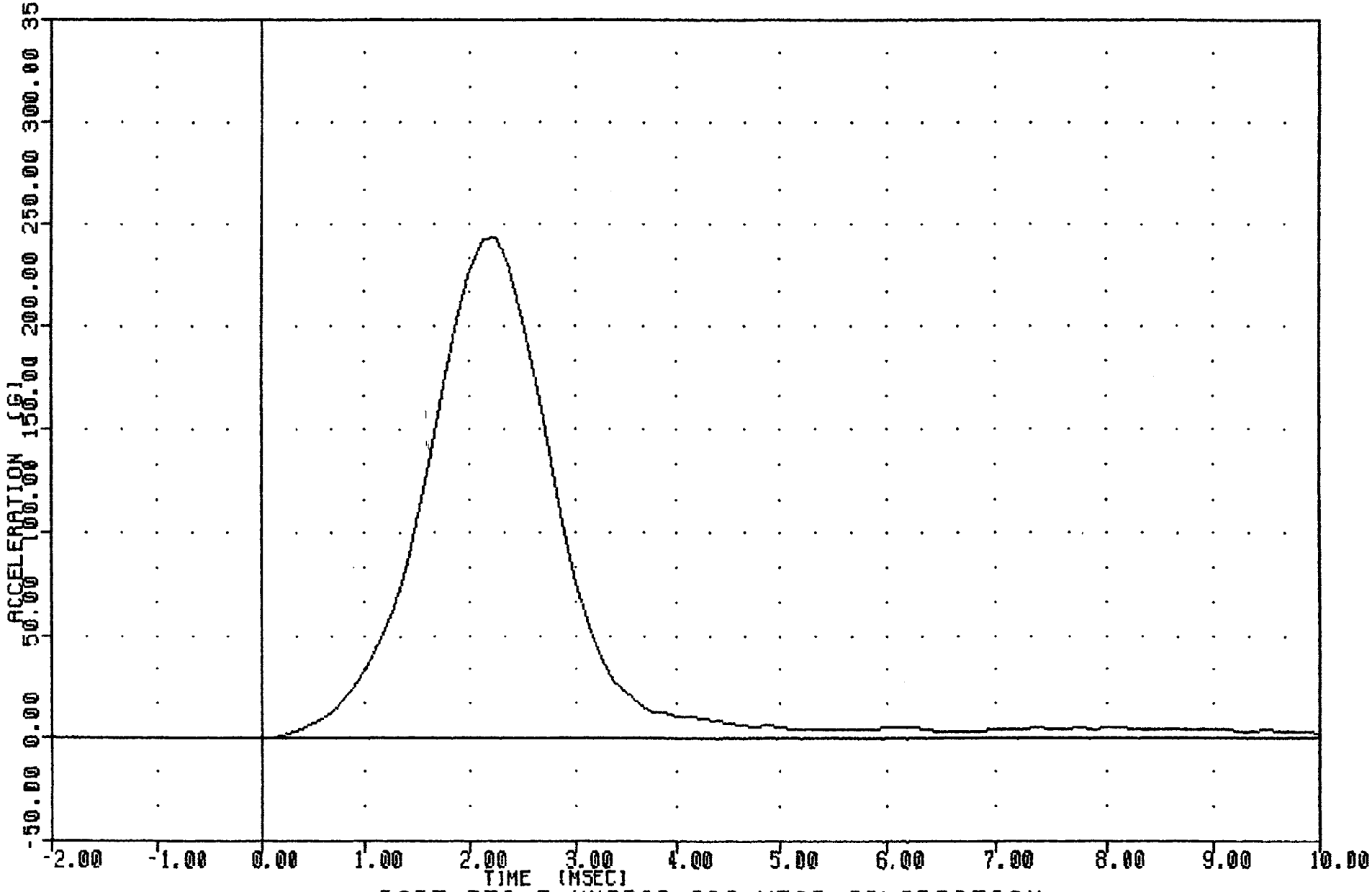
TRC , 48C3HD2
572E SN40 HEAD DROP CAL 03
92303
HEDZG

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -119.66 @ 2.25 , 0.00 @ -2.00



PART 572-E HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Z AXIS

TRC , 48C3HD2
572E SN48 HEAD DROP CAL 03
92303 FILTER = ALPF 1650/ 5214/ -40
HEDRG MIN, MAX VALUES = 0.00 @ -2.00 , 244.09 @ 2.25



PART 572-E HYBRID III HEAD CALIBRATION
HEAD RESULTANT ACCELERATION

TRANSPORTATION RESEARCH CENTER OF OHIO

NECK FLEXION TEST

HYBRID III 19-AUG-92

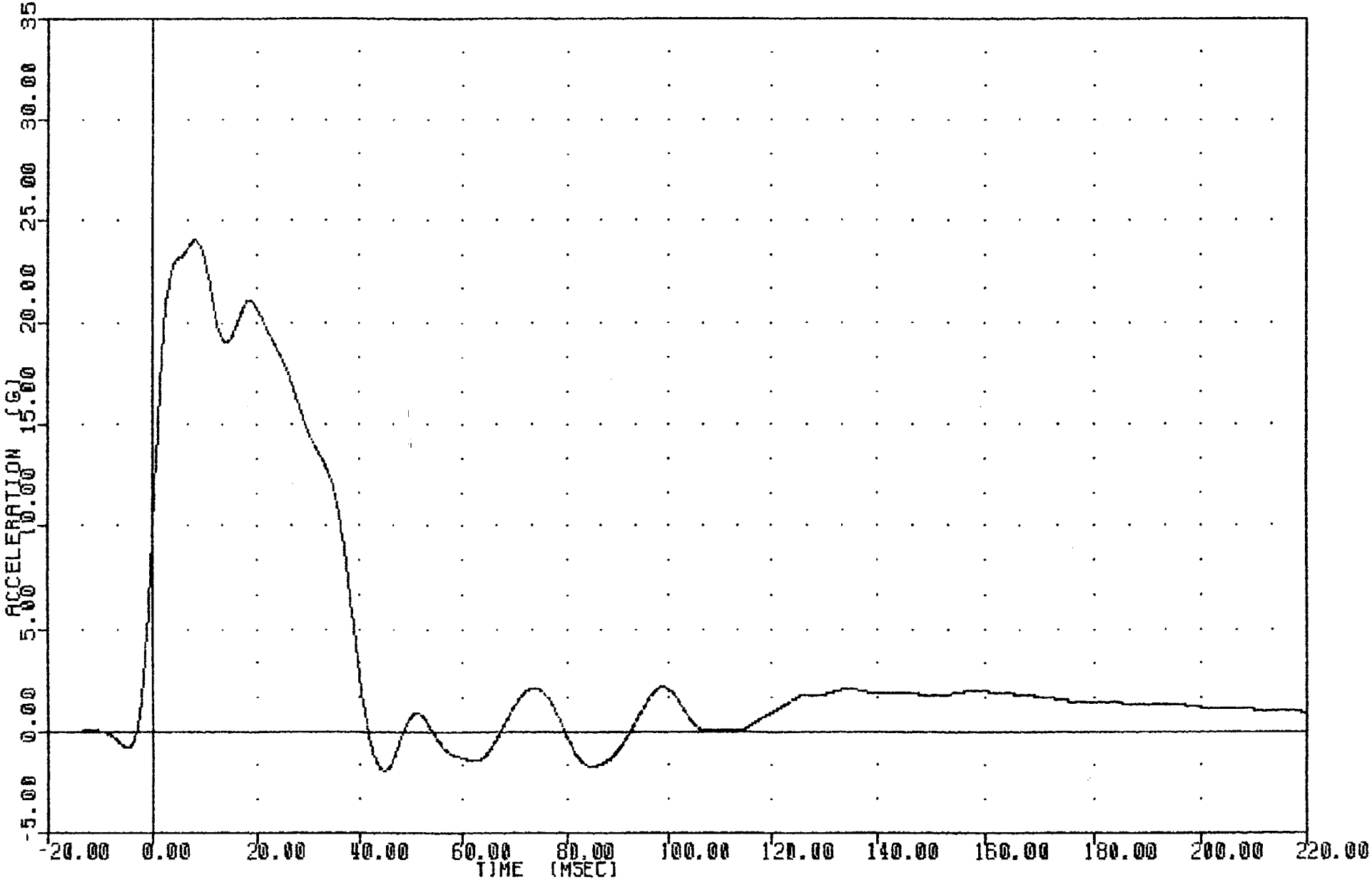
6 AXIS NECK TRANSDUCER
TRC 48C3NF2 572E SN48 NECK FLEXION CAL03

TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY		10% - 70%	57.0 %
IMPACT VELOCITY		22.6 - 23.4 FT/SEC	23.08 FT/SEC
PENDULUM DECELERATION	10 MS	22.50 - 27.50 G	22.86 G
	20 MS	17.60 - 22.60 G	20.74 G
	30 MS	12.50 - 18.50 G	14.62 G
MAX PENDULUM G ABOVE 30 MS		29 G MAX	14.55 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		34 - 42 MS	38.75 MS
D PLANE ROTATION	MAX	64 - 78 DEG.	70.53 DEG.
	TIME	57 - 64 MS	58.00 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MAX	65 - 80 FT.LBS	68.85 FT.LBS
	TIME	47 - 58 MS	51.13 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		113 - 128 MS	117.38 MS
POSITIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		97 - 107 MS	99.63 MS

TEST MEETS SPECIFICATIONS

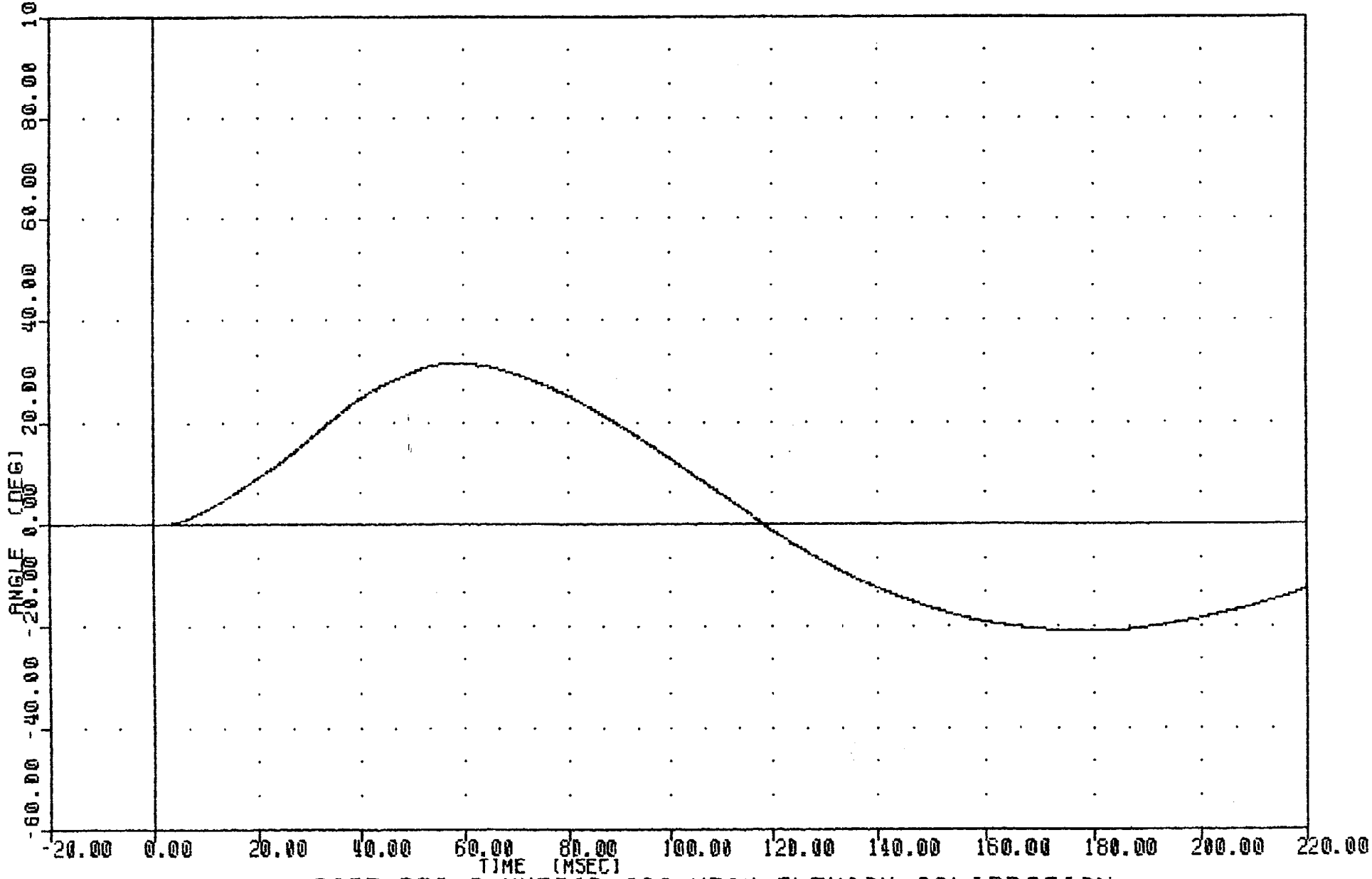
TECHNICIAN Pete Font

TRC , 48C3NF2
572E SN48 NECK FLEXION CAL03
92232 FILTER = BLPP 100/ 317/ -40
PENXG MIN, MAX VALUES = -1.91 @ 44.63 , 24.01 @ 8.13



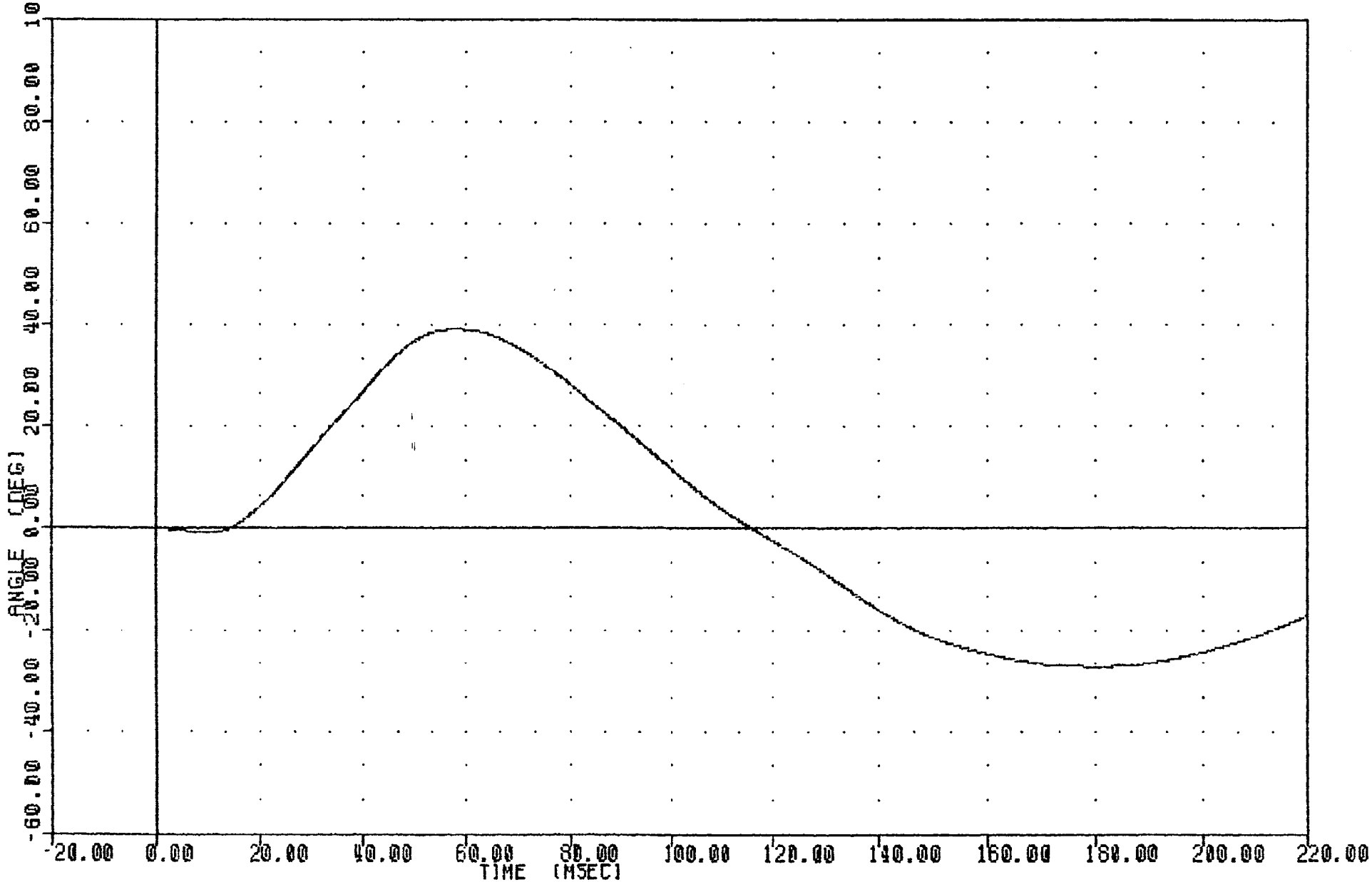
PART 572-E HYBRID III NECK FLEXION CALIBRATION
PENDULUM DECELERATION

TRC , 48C3NF2
572E SN48 NECK FLEXION CAL03
92232 FILTER = BLPP 100/ 317/ -40
BETA MIN, MAX VALUES = -21.05 @ 181.75 , 31.48 @ 58.38

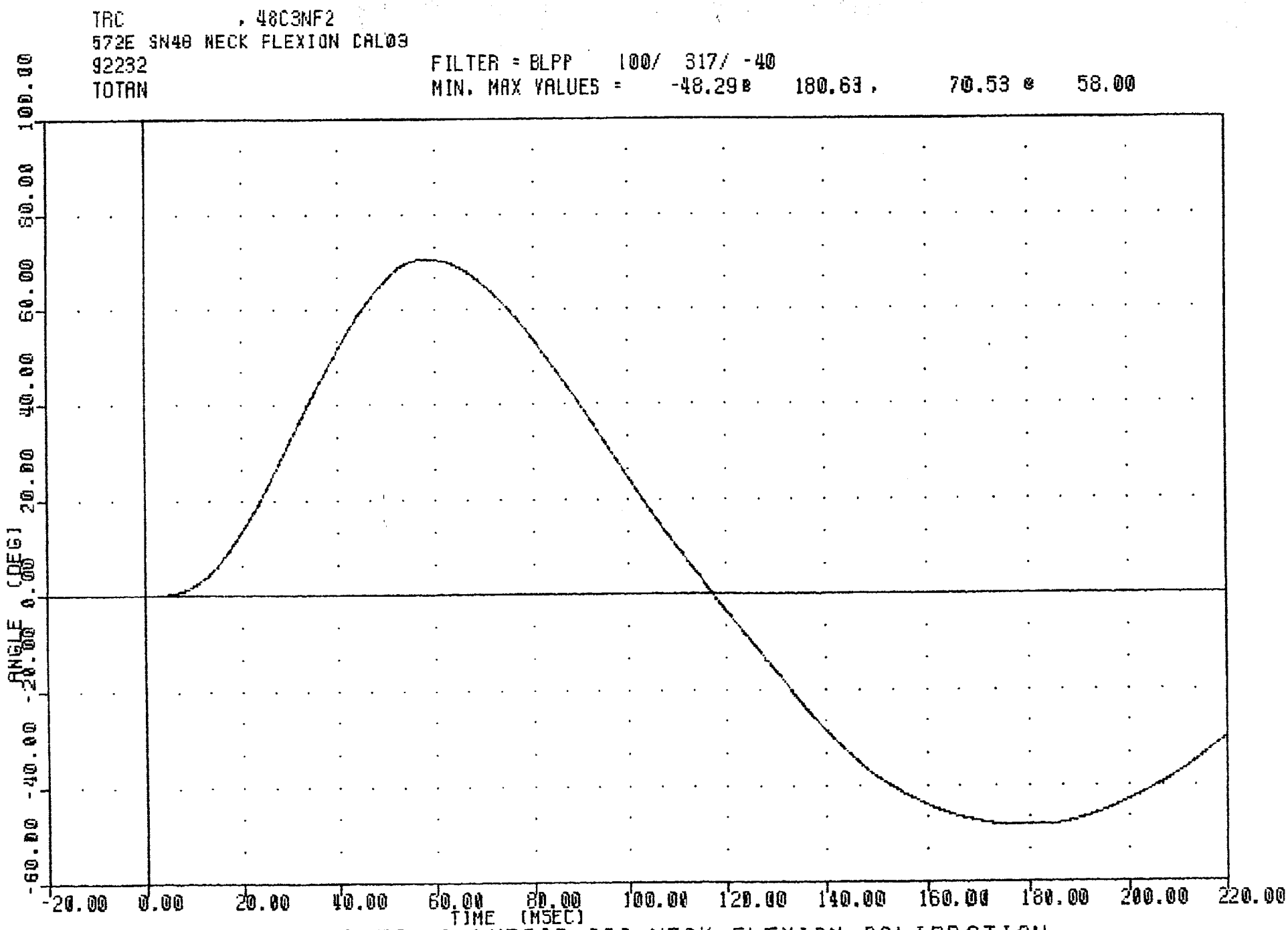


PART 572-E HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT BASE OF NECK

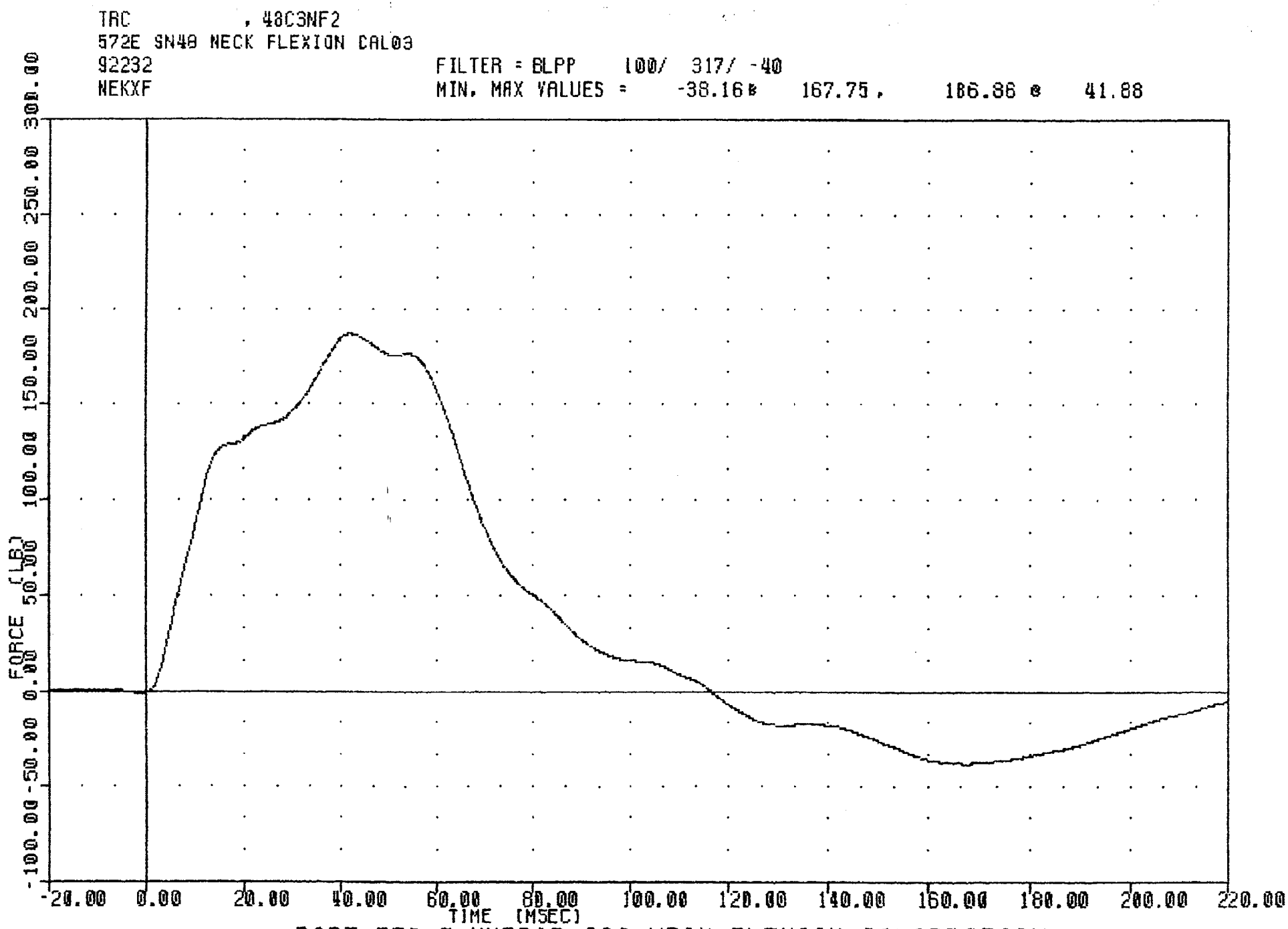
TRC , 48C3NF2
572E SN48 NECK FLEXION CAL03
92232 FILTER = BLPP 100/ 317/ -40
THETA MIN, MAX VALUES = -27.25 @ 180.50 , 39.05 @ 57.88



PART 572-E HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT OCCIPITAL CONDYLE

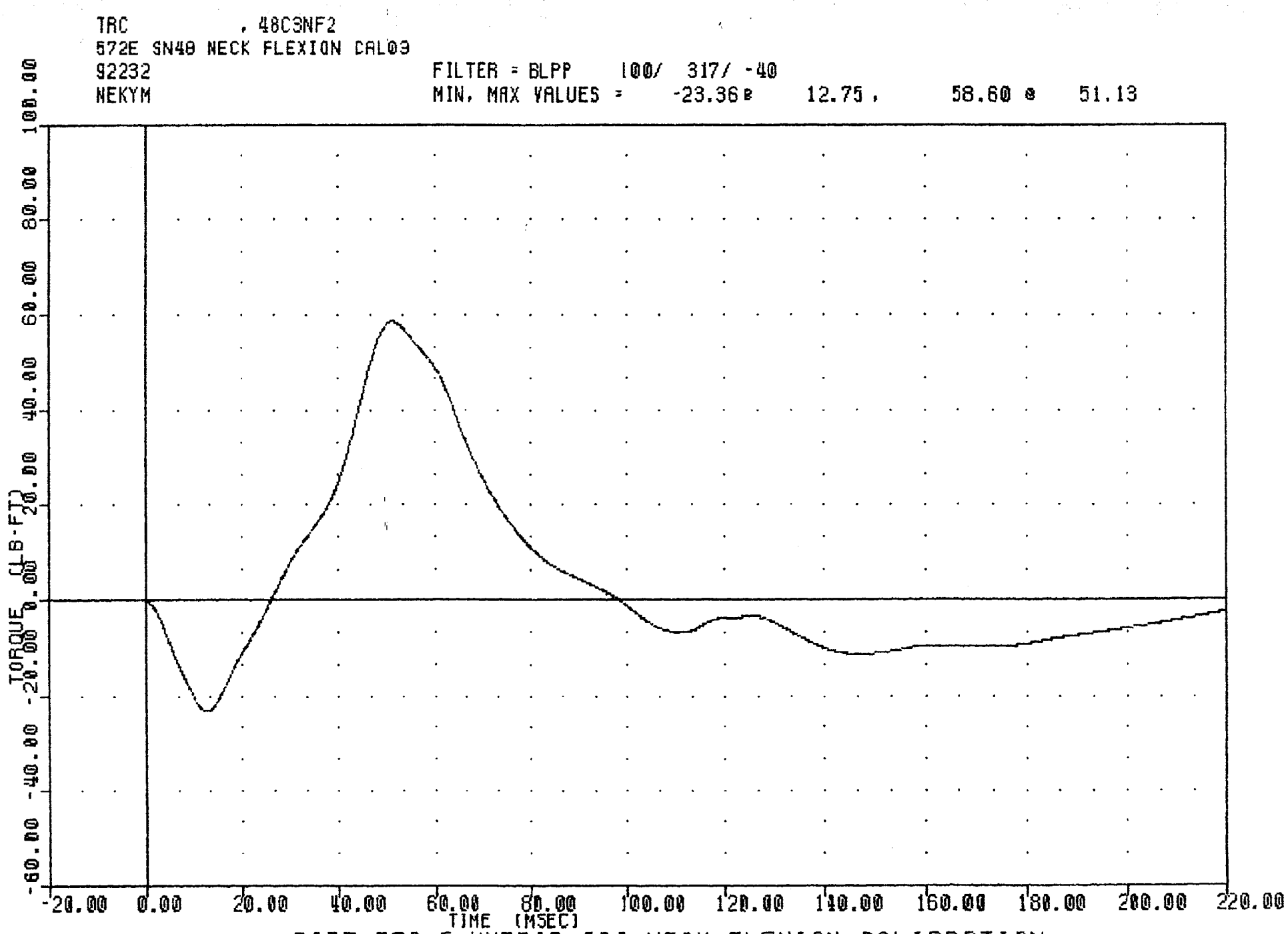


PART 572-E HYBRID III NECK FLEXION CALIBRATION
TOTAL ROTATION

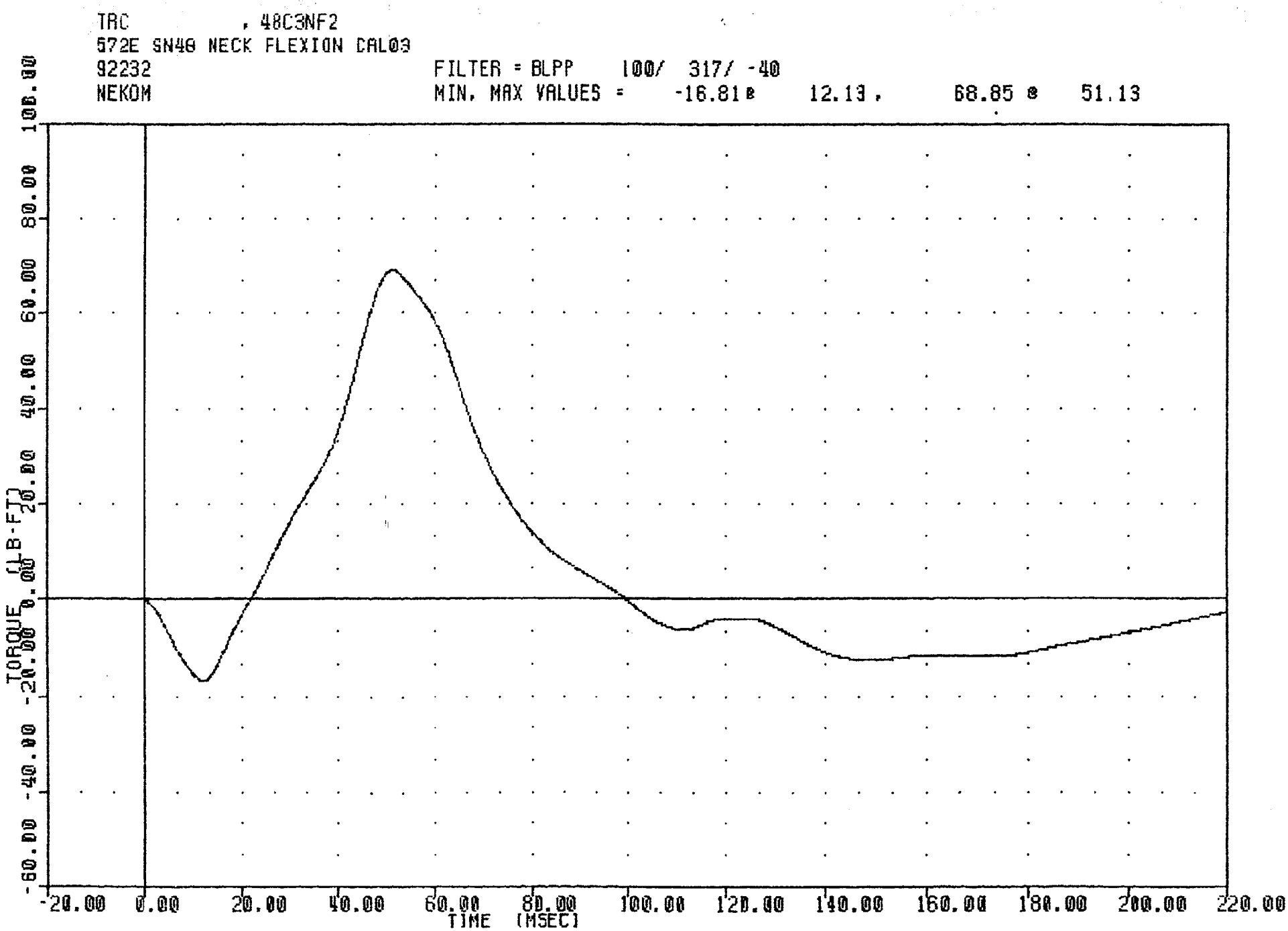


PART 572-E HYBRID III NECK FLEXION CALIBRATION

NECK FORCE Y AXIS



PART 572-E HYBRID III NECK FLEXION CALIBRATION
NECK MOMENT Y AXIS



PART 572-E HYBRID III NECK FLEXION CALIBRATION

TOTAL MOMENT ABOUT OCCIPITAL CONDYLE

TRANSPORTATION RESEARCH CENTER OF OHIO

NECK EXTENSION TEST

HYBRID III 19-AUG-92

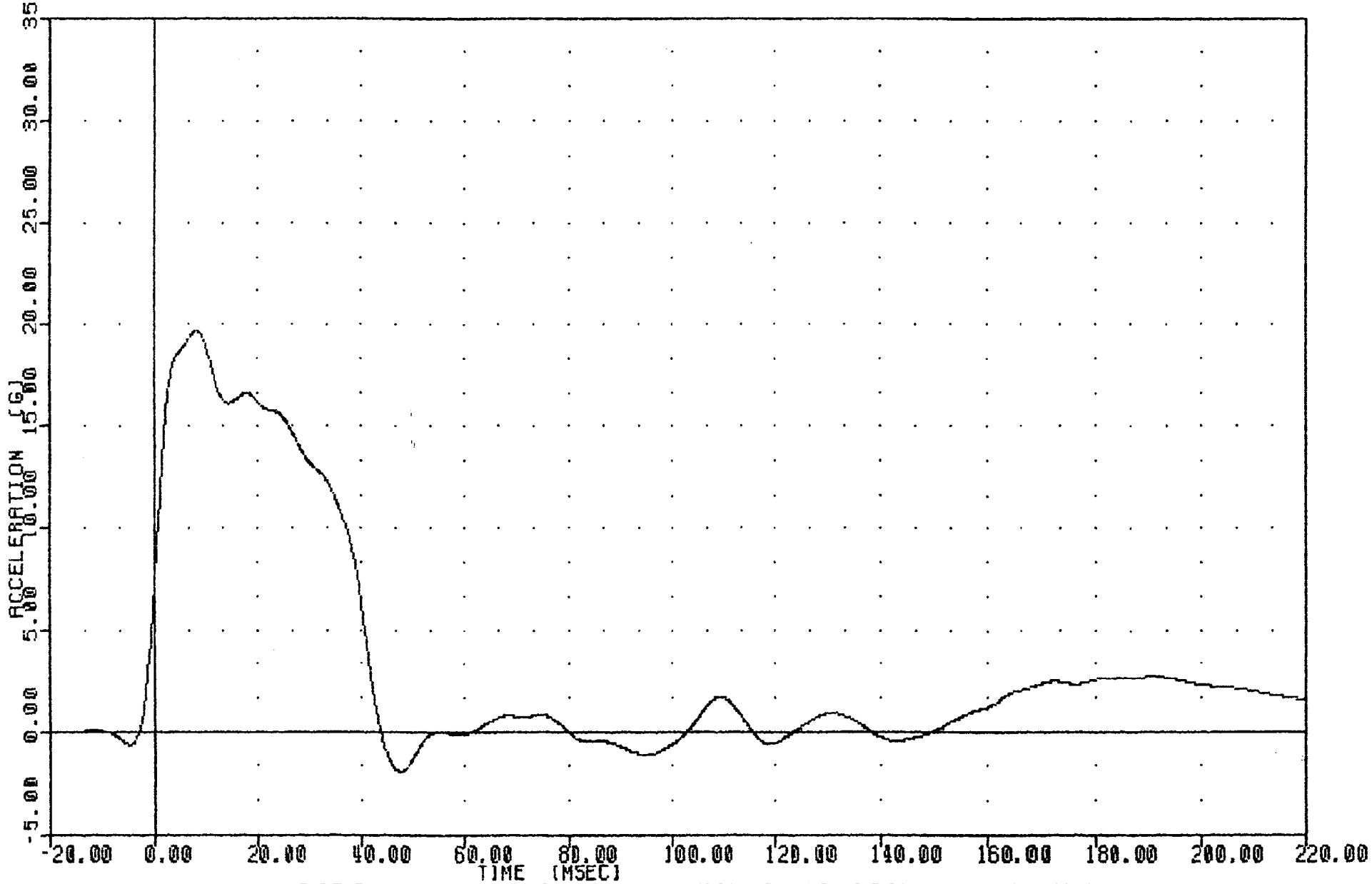
6 AXIS NECK TRANSDUCER
TRC 48C3NE2 572E SN48 NECK EXT. CAL02

TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY		10% - 70%	57.0 %
IMPACT VELOCITY		19.50-20.30 FT/SEC	19.67 FT/SEC
PENDULUM DECELERATION	10 MS	17.20 - 21.20 G	18.85 G
	20 MS	14.00 - 19.00 G	16.23 G
	30 MS	11.00 - 16.00 G	13.25 G
MAX PENDULUM G ABOVE 30 MS		22 G MAX	13.21 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		38 - 46 MS	40.50 MS
D PLANE ROTATION	MAX	81 - 106 DEG.	98.61 DEG.
	TIME	72 - 82 MS	77.63 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MIN	-59.0/-39.0 FT.LBS	-49.68 FT.LBS
	TIME	65 - 79 MS	70.88 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		147 - 174 MS	161.38 MS
NEGATIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		120 - 148 MS	147.50 MS

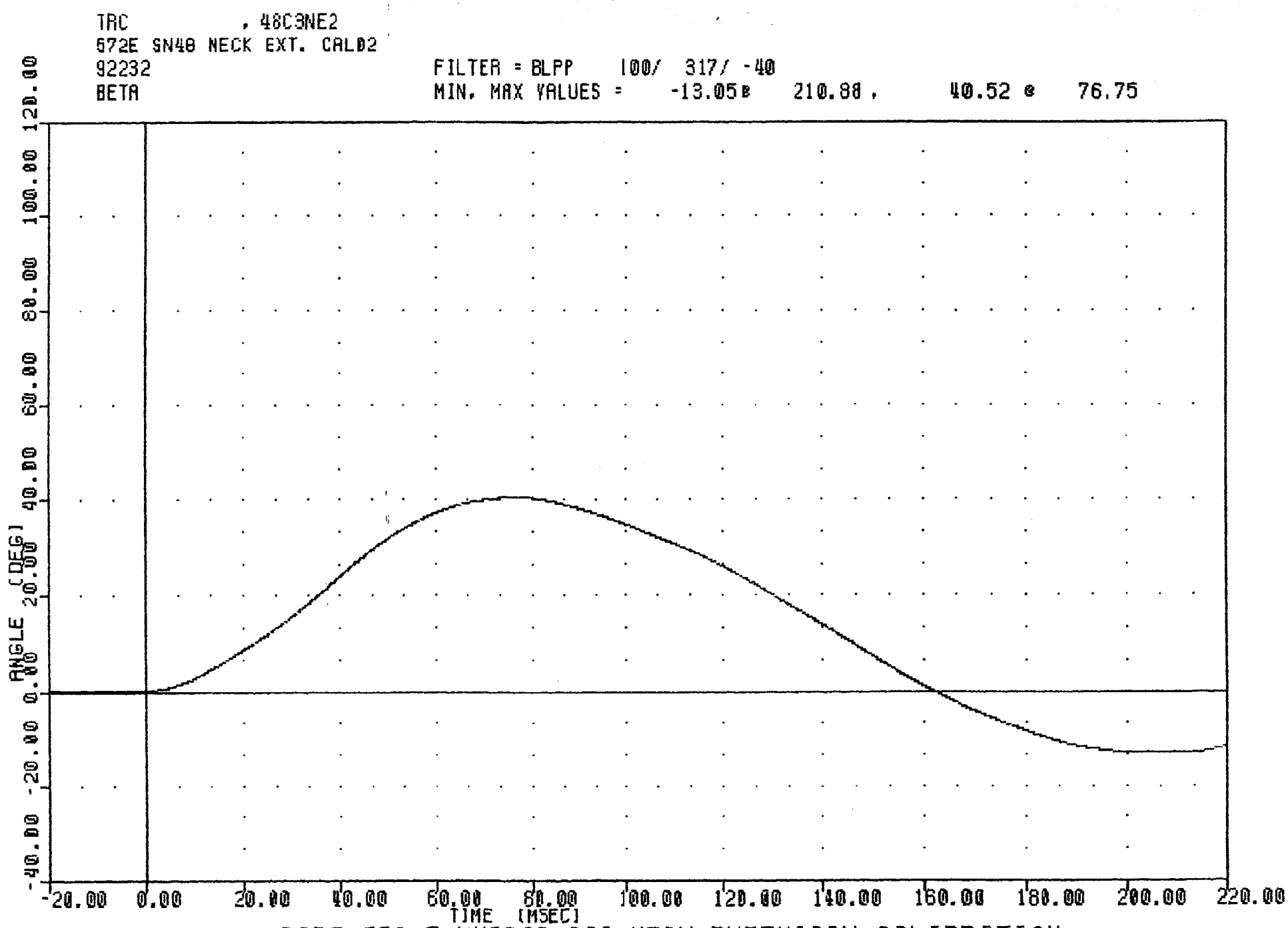
TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fort

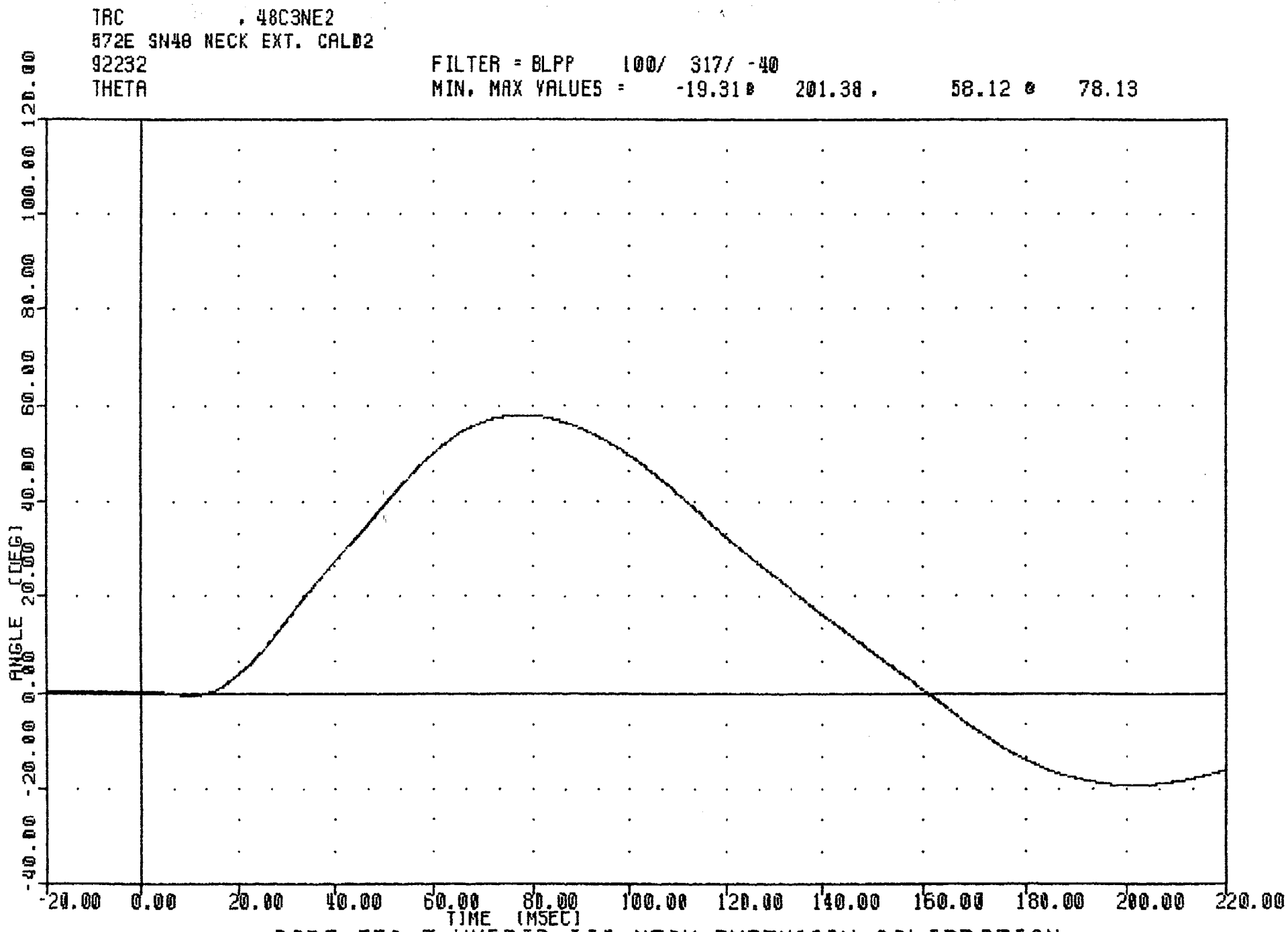
TRC , 48C3NE2
572E SN48 NECK EXT. CALD2
92232 FILTER = BLPP 100/ 317/ -40
PENXG MIN, MAX VALUES = -1.93 @ 47.38 , 19.66 @ 8.25



PART 572-E HYBRID III NECK EXTENSION CALIBRATION
PENDULUM DECELERATION



PART 572-E HYBRID III NECK EXTENSION CALIBRATION
ROTATION ABOUT BASE OF NECK

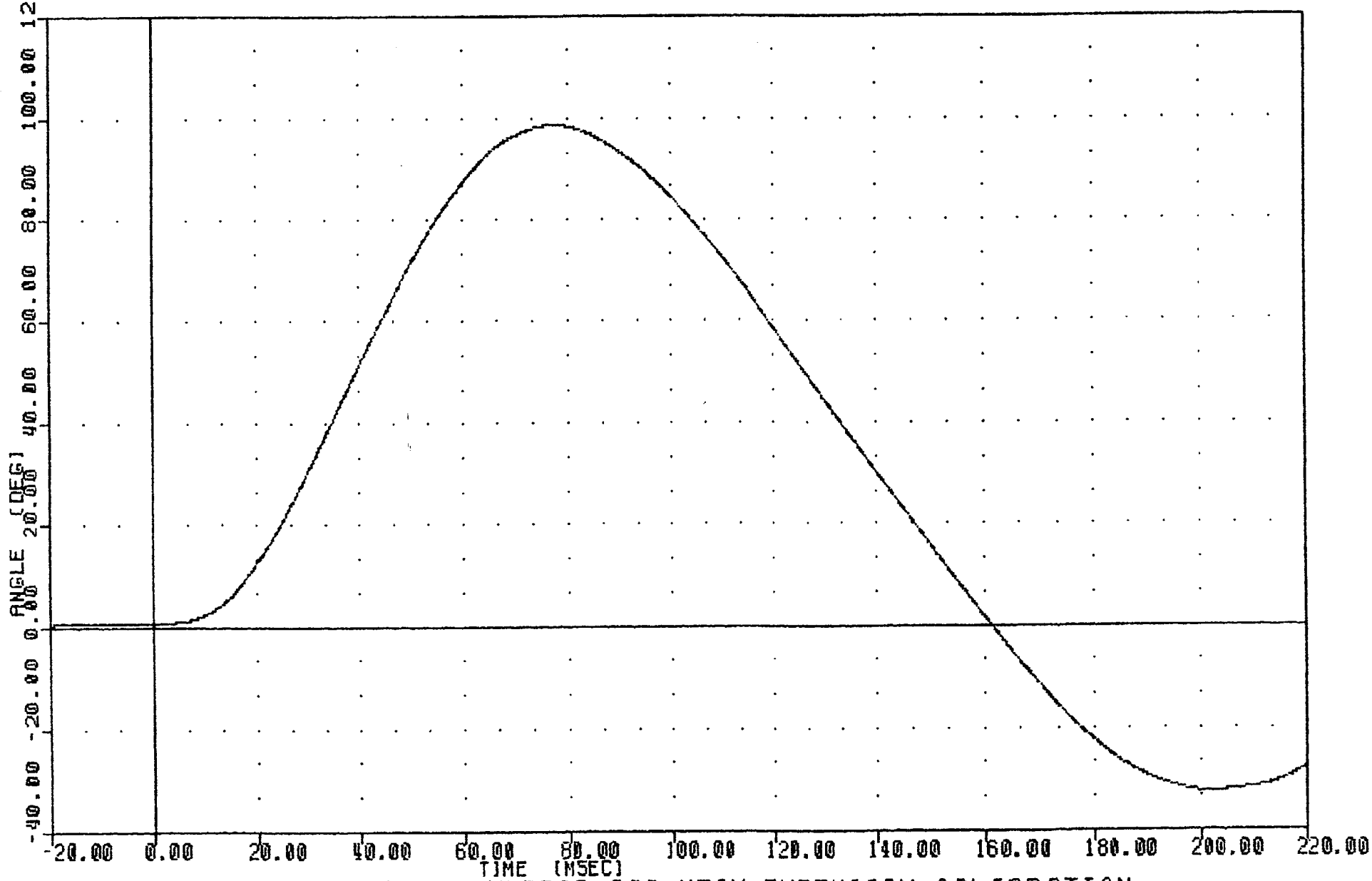


PART 572-E HYBRID III NECK EXTENSION CALIBRATION

ROTATION ABOUT OCCIPITAL CONDYLE

TRC , 48C3NE2
572E SN48 NECK EXT. CAL02
92232
TOTAN

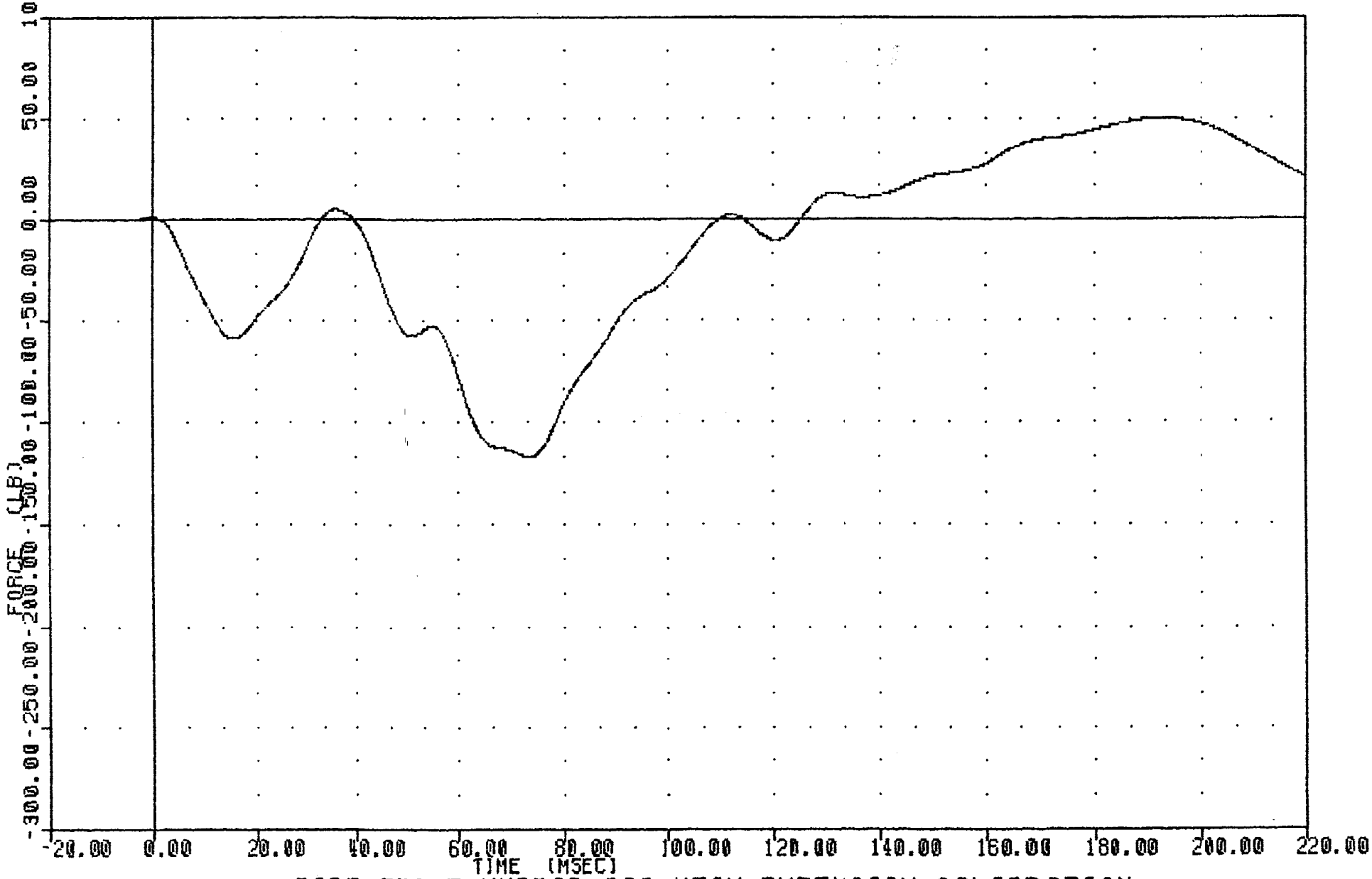
FILTER = BLPP 100/ 317/ -40
MIN, MAX VALUES = -32.35 @ 201.75 , 98.62 @ 77.63



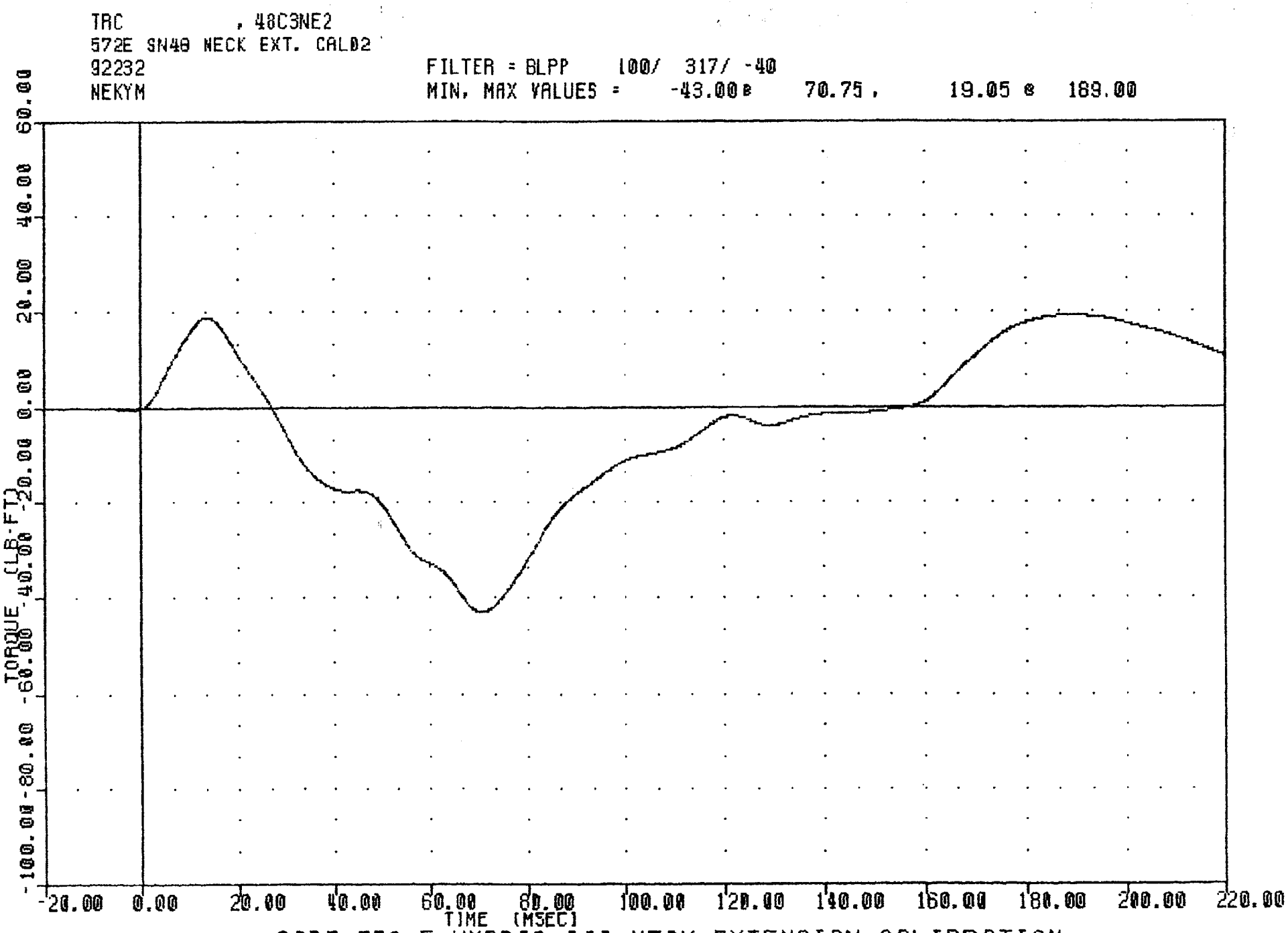
PART 572-E HYBRID III NECK EXTENSION CALIBRATION
TOTAL ROTATION

TRC , 48C3NE2
572E SN40 NECK EXT. CALD2
92232
NEKXF

FILTER = BLPP 100/ 317/ -40
MIN, MAX VALUES = -117.05 @ 73.63 , 50.08 @ 192.38



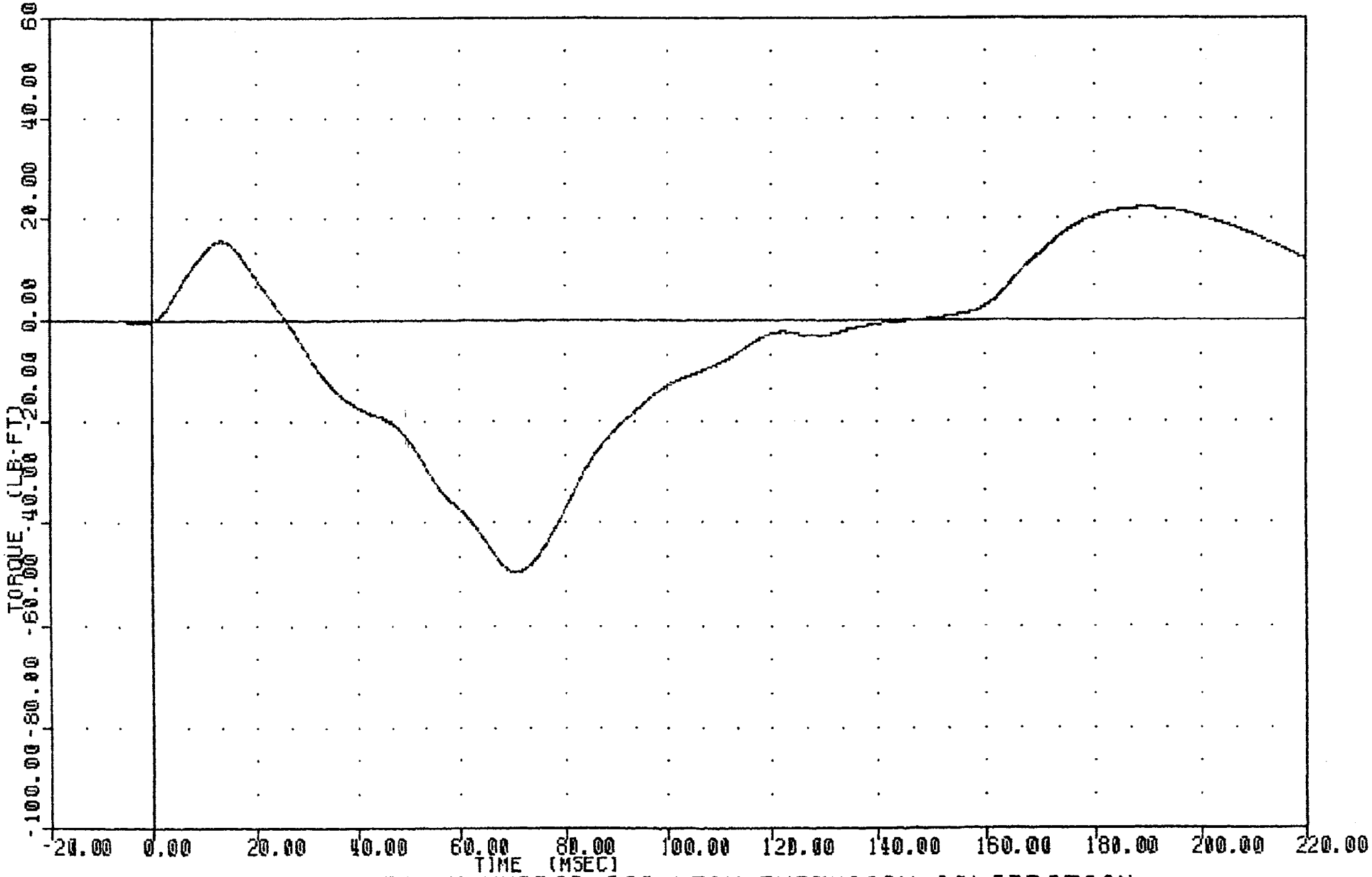
PART 572-E HYBRID III NECK EXTENSION CALIBRATION
NECK FORCE Y AXIS



PART 572-E HYBRID III NECK EXTENSION CALIBRATION
NECK MOMENT Y AXIS

TRC , 48C3NE2
572E SN48 NECK EXT. CALD2
92232
NEKOM

FILTER = BLPP 100/ 317/ -40
MIN, MAX VALUES = -49.68 @ 70.88 , 21.94 @ 189.75



PART 572-E HYBRID III NECK EXTENSION CALIBRATION
TOTAL MOMENT ABOUT OCCIPITAL CONDYLE

TRANSPORTATION RESEARCH CENTER OF OHIO

THORAX IMPACT TEST

HYBRID III 19-AUG-92

TRC 48C3TH1 572E SN48 H. S. THORAX CAL03

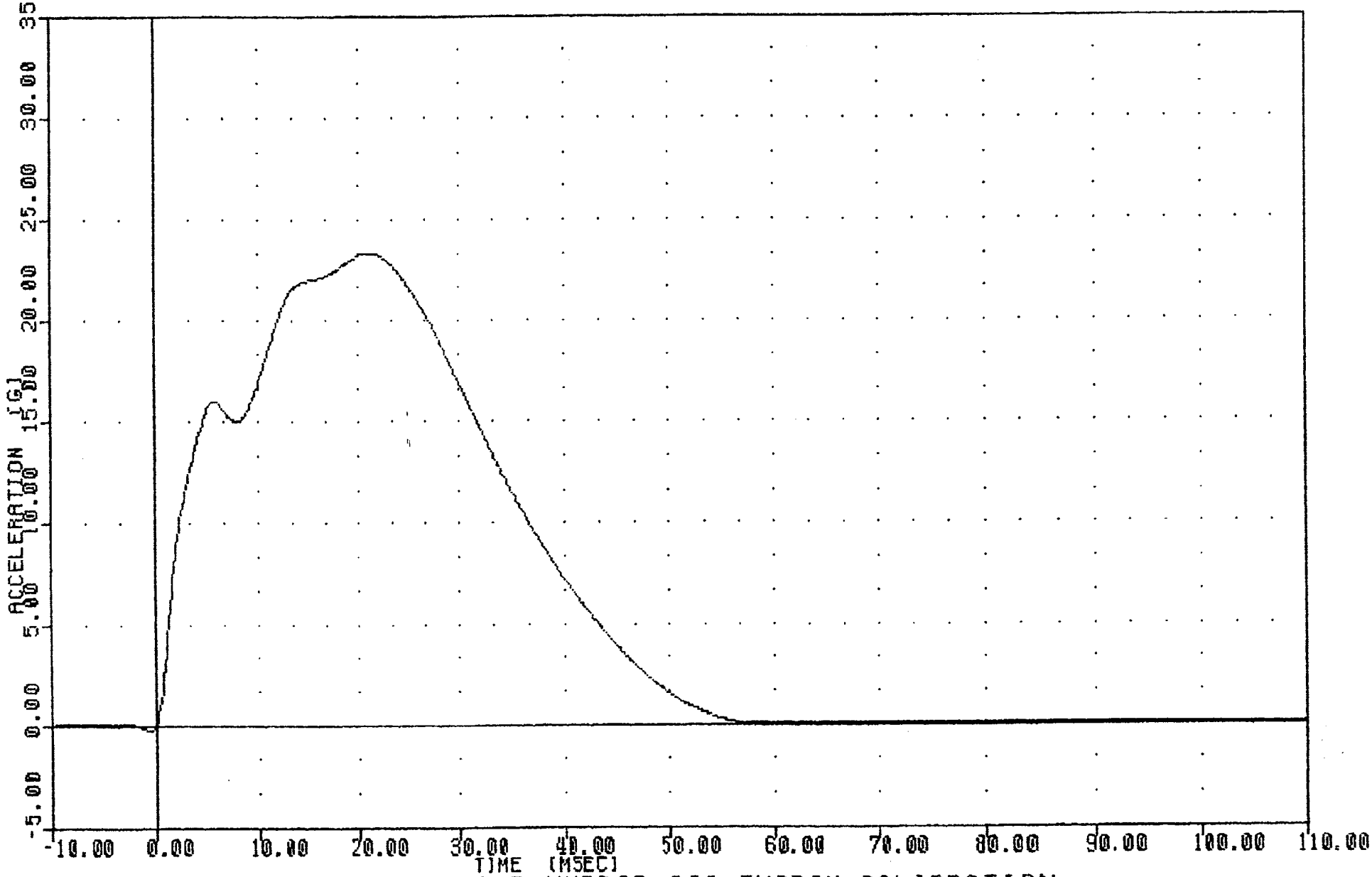
TEST PARAMETER	HIGH SPEED TEST SPECIFICATION	TEST RESULTS
TEMPERATURE	69 - 72 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	57.0 %
PENDULUM VELOCITY	21.6-22.4 FT/SEC	21.91 FT/SEC
MAXIMUM DEFLECTION	2.50 - 2.86 IN	2.75 IN
MAXIMUM RESISTIVE FORCE	1160 - 1325 LBS	1201.8 LBS
INTERNAL HYSTERESIS	69% - 85%	72.5%

TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fort

TRC , 48C3TH1
572E SN48 H.S.THORAX CAL03
92232
PENXG

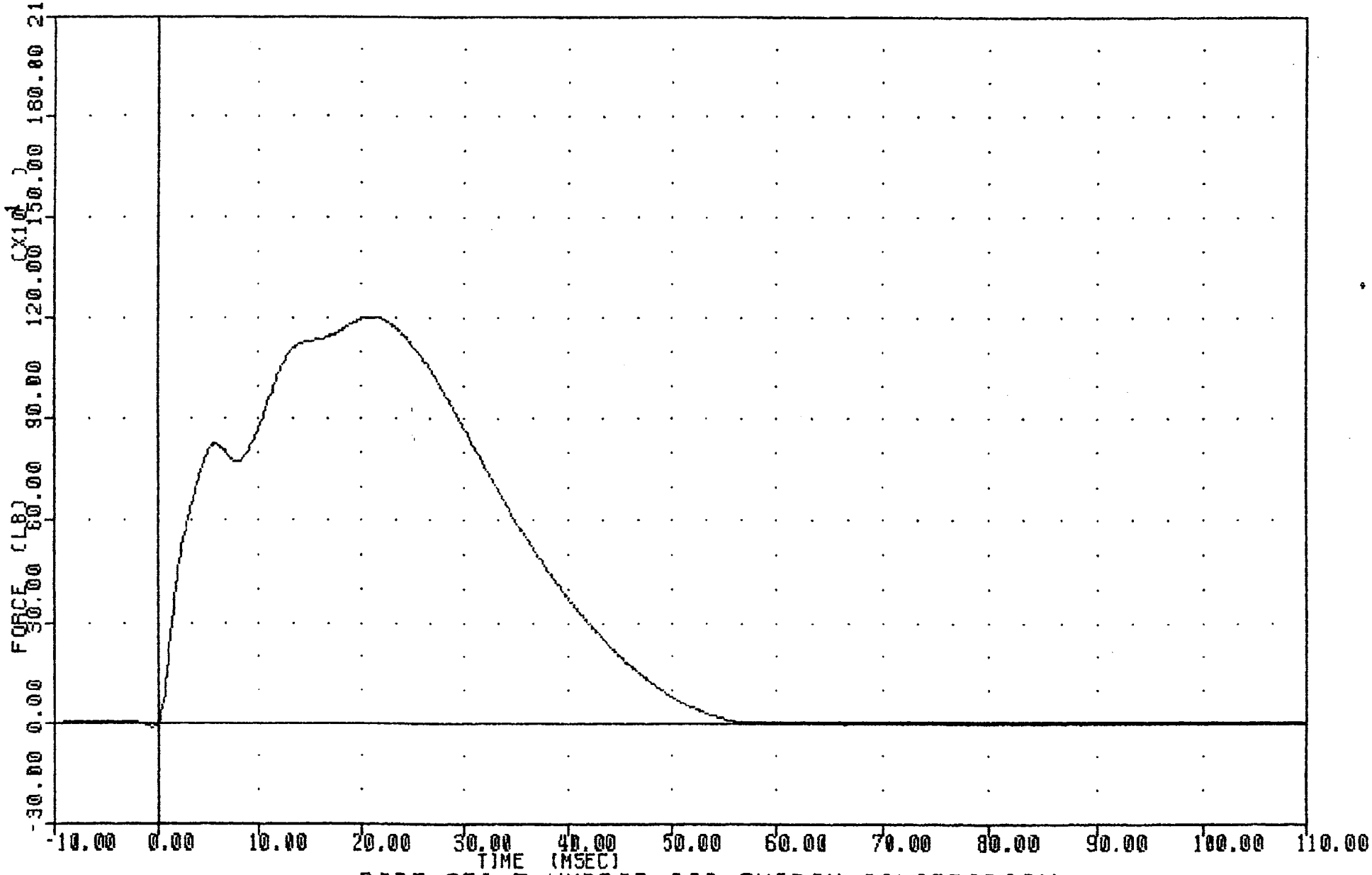
FILTER = BLPP 300/ 949/ -40
MIN, MAX VALUES = -0.24 @ -0.63 , 23.34 @ 21.00



PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM DECELERATION

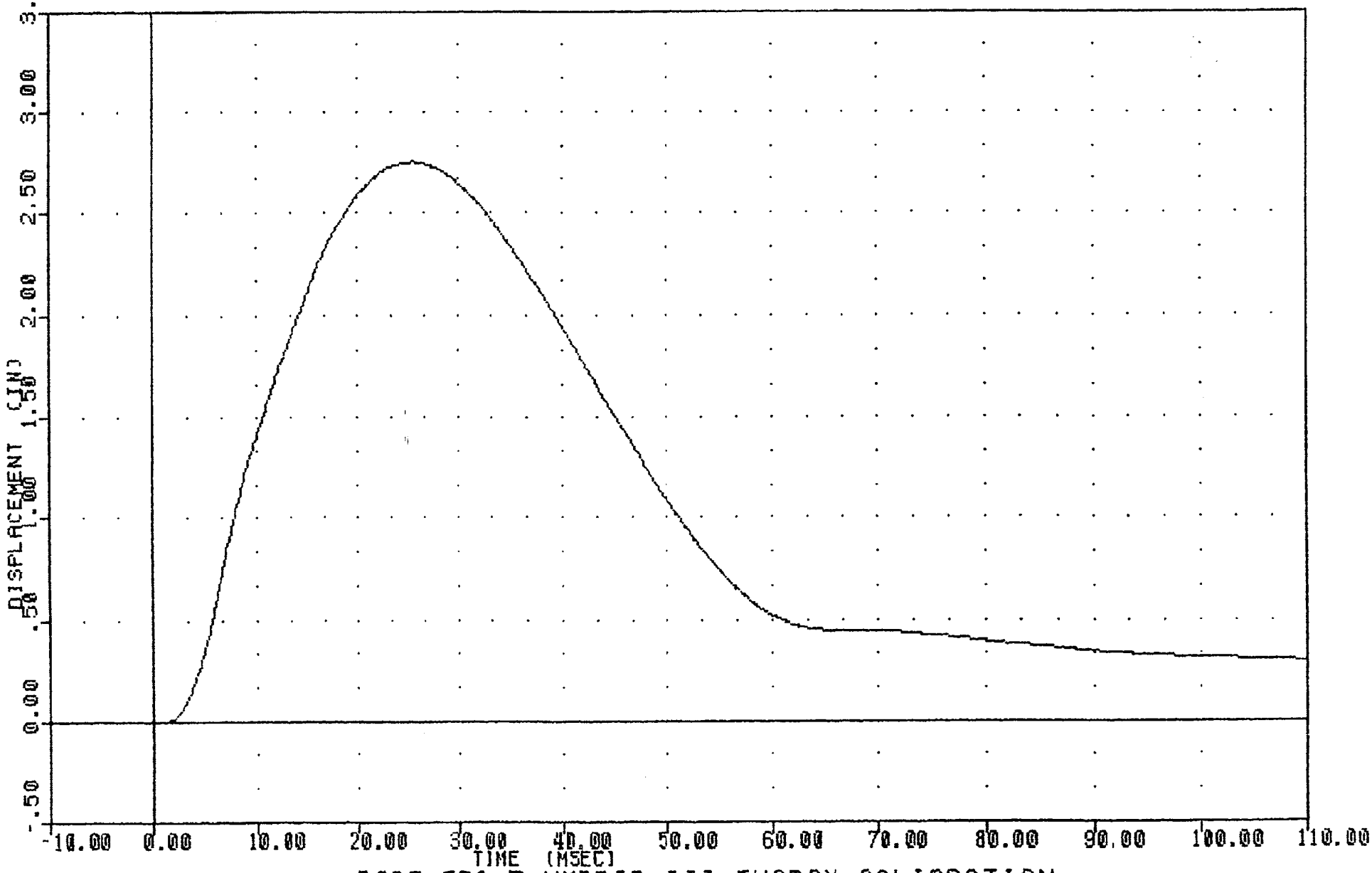
TRC , 48C3TH1
572E SN48 H.S.THORAX CAL03
92232
PENXF

FILTER = BLPP 300/ 949/ -40
MIN. MAX VALUES = -12.13 @ -0.63 , 1201.81 @ 21.00



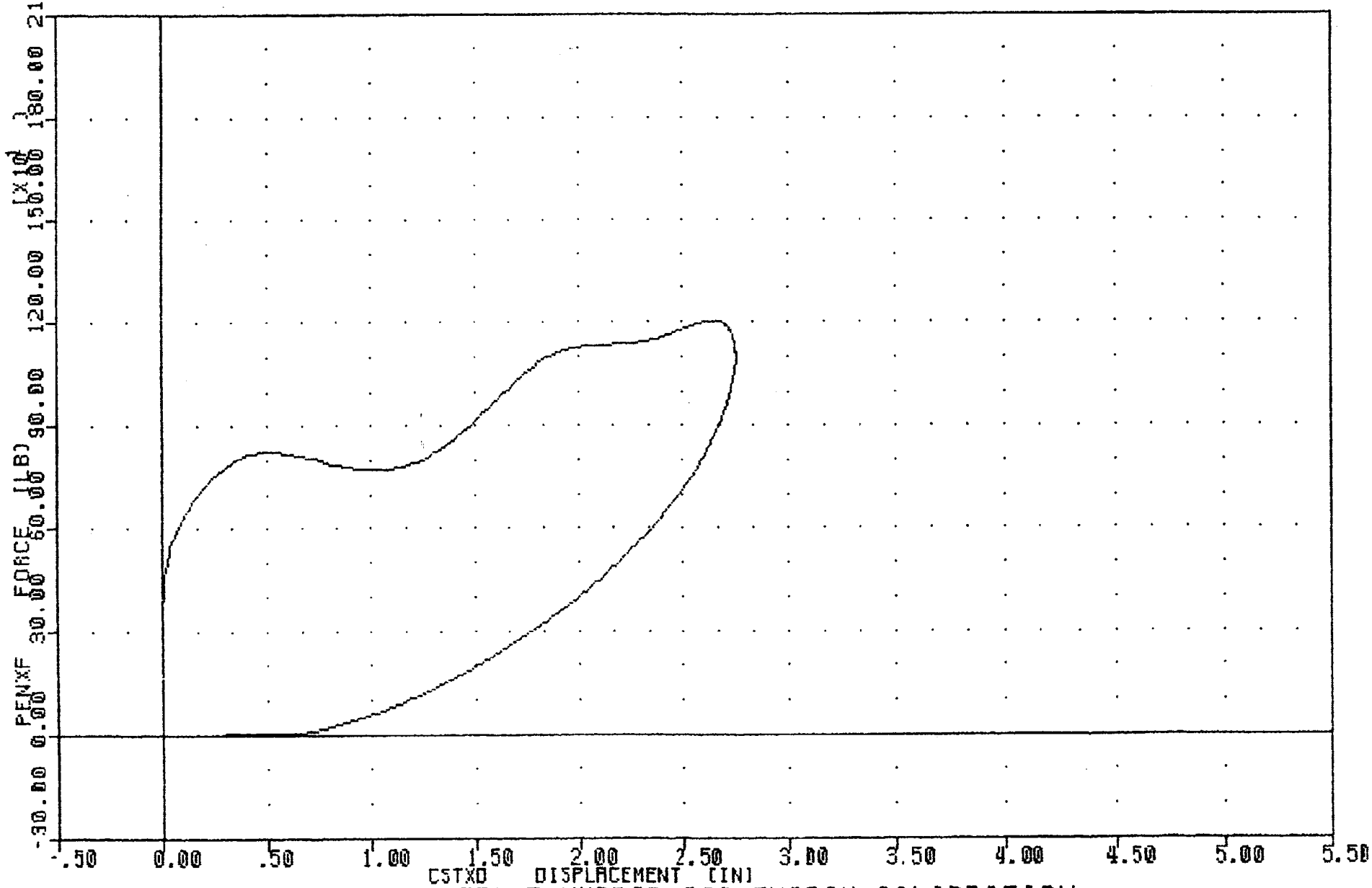
PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM FORCE

TRC , 48C3TH1
572E SN48 H.S.THORAX CAL03
92232 FILTER = BLPP 300/ 949/ -40
CSTXD MIN. MAX VALUES = 0.00 @ 0.88 , 2.75 @ 25.50



PART 572-E HYBRID III THORAX CALIBRATION
STERNUM DISPLACEMENT

TRC	,48C3TH1	572E SN48 H.S.THORAX CAL03			92232			
CSTXD	FILTER = BLPP	300/ 949/ -40	MIN, MAX =		0.00 @	0.88 ,	2.75 @	25.50
PENXF	FILTER = BLPP	300/ 949/ -40	MIN, MAX =		-12.13 @	-0.63 ,	1201.81 @	21.00



PART 572-E HYBRID III THORAX CALIBRATION

CHEST DISPLACEMENT VS PENDULUM FORCE

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

HYBRID III 29-OCT-92

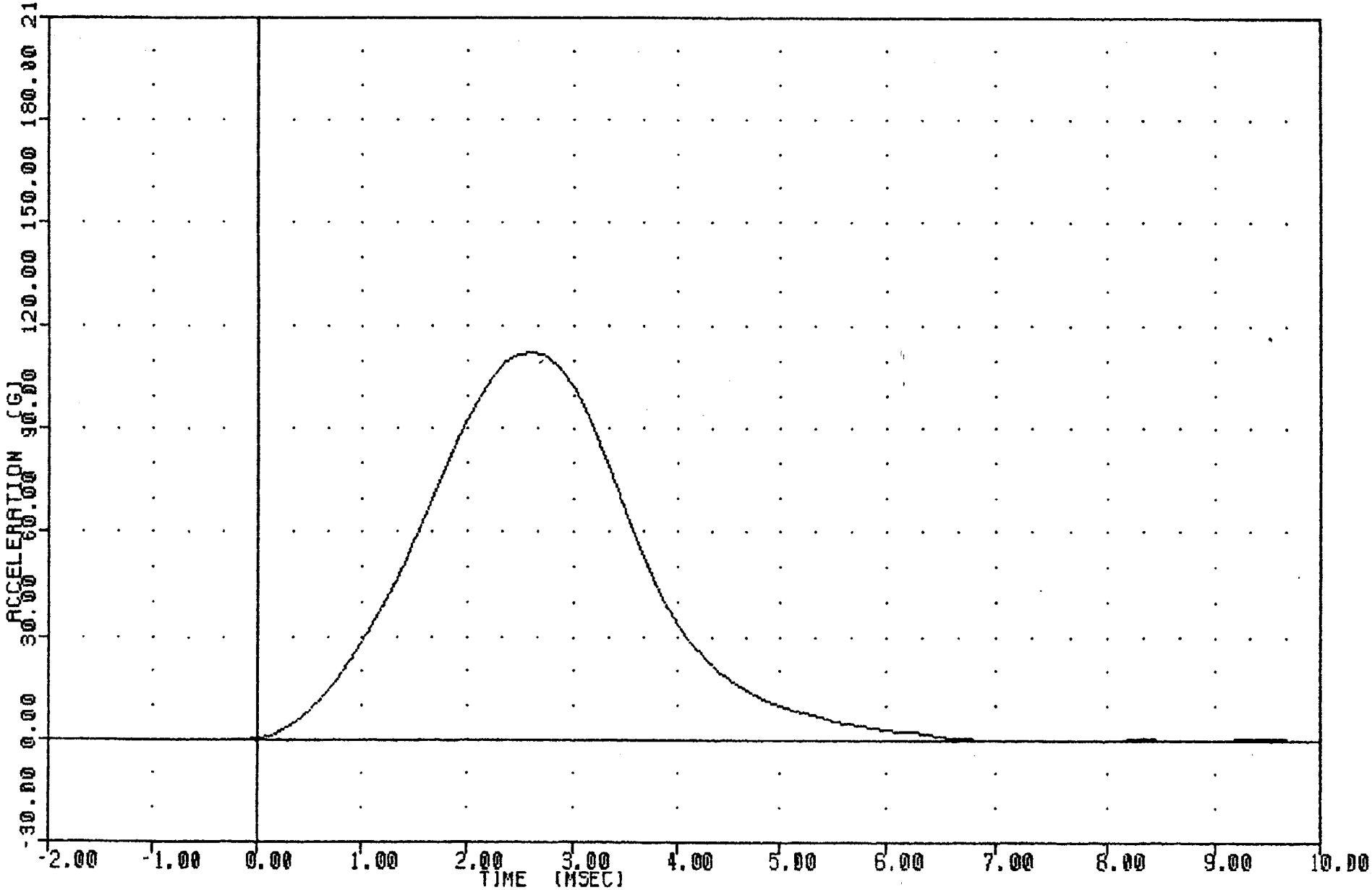
RIGHT KNEE
TRC 48C3RK2 572E SN48 RIGHT KNEE CAL 03

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	71.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	56.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.92 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1238.34 LBS
PROBE WEIGHT	11.0 LBS	

TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Foust

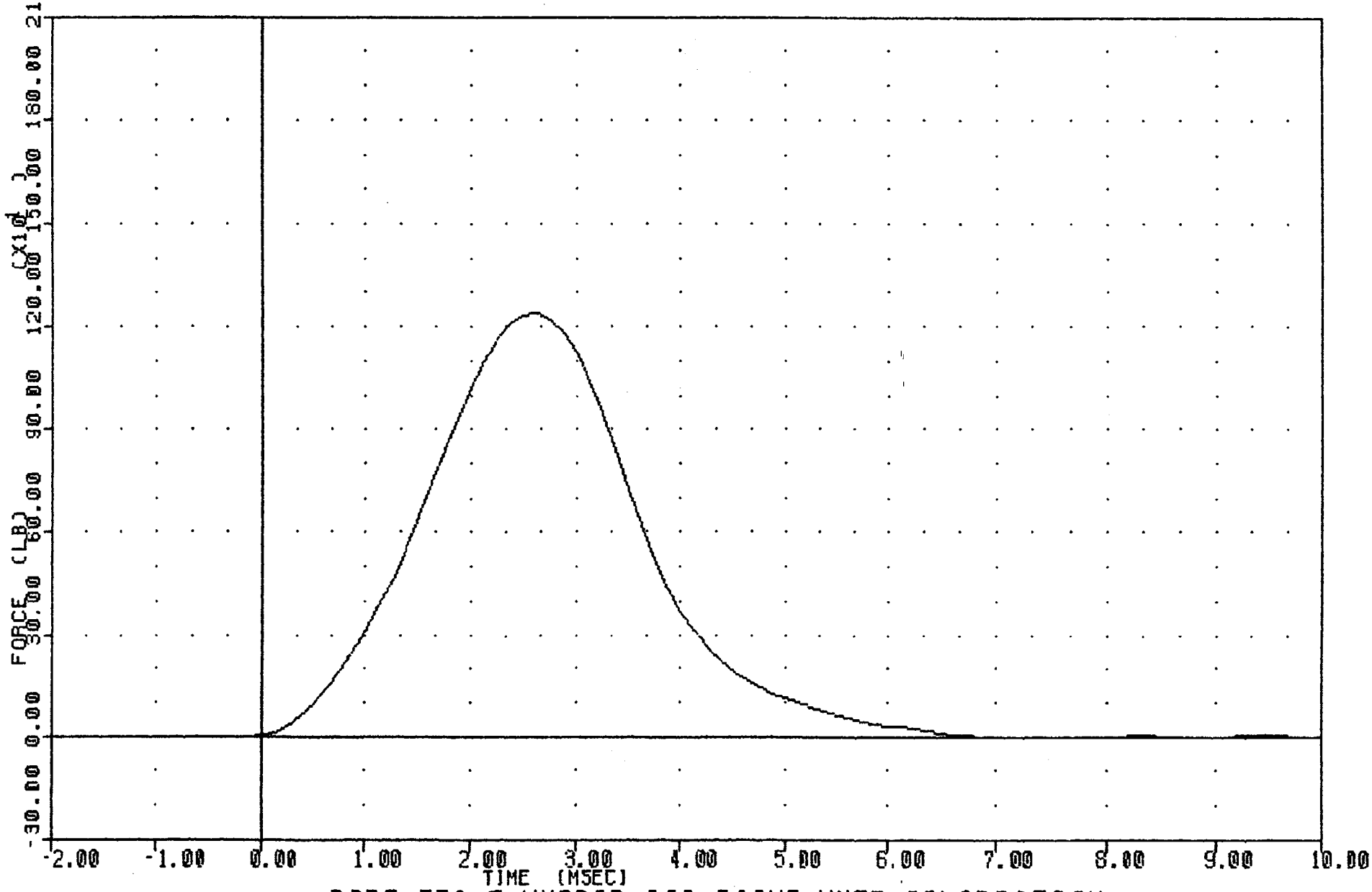
TRC , 48C3RK2
572E SN48 RIGHT KNEE CAL 03
92303 FILTER = BLPP 1000/ 3162/ -40
PENXG MIN, MAX VALUES = -0.21 @ -0.25 , 112.58 @ 2.63



PART 572-E HYBRID III RIGHT KNEE CALIBRATION
PENDULUM DECELERATION (1) LB PEND.)

TRC , 48C3RK2
572E SN40 RIGHT KNEE CAL 03
92303
PENXF

FILTER = BLPP 1000/ 3162/ -40
MIN, MAX VALUES = -2.27 @ -0.25 , 1238.34 @ 2.63



PART 572-E HYBRID III RIGHT KNEE CALIBRATION
PENDULUM FORCE (11 LB PEND.)

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

HYBRID III 29-OCT-92

LEFT KNEE
TRC 48C3LK2 572E SN48 LEFT KNEE CAL 03

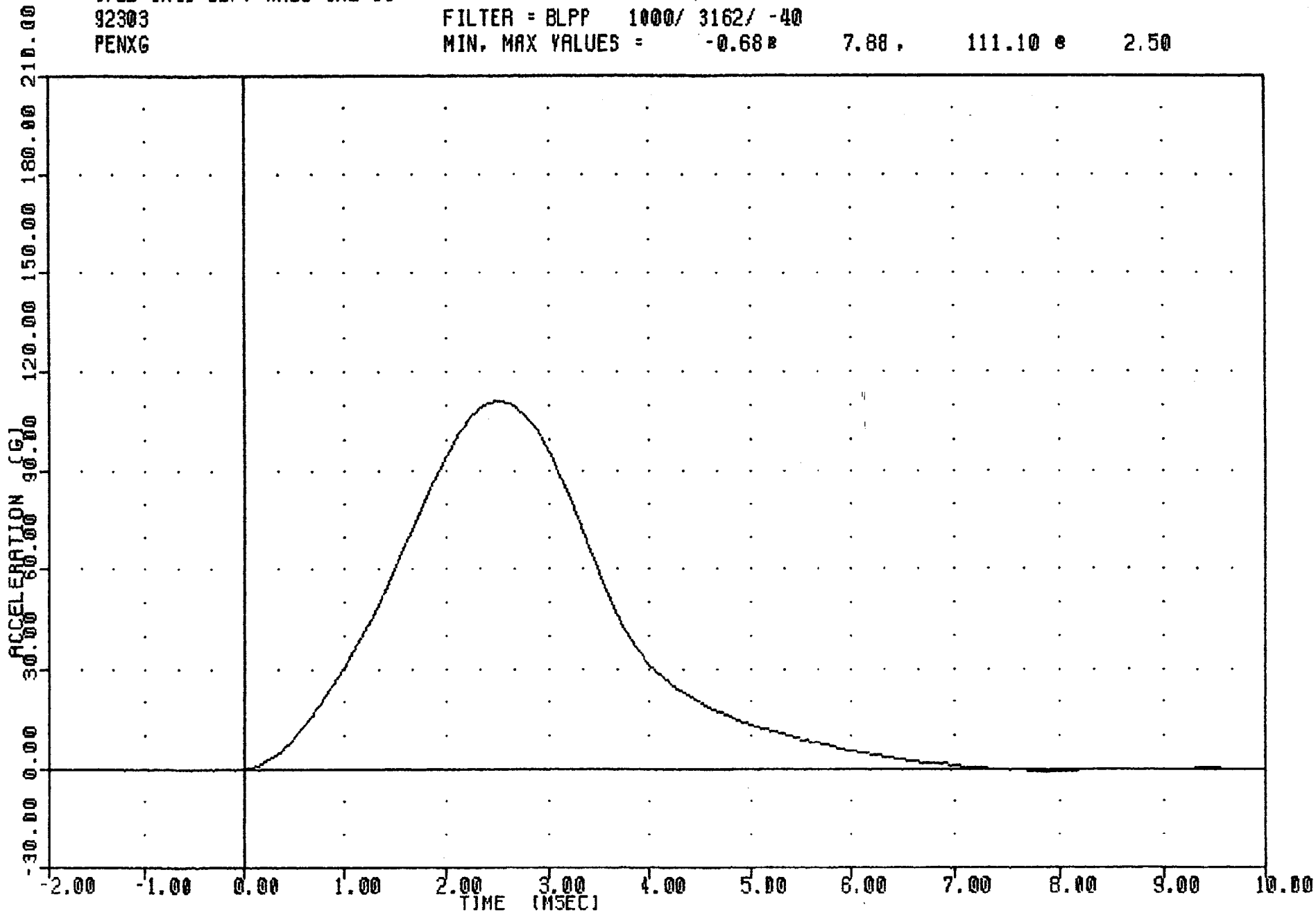
TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	71.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.82 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1222.05 LBS
PROBE WEIGHT	11.0 LBS	

TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Foust

TRC , 48C3LK2
572E SN40 LEFT KNEE CAL 03
92303
PENXG

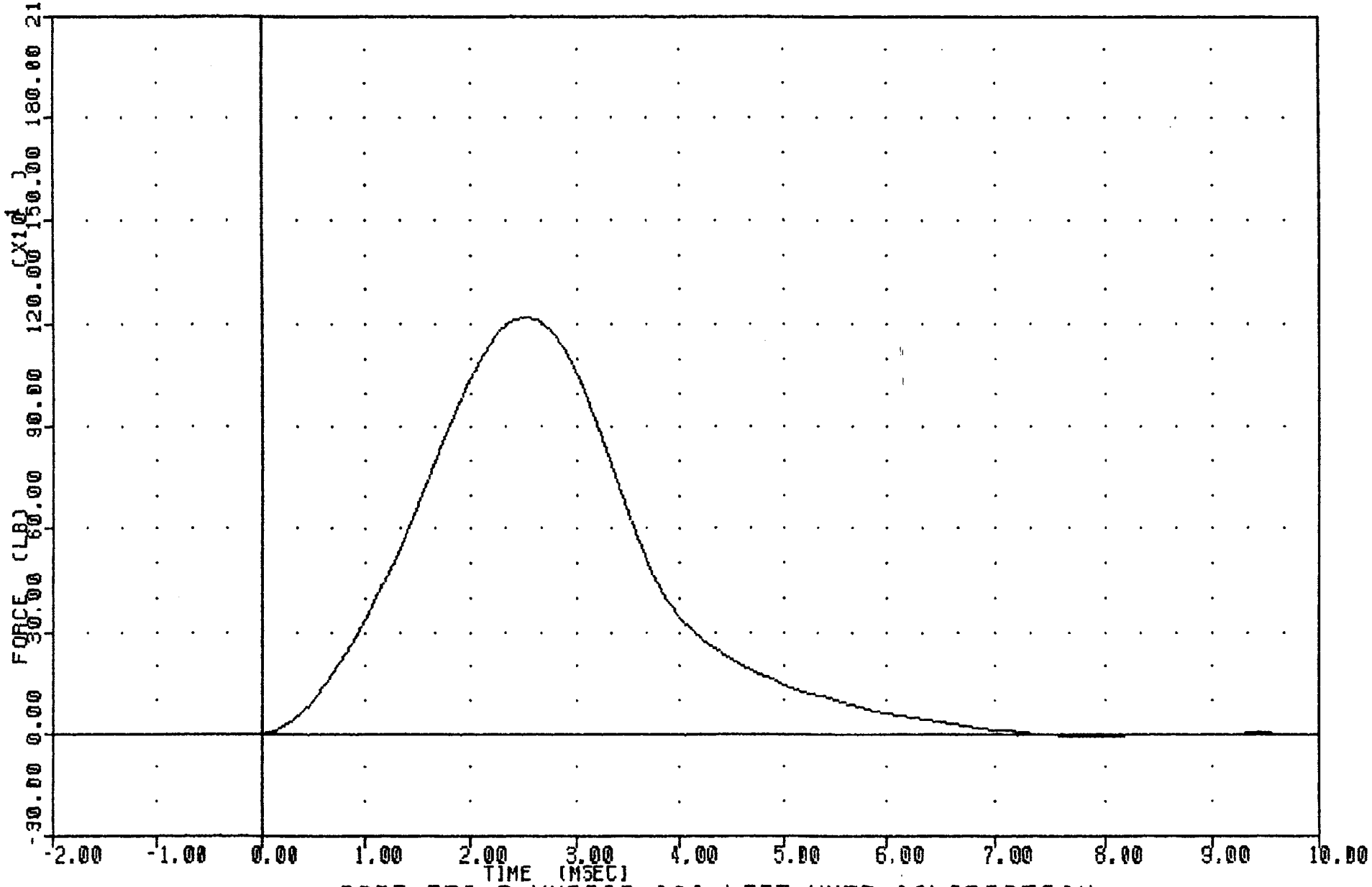
FILTER = BLPP 1000/ 3162/ -40
MIN, MAX VALUES = -0.68 @ 7.88 , 111.10 @ 2.50



PART 572-E HYBRID III LEFT KNEE CALIBRATION
PENDULUM DECELERATION (11 LB PEND.)

TRC , 48C3LK2
572E SN48 LEFT KNEE CAL 03
92303
PENXF

FILTER = BLPP 1000/ 3162/ -40
MIN, MAX VALUES = -7.43@ 7.88 , 1222.05 @ 2.50



PART 572-E HYBRID III LEFT KNEE CALIBRATION
PENDULUM FORCE [11 LB PEND.]

PRE-TEST CERTIFICATION DATA

PASSENGER DUMMY S/N 043

TRANSPORTATION RESEARCH CENTER OF OHIO
HYBRID III EXTERNAL DIMENSIONS
43 HUMANOID

30-OCT-92

TRC 43C1ED1 572E SN43 EXT. DIMENSION CAL01

TEST PARAMETER	(DIMEN.)	SPECIFICATION	TEST RESULTS
TEMPERATURE			69.0 DEG. F
RELATIVE HUMIDITY			55.0 %
LOCATION FOR CHEST CIRCUMFERENCE	(AA)	16.9-17.1 IN	17.0 IN
LOCATION FOR WAIST CIRCUMFERENCE	(BB)	8.9- 9.1 IN	9.0 IN
CHEST CIRCUMFERENCE	(Y)	38.2-39.4 IN	39.3 IN
WAIST CIRCUMFERENCE	(Z)	32.9-34.1 IN	33.4 IN
CHEST DEPTH	(O)	8.4- 9.0 IN	8.6 IN
H-POINT HEIGHT	(C)	3.3- 3.5 IN	3.4 IN
H-POINT FROM SEATBACK	(D)	5.3- 5.5 IN	5.4 IN
SKULL CAP TO BACKLINE	(H)	1.6- 1.8 IN	1.7 IN
TOTAL SITTING HEIGHT	(A)	34.6-35.0 IN	34.8 IN
THIGH CLEARANCE	(F)	5.5- 6.1 IN	6.1 IN
BUTTOCK KNEE LENGTH	(K)	22.8-23.8 IN	23.8 IN
BUTTOCK POPLITEAL LENGTH	(N)	17.8-18.8 IN	18.7 IN
POPLITEAL HEIGHT	(L)	16.9-17.9 IN	16.9 IN
KNEE PIVOT HEIGHT	(M)	19.1-19.7 IN	19.3 IN
FOOT LENGTH	(P)	9.9-10.5 IN	10.1 IN
FOOT BREADTH	(W)	3.6- 4.2 IN	3.8 IN
SHOULDER PIVOT FROM BACKLINE	(E)	3.3- 3.7 IN	3.6 IN
SHOULDER BREADTH	(V)	16.6-17.2 IN	16.7 IN
SHOULDER PIVOT HEIGHT	(B)	19.9-20.5 IN	20.2 IN
ELBOW REST HEIGHT	(J)	7.5- 8.3 IN	7.9 IN
SHOULDER-ELBOW LENGTH	(I)	13.0-13.6 IN	13.5 IN
BACK OF ELBOW TO WRIST PIVOT	(G)	11.4-12.0 IN	11.4 IN

TEST MEETS SPECIFICATIONS

TECHNICIAN

TRANSPORTATION RESEARCH CENTER OF OHIO

HEAD DROP TEST

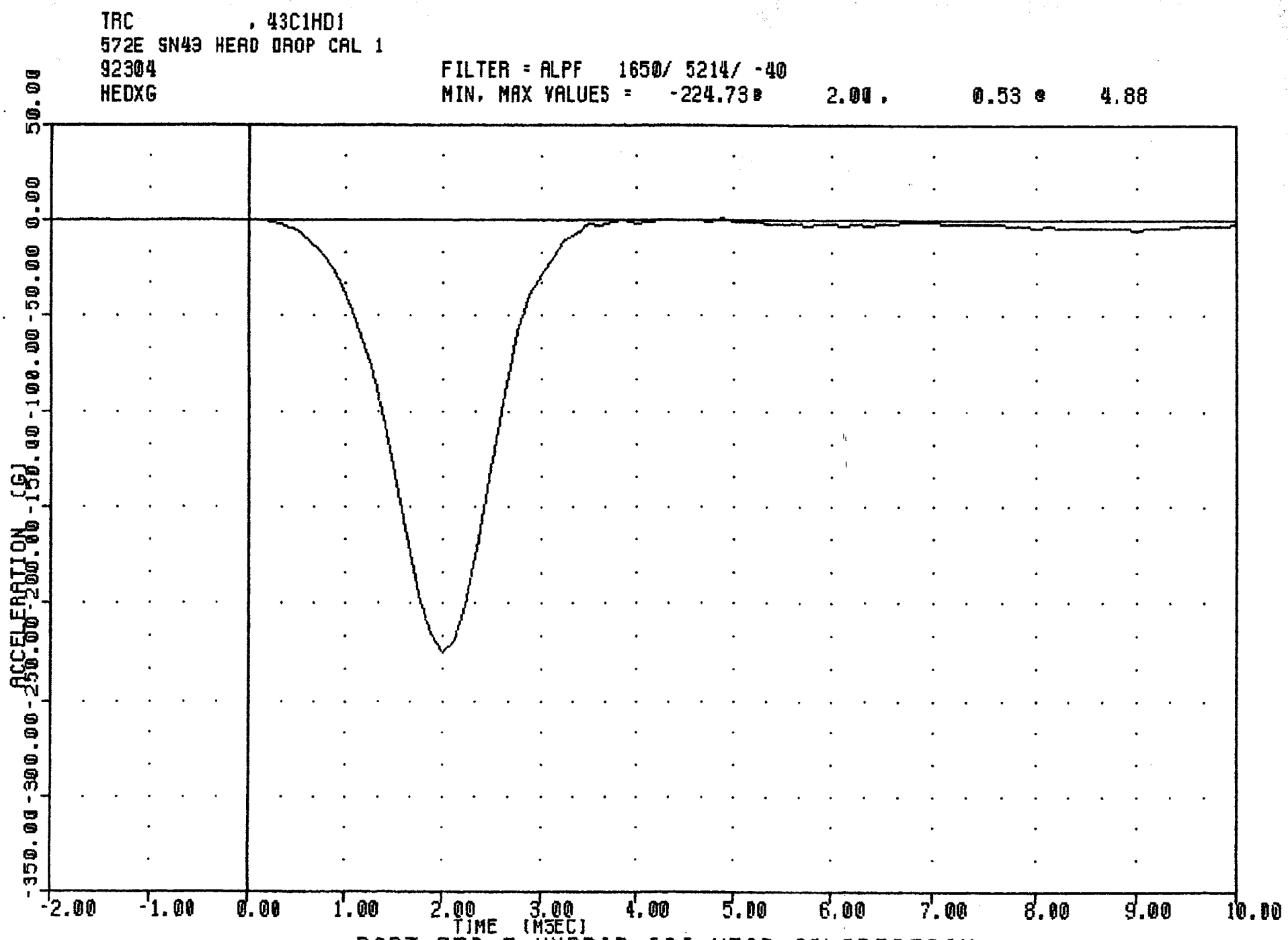
HYBRID III 30-OCT-92

TRC 43C1HD1 572E SN43 HEAD DROP CAL 1

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	69.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PEAK RESULTANT ACCELERATION	225 - 275 G	255.65 G
PEAK LATERAL ACCELERATION	15 G MAX	-2.99 G
IS ACCELERATION CURVE UNIMODAL?	YES	YES

TEST MEETS SPECIFICATIONS

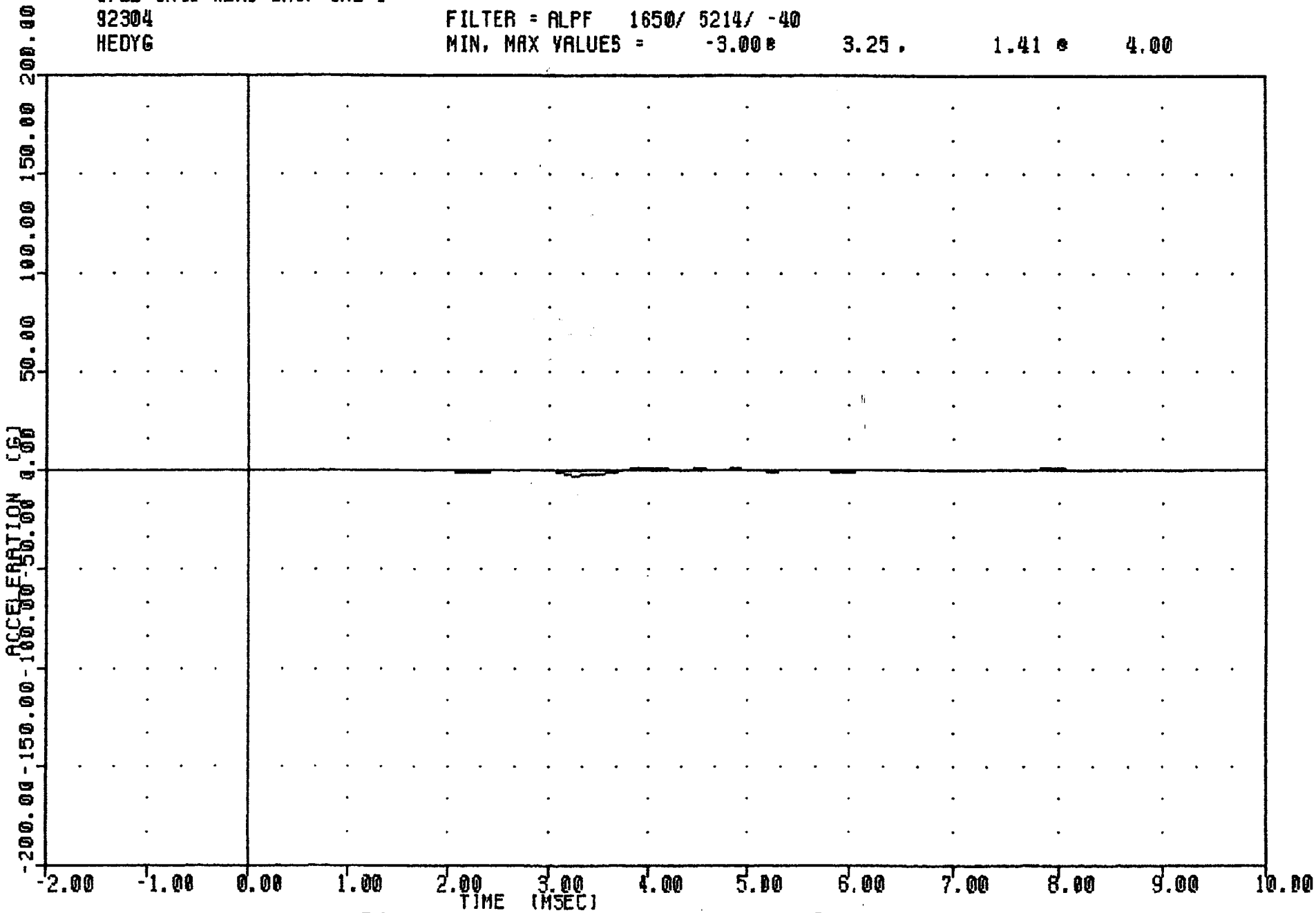
TECHNICIAN Pete Faust



PART 572-E HYBRID III HEAD CALIBRATION
HEAD ACCELERATION X AXIS

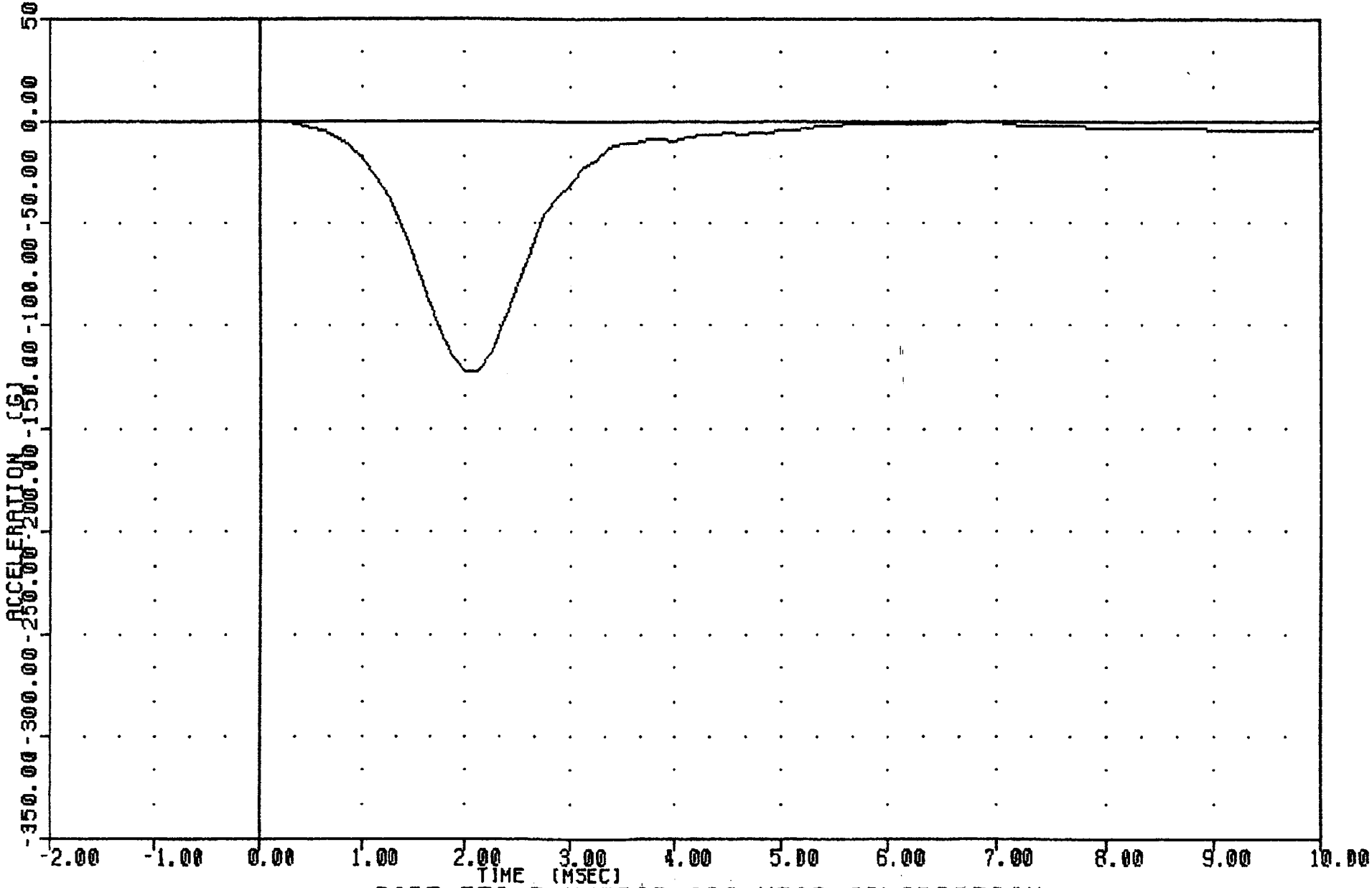
TRC , 43C1HD1
572E SN43 HEAD DROP CAL 1
92304
HEDYG

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -3.00 @ 3.25 , 1.41 @ 4.00

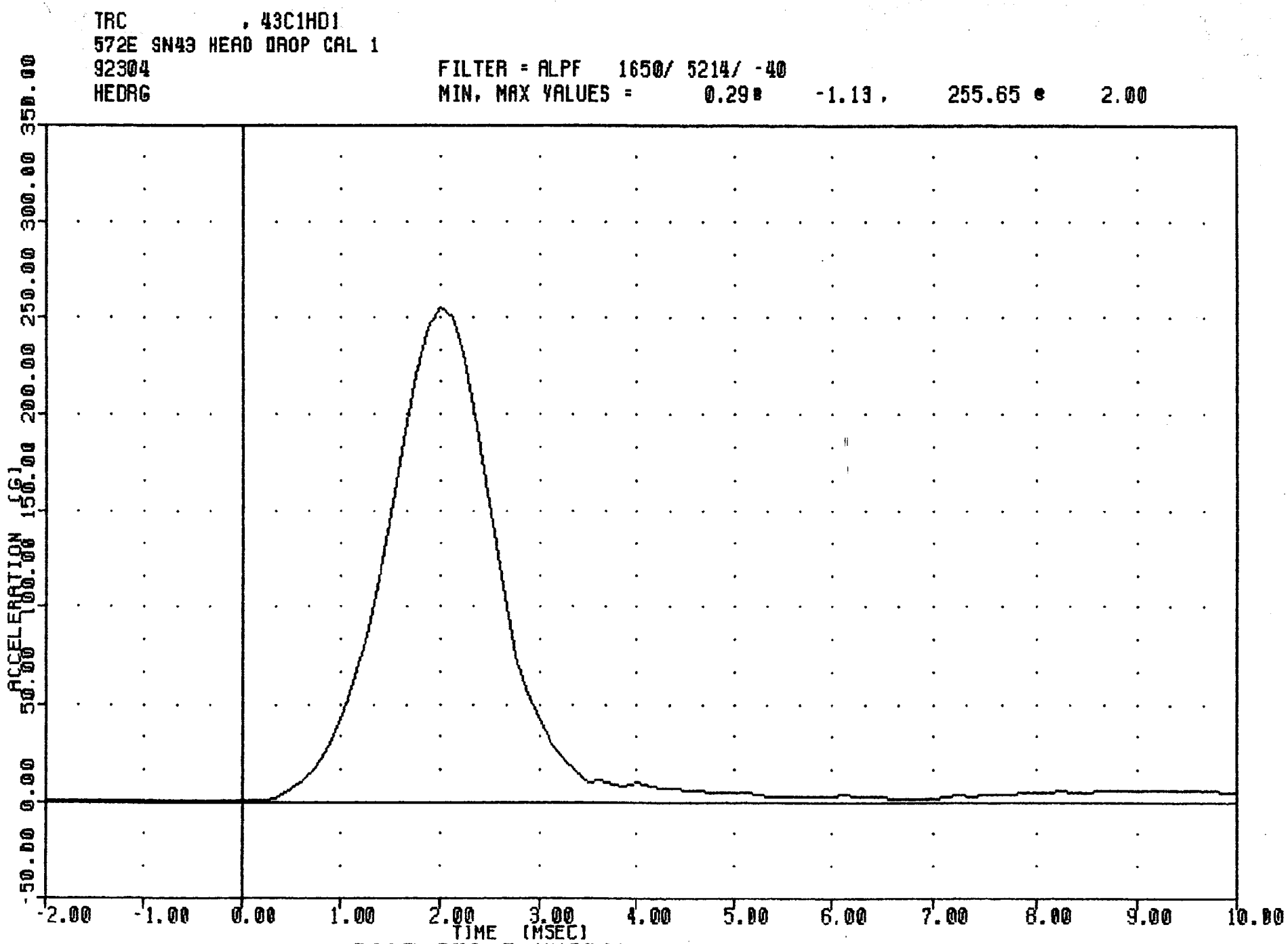


PART 572-E HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Y AXIS

TRC , 43C1HD1
572E SN43 HEAD DROP CAL 1
92304 FILTER = ALPF 1650/ 5214/ -40
HEDZG MIN, MAX VALUES = -121.95 @ 2.13 , -0.21 @ -1.88



PART 572-E HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Z AXIS



PART 572-E HYBRID III HEAD CALIBRATION
HEAD RESULTANT ACCELERATION

TRANSPORTATION RESEARCH CENTER OF OHIO

NECK FLEXION TEST

HYBRID III 30-OCT-92

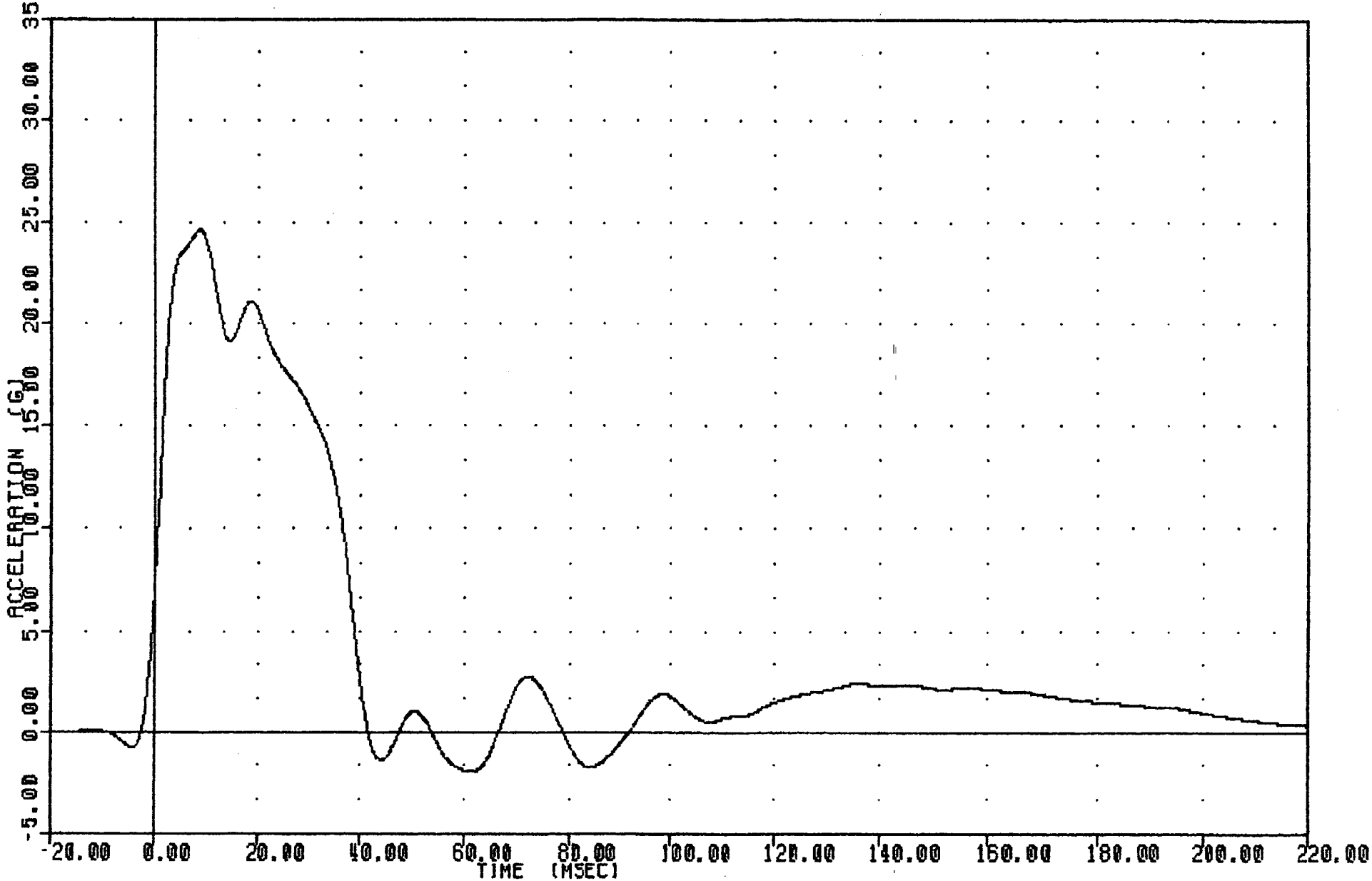
6 AXIS NECK TRANSDUCER
TRC 43C1NF1 572E SN43 NECK FLEXION CAL1

TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	69.0 DEG. F
RELATIVE HUMIDITY		10% - 70%	55.0 %
IMPACT VELOCITY		22.6 - 23.4 FT/SEC	23.08 FT/SEC
PENDULUM DECELERATION	10 MS	22.50 - 27.50 G	23.98 G
	20 MS	17.60 - 22.60 G	20.66 G
	30 MS	12.50 - 18.50 G	15.83 G
MAX PENDULUM G ABOVE 30 MS		29 G MAX	15.77 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		34 - 42 MS	38.75 MS
D PLANE ROTATION	MAX	64 - 78 DEG.	65.42 DEG.
	TIME	57 - 64 MS	58.00 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MAX	65 - 80 FT.LBS	76.27 FT.LBS
	TIME	47 - 58 MS	51.00 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		113 - 128 MS	113.00 MS
POSITIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		97 - 107 MS	97.63 MS

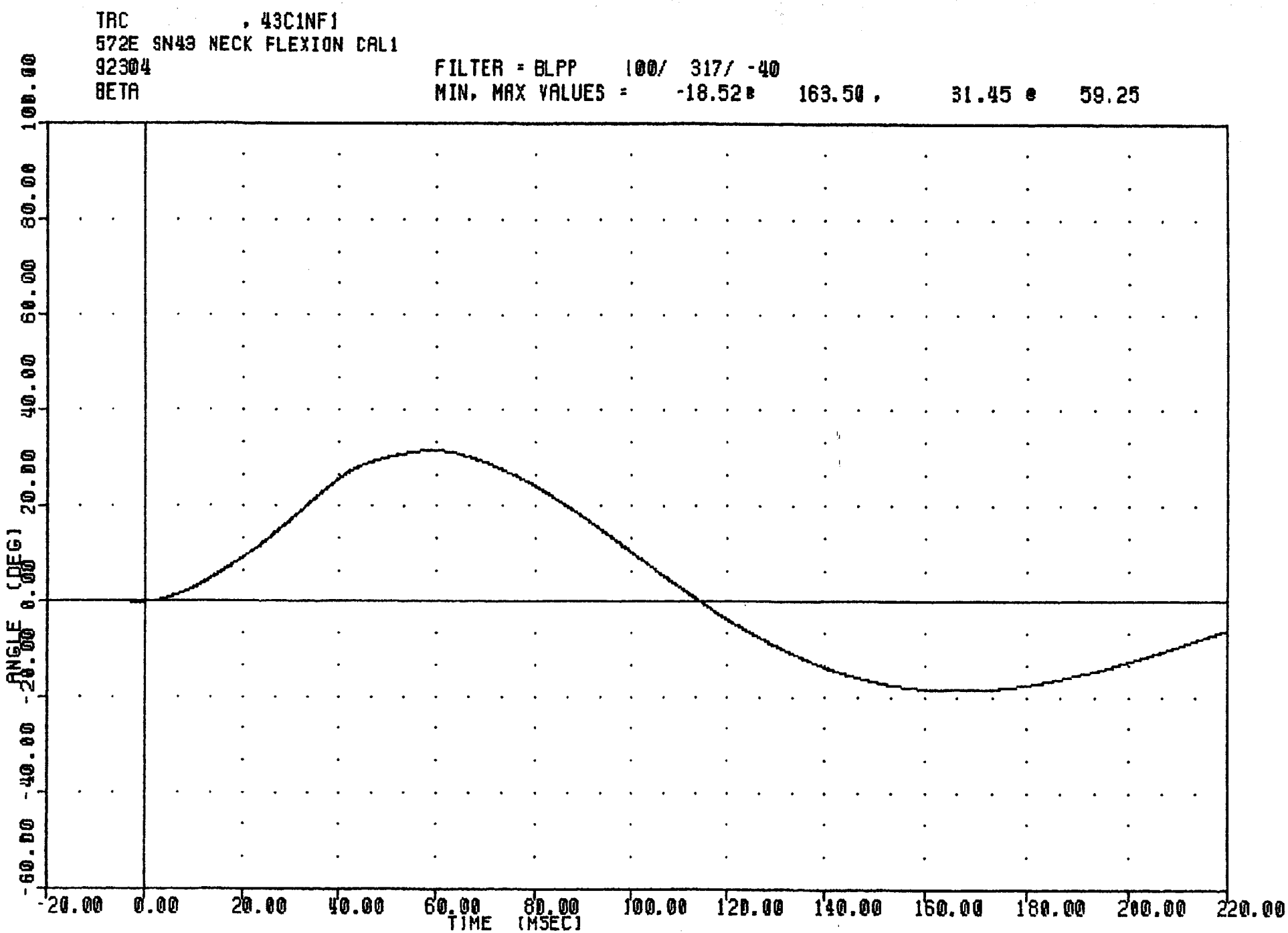
TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Faust

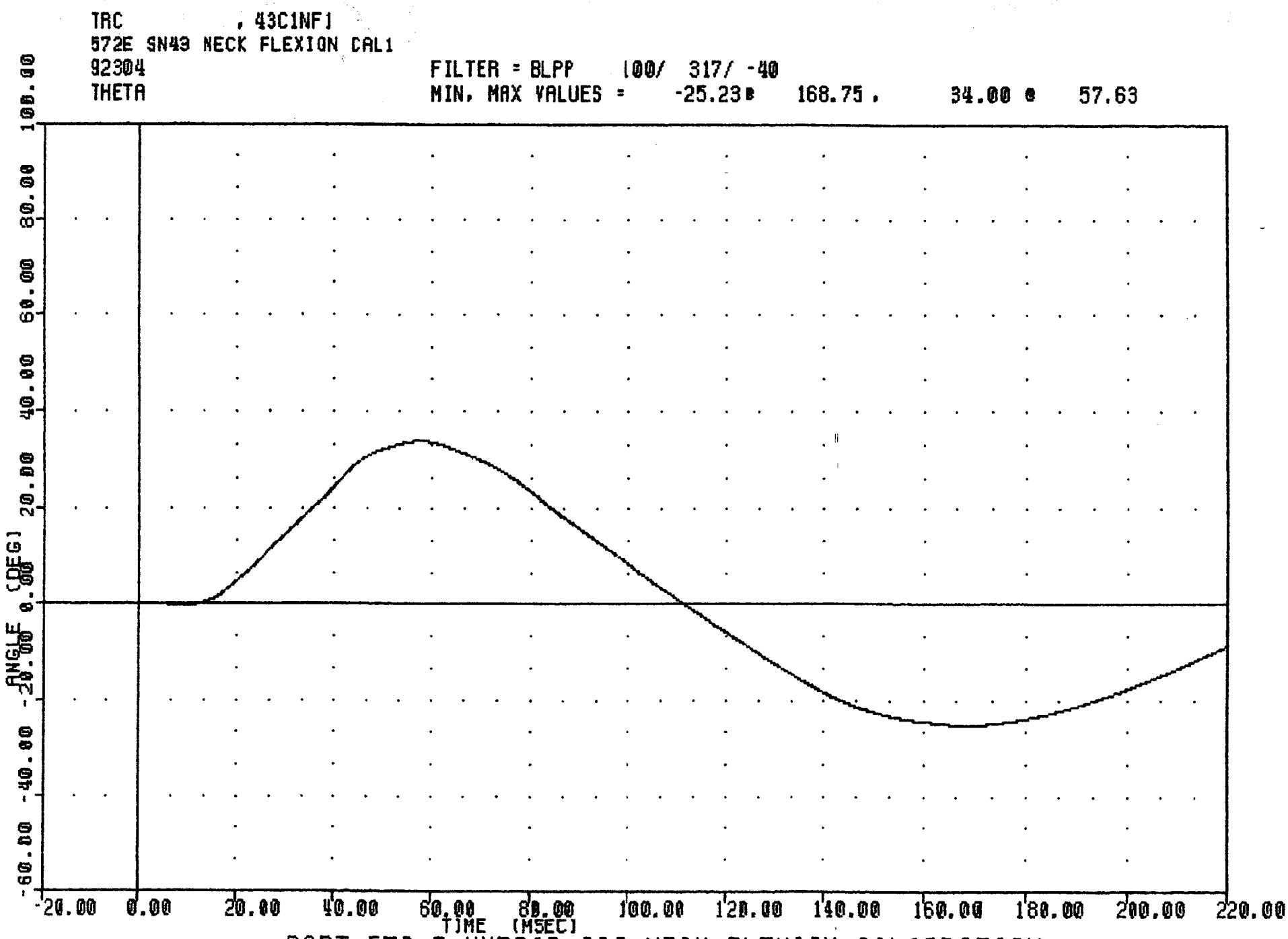
TRC , 43C1NF1
572E SN43 NECK FLEXION CAL1
92304 FILTER = BLPP 100/ 317/ -40
PENXG MIN, MAX VALUES = -1.97@ 61.13 , 24.63 @ 8.63



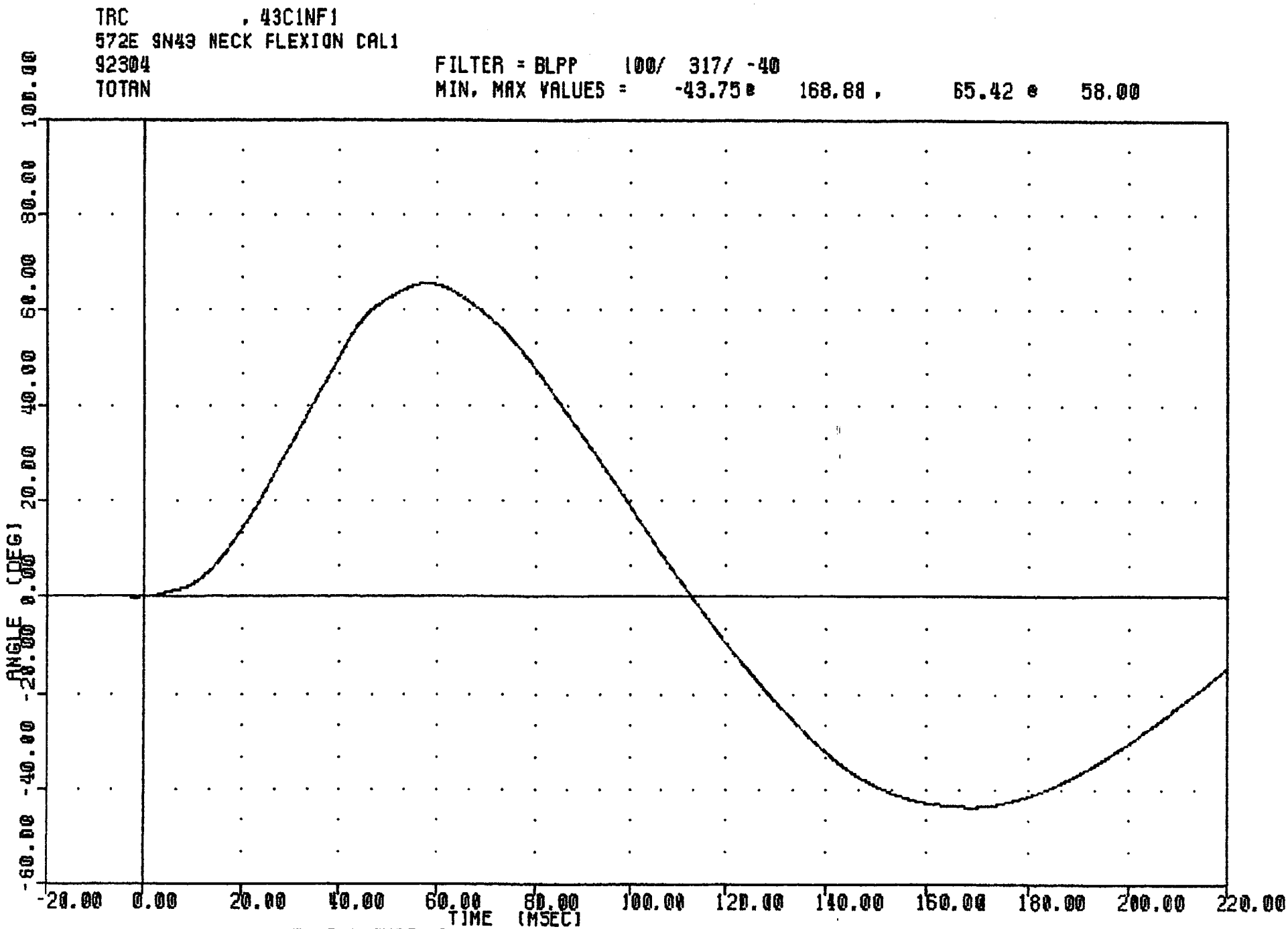
PART 572-E HYBRID III NECK FLEXION CALIBRATION
PENDULUM DECELERATION



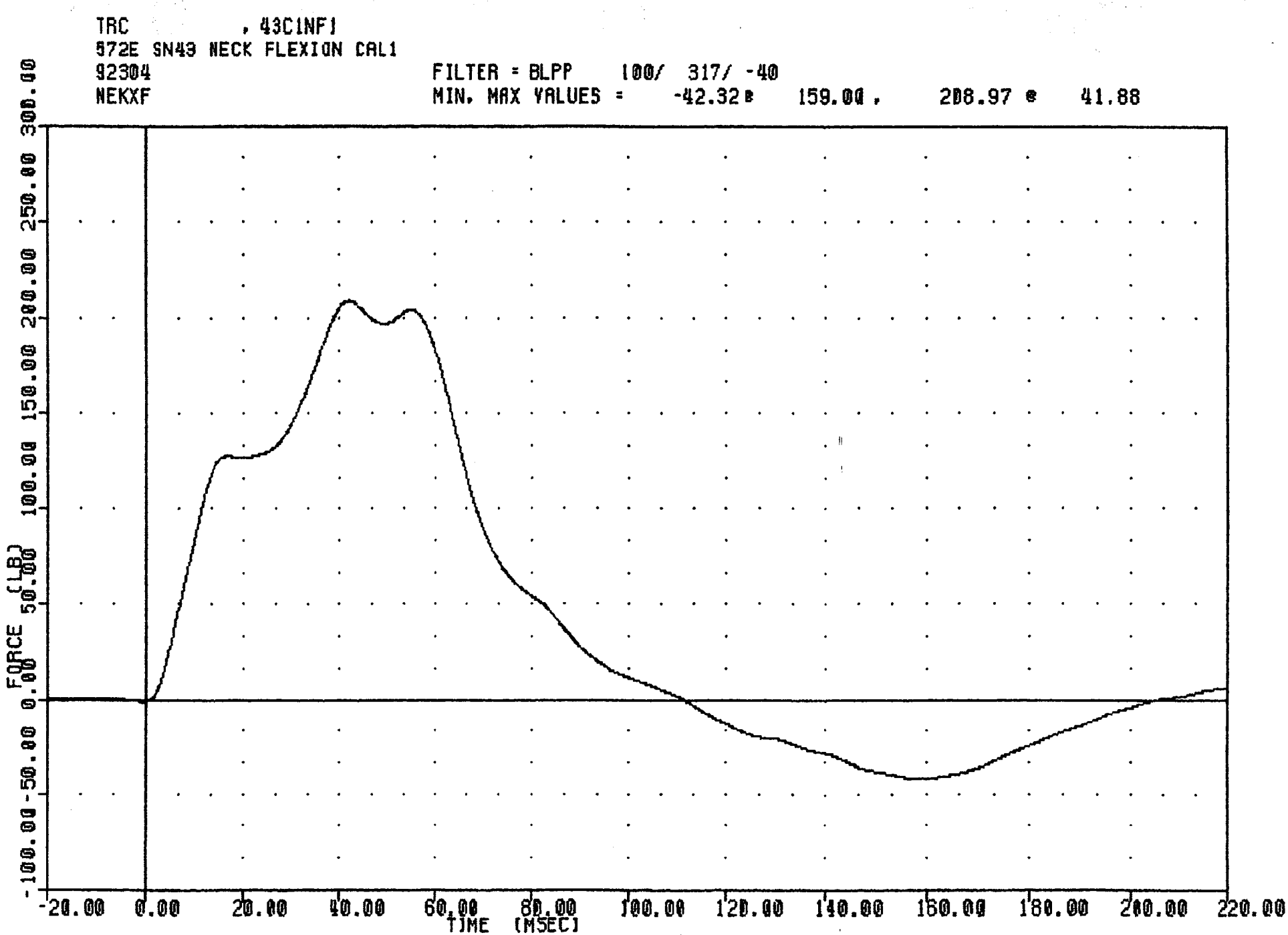
PART 572-E HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT BASE OF NECK



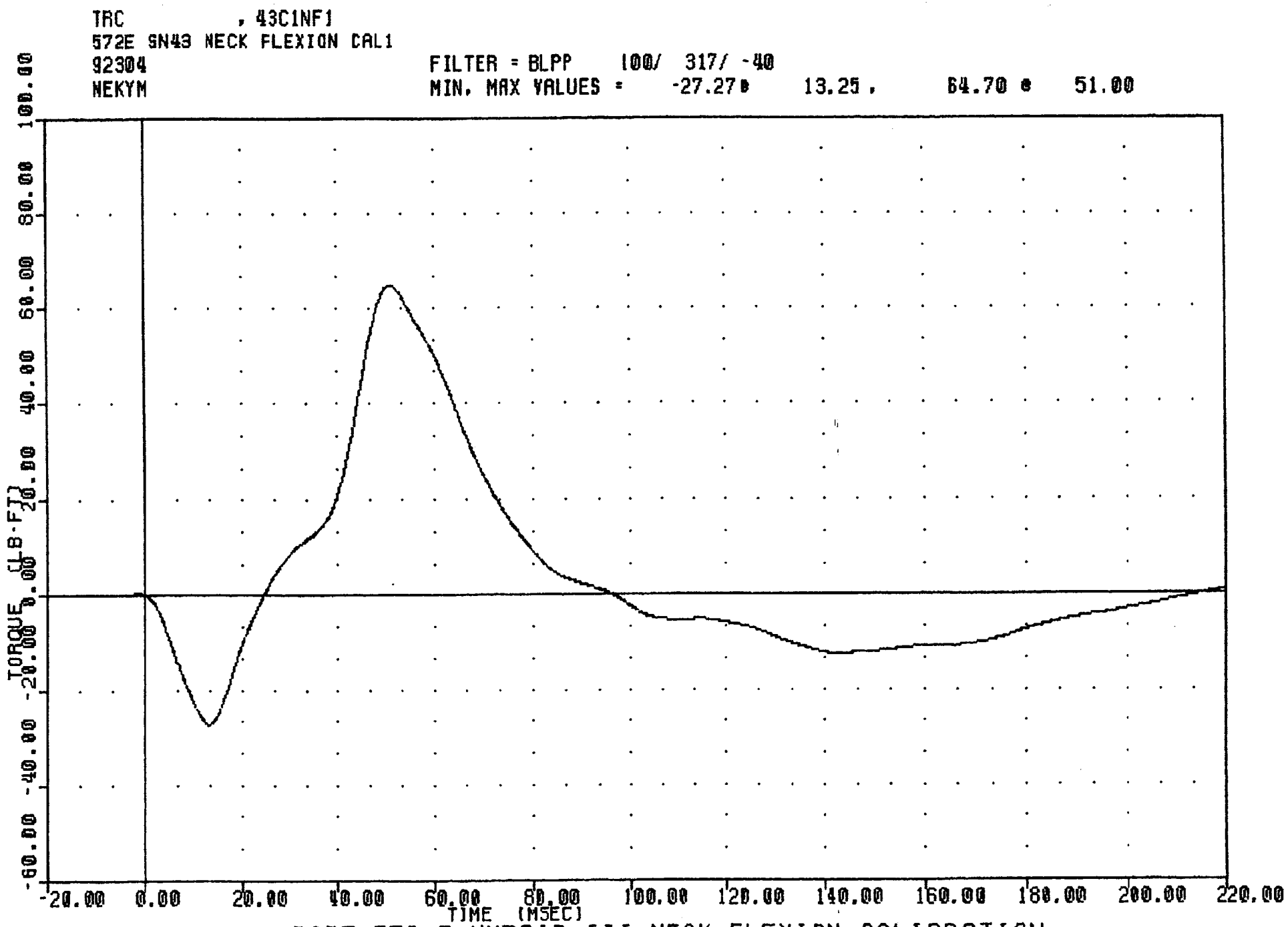
PART 572-E HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT OCCIPITAL CONDYLE



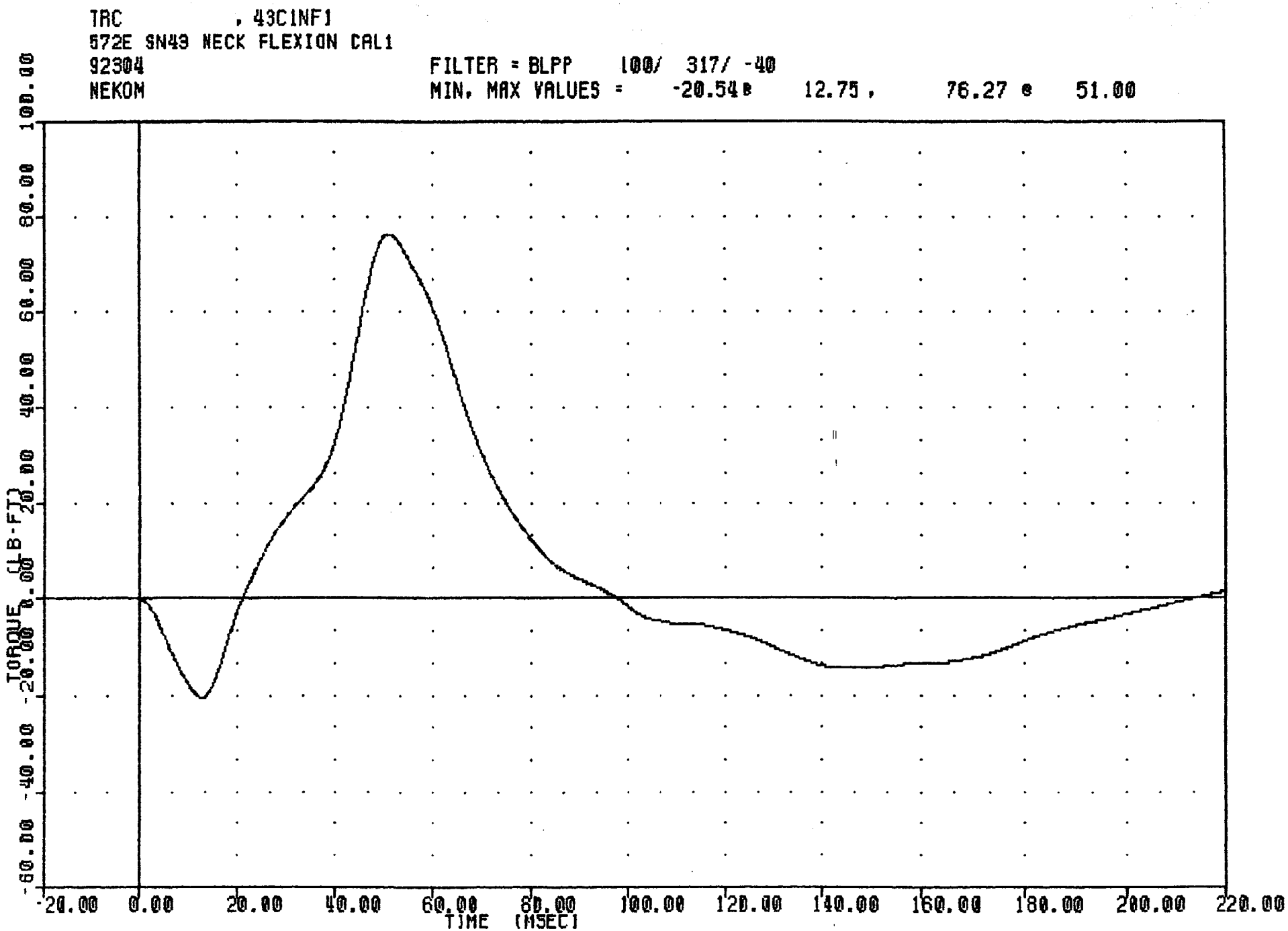
PART 572-E HYBRID III NECK FLEXION CALIBRATION
TOTAL ROTATION



PART 572-E HYBRID III NECK FLEXION CALIBRATION
NECK FORCE X AXIS



PART 572-E HYBRID III NECK FLEXION CALIBRATION
NECK MOMENT Y AXIS



PART 572-E HYBRID III NECK FLEXION CALIBRATION
TOTAL MOMENT ABOUT OCCIPITAL CONDYLE

TRANSPORTATION RESEARCH CENTER OF OHIO

NECK EXTENSION TEST

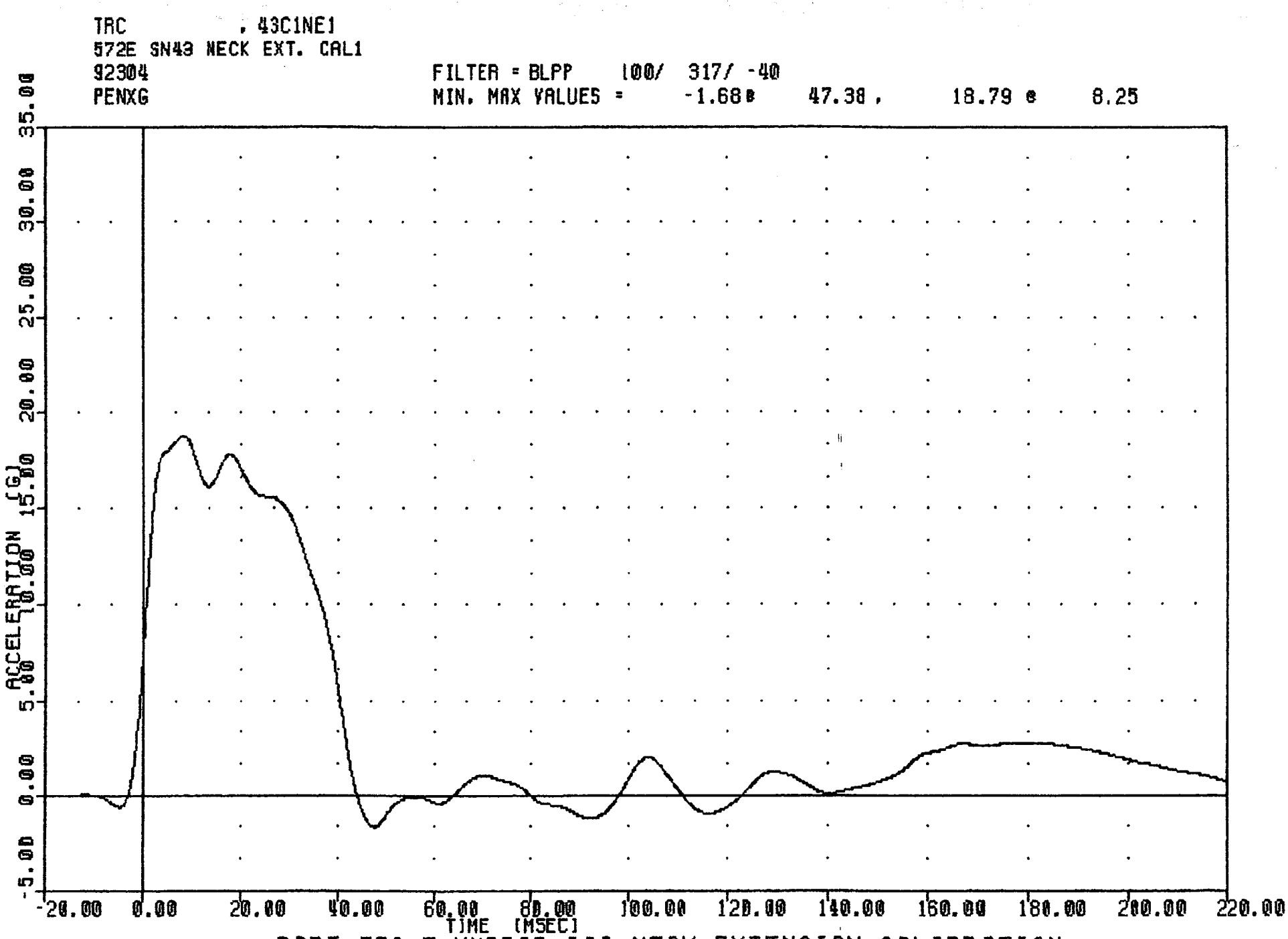
HYBRID III 30-OCT-92

6 AXIS NECK TRANSDUCER
TRC 43C1NE1 572E SN43 NECK EXT. CAL1

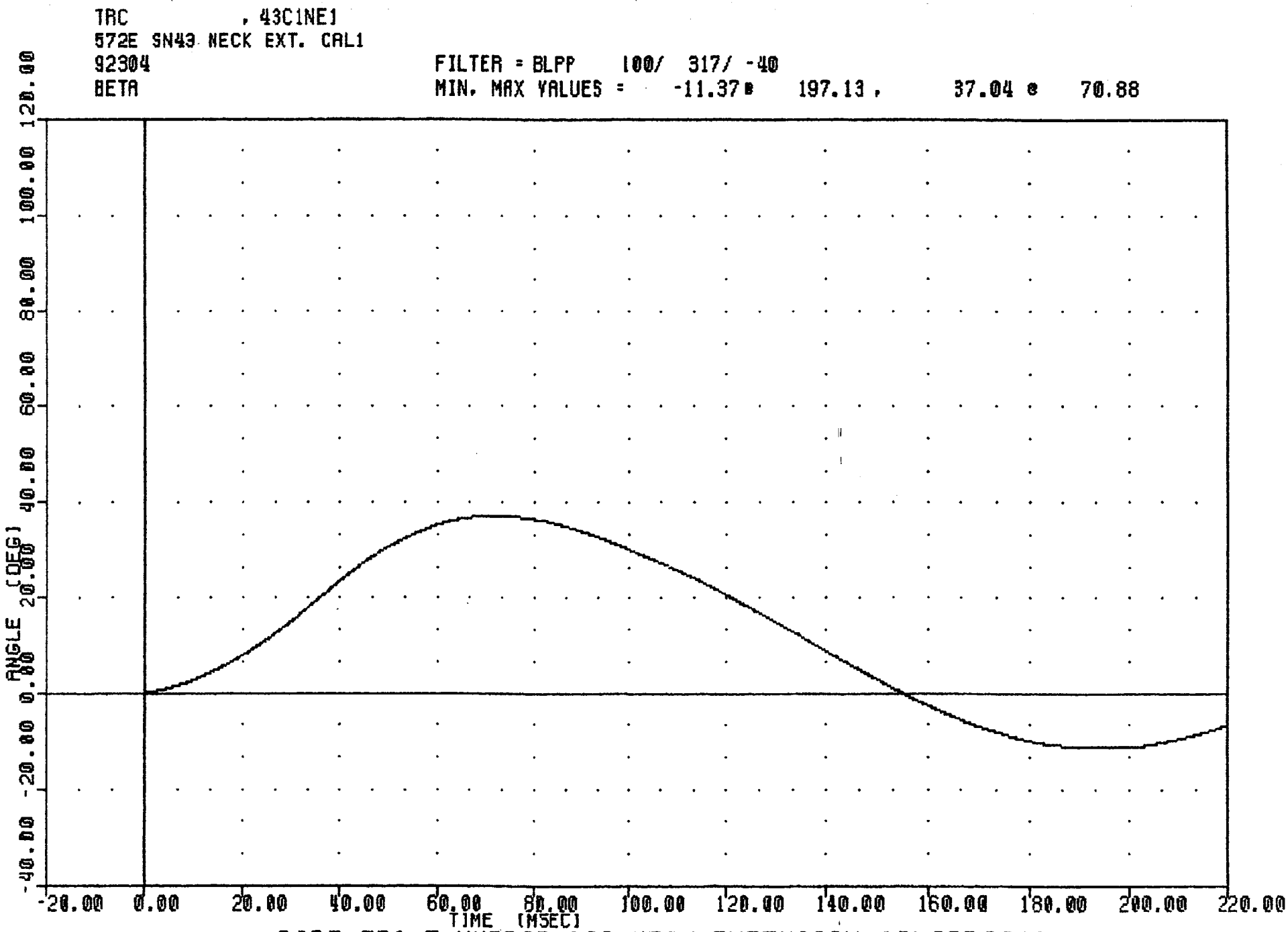
TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	69.0 DEG. F
RELATIVE HUMIDITY		10% - 70%	55.0 %
IMPACT VELOCITY		19.50-20.30 FT/SEC	19.83 FT/SEC
PENDULUM DECELERATION	10 MS	17.20 - 21.20 G	18.11 G
	20 MS	14.00 - 19.00 G	17.07 G
	30 MS	11.00 - 16.00 G	14.69 G
MAX PENDULUM G ABOVE 30 MS		22 G MAX	14.63 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		38 - 46 MS	40.13 MS
D PLANE ROTATION	MAX	81 - 106 DEG.	89.31 DEG.
	TIME	72 - 82 MS	74.00 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MIN	-59.0/-39.0 FT.LBS	-45.90 FT.LBS
	TIME	65 - 79 MS	68.75 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		147 - 174 MS	154.63 MS
NEGATIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		120 - 148 MS	134.38 MS

TEST MEETS SPECIFICATIONS

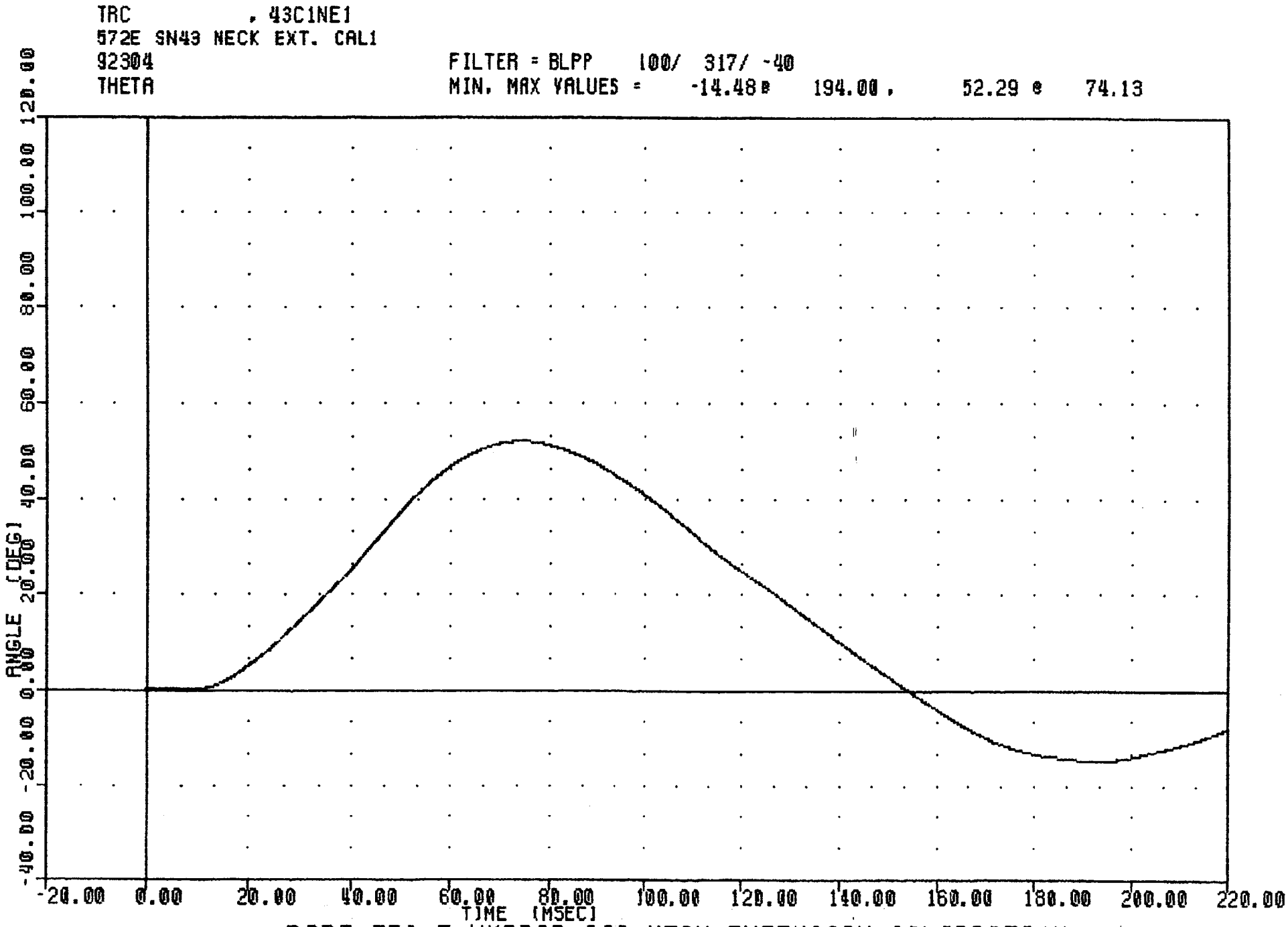
TECHNICIAN Pete Faust



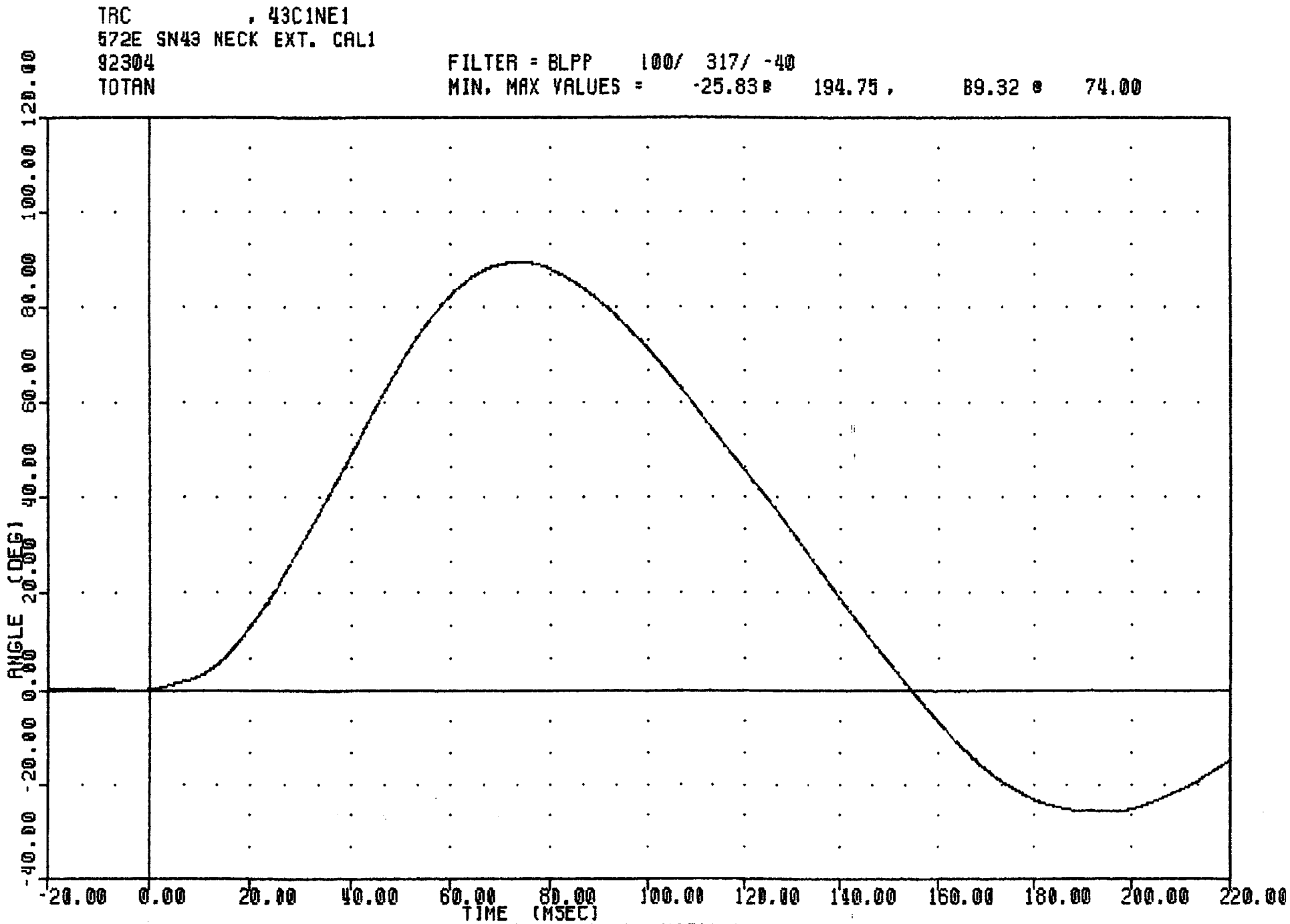
PART 572-E HYBRID III NECK EXTENSION CALIBRATION
PENDULUM DECELERATION



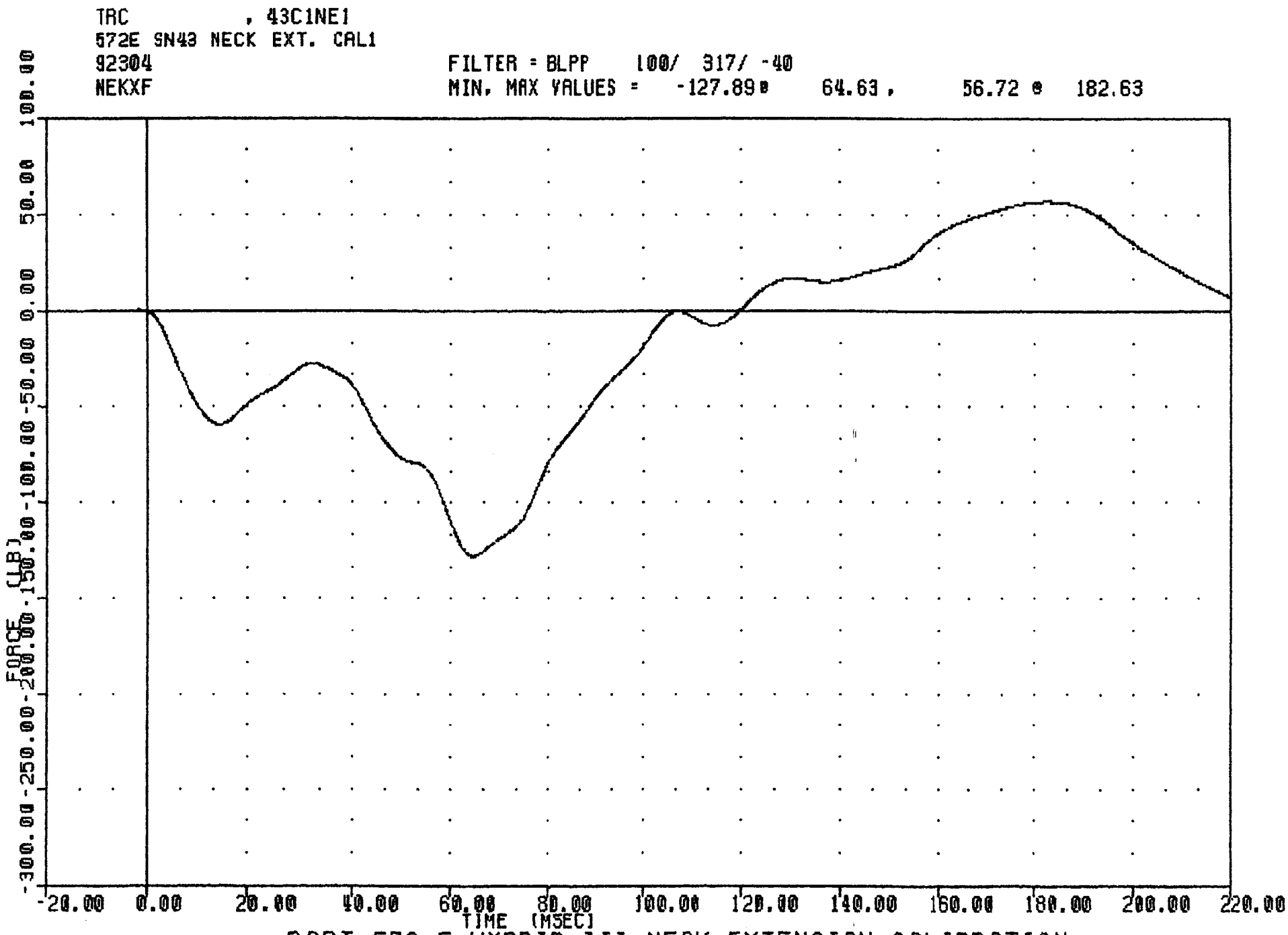
PART 572-E HYBRID III NECK EXTENSION CALIBRATION
ROTATION ABOUT BASE OF NECK



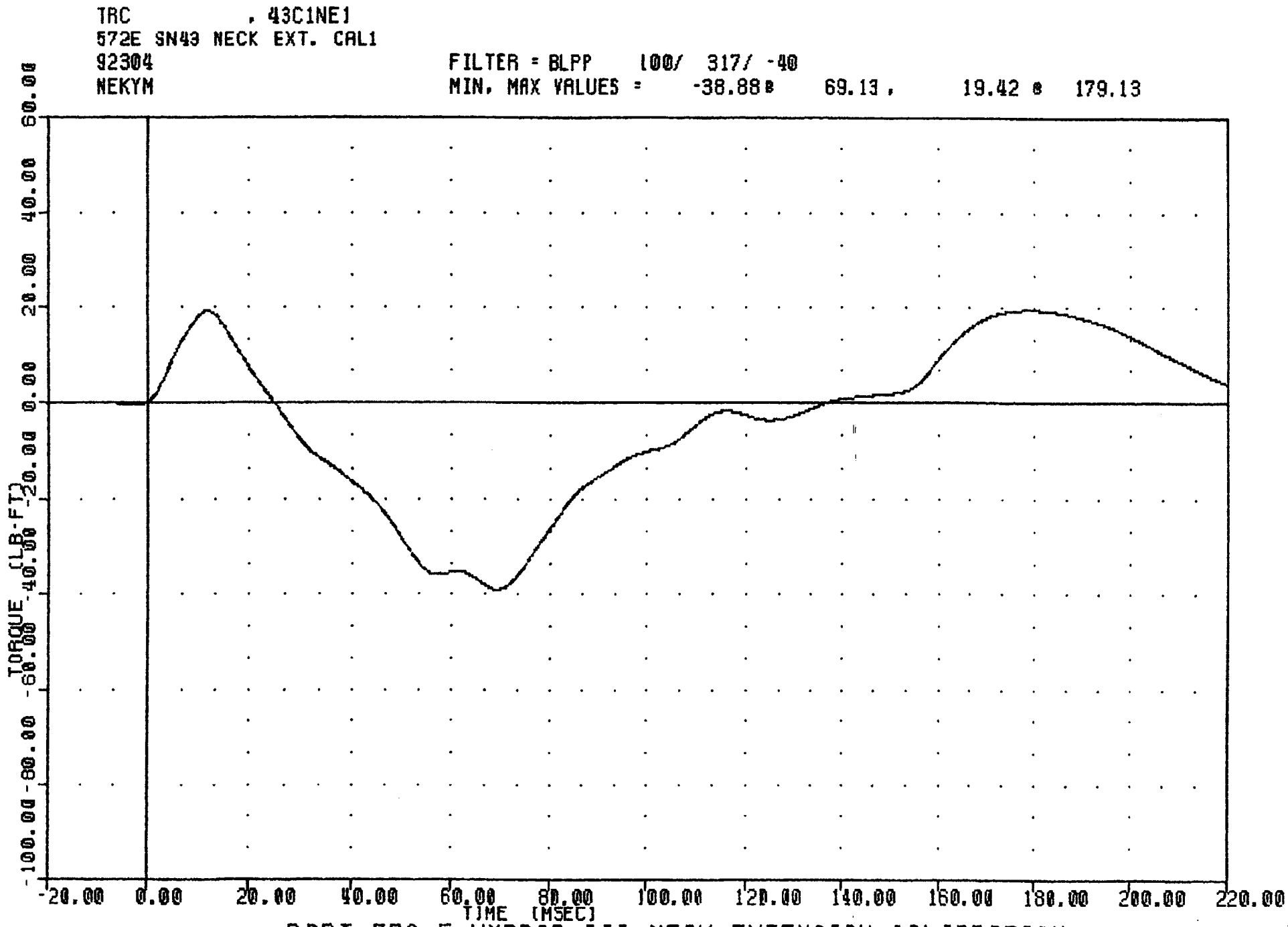
PART 572-E HYBRID III NECK EXTENSION CALIBRATION
ROTATION ABOUT OCCIPITAL CONDYLE



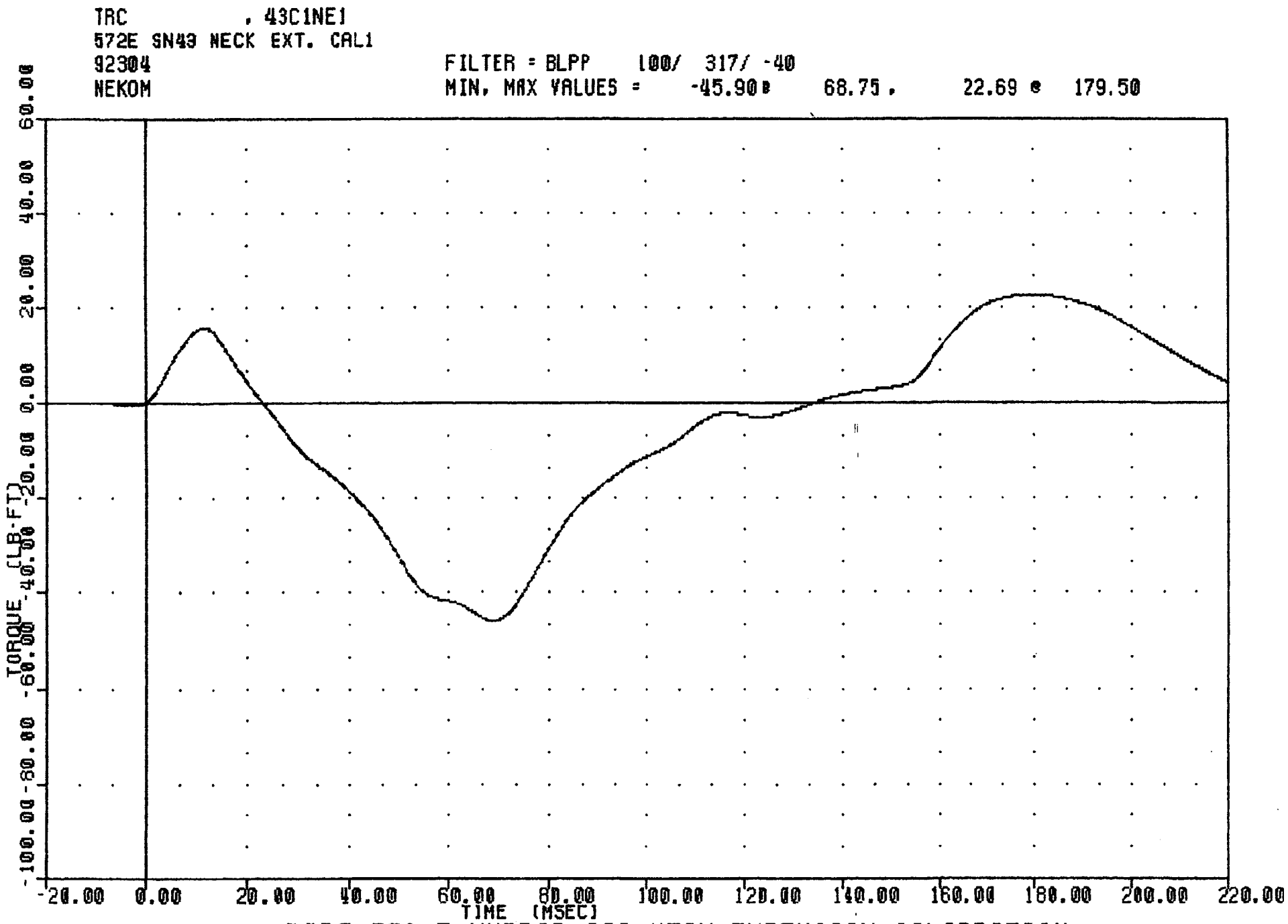
PART 572-E HYBRID III NECK EXTENSION CALIBRATION
TOTAL ROTATION



PART 572-E HYBRID III NECK EXTENSION CALIBRATION
NECK FORCE X AXIS



PART 572-E HYBRID III NECK EXTENSION CALIBRATION
NECK MOMENT Y AXIS



PART 572-E HYBRID III NECK EXTENSION CALIBRATION
TOTAL MOMENT ABOUT OCCIPITAL CONDYLE

TRANSPORTATION RESEARCH CENTER OF OHIO

THORAX IMPACT TEST

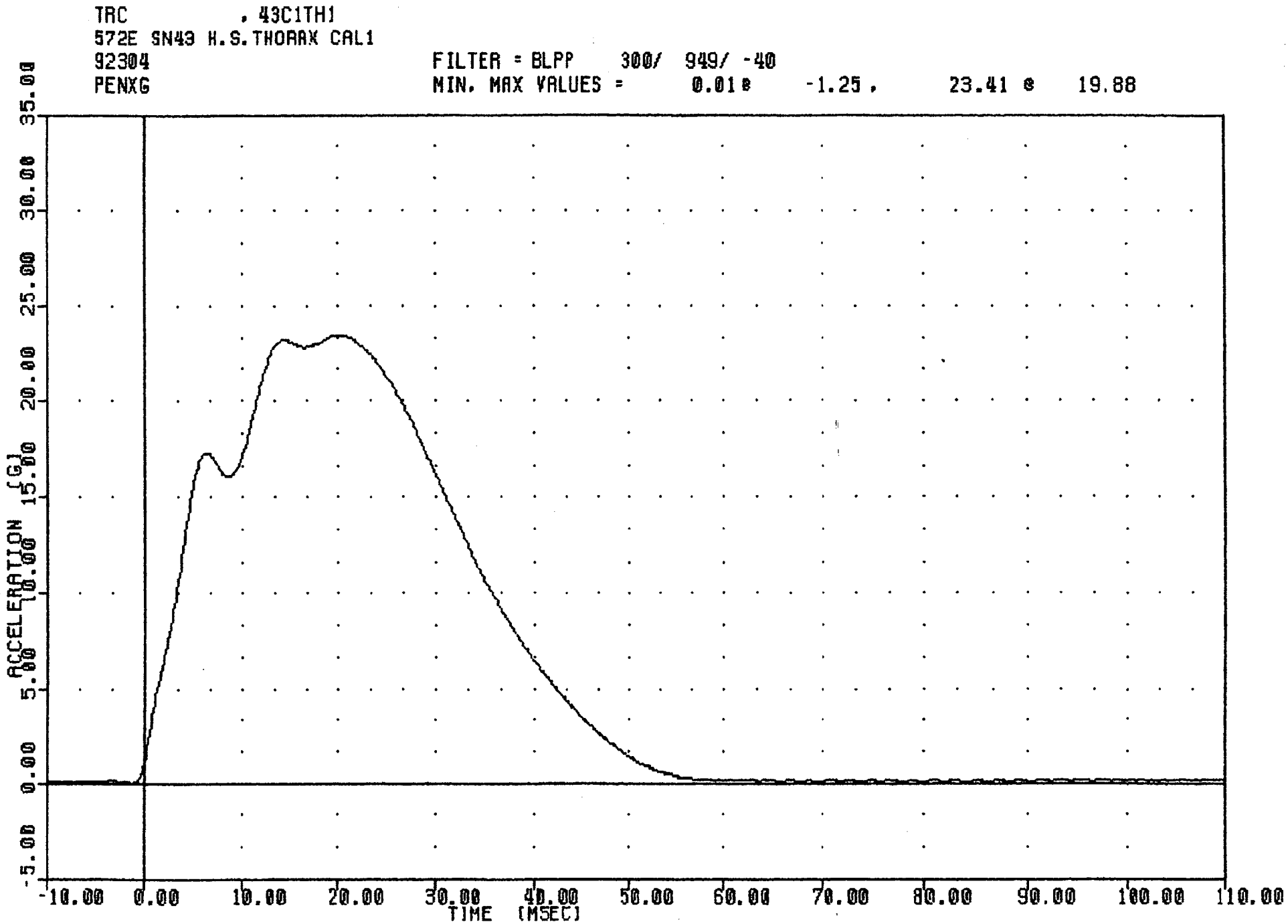
HYBRID III 30-OCT-92

TRC 43C1TH1 572E SN43 H.S.THORAX CAL3

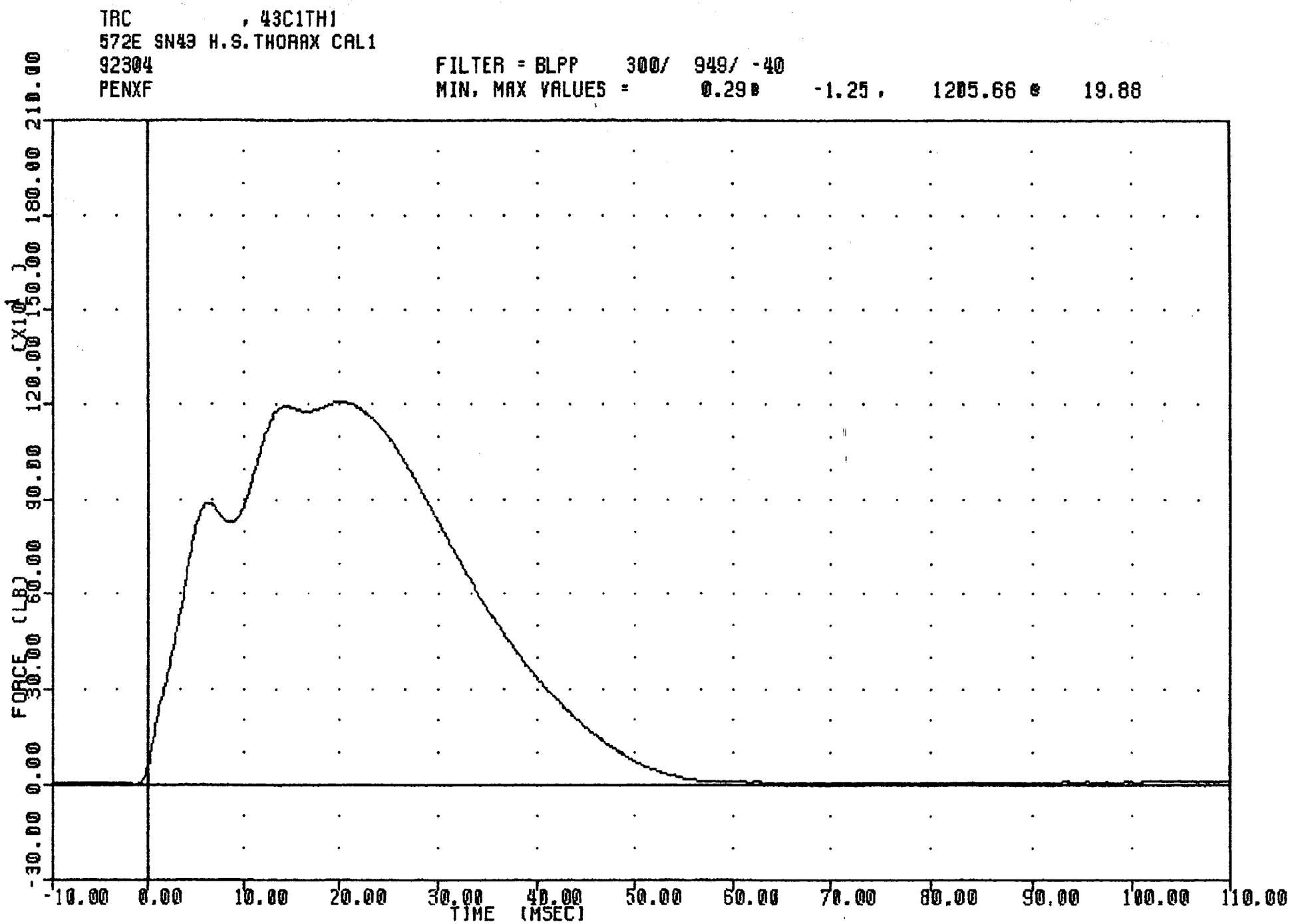
TEST PARAMETER	HIGH SPEED TEST SPECIFICATION	TEST RESULTS
TEMPERATURE	69 - 72 DEG. F	69.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PENDULUM VELOCITY	21.6-22.4 FT/SEC	21.91 FT/SEC
MAXIMUM DEFLECTION	2.50 - 2.86 IN	2.72 IN
MAXIMUM RESISTIVE FORCE	1160 - 1325 LBS	1205.6 LBS
INTERNAL HYSTERESIS	69% - 85%	75.8%

TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fouts

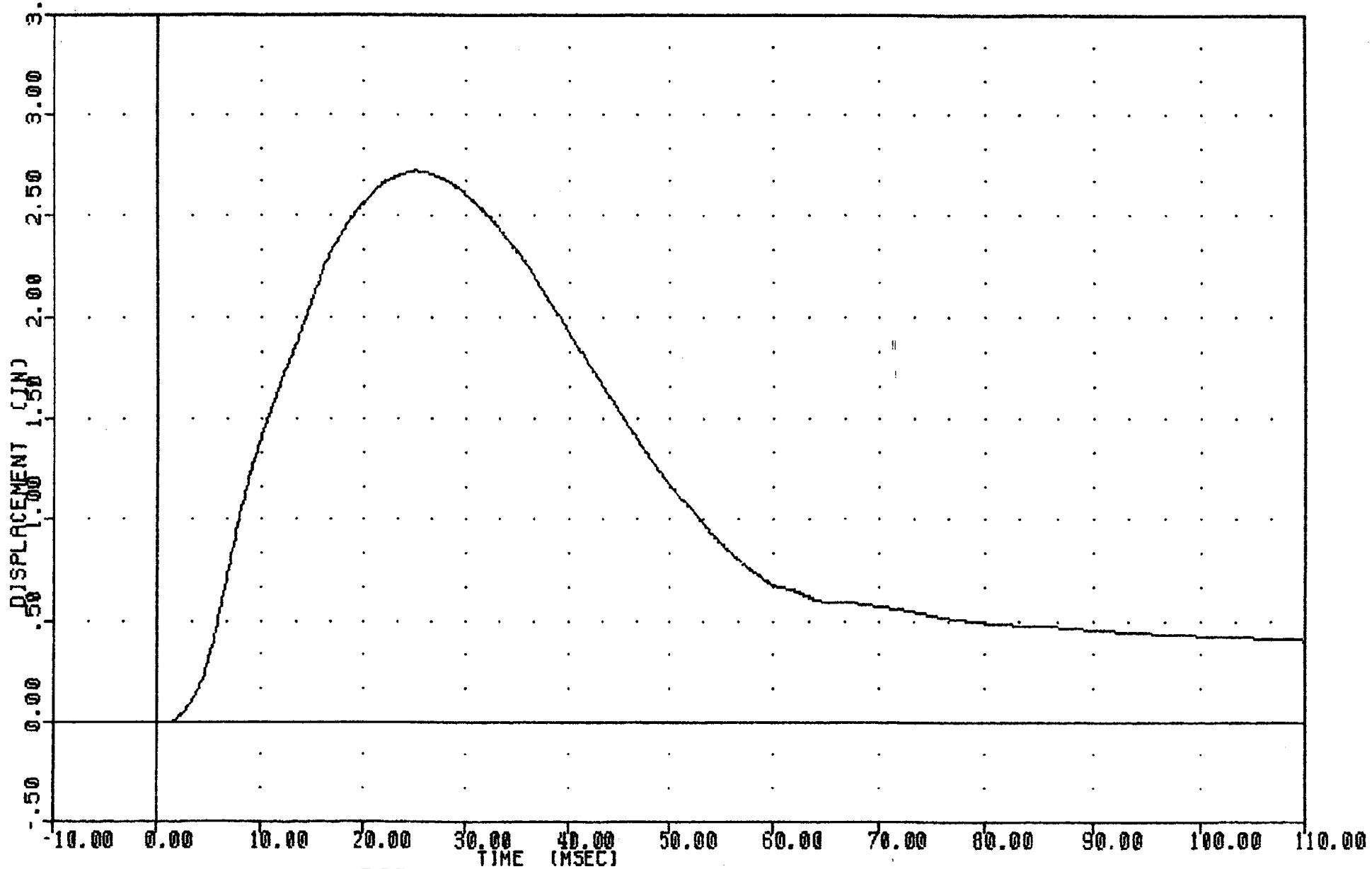


PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM DECELERATION

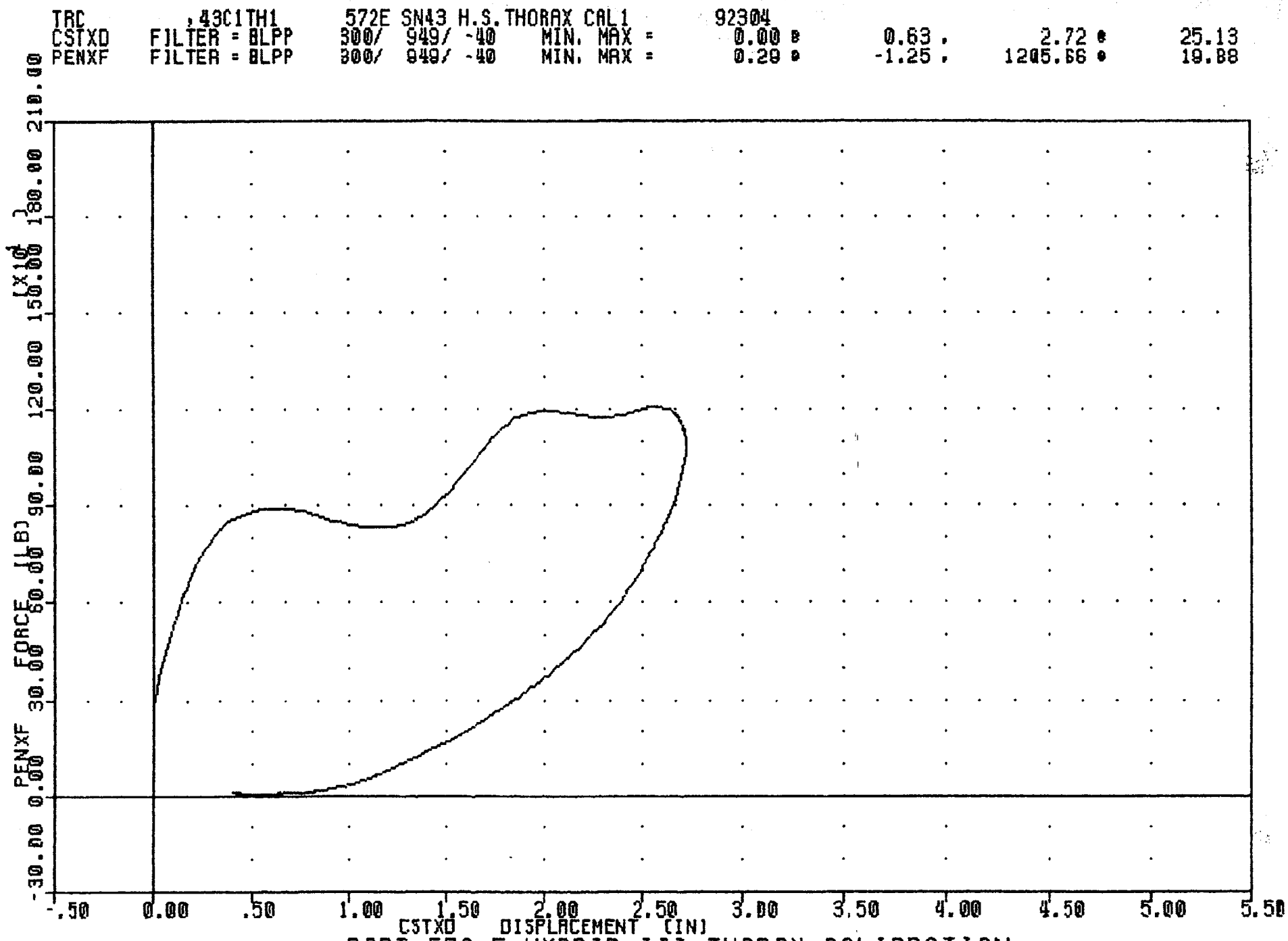


PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM FORCE

TRC , 43C1TH1
572E SN43 H.S.THORAX CAL1
92304 FILTER = BLPP 300/ 949/ -40
CSTXD MIN, MAX VALUES = 0.00 @ 0.63 , 2.72 @ 25.13



PART 572-E HYBRID III THORAX CALIBRATION
STERNUM DISPLACEMENT



PART 572-E HYBRID III THORAX CALIBRATION
CHEST DISPLACEMENT VS PENDULUM FORCE

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

HYBRID III 29-OCT-92

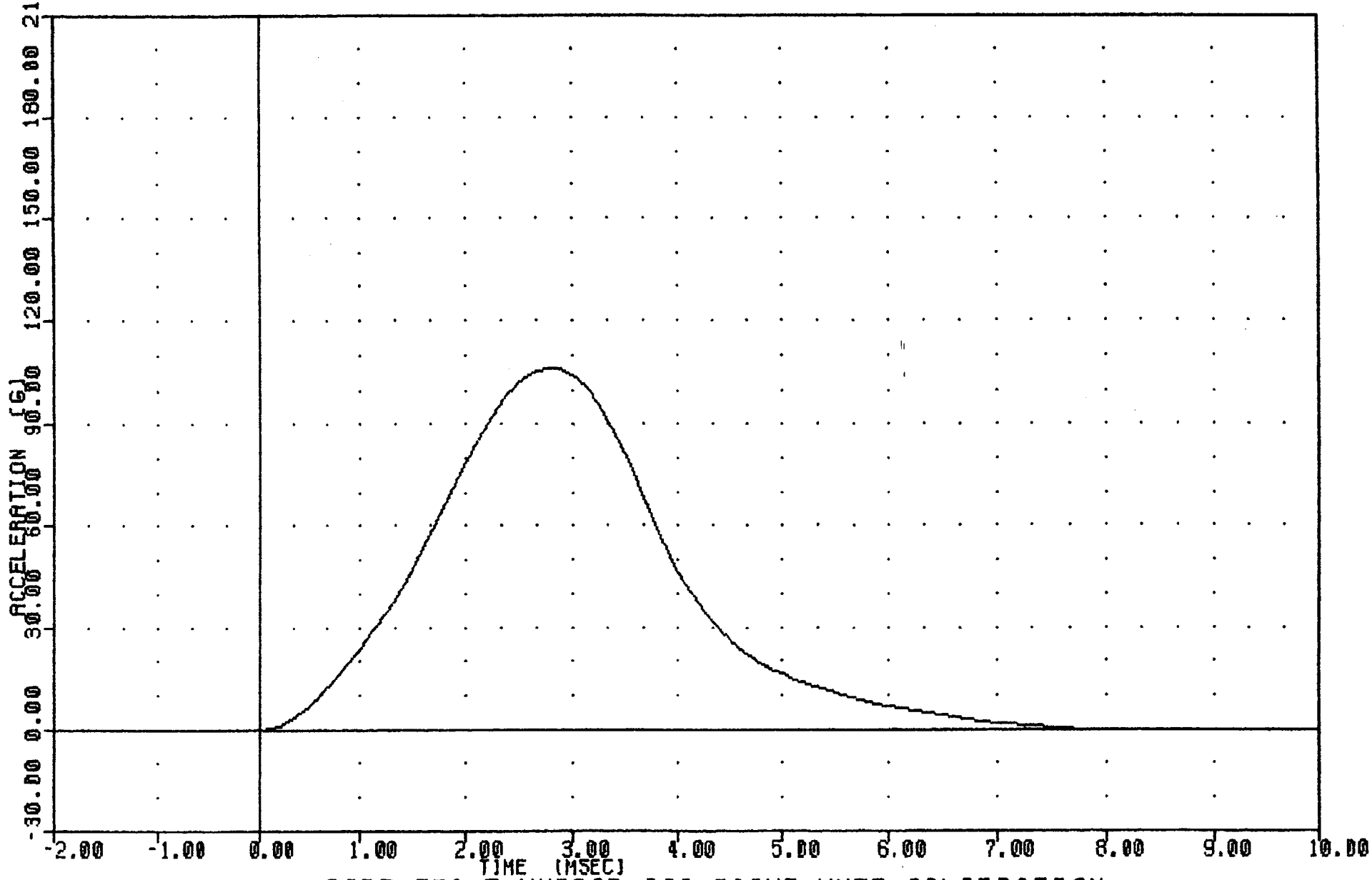
RIGHT KNEE
TRC 43C1RK1 572E SN43 RIGHT KNEE CAL 1

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	71.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.85 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1167.52 LBS
PROBE WEIGHT	11.0 LBS	

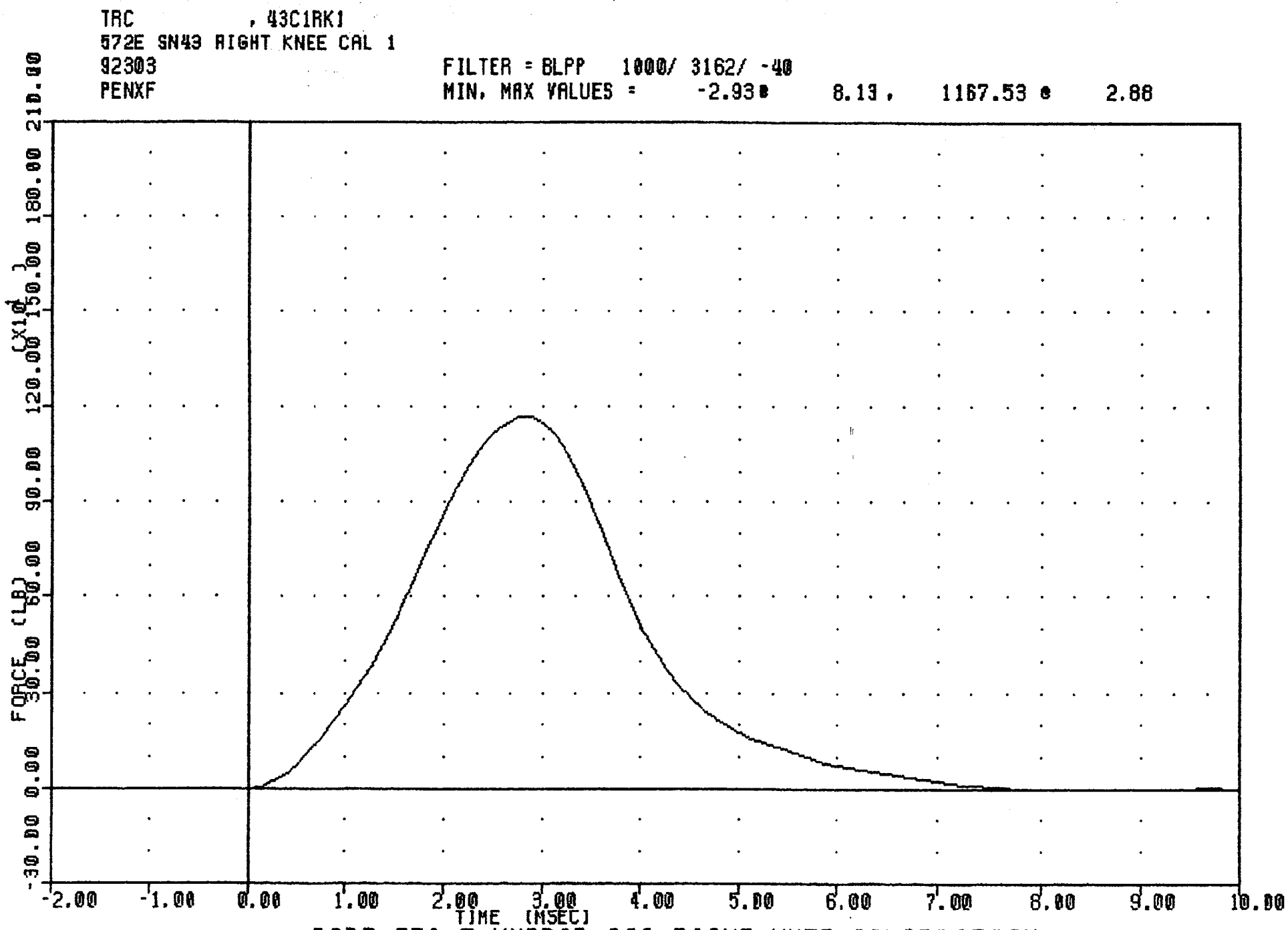
TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fort

TRC , 43C1RK1
572E SN49 RIGHT KNEE CAL 1
92303 FILTER = BLPP 1000/ 3162/ -40
PENXG MIN, MAX VALUES = -0.27@ 8.13 , 106.14 @ 2.88



PART 572-E HYBRID III RIGHT KNEE CALIBRATION
PENDULUM DECELERATION (11 LB PEND.)



PART 572-E HYBRID III RIGHT KNEE CALIBRATION
PENDULUM FORCE (11 LB PEND.)

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

HYBRID III 29-OCT-92

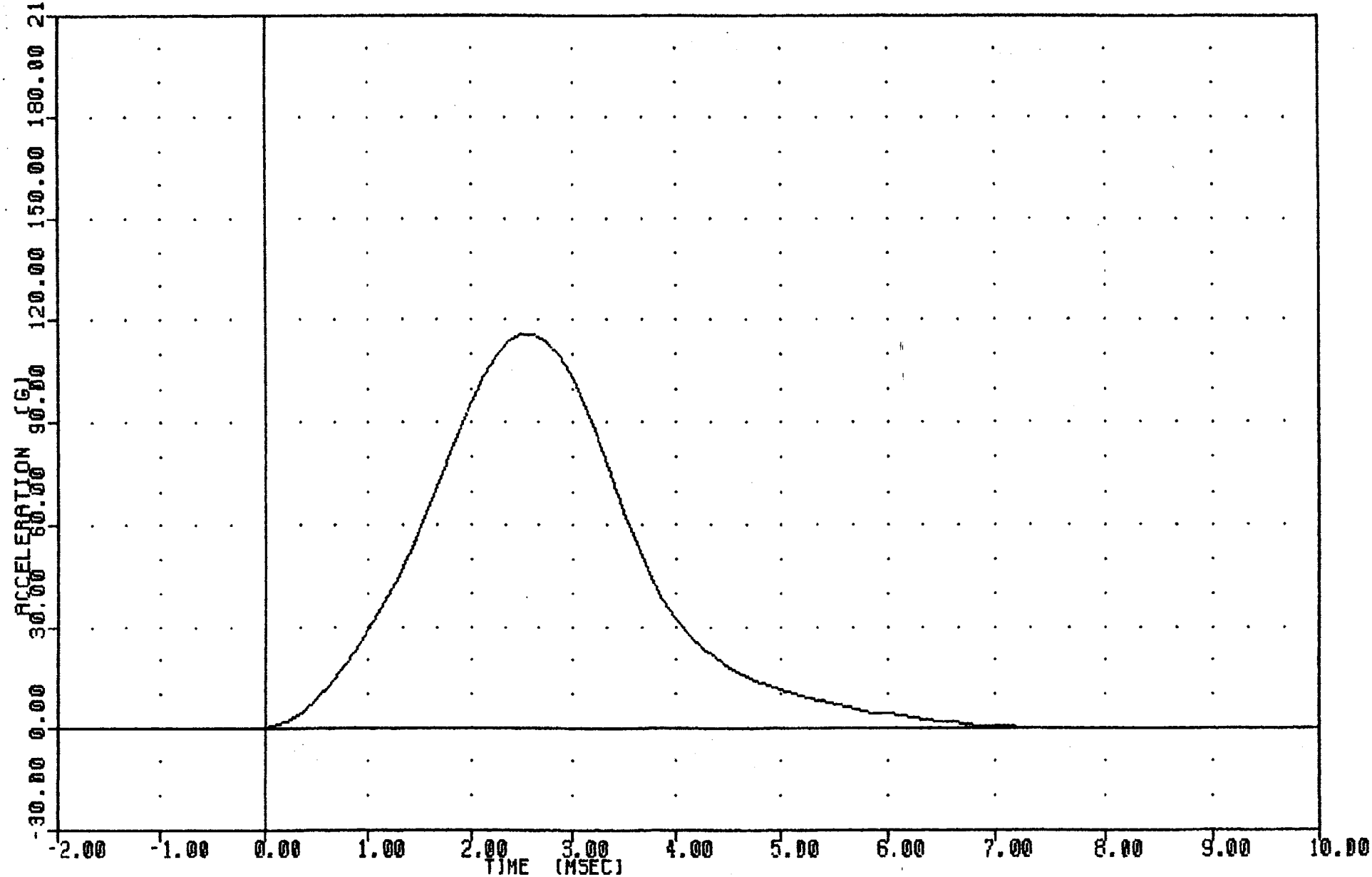
LEFT KNEE
TRC 43C1LK1 572E SN43 LEFT KNEE CAL 1

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	71.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.82 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1271.95 LBS
PROBE WEIGHT	11.0 LBS	

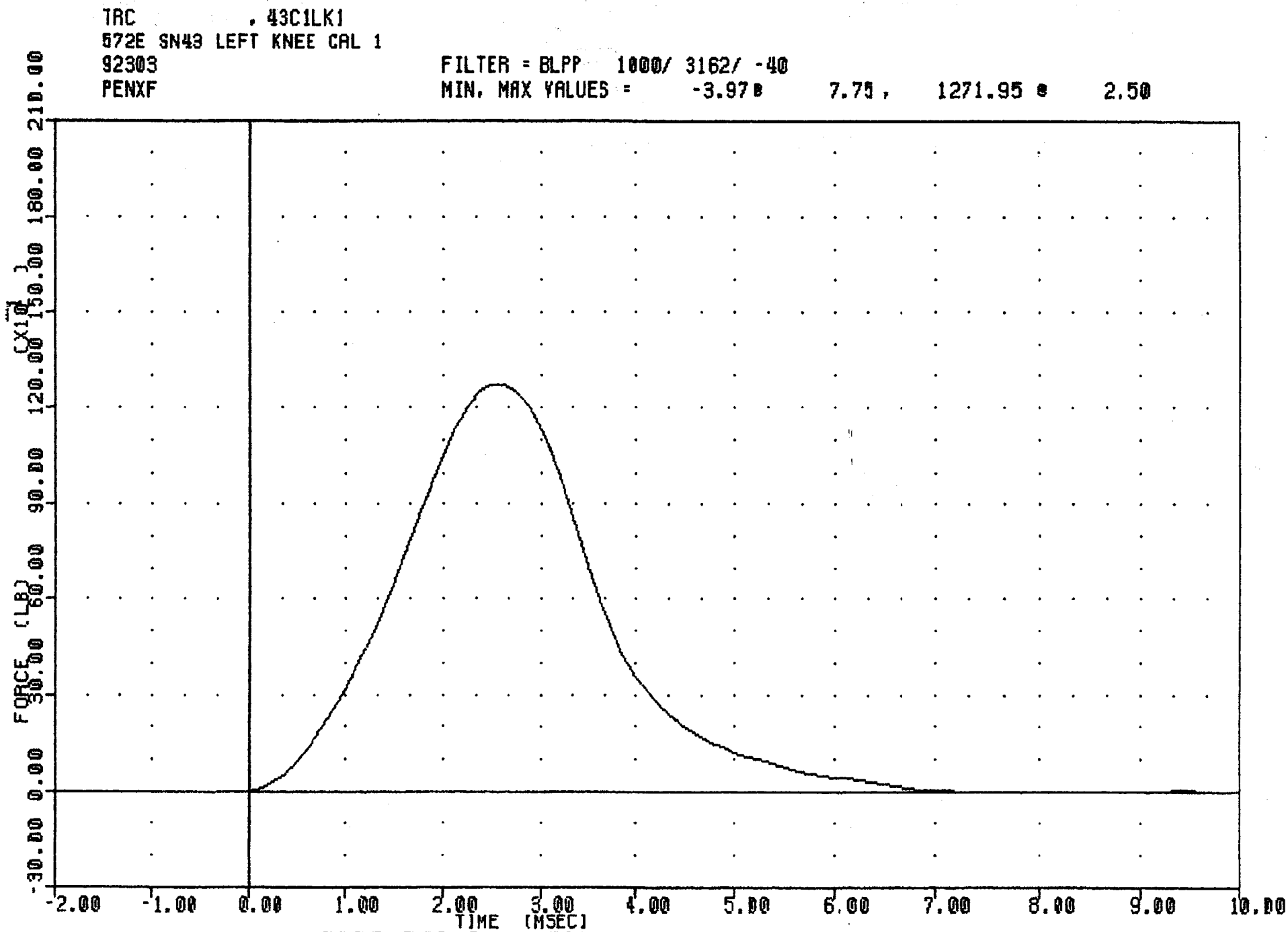
TEST MEETS SPECIFICATIONS

TECHNICIAN Peter Fort

TRC , 43C1LK1
572E SN43 LEFT KNEE CAL 1
92303 FILTER = BLPP 1000/ 3162/ -40
PENXG MIN, MAX VALUES = -0.36 @ 7.75 , 115.63 @ 2.50



PART 572-E HYBRID III LEFT KNEE CALIBRATION
PENDULUM DECELERATION (11 LB PEND.)



PART 572-E HYBRID III LEFT KNEE CALIBRATION
PENDULUM FORCE [11 LB PEND.]

APPENDIX D

MISCELLANEOUS TEST INFORMATION

DUMMY INSTRUMENTATION PLACEMENT

DUMMY MANUFACTURER & S/N: HUMANOID SYSTEMS #048

SEATING POSITION: DRIVER

DESCRIPTION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
HEAD ACCELERATION	X	ENDEVCO	7264	EH78J	REAR
HEAD ACCELERATION	Y	ENDEVCO	7264	DH37J	LEFT
HEAD ACCELERATION	Z	ENDEVCO	7264	DD17J	UP
NECK SHEAR FORCE	X	DENTON	1716	0106	HEAD REARWARD
NECK SHEAR FORCE	Y	DENTON	1716	0106	HEAD LEFTWARD
NECK AXIAL FORCE	Z	DENTON	1716	0106	HEAD UPWARD
NECK MOMENT	X	DENTON	1716	0106	LEFT EAR TOWARD LEFT SHOULDER
NECK MOMENT	Y	DENTON	1716	0106	CHIN TO CHEST
NECK MOMENT	Z	DENTON	1716	0106	CHIN TOWARD LEFT SHOULDER
CHEST ACCELERATION	X	ENDEVCO	7264	EH92J	FRONT
CHEST ACCELERATION	Y	ENDEVCO	7264	CC24H	LEFT
CHEST ACCELERATION	Z	ENDEVCO	7264	FG28J	UP
CHEST DISPLACEMENT	X	SERVO	14CB1-2897	9041	OUTWARD
PELVIS ACCELERATION	X	ENDEVCO	7264	BC75J	REAR
PELVIS ACCELERATION	X	ENDEVCO	7264	FC43J	LEFT
PELVIS ACCELERATION	X	ENDEVCO	7264	AP87	UP
LEFT FEMUR FORCE		GSE	2430	014	TENSION
RIGHT FEMUR FORCE		GSE	2430	756	TENSION

DUMMY INSTRUMENTATION PLACEMENT

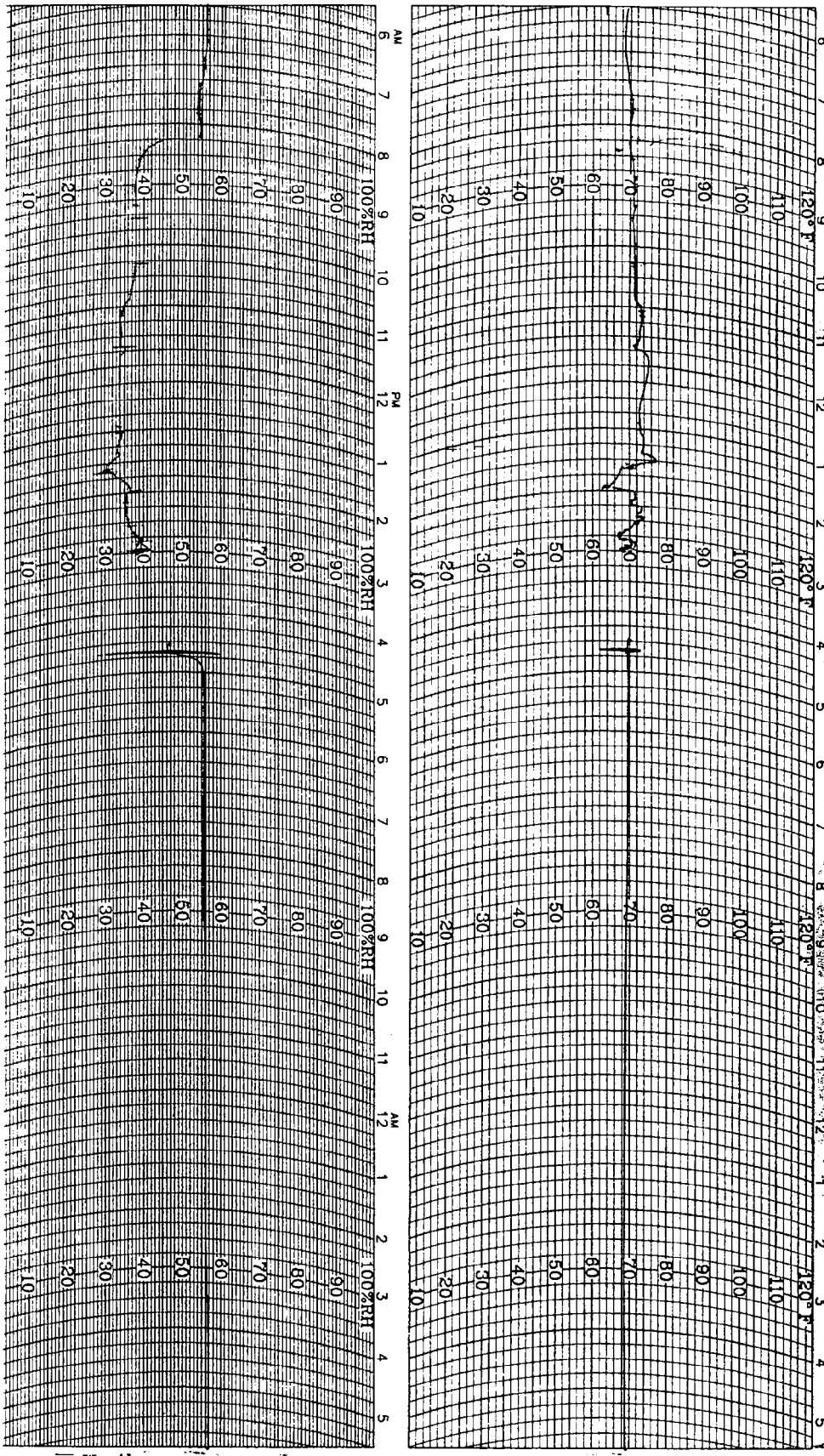
DUMMY MANUFACTURER & S/N: HUMANOID SYSTEMS #043

SEATING POSITION: RIGHT FRONT PASSENGER

DESCRIPTION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
HEAD ACCELERATION	X	ENDEVCO	7264	BG23J	FRONT
HEAD ACCELERATION	Y	ENDEVCO	7264	FG33J	RIGHT
HEAD ACCELERATION	Z	ENDEVCO	7264	DP32J	UP
NECK SHEAR FORCE	X	DENTON	1716A	0425	HEAD REARWARD
NECK SHEAR FORCE	Y	DENTON	1716A	0425	HEAD LEFTWARD
NECK AXIAL FORCE	Z	DENTON	1716A	0425	HEAD UPWARD
NECK MOMENT	X	DENTON	1716A	0425	LEFT EAR TOWARD LEFT SHOULDER
NECK MOMENT	Y	DENTON	1716A	0425	CHIN TO CHEST
NECK MOMENT	Z	DENTON	1716A	0425	CHIN TOWARD LEFT SHOULDER
CHEST ACCELERATION	X	ENDEVCO	7264	EJ01J	FRONT
CHEST ACCELERATION	Y	ENDEVCO	7264	DH31J	LEFT
CHEST ACCELERATION	Z	ENDEVCO	7264	RF79J	UP
CHEST DISPLACEMENT	X	BOURNS	NA	043	OUTWARD
PELVIS ACCELERATION	X	ENDEVCO	7264	DM72J	REAR
PELVIS ACCELERATION	X	ENDEVCO	7264	BG11J	LEFT
PELVIS ACCELERATION	X	ENDEVCO	7264	BH87J	UP
LEFT FEMUR FORCE		GSE	2430	631	TENSION
RIGHT FEMUR FORCE		GSE	2430	633	TENSION

VEHICLE INSTRUMENTATION PLACEMENT

NO.	LOCATION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
1	LEFT REAR SEAT	X	ENDEVCO	7264	CP37H	REAR
		Y	ENDEVCO	7264	CW79H	RIGHT
2	RIGHT REAR SEAT	X	ENDEVCO	7264	BY01J	REAR
		Y	ENDEVCO	7264	CH24H	RIGHT
3	CAR CENTER OF GRAVITY	X	ENDEVCO	7264	CL83H	REAR
		Y	ENDEVCO	7264	CW83H	RIGHT
		Z	ENDEVCO	7264	CH28H	UP
	DRIVER'S SHOULDER BELT		LEBOW	3419	615	TENSION
	RIGHT FRONT PASSENGER'S SHOULDER BELT		LEBOW	3419	616	TENSION



*Weather*Measure
*WEATHER*tronics
Division of QUALIMETRICS, Inc.
P.O. BOX 41039
SACRAMENTO, CA 95841
PHONE: (916) 923-0055

HYGROTHERMOGRAPH
1 DAY

CHART NO. M699123
C311-D-HF
ECN 2717
6-9-87

STATION

DATE ON

DATE OFF