NHTSA # 1805

HEAVY TRUCK UNDERRIDE PROTECTION

1993 FORD TEMPO

INTO HEAVY TRUCK REAR UNDERRIDE GUARD

WITH 1.0-INCH MOUNTING BOLTS

TRC TEST NO. 921203

PREPARED BY:

TRANSPORTATION RESEARCH CENTER OF OHIO

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FINAL REPORT

DECEMBER 1992 - JANUARY 1993

PREPARED FOR:

VEHICLE RESEARCH AND TEST CENTER

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16. Abstract

A 1993 Ford Tempo 2-door coupe was impacted into a heavy truck rear underride guard at the Transportation Research Center Inc. on December 3, 1992. This test was conducted to determine the performance of the underride guard with 1.0-inch mounting bolts in the 0°, 30 mph impact mode. The actual test speed was 30.0 mph. The ambient temperature was 70° F. At maximum vehicle displacement, the clearance from the simulated truck rear to the windshield was 12.4 inches.

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Heavy Truck Rear Underride Guard 1.0-inch Mounting Bolts	

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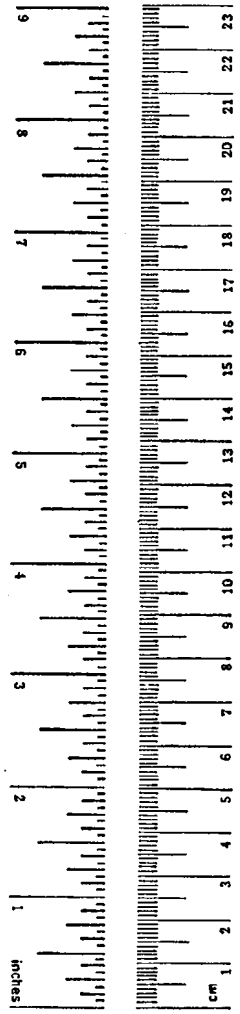
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

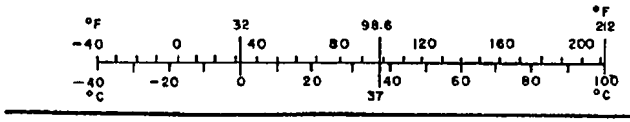
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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 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. The passenger's 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 1.0-inch mounting bolts onto a heavy truck frame surrogate attached to the rigid barrier at the Transportation Research Center Inc.

The underride guard was instrumented with two (2) accelerometer blocks mounted to the guard's rear surface where the web sections of the vertical crossmembers meet the web section of the horizontal crossmember. The accelerometers were oriented to measure vertical and longitudinal accelerations.

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-eight (48) 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 fifteen (15) high-speed motion picture cameras.

The heavy truck underride guard data are summarized in Section 2.0. The occupant, vehicle, & camera information 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 December 3, 1992.

The test vehicle, a 1993 Ford Tempo 2-door coupe, was equipped with a 2.3 liter, transverse engine, automatic transmission, power steering, and power brakes. The vehicle's test weight was 3087 pounds. The vehicle's impact speed was 30.0 mph. At maximum vehicle displacement, the clearance from the simulated truck rear to the vehicle's windshield was 12.4 inches. This value was obtained from digital analysis of the high-speed film.

The driver's head injury criteria (HIC) was 139 (See TEST ANOMALIES). The driver's maximum chest resultant acceleration with three (3) milliseconds minimum duration was 19.2 g. The driver's chest deflection was 0.7 inches. The driver's maximum left and right femur forces were 662 pounds and 650 pounds, respectively.

The right front passenger's head injury criteria (HIC) was 117. The right front passenger's maximum chest resultant acceleration with three (3) milliseconds minimum duration was 24.6 g. The right front passenger's chest deflection was 0.8 inches. The right front passenger's maximum left and right femur forces were 297 pounds and 288 pounds, respectively.

TEST ANOMALIES

The driver dummy's head X-, Y-, and Z-axis accelerometers, HEDXG1, HEDYG1, and HEDZG1, recorded an anomalous data spike at 137 milliseconds. This anomaly affected the computations of the driver dummy's head resultant acceleration, HEDRG1, and HIC.

The barrier right crossmember X-axis accelerometer, BFCXG2, exceeded its full scale at 11 milliseconds. This anomaly affected the computed velocity and displacement of the barrier's right crossmember in the X-axis direction.

TABLE 1 CRASH TEST SUMMARY

TEST TYPE: Heavy Truck Rear Underride Guard

TEST DATE: 12/03/92 TEST TIME: 1451 AMBIENT TEMP. (°F): 70

VEHICLE YEAR/MAKE/MODEL/BODY STYLE: 1993/Ford/Tempo/2-door coupe

VEHICLE TEST WEIGHT (LBS): 3087

IMPACT ANGLE (DEG)*: 0

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

MAXIMUM STATIC CRUSH (IN): 0.7

DUMMIES:	Driver #043	Passenger #048
TYPE:	Part 572 E	Part 572 E
LOCATION:	Left front	Right front
RESTRAINT:	Driver's airbag	3-point belt

NUMBER OF DATA CHANNELS: 48

NUMBER OF CAMERAS: HIGH-SPEED 15 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: Ford Motor Company, USA

MAKE/MODEL: Ford/Tempo VIN: 1FACP31X3PK113466

BODY STYLE: 2-door coupe MODEL YEAR: 1993

COLOR: Black

ENGINE DATA: TYPE: transverse CYLINDERS: 4 DISPLACEMENT: 2.3 liter

TRANSMISSION DATA: _3_SPEED, ___MANUAL, _X_AUTOMATIC, ___FWD, ___RWD,___4WD

DATE VEHICLE RECEIVED: 11/27/92 ODOMETER READING: 25.0

DEALER'S NAME AND ADDRESS: NA

ACCESSORIES:

POWER STEERING	Yes	AUTOMATIC TRANSMISSION	Yes
POWER BRAKES	Yes	AUTOMATIC SPEED CONTROL	No
POWER SEATS	No	TILTING STEERING WHEEL	No
POWER WINDOWS	No	TELESCOPING STEERING WHEEL	No
TINTED GLASS	Yes	AIR CONDITIONING	Yes
RADIO	Yes	ANTI-SKID BRAKE	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: Ford Motor Company, USA

DATE OF MANUFACTURE: 08/92 VIN: 1FACP31X3PK113466

GVWR: 3825 LBS

GAWR: FRONT: 1998 LBS., REAR: 1847 LBS.

TABLE 2 TEST VEHICLE INFORMATION CONT'D

TIRES ON VEHICLE (MFR., LINE, SIZE): Goodyear, Invicta GA, P185/70R14

TIRE PRESSURE WITH MAXIMUM CAPACITY VEHICLE LOAD: FRONT: 44 PSI
REAR: 44 PSI

SPARE TIRE (MFR., LINE, SIZE): Space saver

TYPE OF SEATS: FRONT: Bucket
REAR: Bench

TYPE OF FRONT SEAT BACKS: Manually-adjustable

MAXIMUM WIDTH: 68.0 INCHES

WHEELBASE: 100.0 INCHES

LOCATION OF LABEL STATING TIRE & CAPACITY DATA:
The label was located on the passenger's door.

TIRE & CAPACITY DATA FROM VEHICLE'S LABEL:

RECOMMENDED TIRE SIZE: P185/70R14

RECOMMENDED COLD TIRE PRESSURE: FRONT: 30 PSI; REAR: 30 PSI

DESIGNATED SEATING CAPACITY: 2 FRONT 3 REAR 5 TOTAL

VEHICLE CAPACITY WEIGHT: 850 LBS.

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

DELIVERED ATTITUDE:	LF	26.2;	RF	26.5;	LR	25.5;	RR	25.5
FULLY LOADED ATTITUDE:	LF	25.8;	RF	26.1;	LR	25.0;	RR	24.5
PRE-TEST ATTITUDE*:	LF	24.2;	RF	24.5;	LR	27.6;	RR	27.6
POST-TEST ATTITUDE:	LF	25.4;	RF	26.9;	LR	27.8;	RR	25.5

*It was determined by VRTC that under heavy braking the front of the test vehicle lowered by 2.75 inches measured at the front bumper centerline and the rear of the test vehicle raised 2.5 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:

RIGHT FRONT	817 LBS.	RIGHT REAR	482 LBS.
LEFT FRONT	853 LBS.	LEFT REAR	490 LBS.
TOTAL FRONT WEIGHT	1670 LBS.	(63.2% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	972 LBS.	(36.8% OF TOTAL VEHICLE WEIGHT)	

TOTAL DELIVERED WEIGHT 2642 LBS.

CALCULATION OF TEST VEHICLE'S TARGET TEST WEIGHT:

RCLW = RATED CARGO AND LUGGAGE WEIGHT*

UDW = UNLOADED DELIVERED WEIGHT (2642 LBS)

VCW = VEHICLE CAPACITY WEIGHT (850 LBS)

DSC = DESIGNATED SEATING CAPACITY (5)

RCLW*= VCW - 150 (DSC) = 100

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

TARGET TEST WEIGHT = 2642 + 100 + 334

TARGET TEST WEIGHT = 3076 LBS

WEIGHT OF TEST VEHICLE WITH REQUIRED DUMMIES AND 111 LBS. OF CARGO WEIGHT:

RIGHT FRONT	848 LBS.	RIGHT REAR	685 LBS.
LEFT FRONT	890 LBS.	LEFT REAR	664 LBS.
TOTAL FRONT WEIGHT	1738 LBS.	(56.3% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	1349 LBS.	(43.7% OF TOTAL VEHICLE WEIGHT)	
TOTAL TEST WEIGHT	3087 LBS.	(0.4% OVER TARGET TEST WEIGHT)	

WEIGHT OF BALLAST SECURED IN VEHICLE CARGO AREA: 0

COMPONENTS REMOVED TO MEET TARGET TEST WEIGHT: Rear view mirrors, rear speakers

CG = 43.7 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: 921203

TEST DATE: 12/03/92 TEST TIME: 1451

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

AMBIENT TEMPERATURE AT IMPACT AREA: 70° F

TEMPERATURE IN OCCUPANT COMPARTMENT: 70° 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.

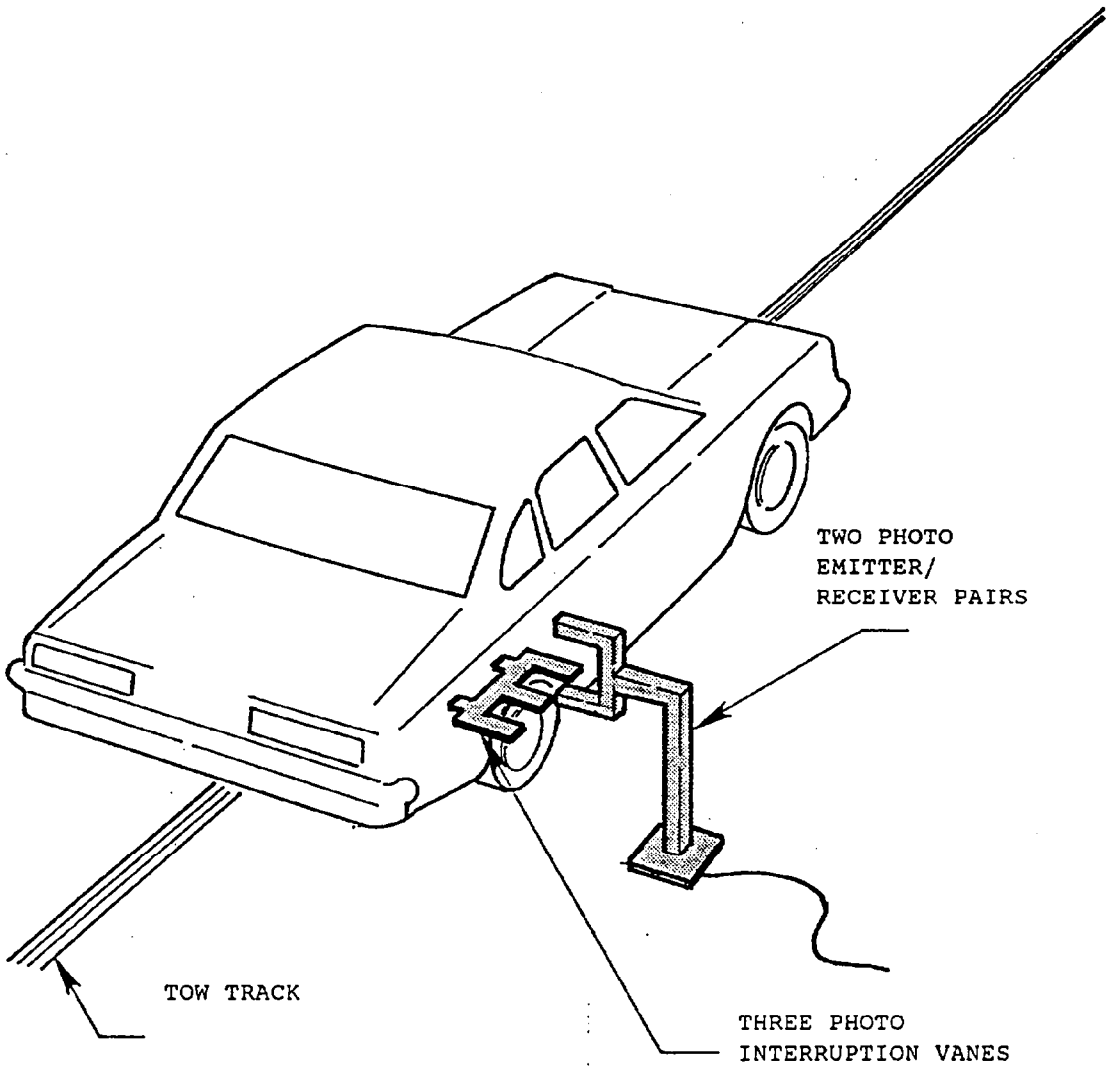
EXITING VELOCITY TRAP = 2.0 IN.

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

OVERALL LENGTH OF TEST VEHICLE:	PRE-TEST:	L	173.4;	C	177.6;	R 173.9
	POST-TEST:	L	174.1;	C	177.2;	R 173.5
	TOTAL CRUSH:	L	-0.7;	C	0.4;	R 0.4
	AVERAGE CRUSH:	0.0				

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

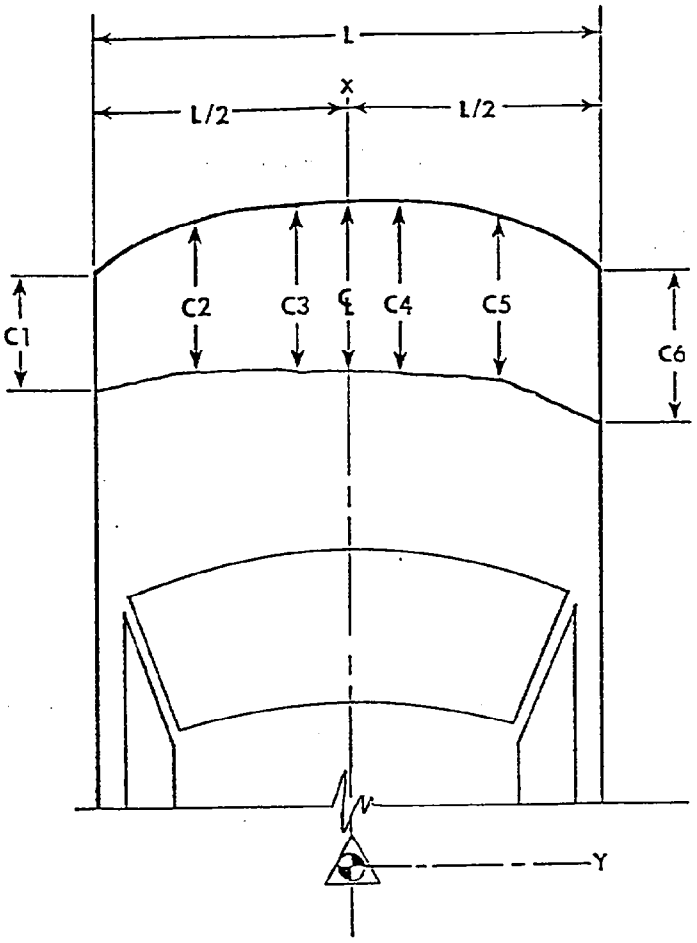
FIGURE 1 IMPACT VELOCITY MEASUREMENT SYSTEM



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

The vanes have one foot spacing.

FIGURE 2 VEHICLE CRUSH



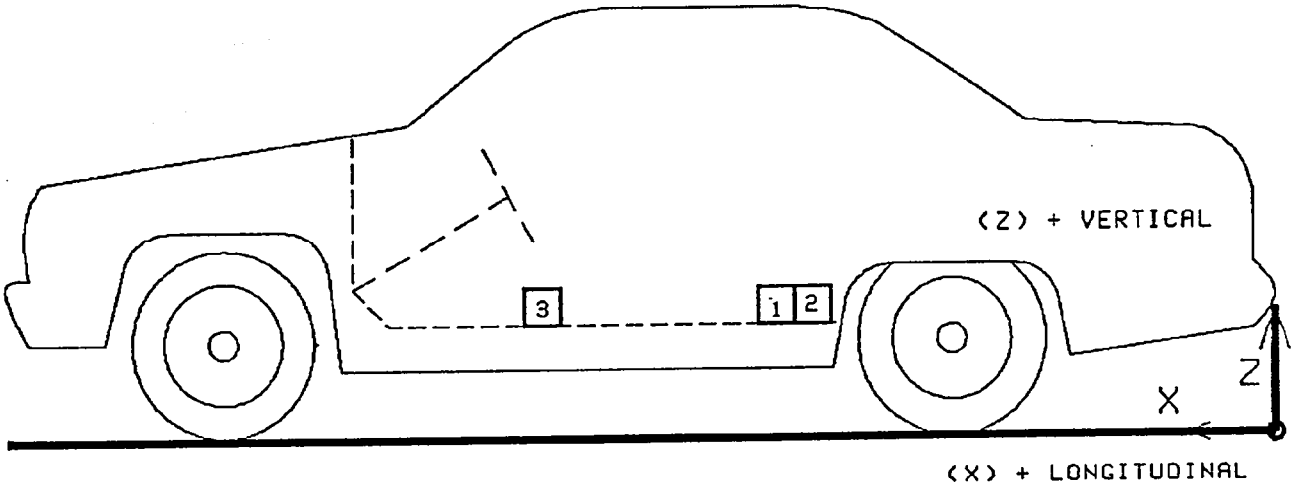
NOTES: L is pre-test length of contact surface.
C1 through C6 are spaced equally apart.
CL is vehicle centerline.
All measurements are in inches.

Vehicle Ford Tempo

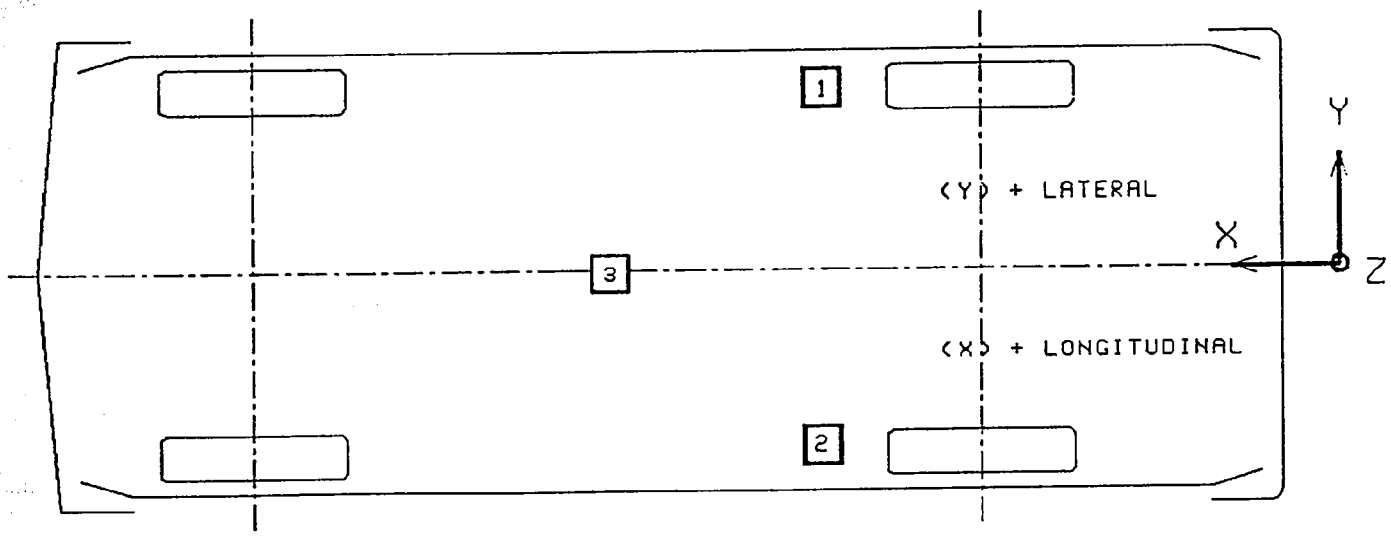
	PRE-TEST		POST-TEST		CRUSH
L	55.0				
C1	173.4	C1	174.1	C1	-0.7
C2	175.9	C2	176.2	C2	-0.3
C3	176.4	C3	176.4	C3	0.0
C4	176.6	C4	176.0	C4	0.6
C5	175.9	C5	175.2	C5	0.7
C6	173.9	C6	173.5	C6	0.4
CL	177.6	CL	177.2	CL	0.4

FIGURE 3

VEHICLE ACCELEROMETER PLACEMENT



SIDE VIEW



BOTTOM VIEW

TABLE 4

VEHICLE ACCELEROMETER LOCATIONS AND DATA SUMMARY

TEST NUMBER 921203

No.	LOCATION		X*	Y*	Z*	POSITIVE DIRECTION MAX G	POSITIVE DIRECTION MSEC	NEGATIVE DIRECTION MAX G	NEGATIVE DIRECTION MSEC
1	LEFT REAR SEAT	PRE	66.8	13.2	17.6				
	CROSSMEMBER	POST	67.1	13.2	16.8				
	LONGITUDINAL					0.1	338.4	12.9	39.1
	LATERAL					3.1	92.4	2.1	167.8
2	RIGHT REAR SEAT	PRE	66.8	-13.2	17.6				
	CROSSMEMBER	POST	66.6	-13.2	16.6				
	LONGITUDINAL					0.5	92.4	12.8	38.0
	LATERAL					2.7	91.6	2.4	73.8
3	VEHICLE CENTER	PRE	97.2	0.0	14.8				
	OF GRAVITY	POST	97.2	0.0	13.8				
	LONGITUDINAL					0.1	4.4	15.2	67.5
	LATERAL					2.7	92.6	4.8	60.1
	VERTICAL					6.2	66.9	9.9	34.5

* ALL MEASUREMENTS OF ACCELEROMETER LOCATIONS ARE IN INCHES.

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

TABLE 5

UNDERRIDE GUARD ACCELEROMETER LOCATIONS AND DATA SUMMARY

TEST NUMBER 921203

No.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION MAX G	POSITIVE DIRECTION MSEC	NEGATIVE DIRECTION MAX G	NEGATIVE DIRECTION MSEC
1	UNDERRIDE GUARD CROSSMEMBER LEFT	4.0	18.4	24.0				
	LONGITUDINAL				416.0	11.9	34.4	71.3
	VERTICAL				117.6	12.8	19.6	132.6
2	UNDERRIDE GUARD CROSSMEMBER RIGHT	4.0	-18.4	24.2				
	LONGITUDINAL				655.7	21.4	43.3	75.1
	VERTICAL				525.5	14.4	16.0	111.1

* ALL MEASUREMENTS OF ACCELEROMETER LOCATIONS ARE IN INCHES.

REFERENCE: X: + REARWARD FROM GUARD FACE TOWARD BARRIER
Y: + LEFTWARD FROM GUARD CENTERLINE
Z: + UPWARD FROM GROUND LEVEL

SECTION 3.0

OCCUPANT, VEHICLE, & CAMERA INFORMATION

TABLE 6

DUMMY DATA SUMMARY

TEST NUMBER 921203

	DRIVER DUMMY SN: 43				PASSENGER DUMMY SN: 48			
	POSITIVE DIRECTION		NEGATIVE DIRECTION		POSITIVE DIRECTION		NEGATIVE DIRECTION	
	MAX	MSEC	MAX	MSEC	MAX	MSEC	MAX	MSEC
HEAD ACCELERATION (g)								
LONGITUDINAL	9.4	149.4 Y	42.1	127.4 Y	5.2	240.0	26.0	134.8
LATERAL	10.2	137.0 Y	5.7	137.4 Y	3.1	148.5	5.0	87.3
VERTICAL	78.0	137.8 Y	18.2	139.8 Y	5.0	240.4	23.4	107.9
RESULTANT	79.0	137.8 Y			29.6	115.8		
HIC	139 FROM 107.0 TO 140.8 Y				117 FROM 105.5 TO 141.5			
NECK FORCE (lb)								
LONGITUDINAL	67.5	165.1	100.1	98.0	199.1	137.6	36.8	240.0
LATERAL	80.9	112.5	326.9	135.0	39.9	86.8	19.8	169.9
VERTICAL	51.1	96.8	136.3	135.0	219.0	91.8	51.6	234.3
NECK MOMENT (in-lb)								
ABOUT X	82.4	149.9	117.8	134.1	43.6	183.6	69.0	104.8
ABOUT Y	380.6	146.6	119.2	164.8	536.5	133.3	241.5	87.1
ABOUT Z	78.7	135.4	15.7	339.0	41.1	91.5	28.0	156.5
CHEST ACCELERATION (g)								
LONGITUDINAL	0.8	6.6	19.0	99.1	1.0	17.5	25.3	83.1
LATERAL	2.0	230.4	2.4	132.3	2.5	113.9	3.4	87.1
VERTICAL	5.0	140.4	12.9	129.3	4.8	235.1	5.1	72.5
RESULTANT	19.7	100.6			25.5	83.1		
3 MSEC	19.2				24.6			
CHEST DEFLECTION (in)								
LONGITUDINAL	0.0	22.0	0.7	117.3	0.0	23.4	0.8	93.1
PELVIS ACCELERATION (g)								
LONGITUDINAL	2.3	23.1	24.2	67.3	2.3	302.6	31.5	73.4
LATERAL	3.7	265.1	3.2	314.4	5.8	104.0	5.6	66.9
VERTICAL	9.3	95.9	8.8	131.9	13.4	83.6	3.5	147.9
RESULTANT	24.8	67.3			32.1	73.4		
FEMUR LOAD (lb)								
LEFT	159.0	26.8	661.8	81.9	74.5	51.0	297.4	73.4
RIGHT	107.6	26.9	650.0	70.3	55.2	147.6	288.1	73.9

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

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

Y See TEST ANOMALIES

TABLE 7 POST-IMPACT DUMMY/VEHICLE DATA

VISIBLE DUMMY CONTACT POINTS:

	DRIVER #043	PASSENGER #048
HEAD	Airbag and windshield	None
CHEST	None	None
ABDOMEN	None	None
LEFT KNEE	Intrument panel	Instrument panel
RIGHT KNEE	Instrument panel	Instrument panel

DOOR OPENING:

	LEFT	RIGHT
FRONT	Easy	Easy
REAR	NA	NA

SEAT MOVEMENT:

	SEAT BACK FAILURE	SEAT SHIFT
FRONT	None	None
REAR	NA	NA

GLAZING DAMAGE:

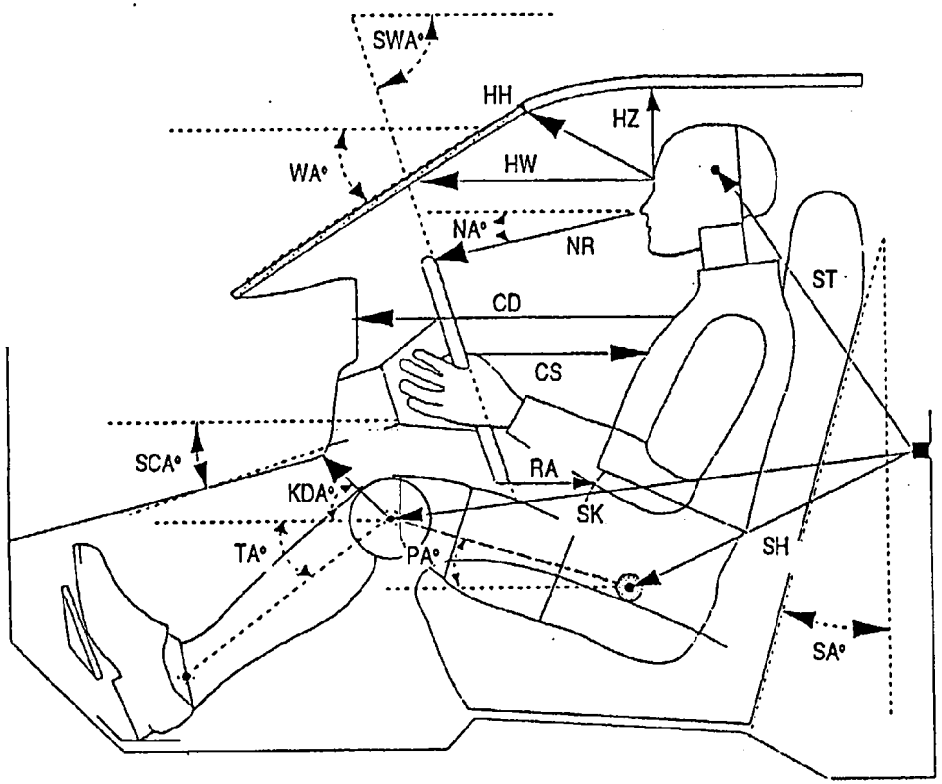
The entire windshield cracked upon impact.

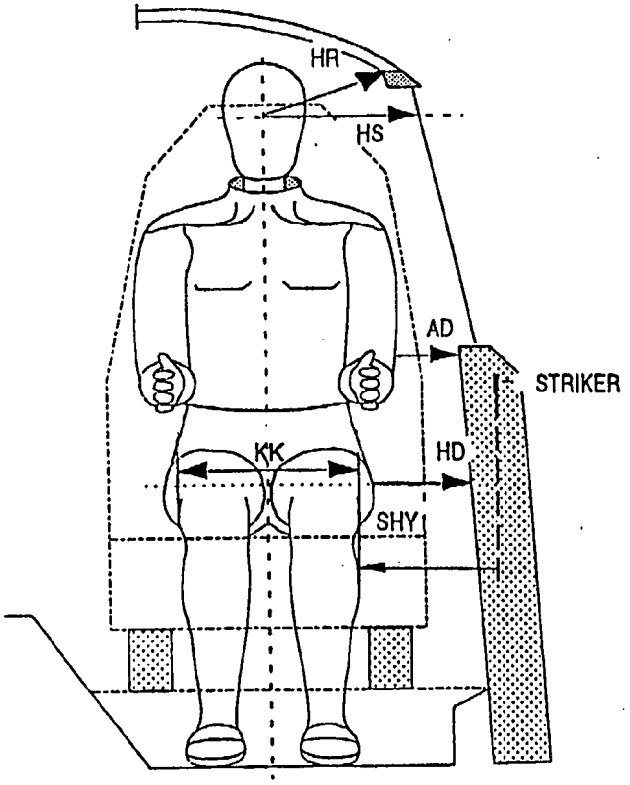
OTHER NOTABLE IMPACT EFFECTS:

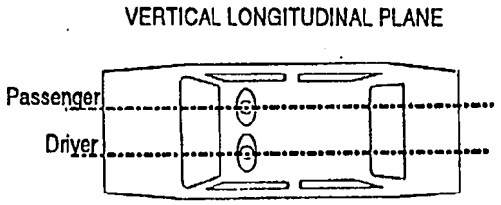
None

FIGURE 4

DUMMY MEASUREMENT LOCATIONS FOR FRONT SEAT OCCUPANTS







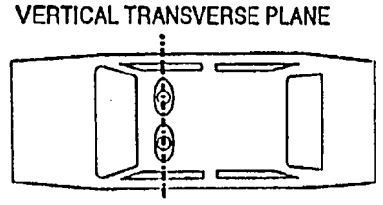


TABLE 8 DUMMY MEASUREMENT DATA FOR FRONT SEAT OCCUPANTS

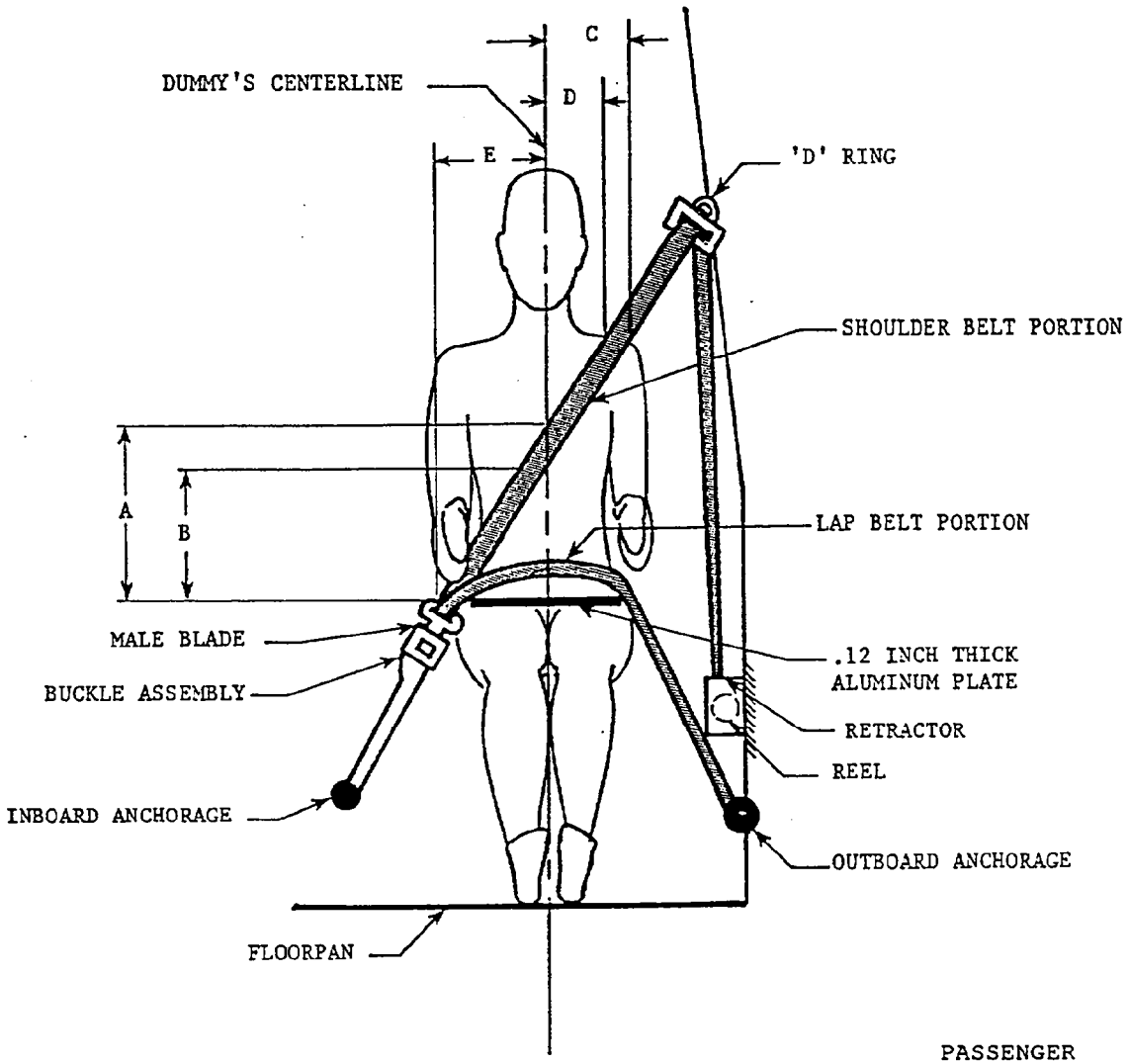
DESIGNATION	TYPE OF MEASUREMENT	DRIVER (SERIAL #043)	PASSENGER (SERIAL #048)
WA°	WINDSHIELD ANGLE	32°	32°
SWA°	STEERING WHEEL ANGLE	64°	NA
SCA°	STEERING COLUMN ANGLE	25°	NA
SA°	SEAT BACK ANGLE	20°	20°
HZ	HEAD TO ROOF	5.8	6.4
HH	HEAD TO HEADER	11.5	11.3
HW	HEAD TO WINDSHIELD	18.1	18.6
HR	HEAD TO SIDE HEADER	8.2	8.4
NR	NOSE TO RIM	15.1	NA
NA	NOSE TO RIM ANGLE	16°	NA
CD	CHEST TO DASH	21.2	21.2
CS	STEERING WHEEL TO CHEST	10.0	NA
RA	RIM TO ABDOMEN	6.4	NA
KDL	LEFT KNEE TO DASH	5.2	4.9
KDR	RIGHT KNEE TO DASH	5.8	5.6
KDA	OUTBOARD KNEE TO DASH ANGLE	23°	25°
PA°	PELVIC ANGLE	24°	22°
TA°	TIBIAL ANGLE	16°	17°
KK	KNEE TO KNEE	10.8	11.5
ST*	STRIKER TO HEAD	21.8	22.2
	STRIKER TO HEAD ANGLE	-58°	-51°
SK*	STRIKER TO KNEE	34.1	32.9
	STRIKER TO KNEE ANGLE	7°	7°
SH*	STRIKER TO H-POINT	20.2	18.9
	STRIKER TO H-POINT ANGLE	24°	28°
SHY	STRIKER TO H-POINT (Y DIR.)	8.9	8.6
HS	HEAD TO SIDE WINDOW	12.1	12.6
HD	H-POINT TO DOOR	4.3	3.9
AD	ARM TO DOOR	4.1	4.4

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



	PASSENGER DUMMY
A - TOP SURFACE OF ALUMINUM PLATE TO BELT UPPER EDGE	13.2
B - TOP SURFACE OF ALUMINUM PLATE TO BELT LOWER EDGE	10.0
C - DUMMY CENTERLINE TO OUTER EDGE OF BELT AT CHEST FLESH TOP	5.1
D - DUMMY CENTERLINE TO INNER EDGE OF BELT AT CHEST FLESH TOP	2.5
E - DUMMY CENTERLINE TO INTERSECTION OF UPPER TORSO BELT AND LAP BELT	8.9

ALL DISTANCE MEASUREMENTS ARE IN INCHES.

FIGURE 6

PRE-TEST AND POST-TEST MEASUREMENT POINTS

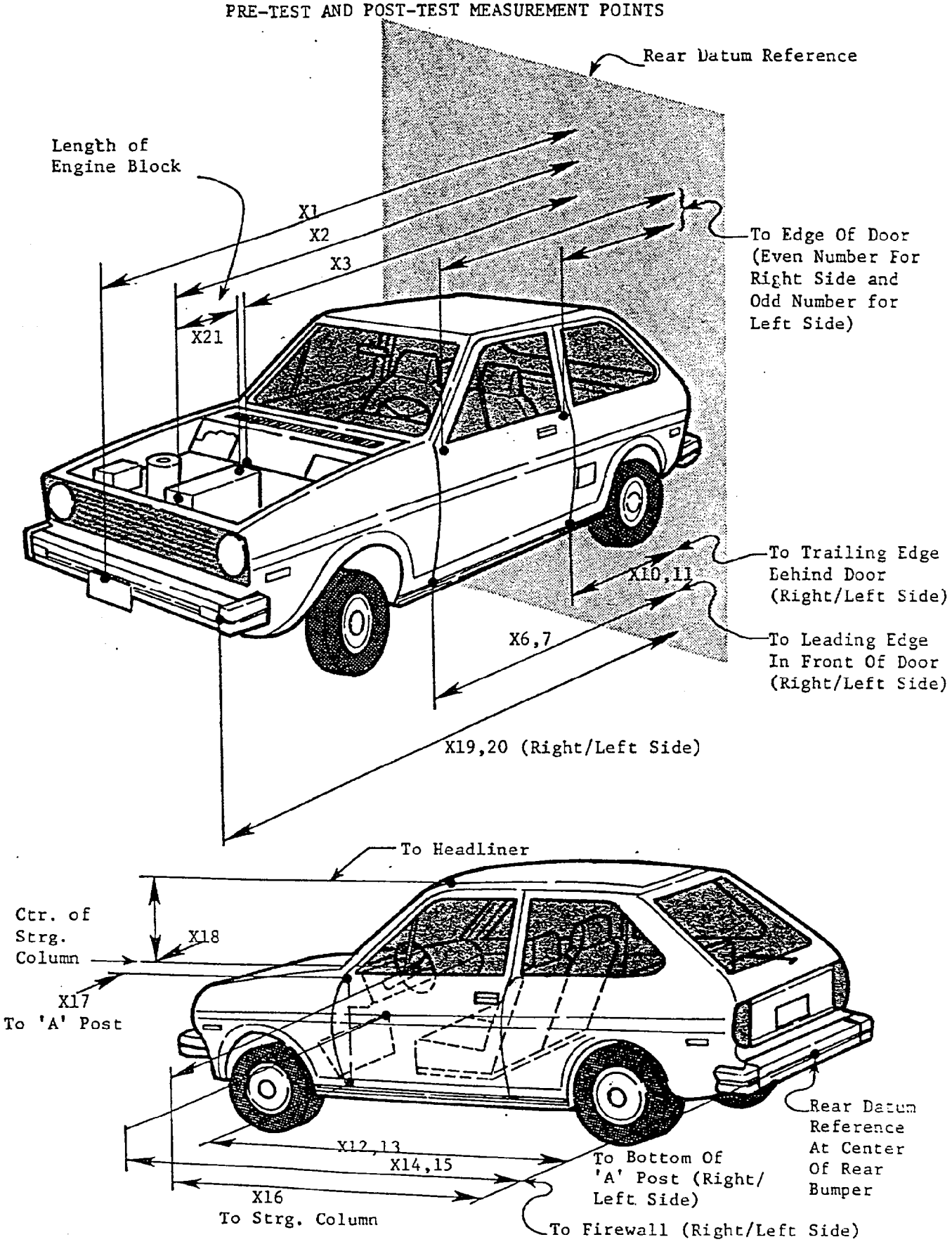


TABLE 9 IMPACTED VEHICLE MEASUREMENTS

VEHICLE MAKE/MODEL: Ford/Tempo TEST NUMBER: 921203

NO.	TYPE OF MEASUREMENT	ALL MEASUREMENTS ARE IN INCHES PRE-TEST	POST-TEST	DIFF.
X1	TOTAL LENGTH OF VEHICLE AT CENTERLINE	177.6	177.2	0.4
X2	REAR SURFACE OF VEHICLE TO FRONT OF ENGINE BLOCK	152.1	150.4	1.7
X3	REAR SURFACE OF VEHICLE TO FIREWALL	134.9	135.1	-0.2
X4	REAR SURFACE OF VEHICLE TO UPPER LEADING EDGE OF RIGHT DOOR	123.1	124.0	-0.9
X5	REAR SURFACE OF VEHICLE TO UPPER LEADING EDGE OF LEFT DOOR	123.2	124.0	-0.8
X6	REAR SURFACE OF VEHICLE TO LOWER LEADING EDGE OF RIGHT DOOR	121.8	121.0	0.8
X7	REAR SURFACE OF VEHICLE TO LOWER LEADING EDGE OF LEFT DOOR	121.9	121.6	0.3
X8	REAR SURFACE OF VEHICLE TO UPPER TRAILING EDGE OF RIGHT DOOR	73.6	74.5	-0.9
X9	REAR SURFACE OF VEHICLE TO UPPER TRAILING EDGE OF LEFT DOOR	73.8	74.6	-0.8
X10	REAR SURFACE OF VEHICLE TO LOWER TRAILING EDGE OF RIGHT DOOR	74.0	73.2	0.8
X11	REAR SURFACE OF VEHICLE TO LOWER TRAILING EDGE OF LEFT DOOR	74.1	73.8	0.3
X12	REAR SURFACE OF VEHICLE TO BOTTOM OF "A" POST ON RIGHT SIDE	121.0	120.9	0.1
X13	REAR SURFACE OF VEHICLE TO BOTTOM OF "A" POST ON LEFT SIDE	121.1	120.8	0.3
X14	REAR SURFACE OF VEHICLE TO FIREWALL - RIGHT SIDE	135.6	133.0	2.6
X15	REAR SURFACE OF VEHICLE TO FIREWALL - LEFT SIDE	134.8	137.1	-2.3
X16	REAR SURFACE OF VEHICLE TO STEERING WHEEL CENTER	103.2	105.2	-2.0
X17	CENTER OF STEERING COLUMN TO "A" POST	11.6	11.6	0.0
X18	CENTER OF STEERING COLUMN TO HEADLINER	16.9	15.5	1.4
X19	REAR SURFACE OF VEHICLE TO RIGHT SIDE OF FRONT BUMPER	173.9	173.5	0.4
X20	REAR SURFACE OF VEHICLE TO LEFT SIDE OF FRONT BUMPER	173.4	174.1	-0.7
X21	LENGTH OF ENGINE BLOCK	18.0	18.0	0.0

FIGURE 7 CAMERA POSITIONS

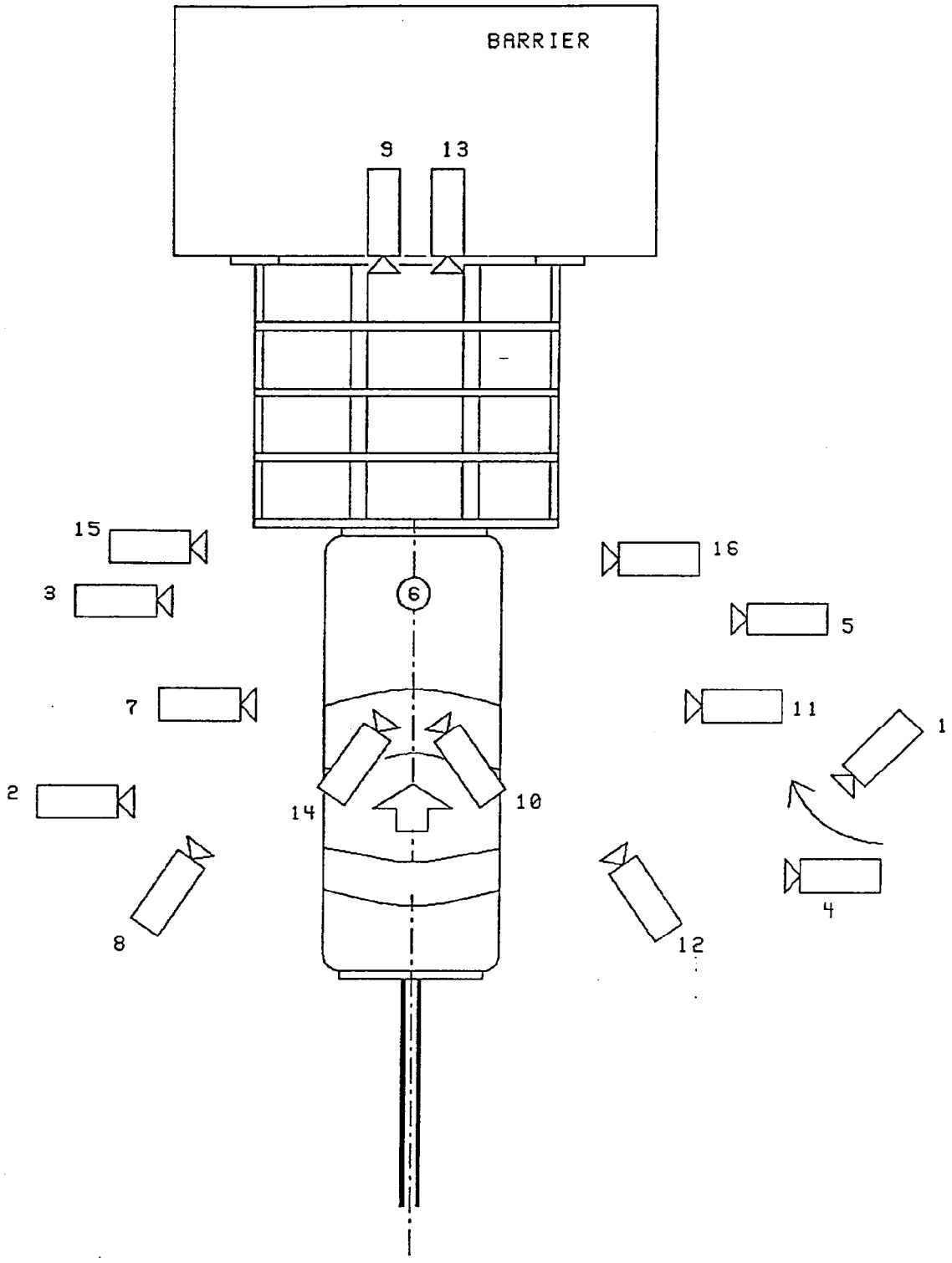


TABLE 10 CAMERA INFORMATION

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	495	Barrier deformation/crush
4	Right wide	Stalex	13	505	Barrier deformation/crush
5	Right front close-up	Stalex	50	495	Barrier deformation/crush
6	Overhead tight	Photosonic	25	505	Barrier deformation/crush
7	Left medium tight	Hycam	25	495	Dummy kinematics
8	Driver angle view	Photosonic	25	502	Dummy kinematics
9	Barrier guard view	Photosonic	17	505	Barrier Deformation
10	Onboard driver	Photosonic	8	505	Dummy kinematics
11	Right medium tight	Hycam	25	500	Dummy kinematics
12	Passenger angle view	Photosonic	25	498	Dummy kinematics
13	Barrier center view	Photosonic	17	508	Dummy kinematics
14	Onboard passenger view	Photosonic	8	500	Dummy kinematics
15	Left underride guard	Photosonic	75	500	Barrier deformation/crush
16	Right underride guard	Photosonic	75	498	Barrier deformation/crush

APPENDIX A

PHOTOGRAPHS

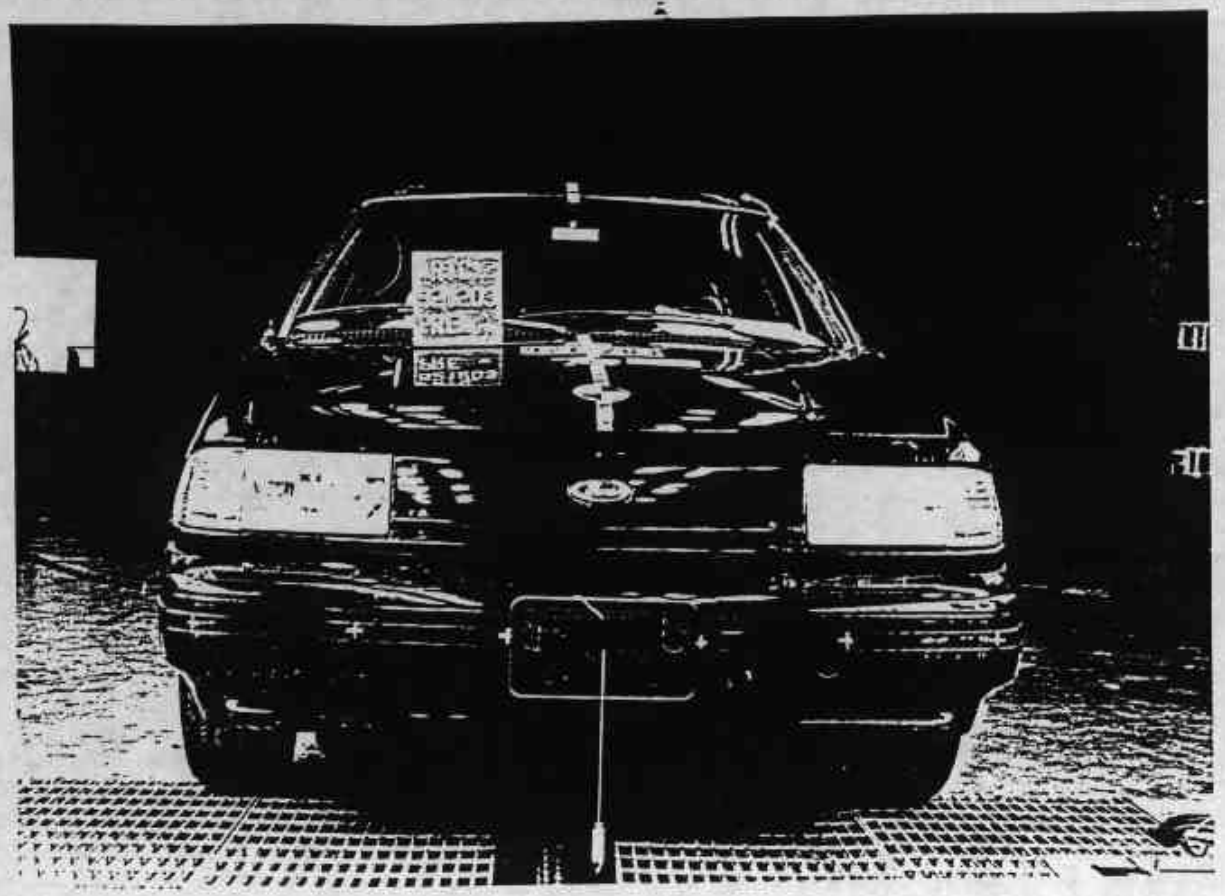


Figure A-1. PRE-TEST FRONT VIEW

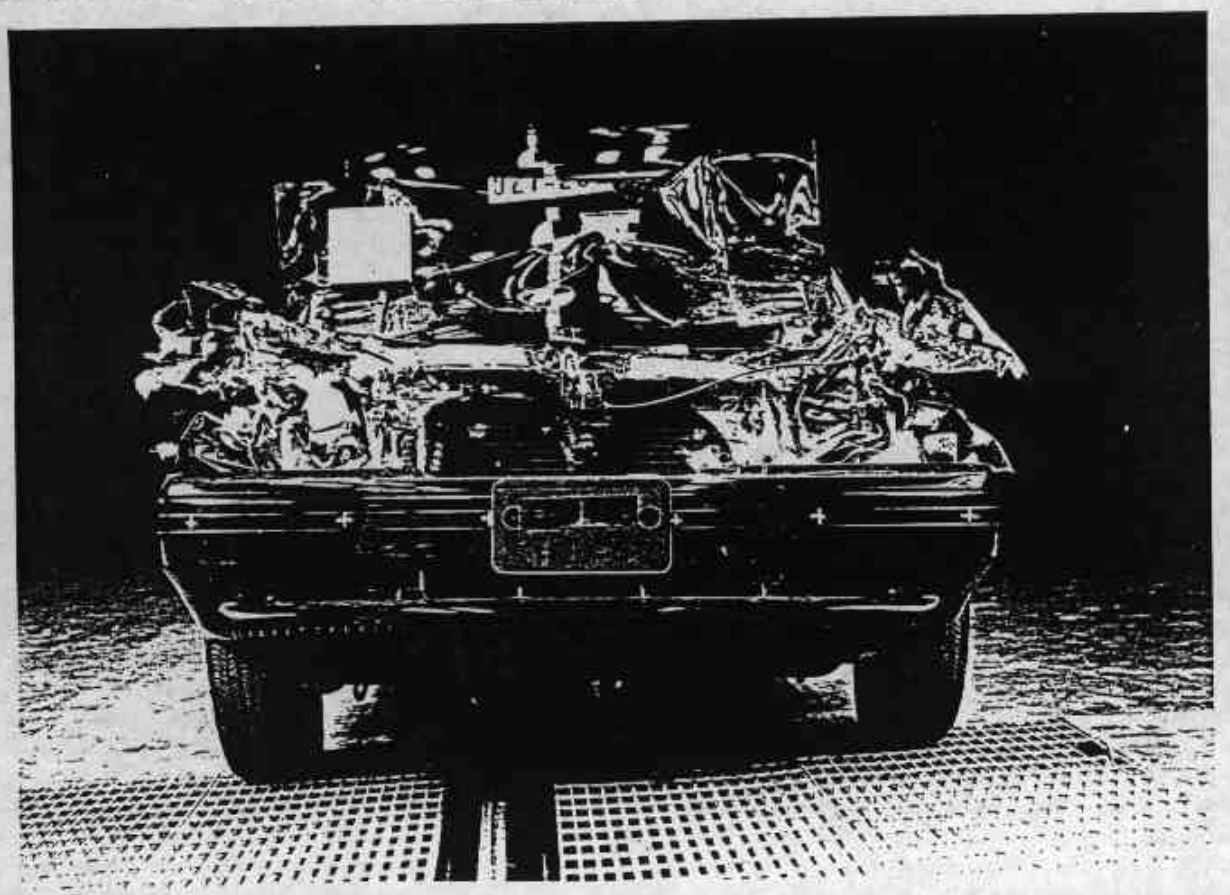


Figure A-2. POST-TEST FRONT VIEW

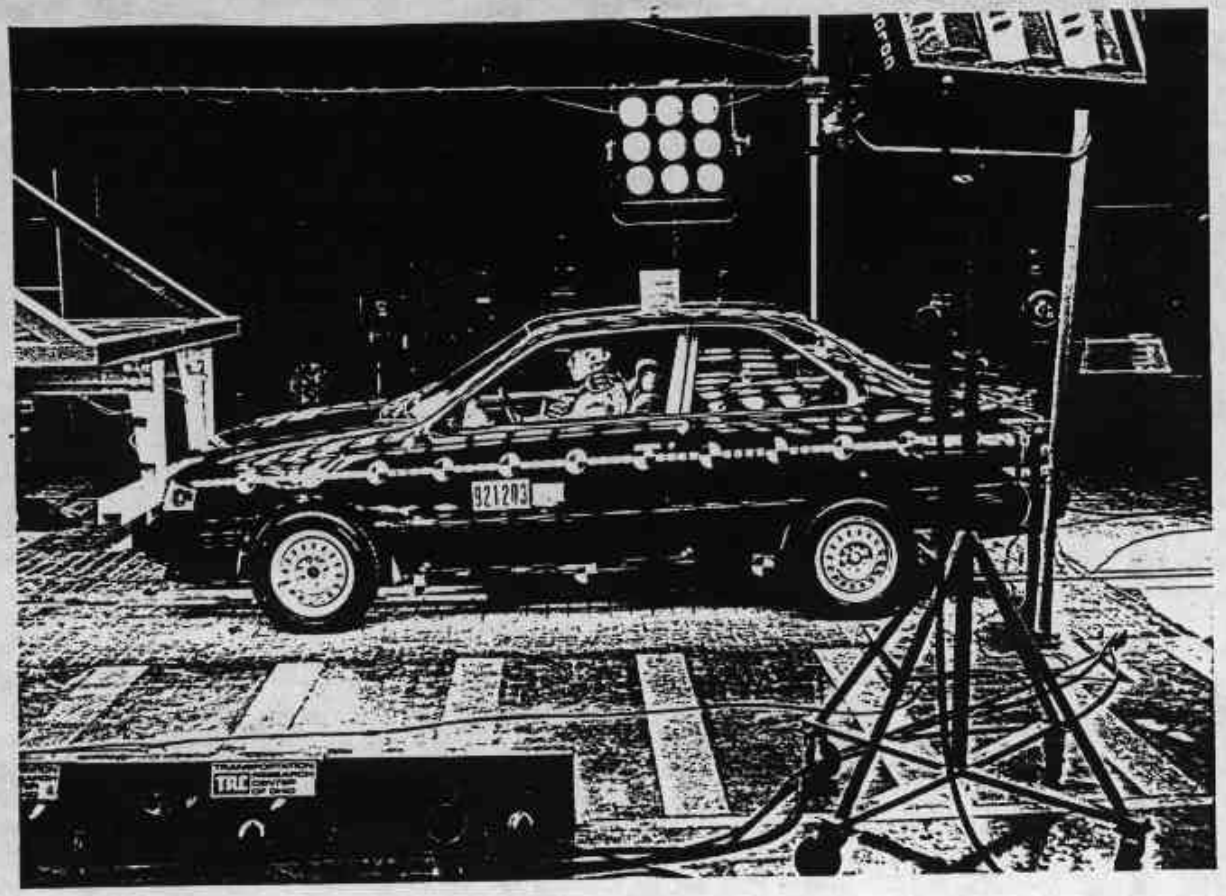


Figure A-3. PRE-TEST LEFT SIDE VIEW

Figure A-4. POST-TEST LEFT SIDE VIEW

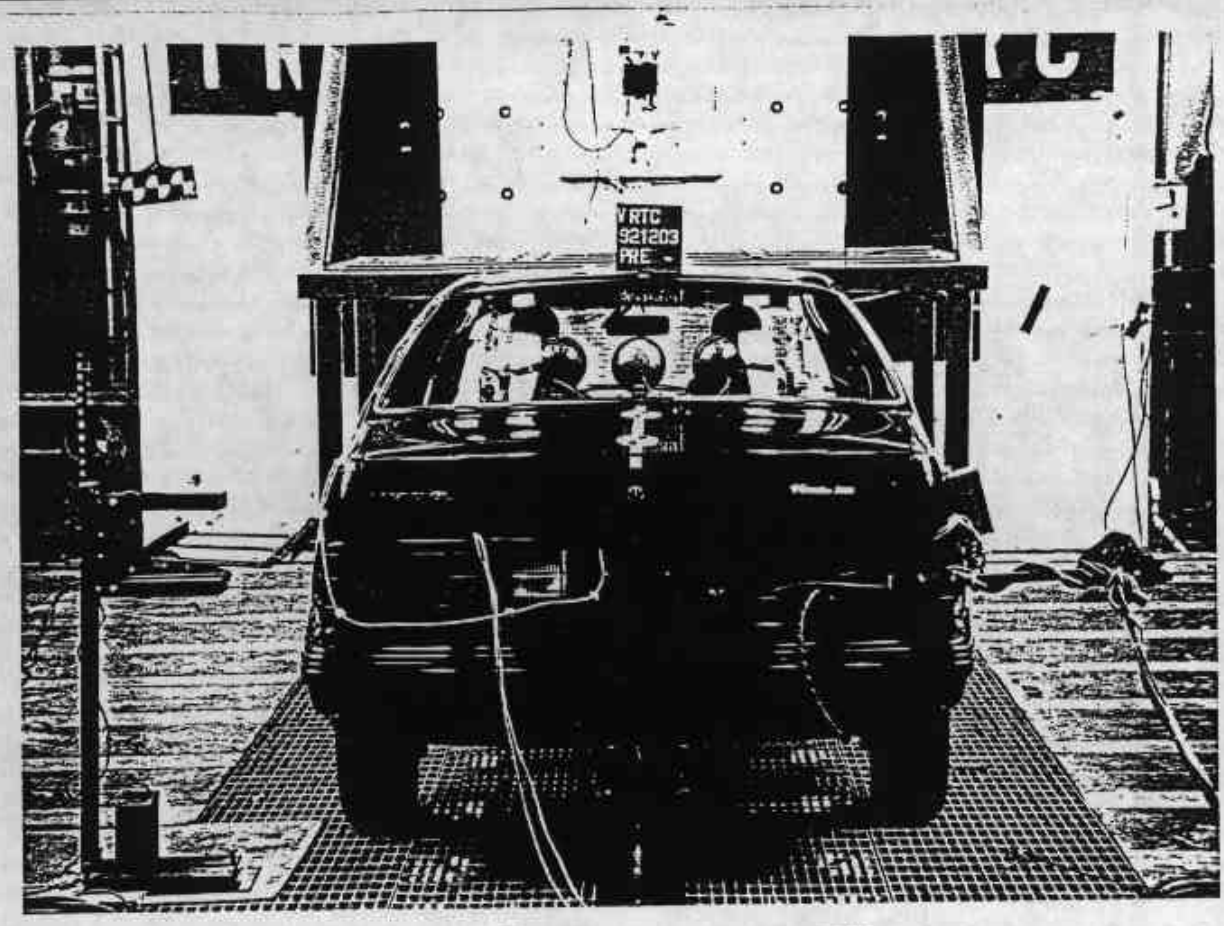


Figure A-5. PRE-TEST REAR VIEW

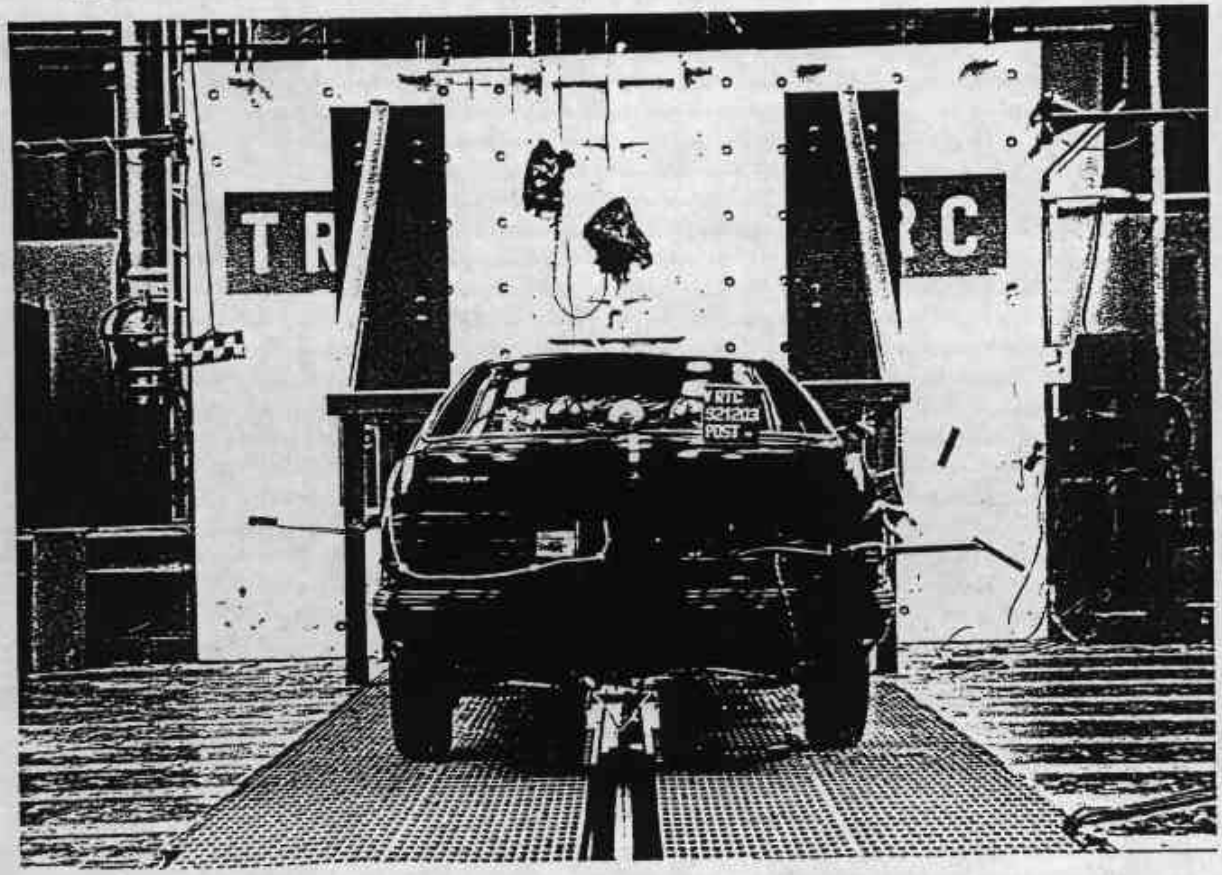


Figure A-6. POST-TEST REAR VIEW

Figure A-7. PRE-TEST RIGHT SIDE VIEW

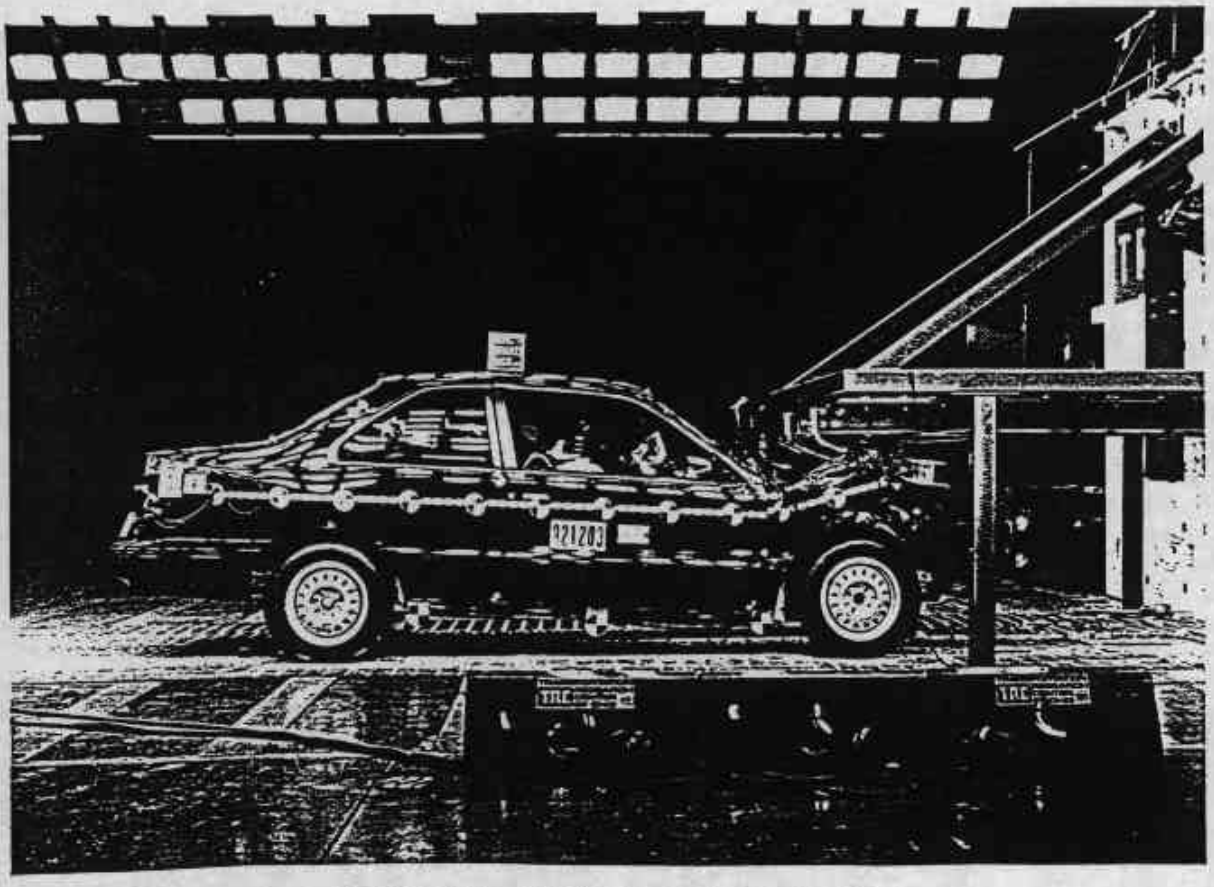


Figure A-8. POST-TEST RIGHT SIDE VIEW

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

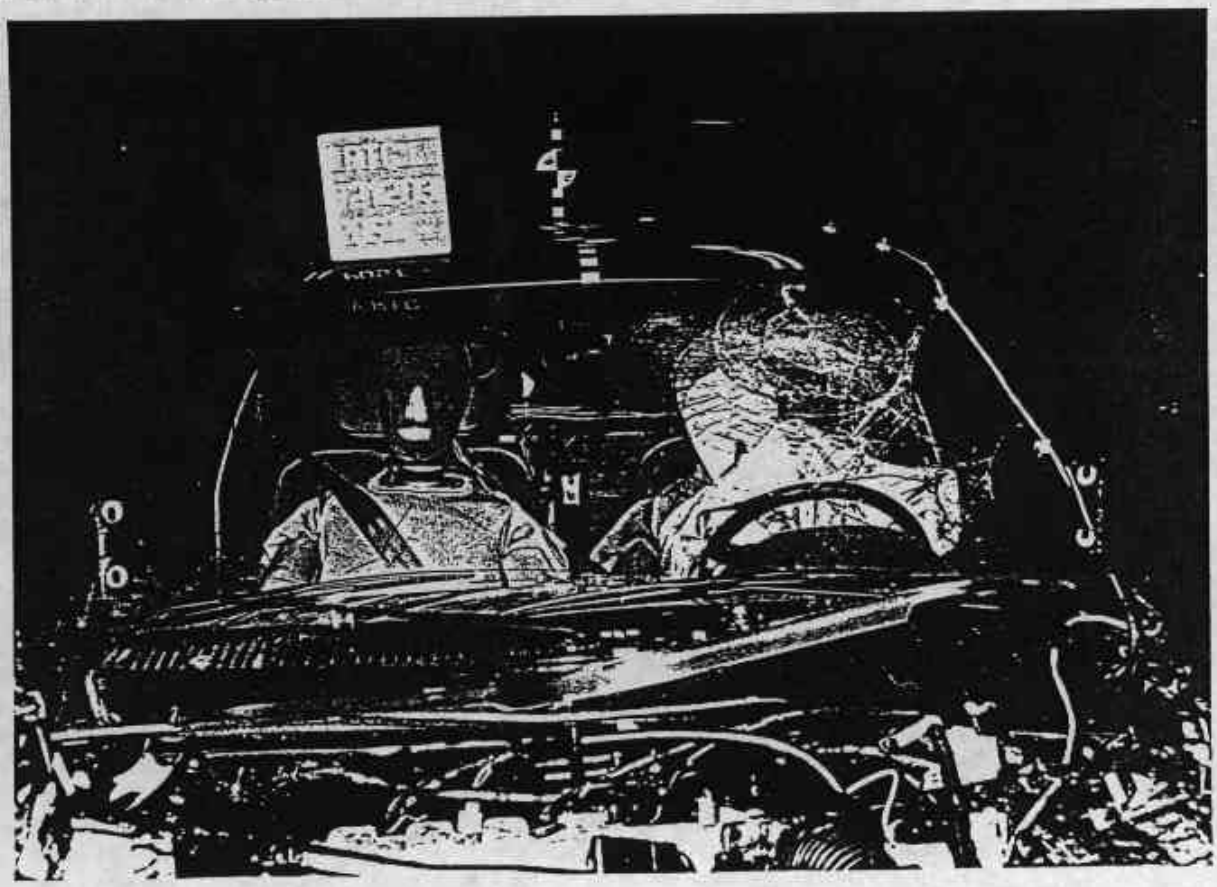


Figure A-14. POST-TEST WINDSHIELD VIEW

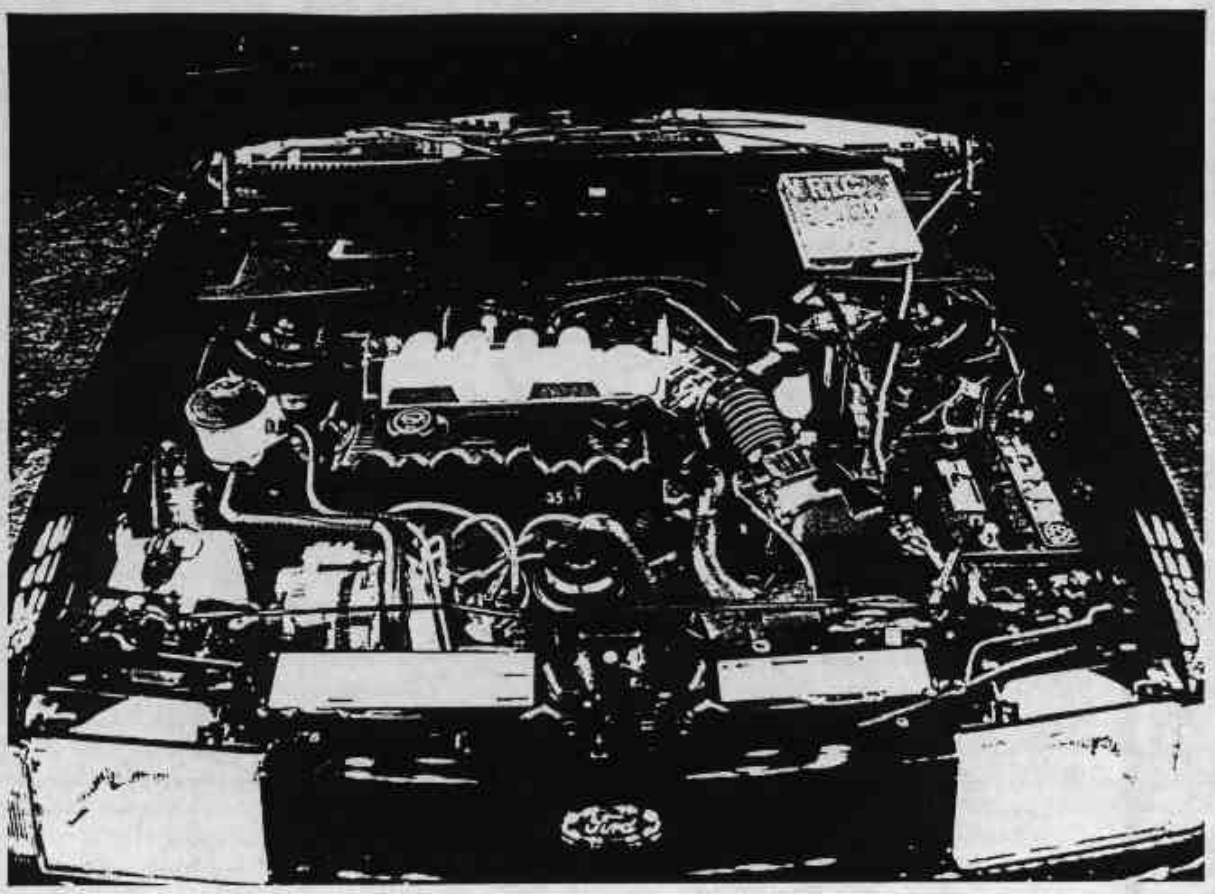


Figure A-15. PRE-TEST ENGINE COMPARTMENT VIEW

Figure A-16. POST-TEST ENGINE COMPARTMENT VIEW

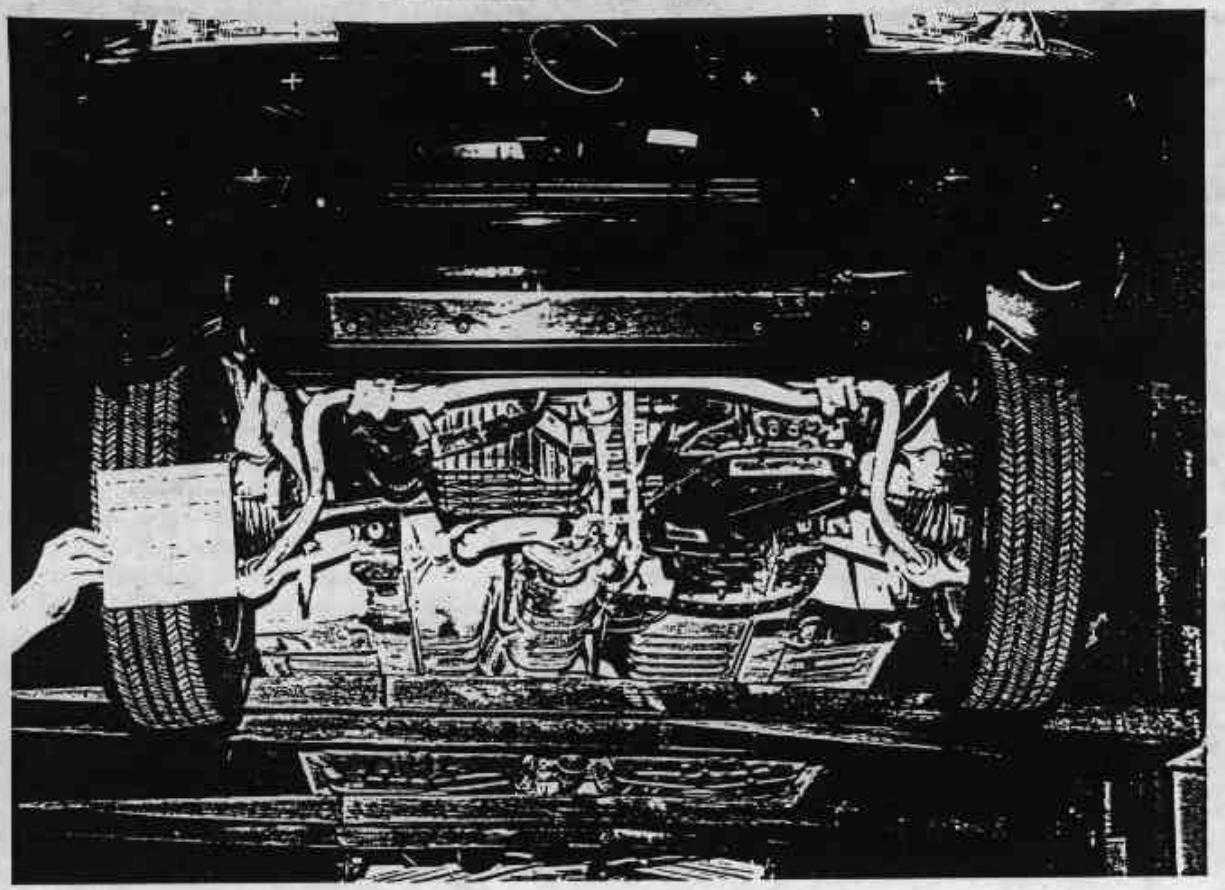


Figure A-17. PRE-TEST FRONT UNDERBODY VIEW

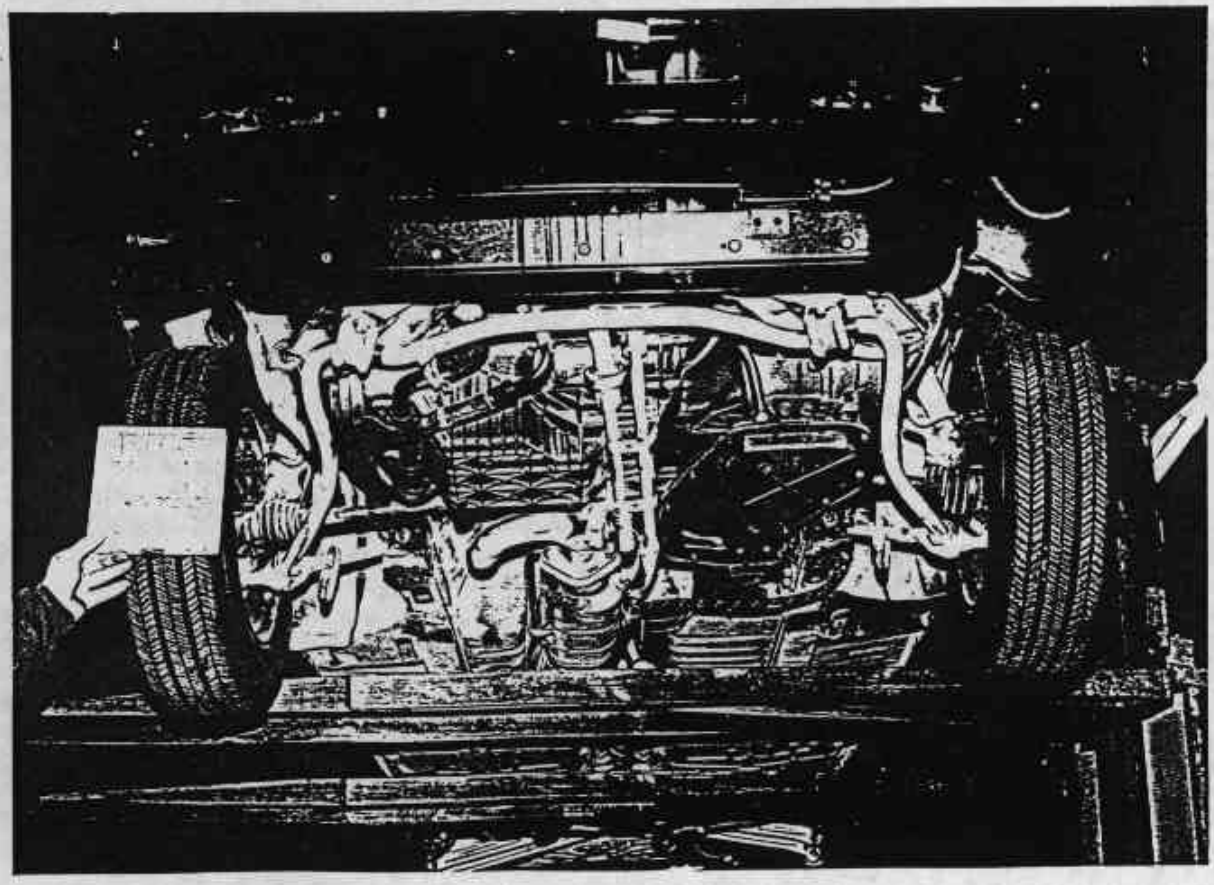


Figure A-18. POST-TEST FRONT UNDERBODY VIEW

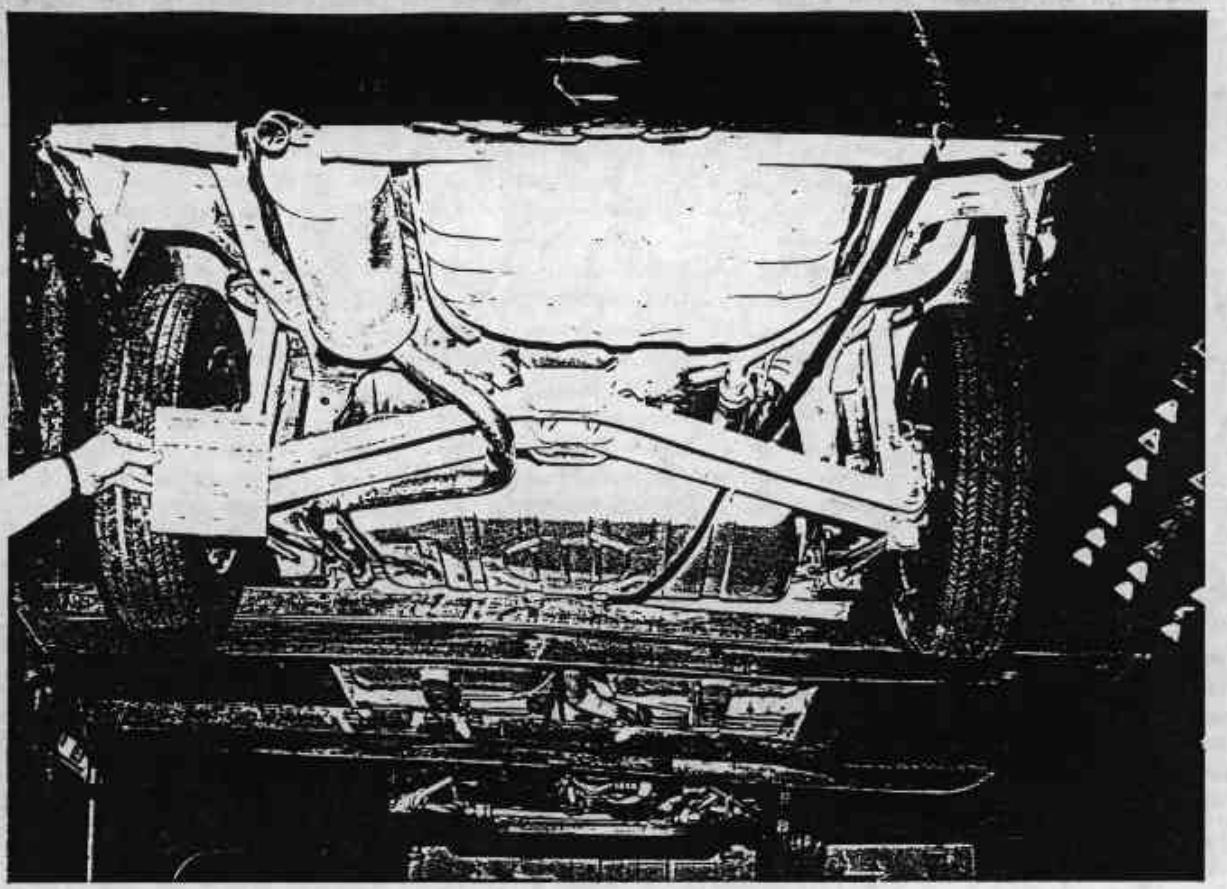


Figure A-19. PRE-TEST REAR UNDERBODY VIEW

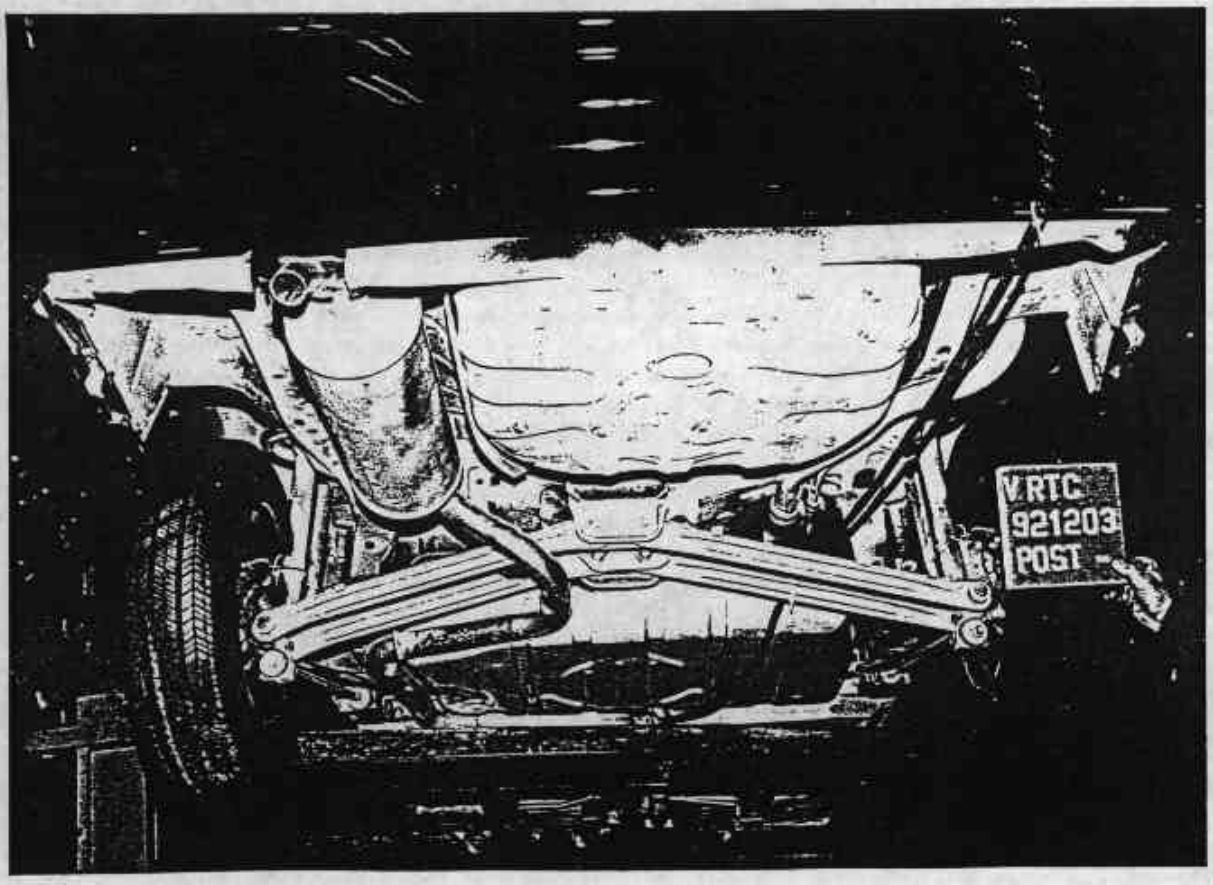


Figure A-20. POST-TEST REAR UNDERBODY VIEW

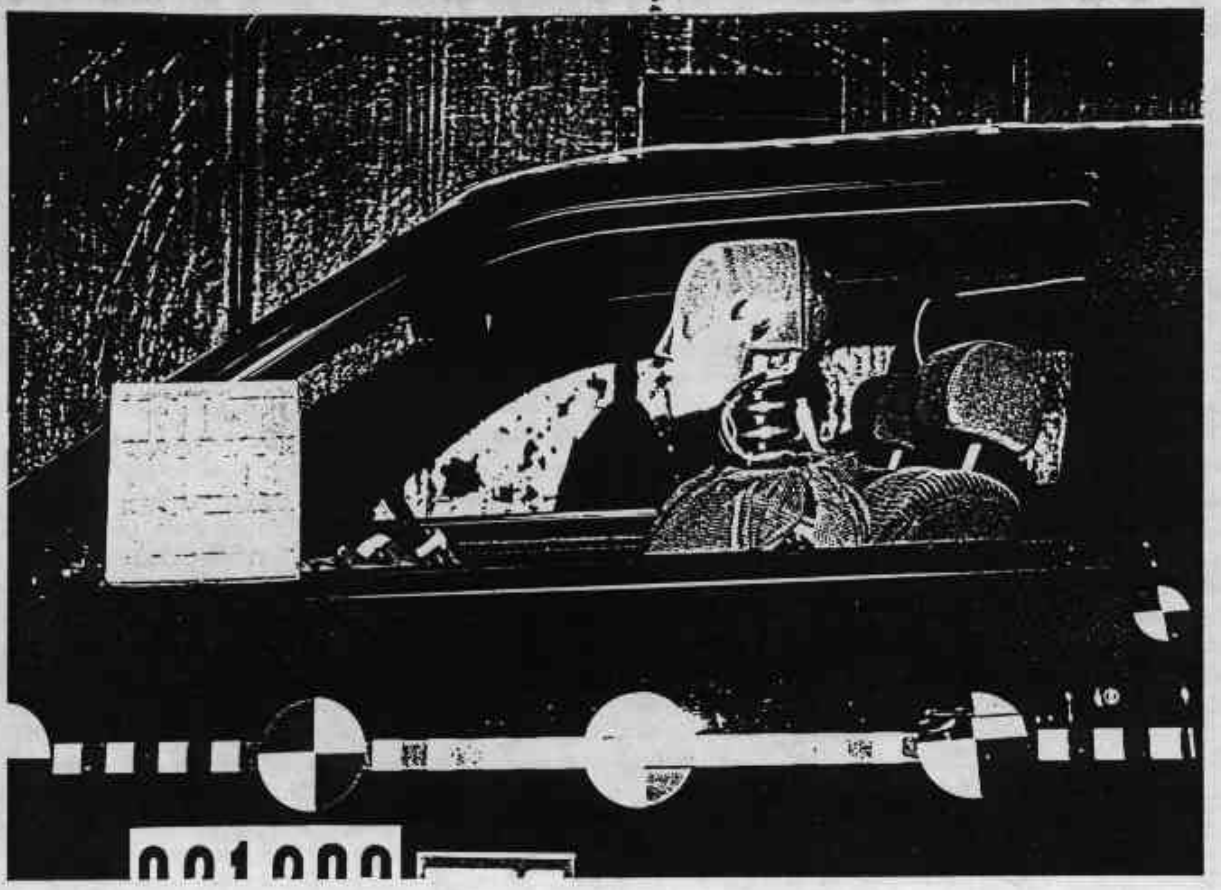


Figure A-21. PRE-TEST DRIVER DUMMY POSITION VIEW

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

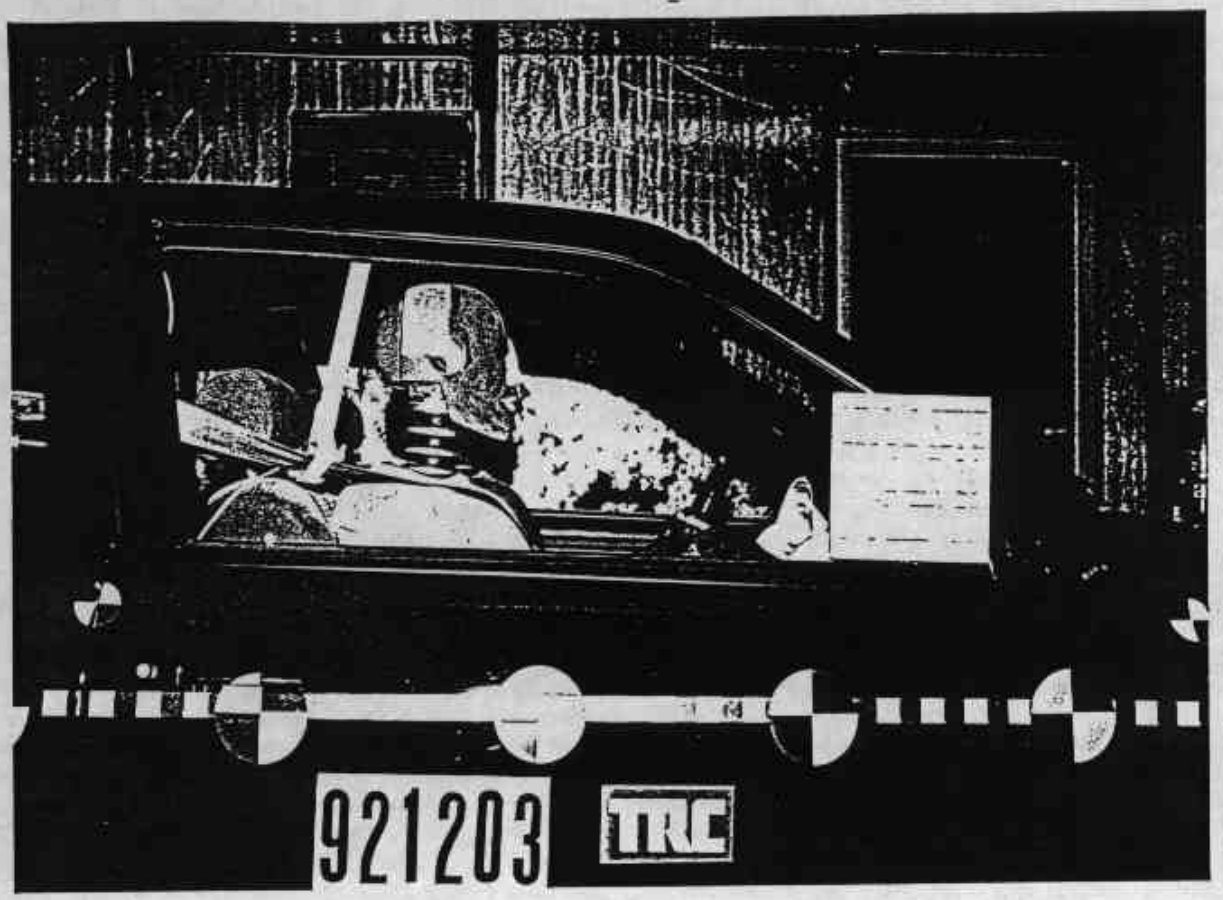


Figure A-23. PRE-TEST PASSENGER DUMMY POSITION VIEW

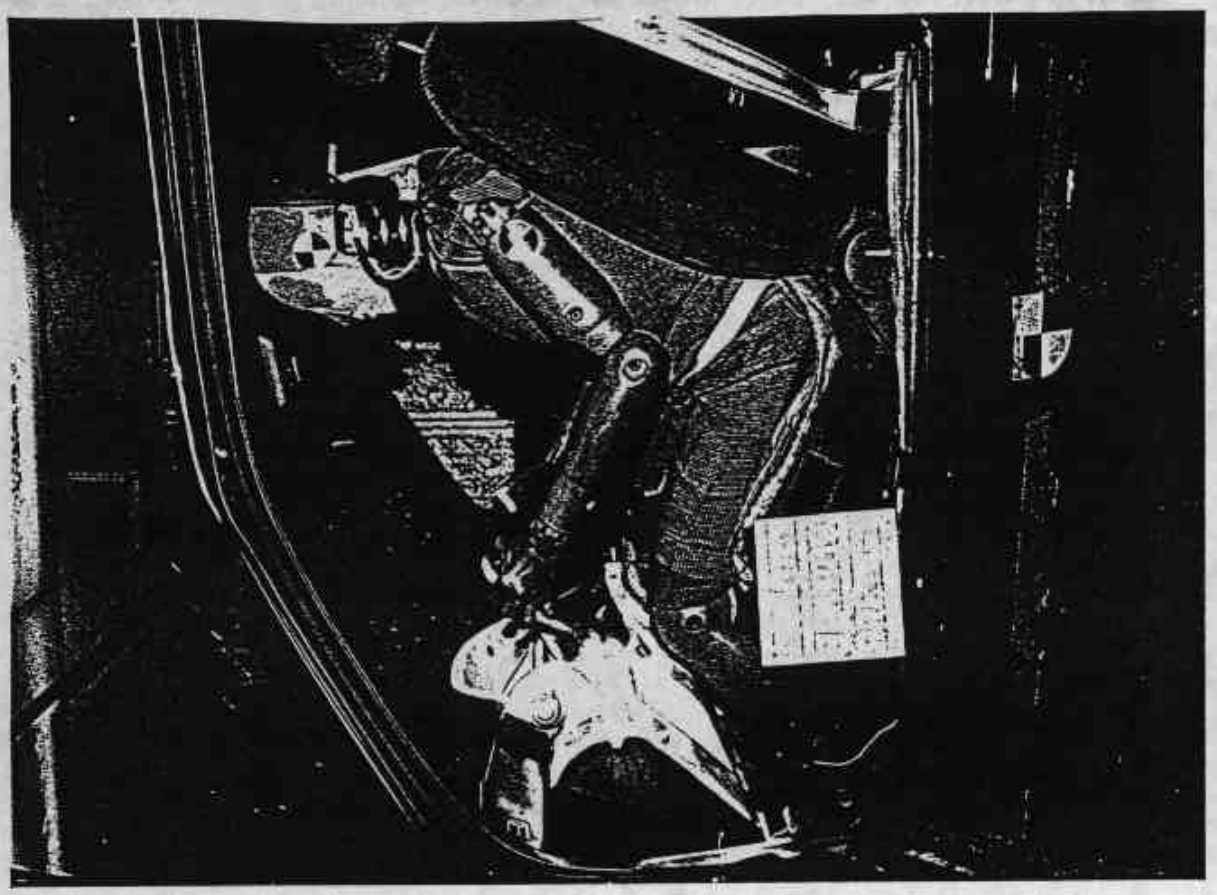


Figure A-25. PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 1

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

Figure A-27. PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 2

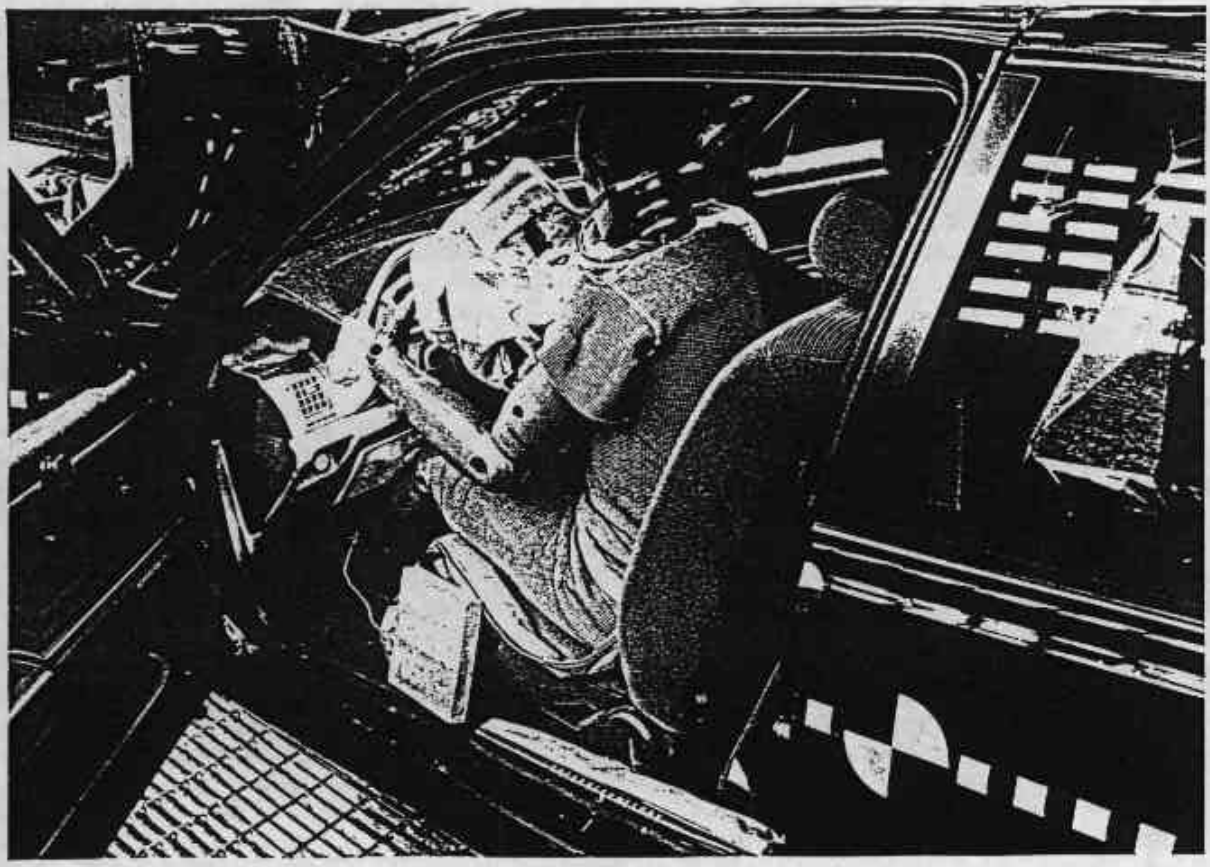


Figure A-28. POST-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 2

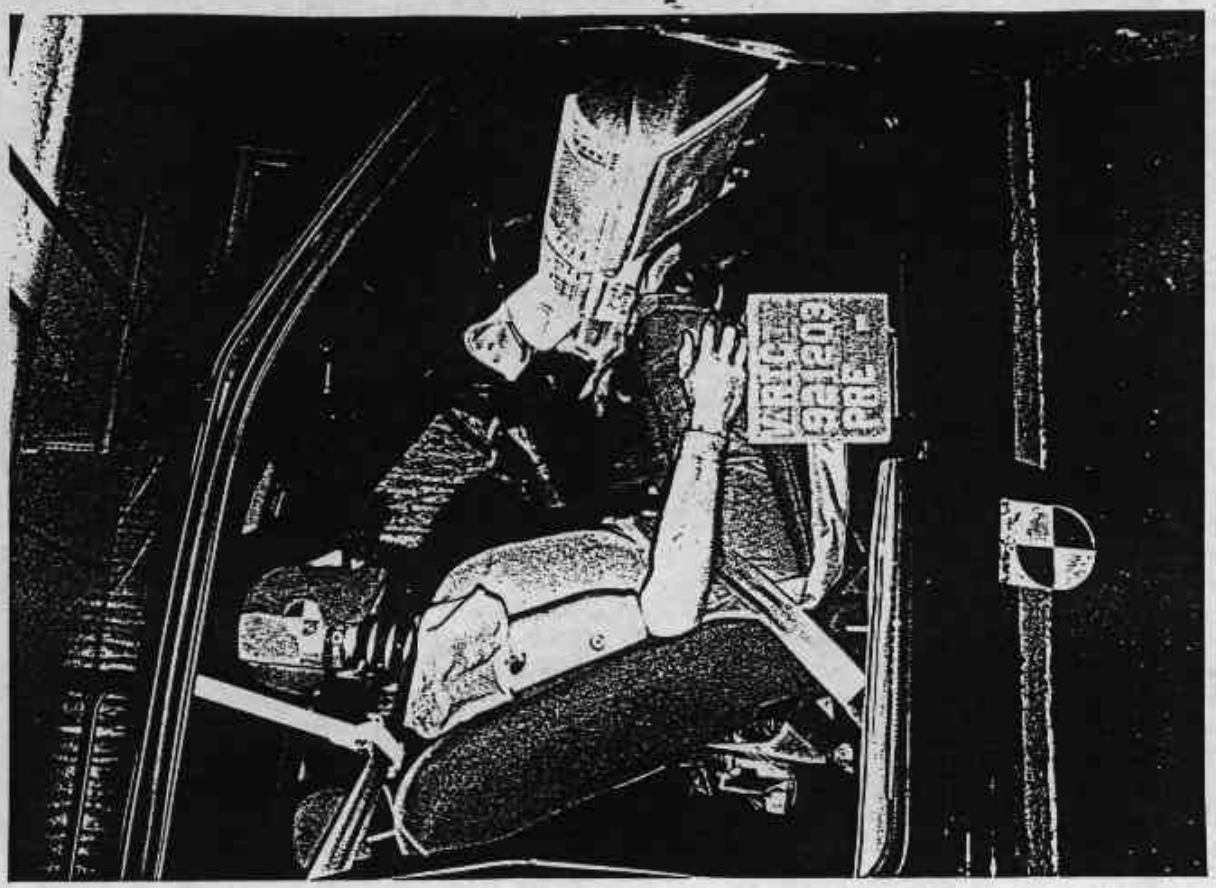


Figure A-29. PRE-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 1

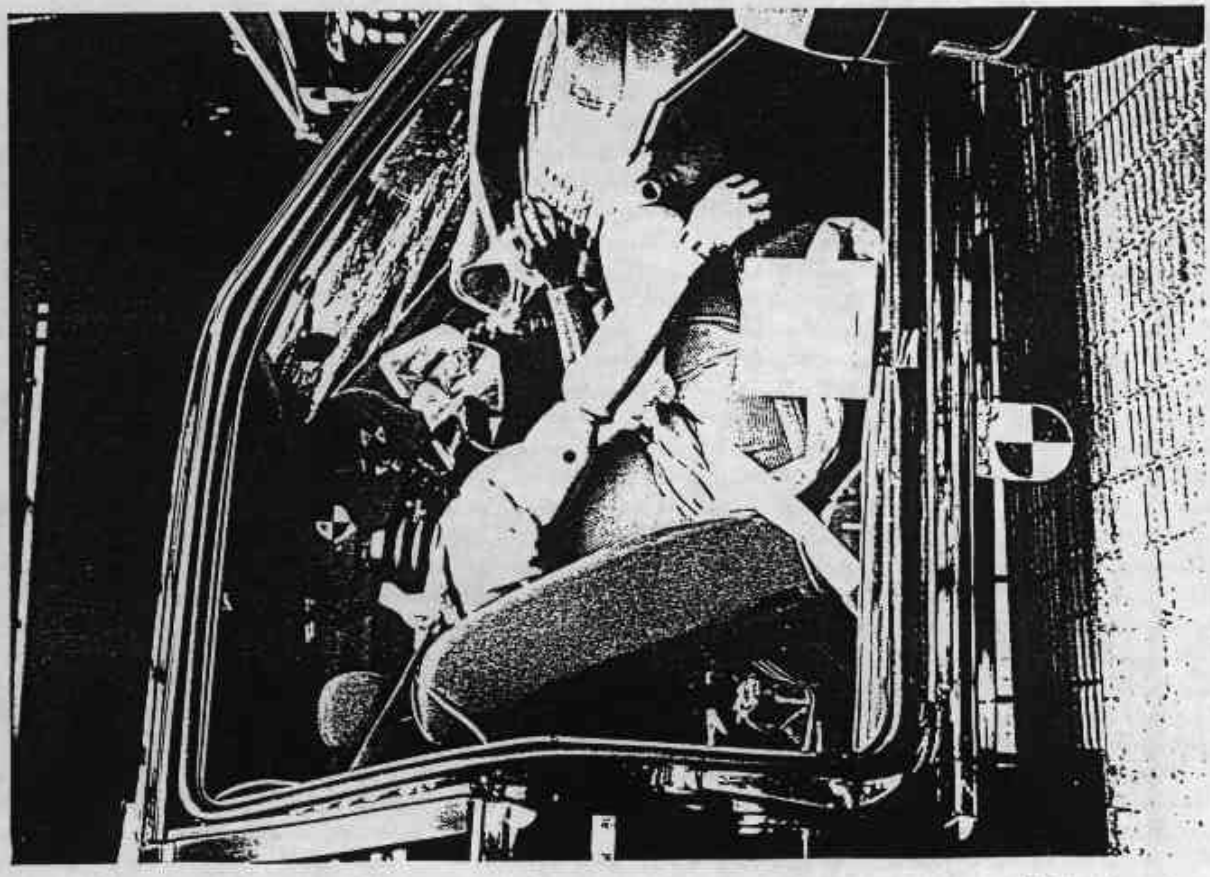


Figure A-30. POST-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 1

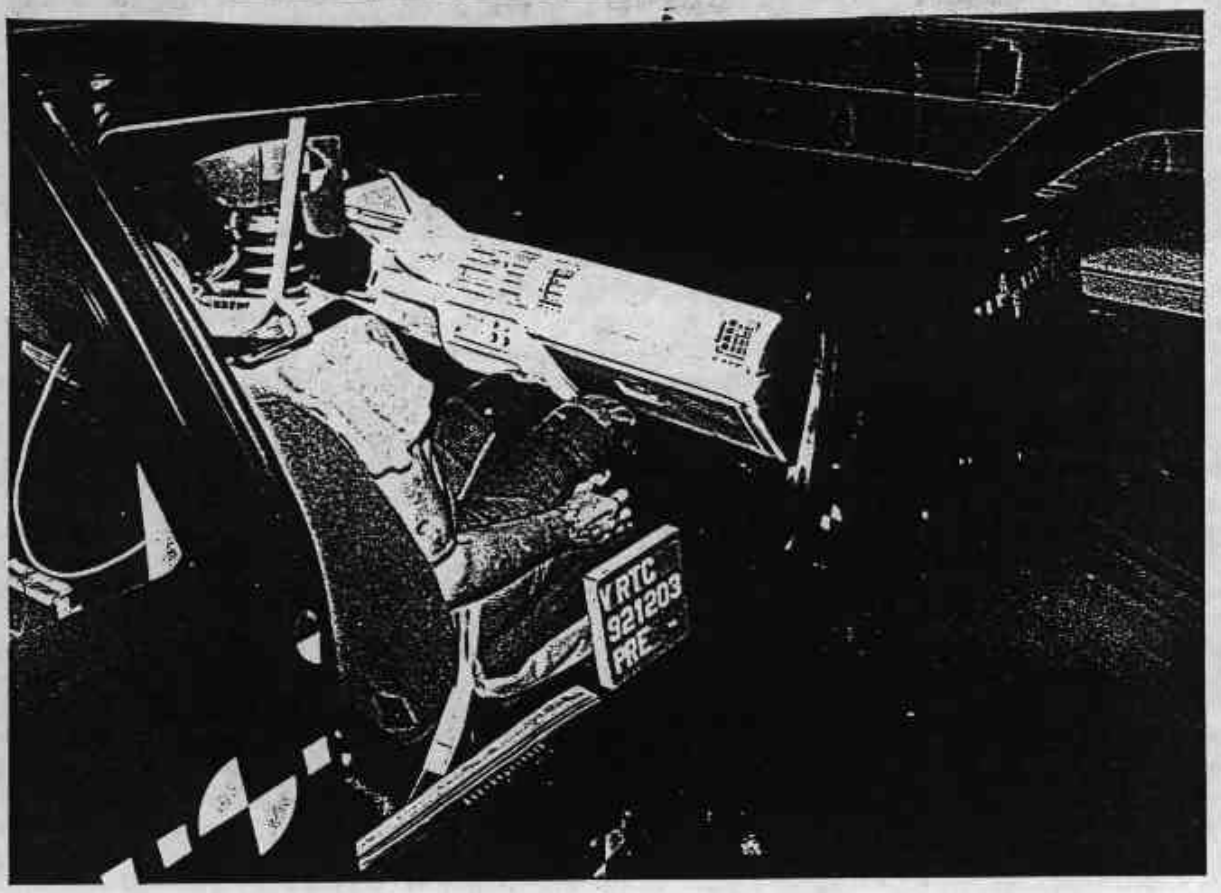


Figure A-31. PRE-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 2

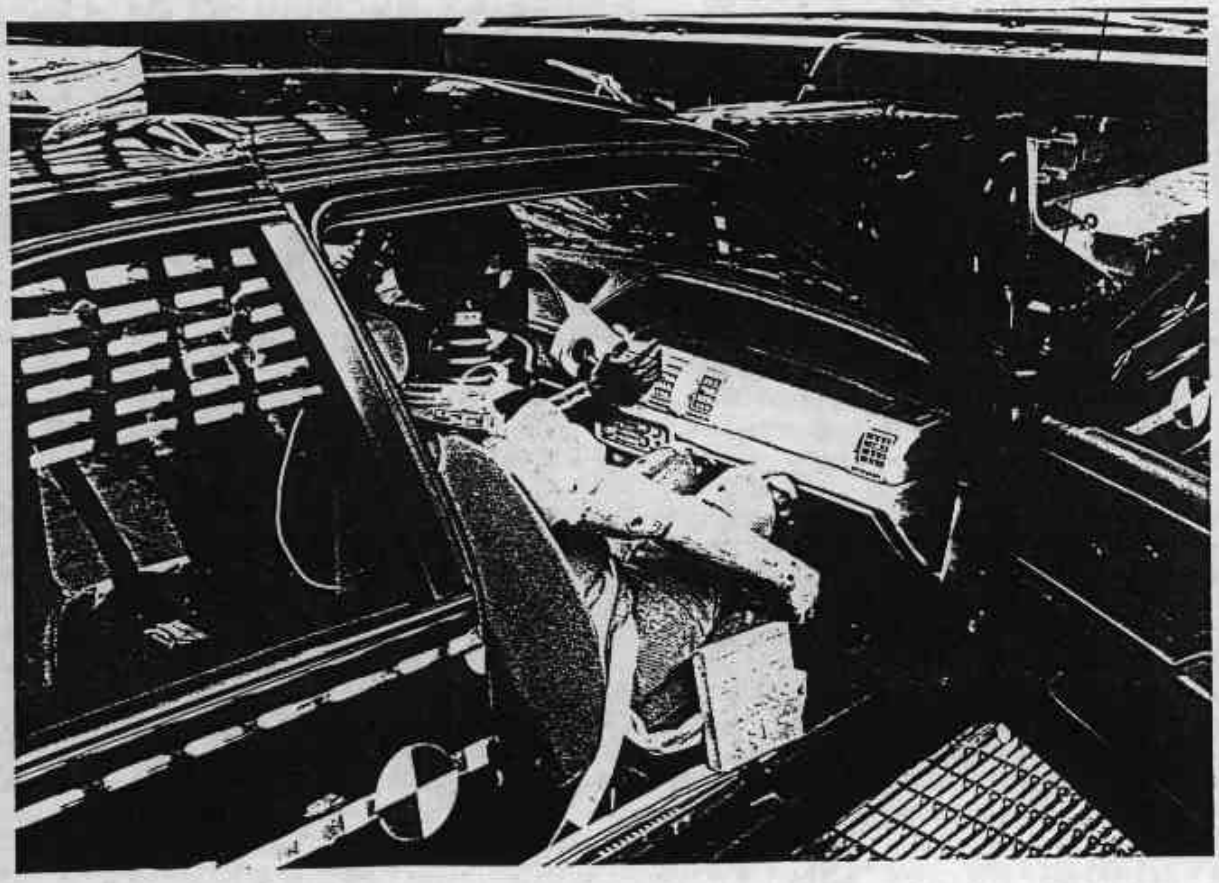


Figure A-32. POST-TEST PASSENGER DUMMY & VEHICLE INTERIOR - VIEW 2

Figure A-33. POST-TEST DRIVER DUMMY HEAD CONTACT - VIEW 1

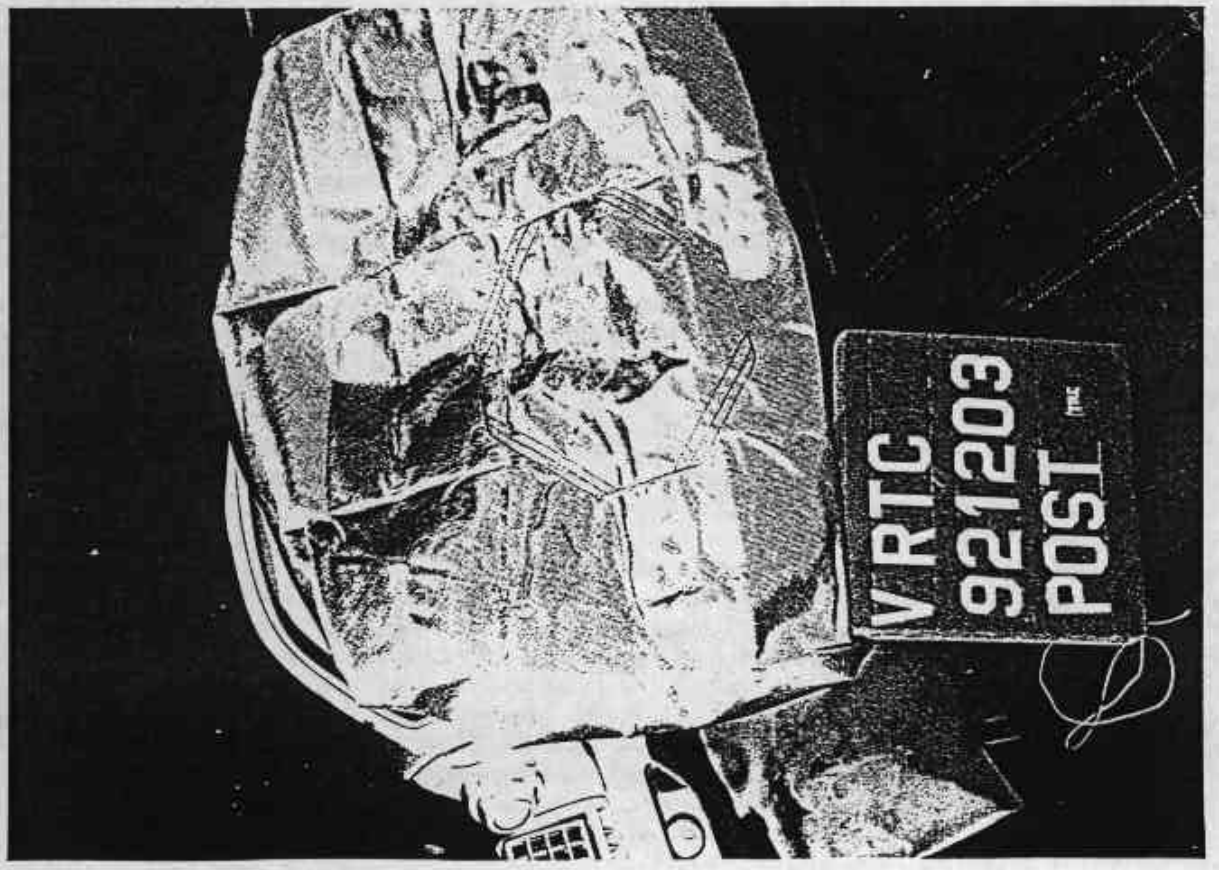


Figure A-34. POST-TEST DRIVER DUMMY HEAD CONTACT - VIEW 2

Figure A-35. POST-TEST DRIVER DUMMY HEAD CONTACT - VIEW 3

Figure A-36. POST-TEST DRIVER DUMMY HEAD CONTACT - VIEW 1

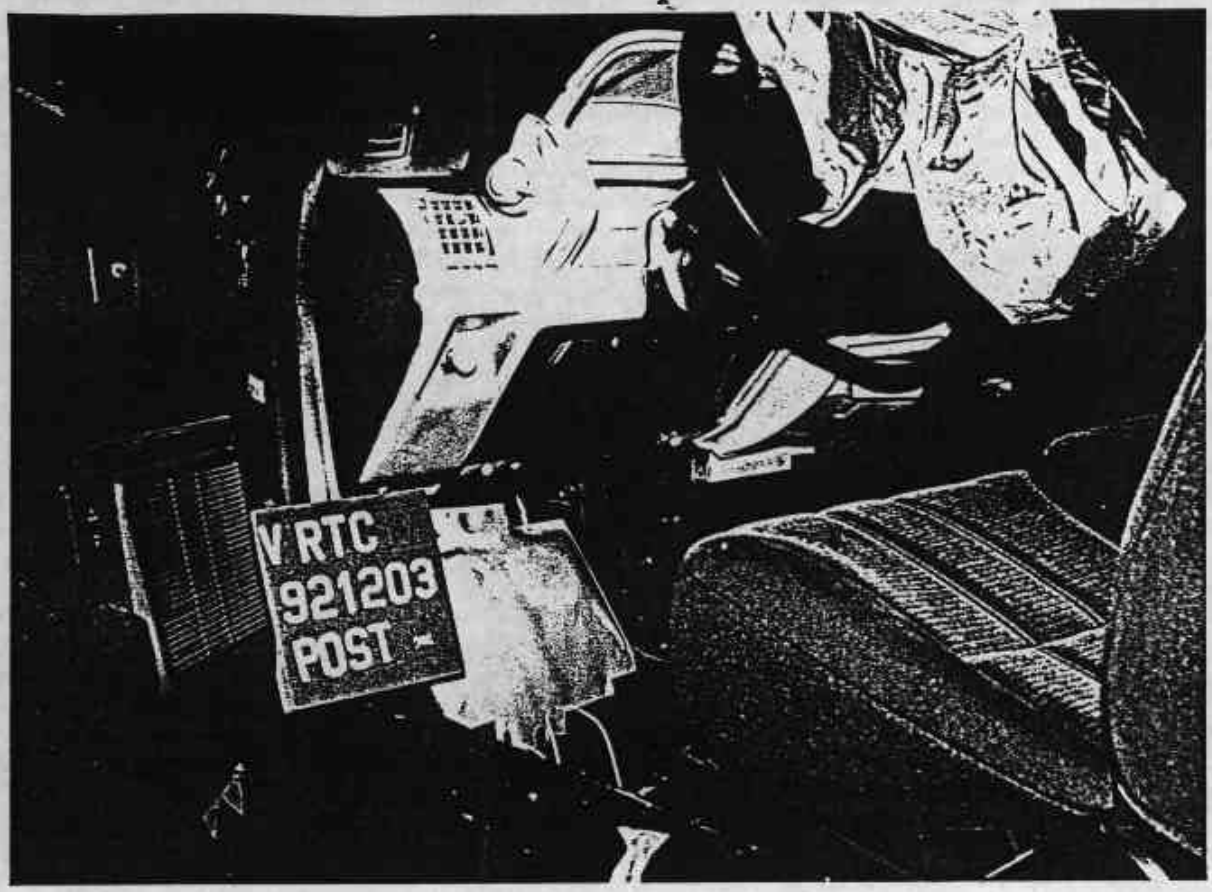


Figure A-37. POST-TEST DRIVER DUMMY KNEE CONTACT - VIEW 2

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

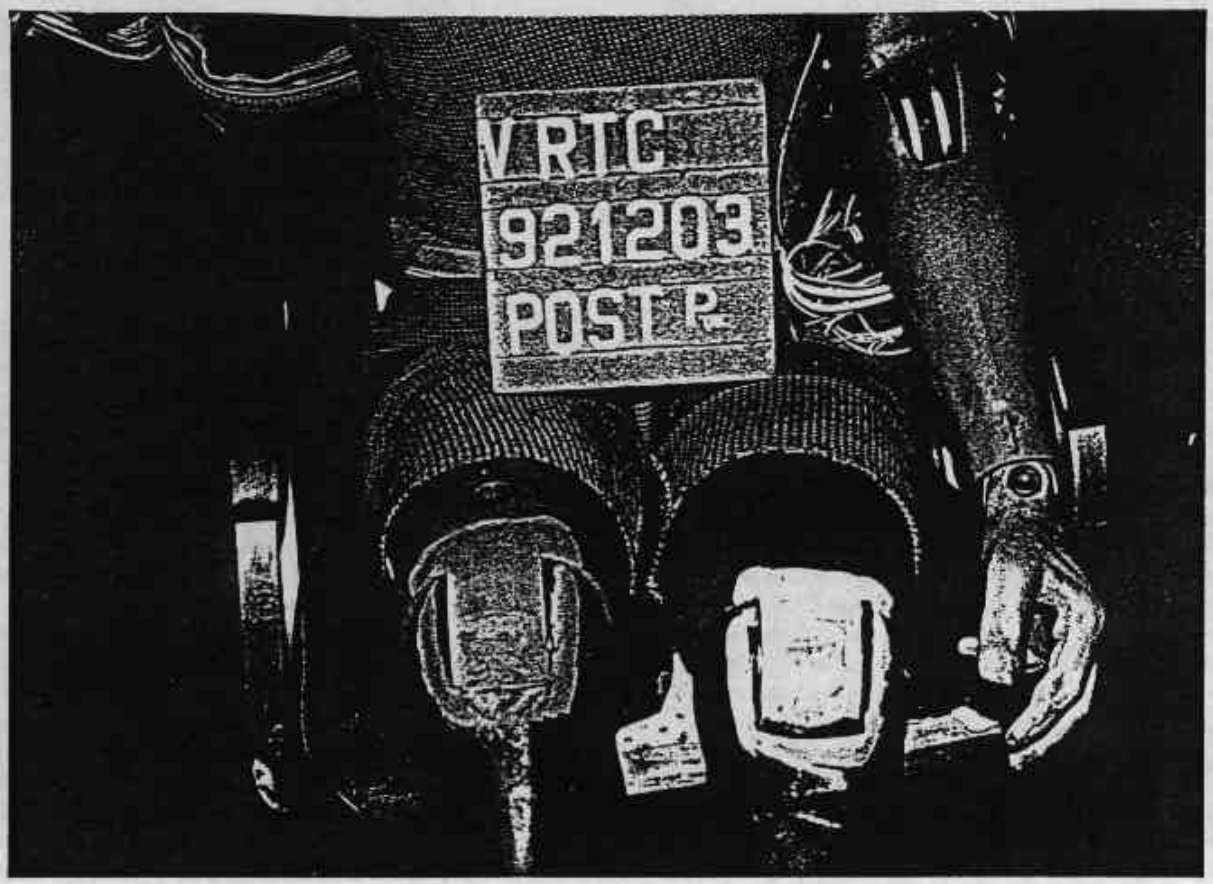


Figure A-39. POST-TEST PASSENGER DUMMY KNEE CONTACT - VIEW 1

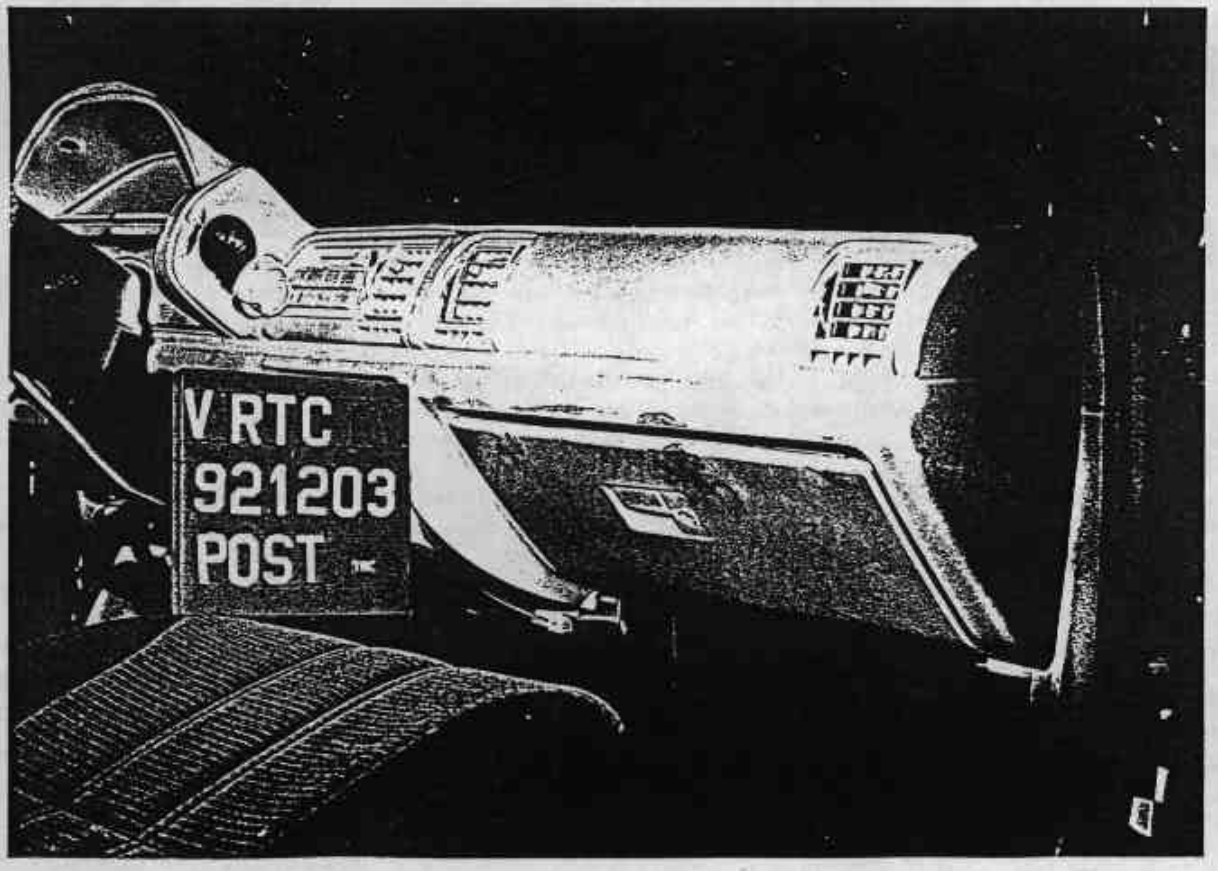


Figure A-40. POST-TEST PASSENGER DUMMY KNEE CONTACT - VIEW 2

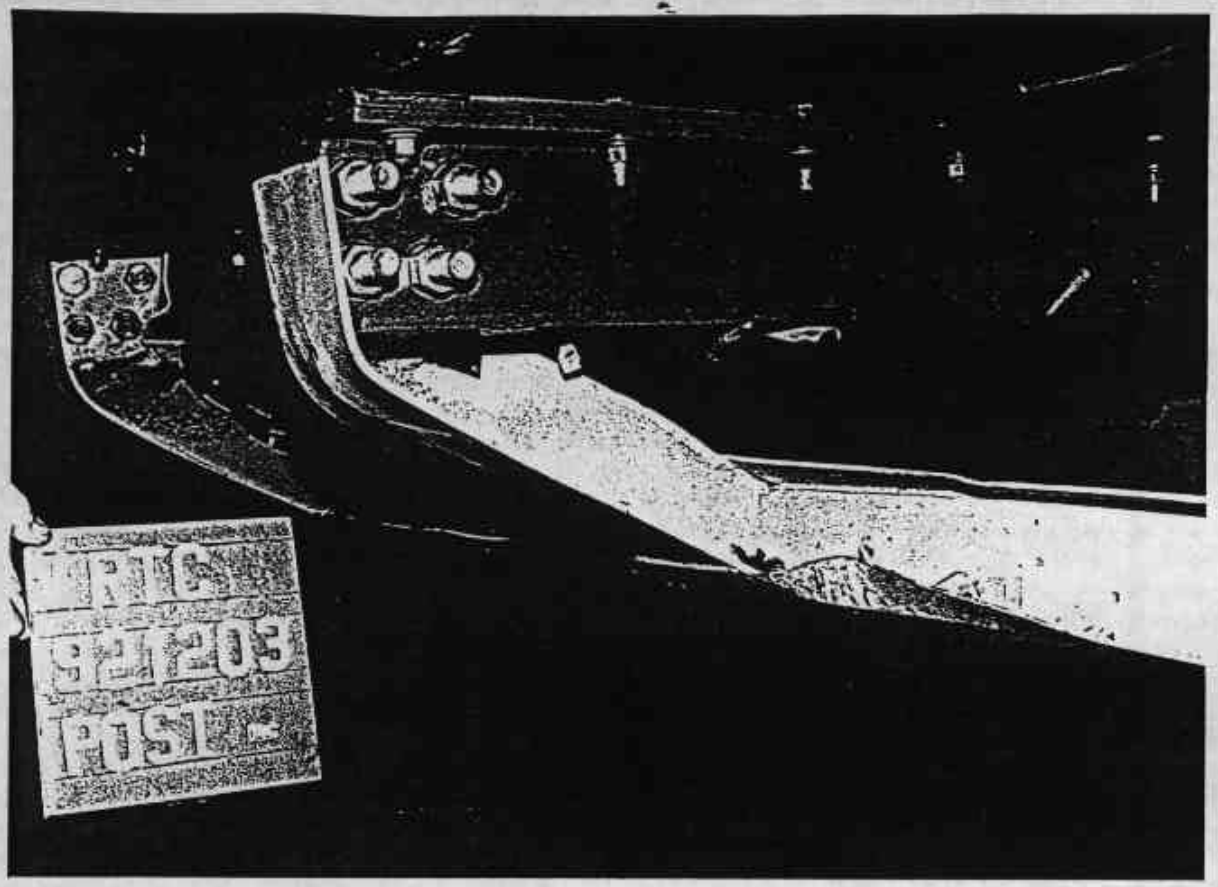


Figure A-41. POST-TEST UNDERRIDE GUARD - VIEW 1

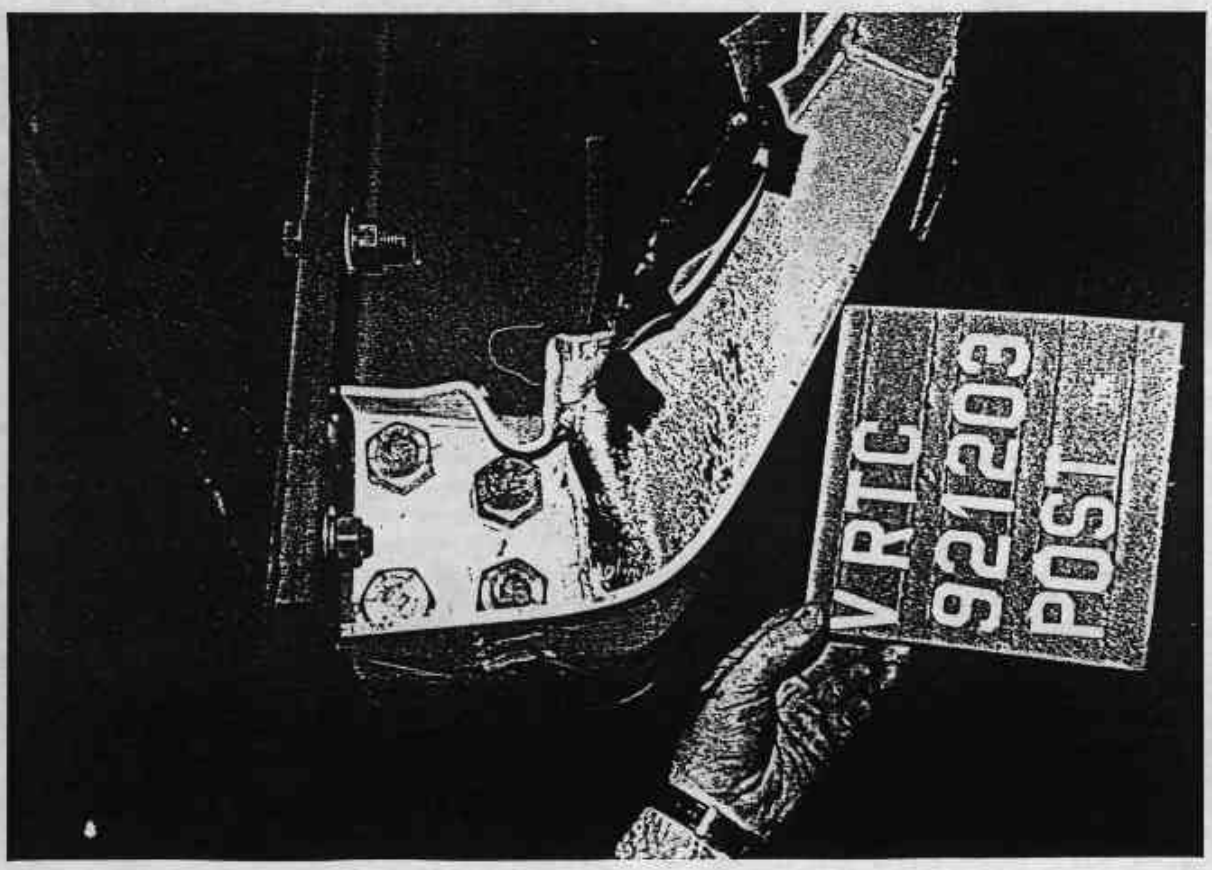


Figure A-42. POST-TEST UNDERRIDE GUARD - VIEW 2

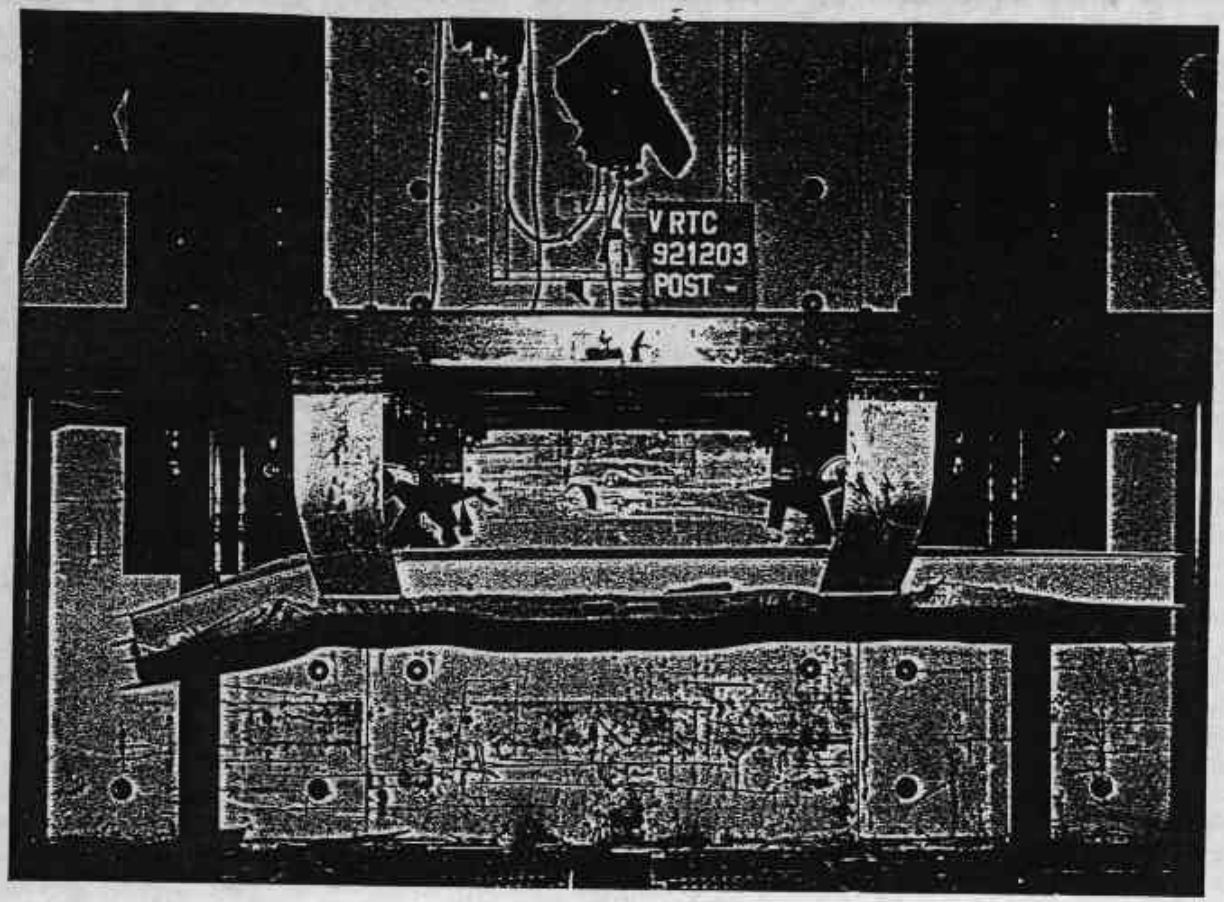


Figure A-43. POST-TEST UNDERRIDE GUARD - VIEW 3

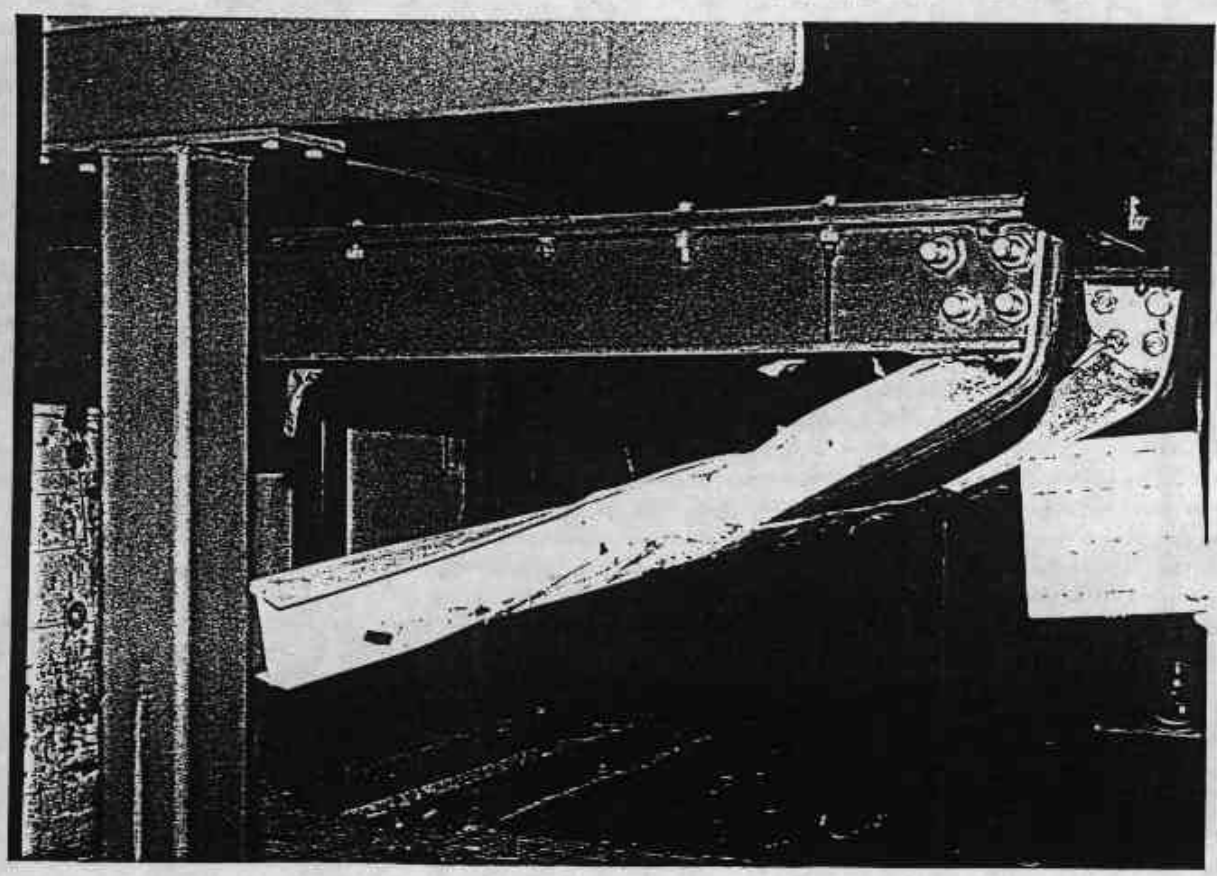


Figure A-44. POST-TEST UNDERRIDE GUARD - VIEW 4

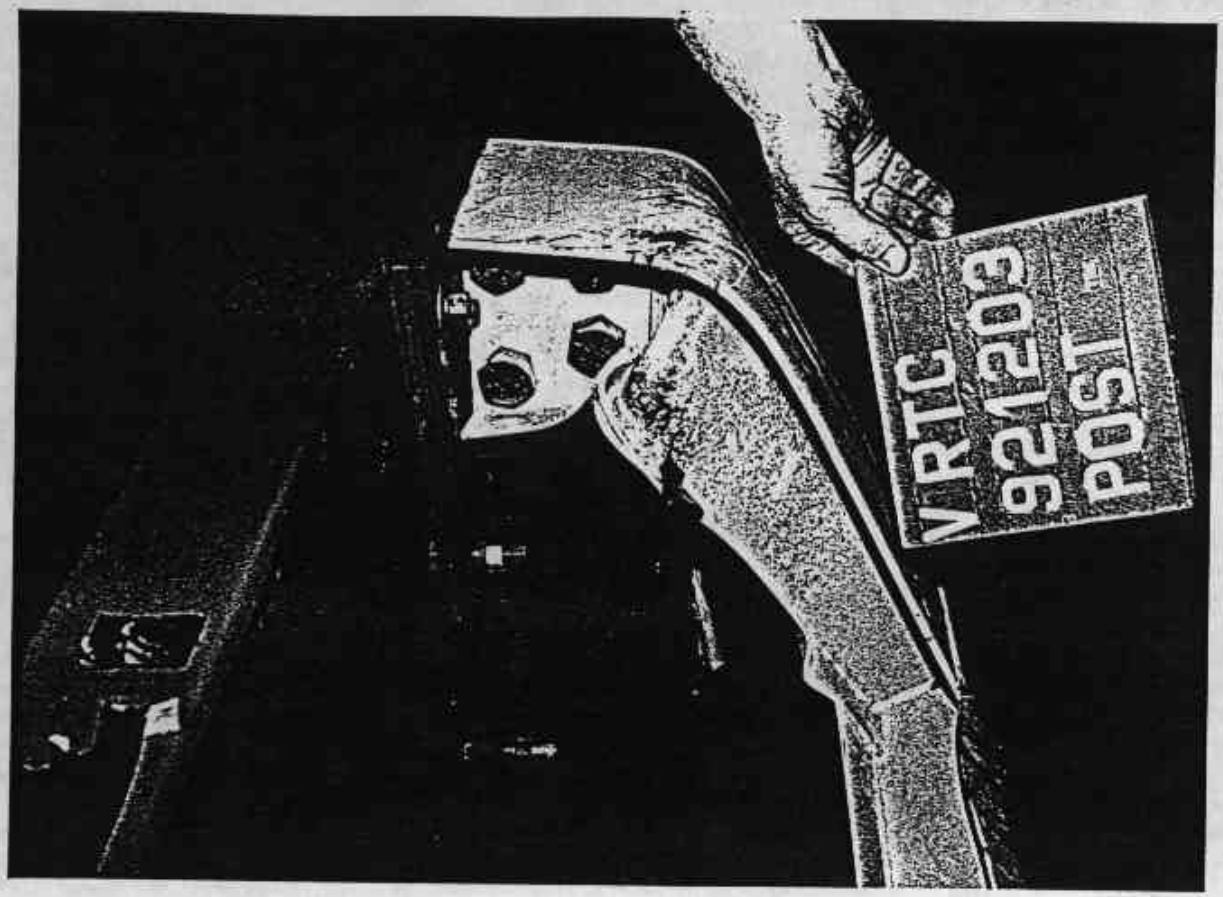
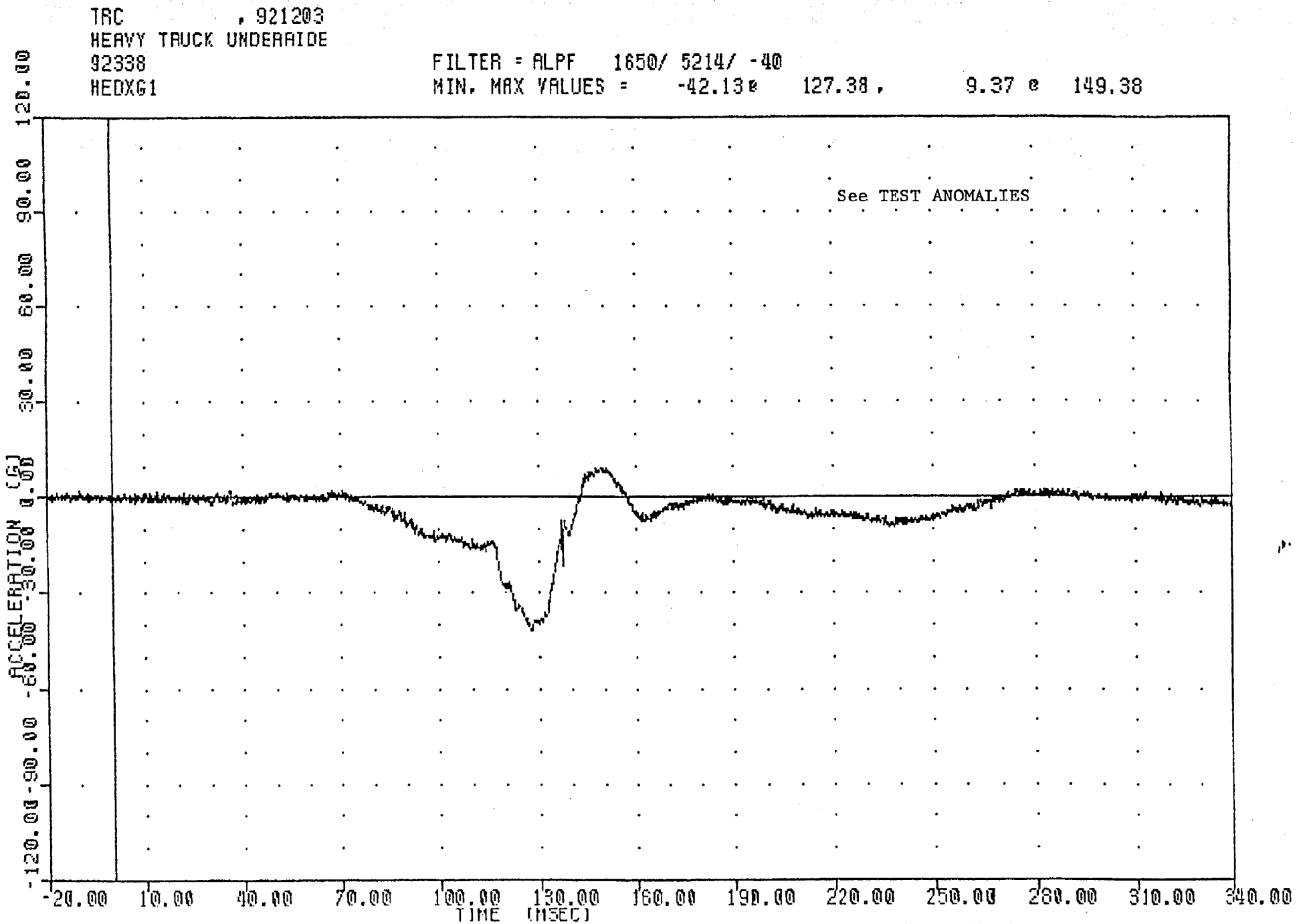


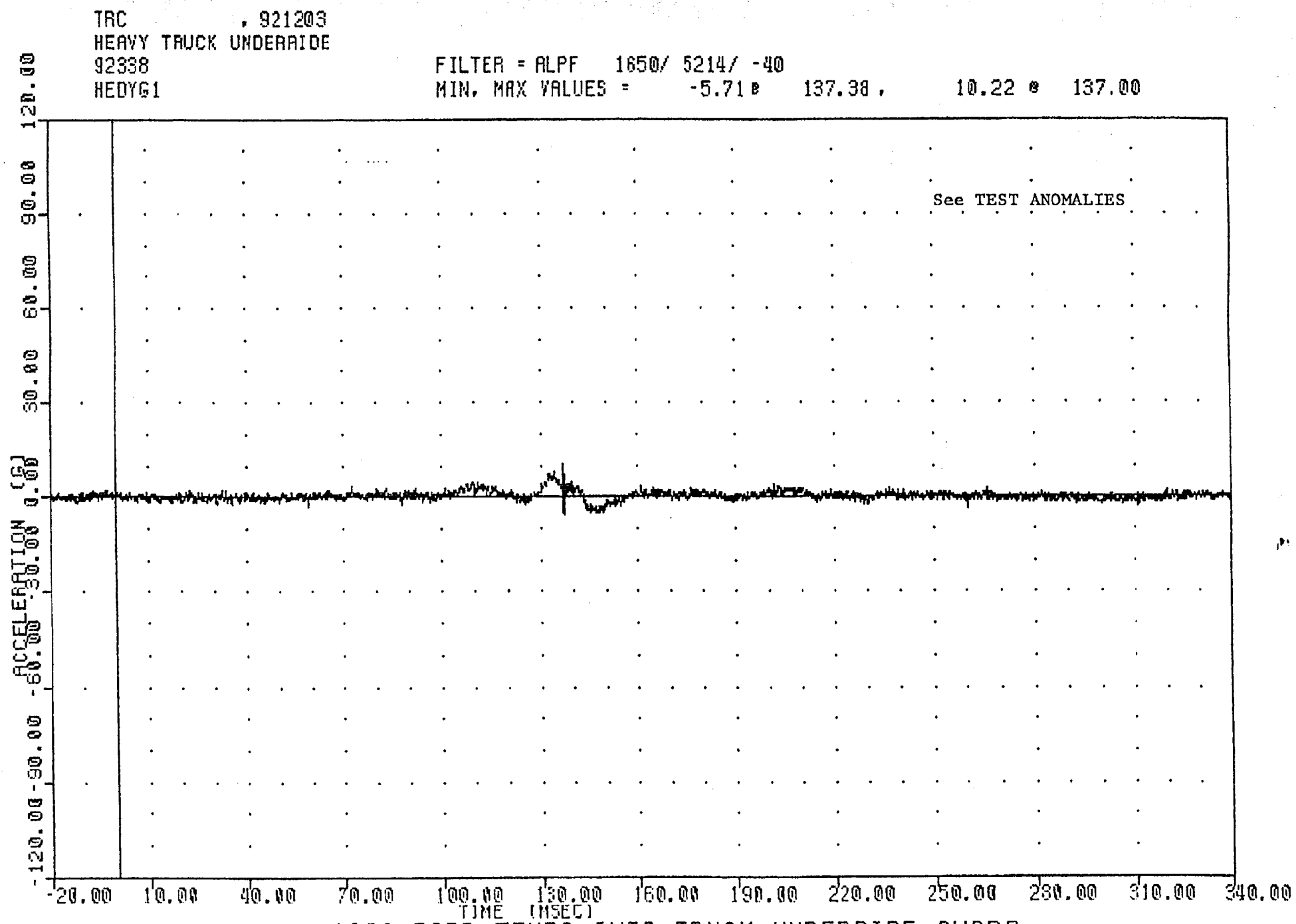
Figure A-45. POST-TEST UNDERRIDE GUARD - VIEW 5

APPENDIX B

DATA PLOTS

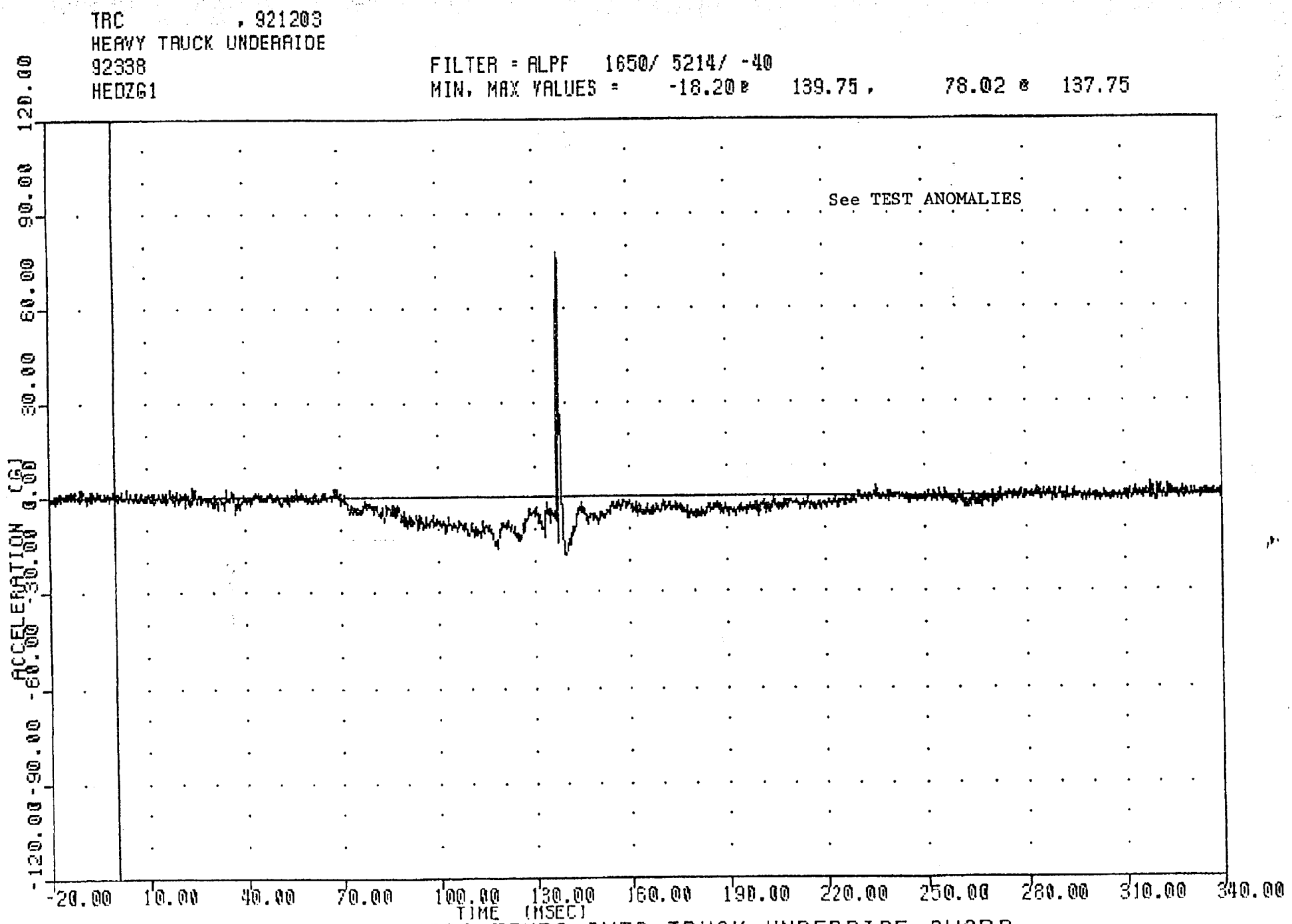


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER HEAD X-AXIS ACCELERATION



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

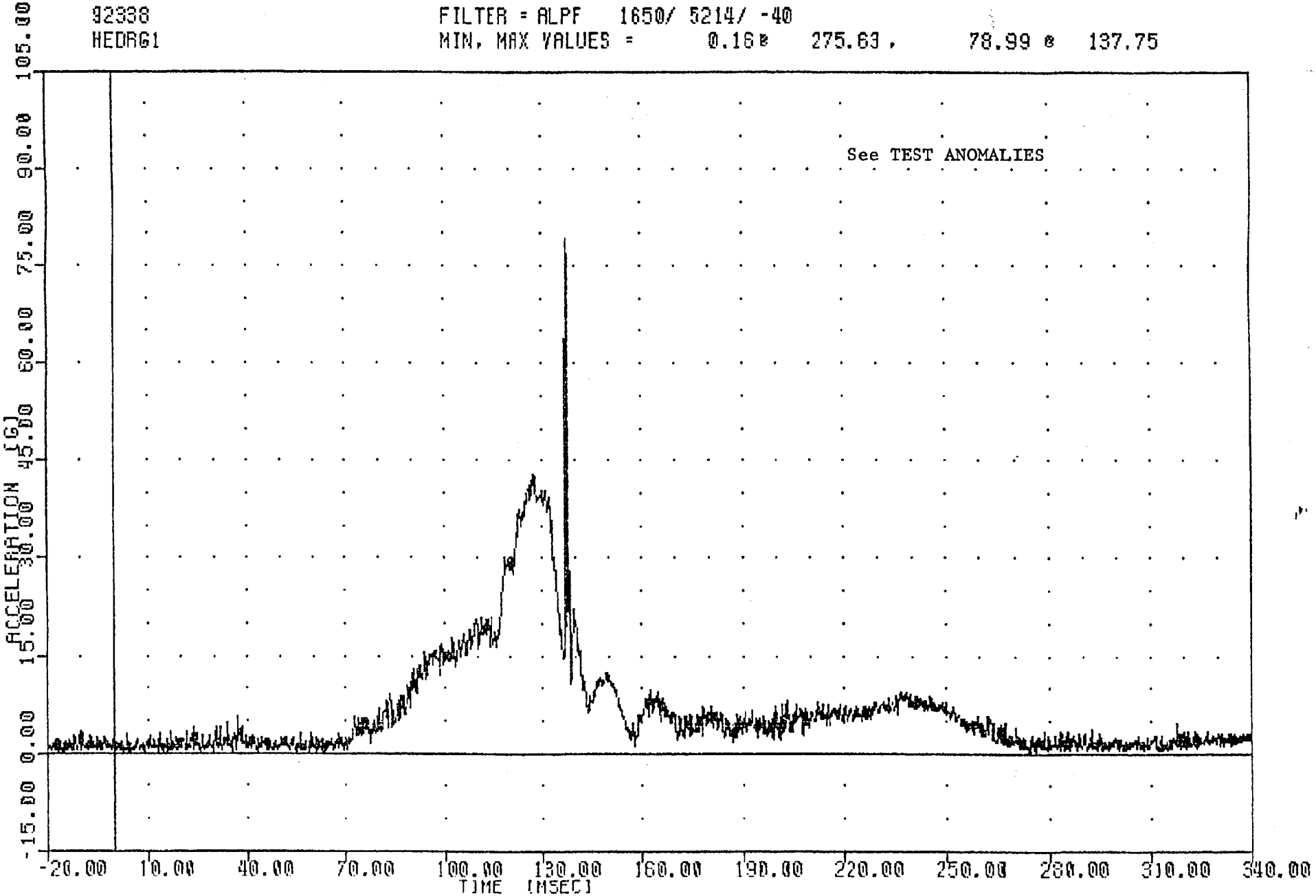
DRIVER HEAD Y-AXIS ACCELERATION



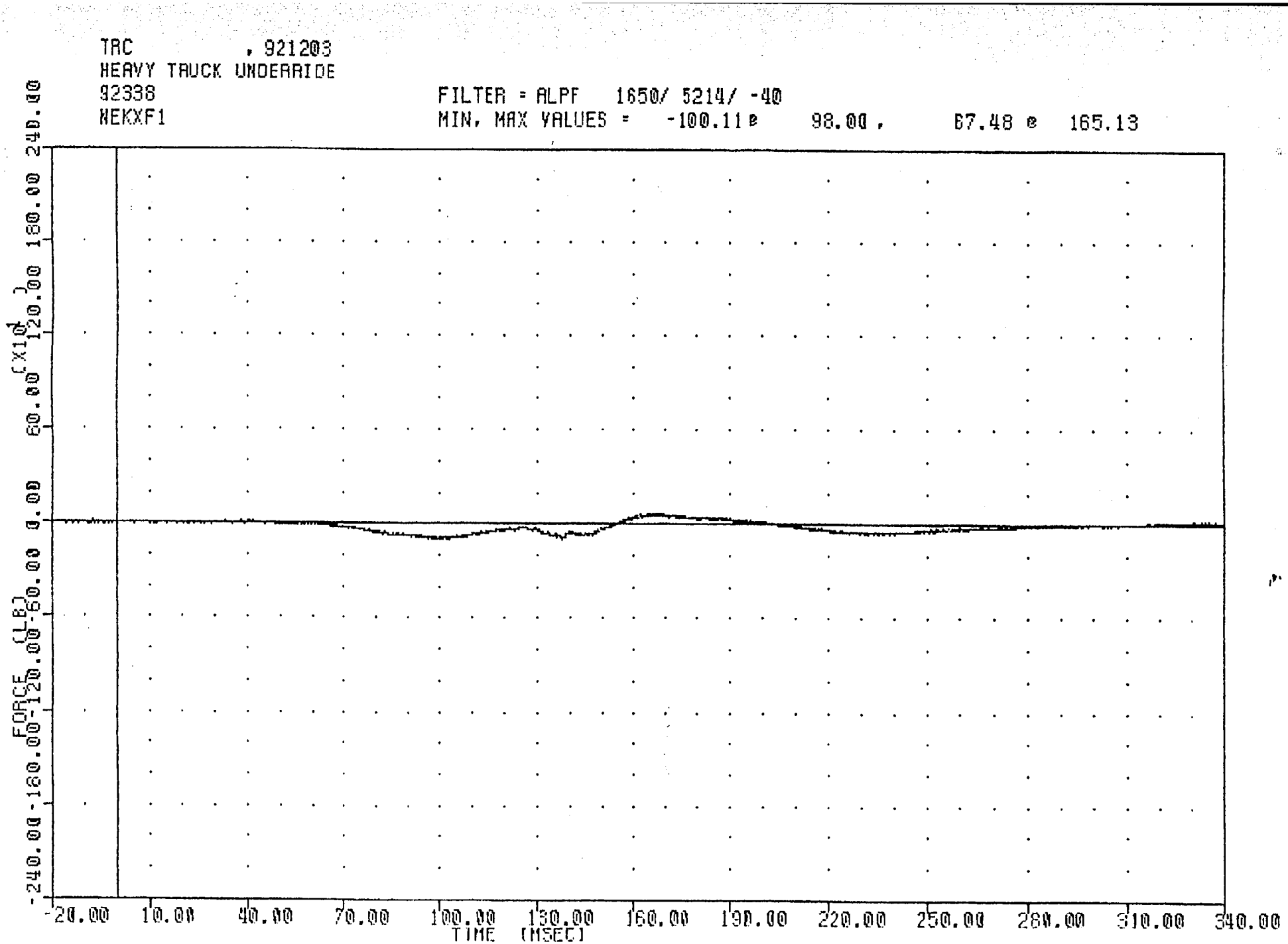
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER HEAD Z-AXIS ACCELERATION

TRC , 921203
HEAVY TRUCK UNDERRIDE
92338
HEDRG1

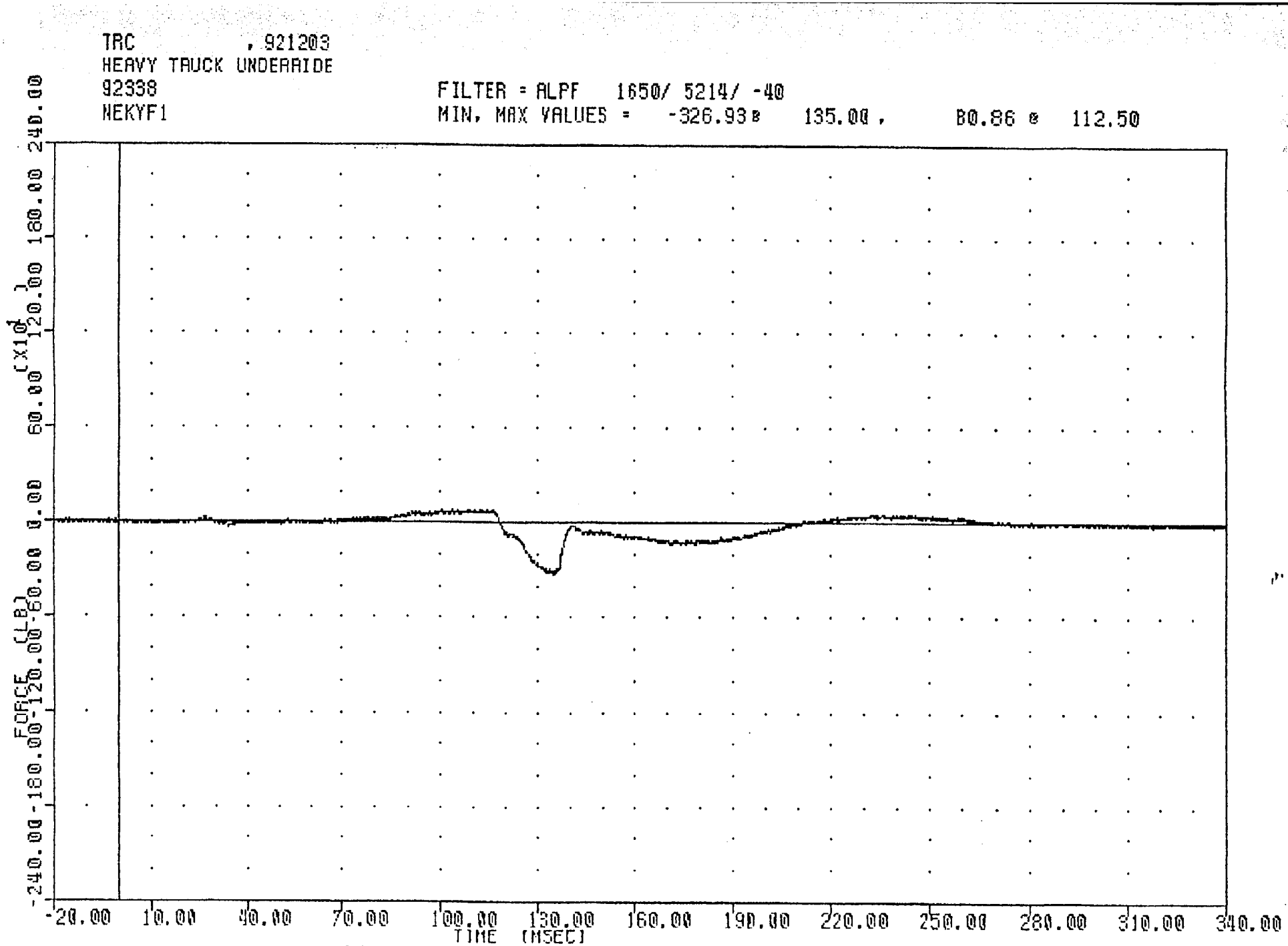
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = 0.16 @ 275.63 , 78.99 @ 137.75



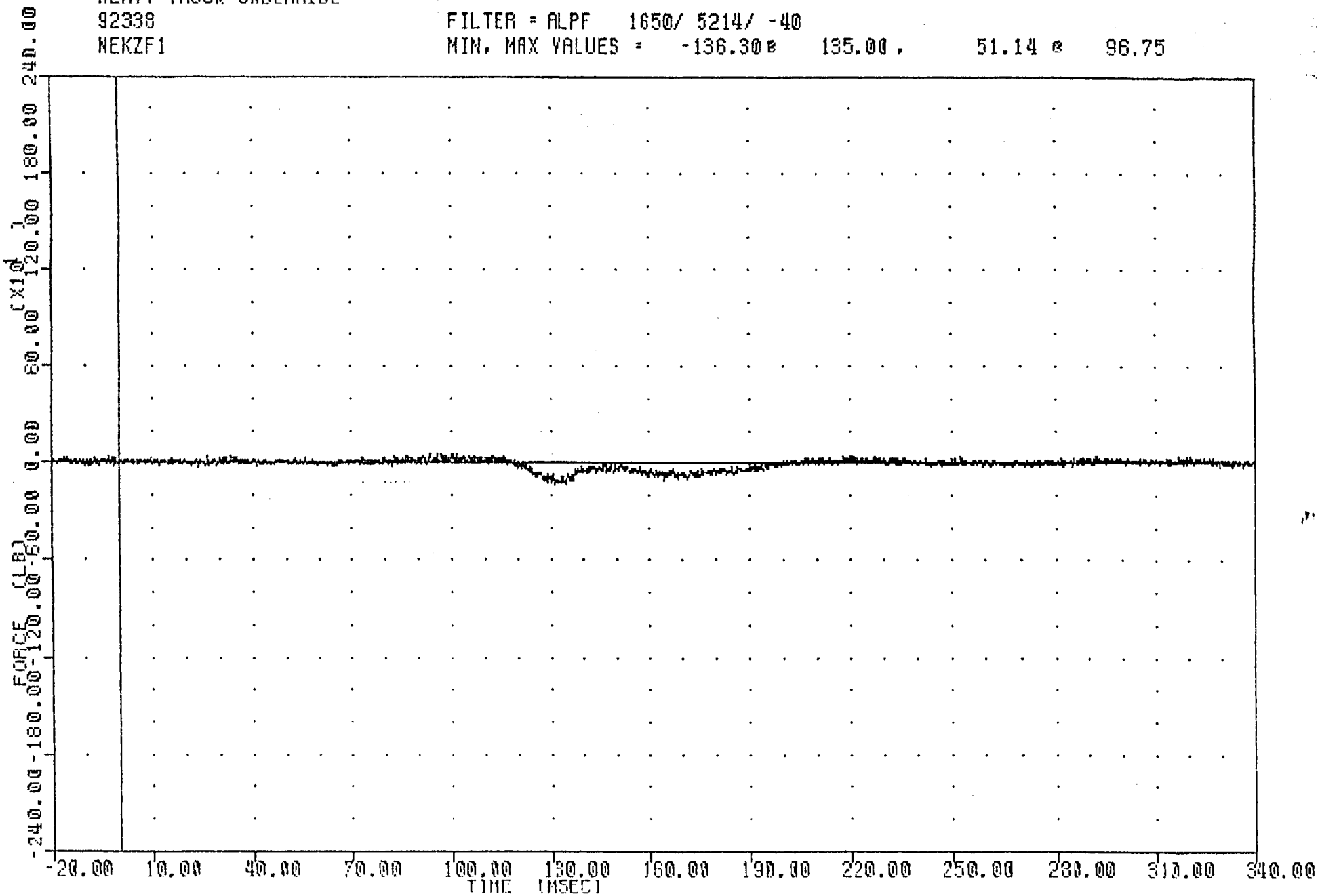
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER HEAD RESULTANT ACCELERATION



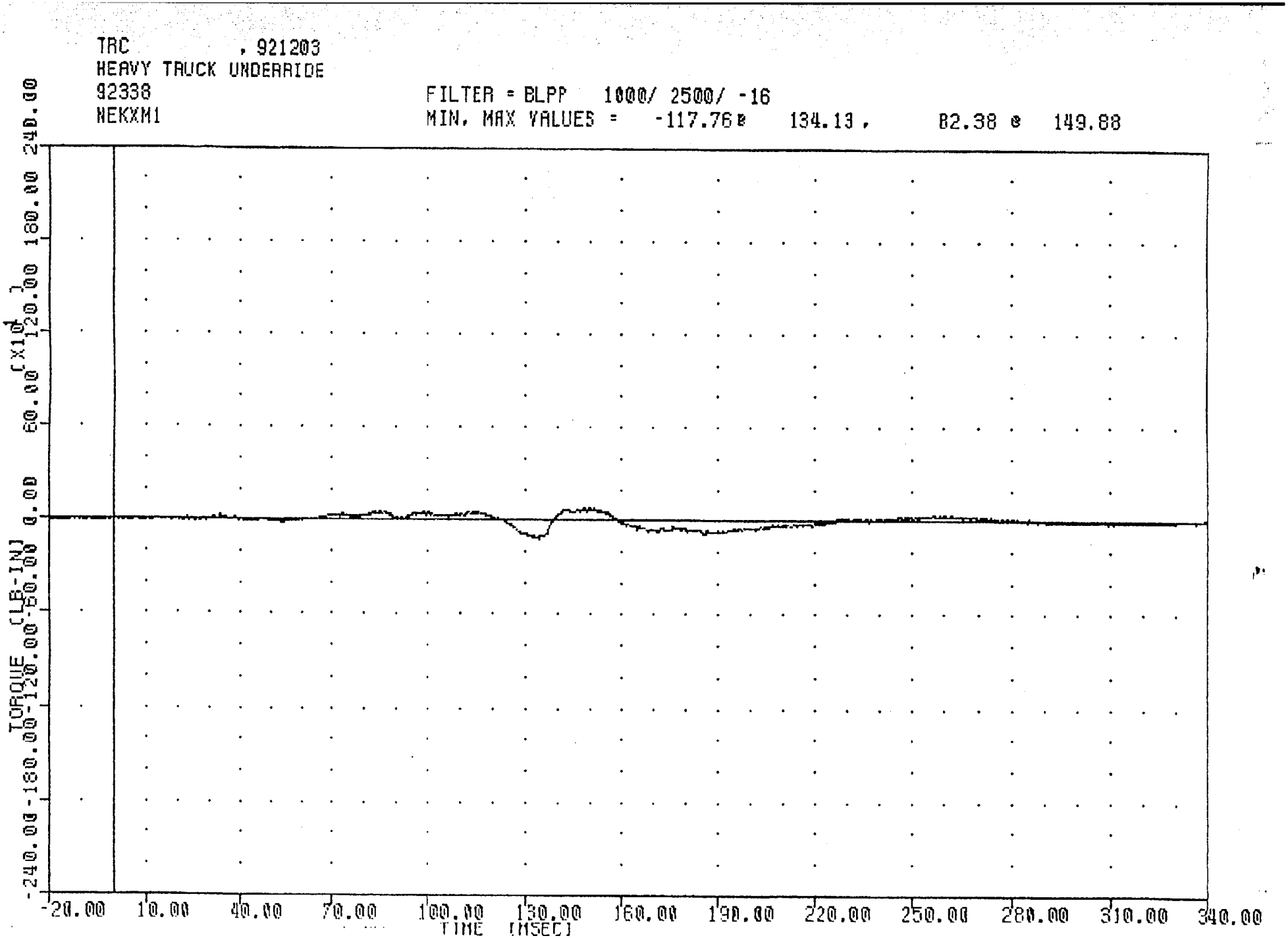
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER NECK X-AXIS SHEAR FORCE



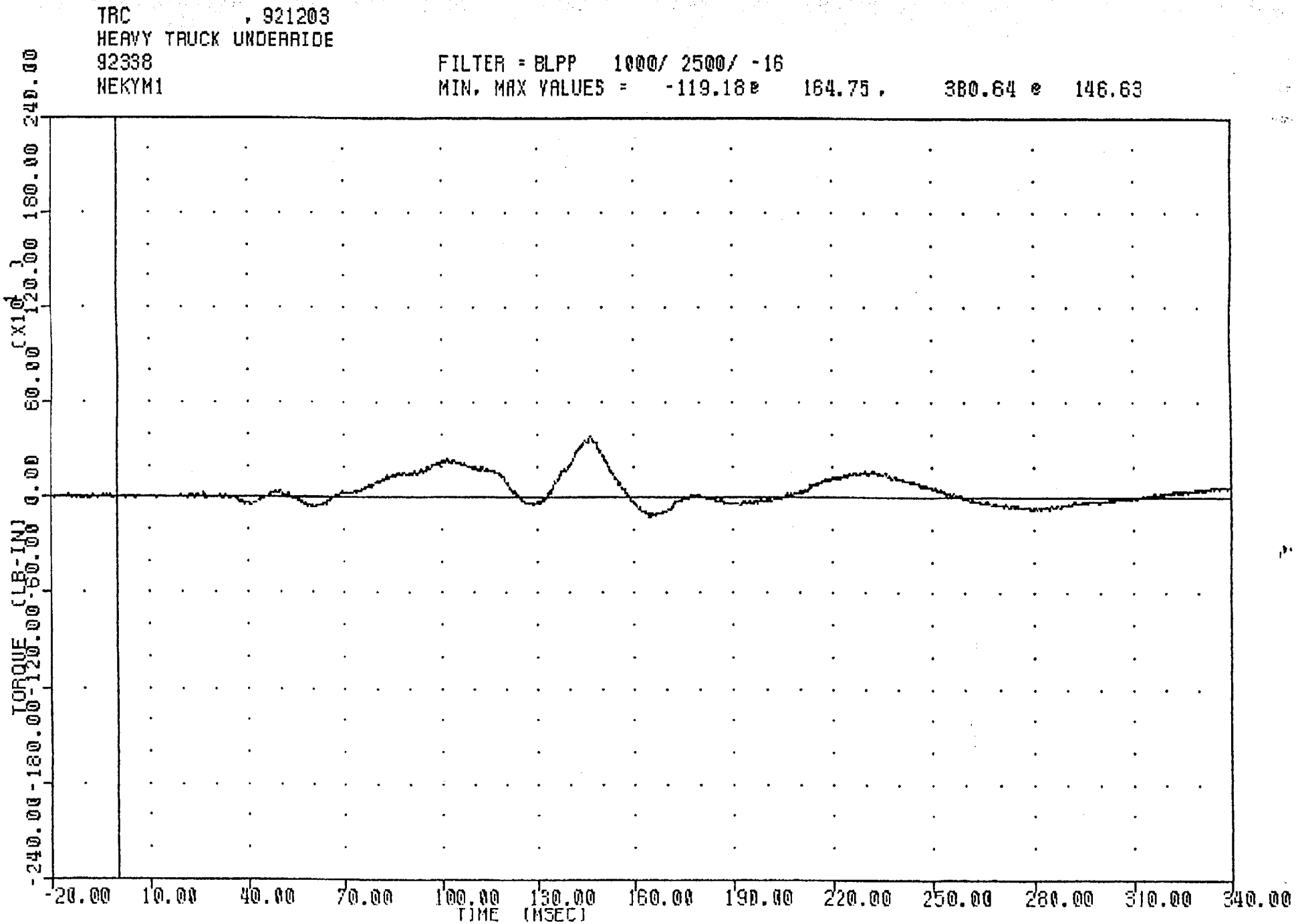
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER NECK Y-AXIS SHEAR FORCE



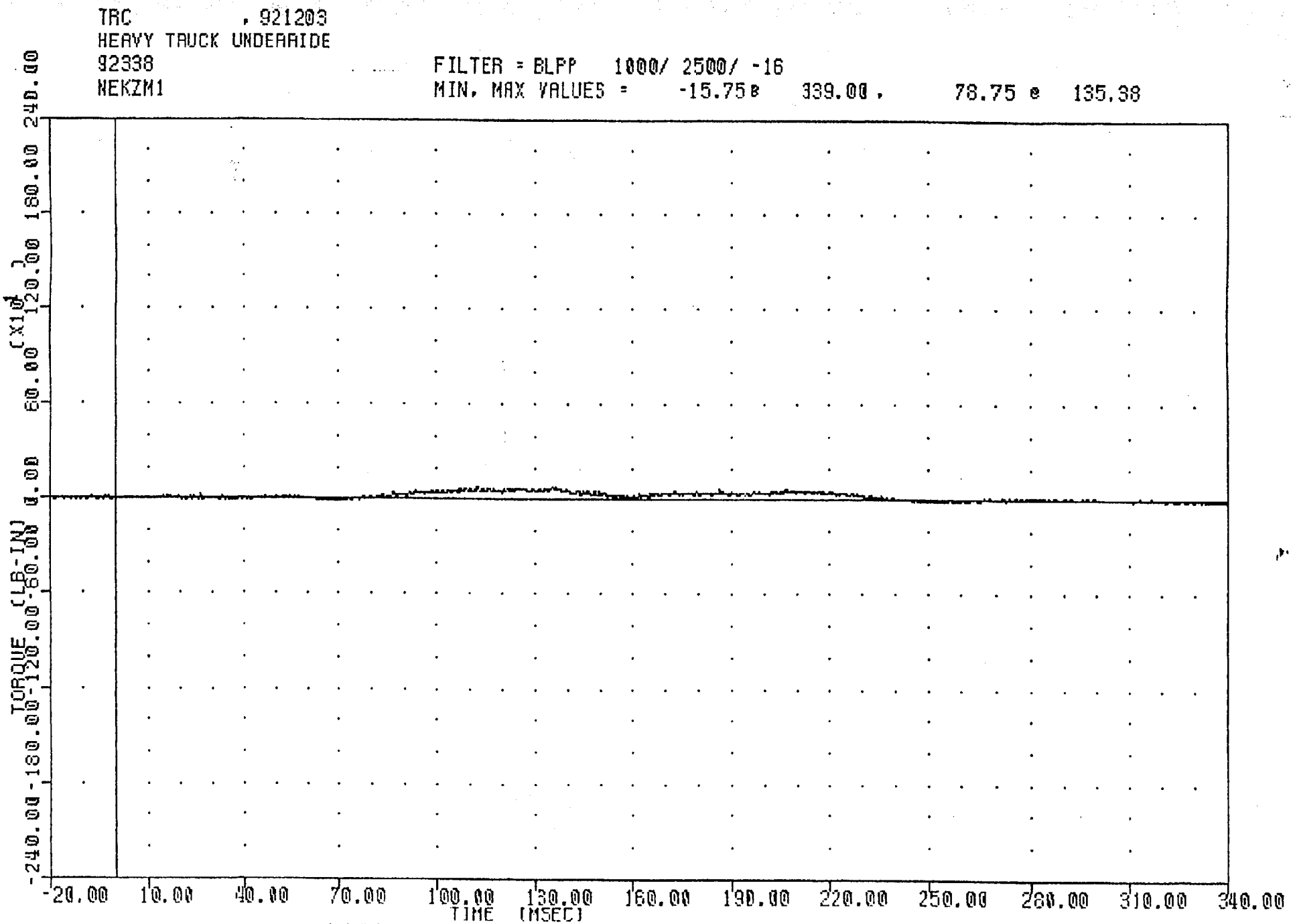
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER NECK Z-AXIS AXIAL FORCE



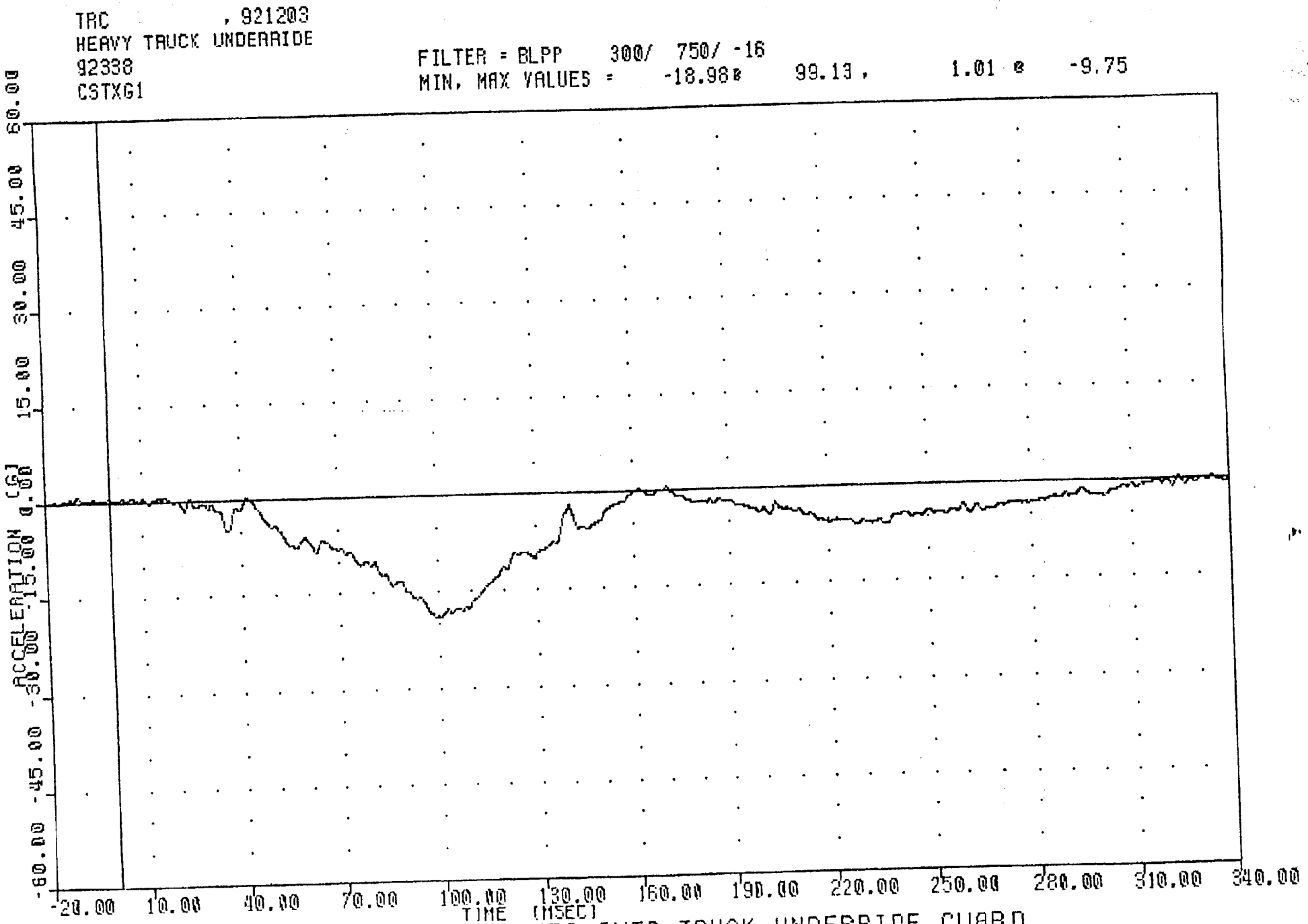
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER NECK MOMENT ABOUT X AXIS



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER NECK MOMENT ABOUT Y AXIS

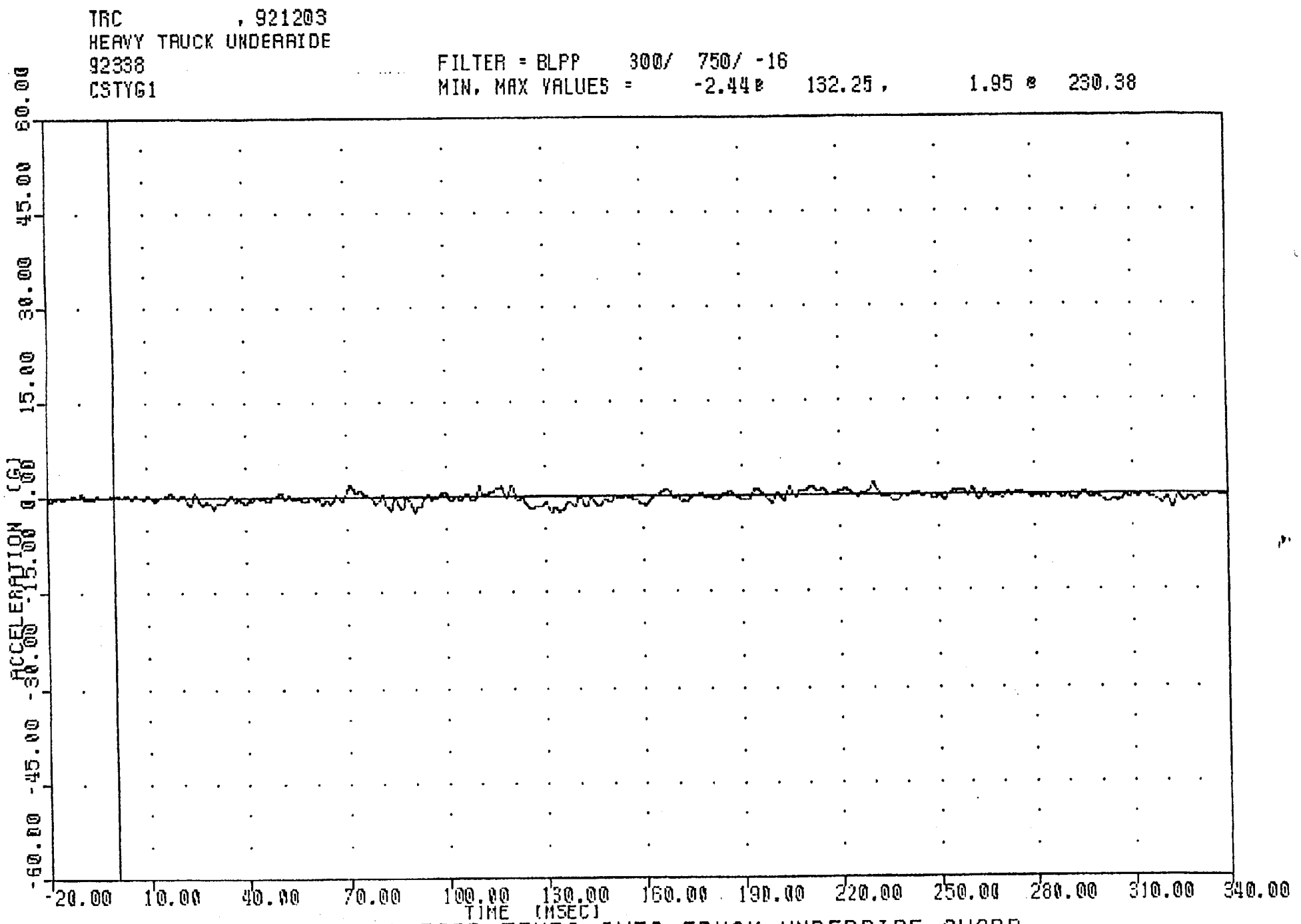


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER NECK MOMENT ABOUT Z AXIS

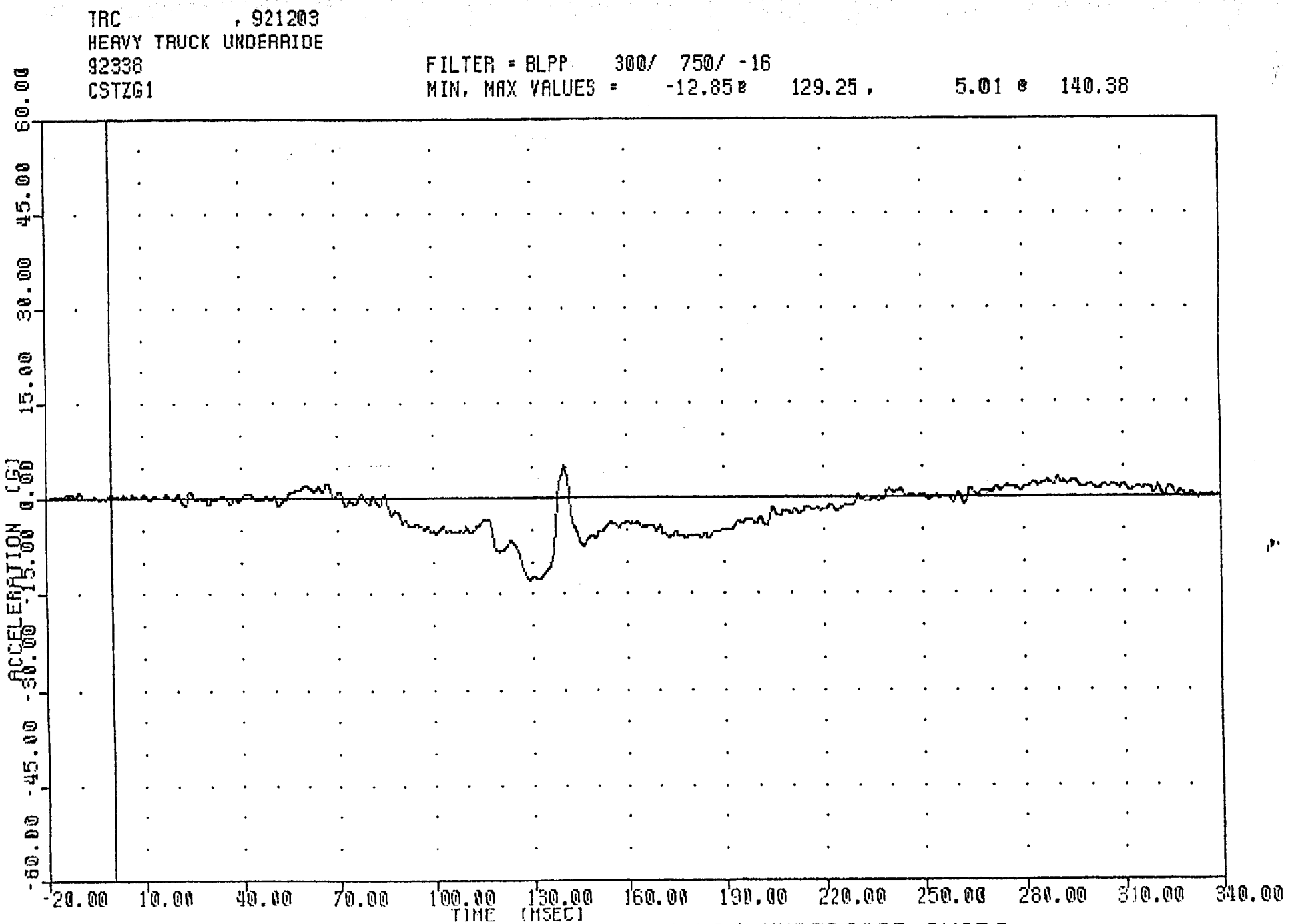


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

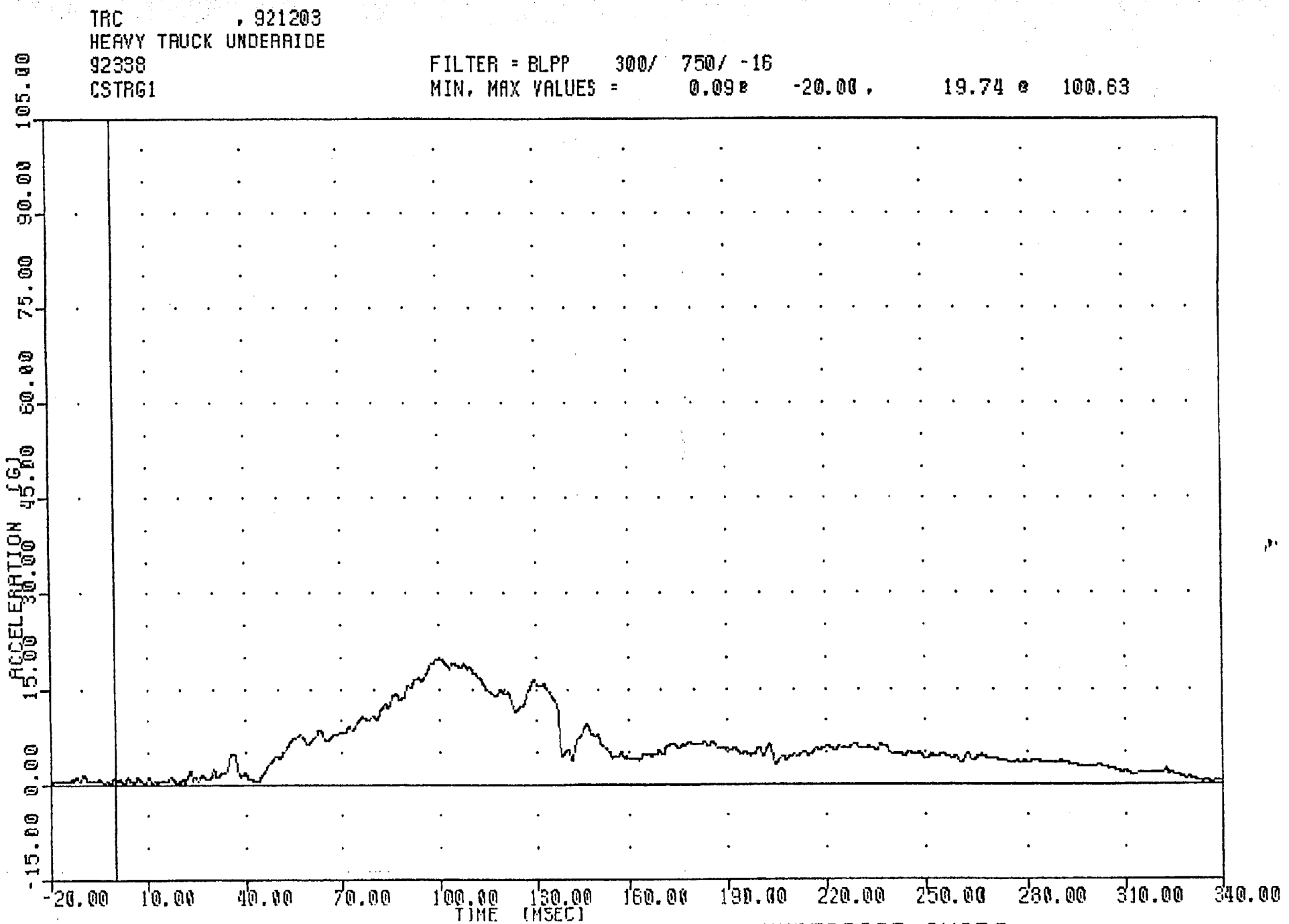
DRIVER CHEST X-AXIS ACCELERATION



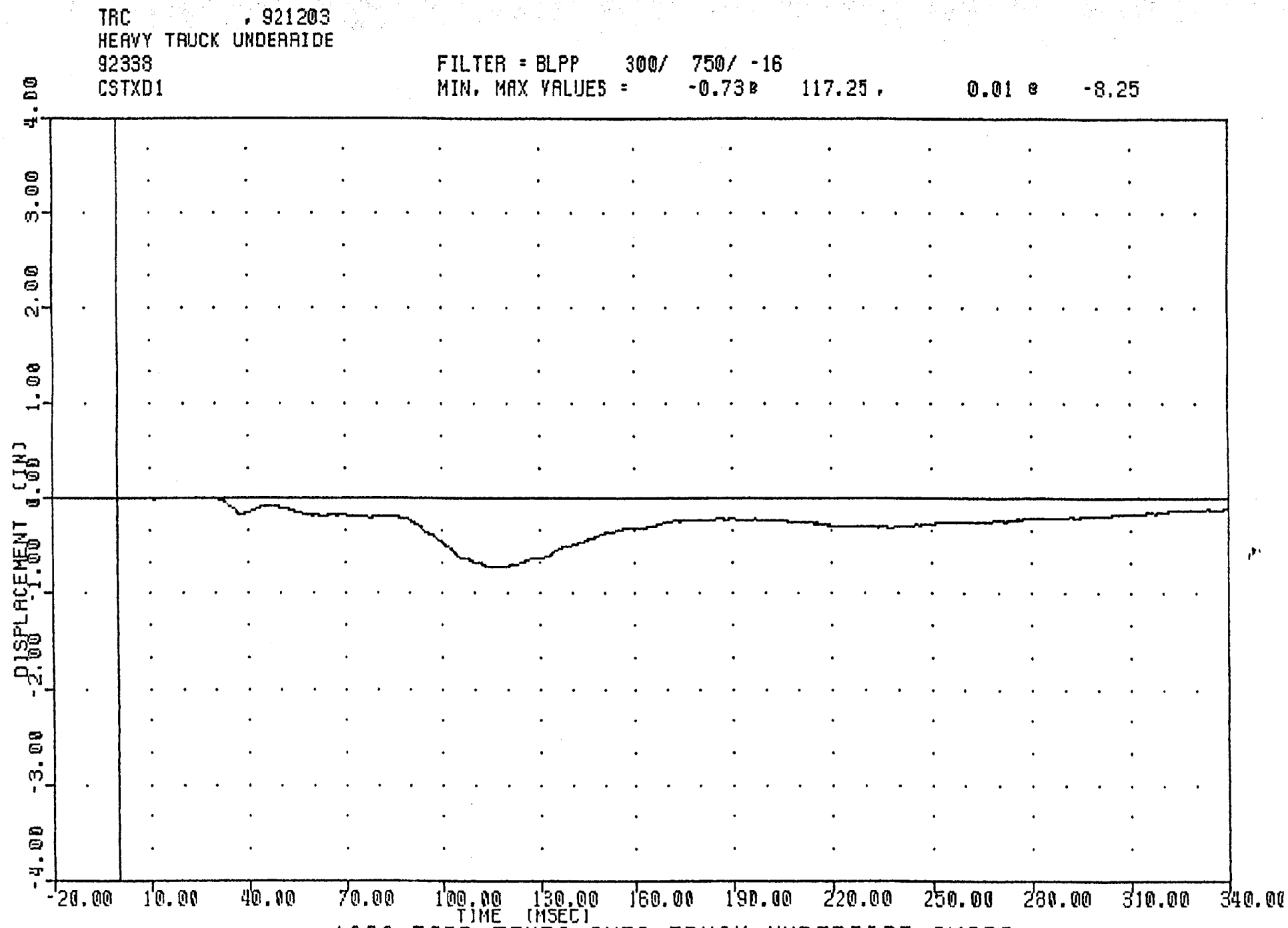
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER CHEST Y-AXIS ACCELERATION



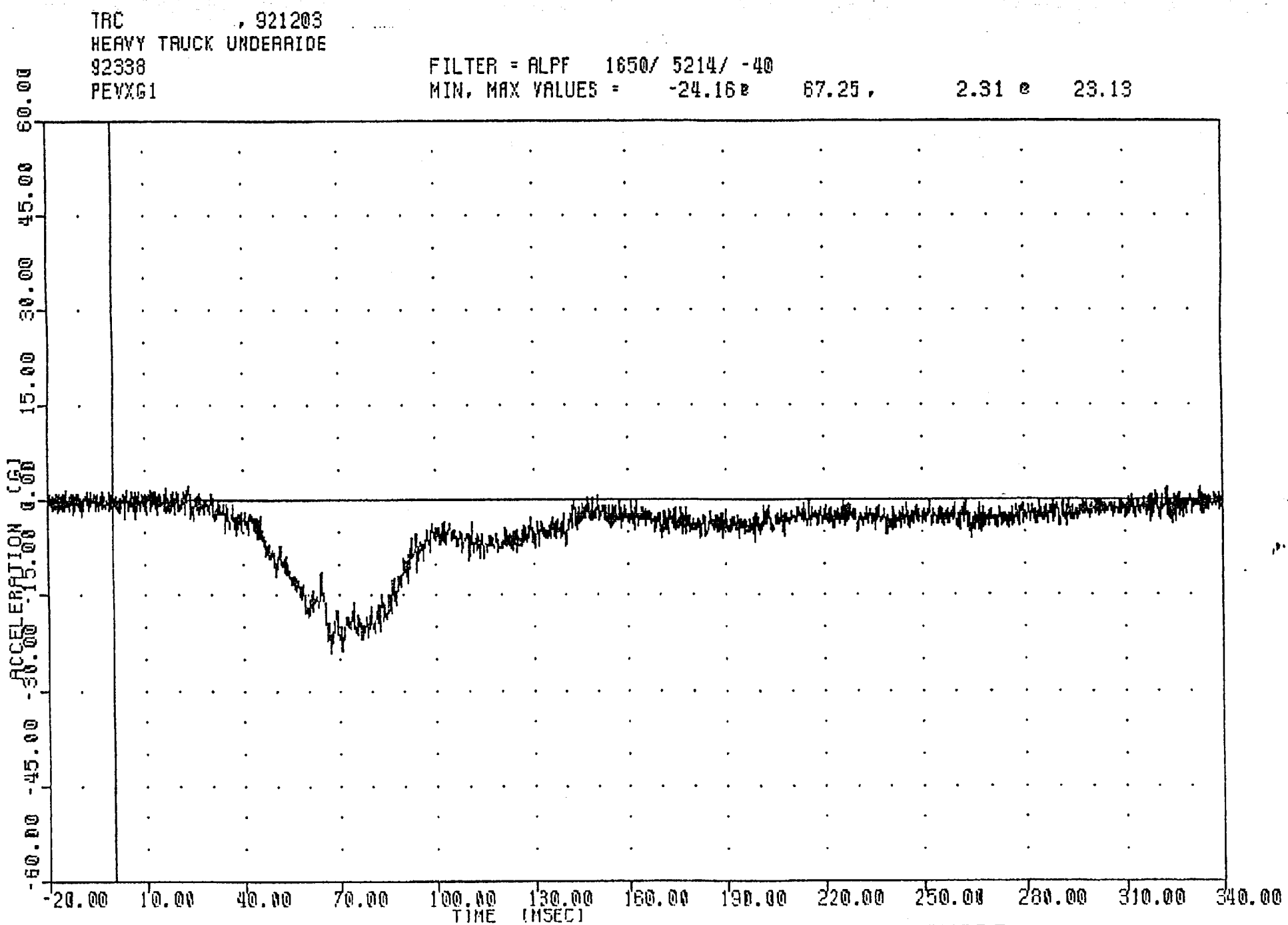
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER CHEST Z-AXIS ACCELERATION



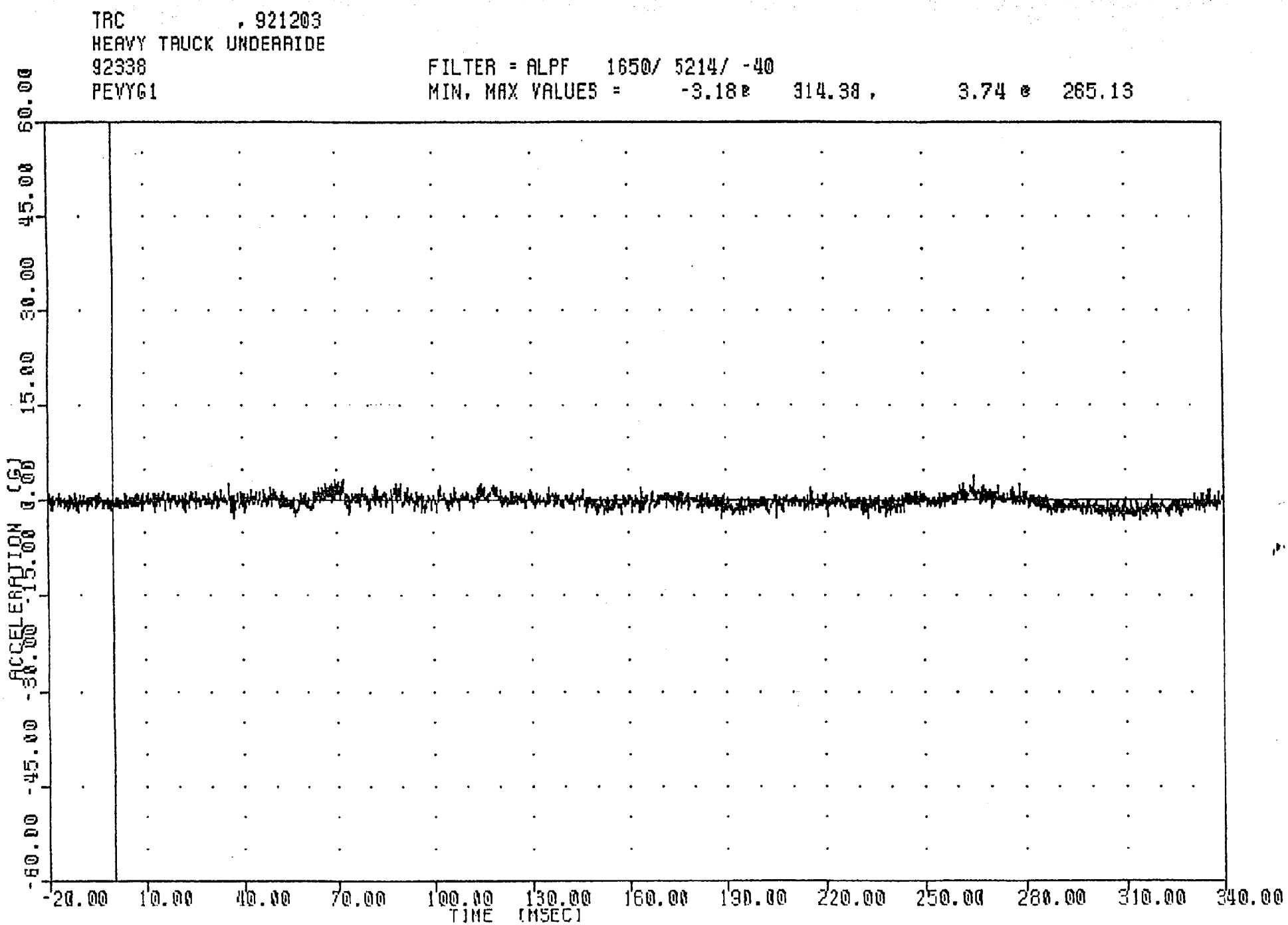
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER CHEST RESULTANT ACCELERATION



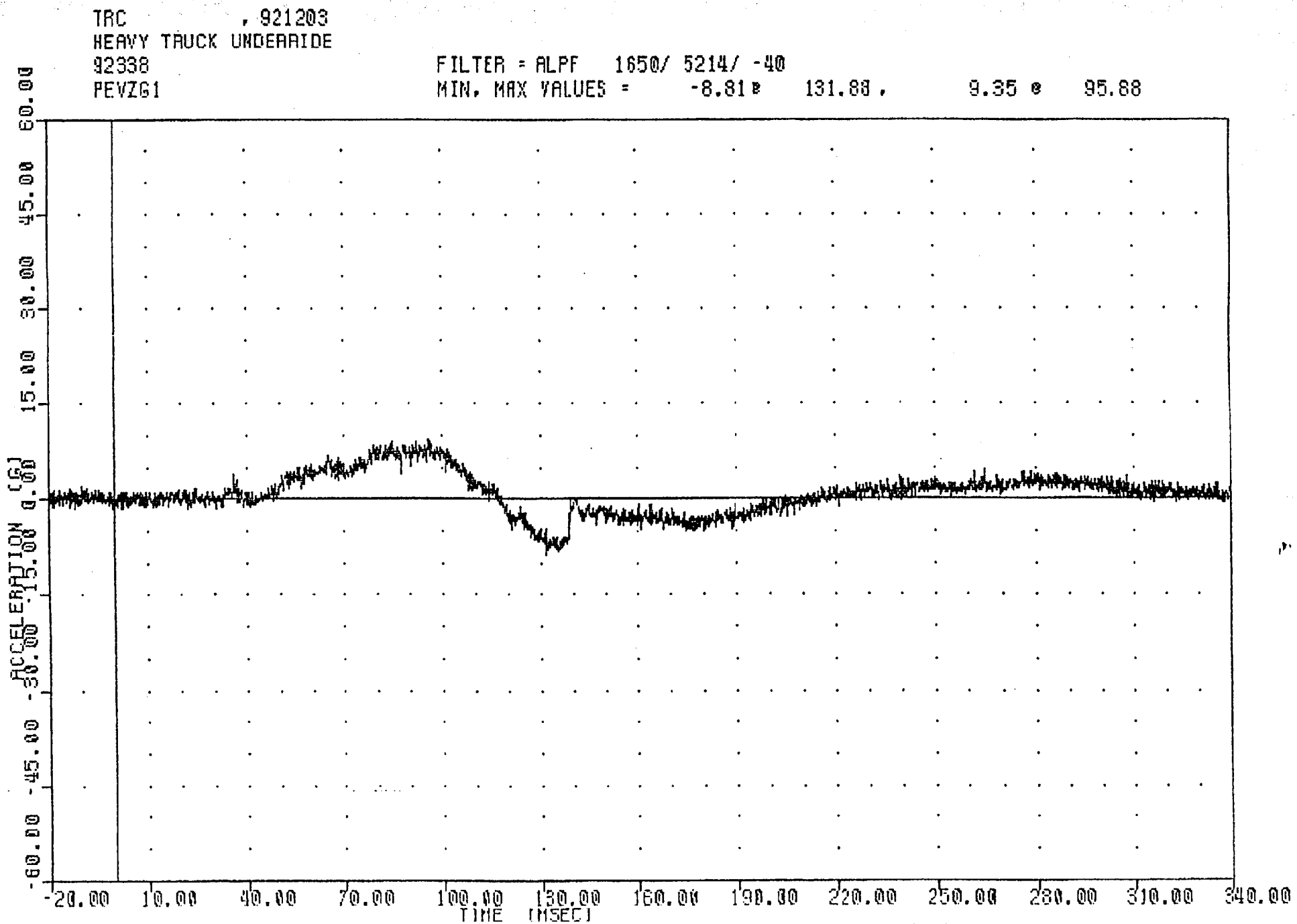
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER CHEST DEFLECTION



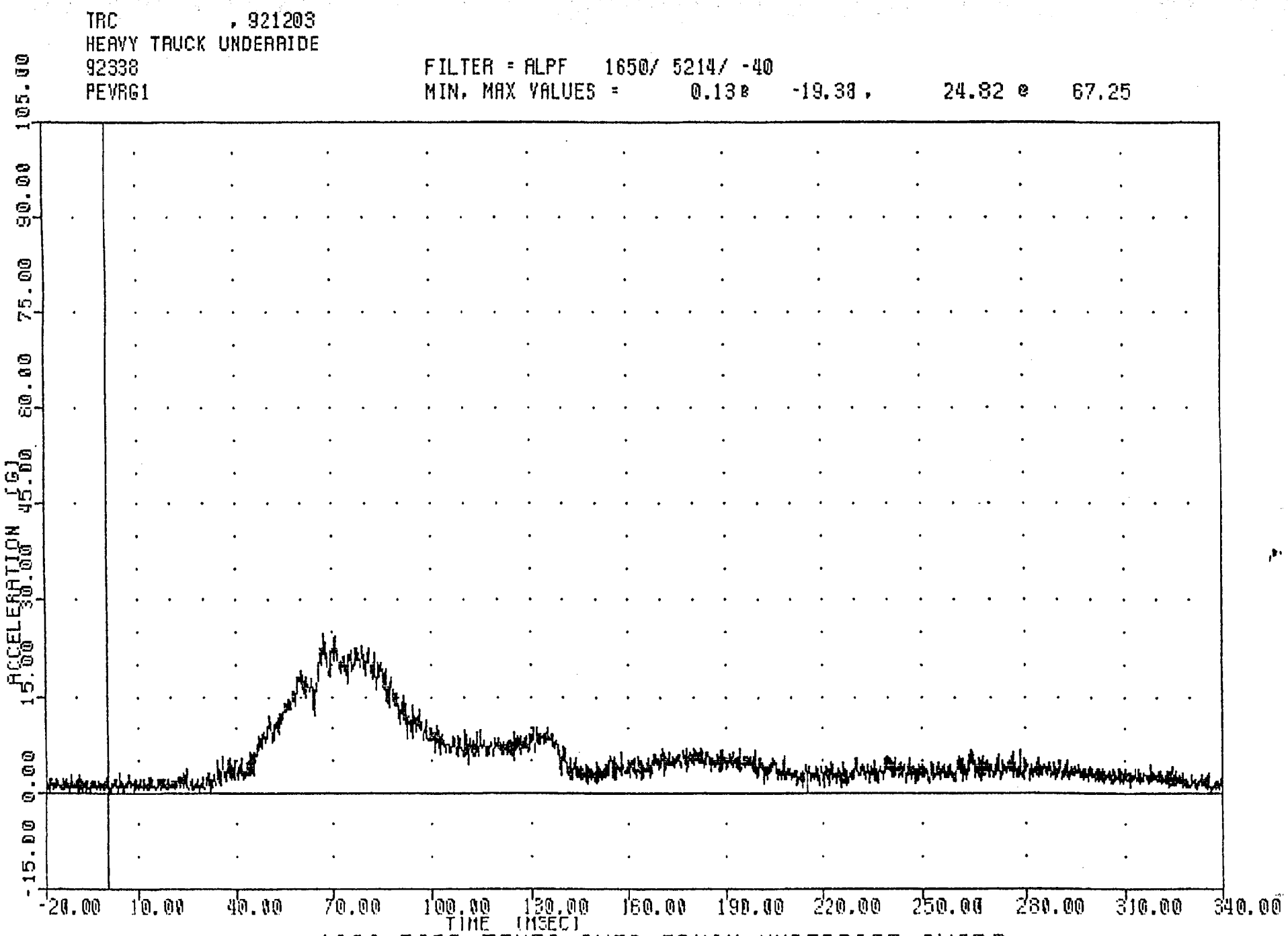
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER PELVIS X-AXIS ACCELERATION



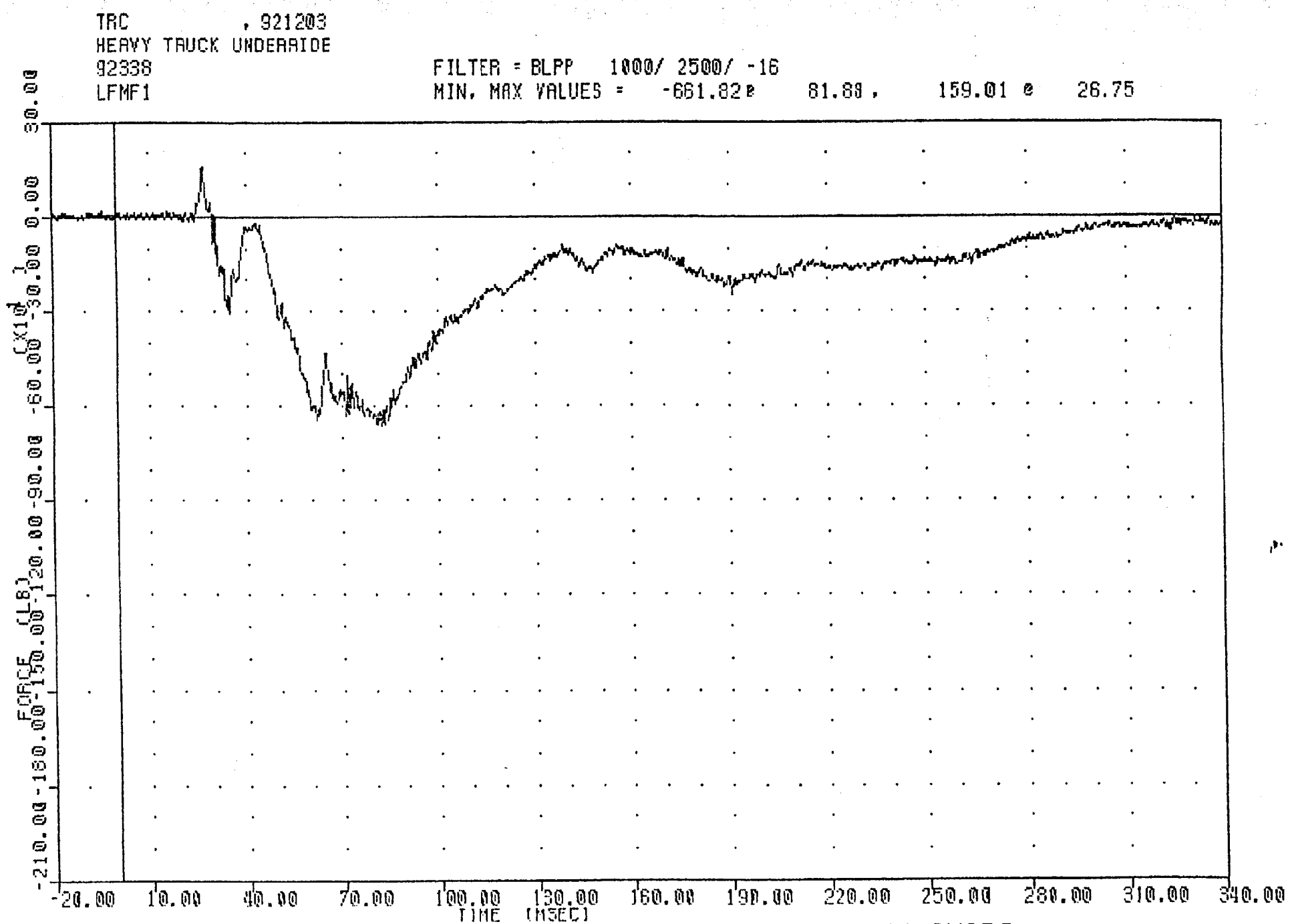
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER PELVIS Y-AXIS ACCELERATION



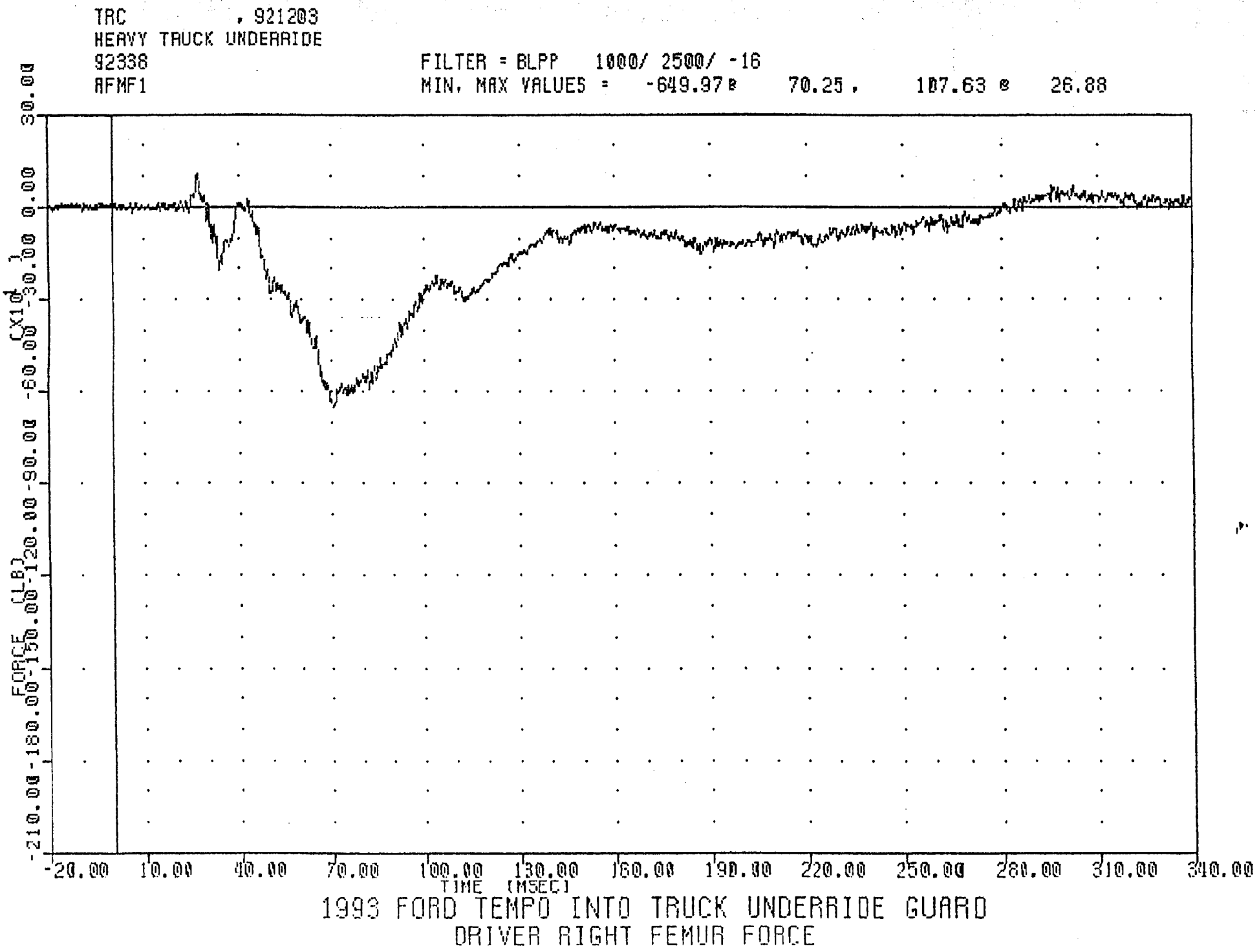
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER PELVIS Z-AXIS ACCELERATION



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER PELVIS RESULTANT ACCELERATION

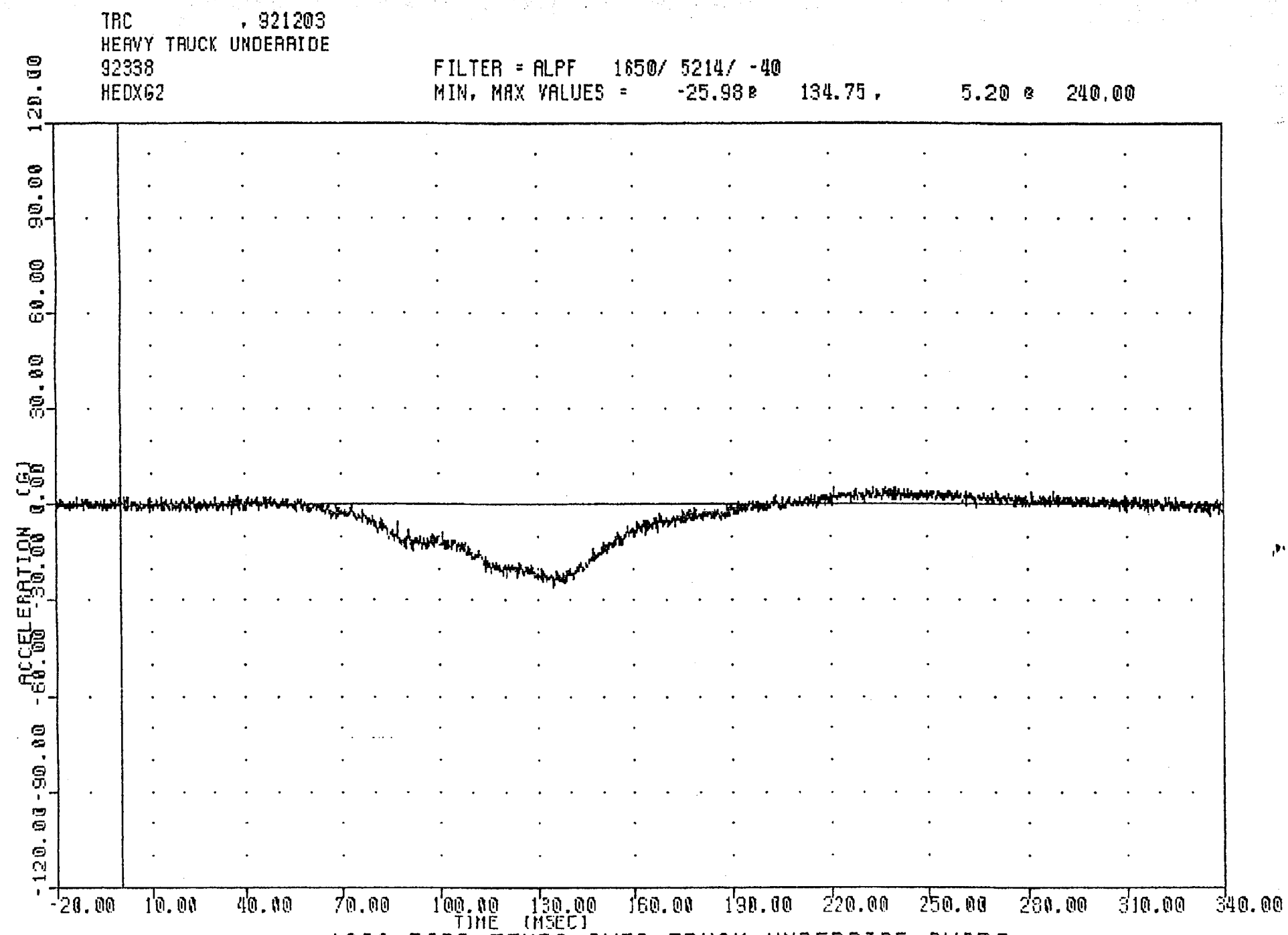


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
DRIVER LEFT FEMUR FORCE

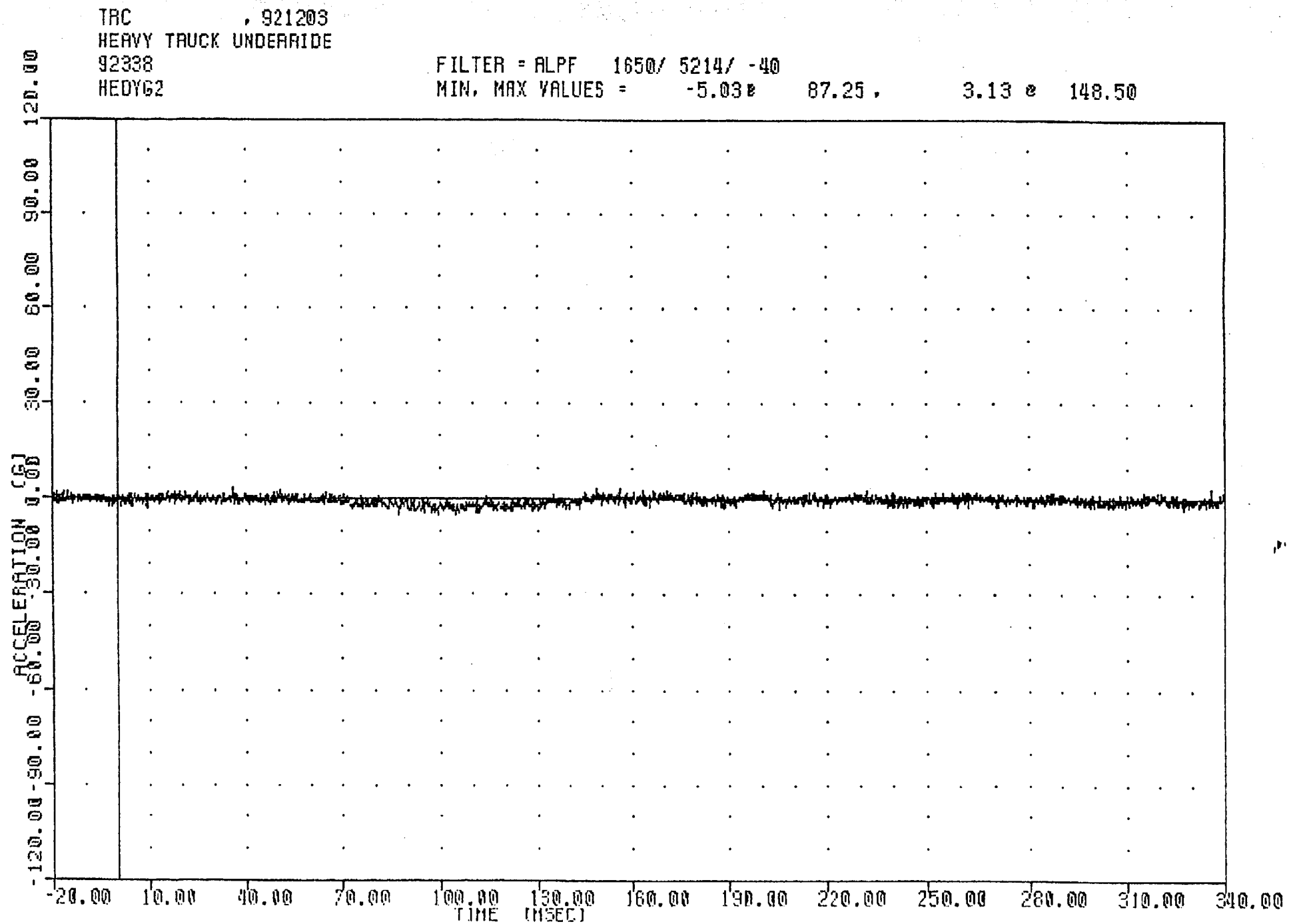


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

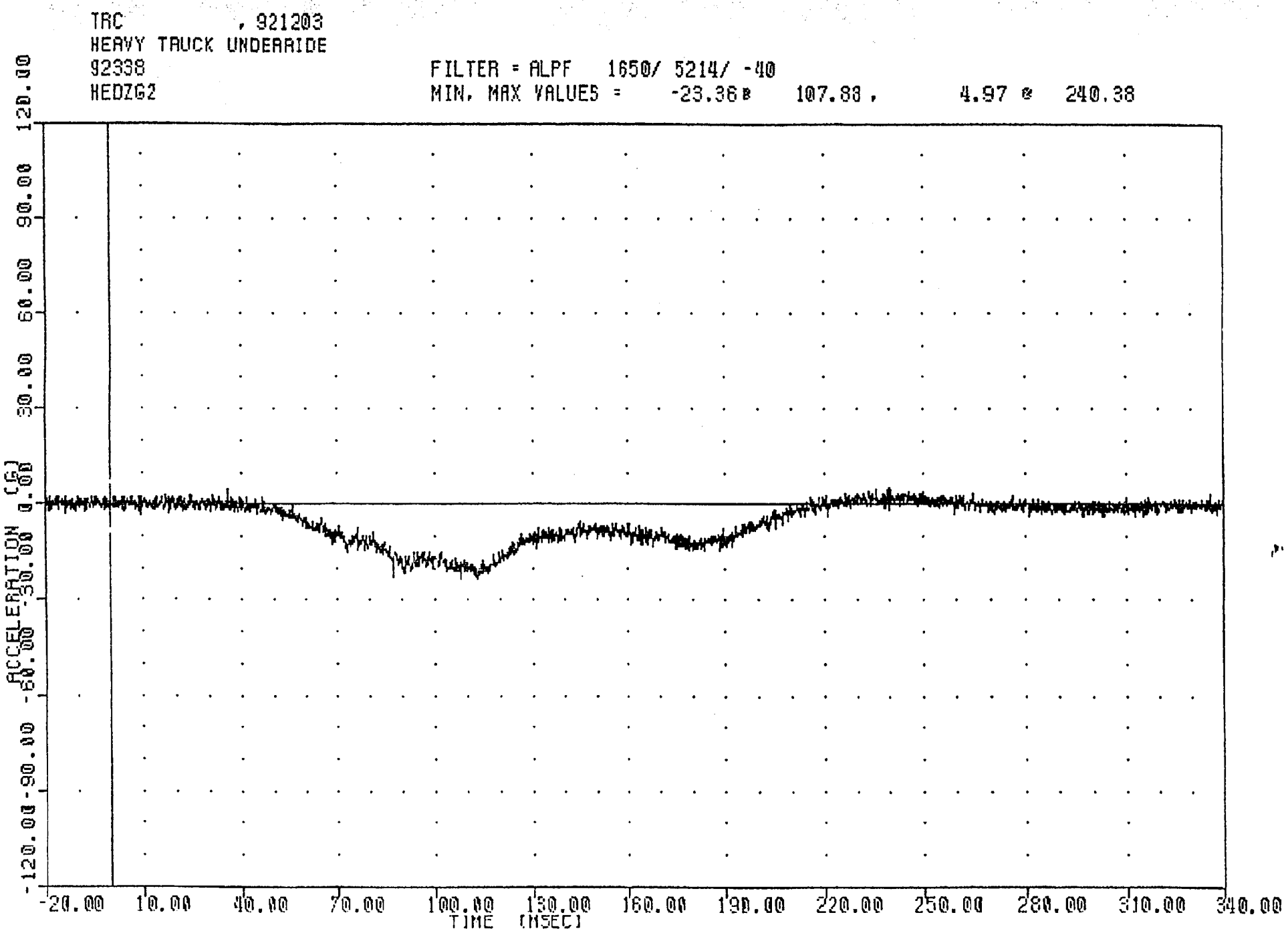
DRIVER RIGHT FEMUR FORCE



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER HEAD X-AXIS ACCELERATION

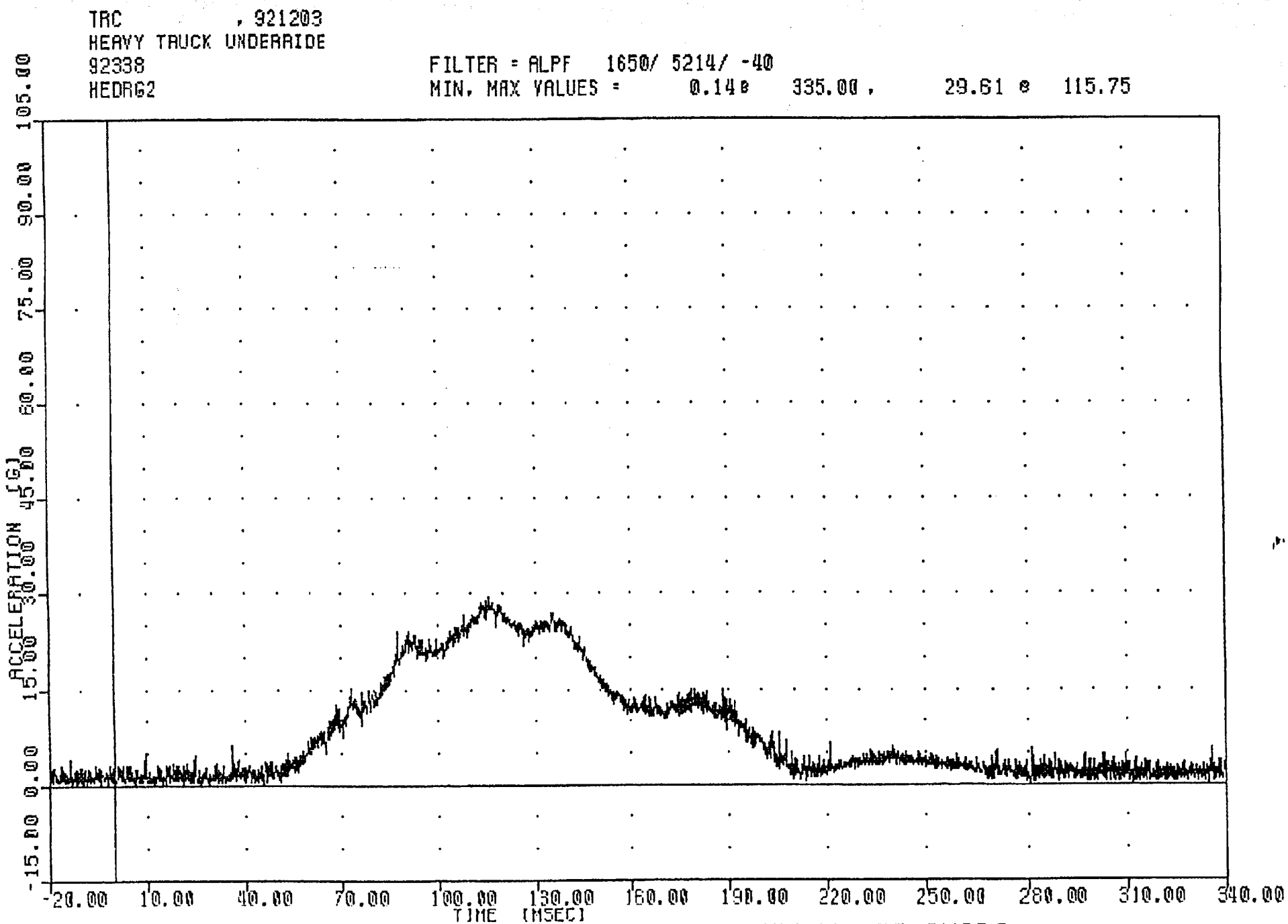


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER HEAD Y-AXIS ACCELERATION

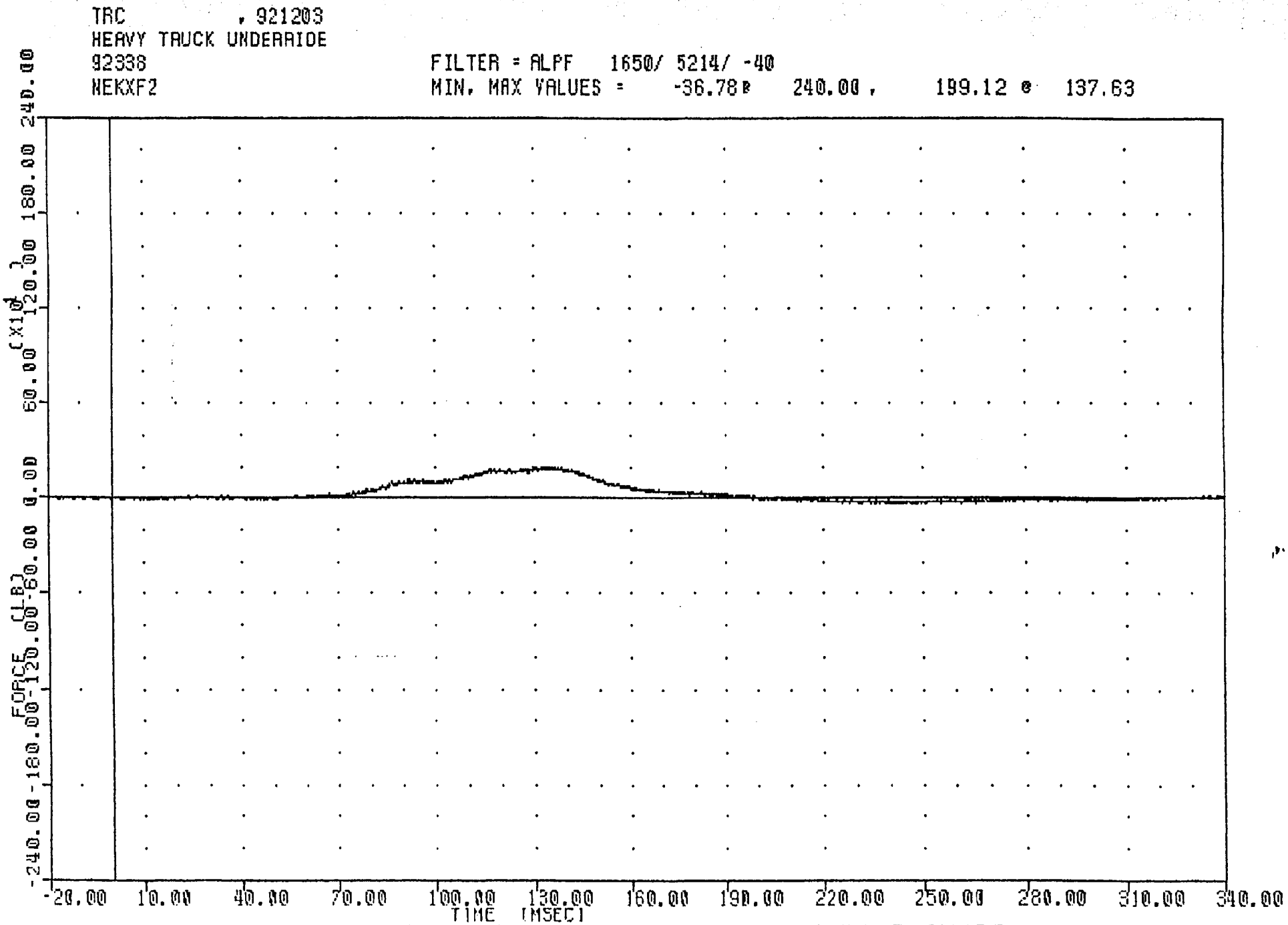


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

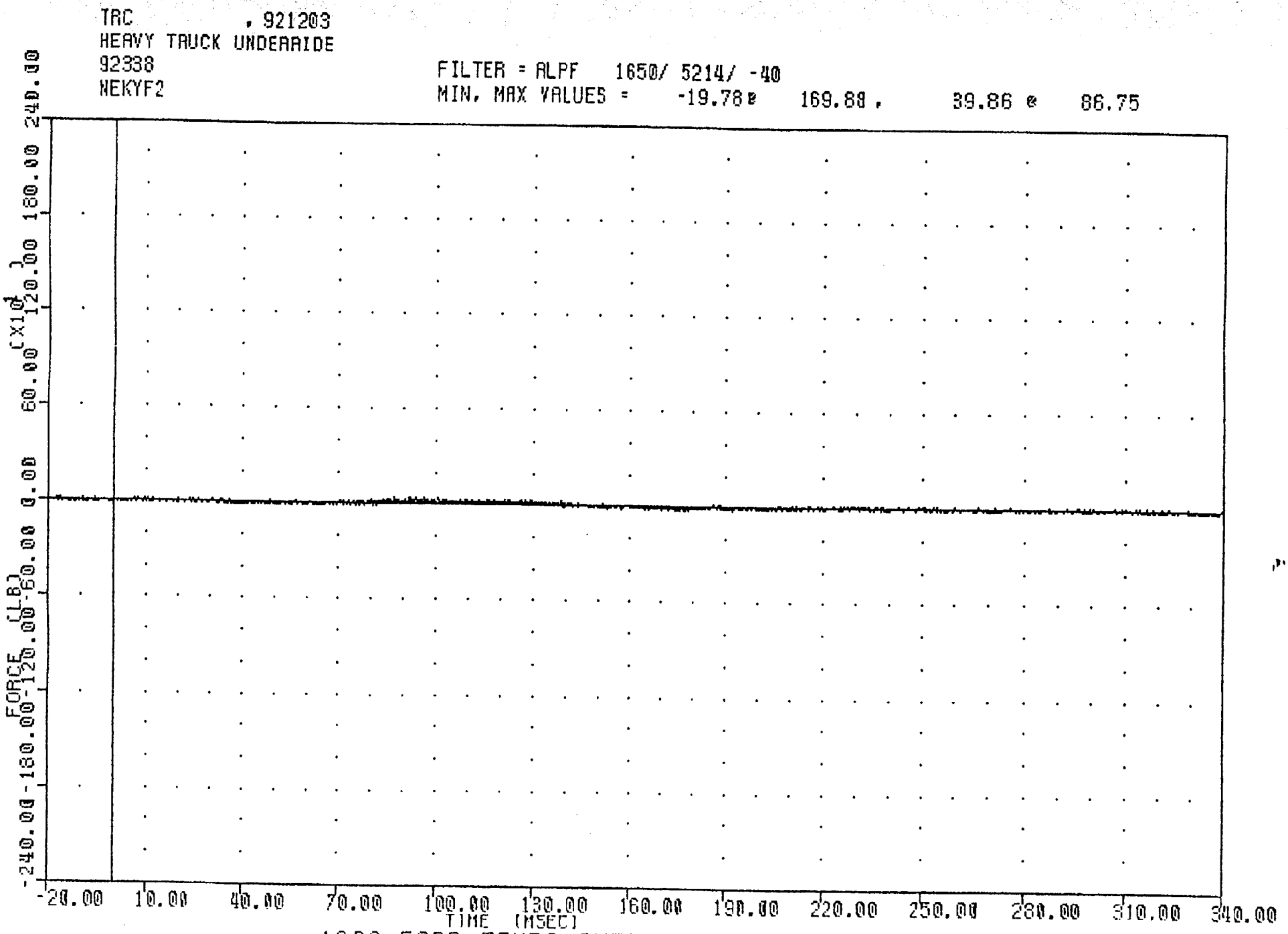
RIGHT FRONT PASSENGER HEAD Z-AXIS ACCELERATION



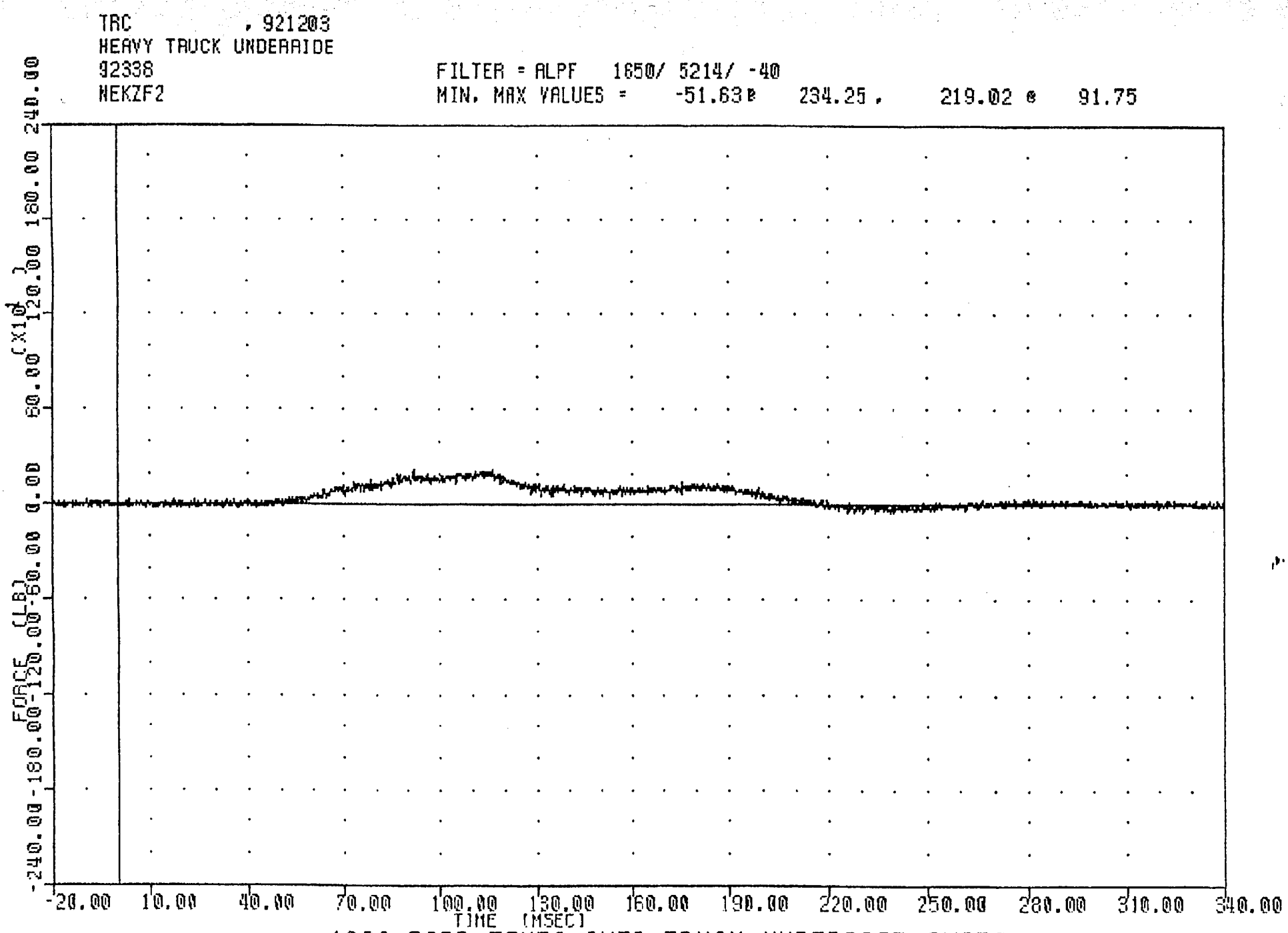
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER HEAD RESULTANT ACCELERATION



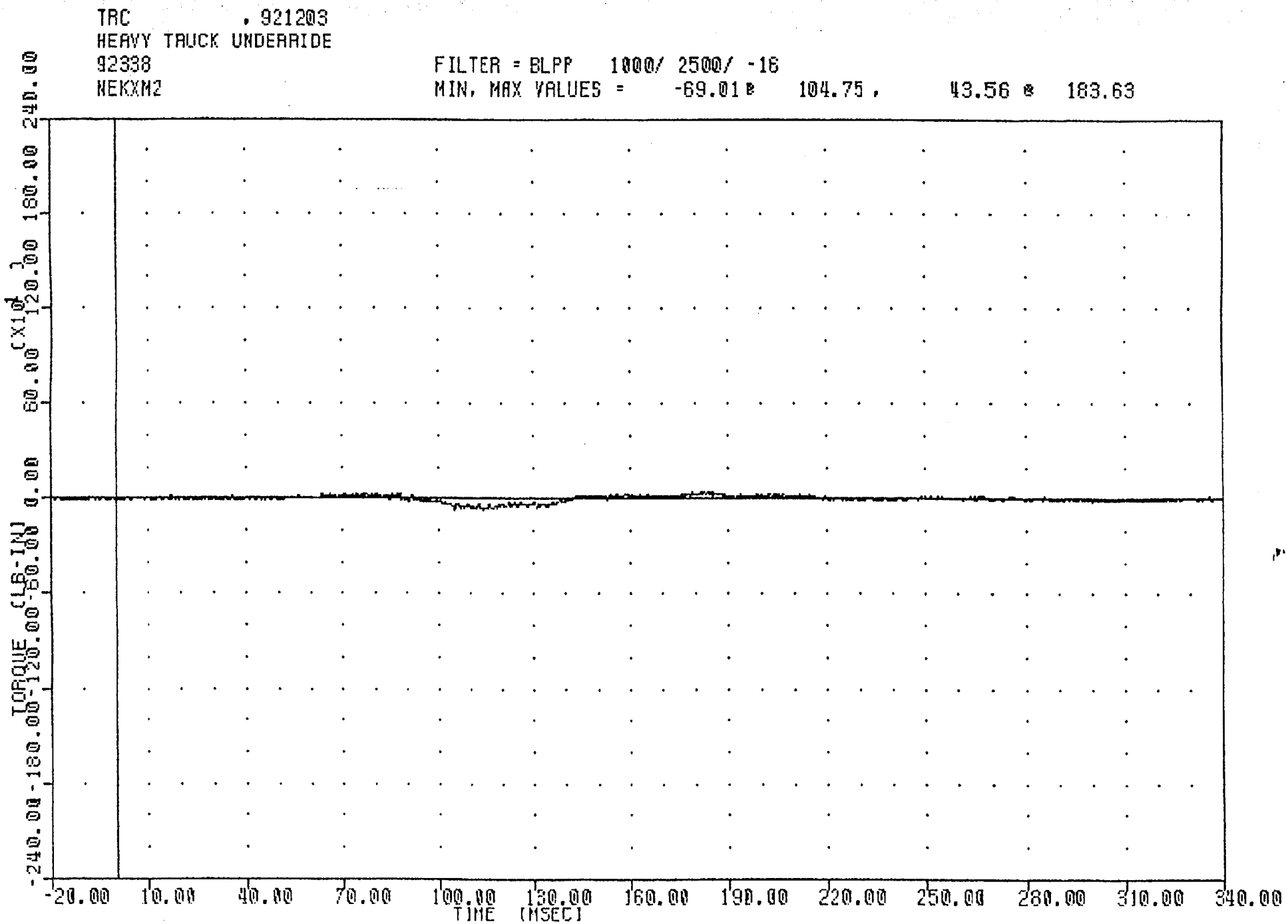
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK X-AXIS SHEAR FORCE



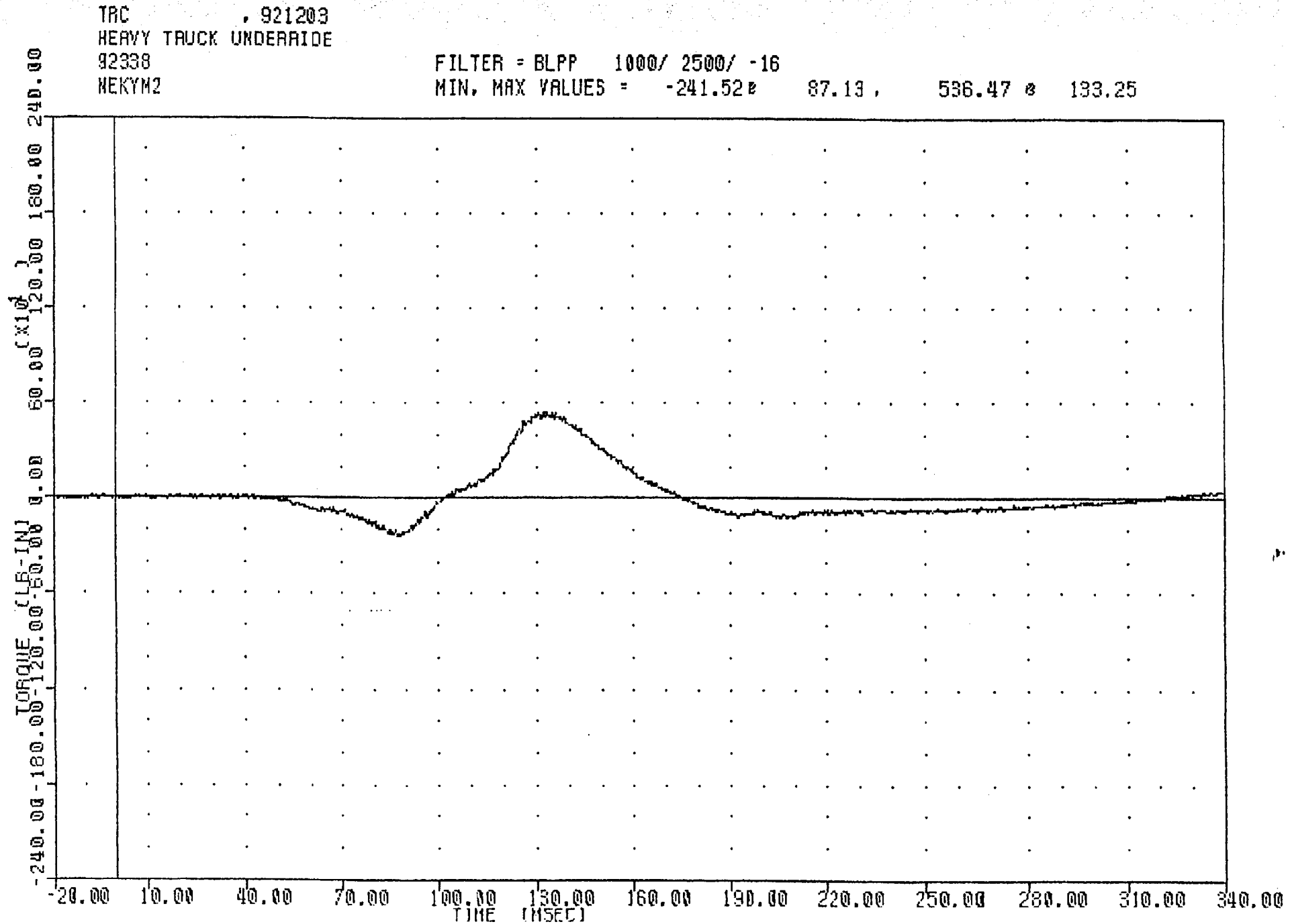
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK Y-AXIS SHEAR FORCE



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK Z-AXIS AXIAL FORCE



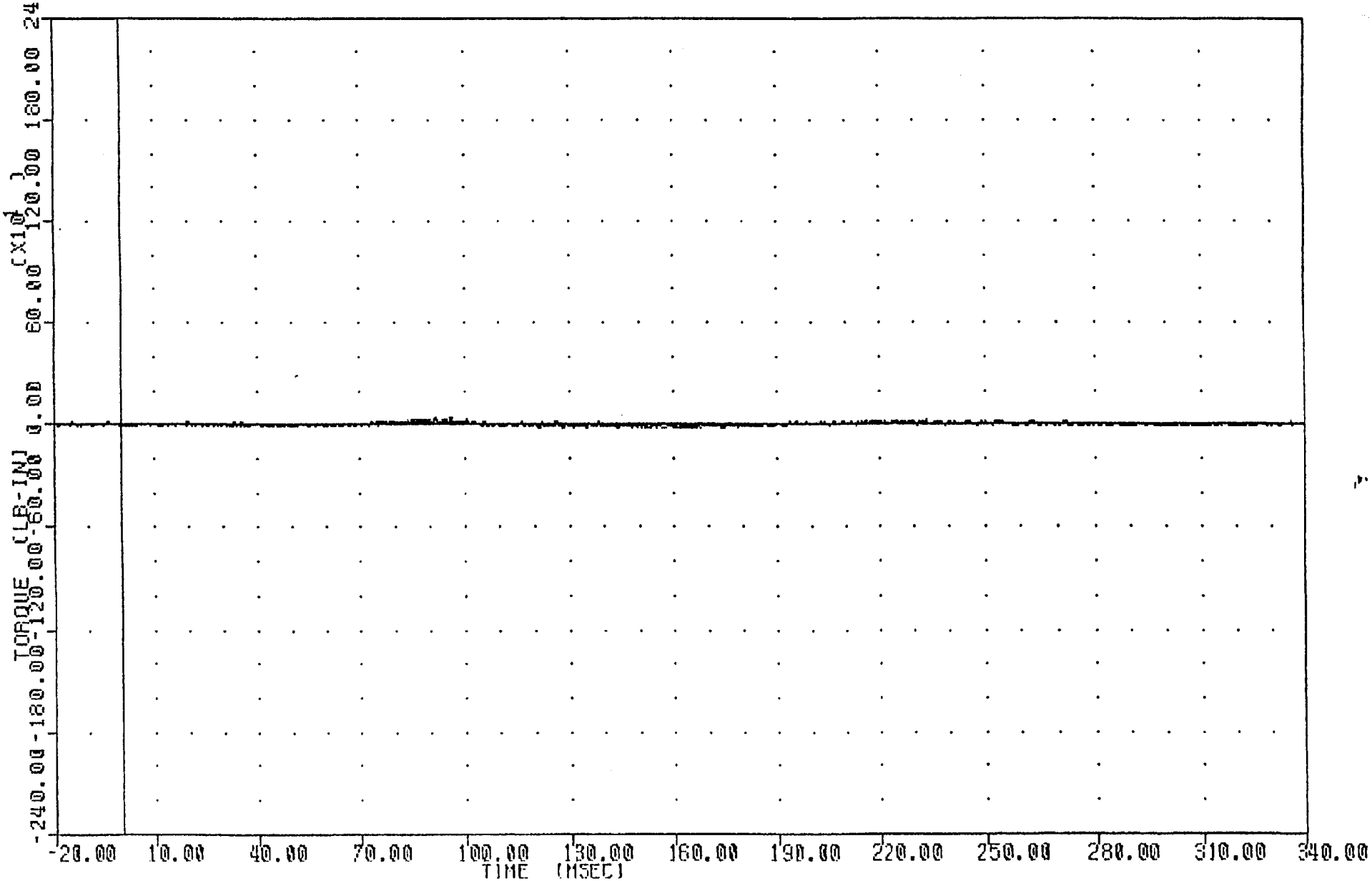
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK MOMENT ABOUT X AXIS



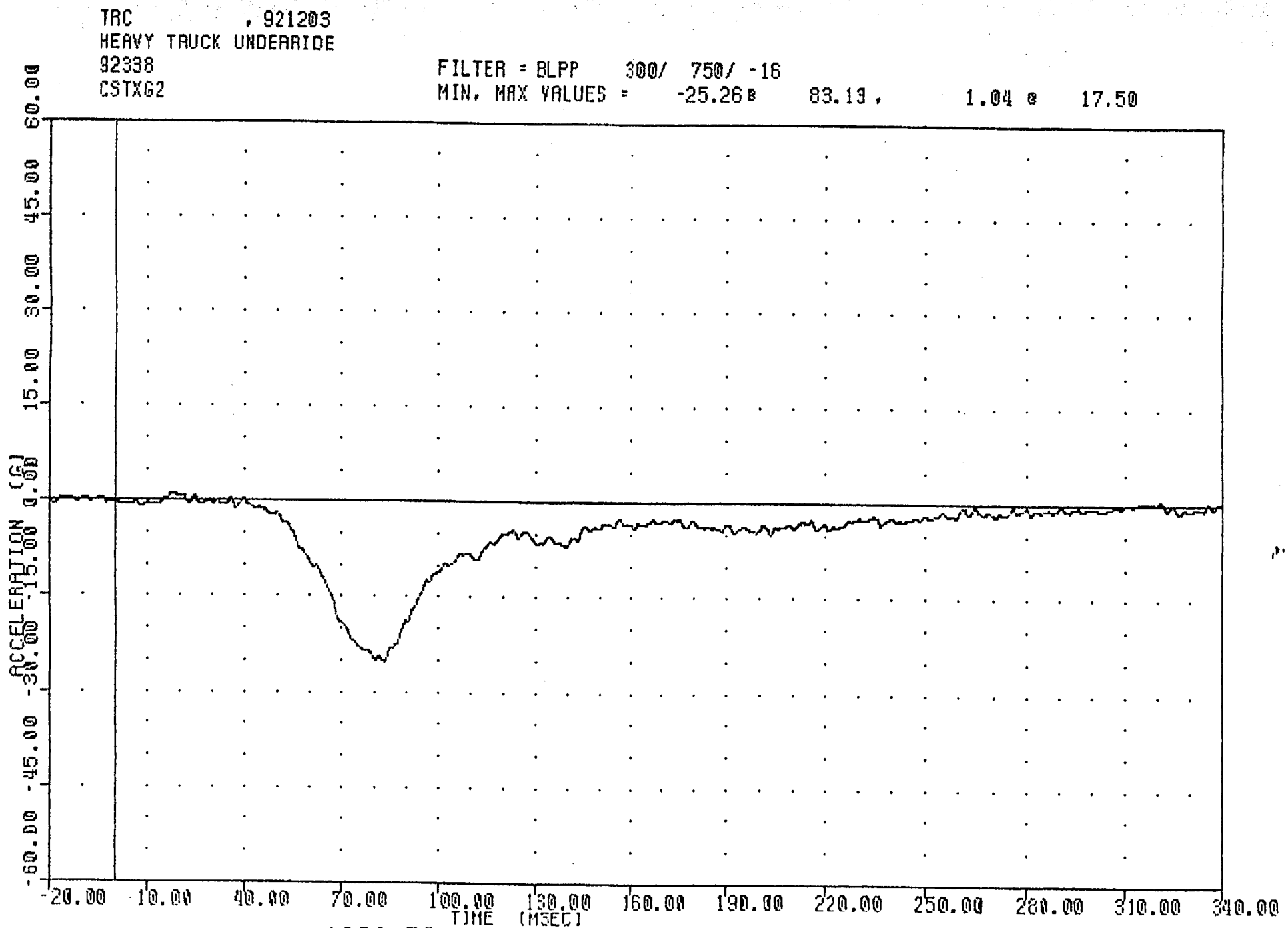
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK MOMENT ABOUT Y AXIS

TRC , 921203
HEAVY TRUCK UNDERRIDE
92338
NEKZM2

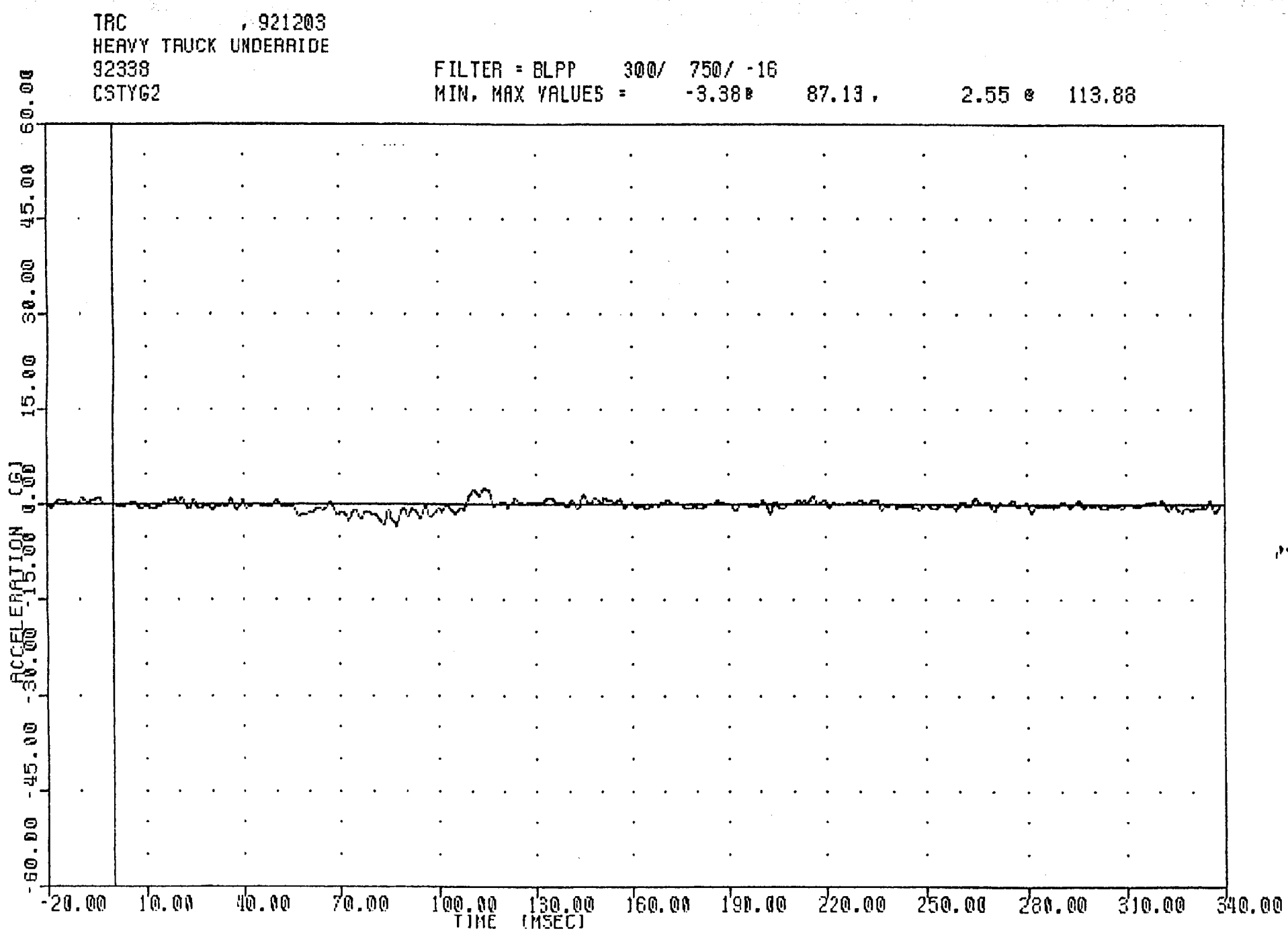
FILTER = BLPP 1000/ 2500/ -16
MIN, MAX VALUES = -27.95 @ 156.50 , 41.09 @ 91.50



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER NECK MOMENT ABOUT Z AXIS

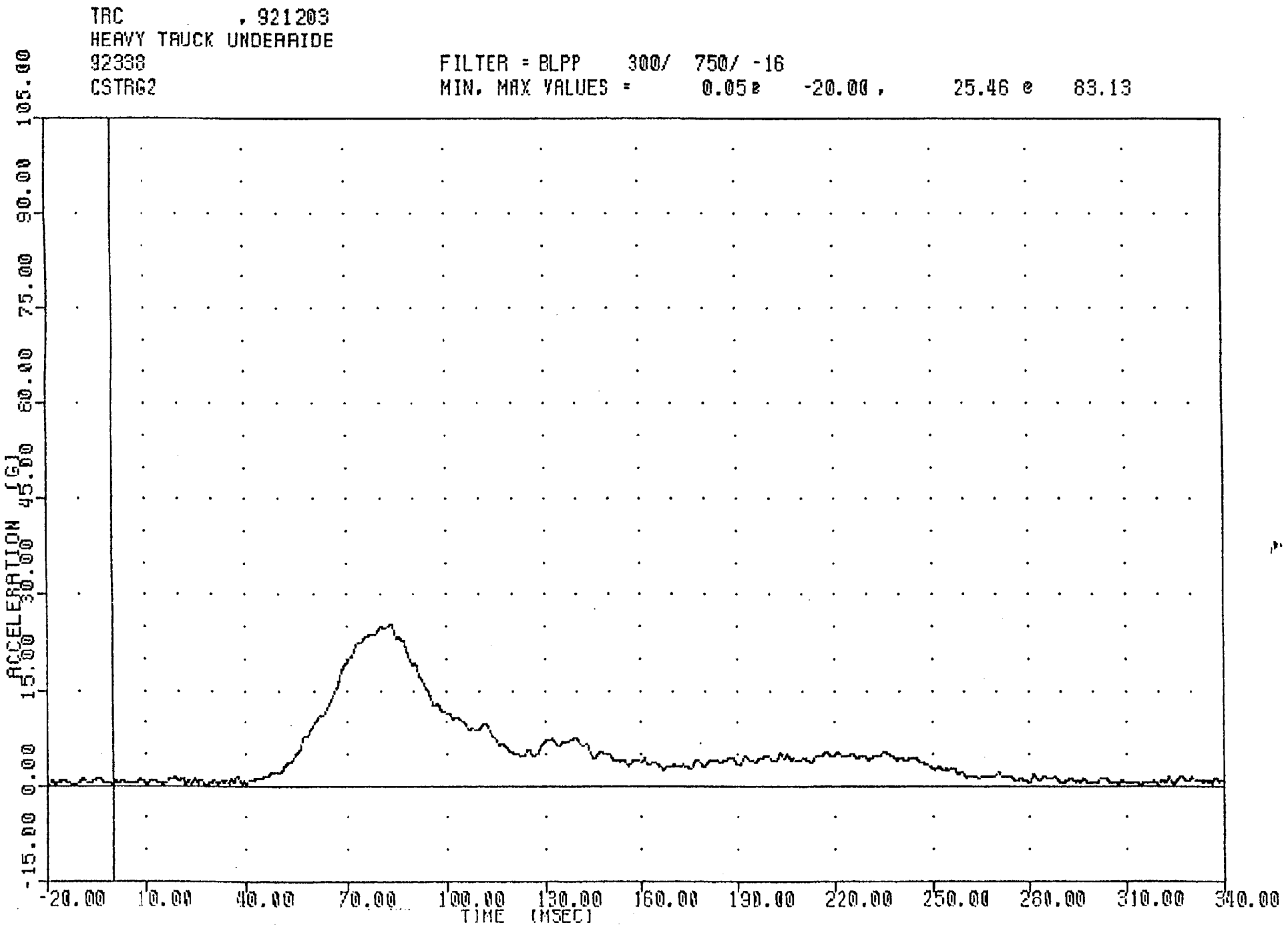


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER CHEST X-AXIS ACCELERATION



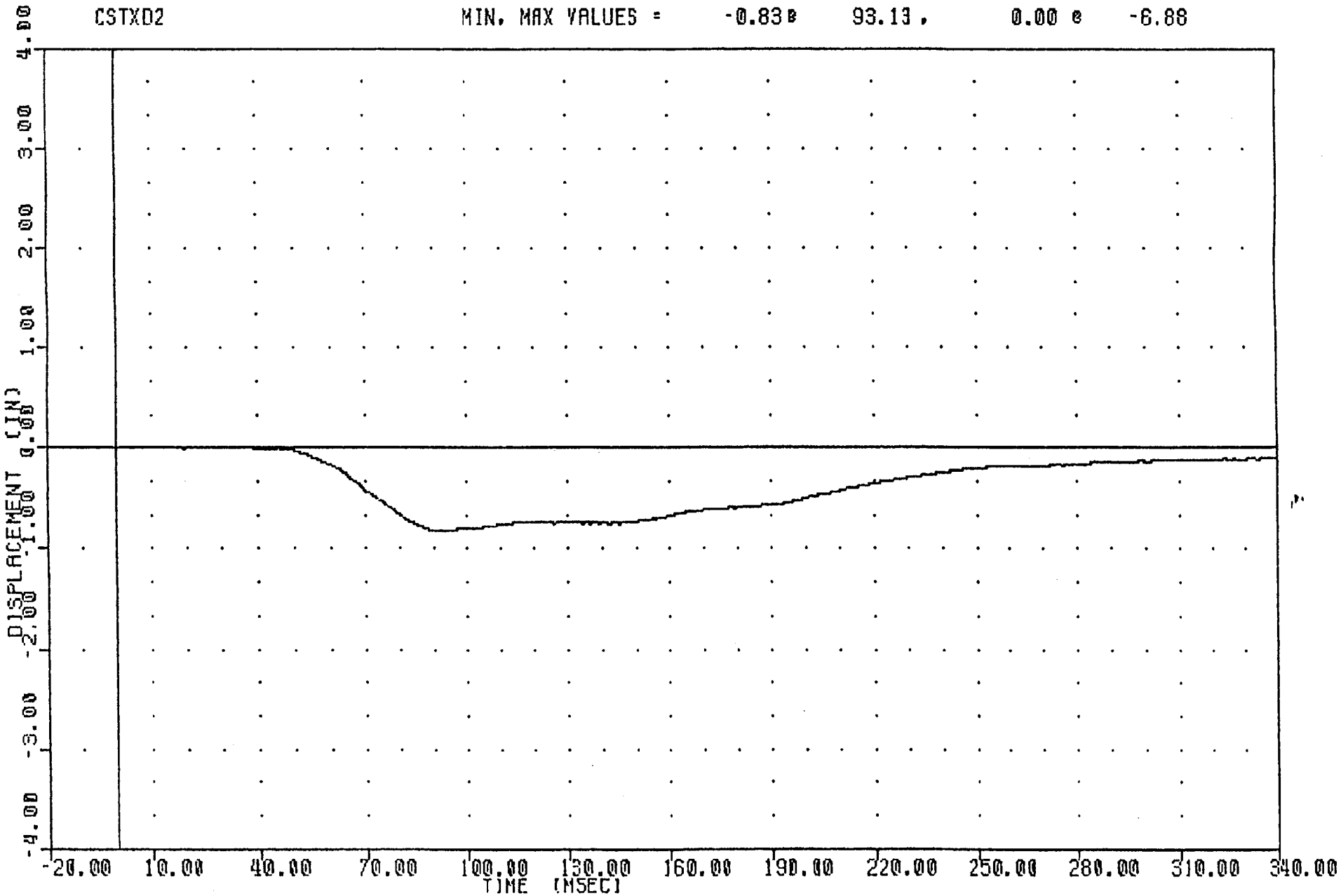
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

RIGHT FRONT PASSENGER CHEST Y-AXIS ACCELERATION

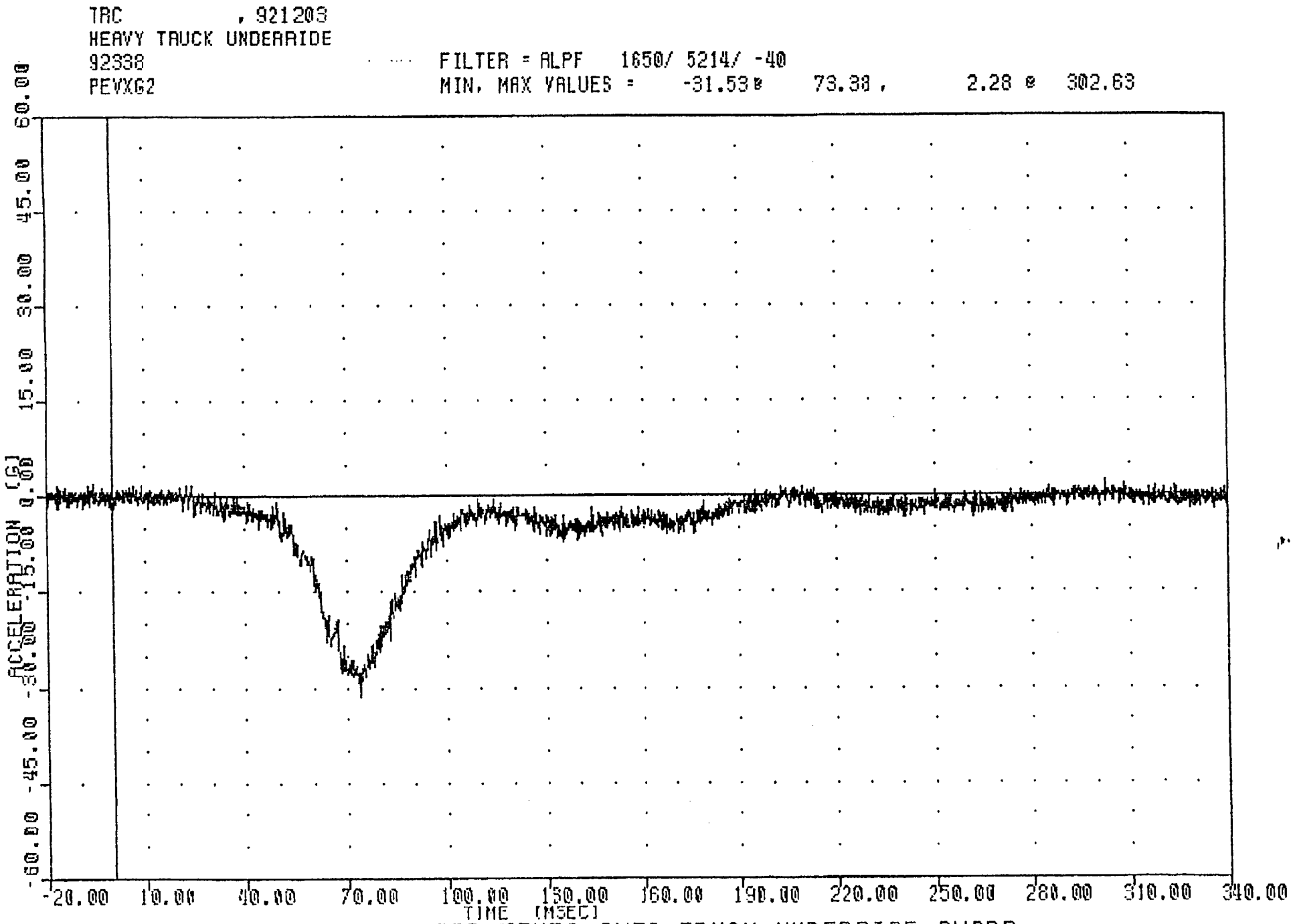


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

RIGHT FRONT PASSENGER CHEST RESULTANT ACCELERATION

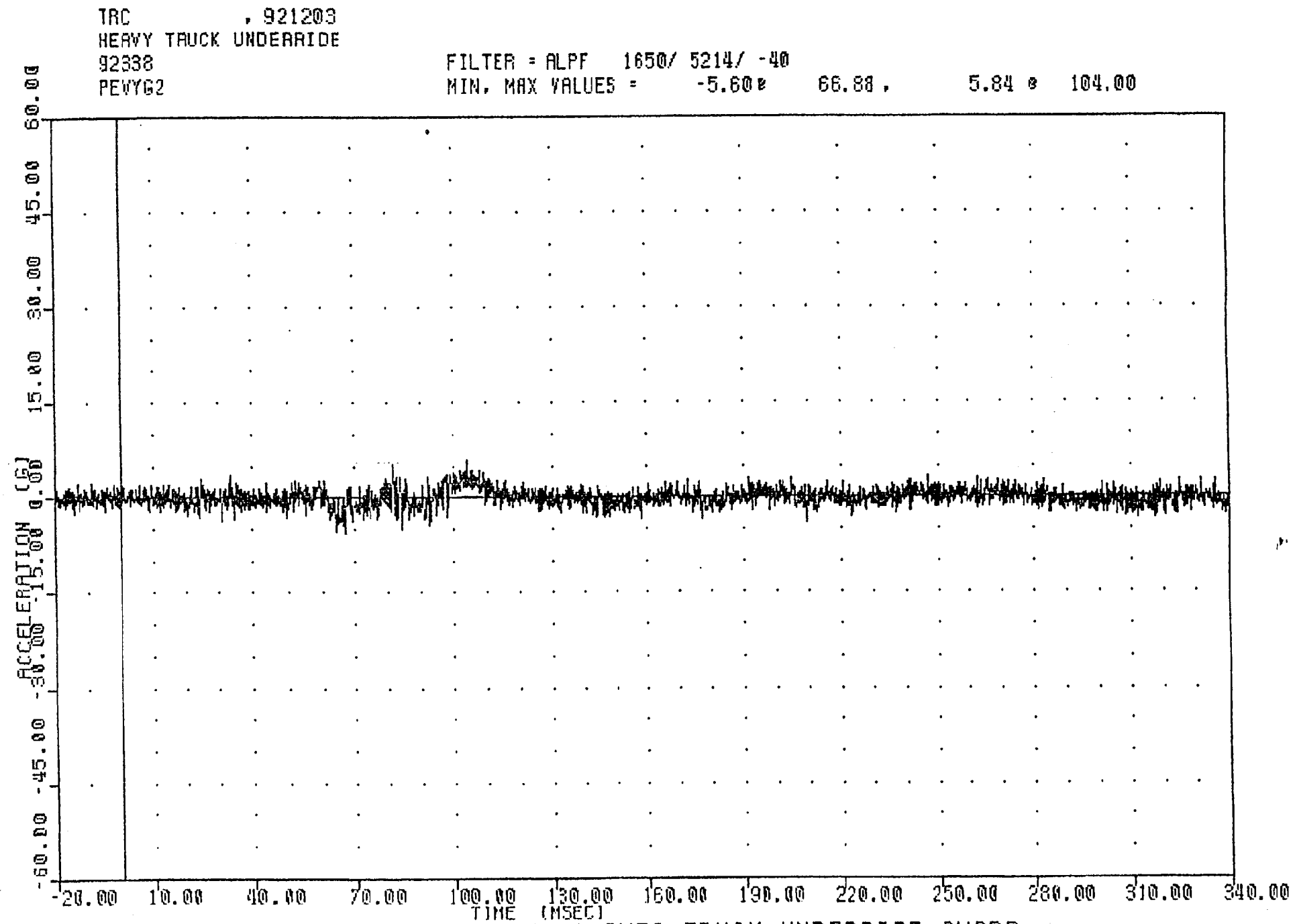


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER CHEST DEFLECTION



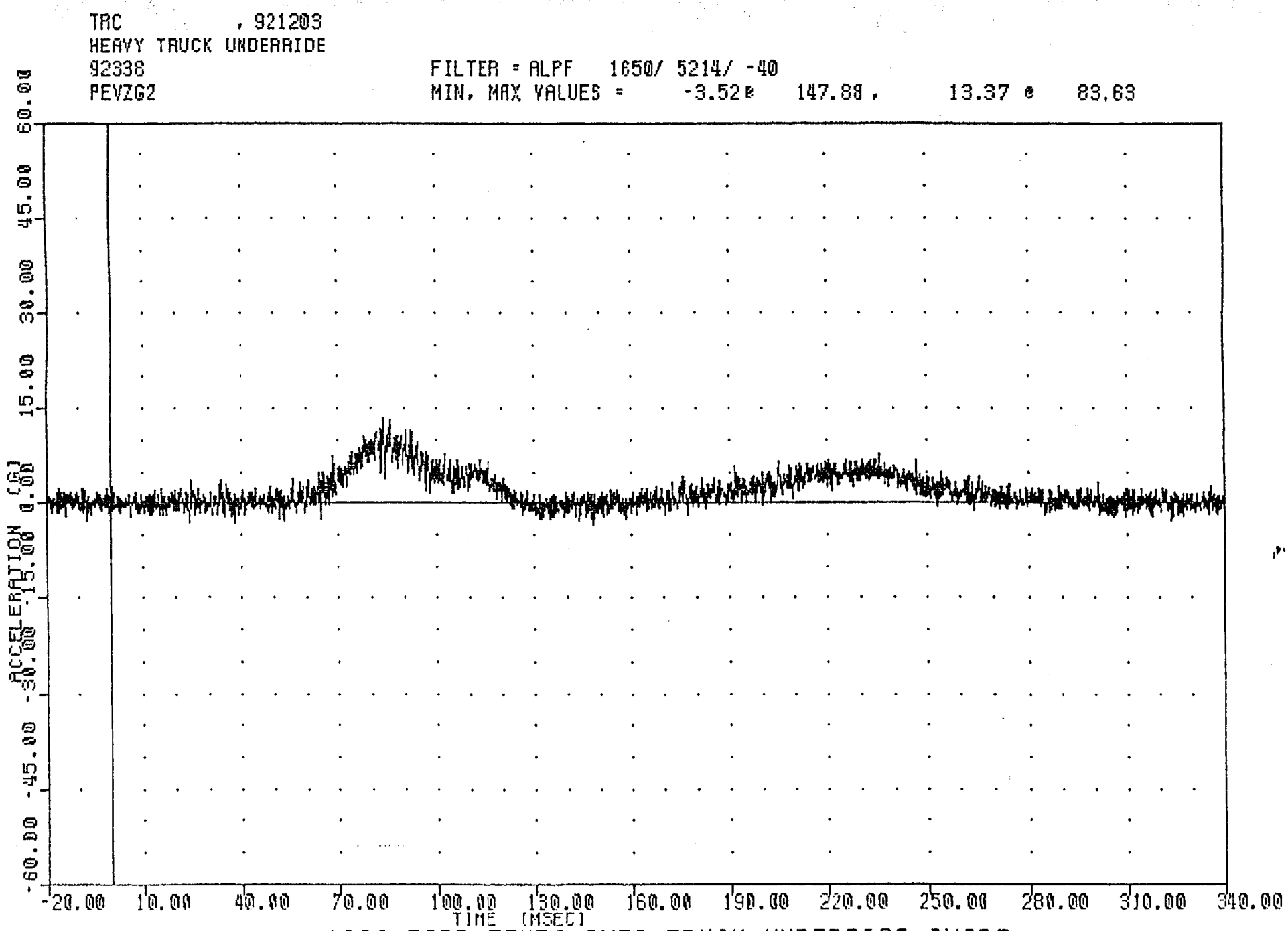
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

RIGHT FRONT PASSENGER PELVIS X-AXIS ACCELERATION

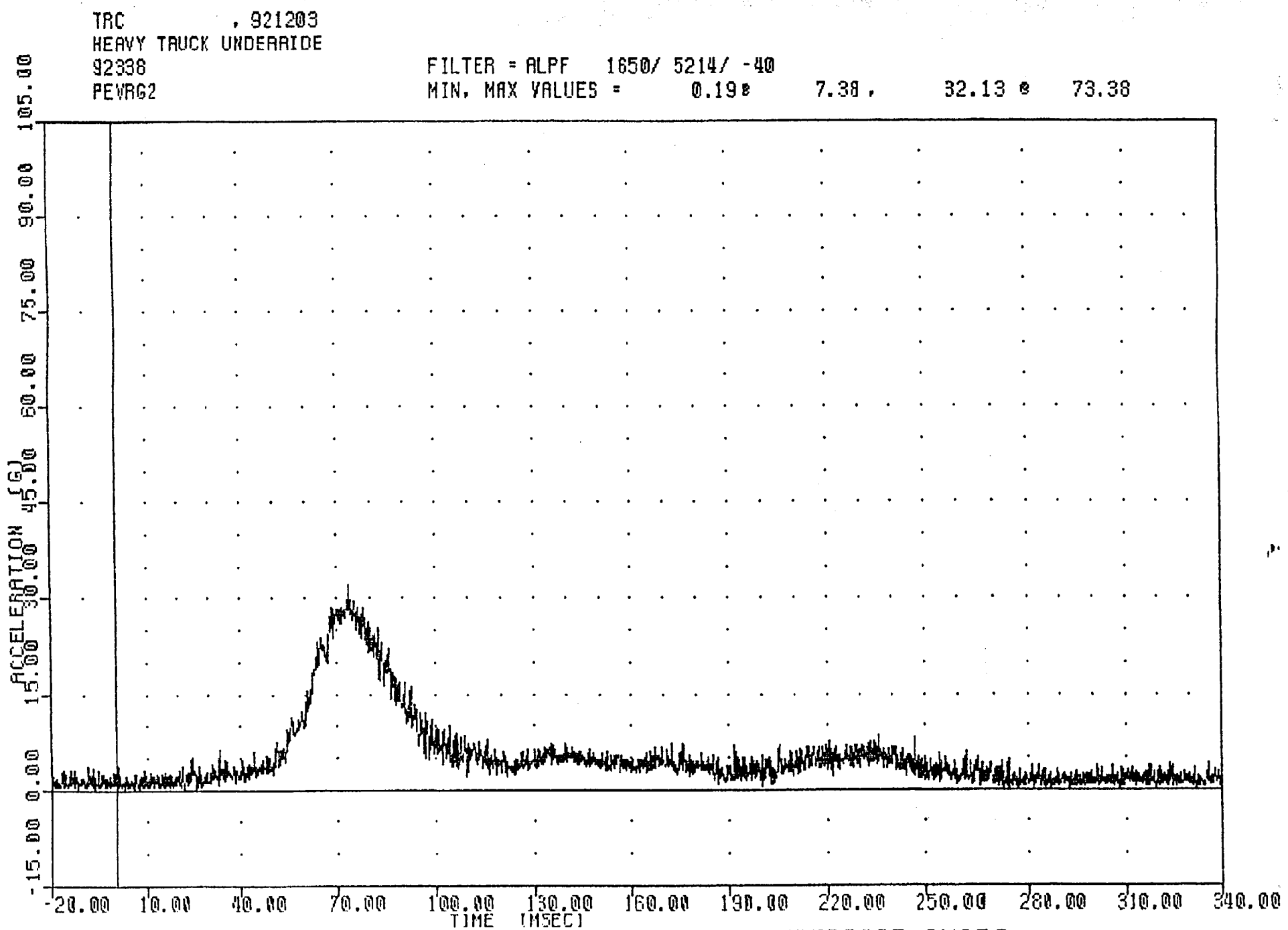


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

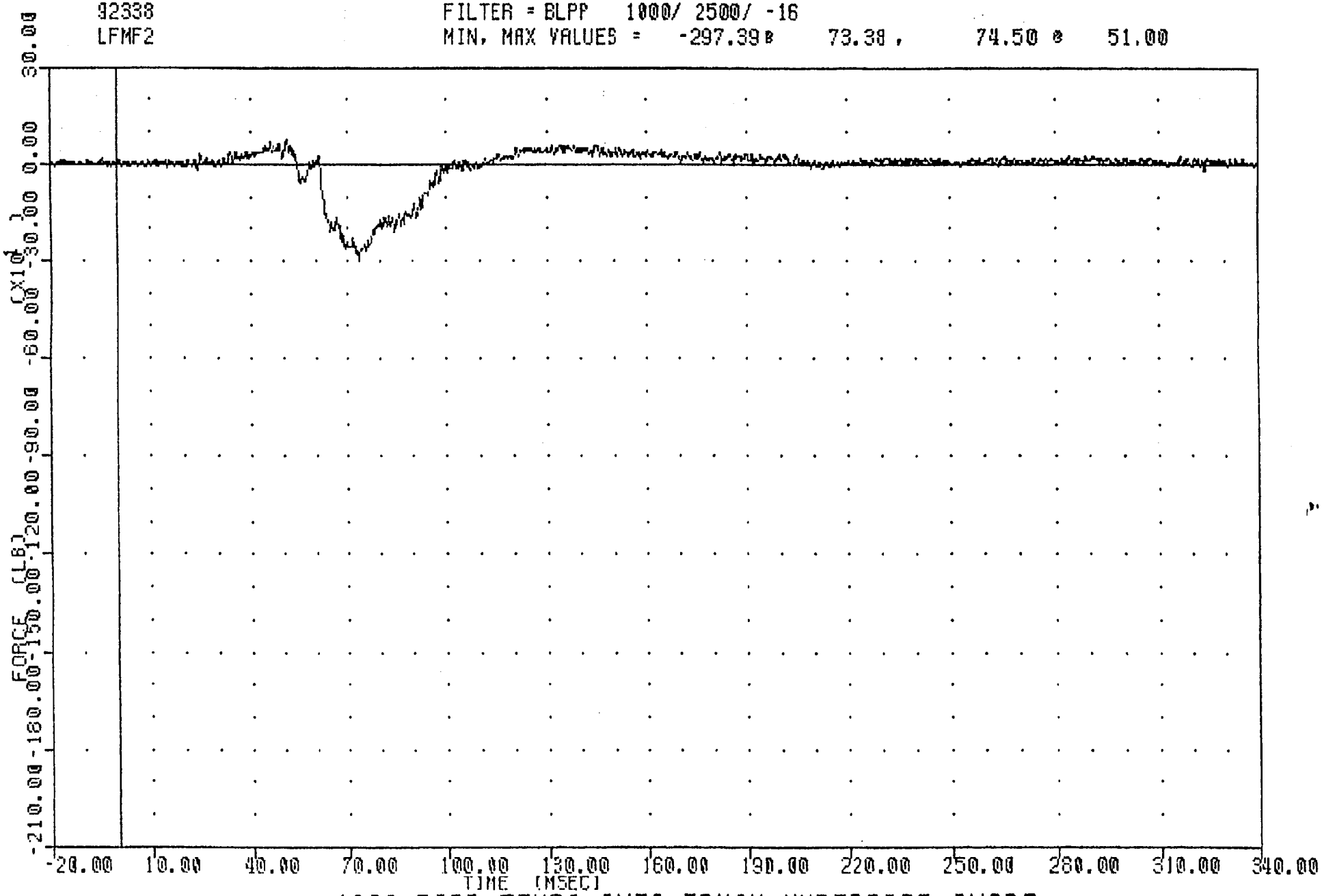
RIGHT FRONT PASSENGER PELVIS Y-AXIS ACCELERATION



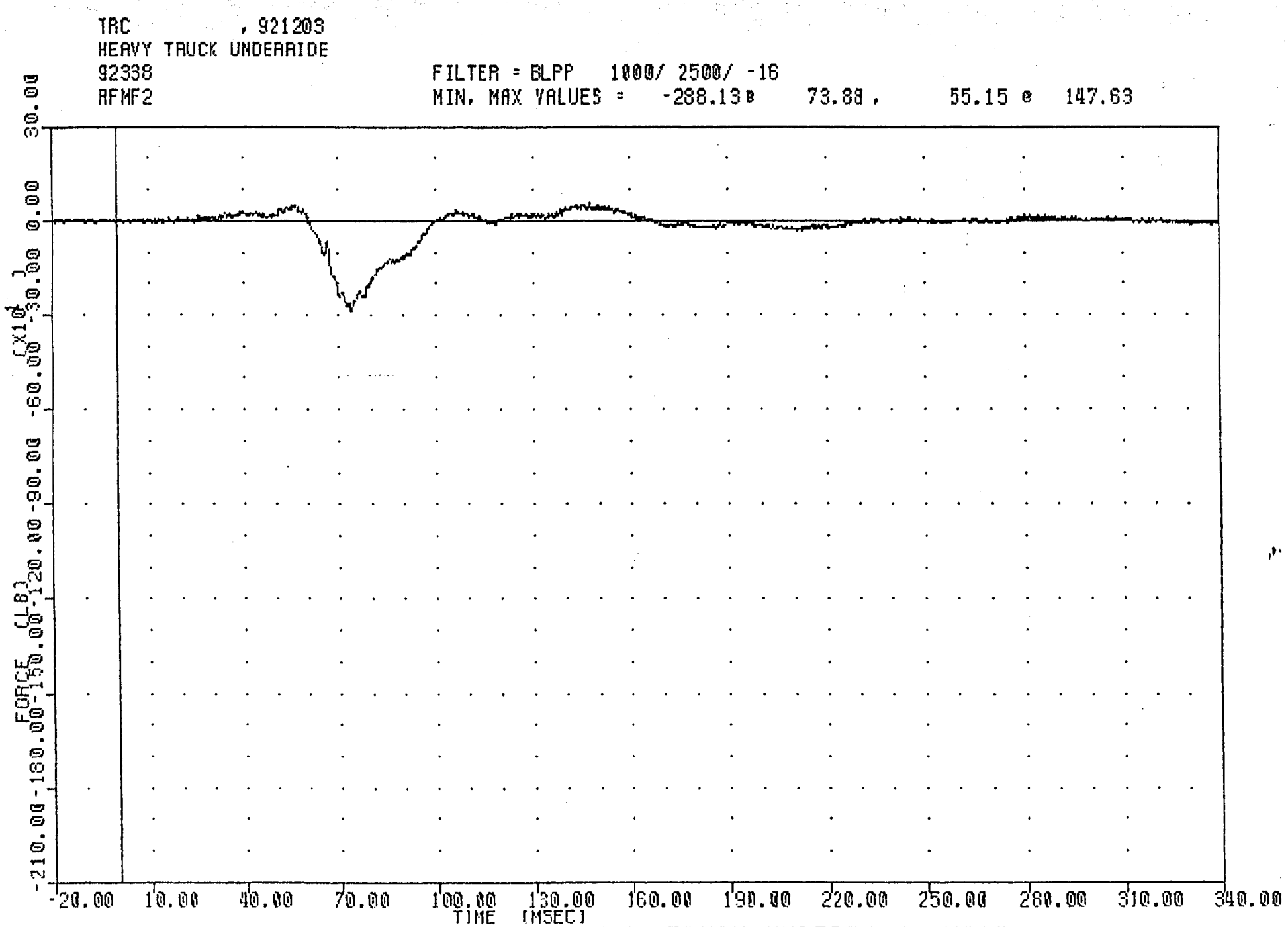
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER PELVIS Z-AXIS ACCELERATION



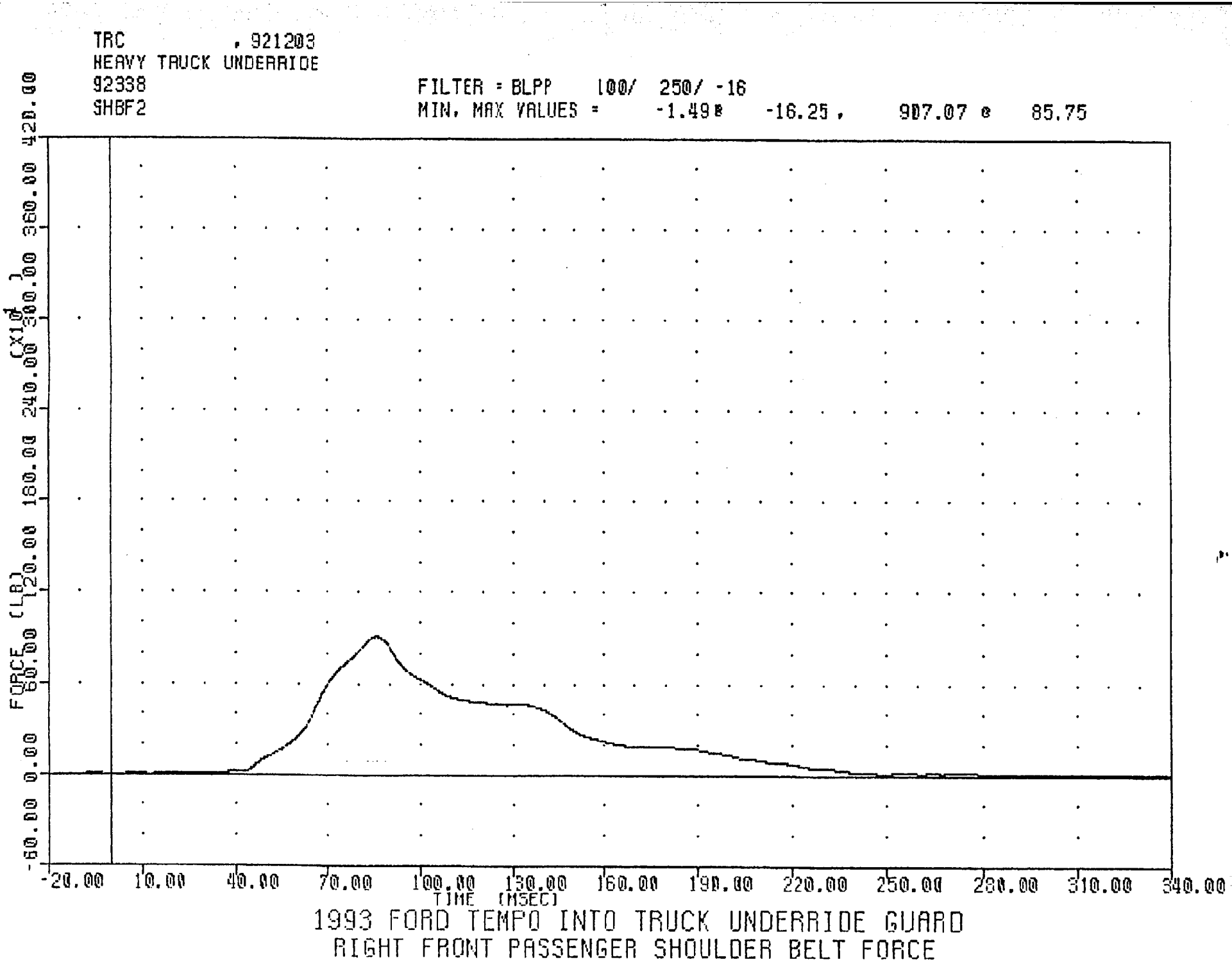
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER PELVIS RESULTANT ACCELERATION



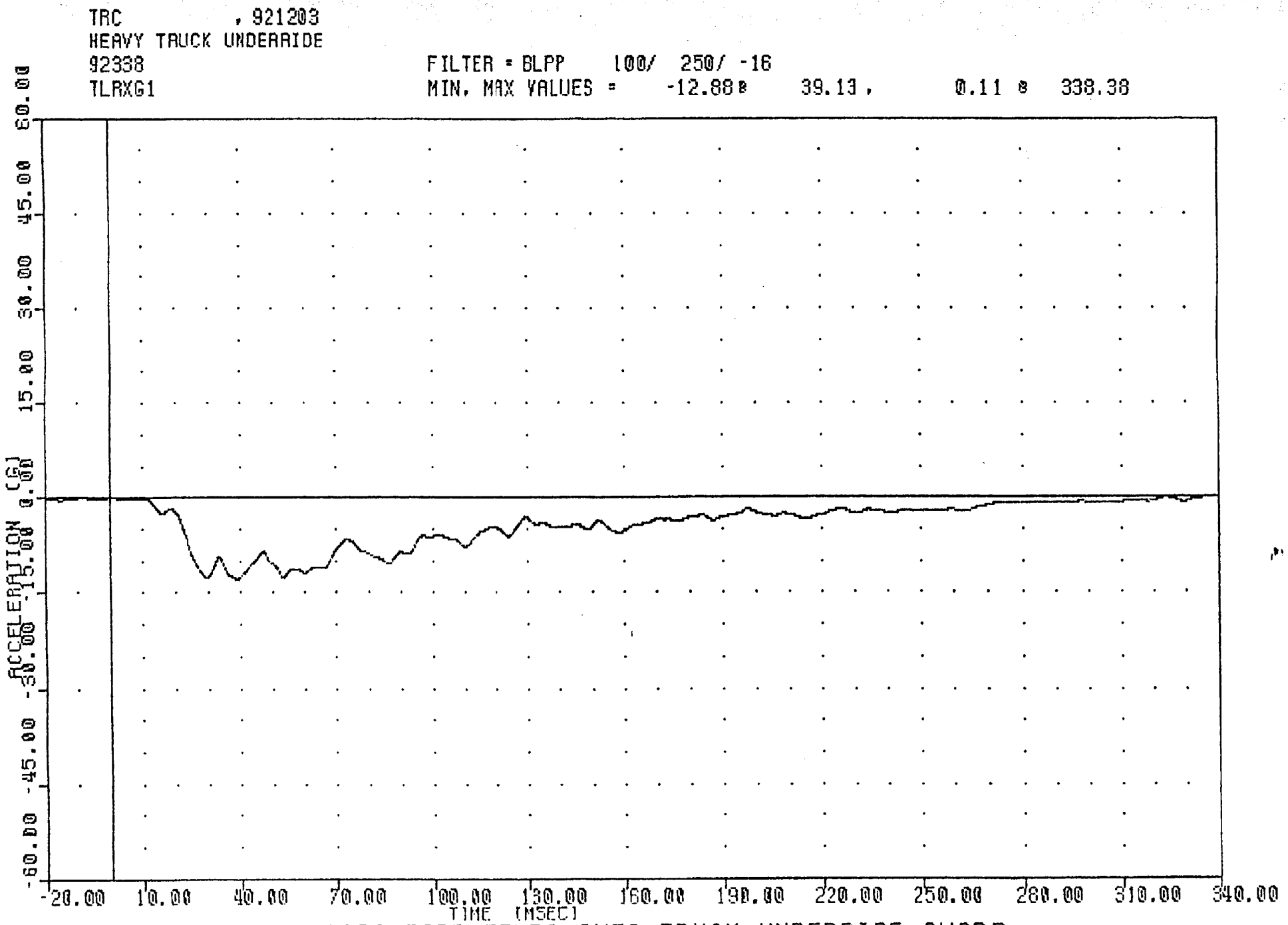
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER LEFT FEMUR FORCE



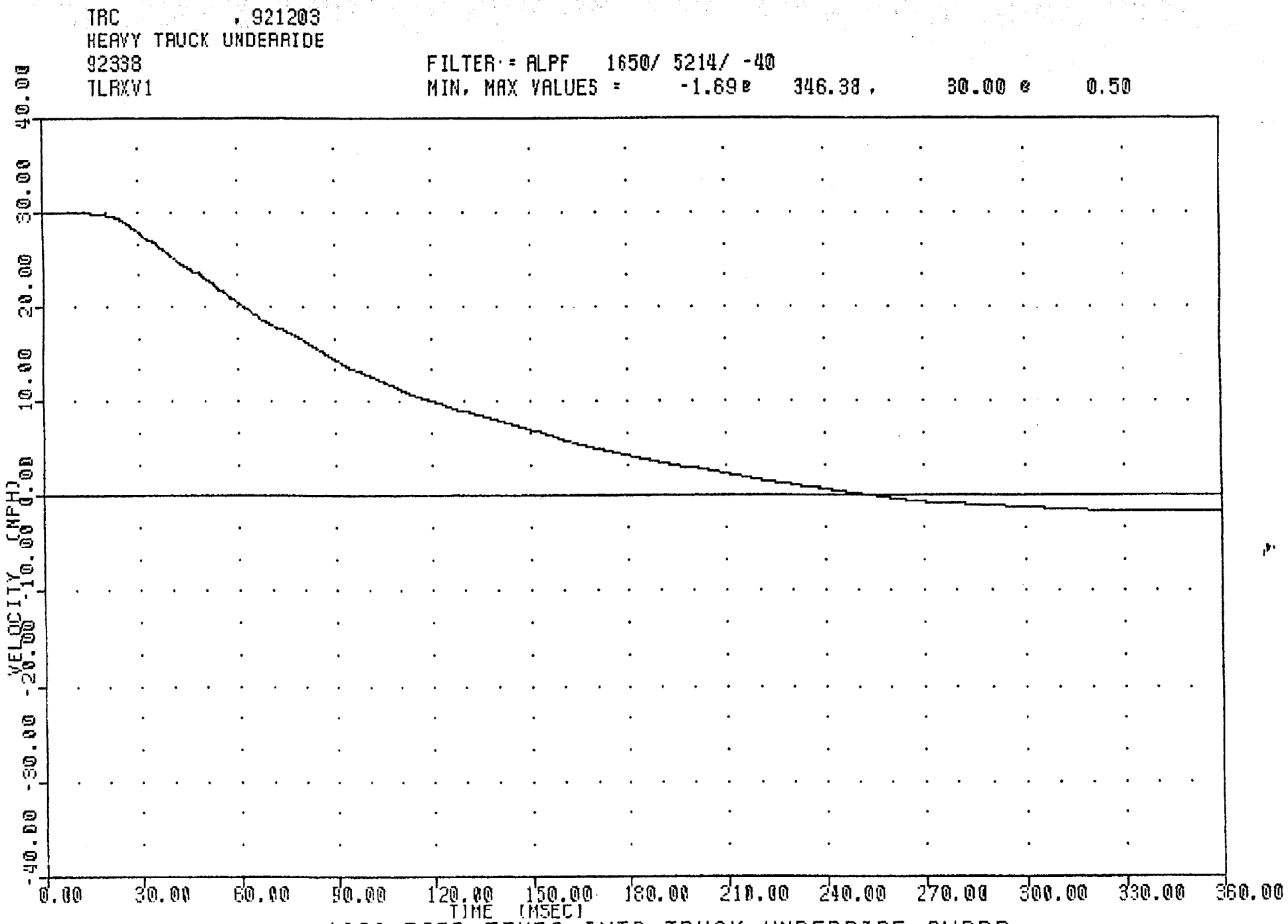
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER RIGHT FEMUR FORCE



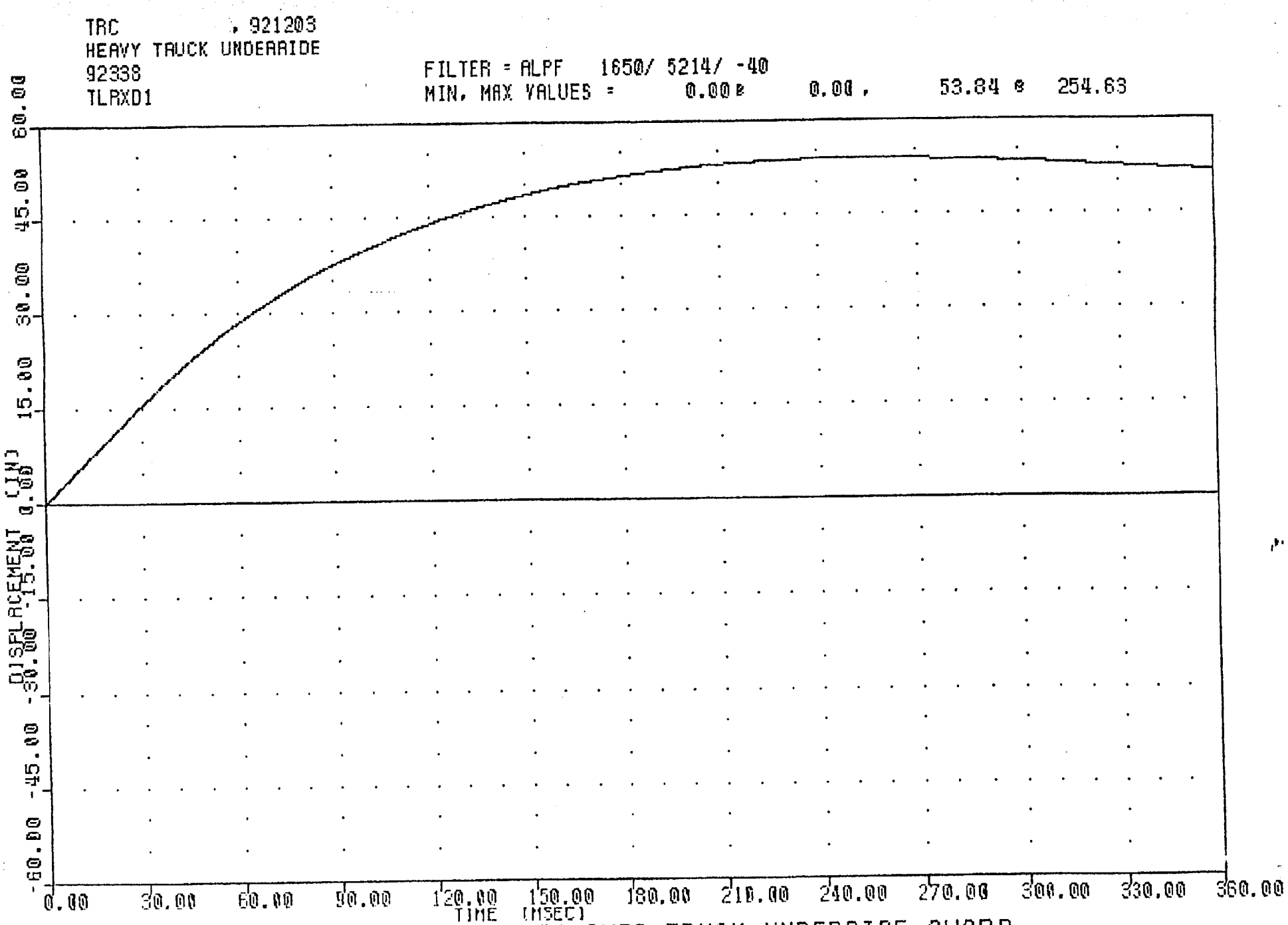
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT FRONT PASSENGER SHOULDER BELT FORCE



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
LEFT REAR SEAT X-AXIS ACCELERATION

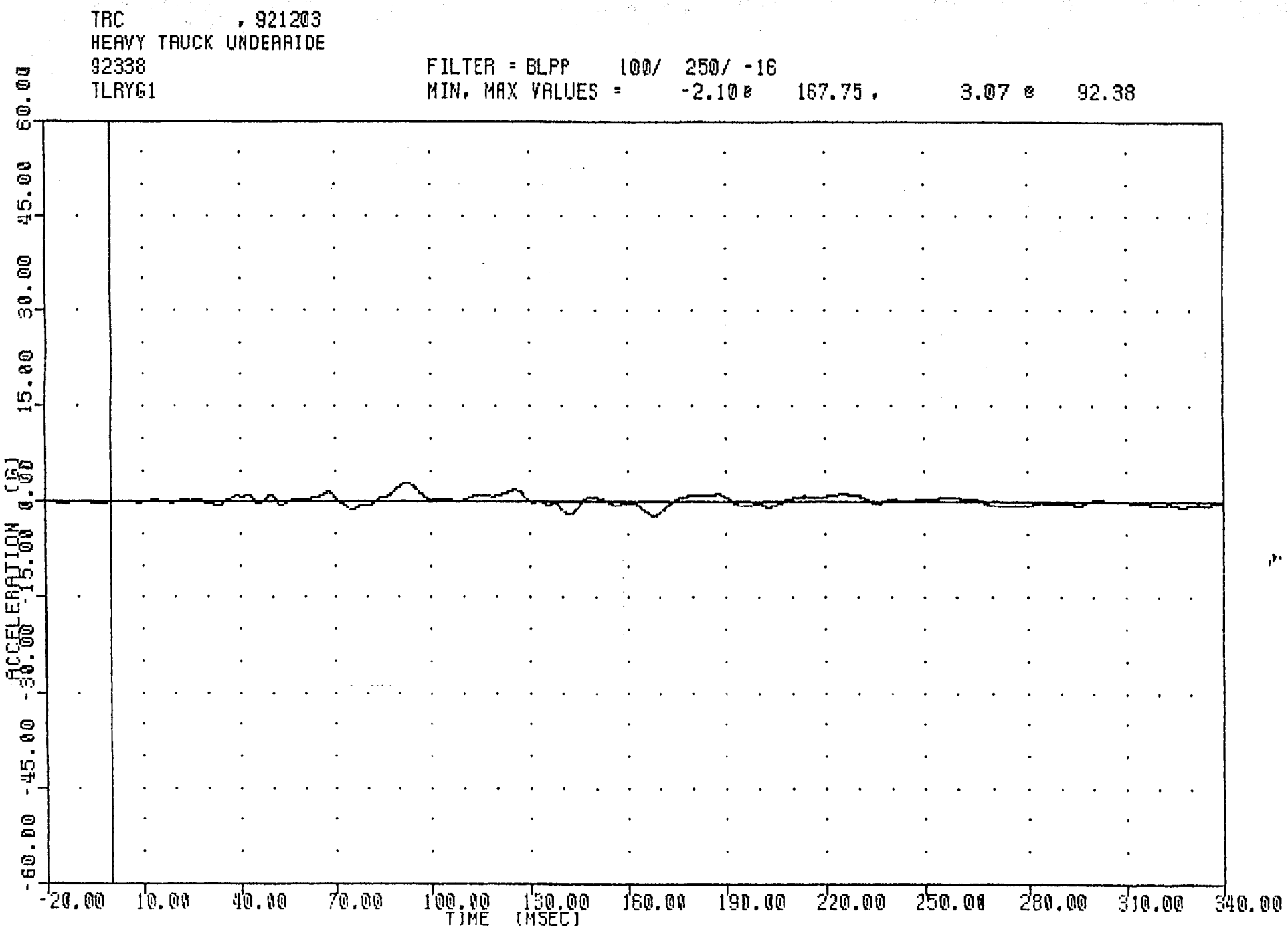


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
LEFT REAR SEAT X-AXIS VELOCITY

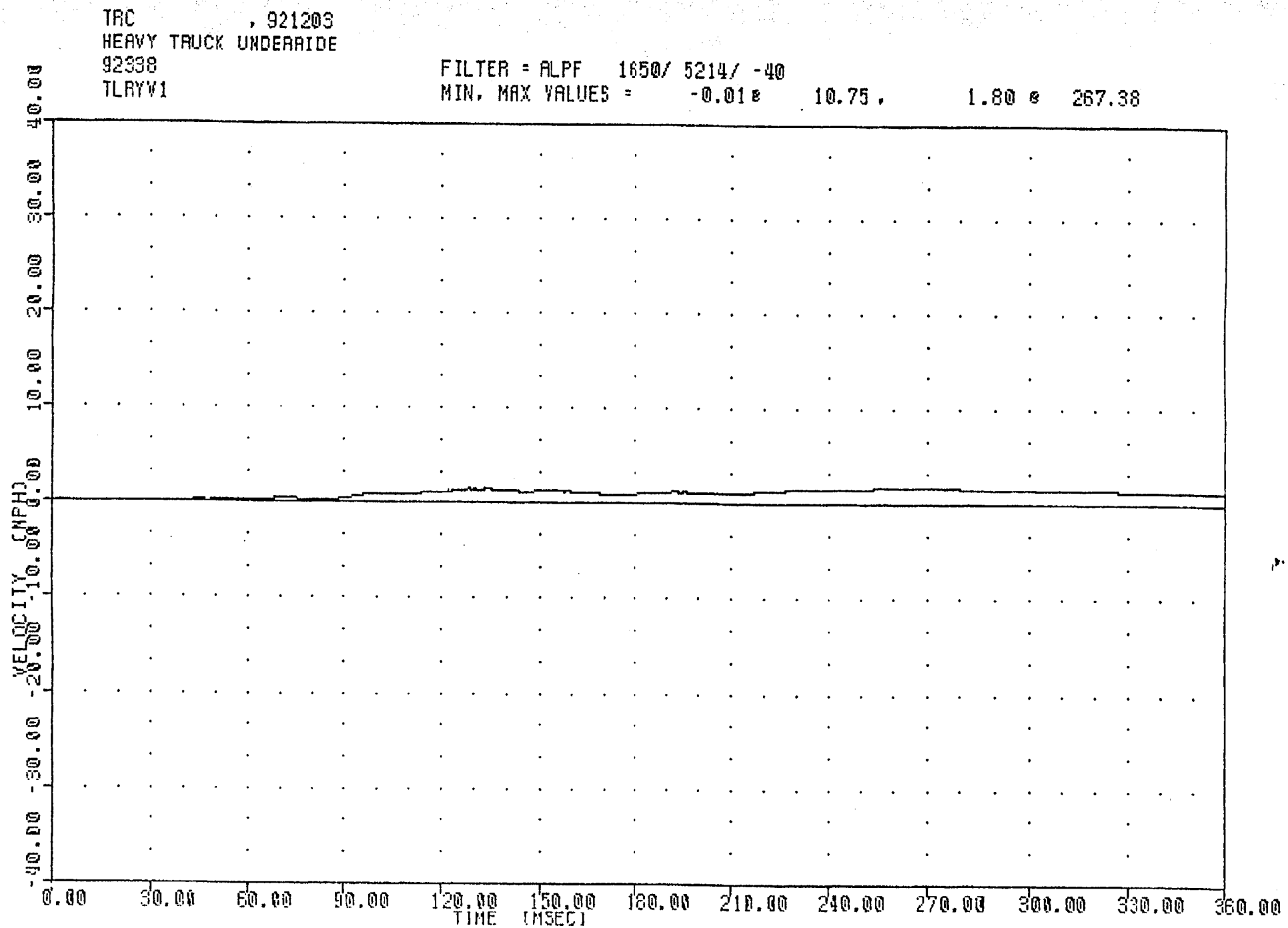


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

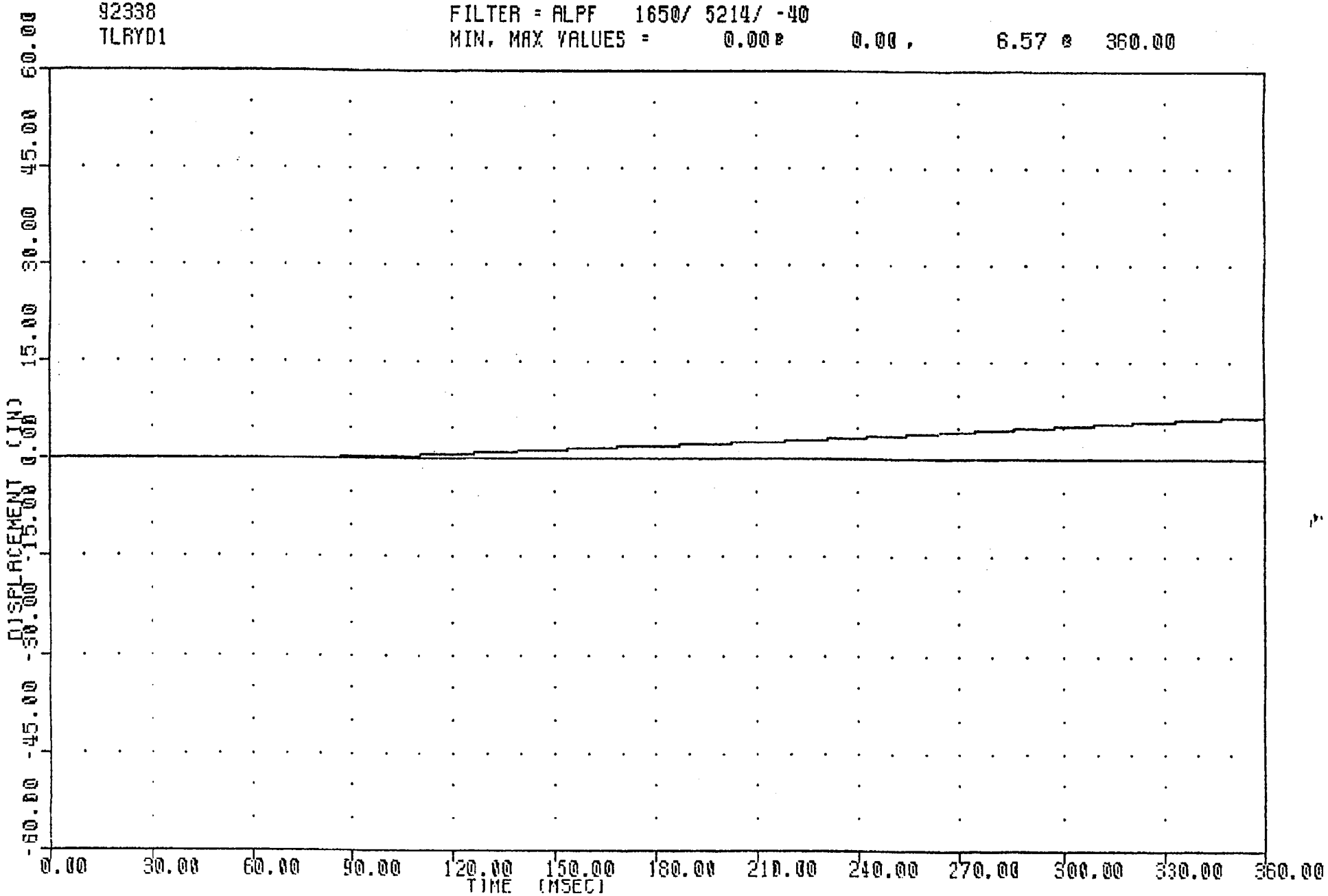
LEFT REAR SEAT X-AXIS DISPLACEMENT



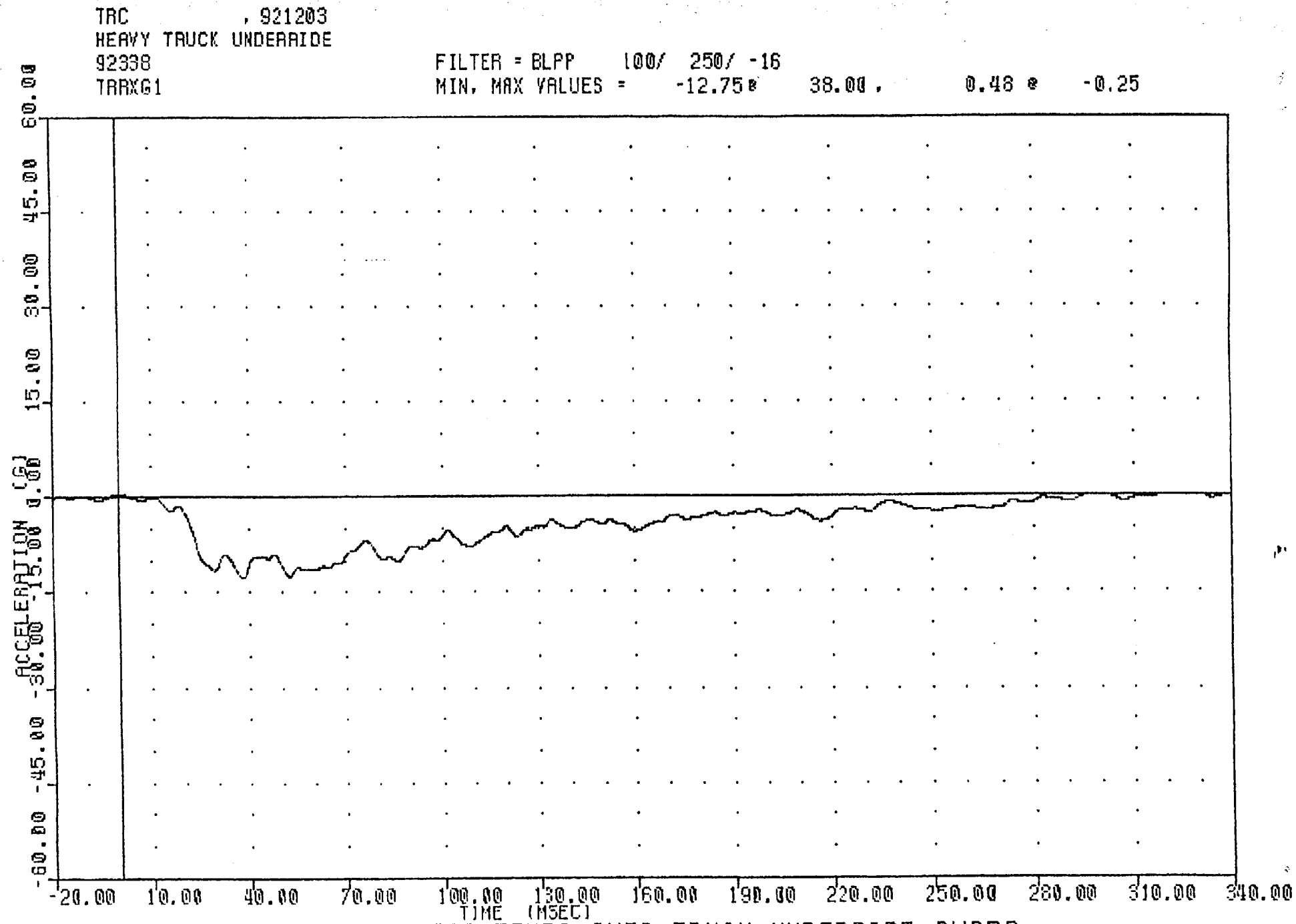
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
LEFT REAR SEAT Y-AXIS ACCELERATION



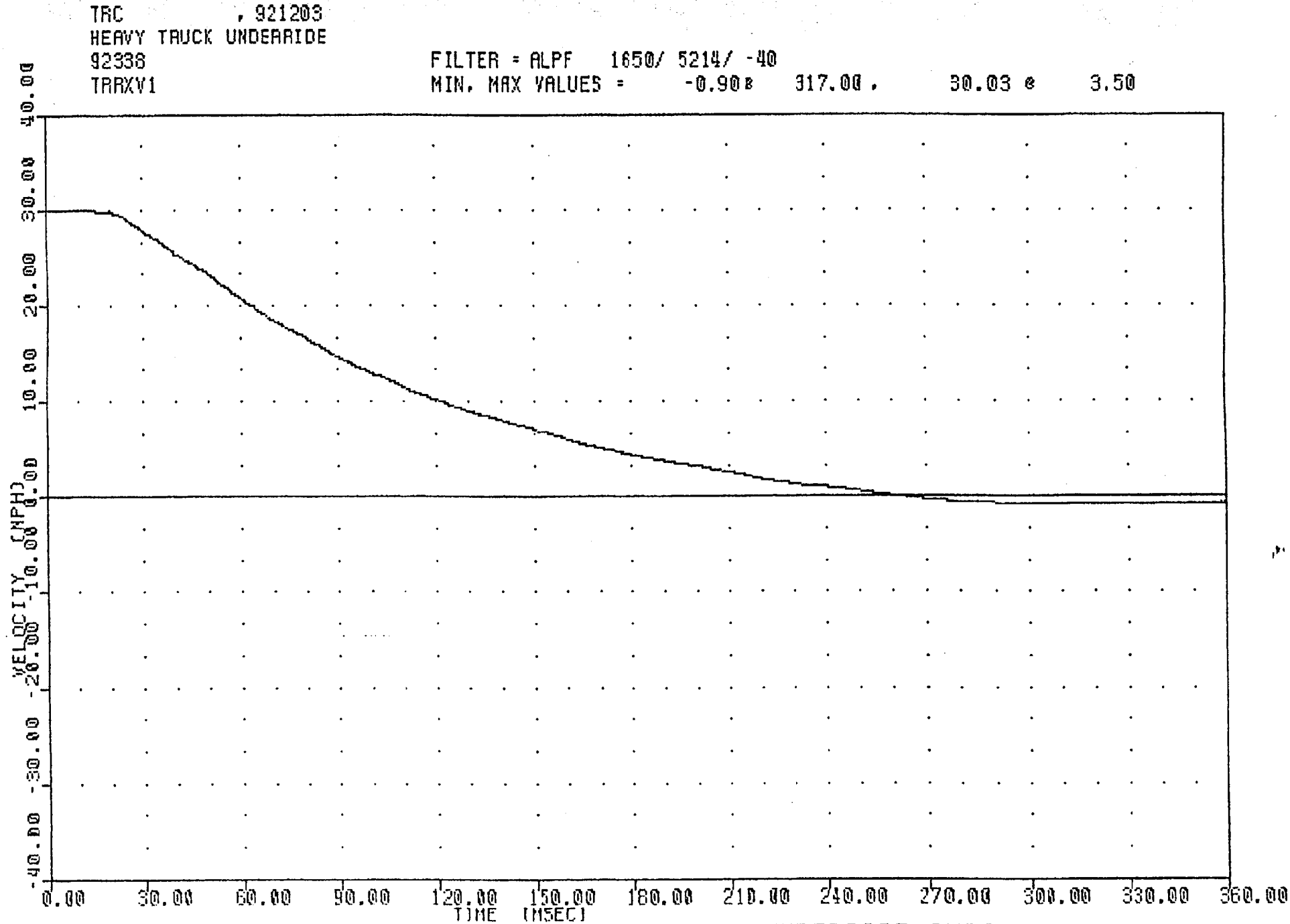
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
LEFT REAR SEAT Y-AXIS VELOCITY



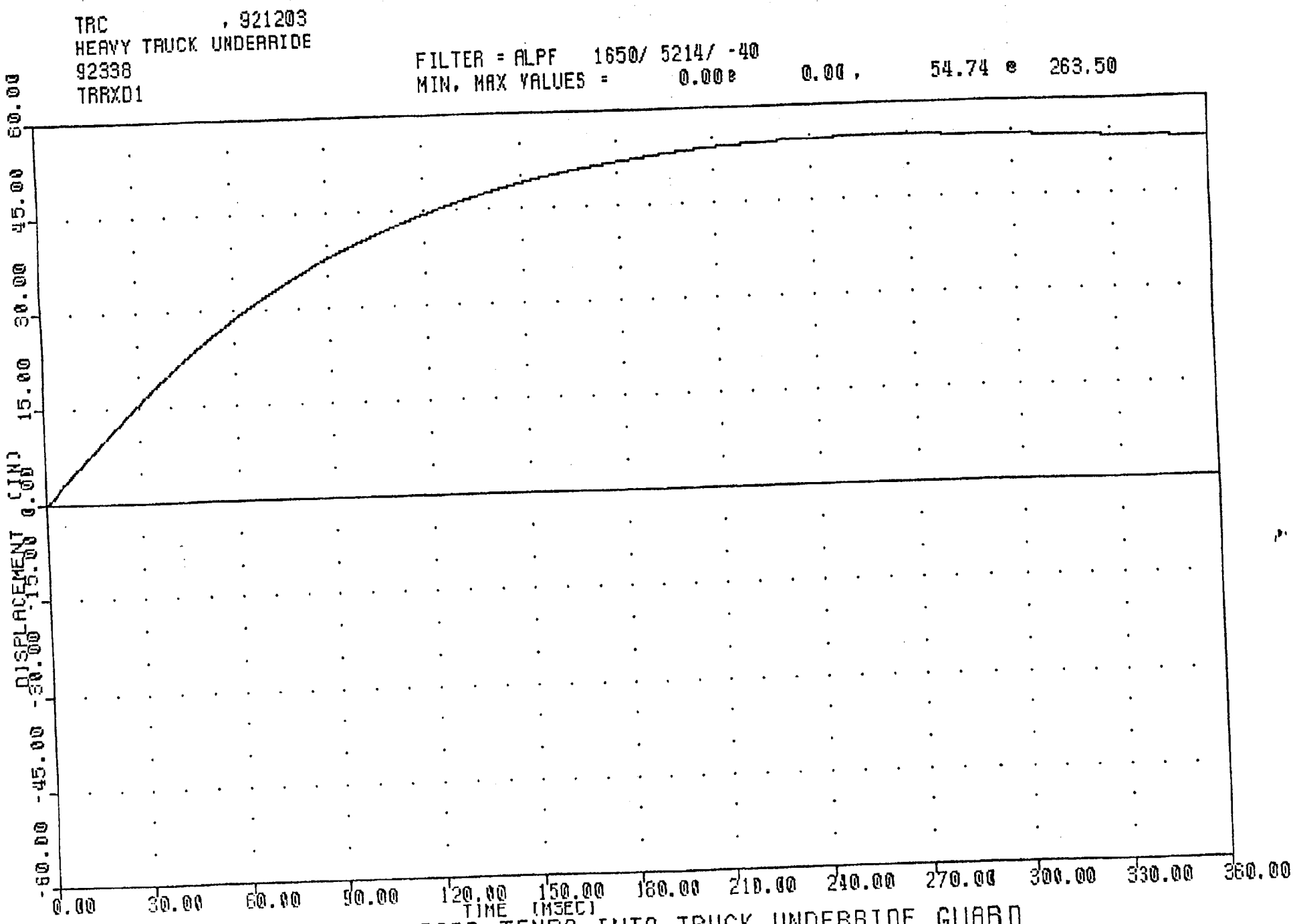
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
LEFT REAR SEAT Y-AXIS DISPLACEMENT



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT REAR SEAT X-AXIS ACCELERATION

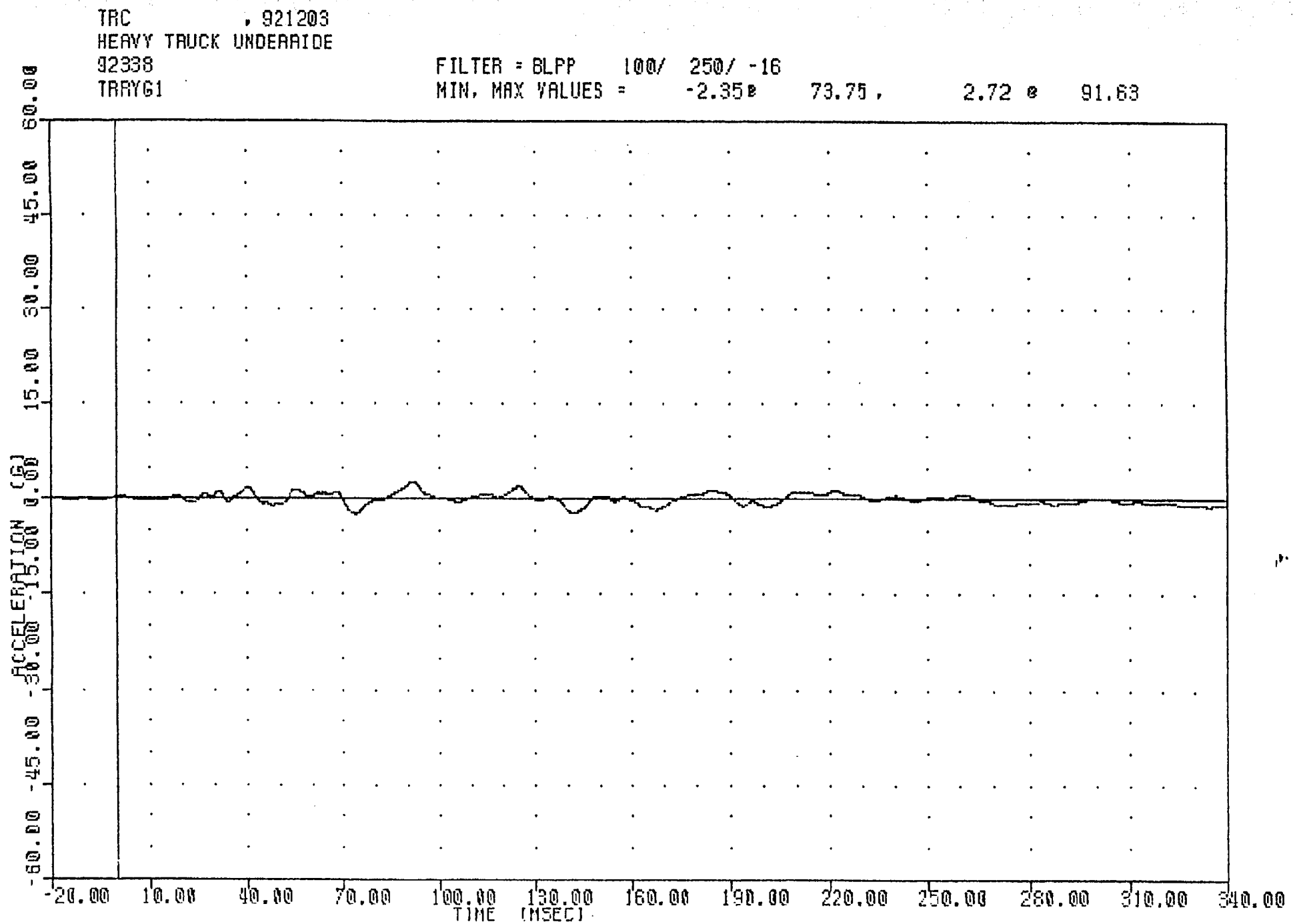


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT REAR SEAT X-AXIS VELOCITY

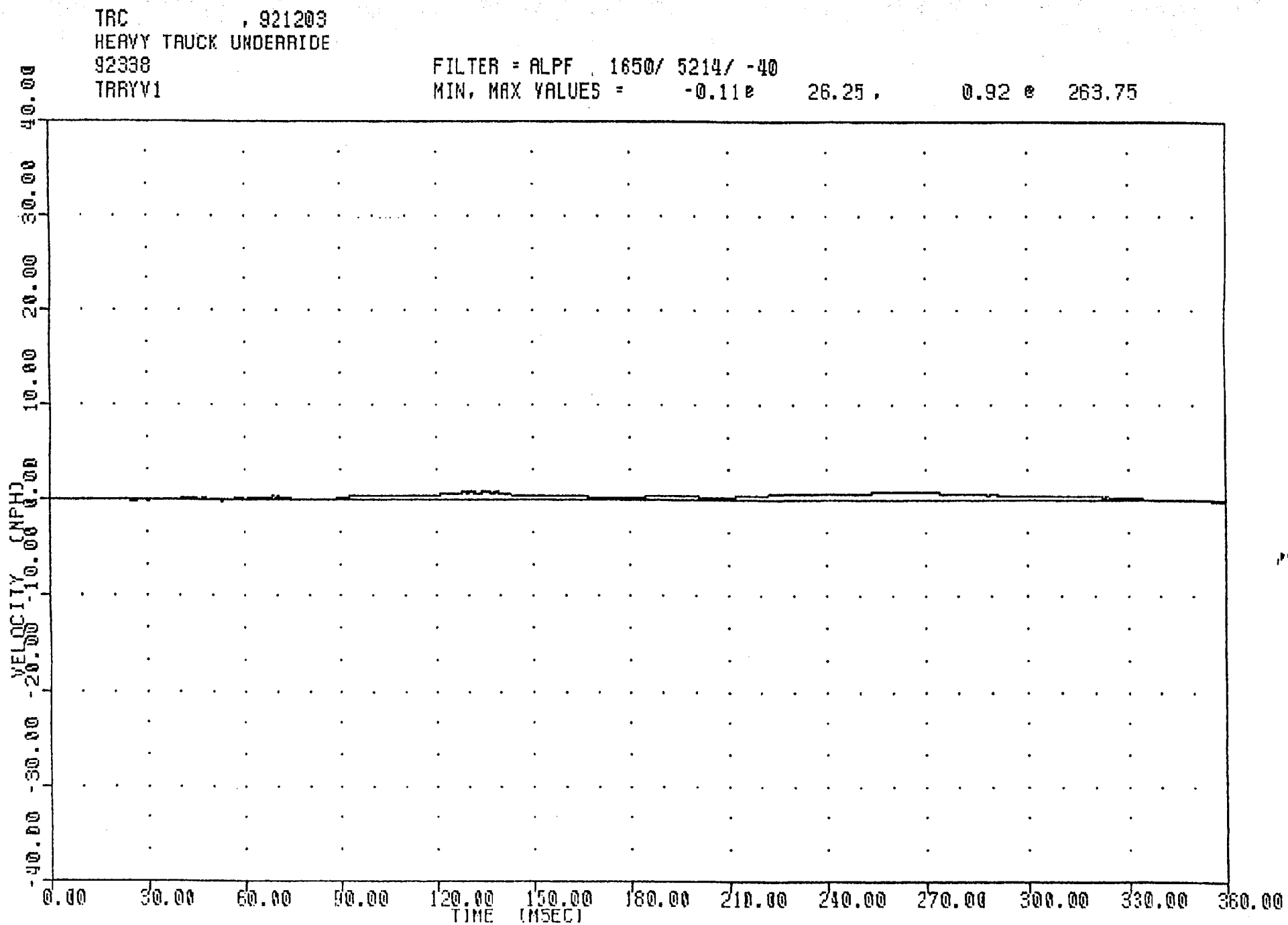


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

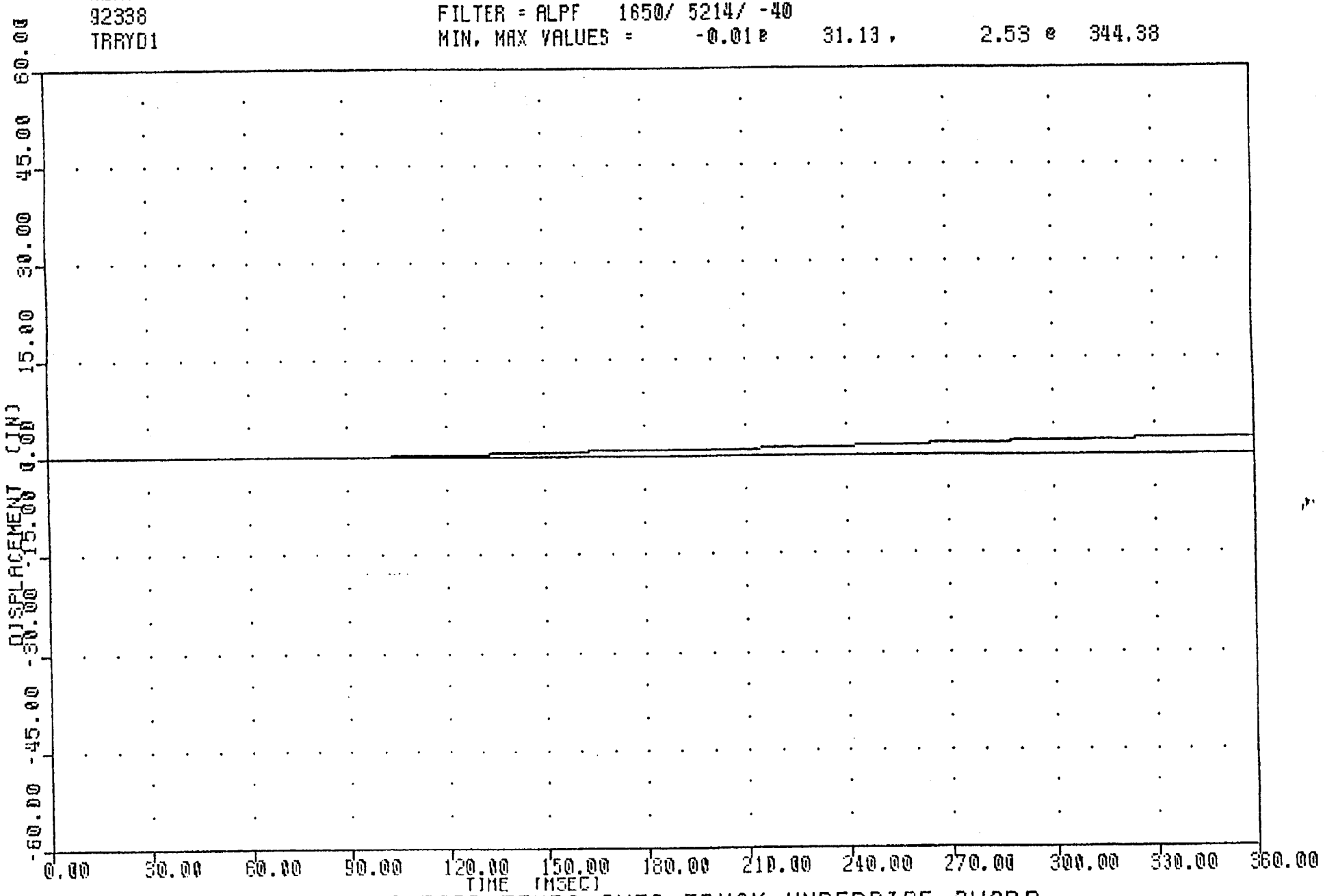
RIGHT REAR SEAT X-AXIS DISPLACEMENT



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT REAR SEAT Y-AXIS ACCELERATION

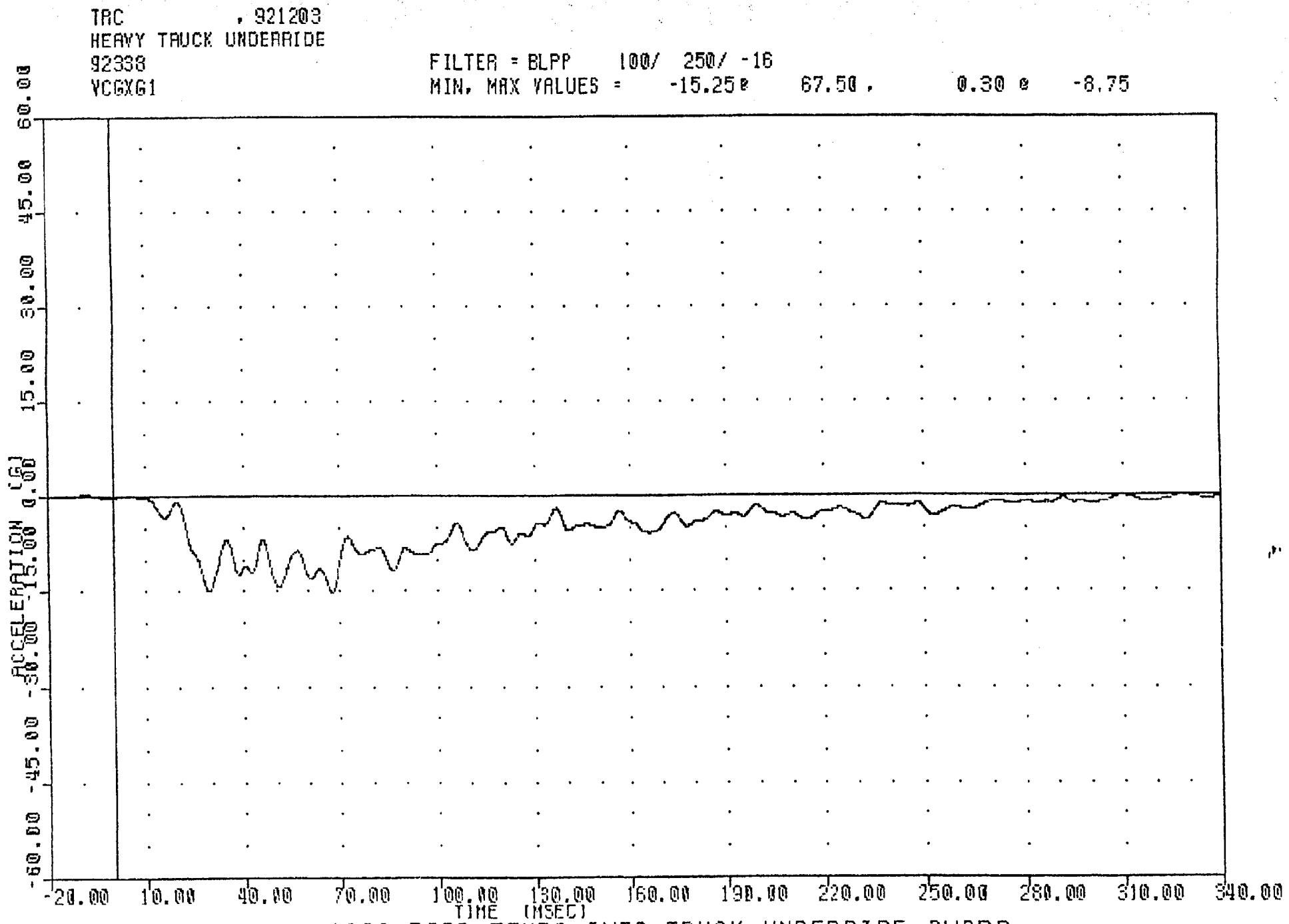


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
RIGHT REAR SEAT Y-AXIS VELOCITY



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

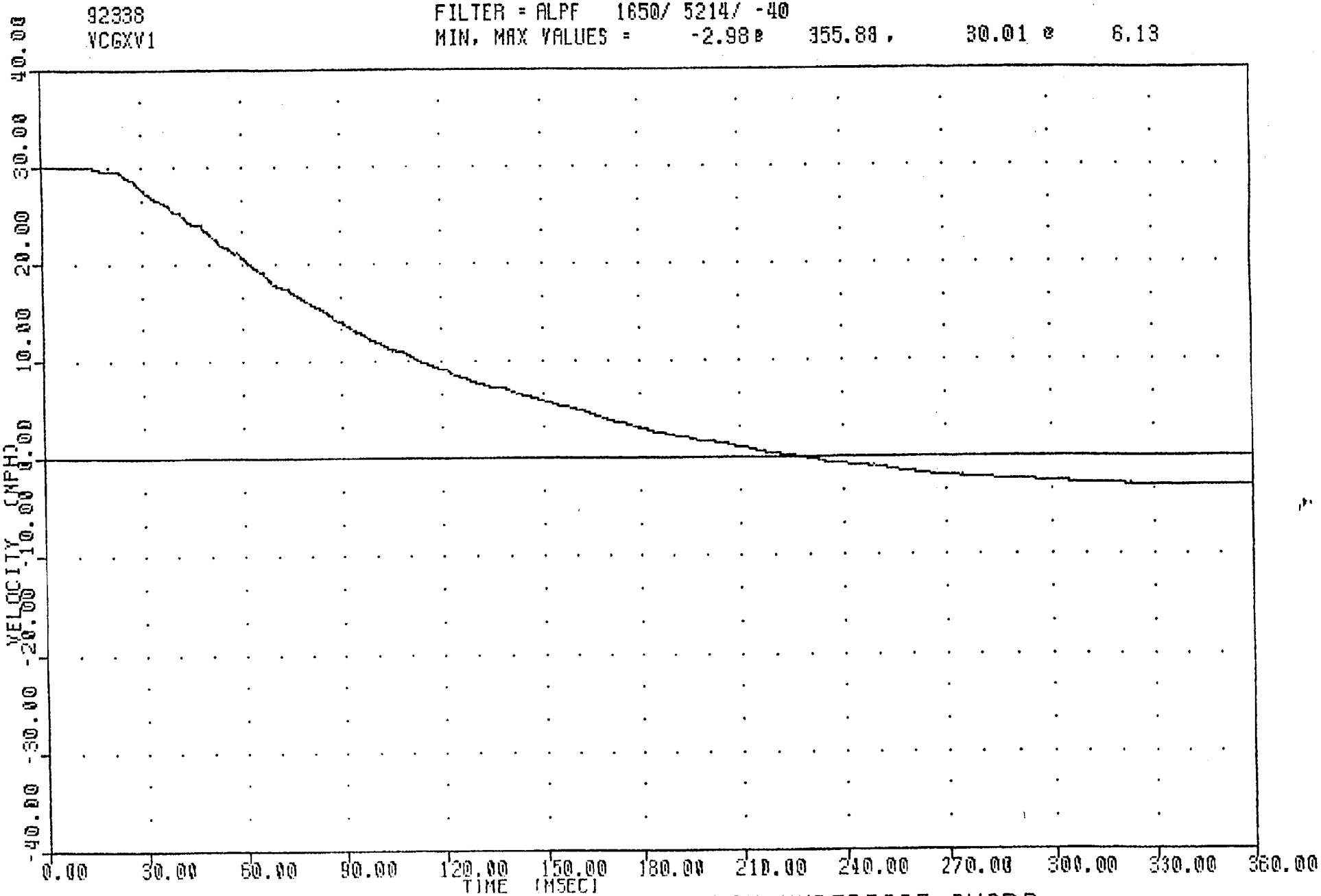
RIGHT REAR SEAT Y-AXIS DISPLACEMENT



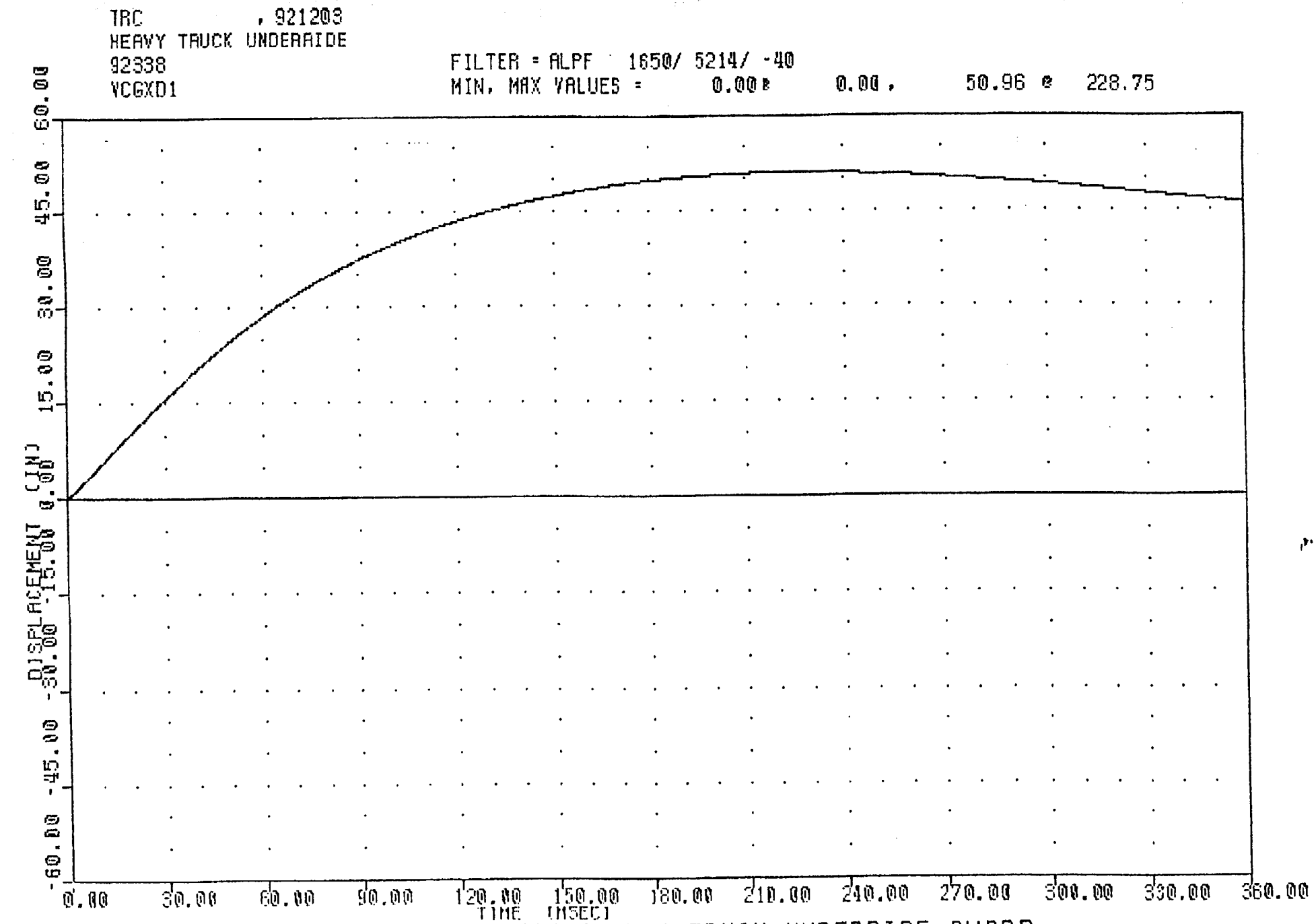
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY X-AXIS ACCELERATION

TRC , 921203
HEAVY TRUCK UNDERRIDE
92338
VCGXV1

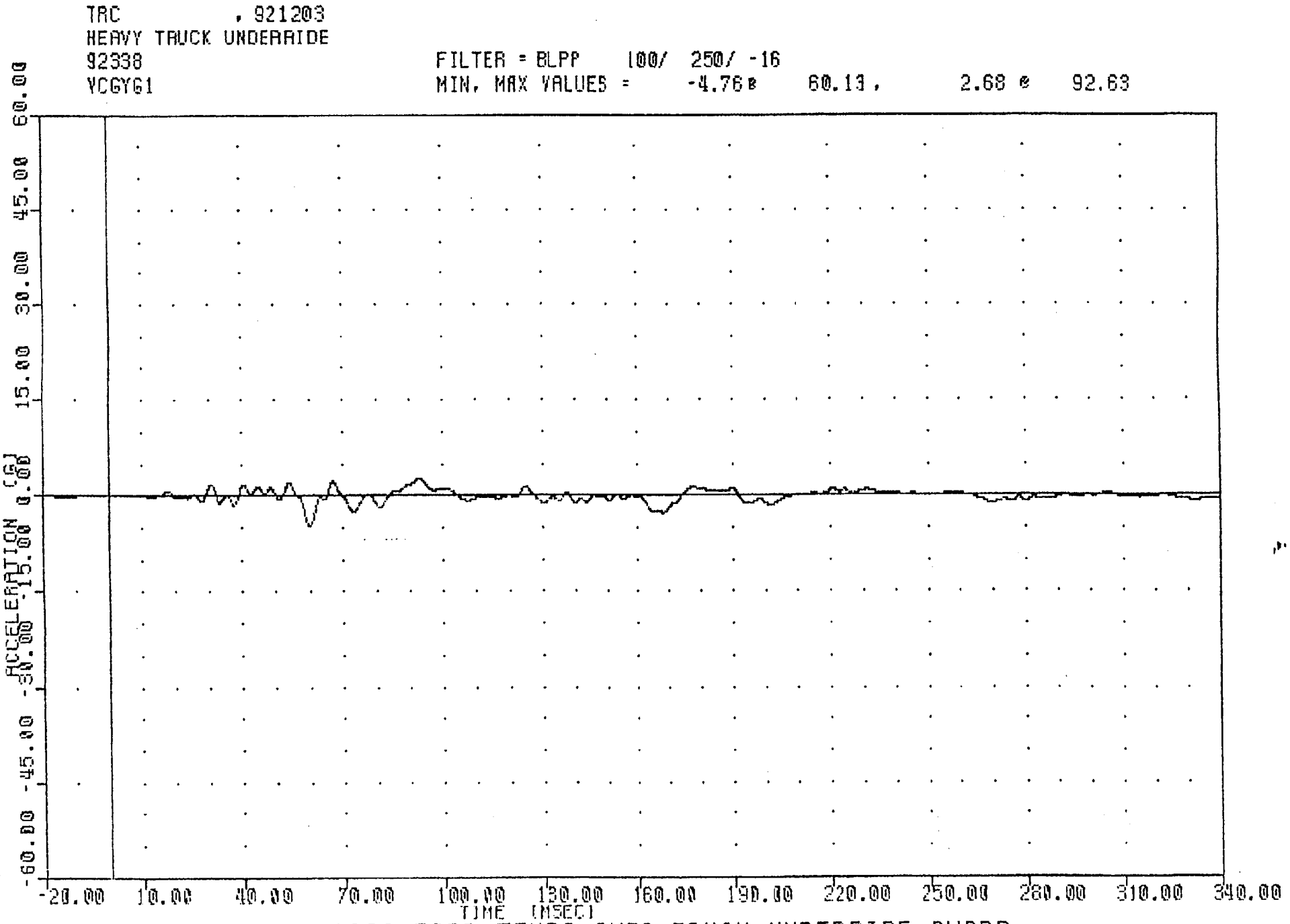
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -2.98 @ 355.88 , 30.01 @ 6.13



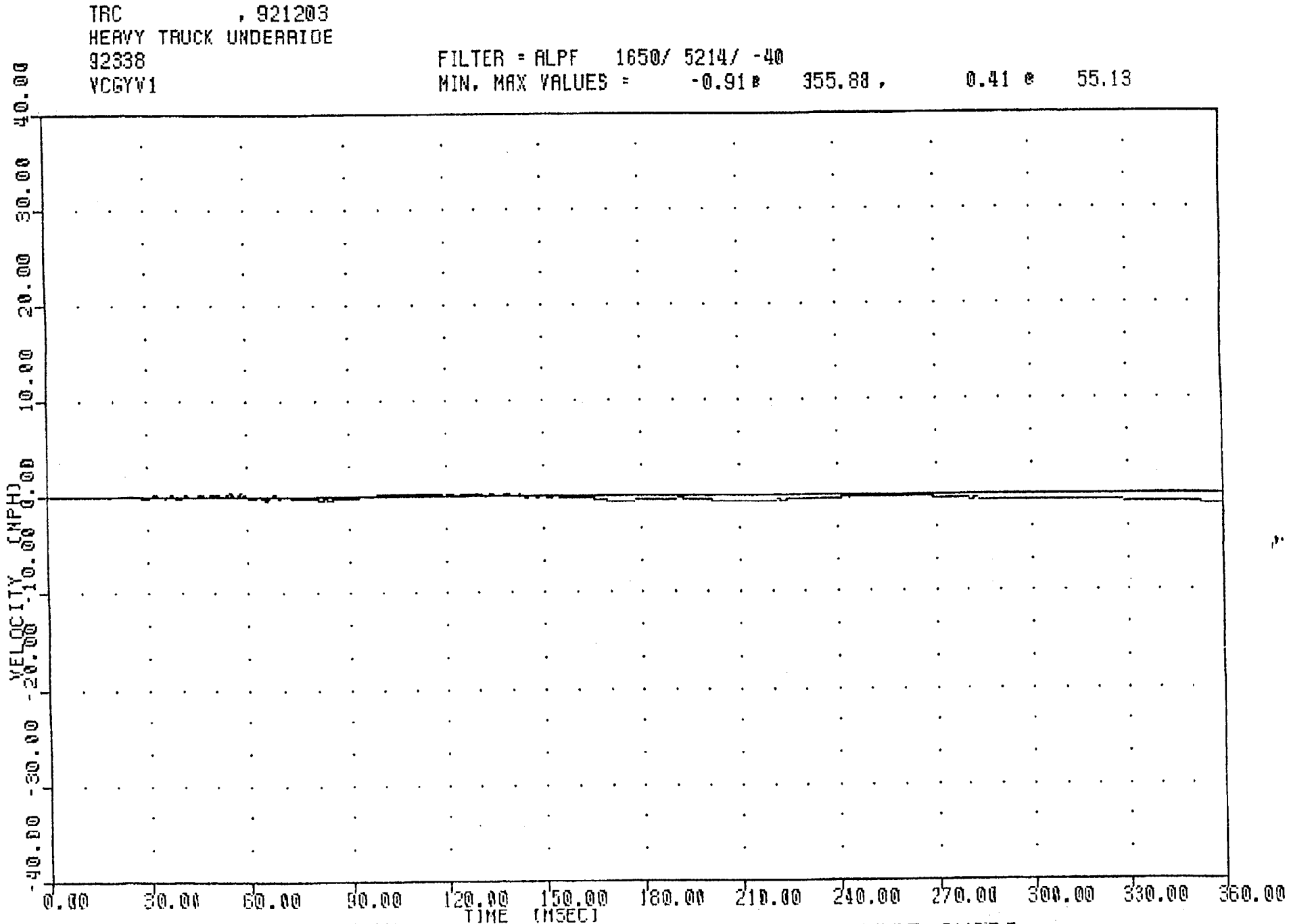
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY X-AXIS VELOCITY



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY X-AXIS DISPLACEMENT

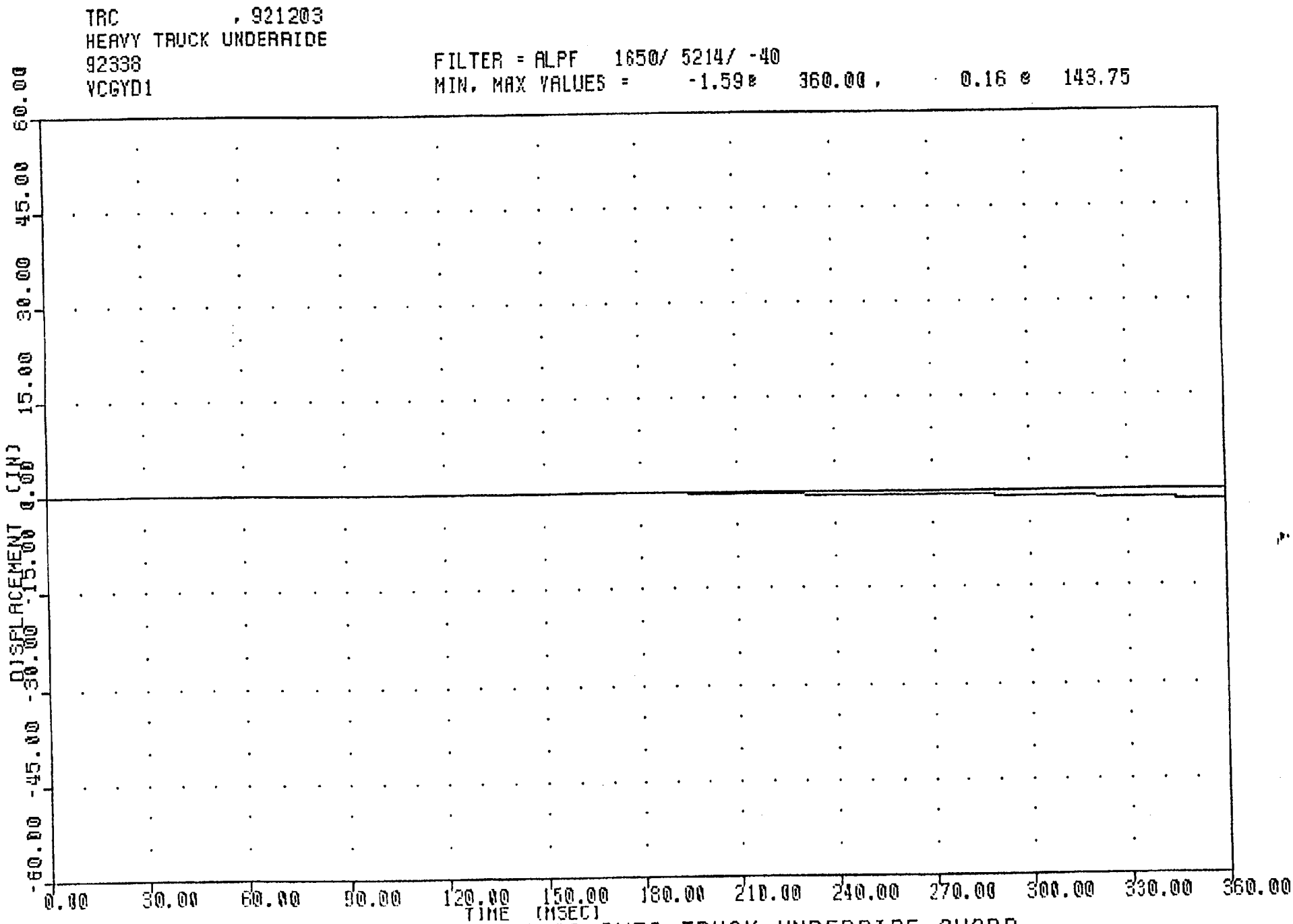


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY Y-AXIS ACCELERATION

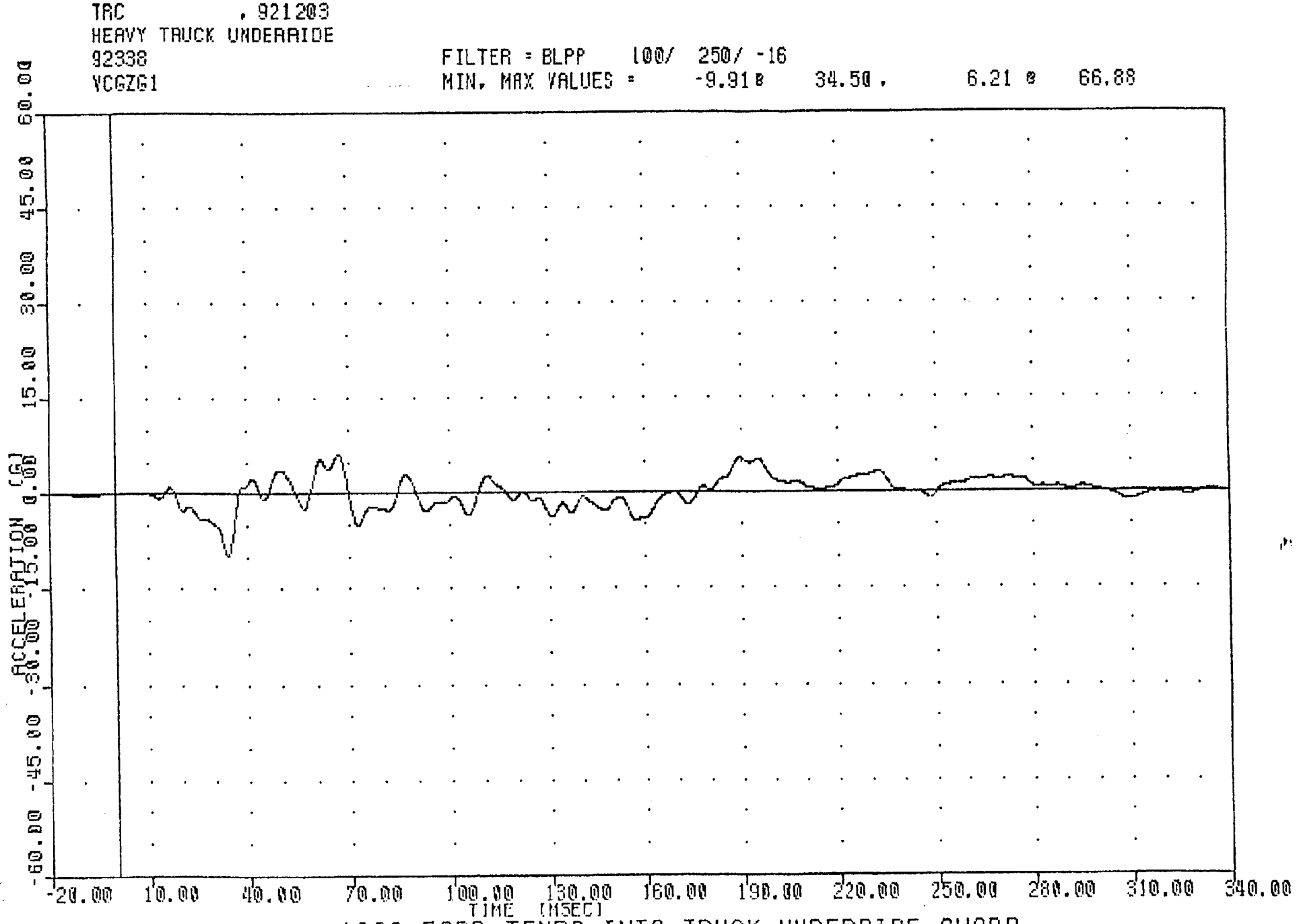


1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

CAR CENTER OF GRAVITY Y-AXIS VELOCITY



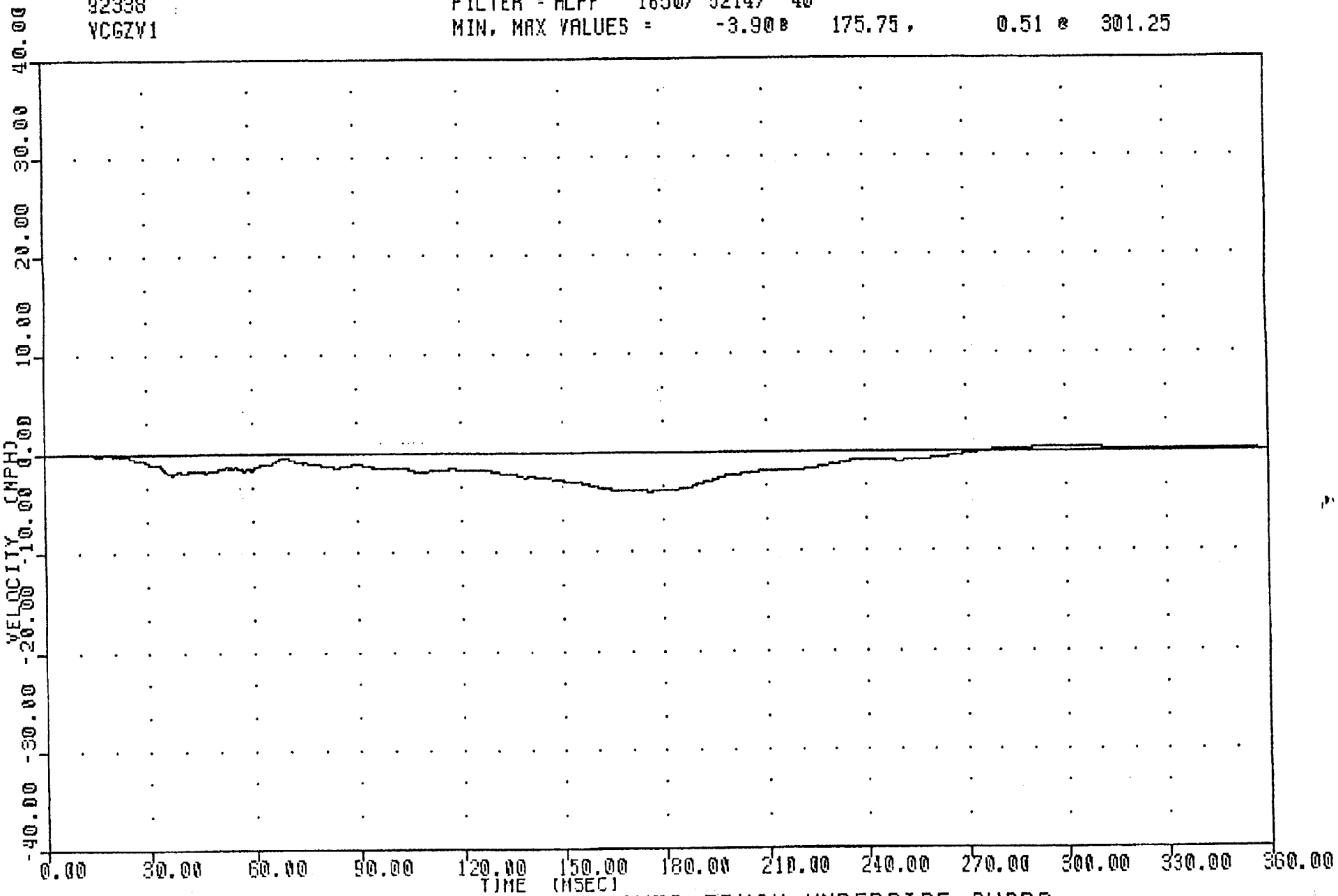
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY Y-AXIS DISPLACEMENT



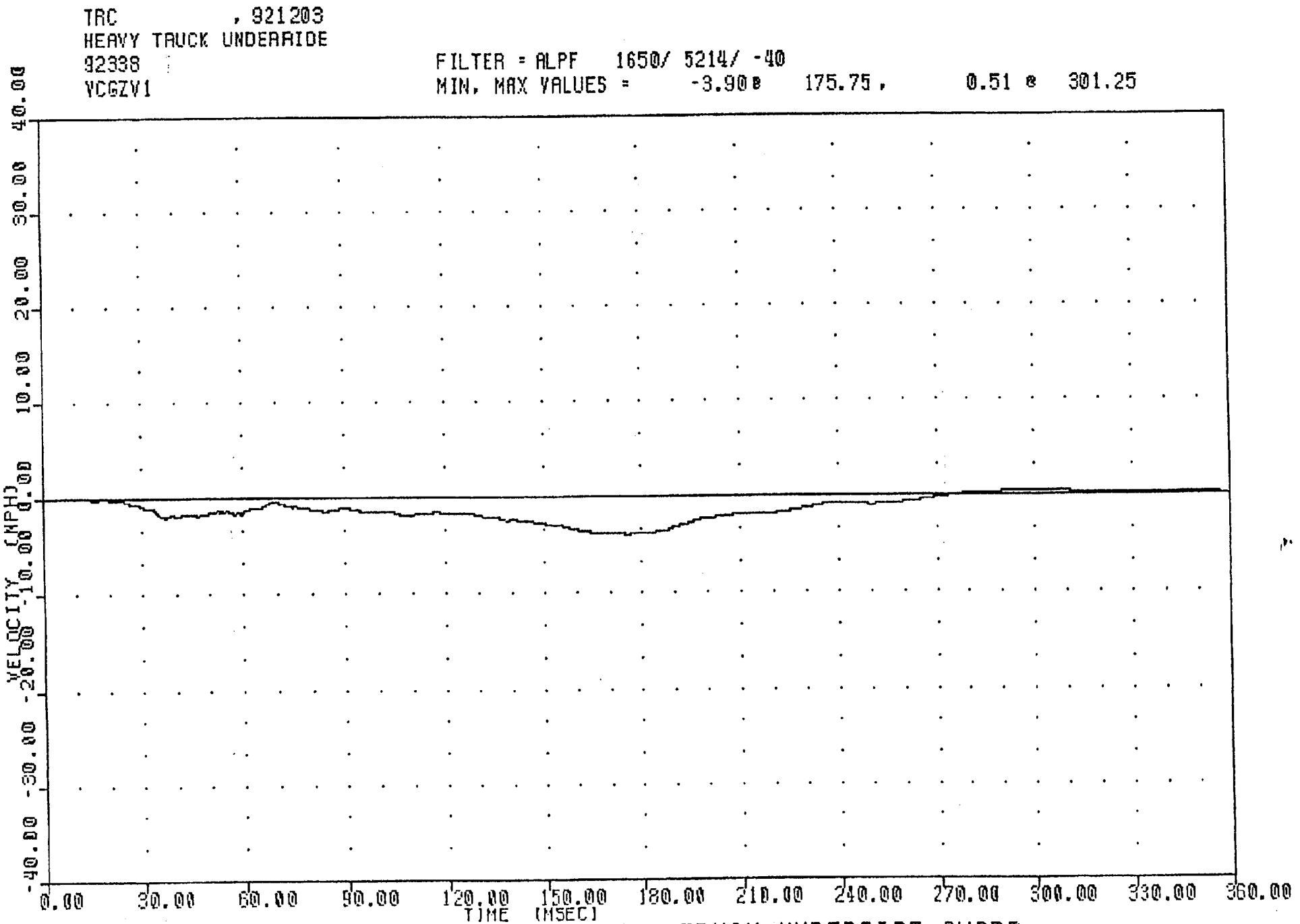
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY Z-AXIS ACCELERATION

TRC , 921203
HEAVY TRUCK UNDERRIDE
92338
VCGZV1

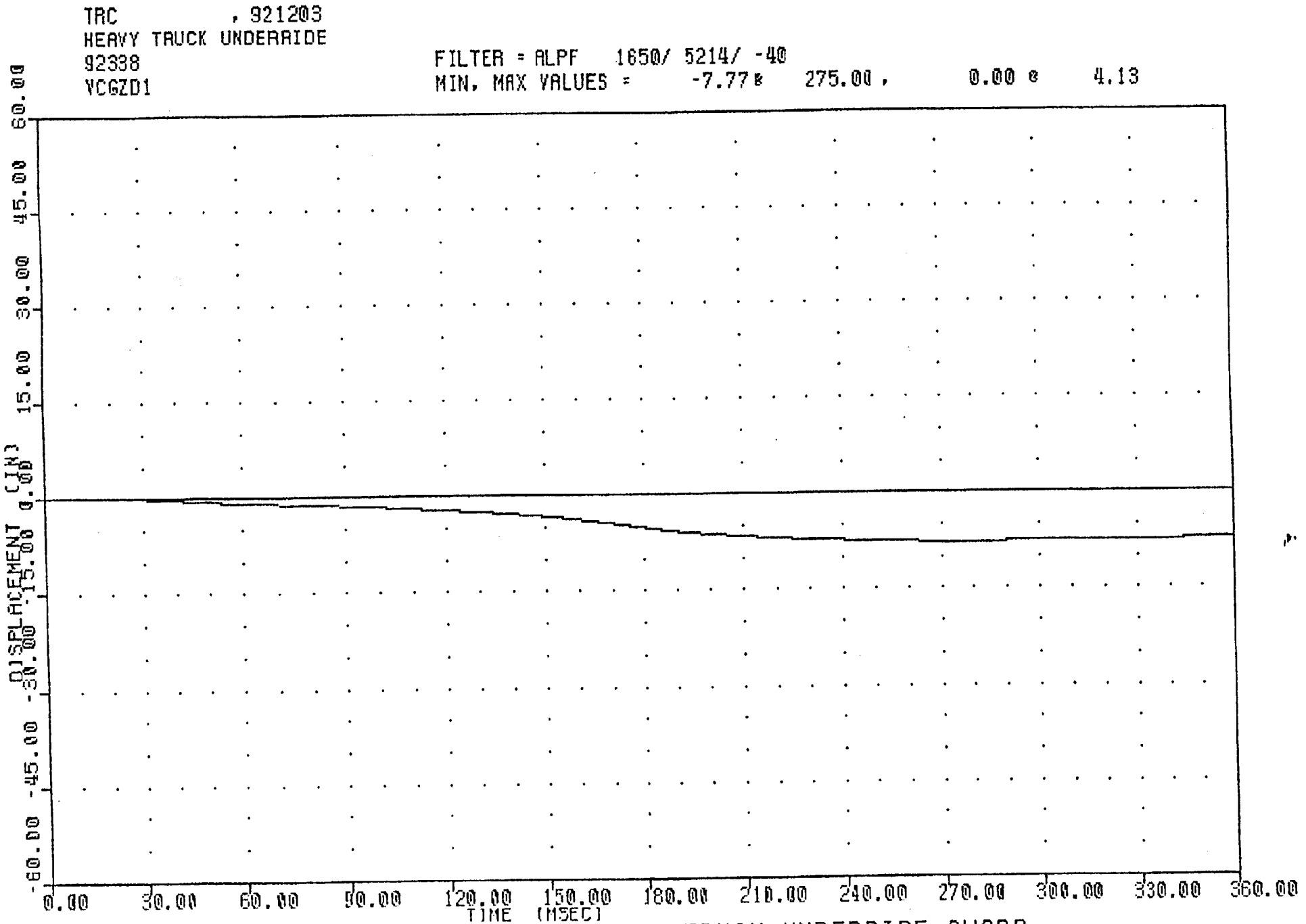
FILTER = RLPF 1650/ 5214/ -40
MIN, MAX VALUES = -3.90 @ 175.75 , 0.51 @ 301.25



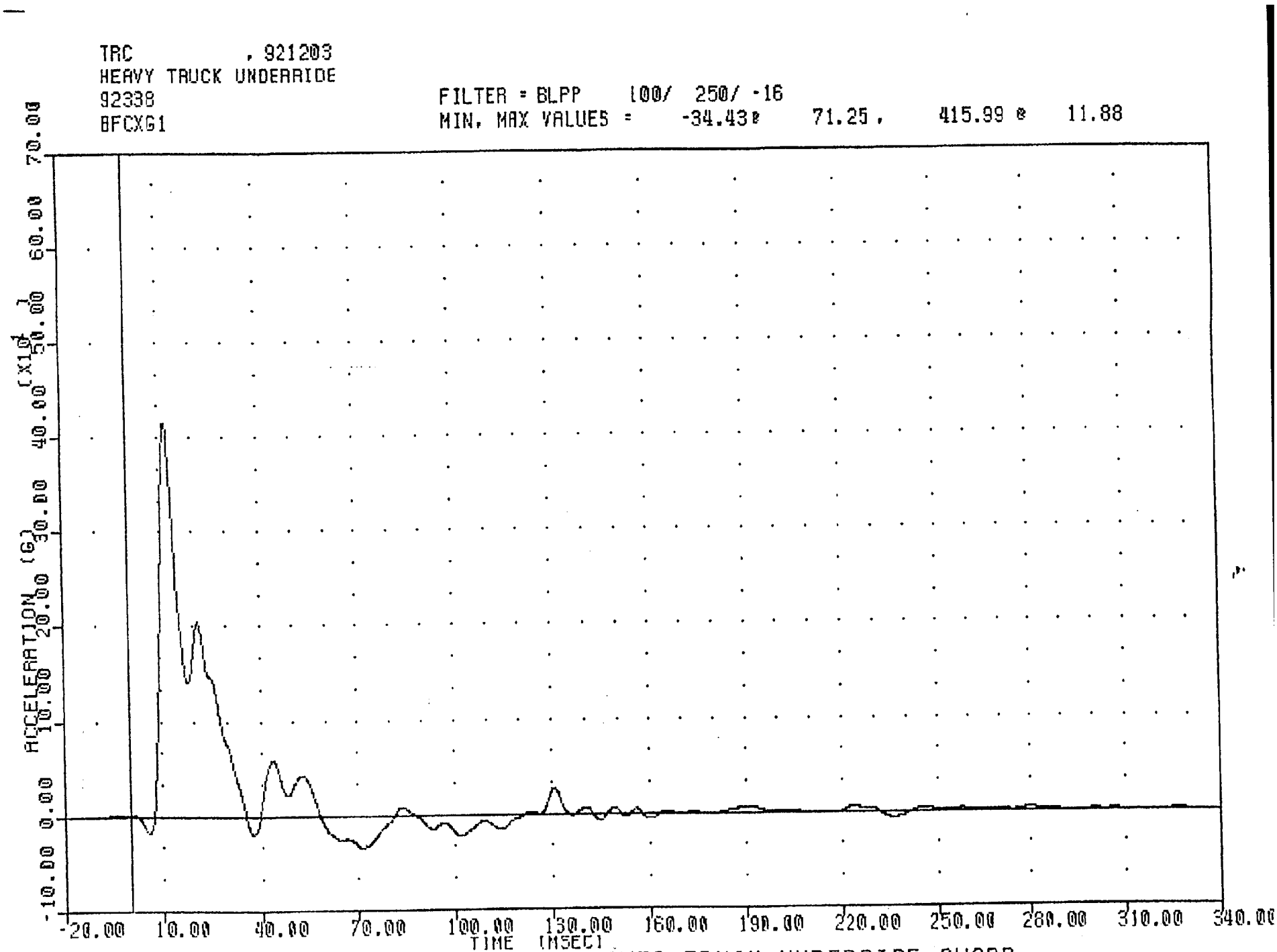
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY Z-AXIS VELOCITY



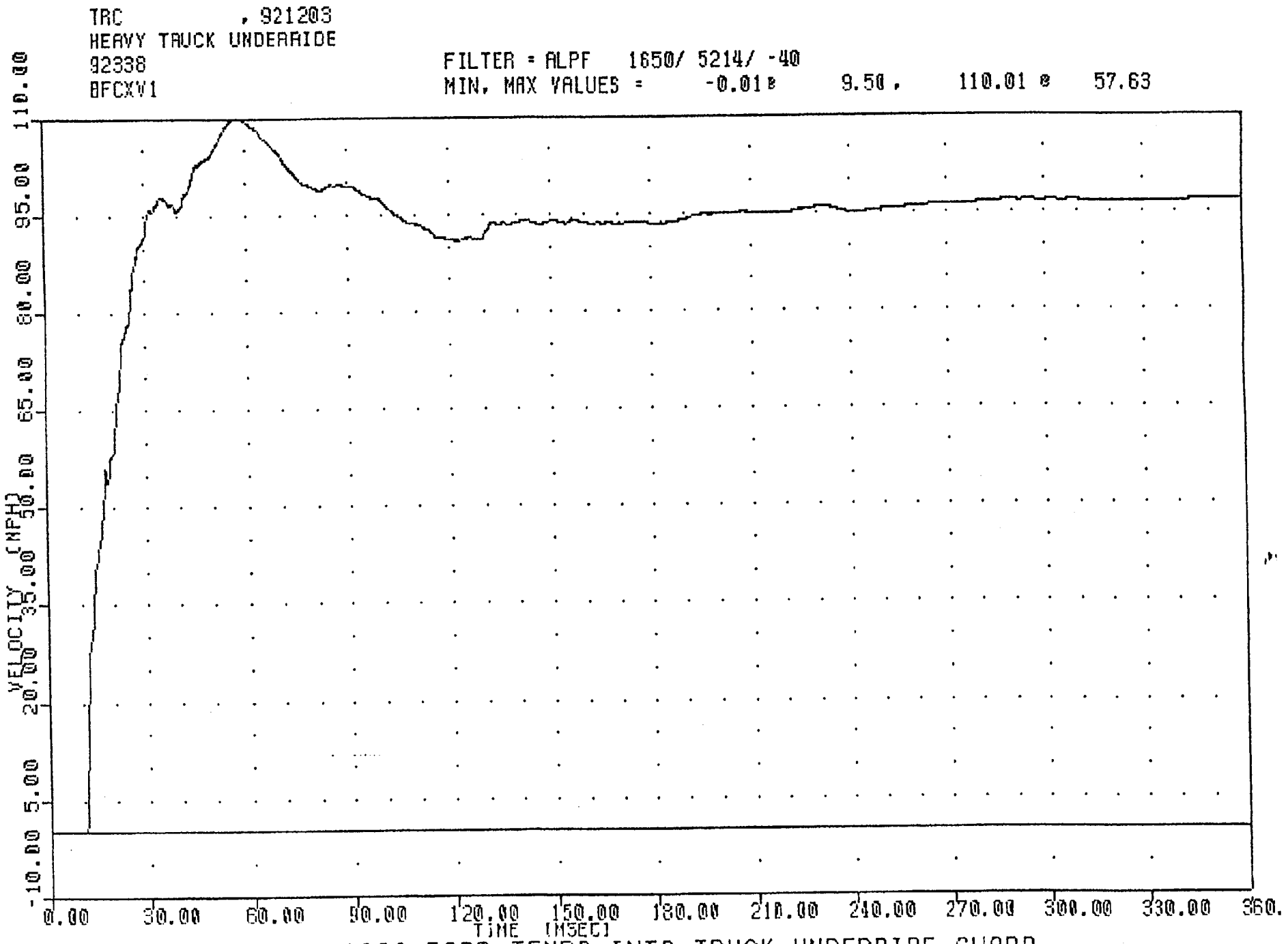
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY Z-AXIS VELOCITY



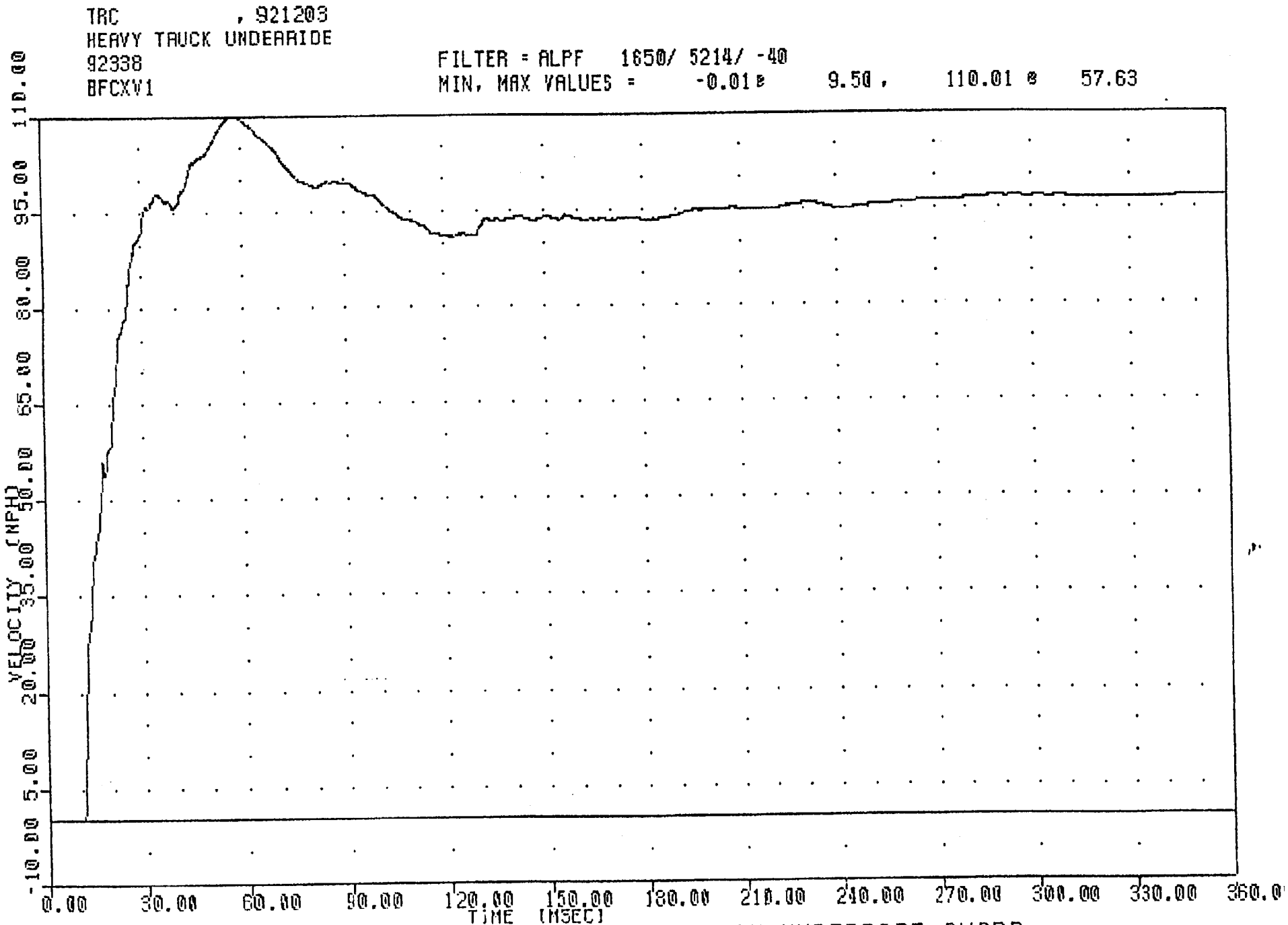
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
CAR CENTER OF GRAVITY Z-AXIS DISPLACEMENT



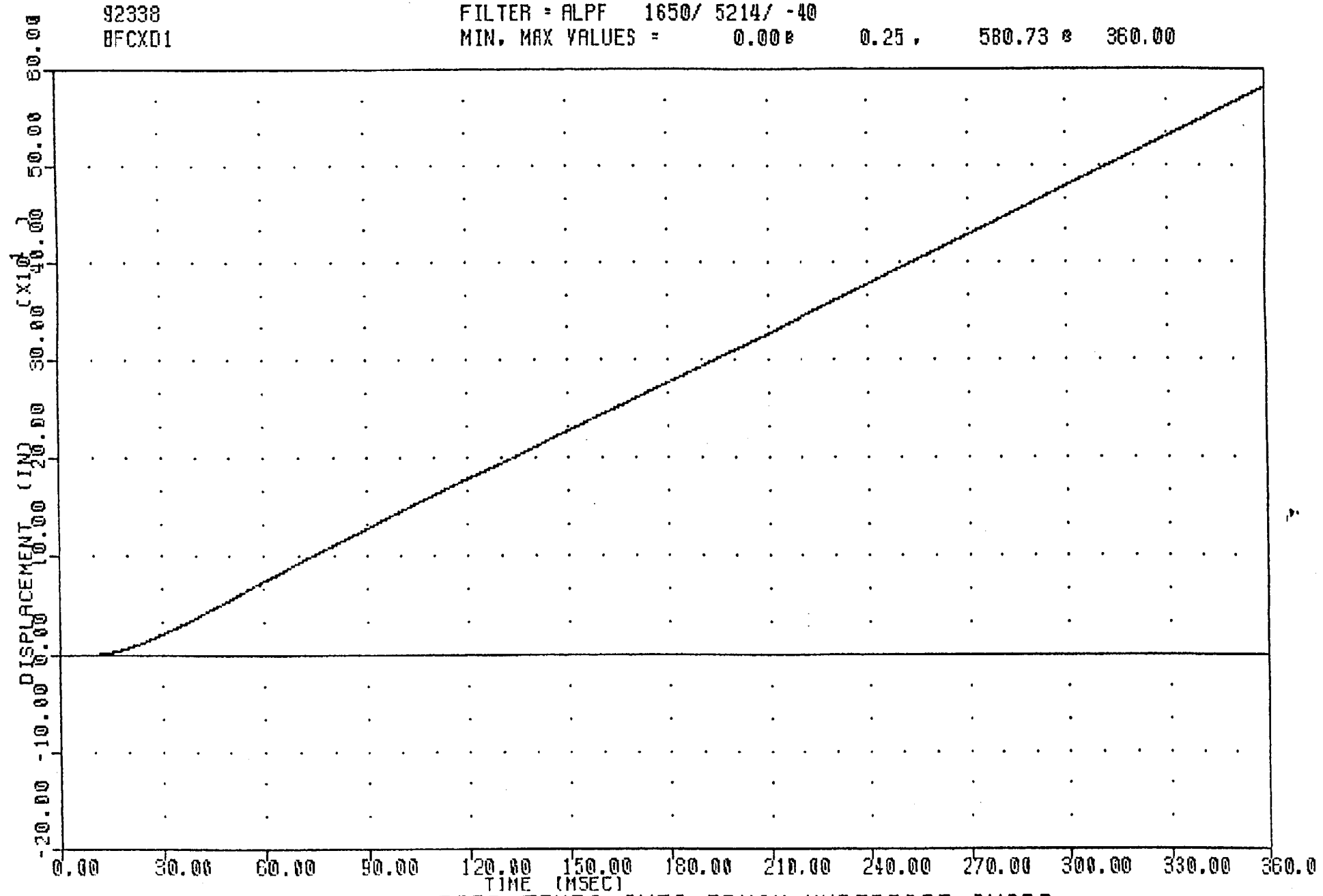
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER LEFT X-AXIS ACCELERATION



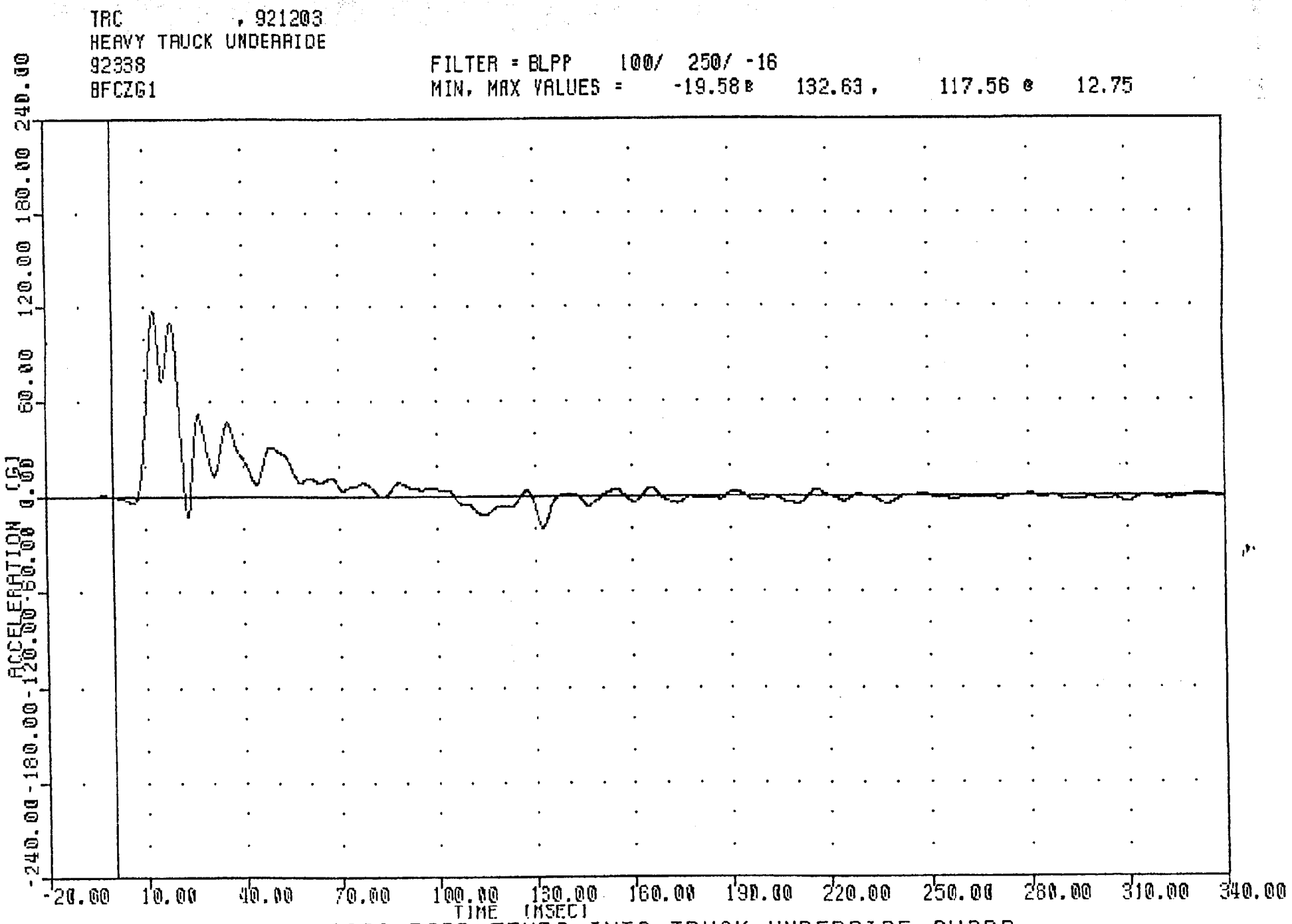
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER LEFT X-AXIS VELOCITY



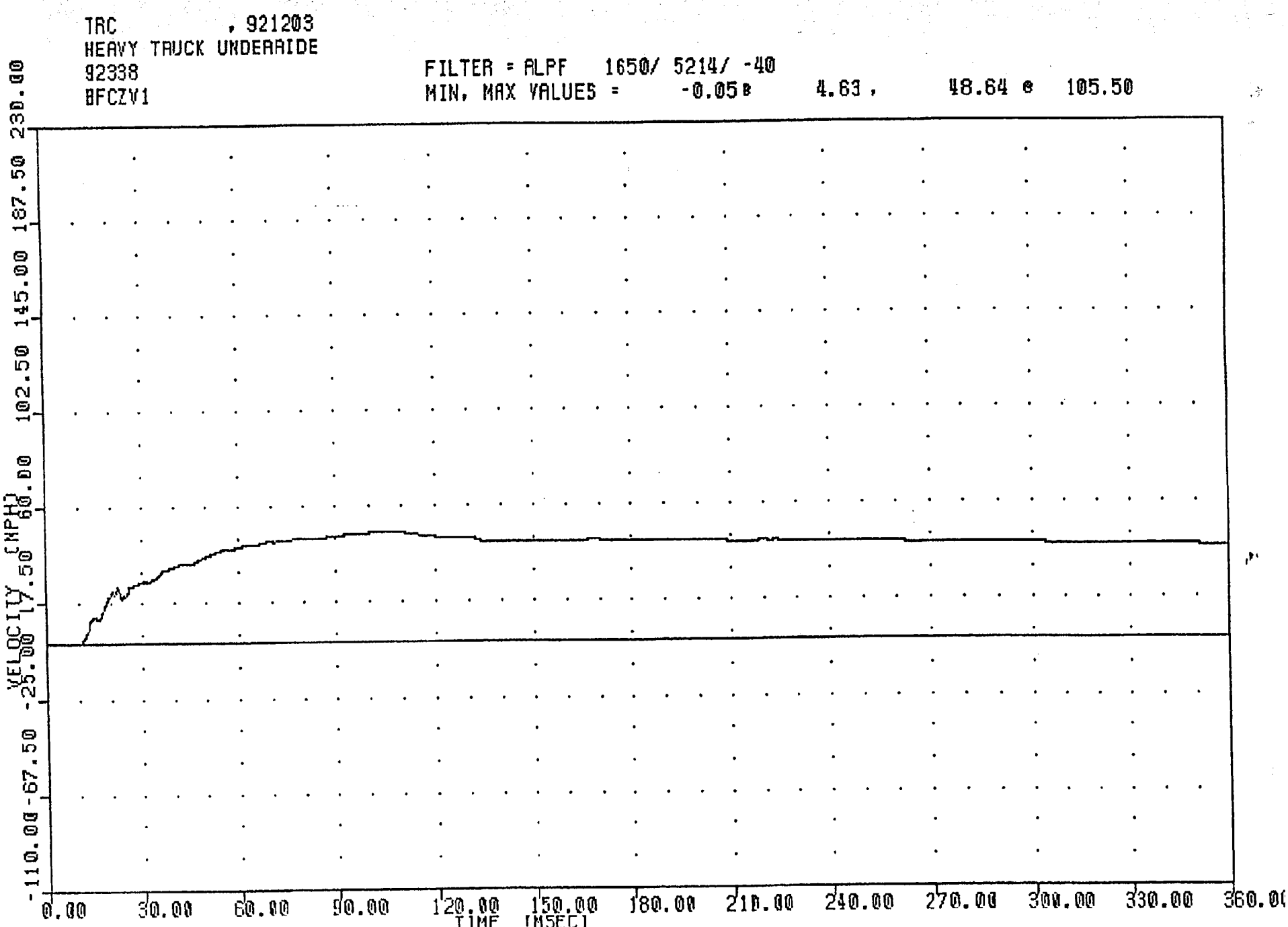
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER LEFT X-AXIS VELOCITY



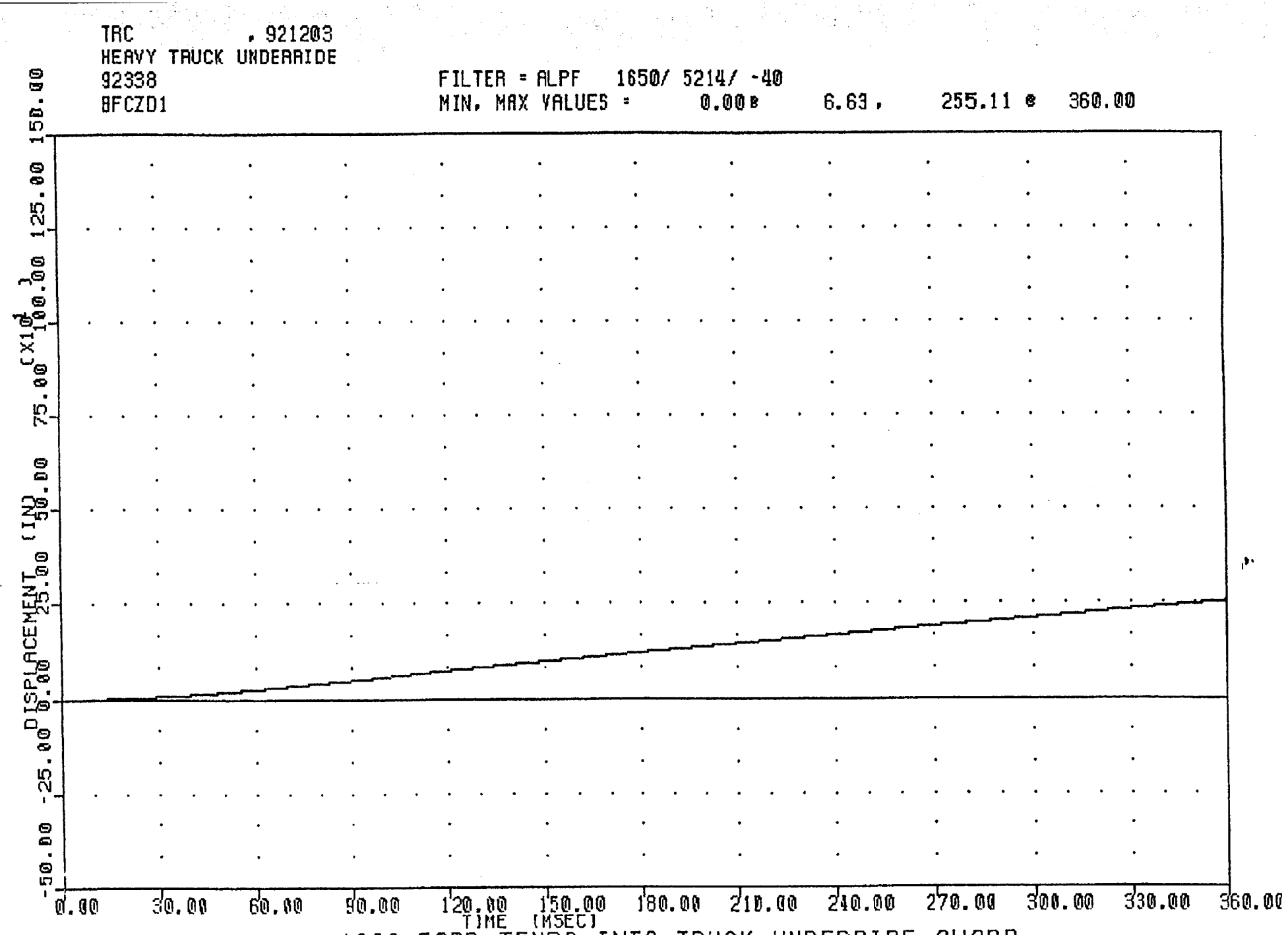
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER LEFT X-AXIS DISPLACEMENT



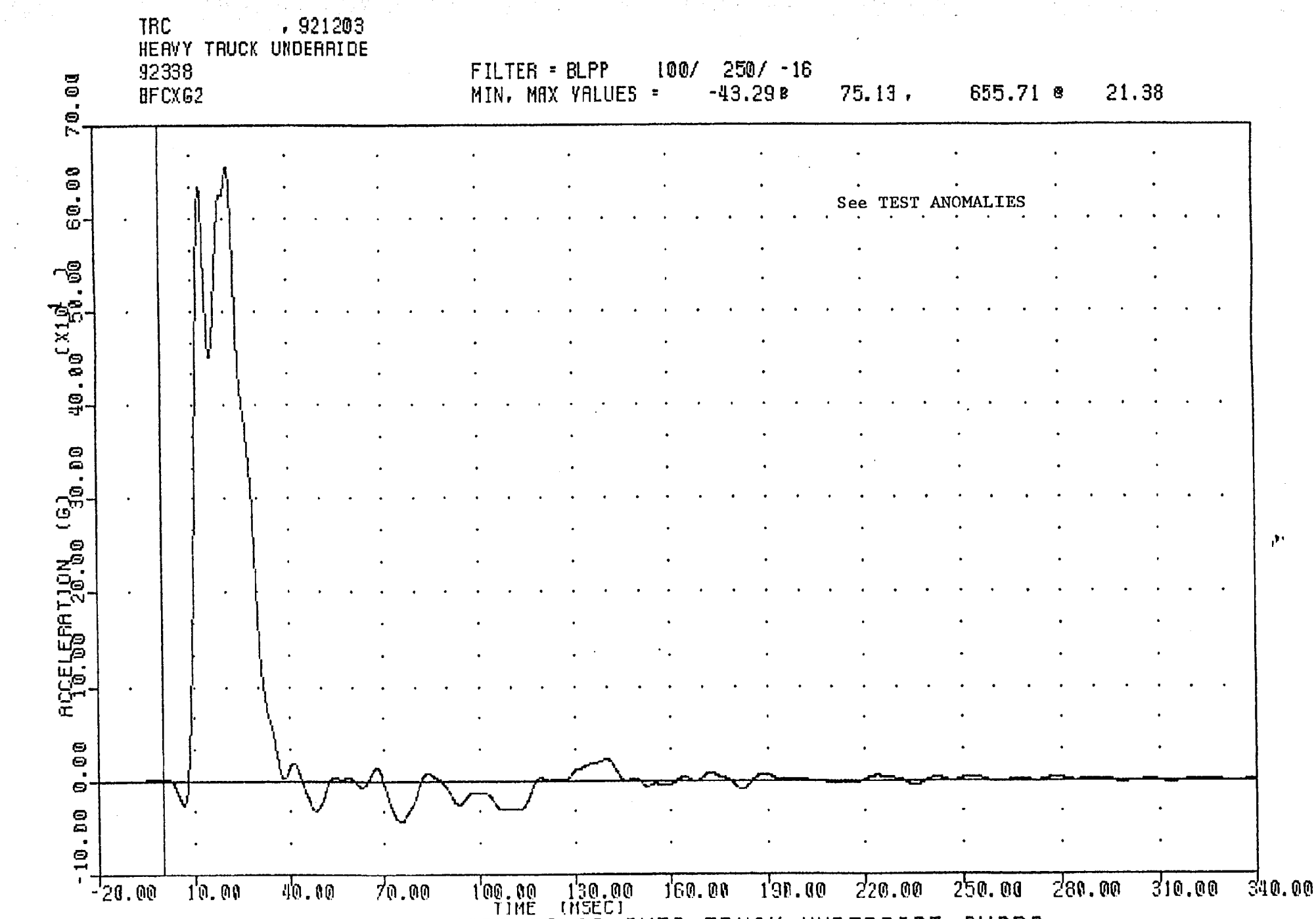
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER LEFT Z-AXIS ACCELERATION



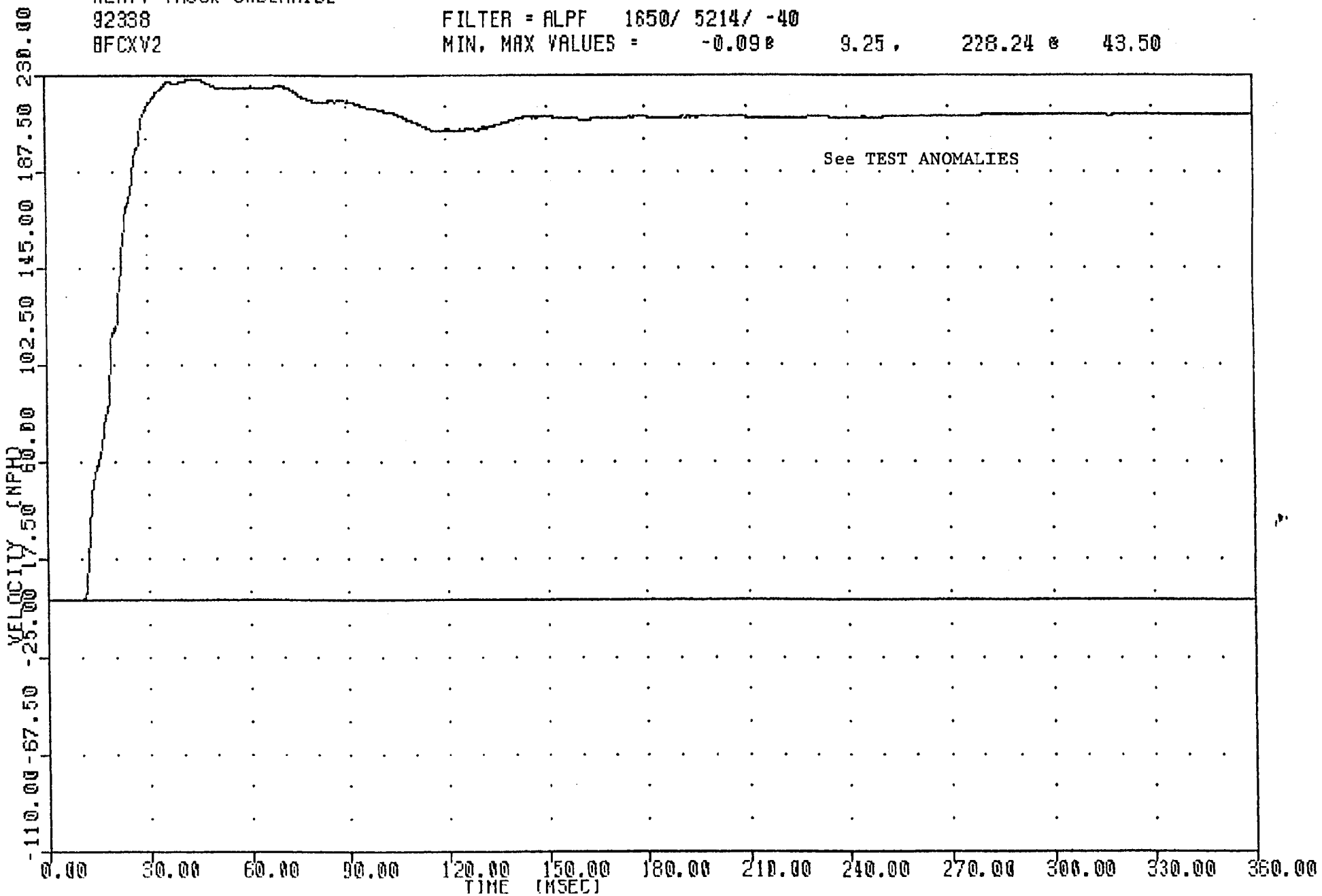
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER LEFT Z-AXIS VELOCITY



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER LEFT Z-AXIS DISPLACEMENT



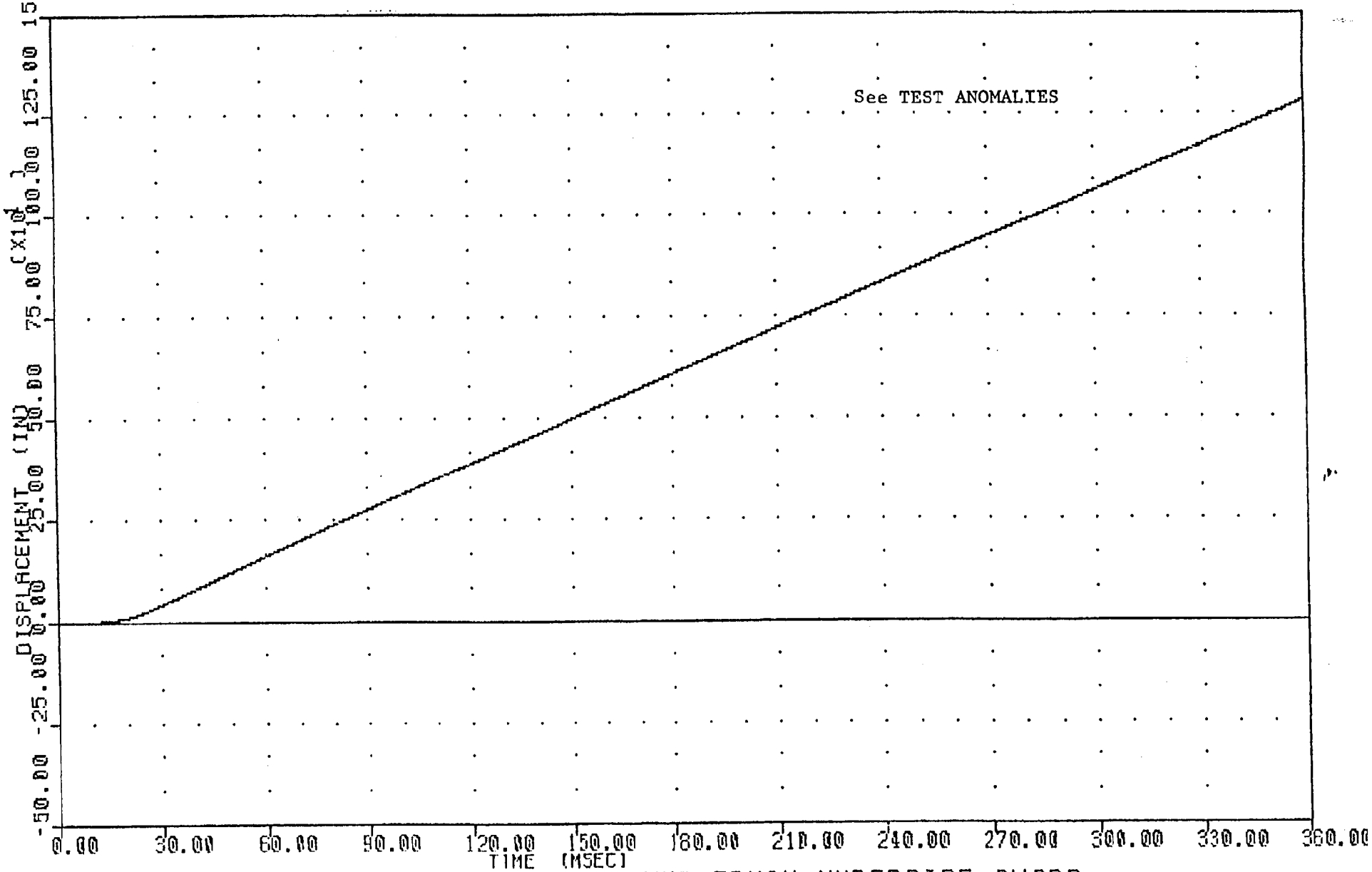
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER RIGHT X-AXIS ACCELERATION



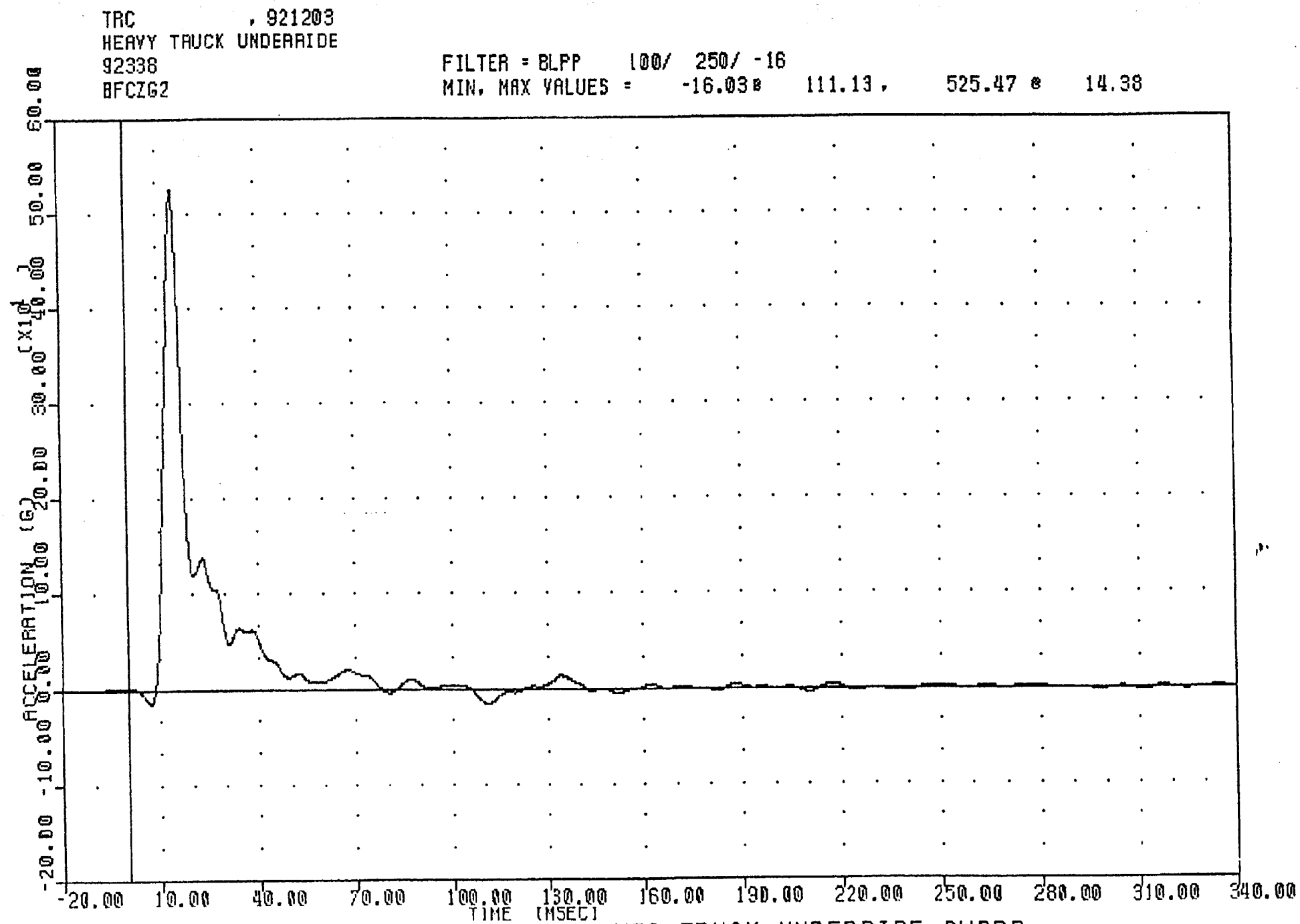
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER RIGHT X-AXIS VELOCITY

TRC , 921203
HEAVY TRUCK UNDERRIDE
92338
8FCXD2

FILTER = ALPF 1650/ 5214/ -40
MIN. MAX VALUES = 0.00 @ 10.38 , 1280.73 @ 360.00



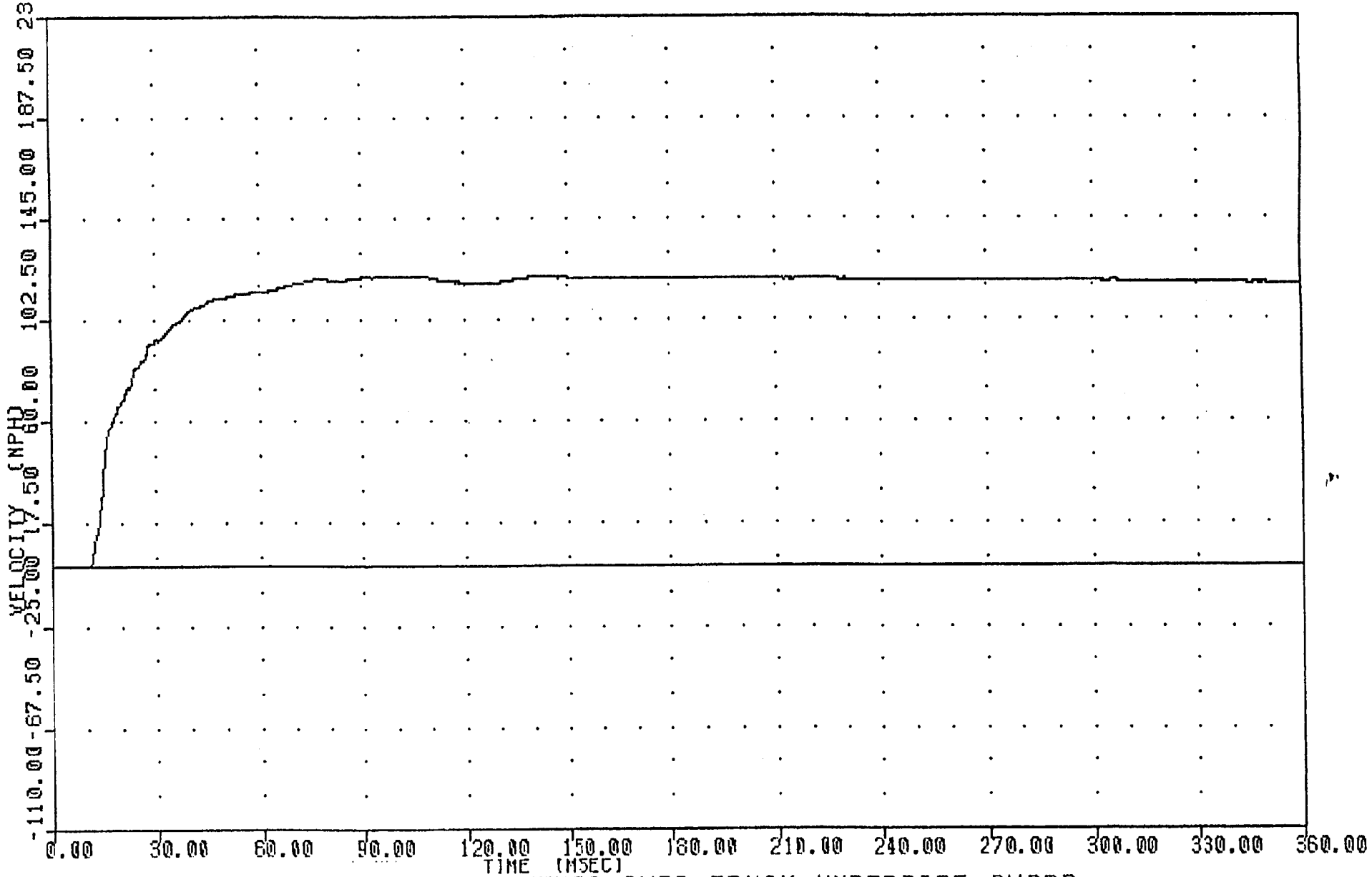
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER RIGHT X-AXIS DISPLACEMENT



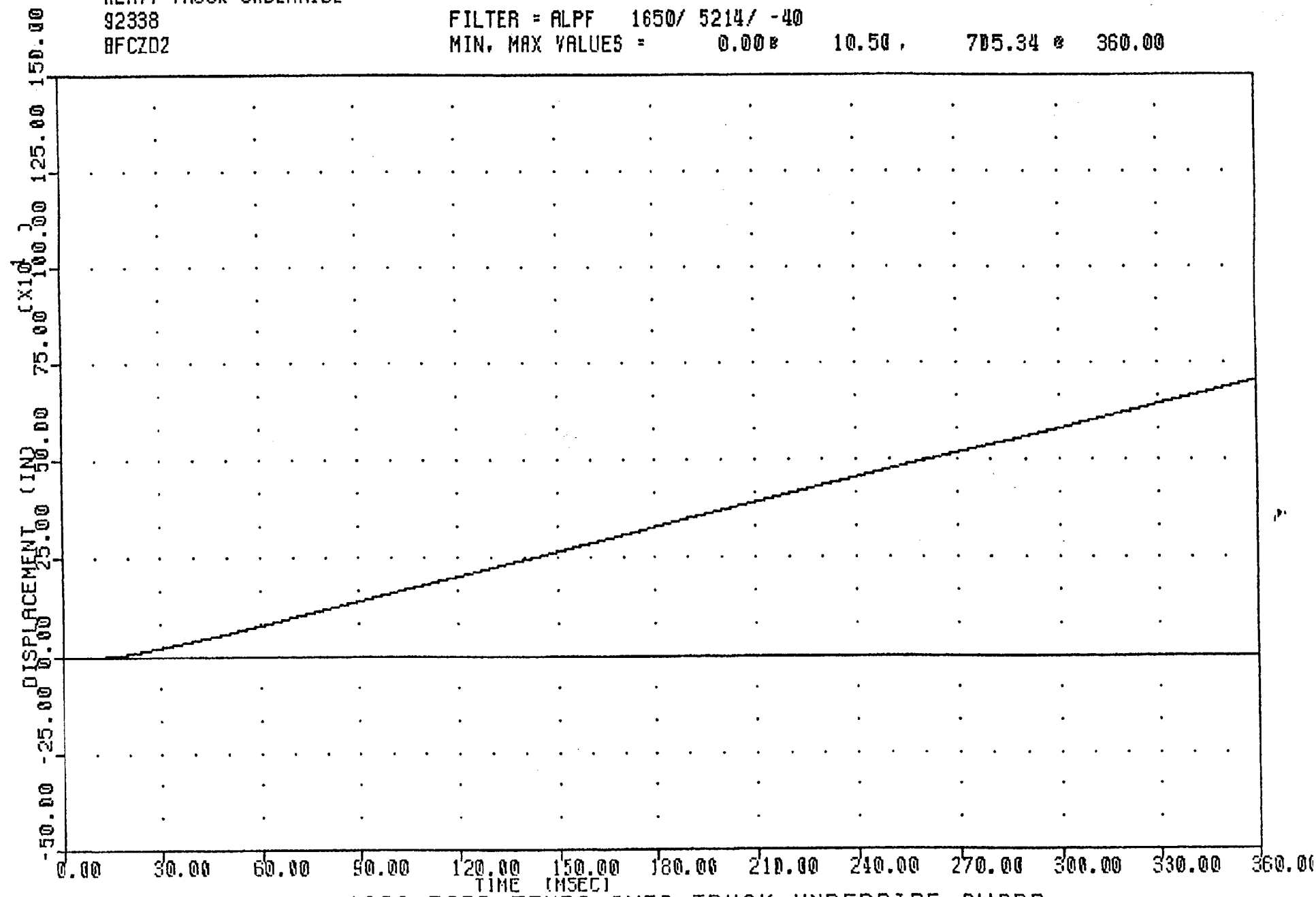
1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER RIGHT Z-AXIS ACCELERATION

TRC , 921203
HEAVY TRUCK UNDERRIDE
92338
BFCZV2

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -0.06 @ 9.63 , 120.81 @ 104.50



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER RIGHT Z-AXIS VELOCITY



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD
BARRIER FRONT CROSSMEMBER RIGHT Z-AXIS DISPLACEMENT

APPENDIX C

DUMMY CERTIFICATION DATA

PRE-TEST CERTIFICATION DATA

DRIVER DUMMY S/N 043

TRANSPORTATION RESEARCH CENTER OF OHIO
HYBRID III EXTERNAL DIMENSIONS
HUMANOID 043

1-DEC-92

TRC 43C2ED1 572E SN43 EXT. DIMENSION CAL02

TEST PARAMETER	(DIMEN.)	SPECIFICATION	TEST RESULTS
TEMPERATURE			70.0 DEG. F
RELATIVE HUMIDITY			48.0 %
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	(D)	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 Pete Foust

TRANSPORTATION RESEARCH CENTER OF OHIO

HEAD DROP TEST

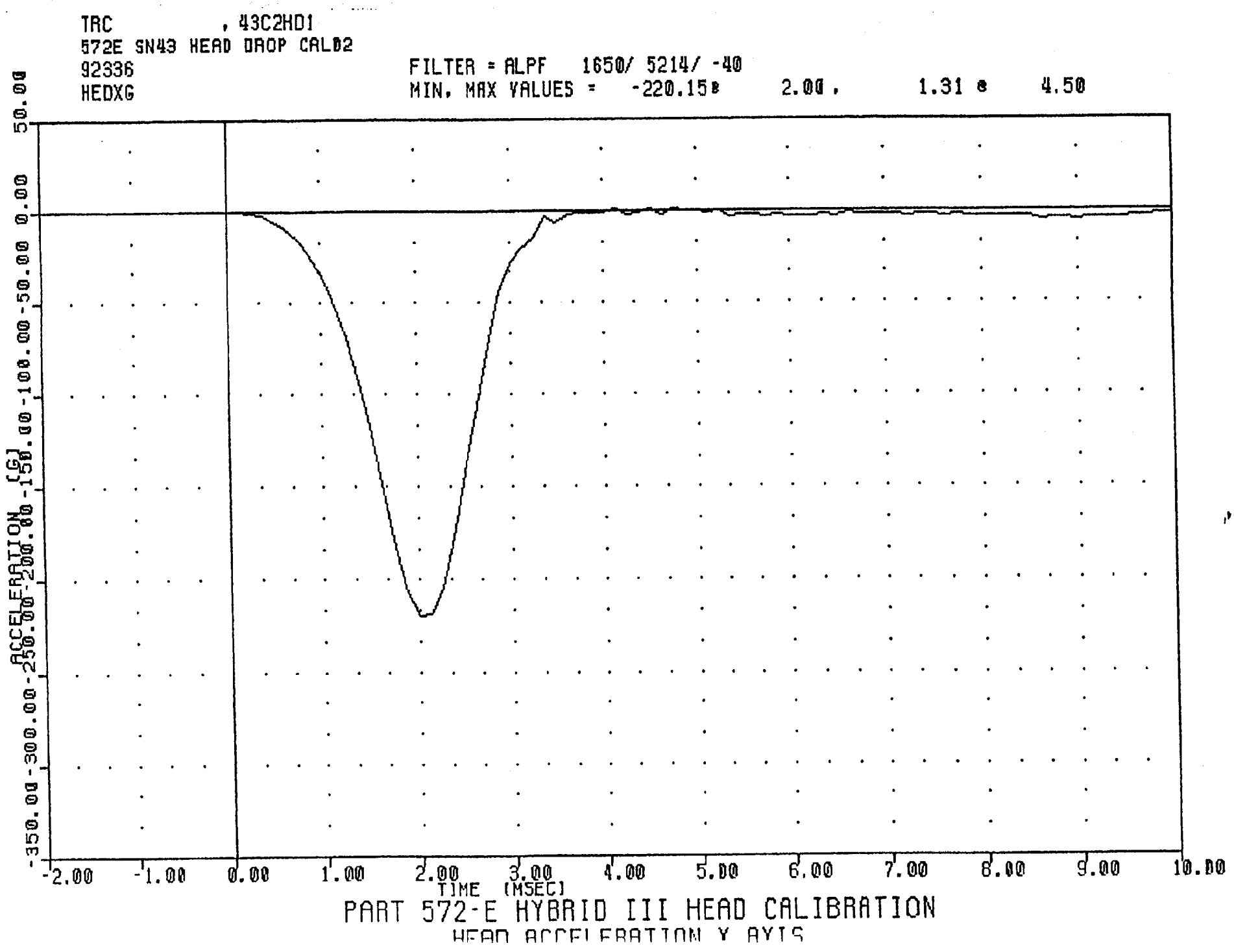
HYBRID III 01-DEC-92

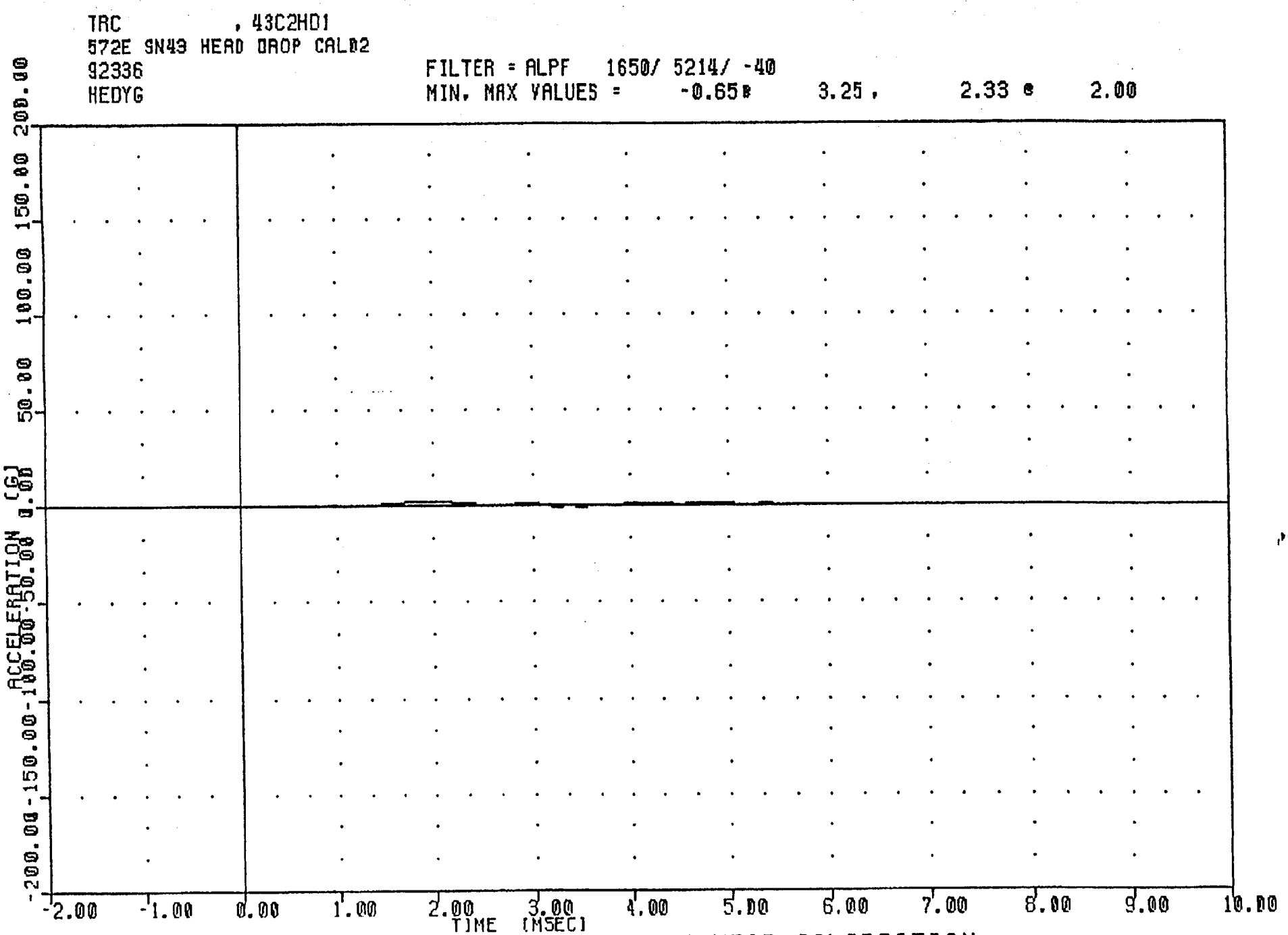
TRC 43C2HD1 572E SN43 HEAD DROP CAL02

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	32.0 %
PEAK RESULTANT ACCELERATION	225 - 275 G	254.15 G
PEAK LATERAL ACCELERATION	15 G MAX	2.33 G
IS ACCELERATION CURVE UNIMODAL?	YES	YES

TEST MEETS SPECIFICATIONS

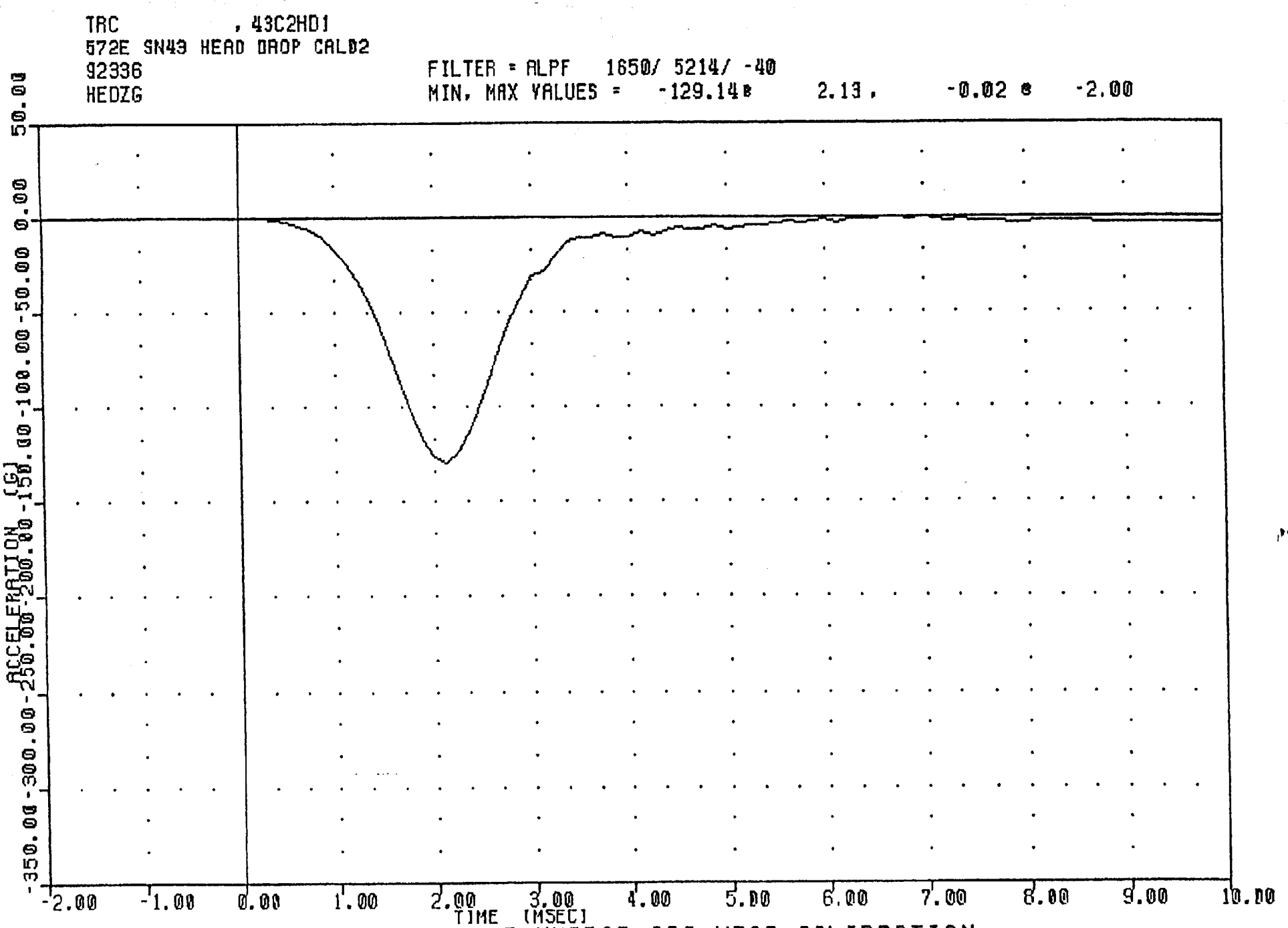
TECHNICIAN Pete Fant


TRC , 43C2HD1
572E SN43 HEAD DROP CAL02
92336
HEDXG
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -220.15 2.00 , 1.31 4.50
ACCELERATION (G)
50.00
0.00
-50.00
-100.00
-150.00
-200.00
-250.00
-300.00
-350.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
TIME (MSEC)
PART 572-E HYBRID III HEAD CALIBRATION
HEAD ACCELERATION Y AXIS



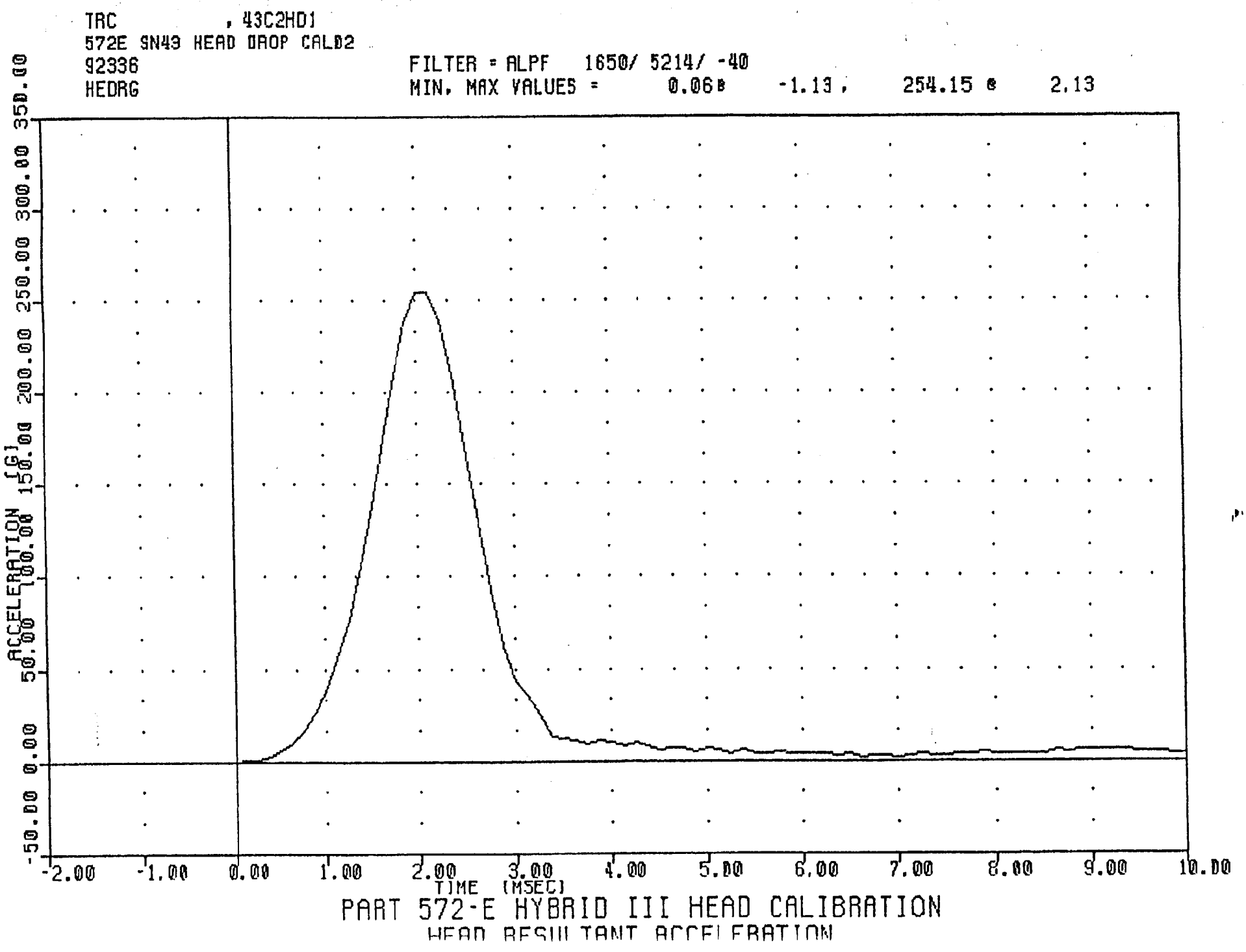
PART 572-E HYBRID III HEAD CALIBRATION

HEAD ACCELERATION Y AXIS



PART 572-E HYBRID III HEAD CALIBRATION

HEAD ACCELERATION Z AXIS


TRC , 43C2HD1
572E SN43 HEAD DROP CAL02
92336
HEDRG
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = 0.06 @ -1.13 , 254.15 @ 2.13
ACCELERATION (G)
-50.00 0.00 50.00 100.00 150.00 200.00 250.00 300.00 350.00
-2.00 -1.00 0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00
TIME (MSEC)
PART 572-E HYBRID III HEAD CALIBRATION
HEAD RESULTANT ACCELERATION

TRANSPORTATION RESEARCH CENTER OF OHIO

NECK FLEXION TEST

HYBRID III

01-DEC-92

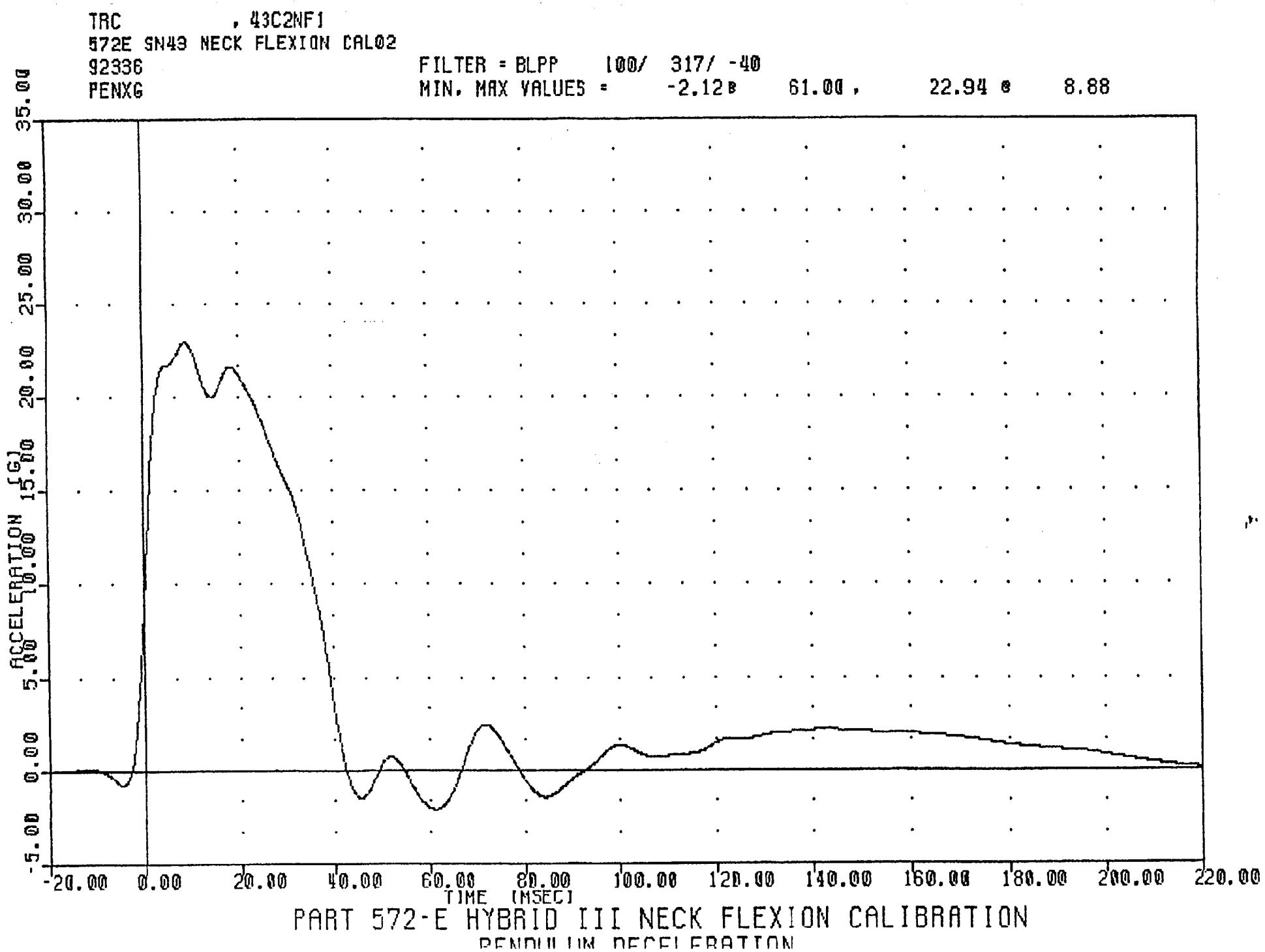
6 AXIS NECK TRANSDUCER
TRC 43C2NF1

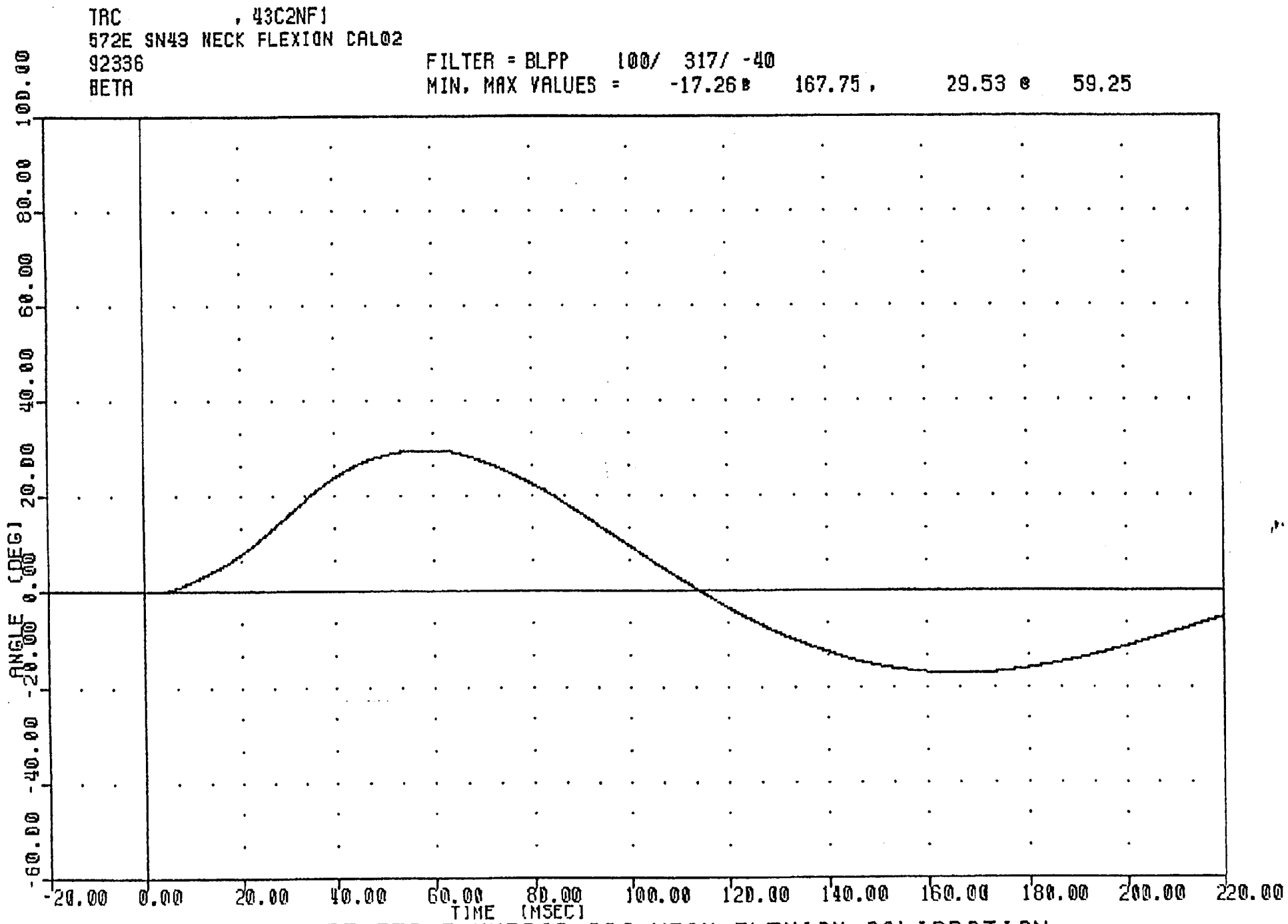
572E SN43 NECK FLEXION CAL02

TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY		10% - 70%	32.0 %
IMPACT VELOCITY		22.6 - 23.4 FT/SEC	23.08 FT/SEC
PENDULUM DECELERATION	10 MS	22.50 - 27.50 G	22.64 G
	20 MS	17.60 - 22.60 G	21.24 G
	30 MS	12.50 - 18.50 G	15.42 G
MAX PENDULUM G ABOVE 30 MS		29 G MAX	15.35 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		34 - 42 MS	38.88 MS
D PLANE ROTATION	MAX	64 - 78 DEG.	64.74 DEG.
	TIME	57 - 64 MS	57.25 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MAX	65 - 80 FT.LBS	73.34 FT.LBS
	TIME	47 - 58 MS	51.88 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		113 - 128 MS	113.75 MS
POSITIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		97 - 107 MS	98.25 MS

TEST MEETS SPECIFICATIONS

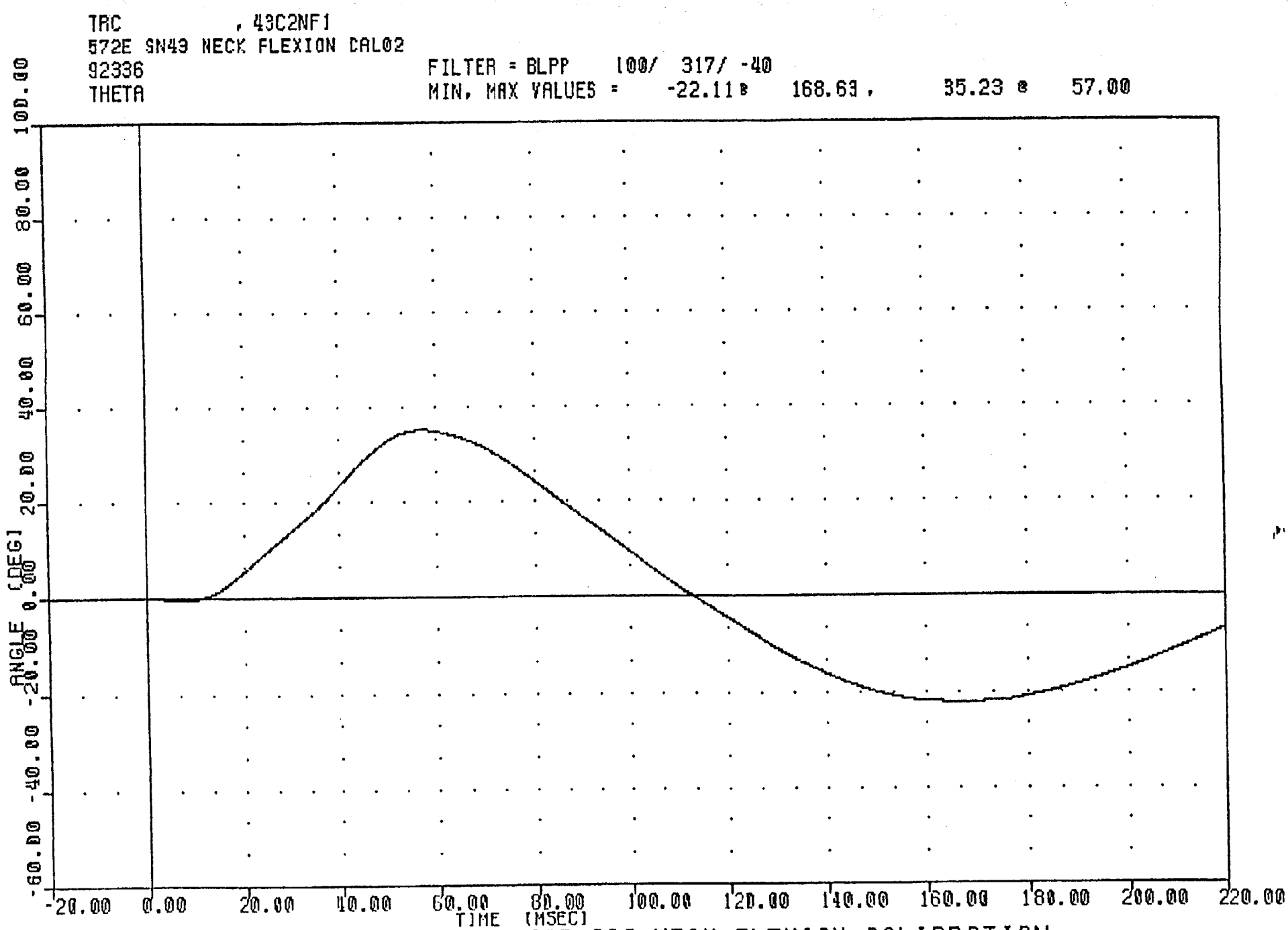
TECHNICIAN Pete Foust


TRC , 43C2NF1
572E SN49 NECK FLEXION CAL02
92336
PENXG
FILTER = BLPP 100/ 317/ -40
MIN, MAX VALUES = -2.12 @ 61.00 , 22.94 @ 8.88
ACCELERATION (G)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
220.00
TIME (MSEC)
PART 572-E HYBRID III NECK FLEXION CALIBRATION
PENDULUM DECELERATION



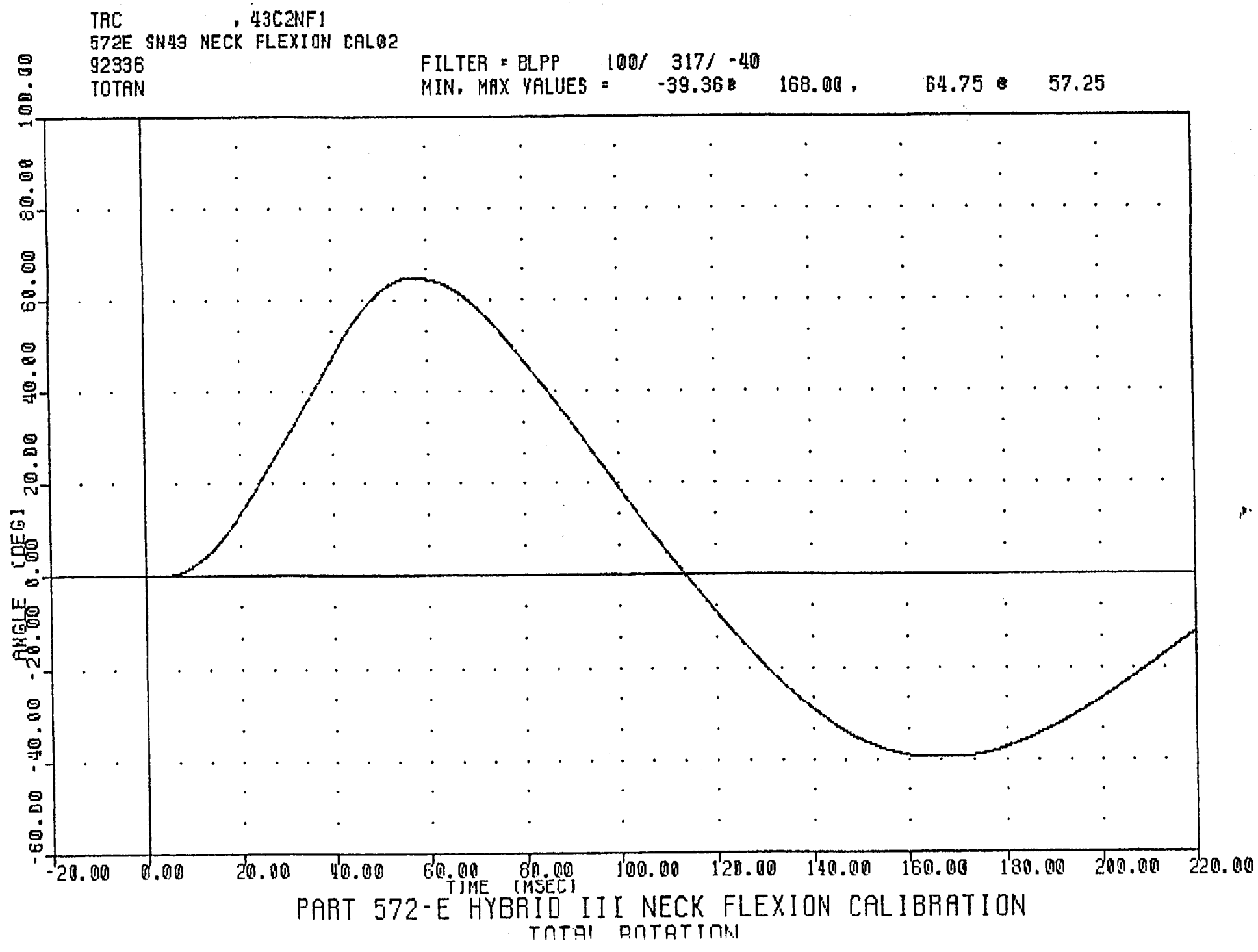
PART 572-E HYBRID III NECK FLEXION CALIBRATION

ROTATION ABOUT BASE OF NECK



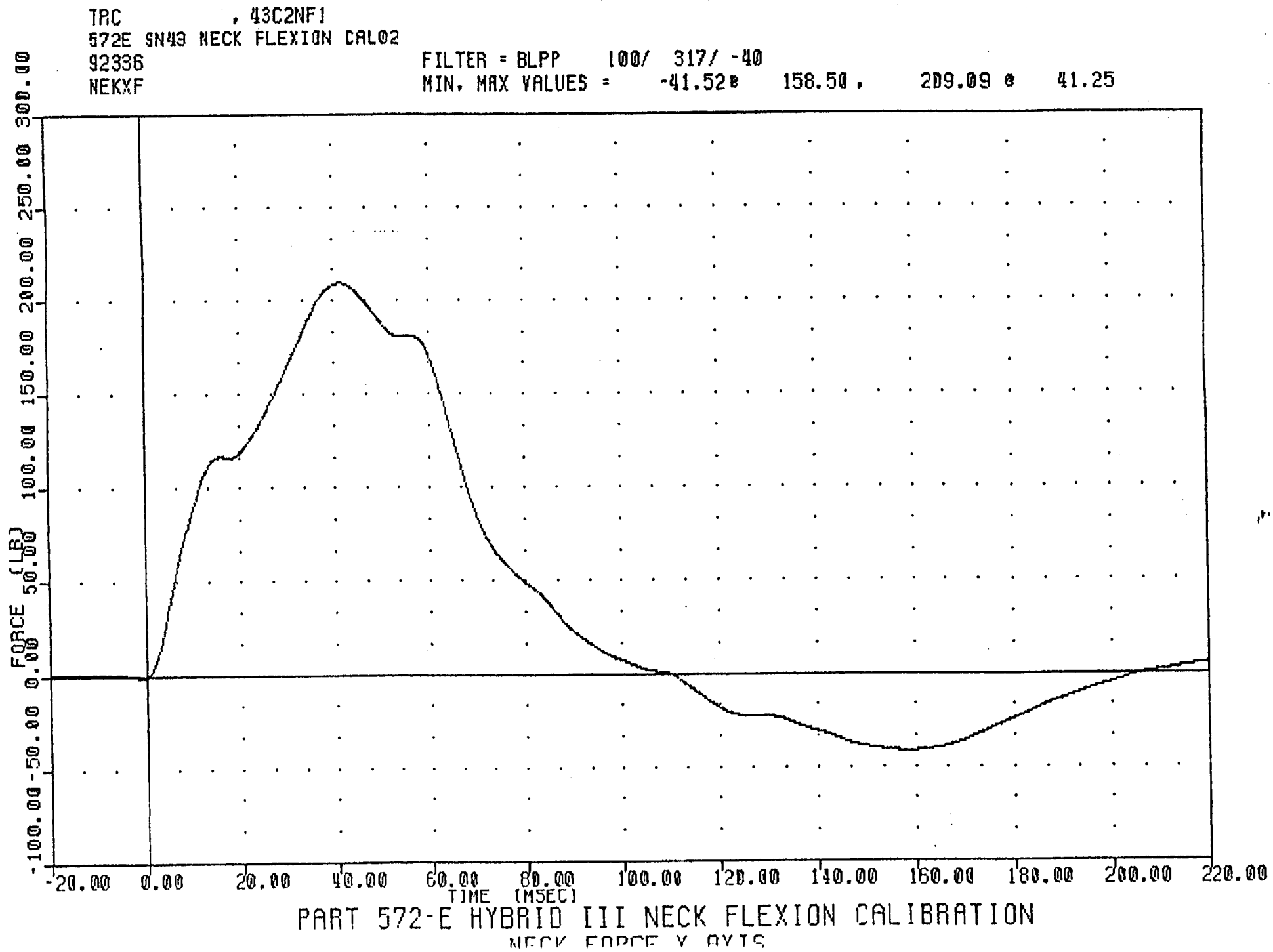
PART 572-E HYBRID III NECK FLEXION CALIBRATION

ROTATION ABOUT OCCIPITAL CONDYLE



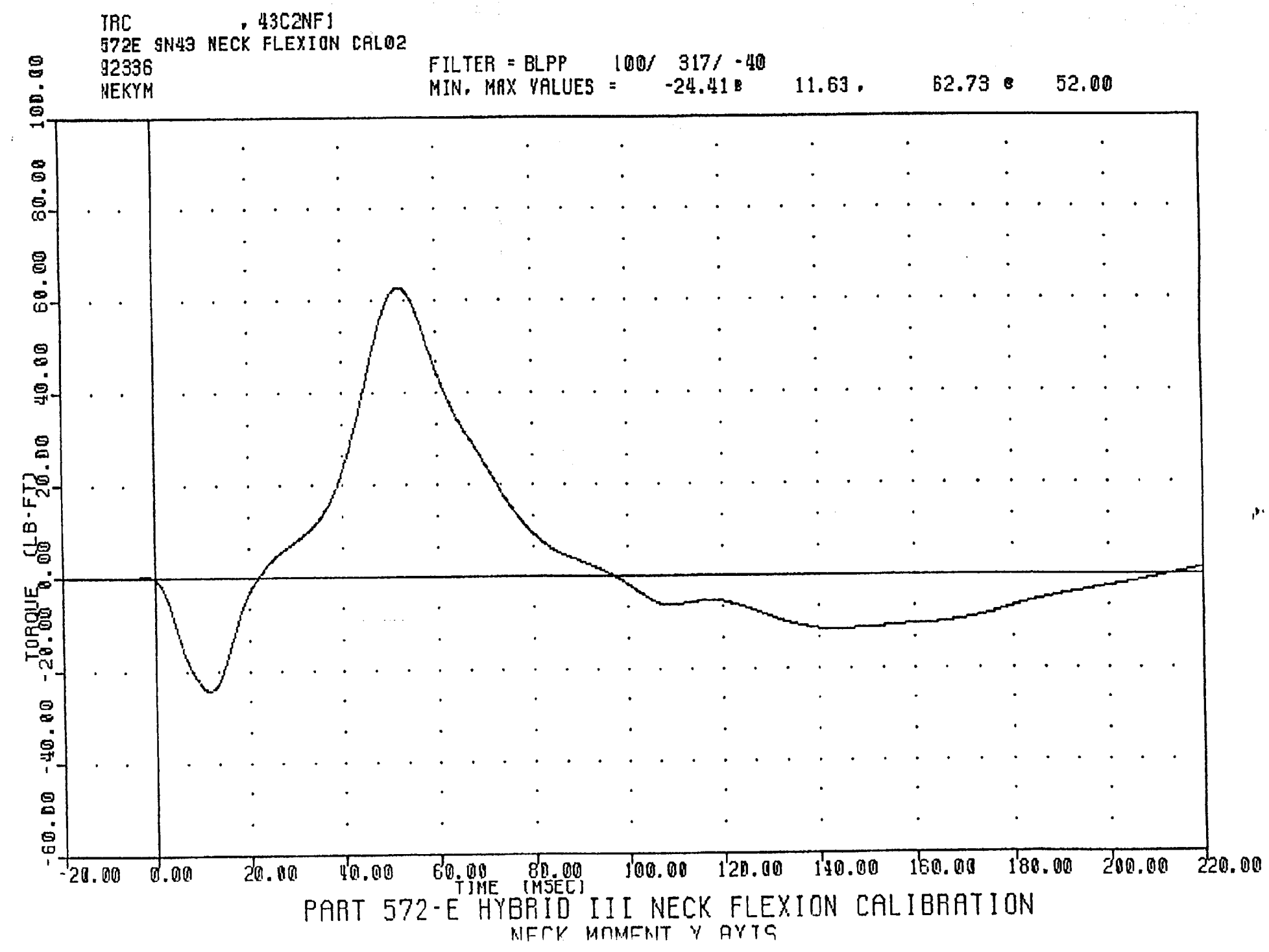
PART 572-E HYBRID III NECK FLEXION CALIBRATION

TOTAL ROTATION



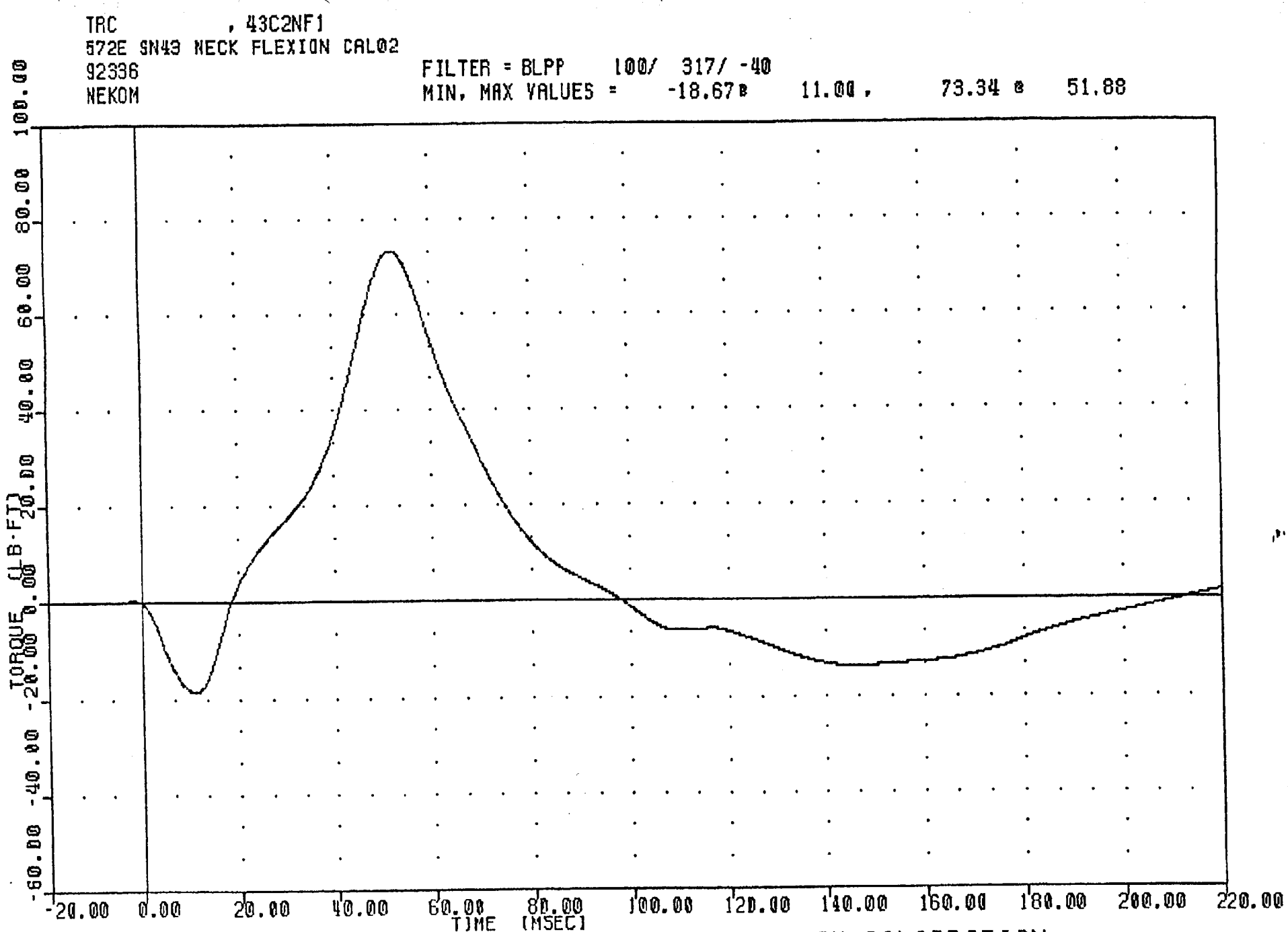
PART 572-E HYBRID III NECK FLEXION CALIBRATION

NECK FORCE 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

01-DEC-92

6 AXIS NECK TRANSDUCER
TRC 43C2NE1

572E SN43 NECK EXT. CAL02

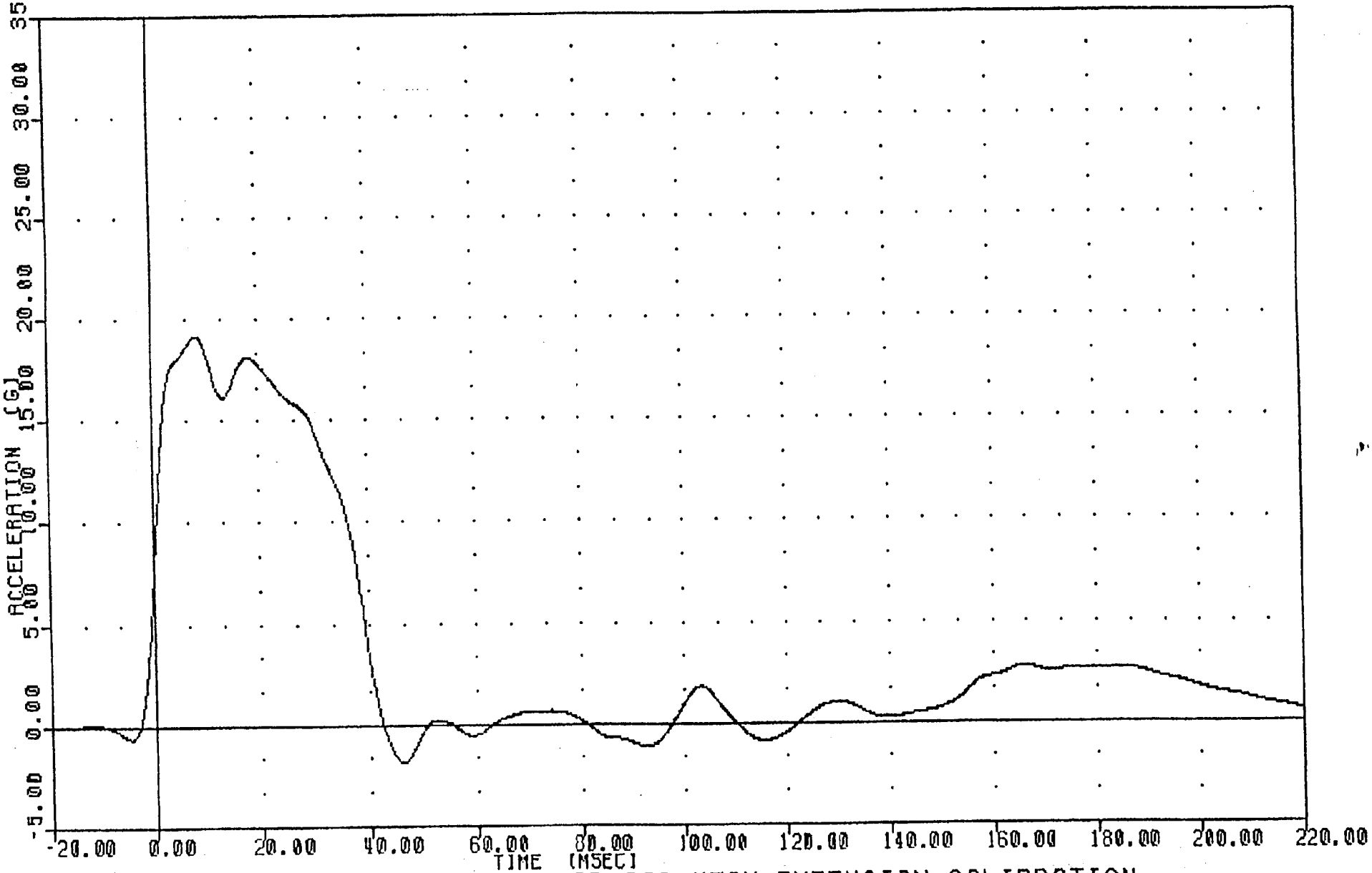
TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY		10% - 70%	48.0 %
IMPACT VELOCITY		19.50-20.30 FT/SEC	19.83 FT/SEC
PENDULUM DECELERATION	10 MS	17.20 - 21.20 G	18.63 G
	20 MS	14.00 - 19.00 G	17.85 G
	30 MS	11.00 - 16.00 G	14.60 G
MAX PENDULUM G ABOVE 30 MS		22 G MAX	14.52 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		38 - 46 MS	39.00 MS
D PLANE ROTATION	MAX	81 - 106 DEG.	88.71 DEG.
	TIME	72 - 82 MS	72.88 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MIN	-59.0/-39.0 FT.LBS	-46.88 FT.LBS
	TIME	65 - 79 MS	68.25 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		147 - 174 MS	153.25 MS
NEGATIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		120 - 148 MS	133.25 MS

TEST MEETS SPECIFICATIONS

TECHNICIAN

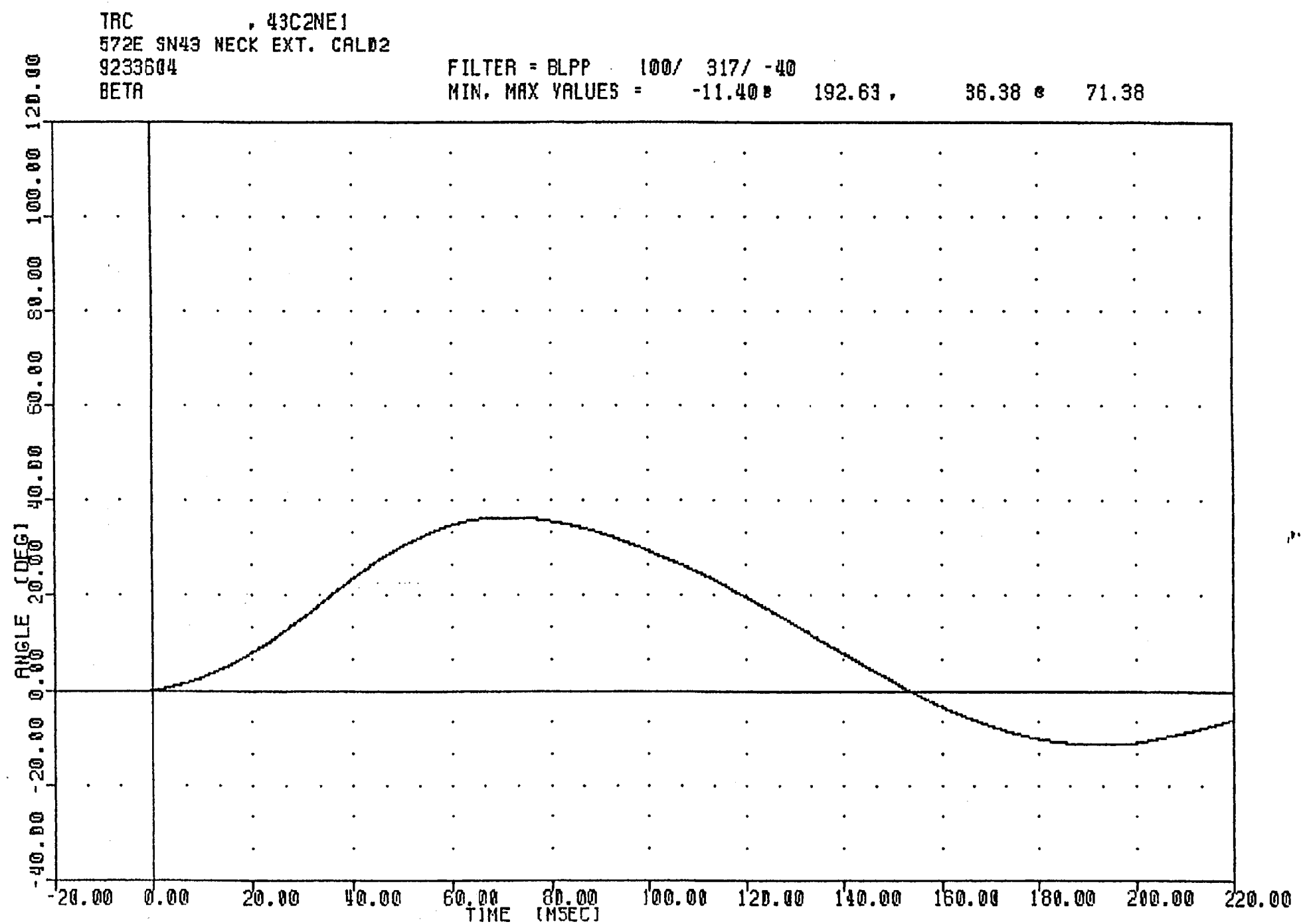
TRC . 43C2NE1
572E SN43 NECK EXT. CAL02
9233604
PENXG

FILTER = BLPP 100/ 317/ -40
MIN, MAX VALUES = -1.85@ 46.00, 19.20 @ 8.50



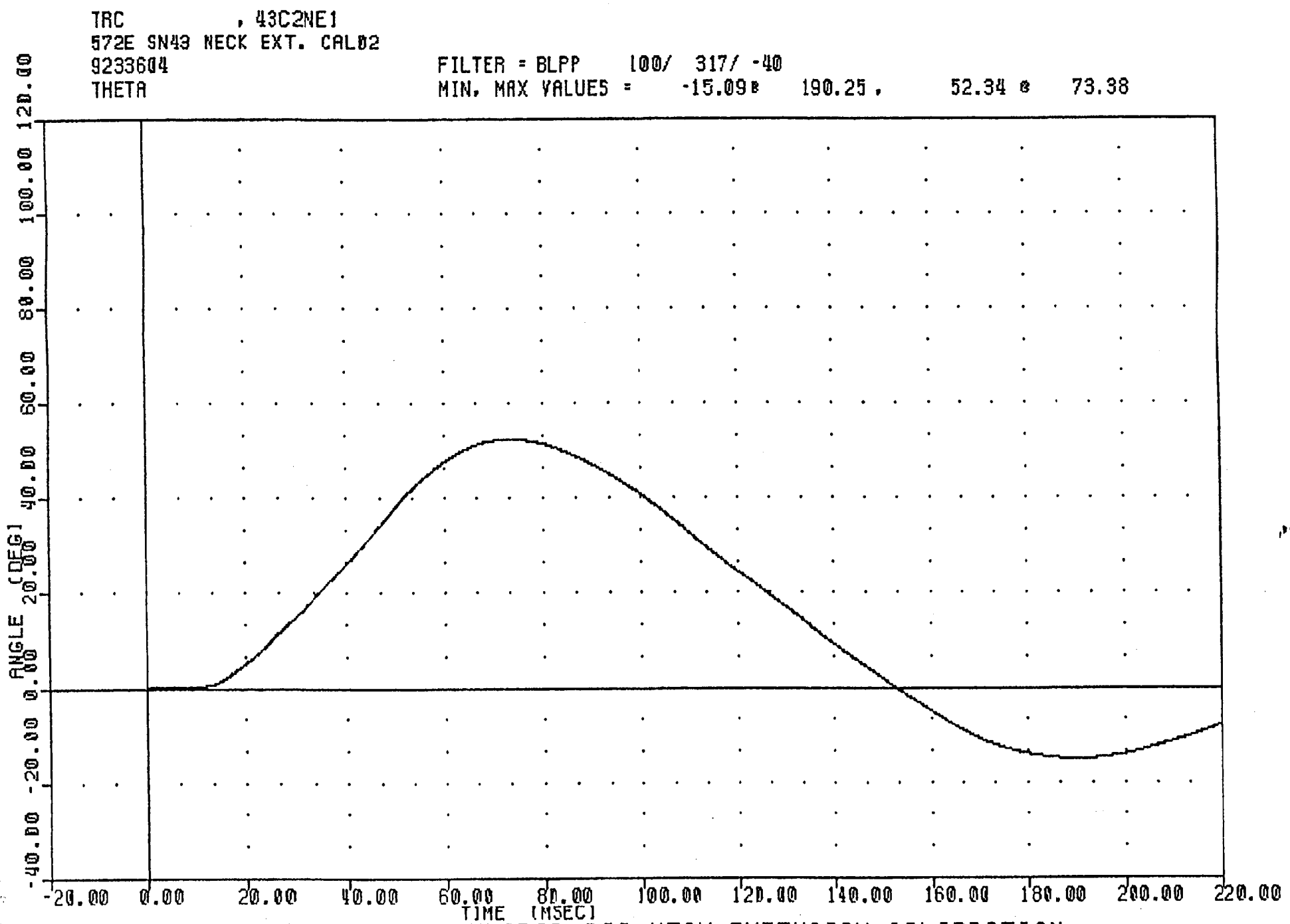
PART 572-E HYBRID III NECK EXTENSION CALIBRATION

PENDULUM DECELERATION



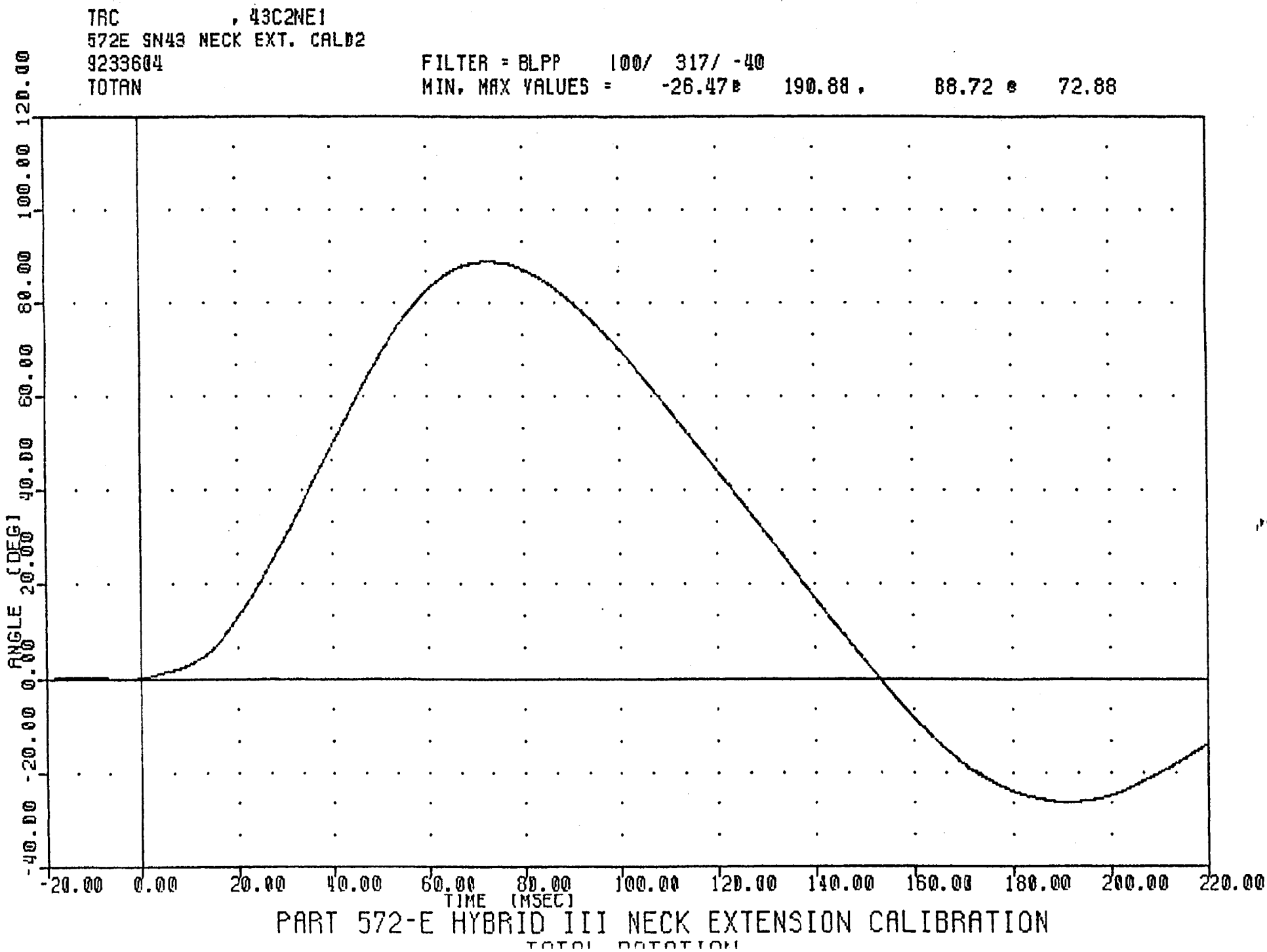
PART 572-E HYBRID III NECK EXTENSION CALIBRATION

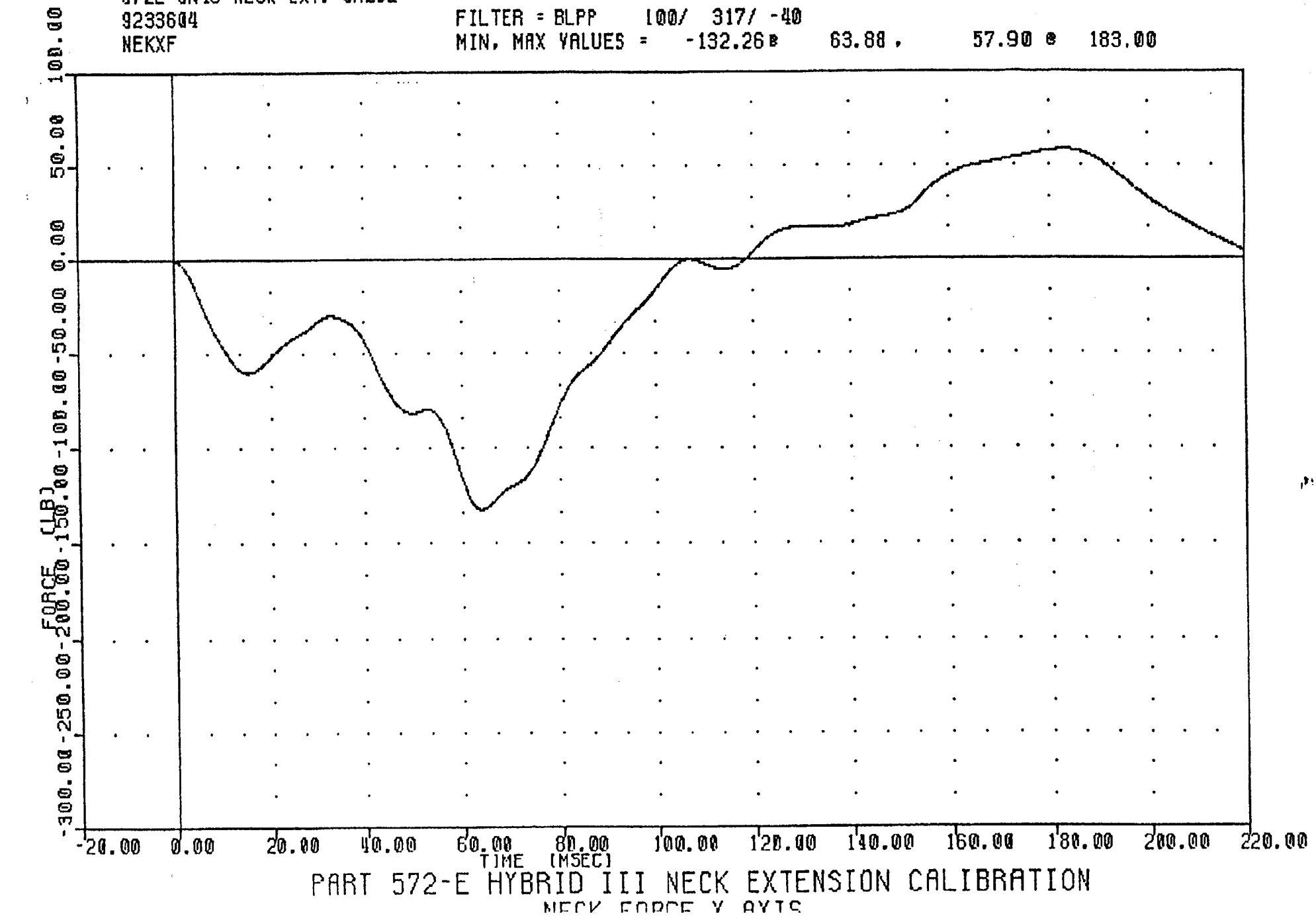
ROTATION ABOUT BASE OF NECK



PART 572-E HYBRID III NECK EXTENSION CALIBRATION

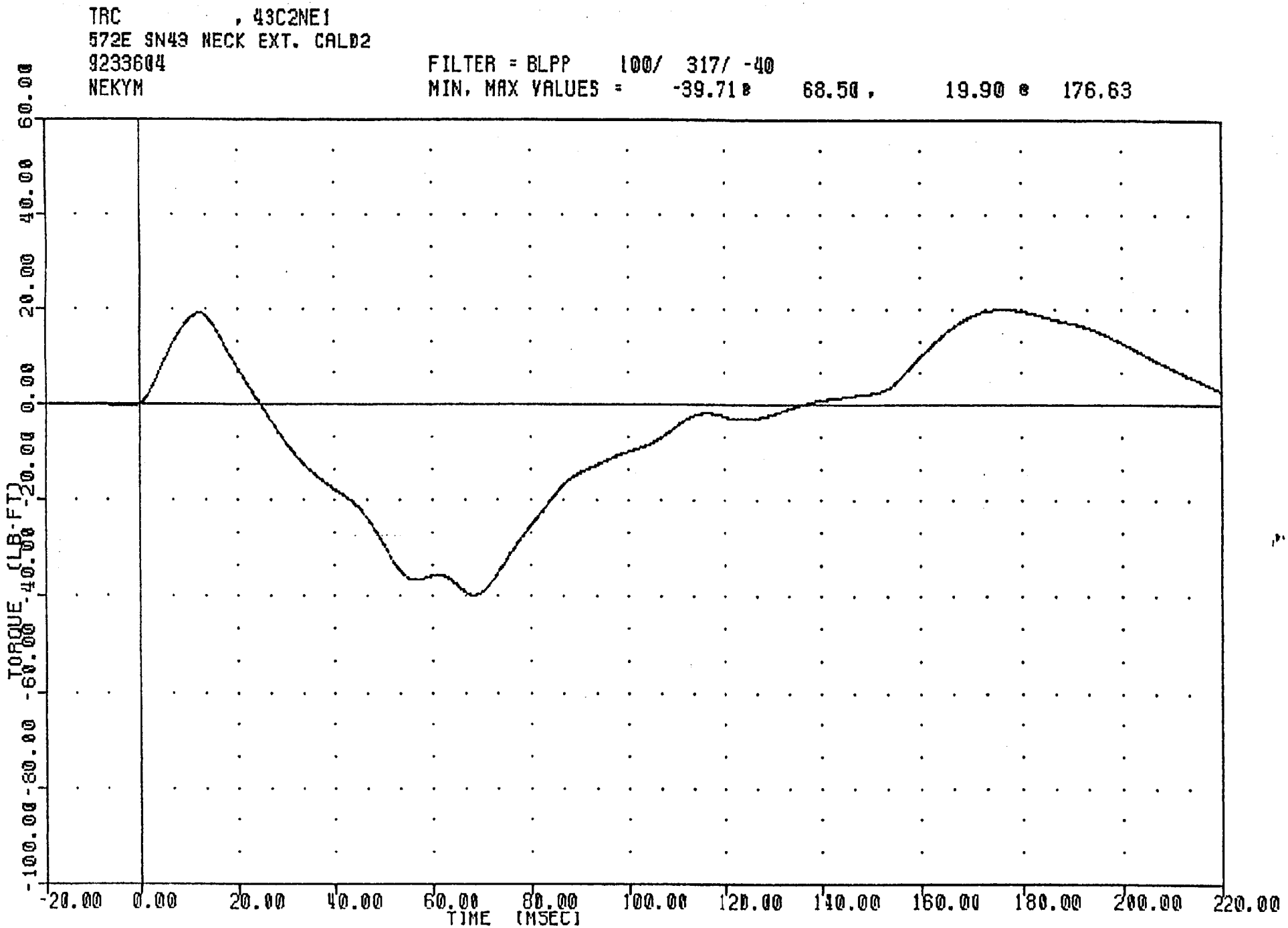
ROTATION ABOUT OCCIPITAL CONDYLE


TRC , 43C2NE1
572E SN43 NECK EXT. CALD2
9233604
TOTAN
FILTER = BLPP 100/ 317/ -40
MIN, MAX VALUES = -26.47 @ 190.88 , 88.72 @ 72.88
ANGLE [DEG]
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
220.00
TIME (MSEC)
PART 572-E HYBRID III NECK EXTENSION CALIBRATION
TOTAL ROTATION



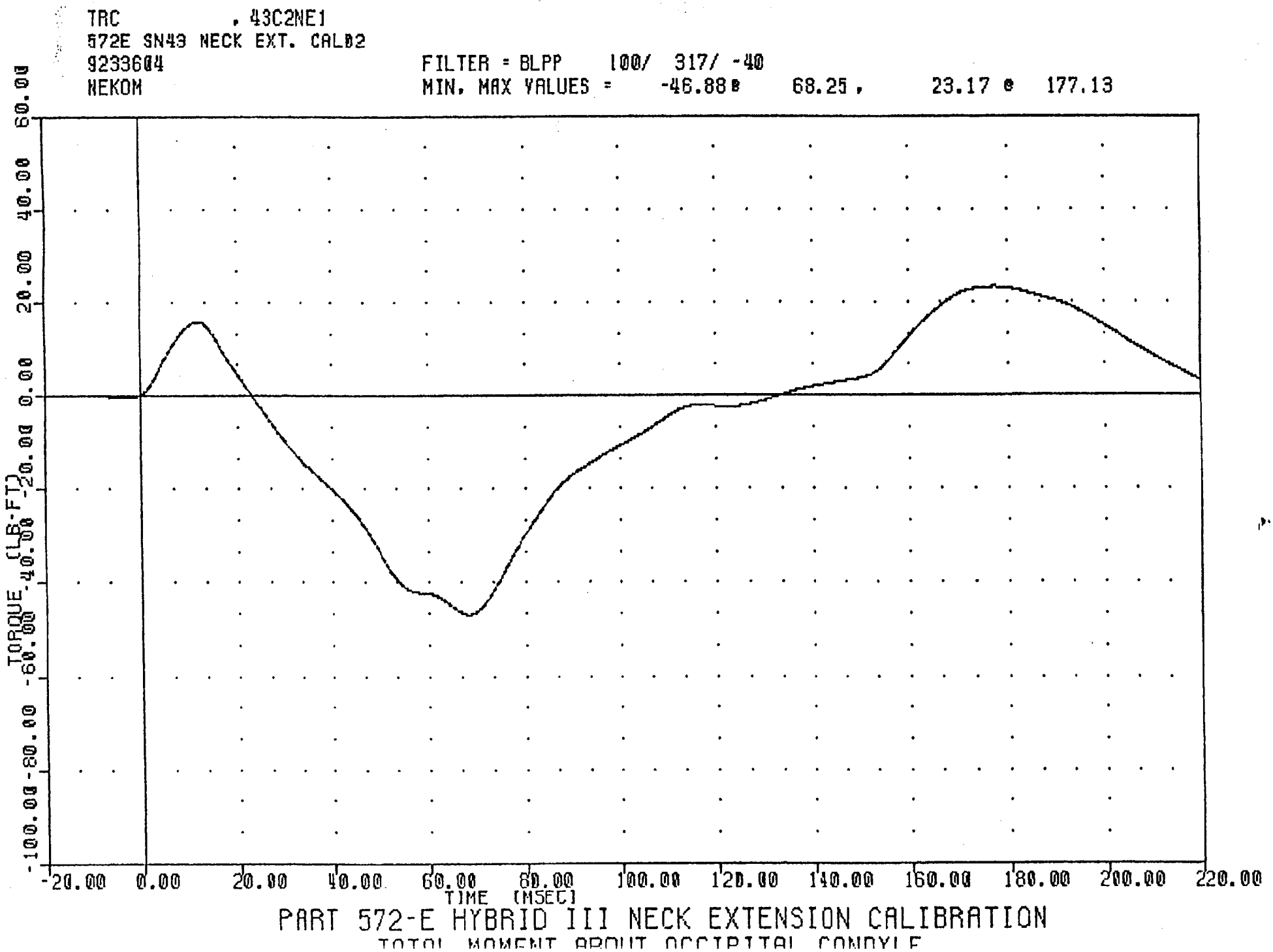
PART 572-E HYBRID III NECK EXTENSION CALIBRATION

NECK FORCE Y 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

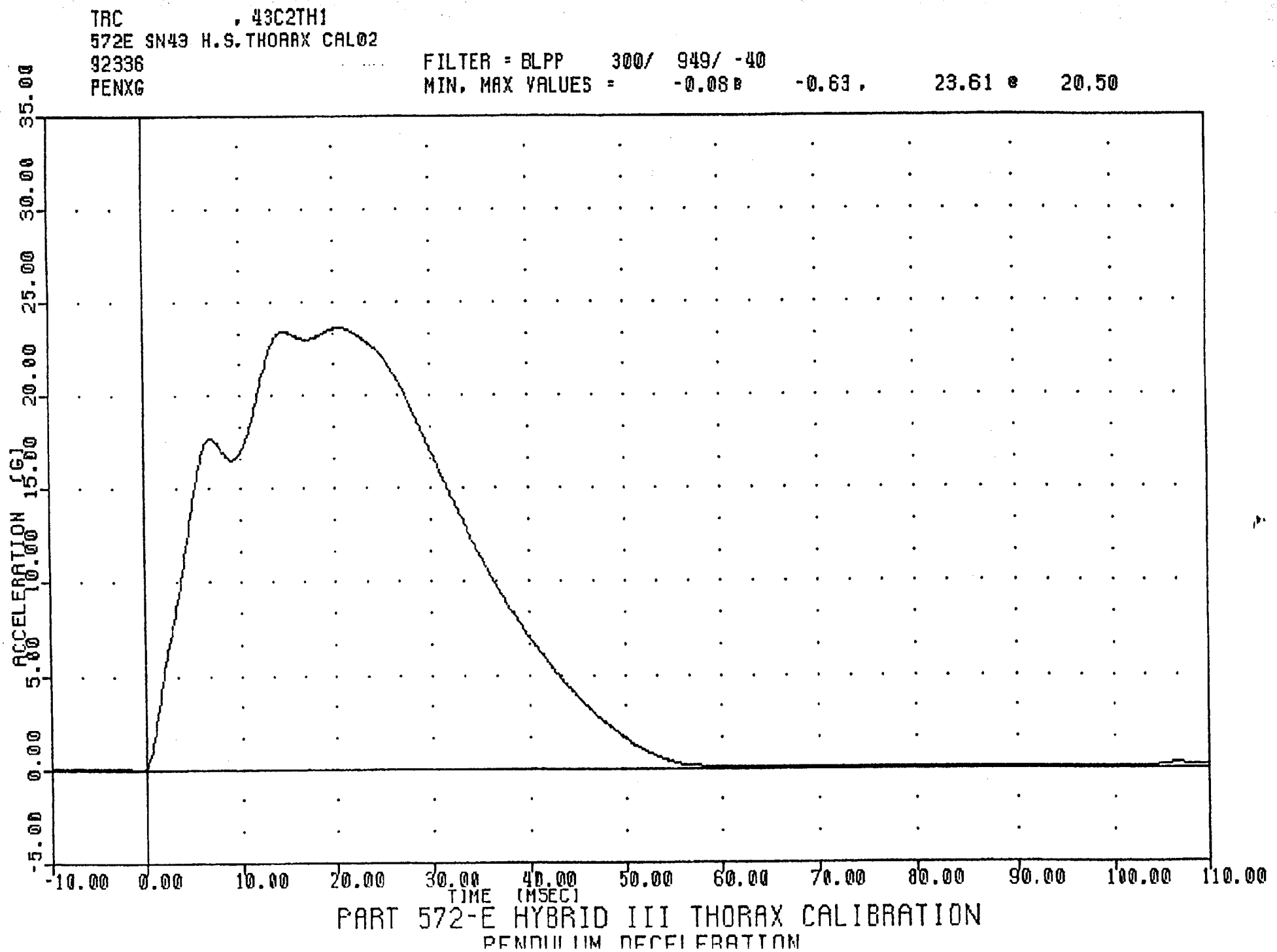
HYBRID III 01-DEC-92

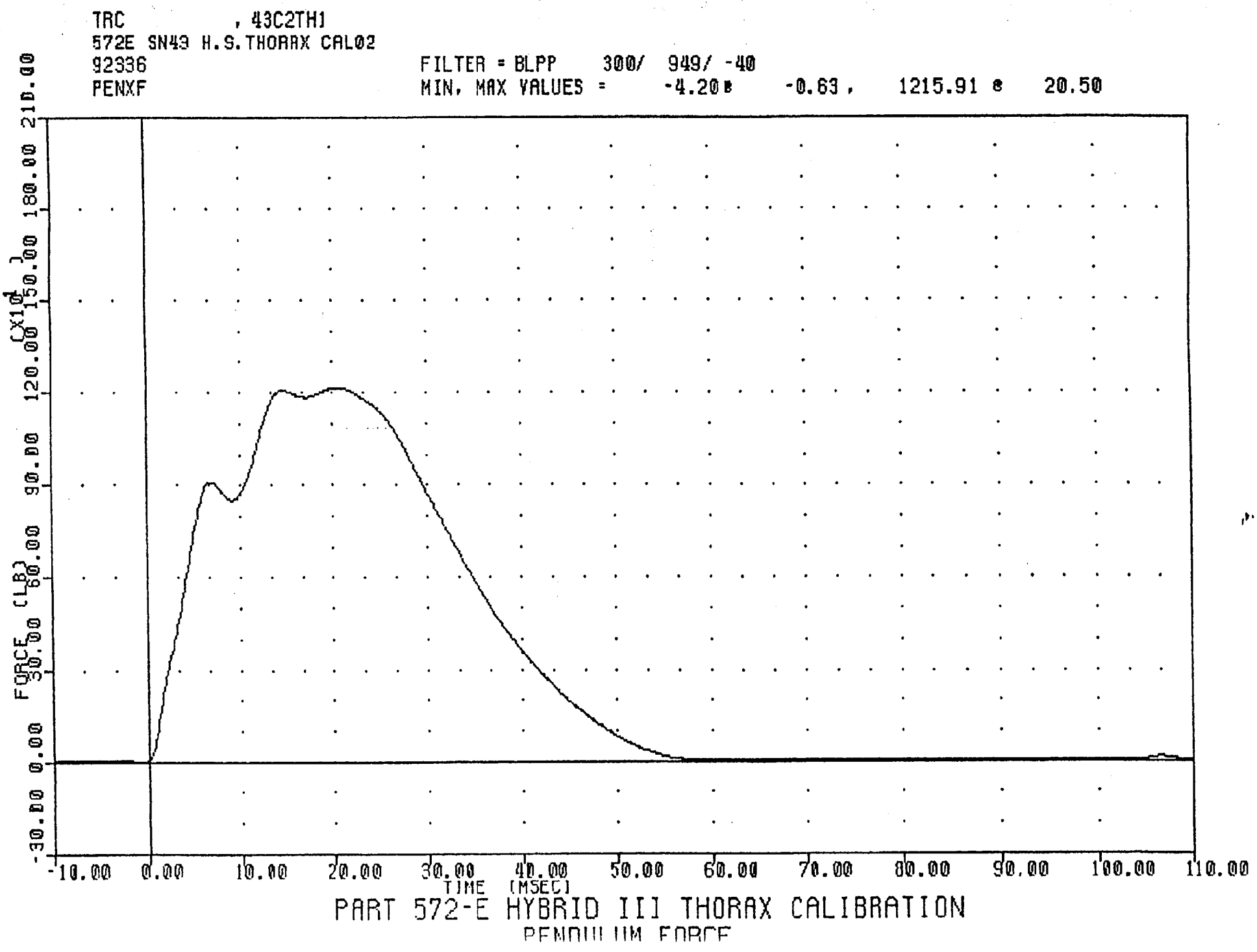
TRC 43C2TH1 572E SN43 H.S.THORAX CAL02

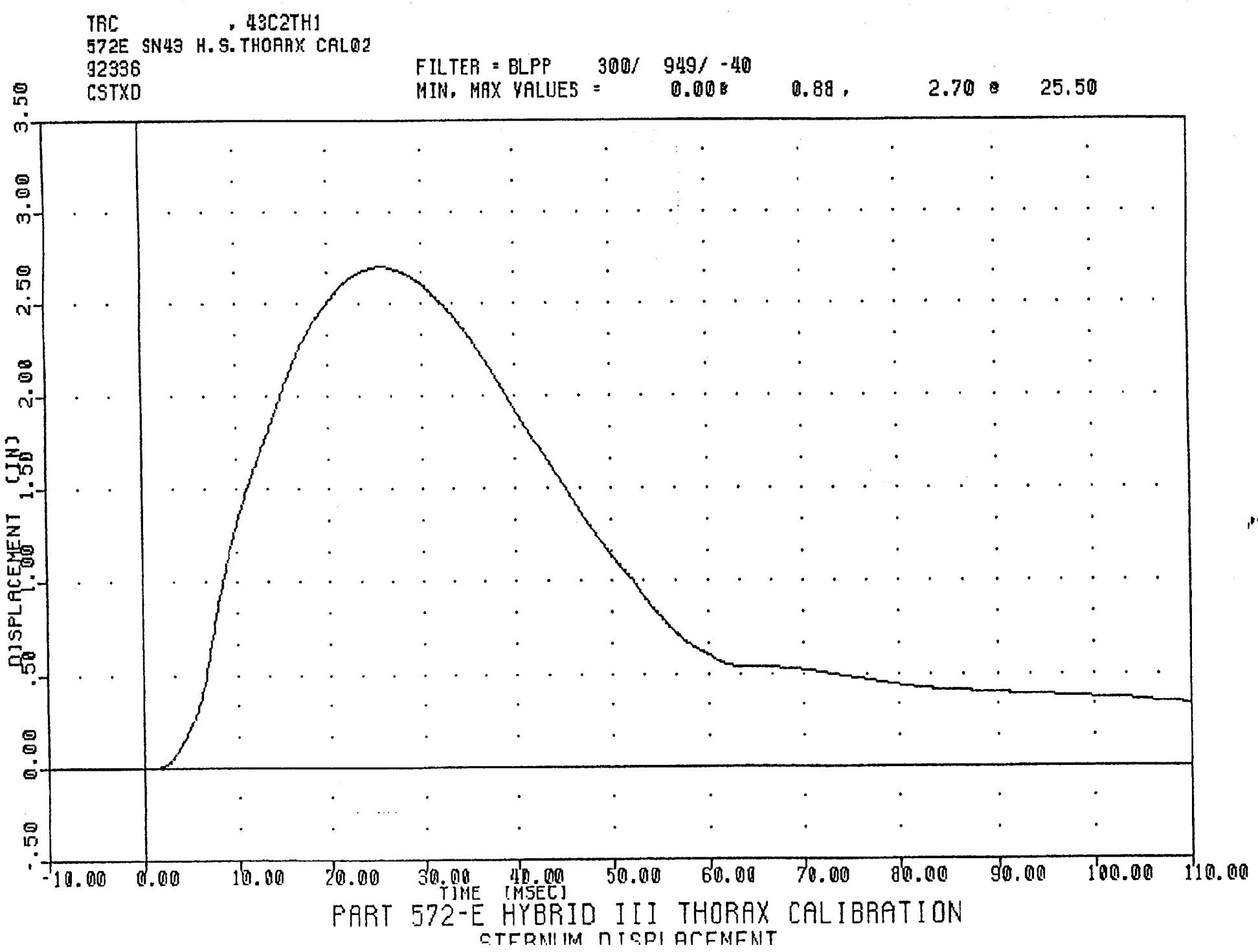
TEST PARAMETER	HIGH SPEED TEST SPECIFICATION	TEST RESULTS
TEMPERATURE	69 - 72 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	48.0 %
PENDULUM VELOCITY	21.6-22.4 FT/SEC	21.91 FT/SEC
MAXIMUM DEFLECTION	2.50 - 2.86 IN	2.70 IN
MAXIMUM RESISTIVE FORCE	1160 - 1325 LBS	1215.9 LBS
INTERNAL HYSTERESIS	69% - 85%	74.9%

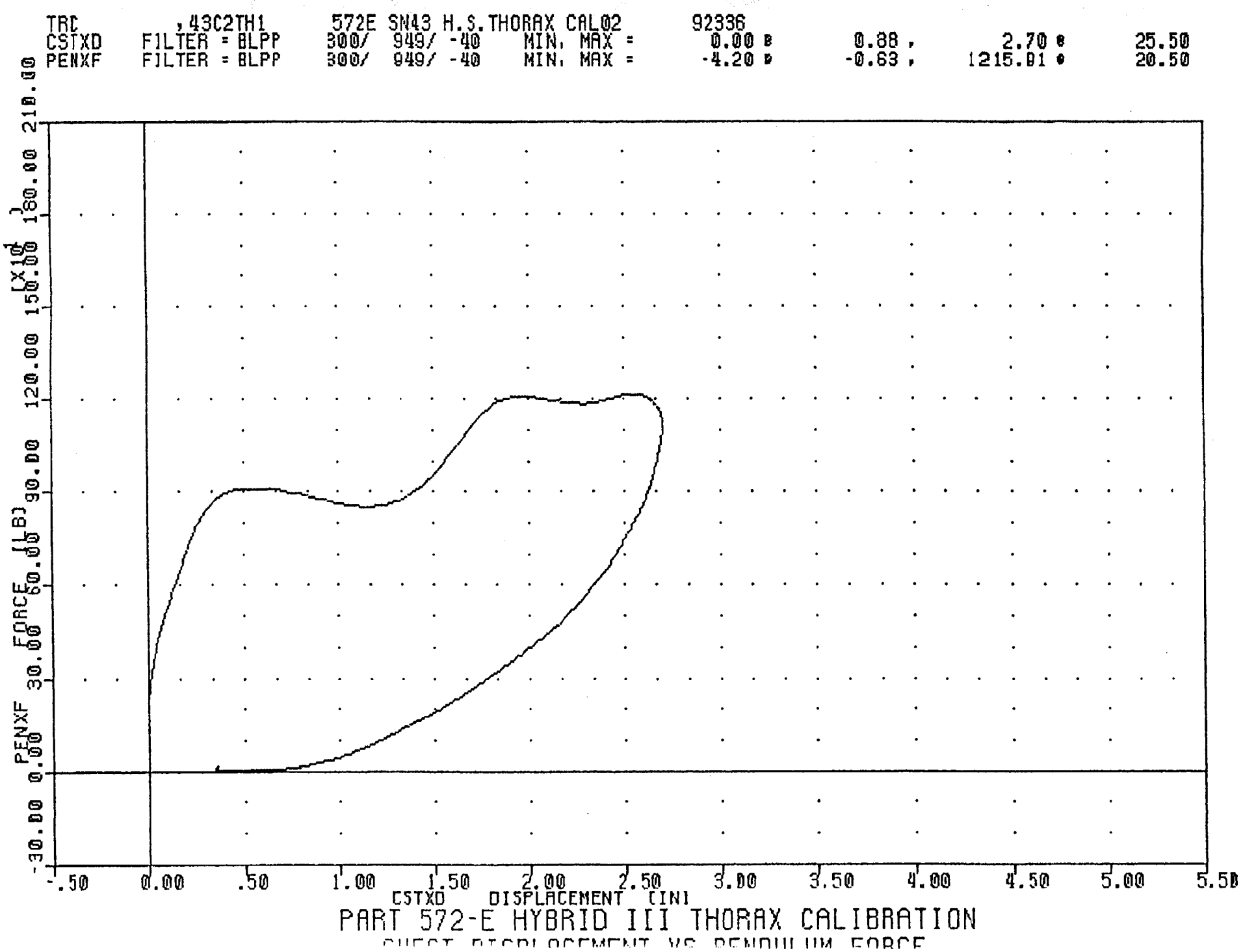
TEST MEETS SPECIFICATIONS

TECHNICIAN ____________________


TRC , 43C2TH1
572E SN43 H.S.THORAX CAL02
92336
PENXG
FILTER = BLPP 300/ 949/ -40
MIN, MAX VALUES = -0.08 @ -0.63 , 23.61 @ 20.50
ACCELERATION [G]
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
TIME (MSEC)
PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM DECELERATION


TRC , 43C2TH1
572E SN43 H.S.THORAX CAL02
92336
PENXF
FILTER = BLPP 300/ 949/ -40
MIN, MAX VALUES = -4.20 @ -0.63 , 1215.91 @ 20.50
FORCE (LB) (X10^1)
210.00
180.00
150.00
120.00
90.00
60.00
30.00
0.00
-30.00
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
TIME (MSEC)
PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM FORCE


TRC , 43C2TH1
572E SN43 H.S.THORAX CAL02
92336
CSTXD
FILTER = BLPP 300/ 949/ -40
MIN, MAX VALUES = 0.00 @ 0.88 , 2.70 @ 25.50
DISPLACEMENT (IN)
3.50
3.00
2.50
2.00
1.50
1.00
.50
0.00
-.50
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
TIME (MSEC)
PART 572-E HYBRID III THORAX CALIBRATION
STERNUM DISPLACEMENT


TRC ,43C2TH1 572E SN43 H.S.THORAX CAL02 92336
CSTXD FILTER = BLPP 300/ 949/ -40 MIN, MAX = 0.00 @ 0.88 , 2.70 @ 25.50
PENXF FILTER = BLPP 300/ 949/ -40 MIN, MAX = -4.20 @ -0.63 , 1215.81 @ 20.50
PENXF FORCE [LB] (X10)
210.00
180.00
150.00
120.00
90.00
60.00
30.00
0.00
-30.00
-.50
0.00
.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
CSTXD DISPLACEMENT [IN]
PART 572-E HYBRID III THORAX CALIBRATION
CHEST DISPLACEMENT VS PENDULUM FORCE

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

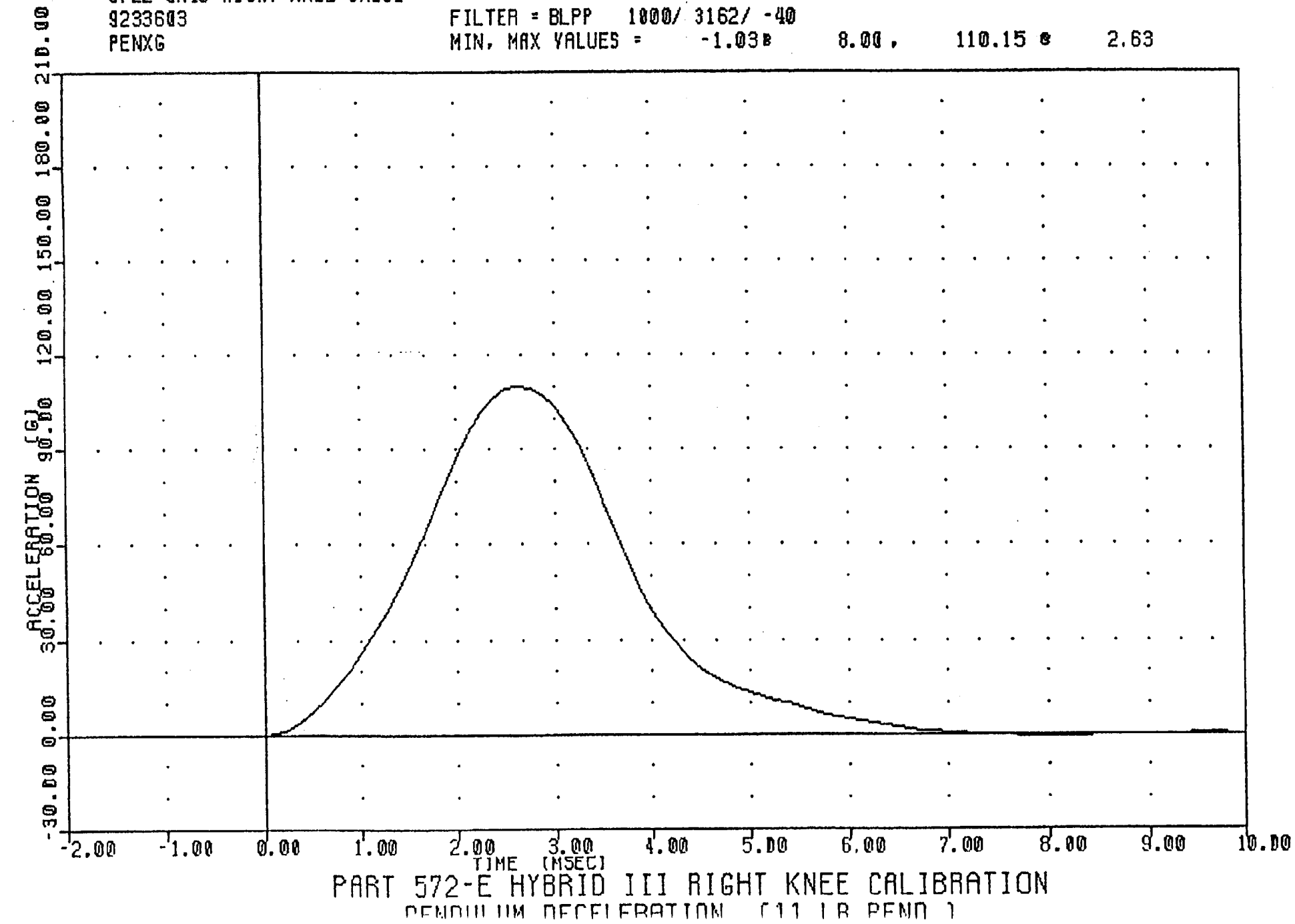
HYBRID III 01-DEC-92

RIGHT KNEE
TRC 43C2RK1 572E SN43 RIGHT KNEE CAL02

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	32.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.86 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1211.70 LBS
PROBE WEIGHT	11.0 LBS	

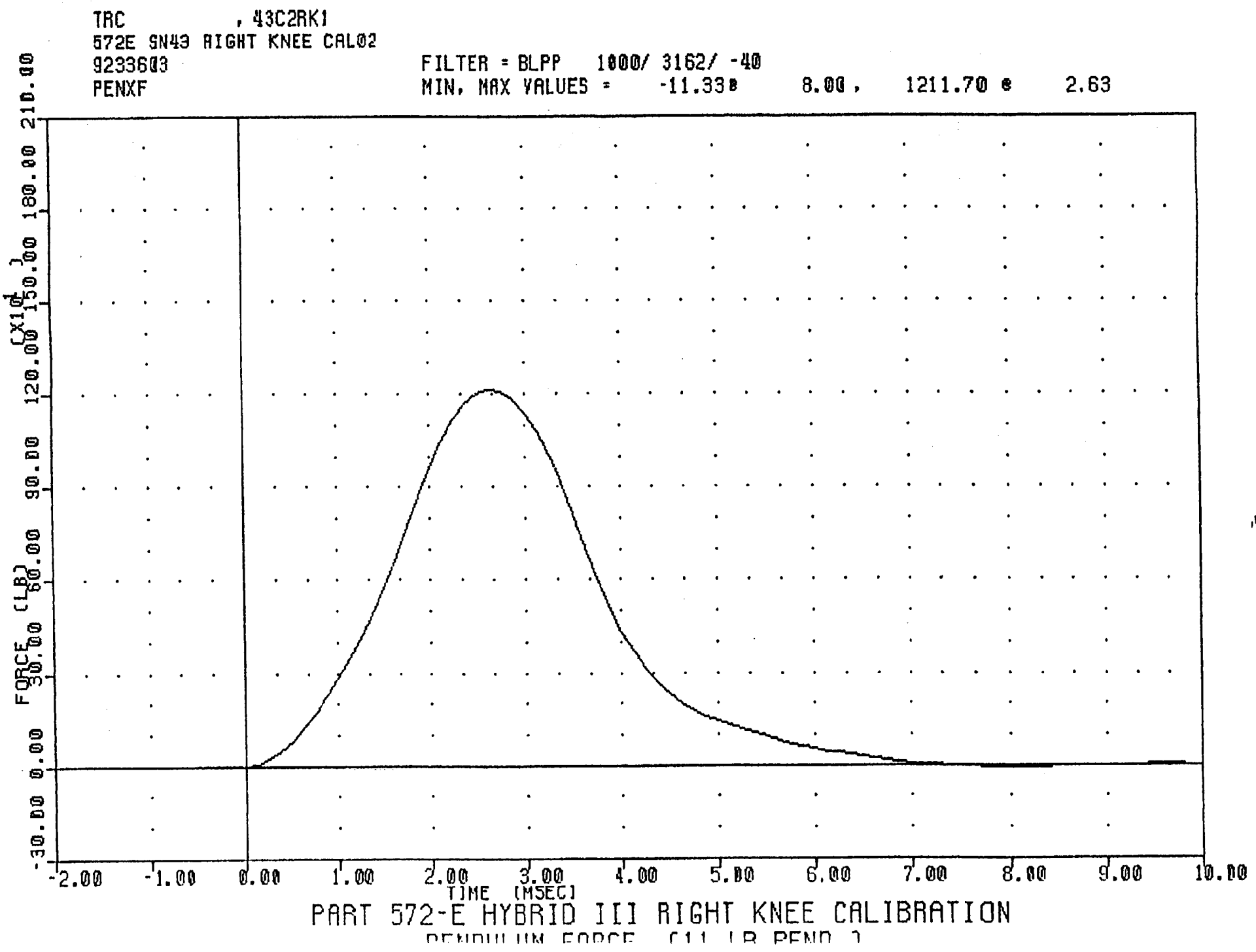
TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fant



PART 572-E HYBRID III RIGHT KNEE CALIBRATION

PENDULUM DECELERATION (11 LB PEND.)


TRC , 43C2RK1
572E SN43 RIGHT KNEE CAL02
9233603
PENXF
FILTER = BLPP 1000/ 3162/ -40
MIN, MAX VALUES = -11.33@ 8.00 , 1211.70 @ 2.63
FORCE (LB) (X10^1)
210.00
180.00
150.00
120.00
90.00
60.00
30.00
0.00
-30.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
TIME (MSEC)
PART 572-E HYBRID III RIGHT KNEE CALIBRATION
PENDULUM FORCE (11 LB PEND.)

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

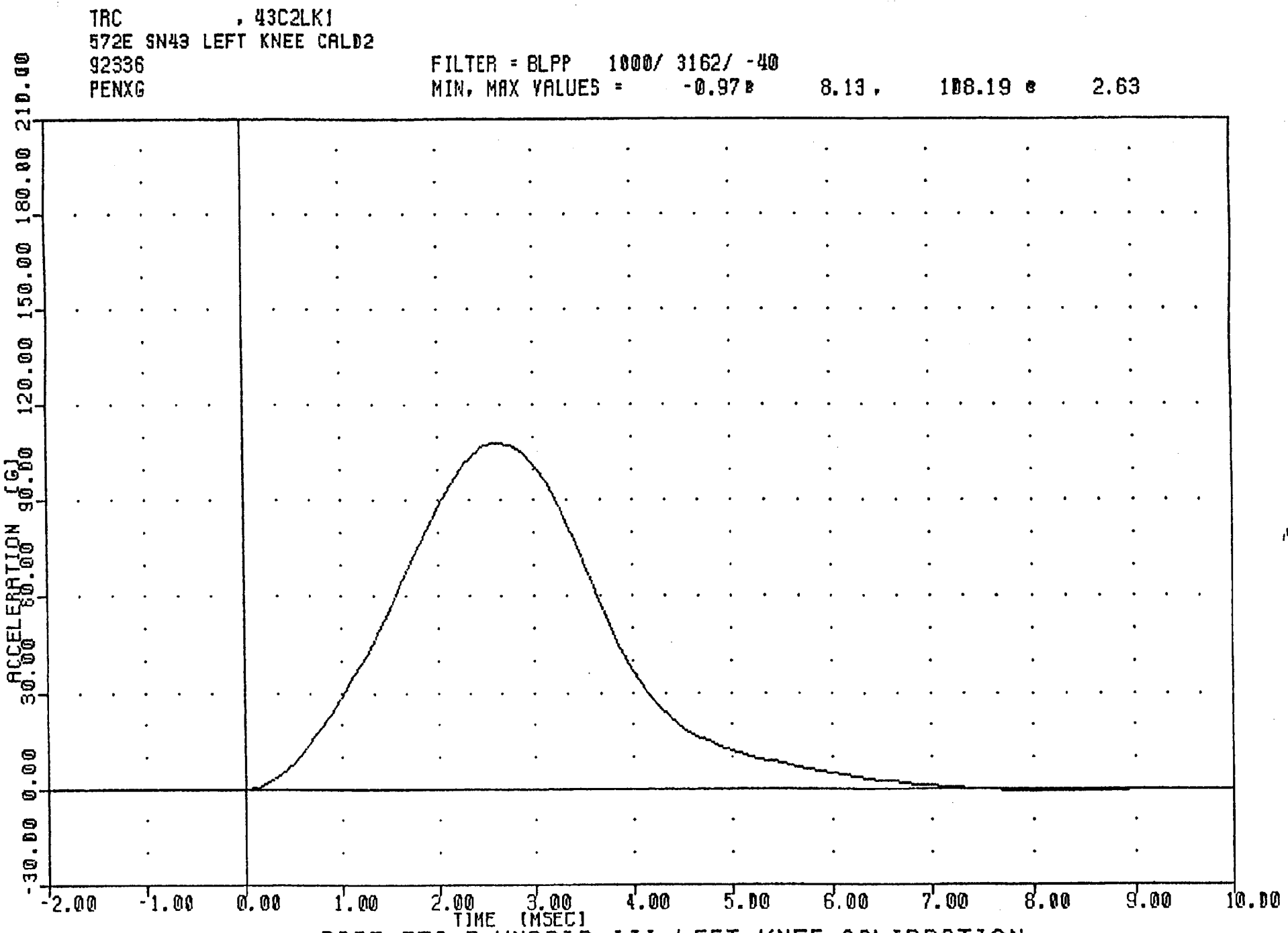
HYBRID III 01-DEC-92

LEFT KNEE
TRC 43C2LK1 572E SN43 LEFT KNEE CAL02

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	32.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.89 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1190.09 LBS
PROBE WEIGHT	11.0 LBS	

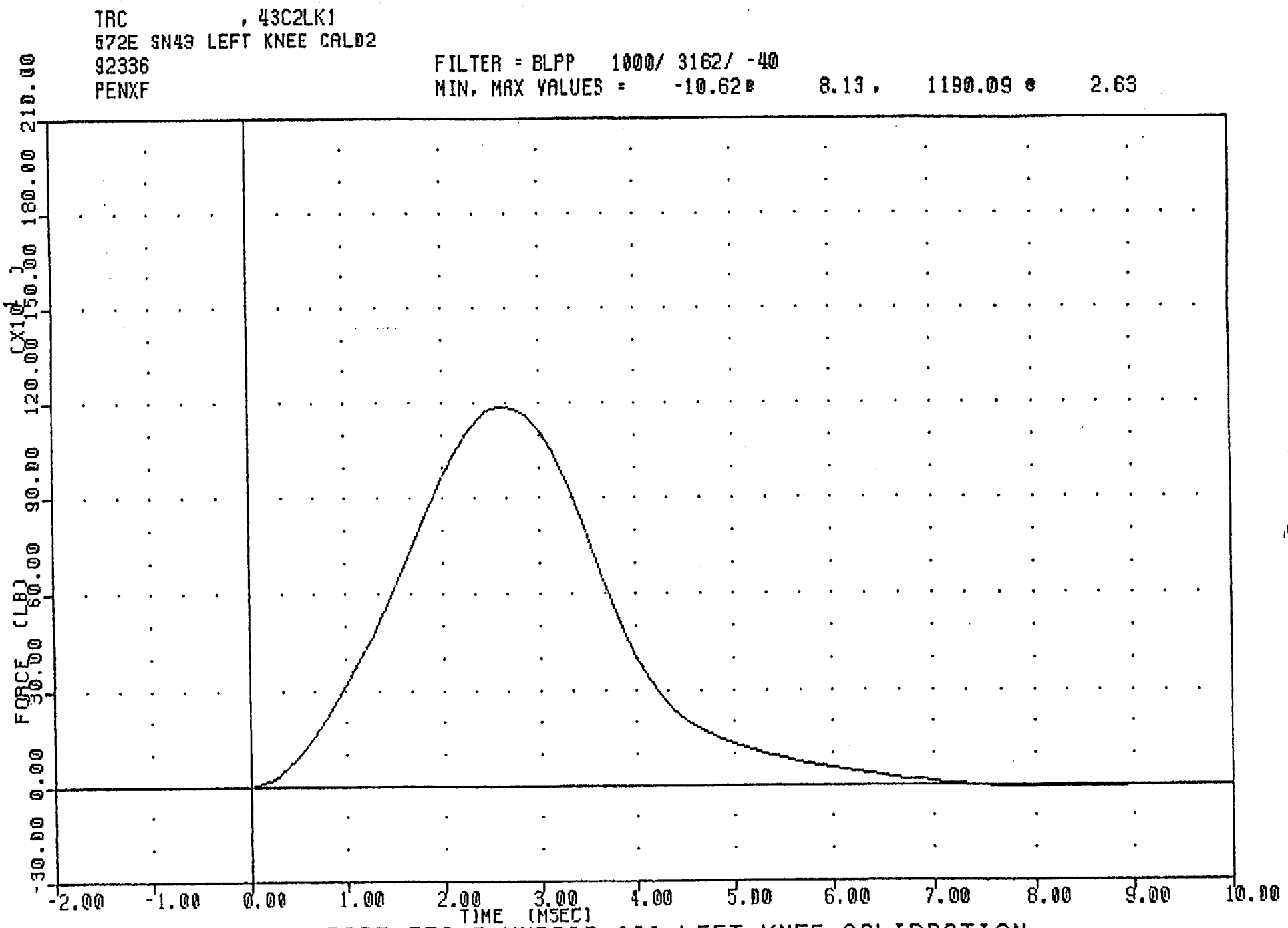
TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fonta



PART 572-E HYBRID III LEFT KNEE CALIBRATION

PENDULUM ACCELERATION (11 LB PEND.)



PART 572-E HYBRID III LEFT KNEE CALIBRATION

PENDULUM FORCE (LB PEND.)

PRE-TEST CERTIFICATION DATA

PASSENGER DUMMY S/N 048

TRANSPORTATION RESEARCH CENTER OF OHIO
HYBRID III EXTERNAL DIMENSIONS
HUMANOID 048

23-NOV-92

TRC 48C4ED1 572E SN48 EXT. DIMENSION CAL04

TEST PARAMETER	(DIMEN.)	SPECIFICATION	TEST RESULTS
TEMPERATURE			70.0 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	38.8 IN
WAIST CIRCUMFERENCE	(Z)	- 32.9-34.1 IN	33.5 IN
CHEST DEPTH	(D)	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 Faust

TRANSPORTATION RESEARCH CENTER OF OHIO

HEAD DROP TEST

HYBRID III 23-NOV-92

TRC 48C4HD1 572E SN48 HEAD DROP CAL 04

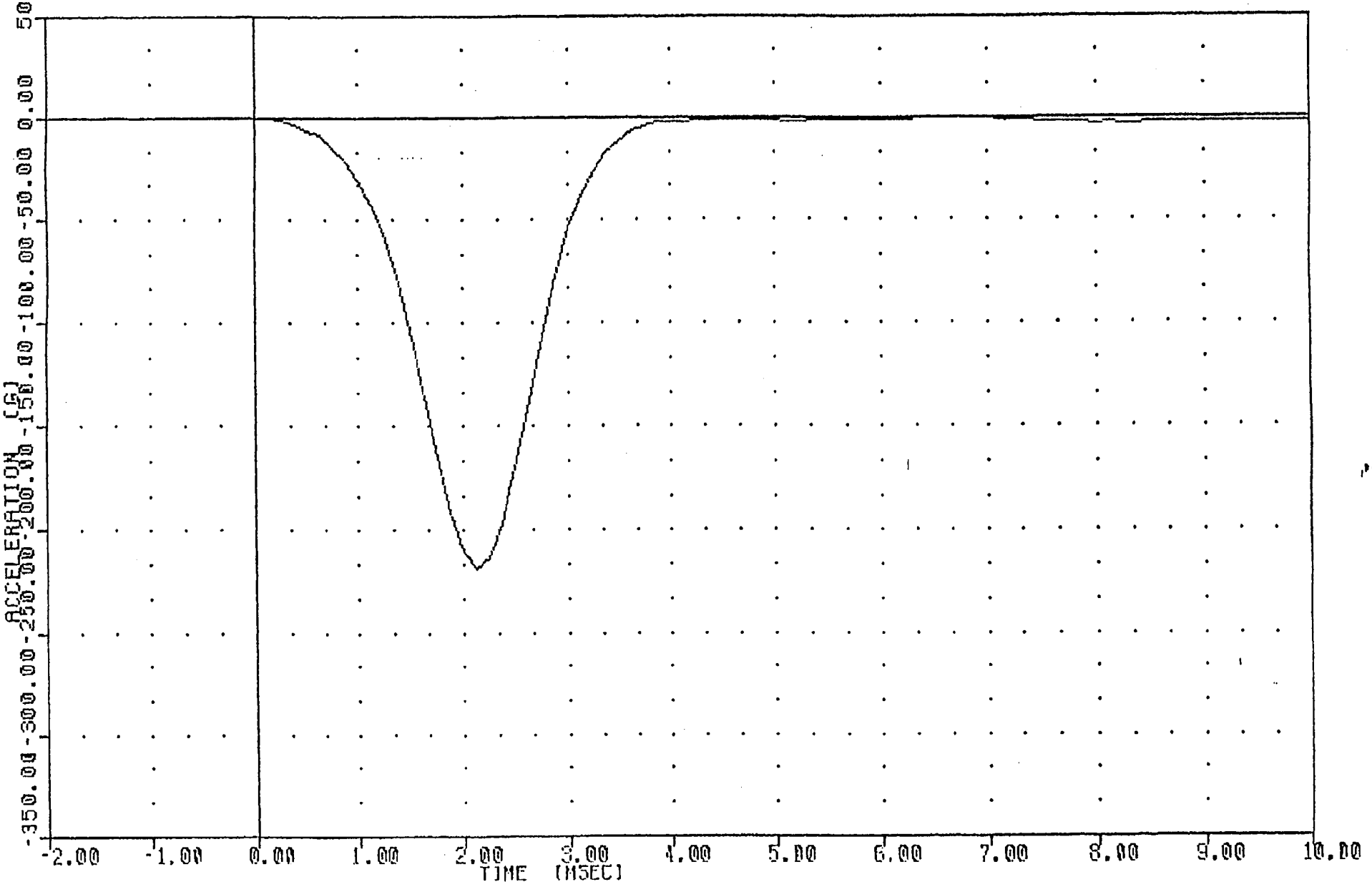
TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PEAK RESULTANT ACCELERATION	225 - 275 G	250.58 G
PEAK LATERAL ACCELERATION	15 G MAX	-3.70 G
IS ACCELERATION CURVE UNIMODAL?	YES	YES

TEST MEETS SPECIFICATIONS

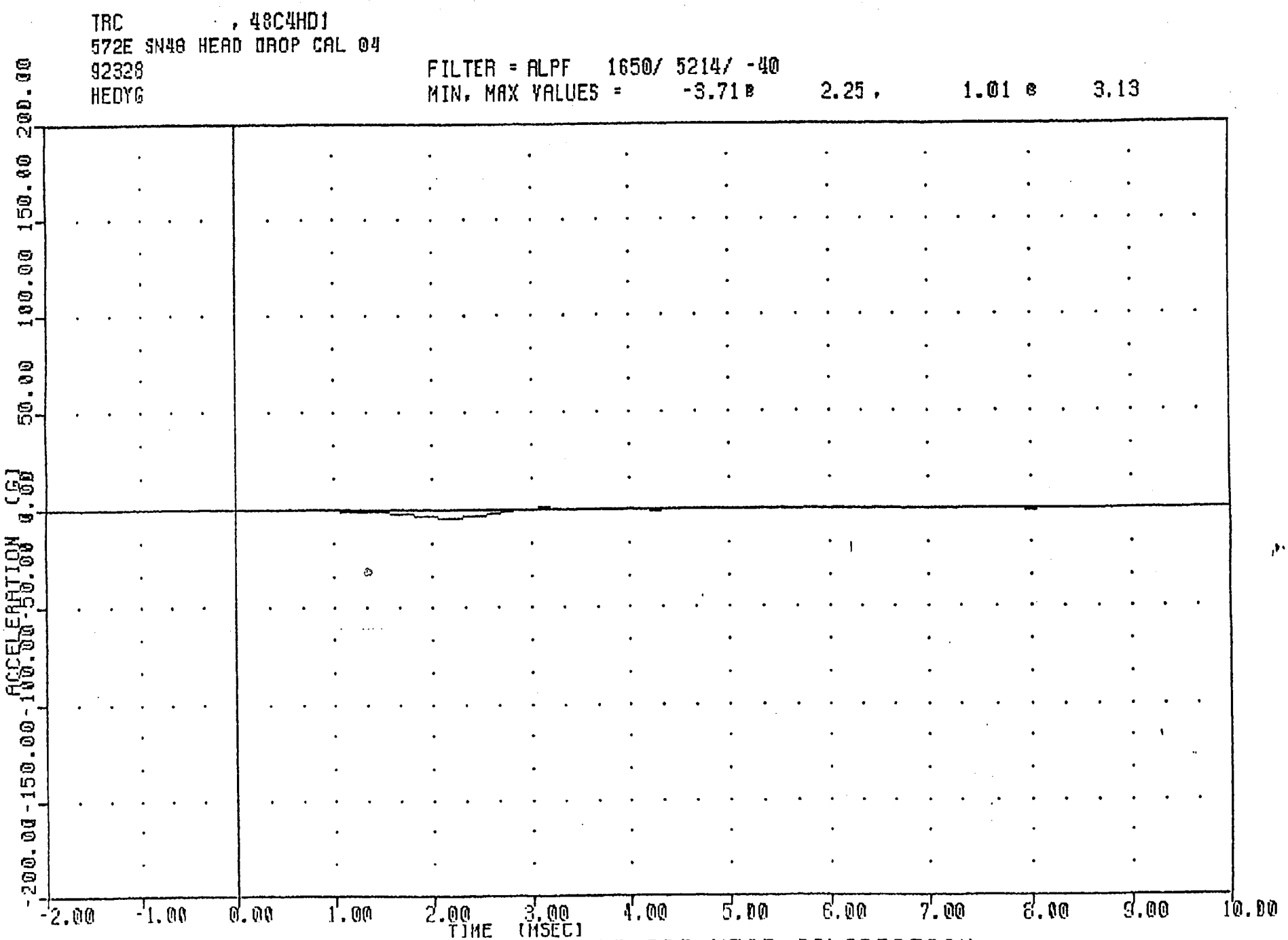
TECHNICIAN Peter Foust

TRC , 48C4HD1
572E SN48 HEAD DROP CAL 04
92328
HEDXG

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -218.49 @ 2.13 , 0.27 @ 6.75



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

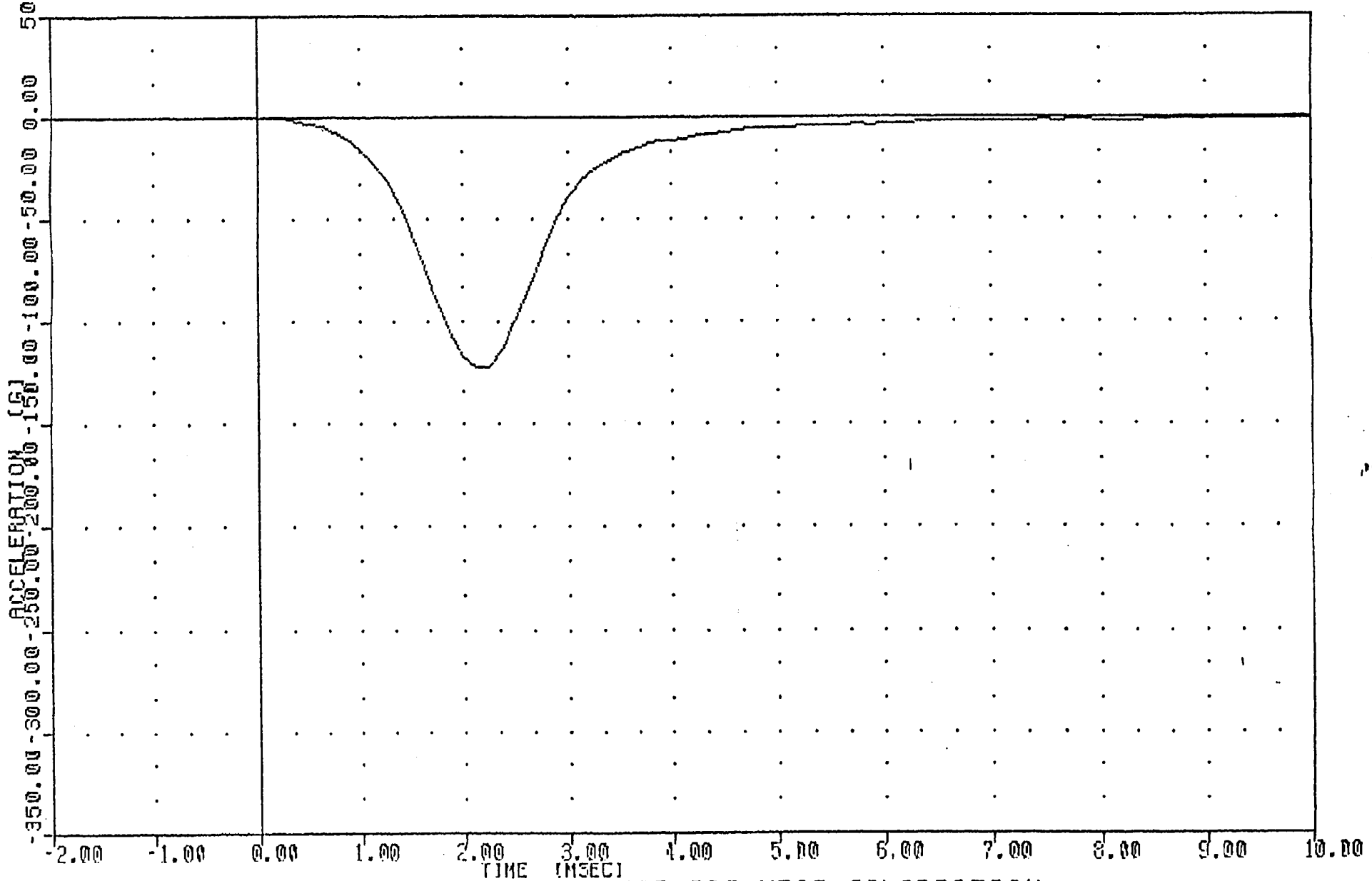


PART 572-E HYBRID III HEAD CALIBRATION

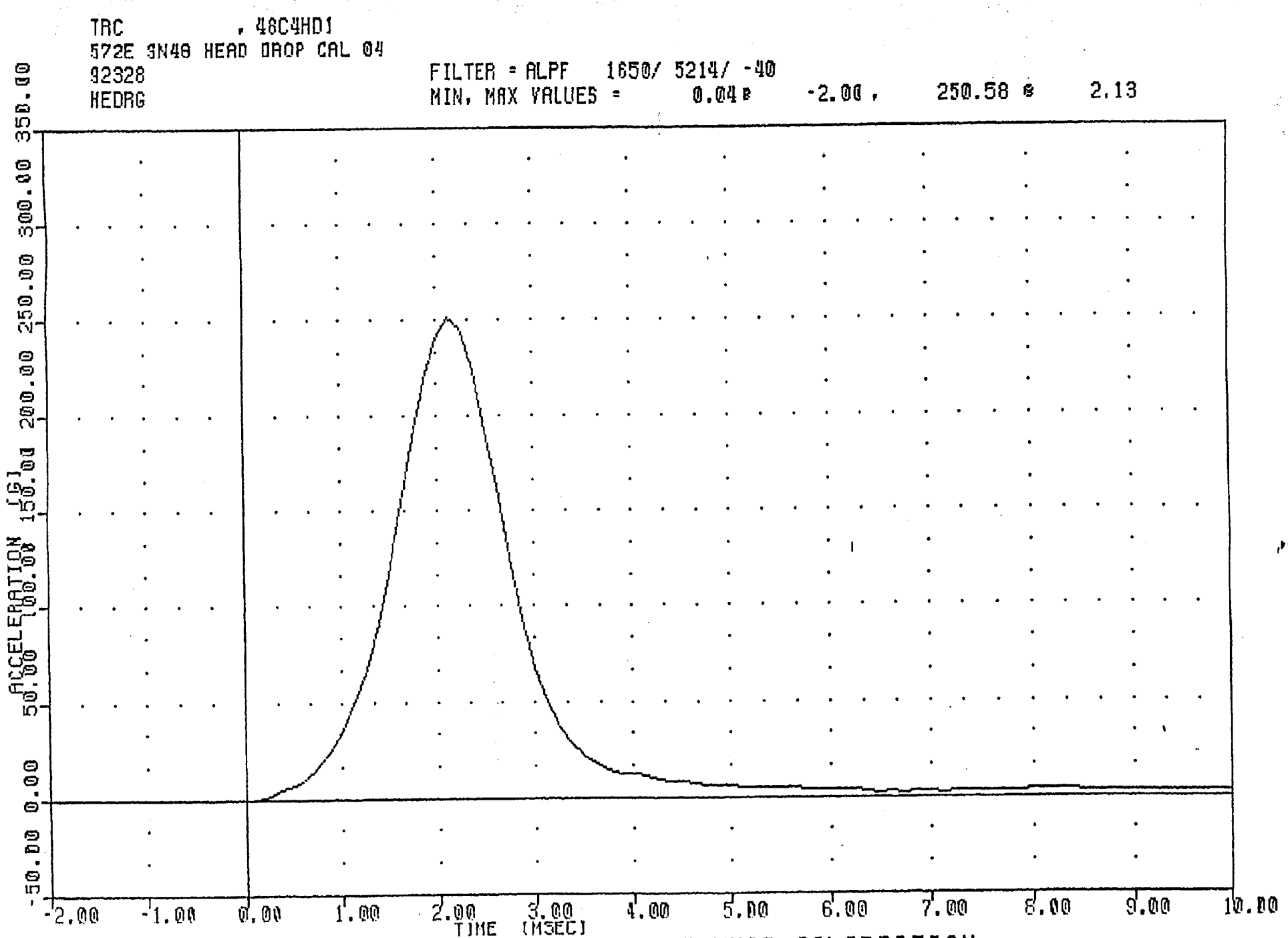
HEAD ACCELERATION Y AXIS

TRC , 48C4HD1
572E SN48 HEAD DROP CAL 04
92328
HEDZG

FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -122.64 @ 2.13 , 0.03 @ -2.00



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

23-NOV-92

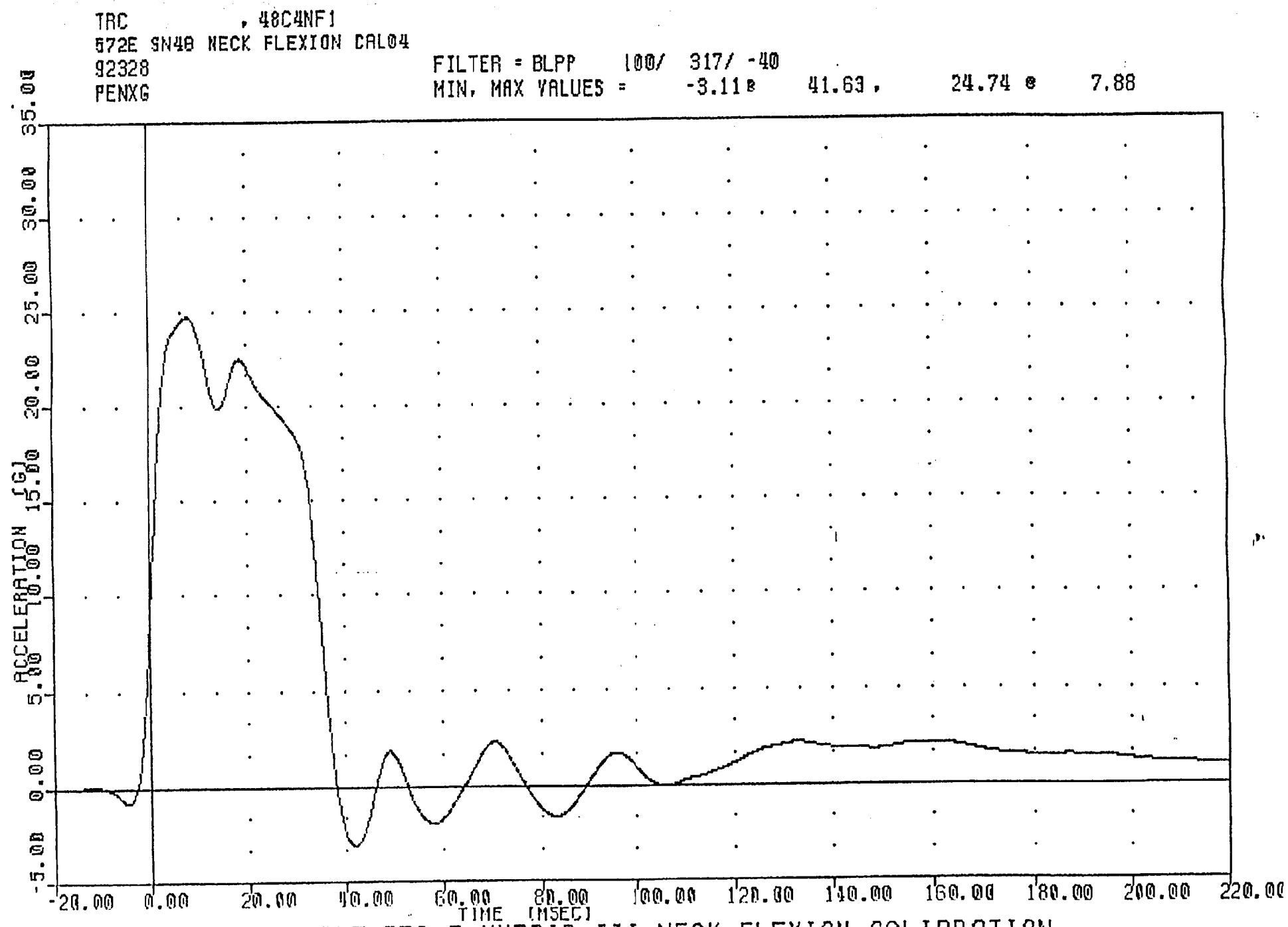
6 AXIS NECK TRANSDUCER
TRC 48C4NF1

572E SN48 NECK FLEXION CAL04

TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	70.0 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	23.76 G
	20 MS	17.60 - 22.60 G	22.12 G
	30 MS	12.50 - 18.50 G	18.38 G
MAX PENDULUM G ABOVE 30 MS		29 G MAX	18.32 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		34 - 42 MS	36.00 MS
D PLANE ROTATION	MAX	64 - 78 DEG.	72.37 DEG.
	TIME	57 - 64 MS	58.25 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MAX	65 - 80 FT.LBS	70.69 FT.LBS
	TIME	47 - 58 MS	49.38 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		113 - 128 MS	115.00 MS
POSITIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		97 - 107 MS	97.88 MS

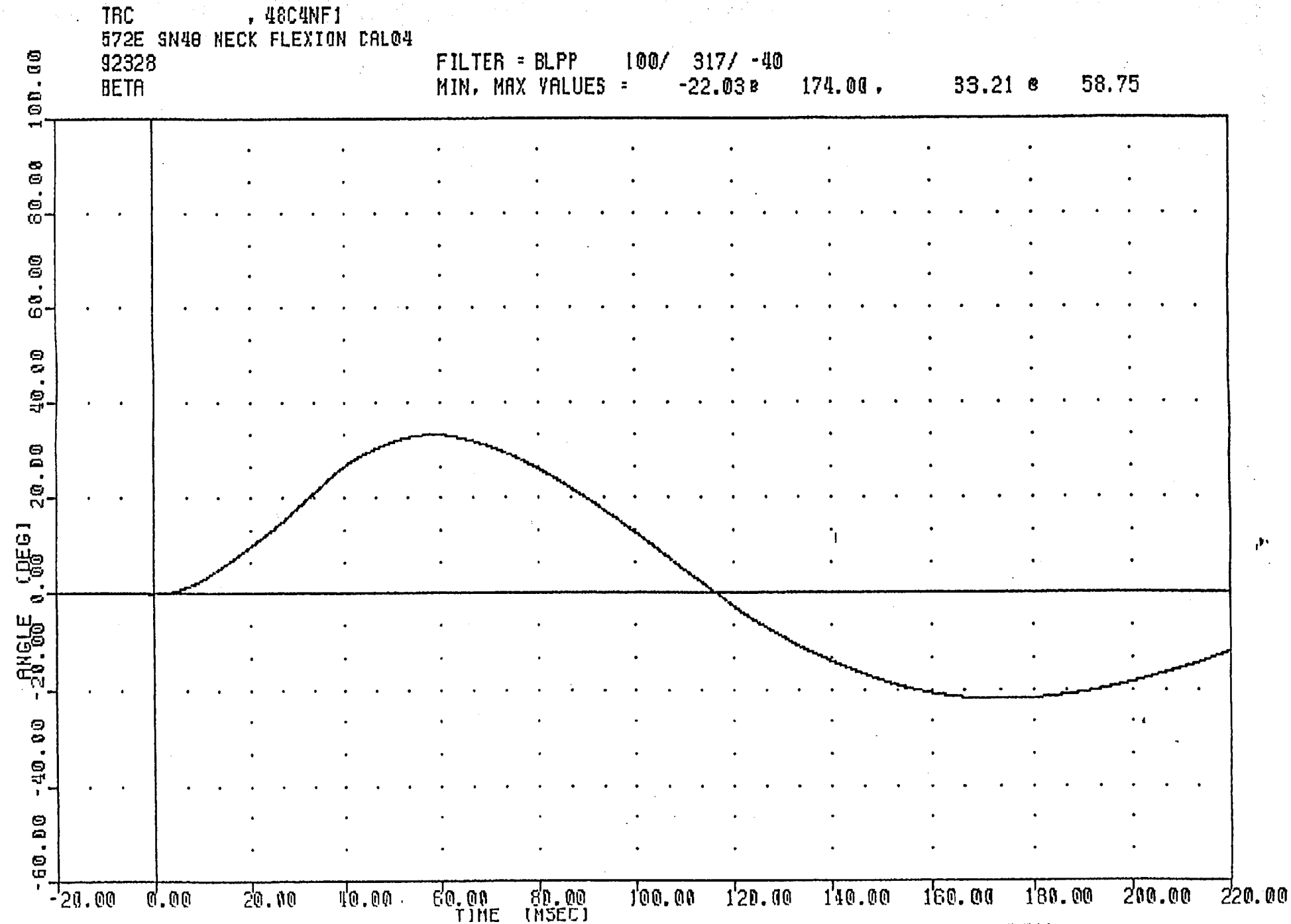
TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Fonts

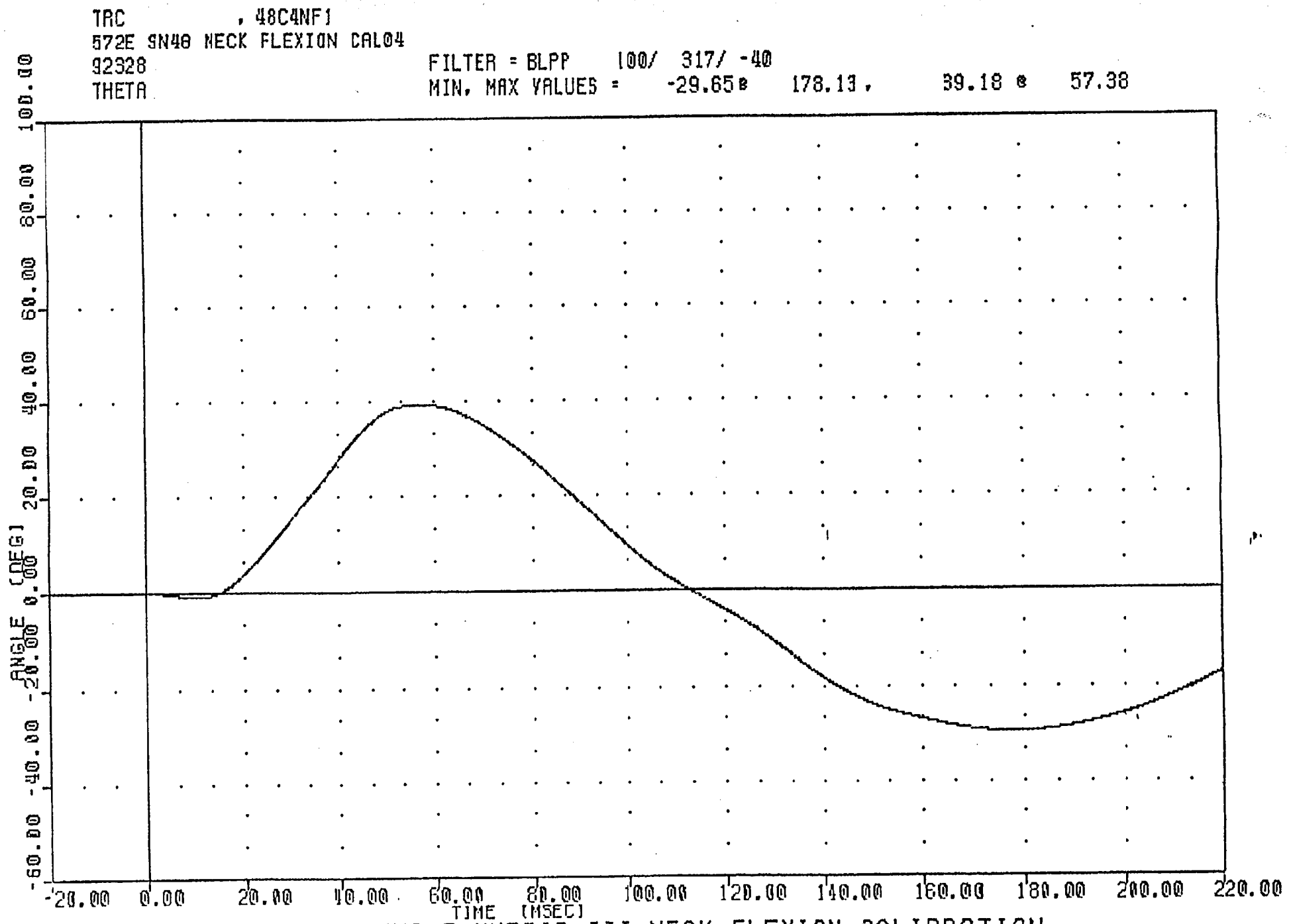


PART 572-E HYBRID III NECK FLEXION CALIBRATION

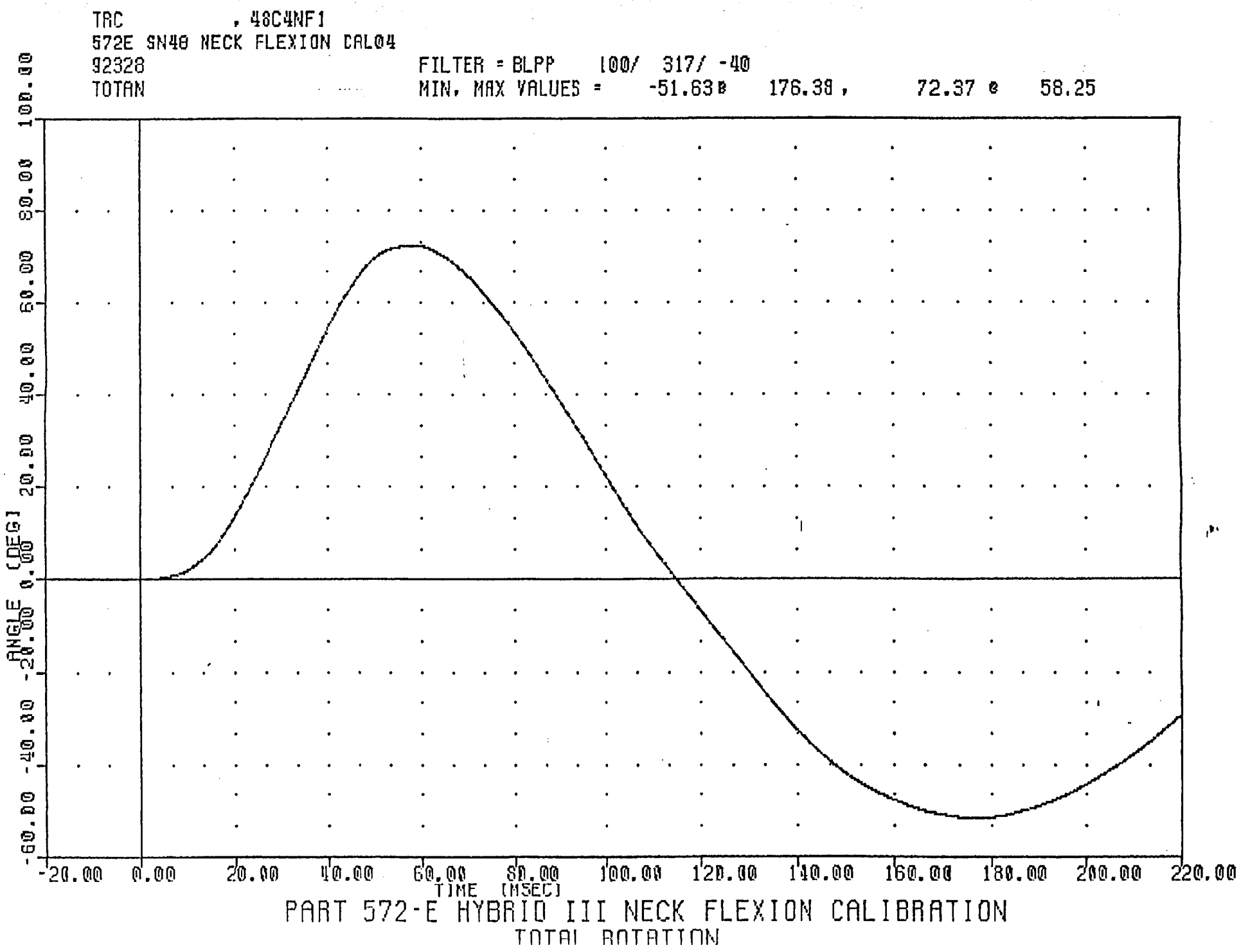
PENDULUM DECELERATION

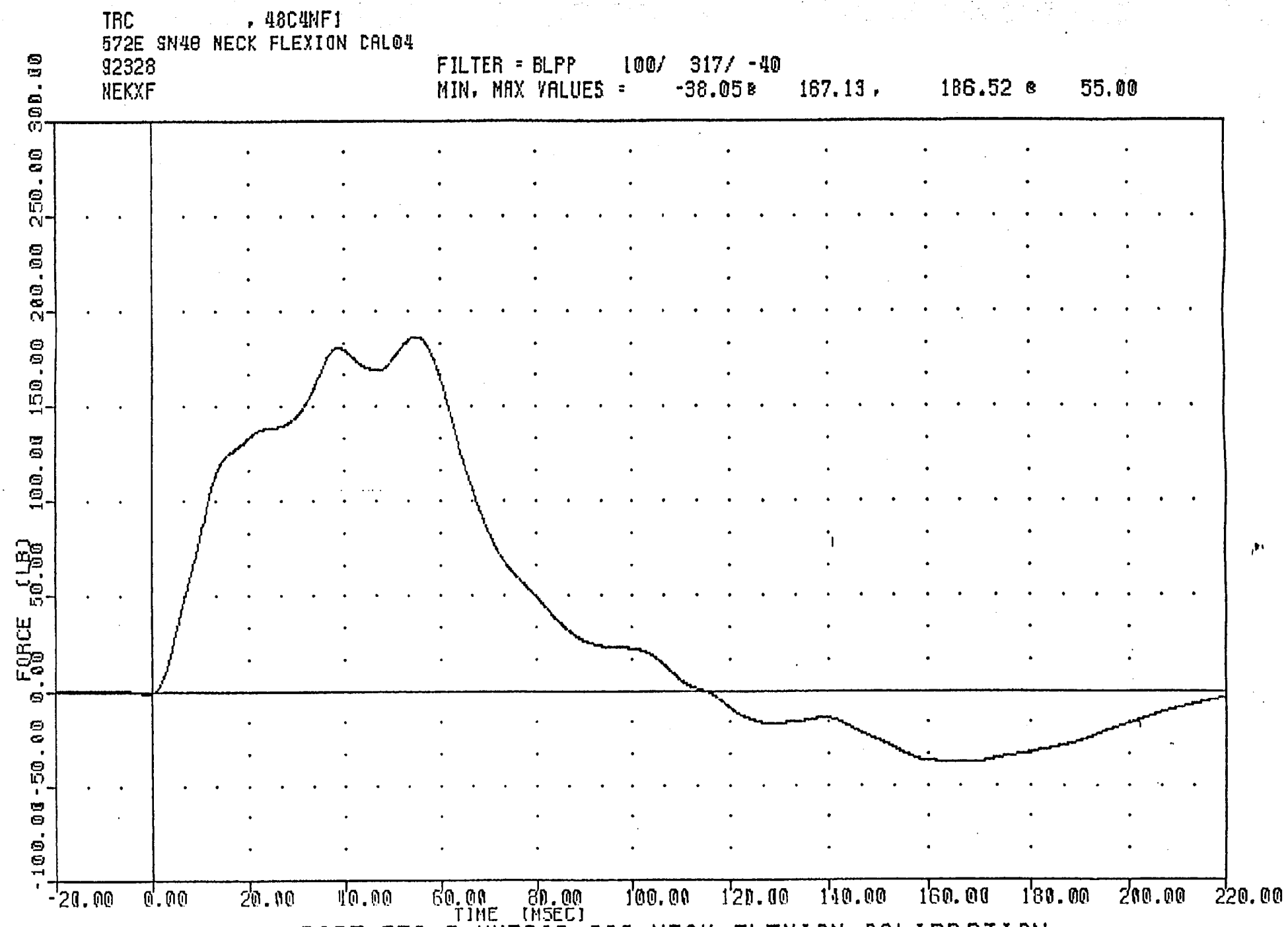


PART 572-E HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT BASE OF NECK

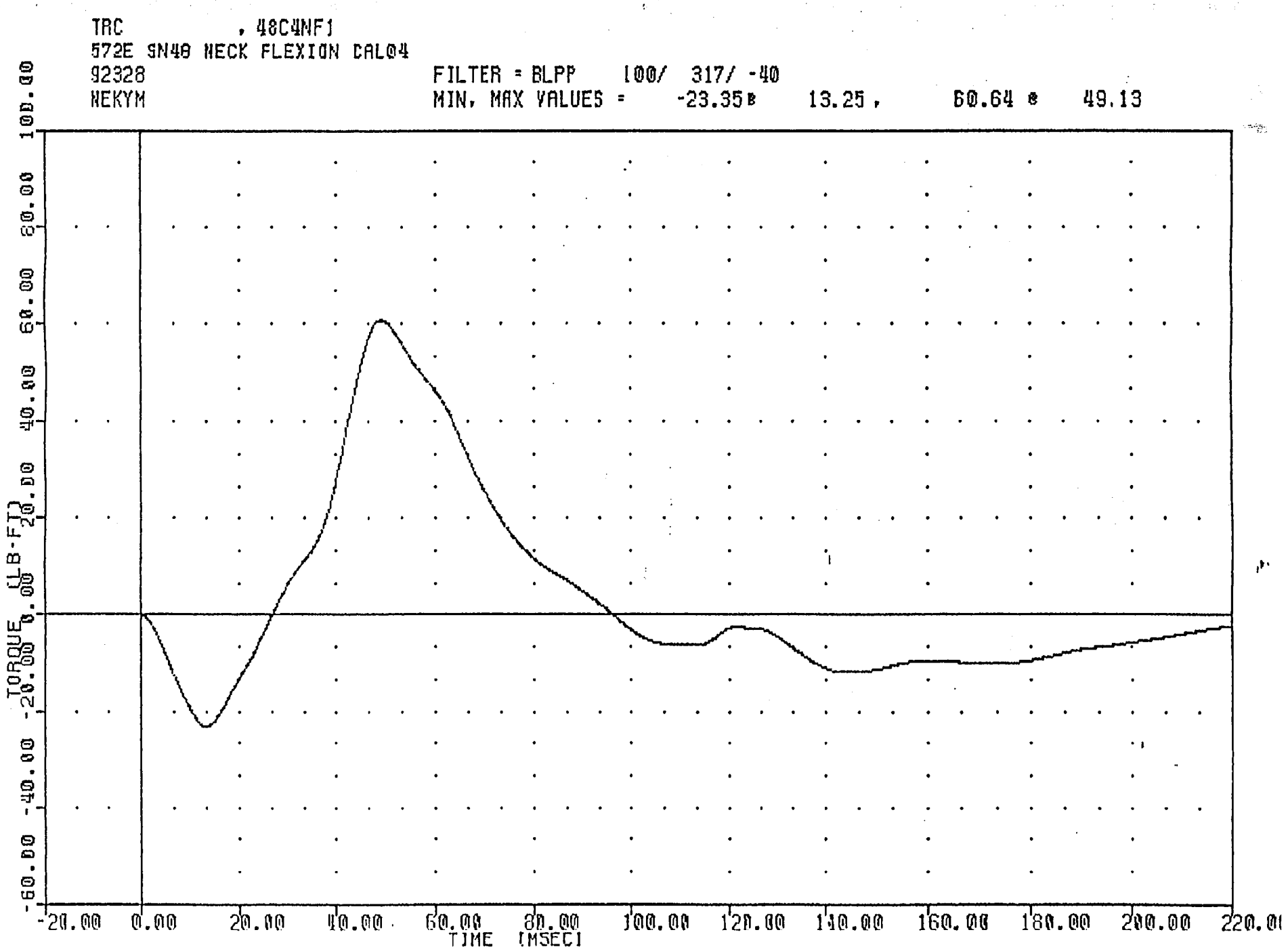


PART 572-E HYBRID III NECK FLEXION CALIBRATION
ROTATION ABOUT OCCIPITAL CONDYLE

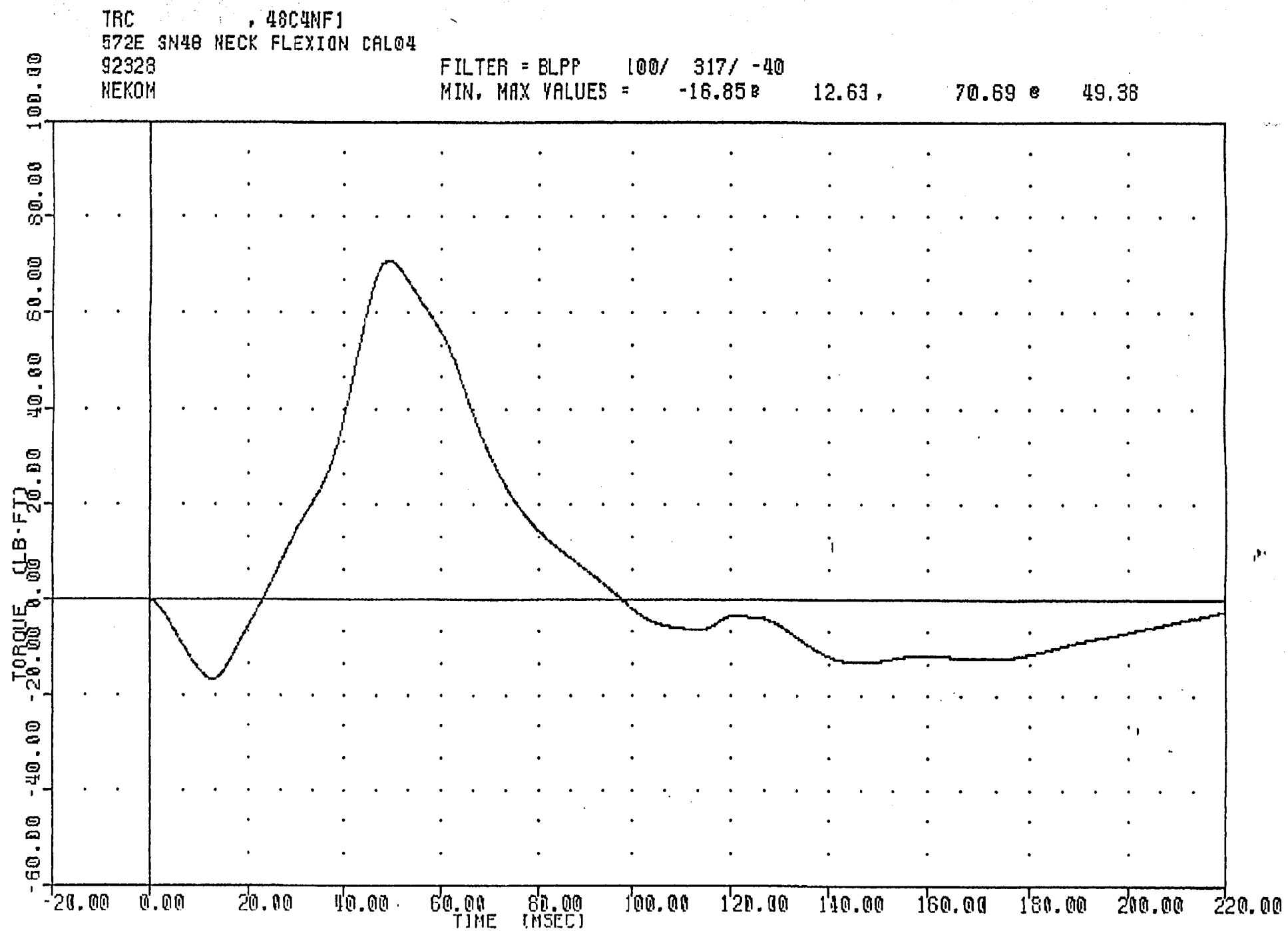

TRC , 48C4NF1
572E SN48 NECK FLEXION CAL04
92328
TOTAN
FILTER = BLPP 100/ 317/ -40
MIN, MAX VALUES = -51.63 @ 176.38 , 72.37 @ 58.25
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
-40.00
-60.00
ANGLE (DEG)
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
220.00
TIME (MSEC)
PART 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

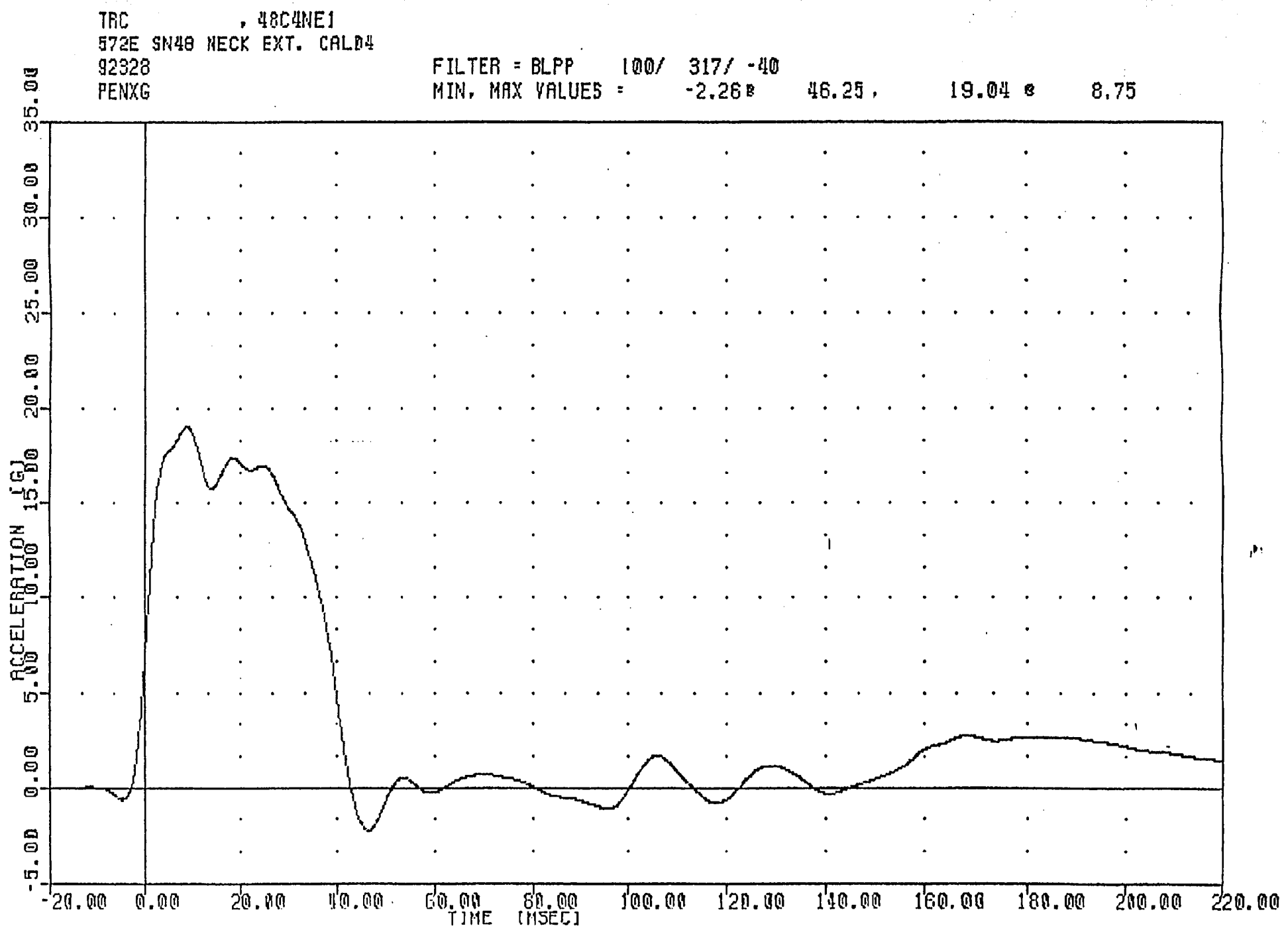
HYBRID III 23-NOV-92

6 AXIS NECK TRANSDUCER
TRC 48C4NE1 572E SN48 NECK EXT. CAL04

TEST PARAMETER		SPECIFICATION	TEST RESULTS
TEMPERATURE		69 - 72 DEG. F	70.0 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	18.58 G
	20 MS	14.00 - 19.00 G	17.13 G
	30 MS	11.00 - 16.00 G	14.80 G
MAX PENDULUM G ABOVE 30 MS		22 G MAX	14.76 G
DECELERATION-TIME CURVE DECAY TIME TO 5 G		38 - 46 MS	39.63 MS
D PLANE ROTATION	MAX	81 - 106 DEG.	99.66 DEG.
	TIME	72 - 82 MS	76.88 MS
MOMENT ABOUT OCCIPITAL CONDYLE	MIN	-59.0/-39.0 FT.LBS	-53.19 FT.LBS
	TIME	65 - 79 MS	69.75 MS
ROTATION ANGLE-TIME CURVE DECAY TIME TO ZERO		147 - 174 MS	155.88 MS
NEGATIVE MOMENT-TIME CURVE DECAY TIME TO ZERO		120 - 148 MS	142.00 MS

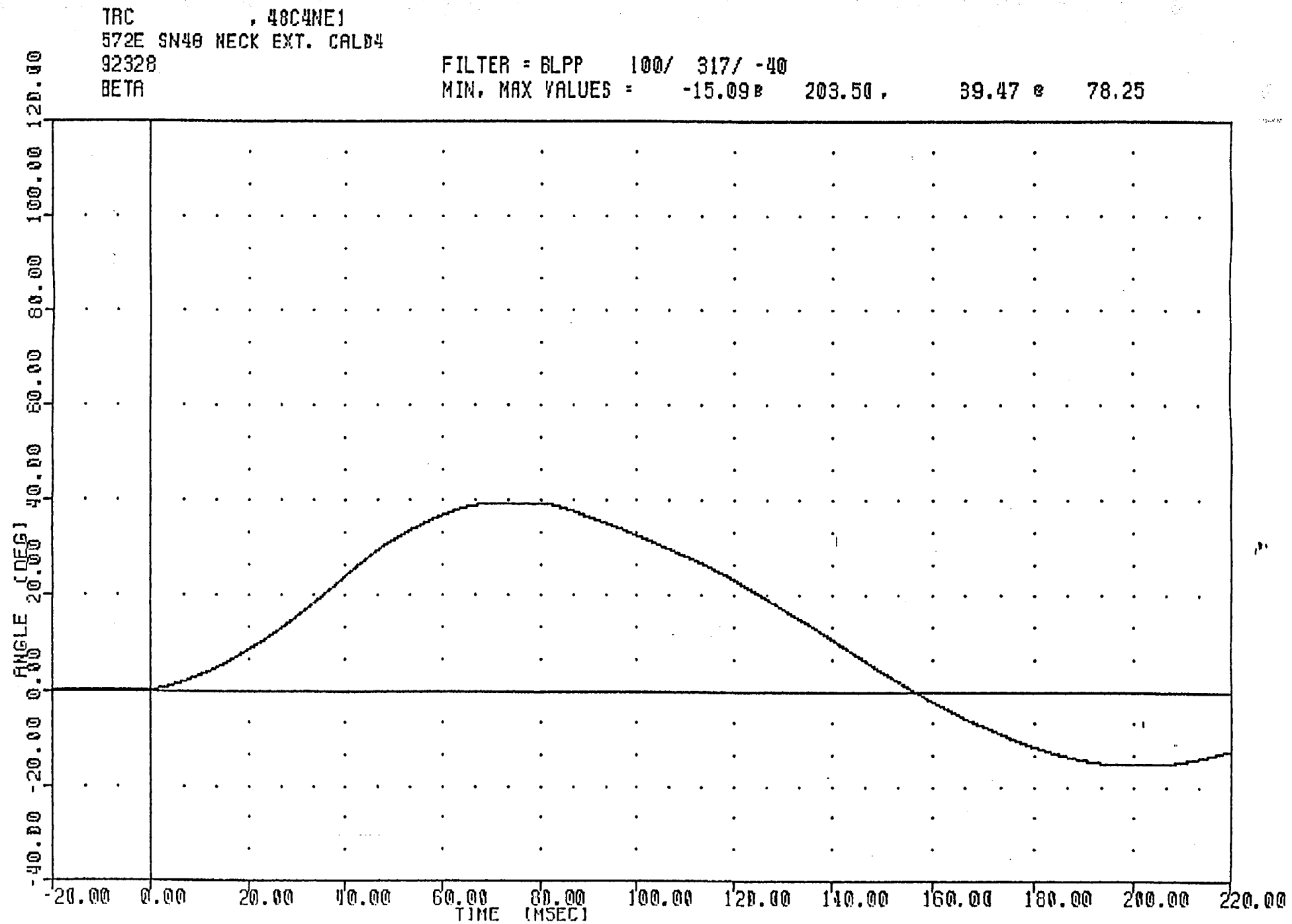
TEST MEETS SPECIFICATIONS

TECHNICIAN Pete Faust



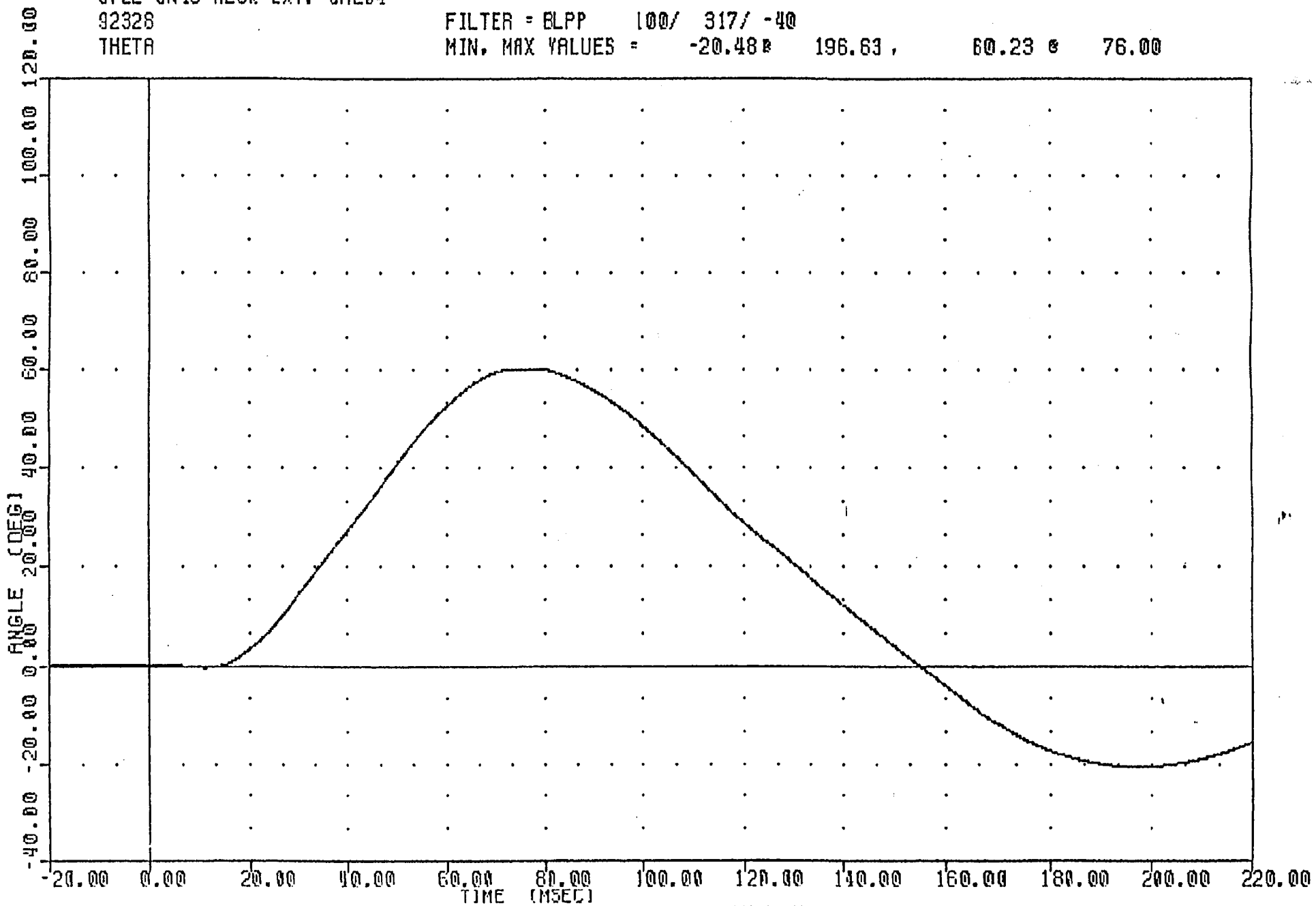
PART 572-E HYBRID III NECK EXTENSION CALIBRATION

PENDULUM DECELERATION

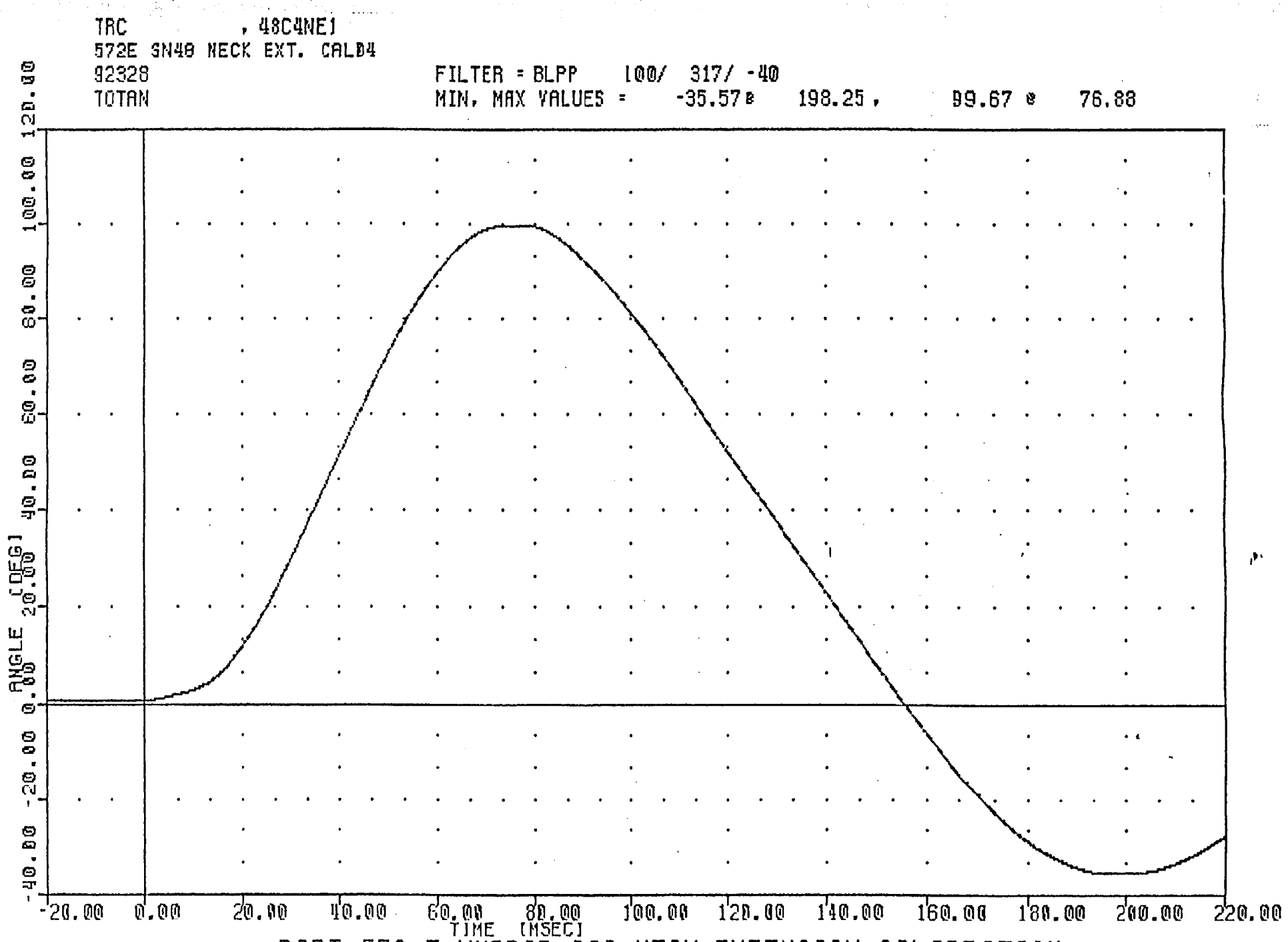


PART 572-E HYBRID III NECK EXTENSION CALIBRATION

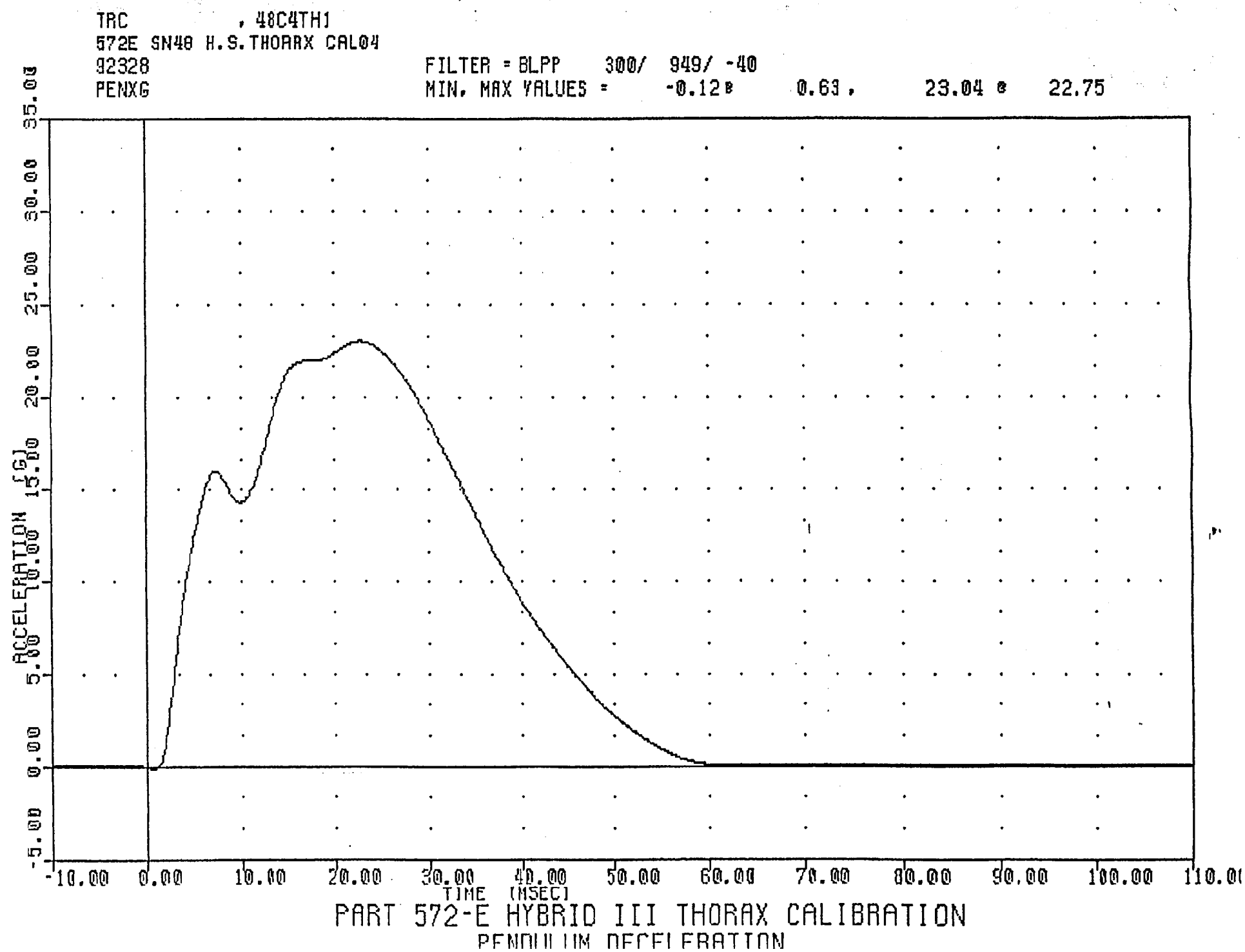
ROTATION ABOUT BASE OF NECK



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

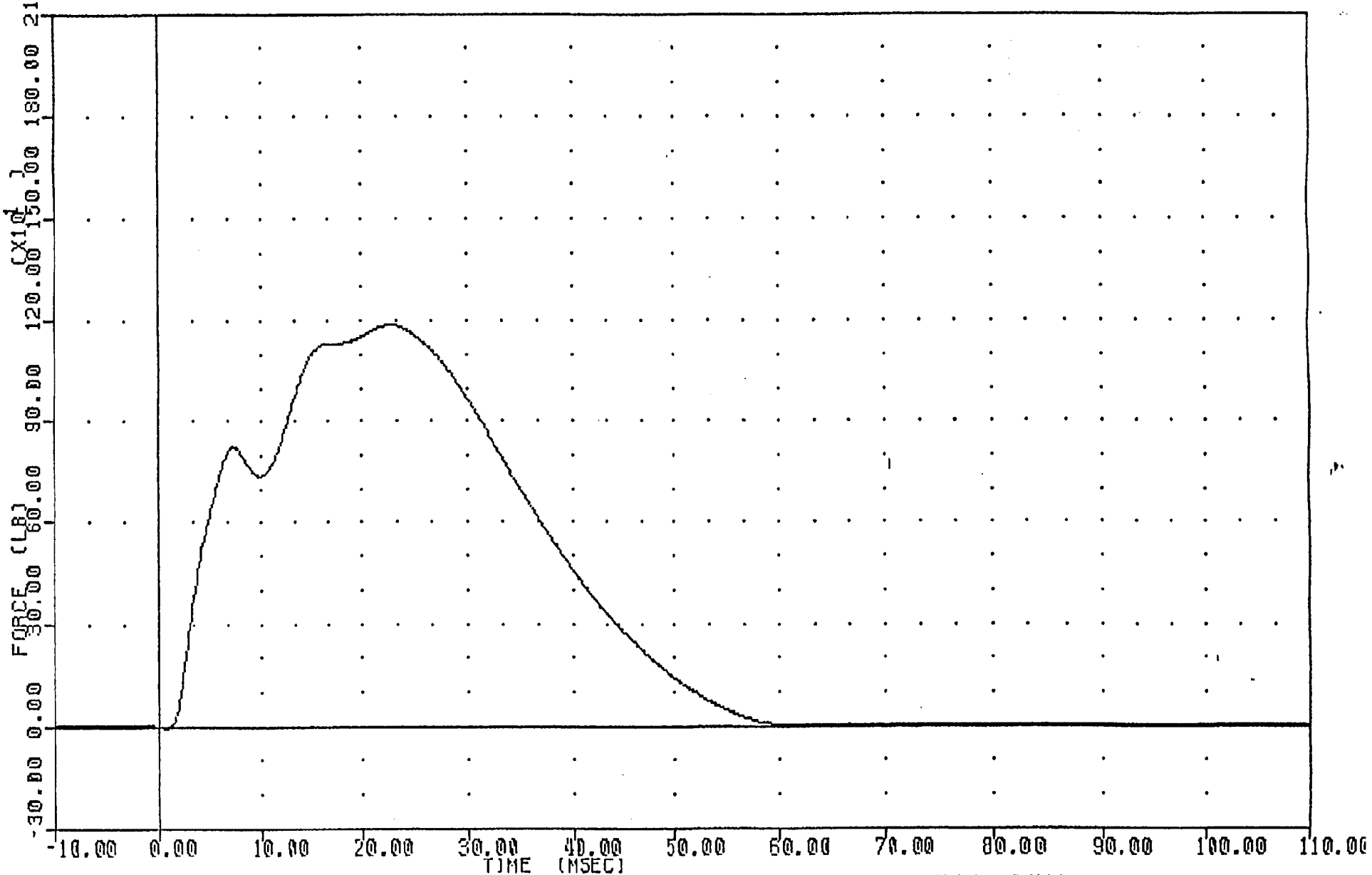


PART 572-E HYBRID III NECK EXTENSION CALIBRATION
TOTAL ROTATION

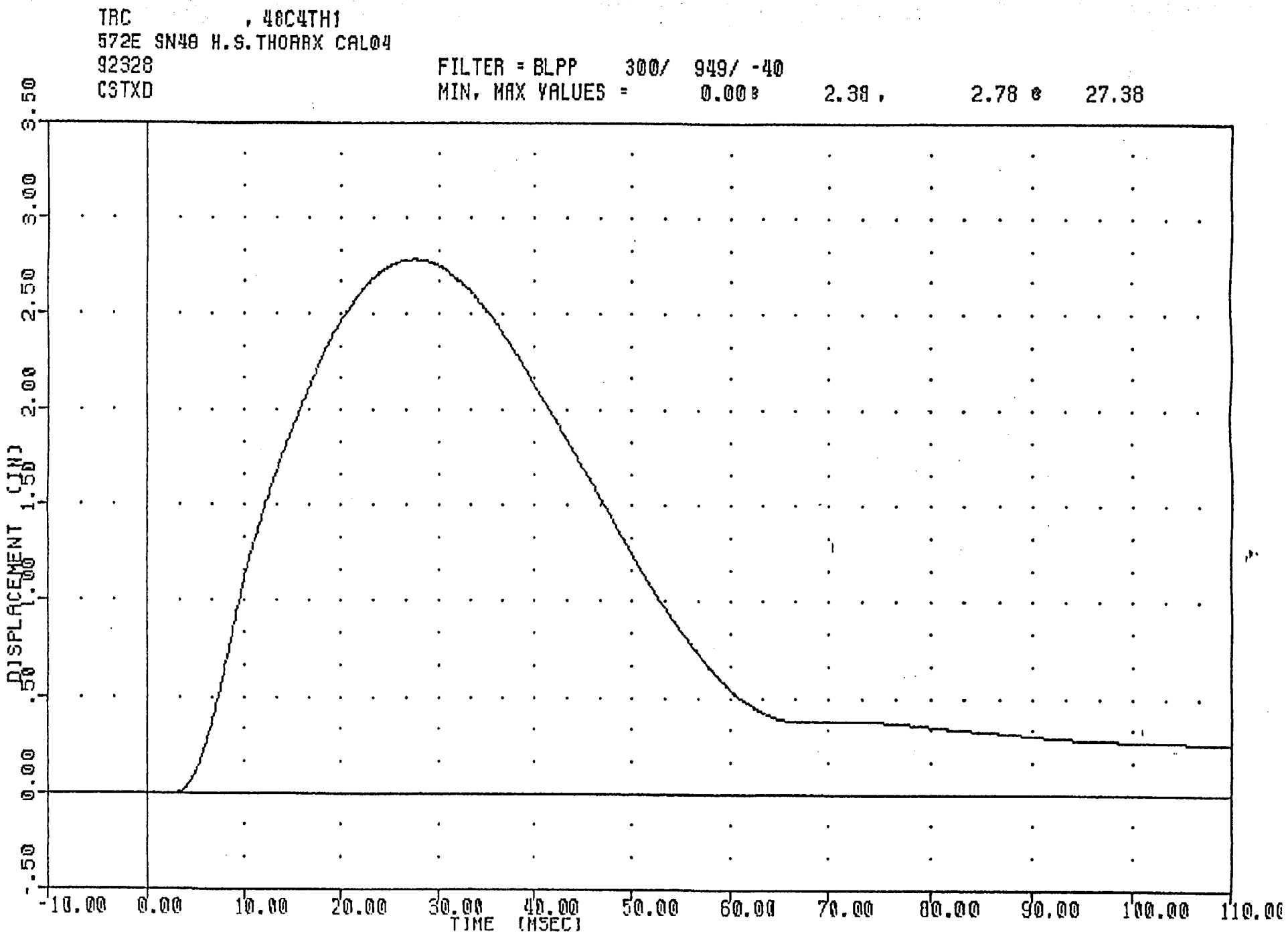

TRC , 48C4TH1
572E SN48 H.S.THORAX CAL04
92328
PENXG
FILTER = BLPP 300/ 949/ -40
MIN, MAX VALUES = -0.12 @ 0.63 , 23.04 @ 22.75
ACCELERATION (G)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
TIME (MSEC)
PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM DECELERATION

TRC , 48C4TH1
572E SN48 H.S.THORAX CAL04
92328
PENXF

FILTER = BLPP 300/ 949/ -40
MIN, MAX VALUES = -6.13 @ 0.63 , 1186.43 @ 22.75



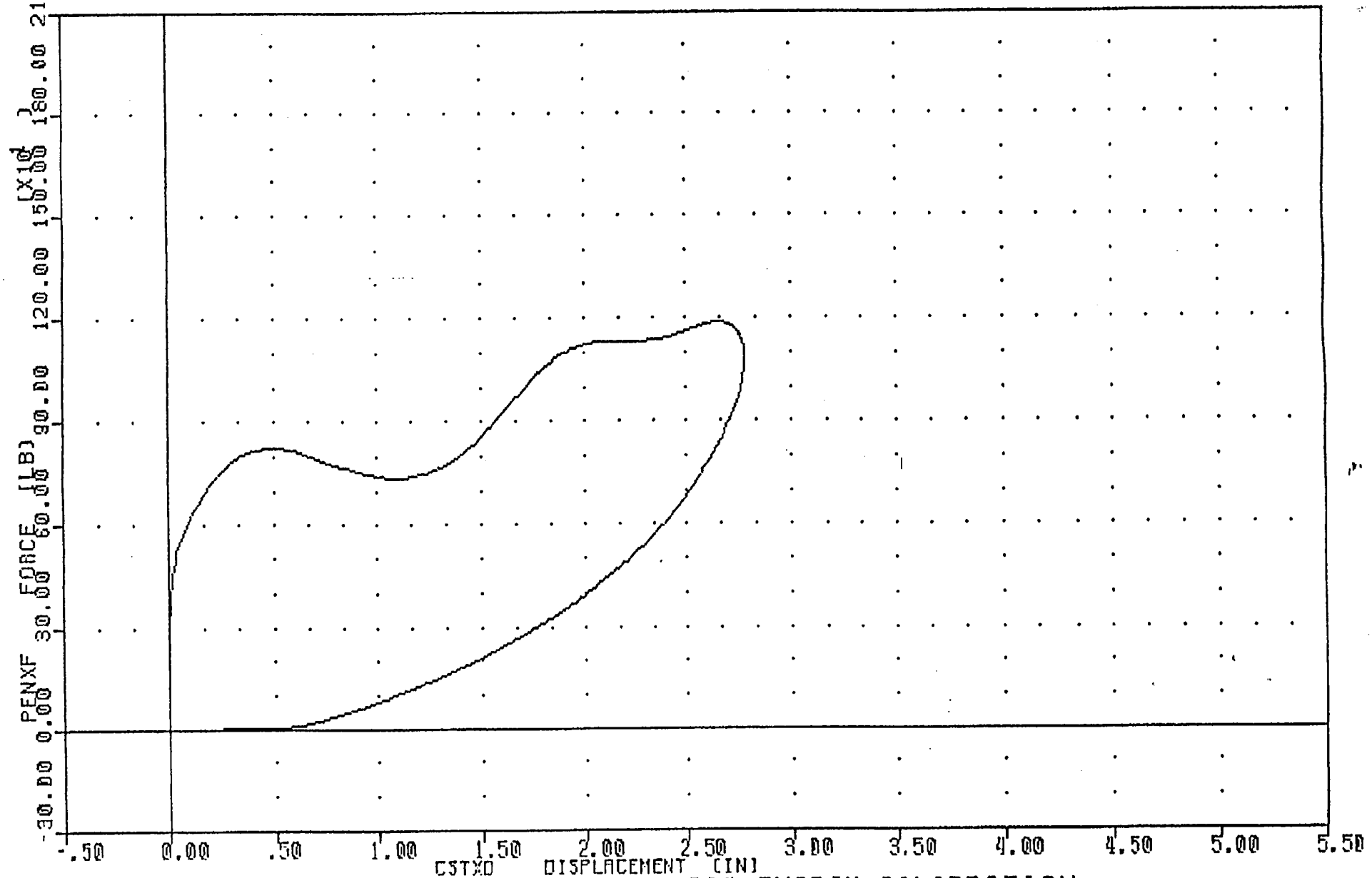
PART 572-E HYBRID III THORAX CALIBRATION
PENDULUM FORCE



PART 572-E HYBRID III THORAX CALIBRATION

STERNUM DISPLACEMENT

TRC	,48C4TH1	572E SN48 H.S.THORAX CAL04		92328			
CSTXD	FILTER = BLPP	300/ 949/ -40	MIN, MAX =	0.00 @	2.38 ,	2.78 @	27.38
PENXF	FILTER = BLPP	300/ 949/ -40	MIN, MAX =	-6.13 @	0.63 ,	1186.43 @	22.75



PART 572-E HYBRID III THORAX CALIBRATION

CHEST DISPLACEMENT VS PENDULUM FORCE

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

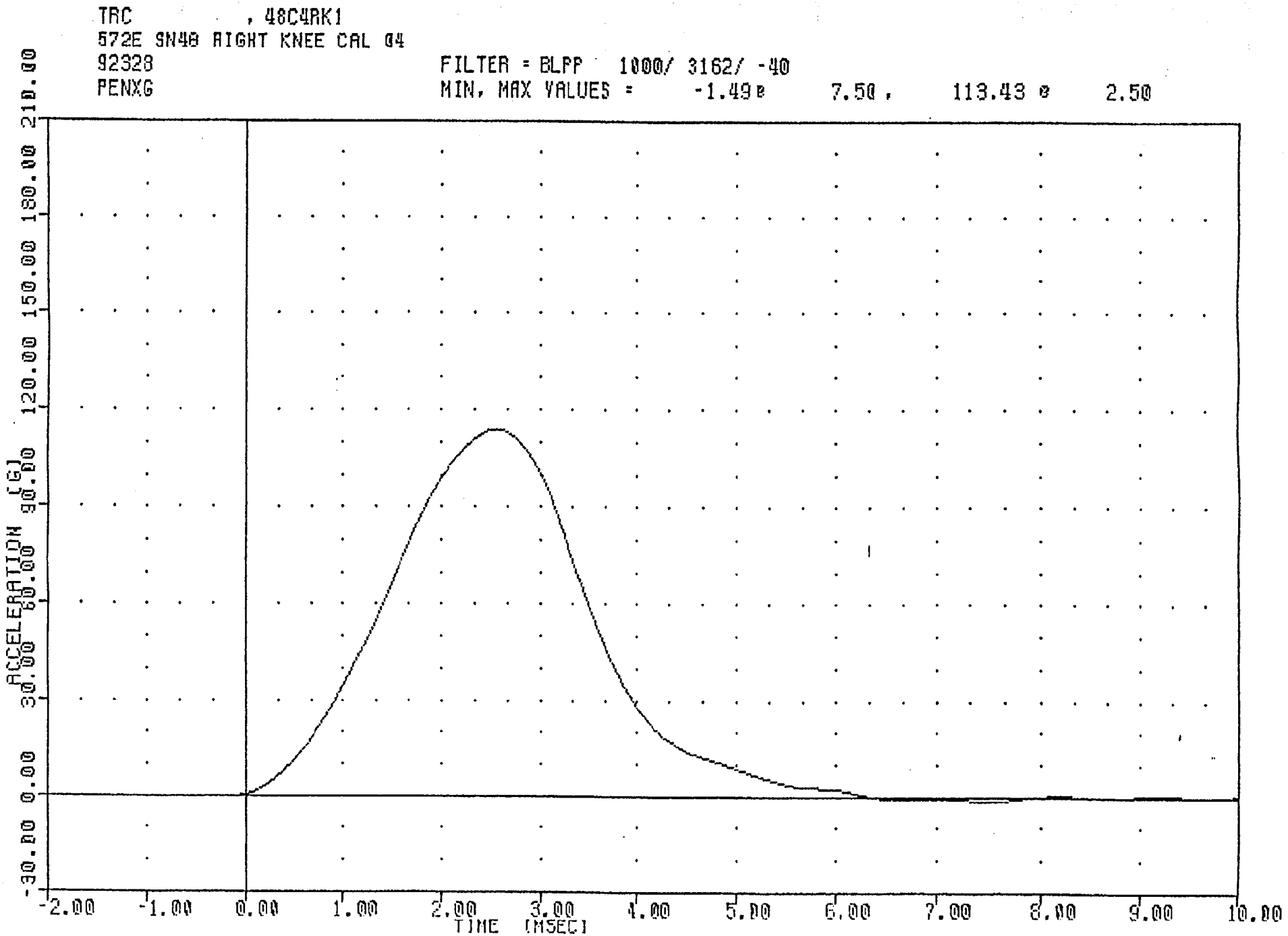
HYBRID III 23-NOV-92

RIGHT KNEE
TRC 48C4RK1 572E SN48 RIGHT KNEE CAL 04

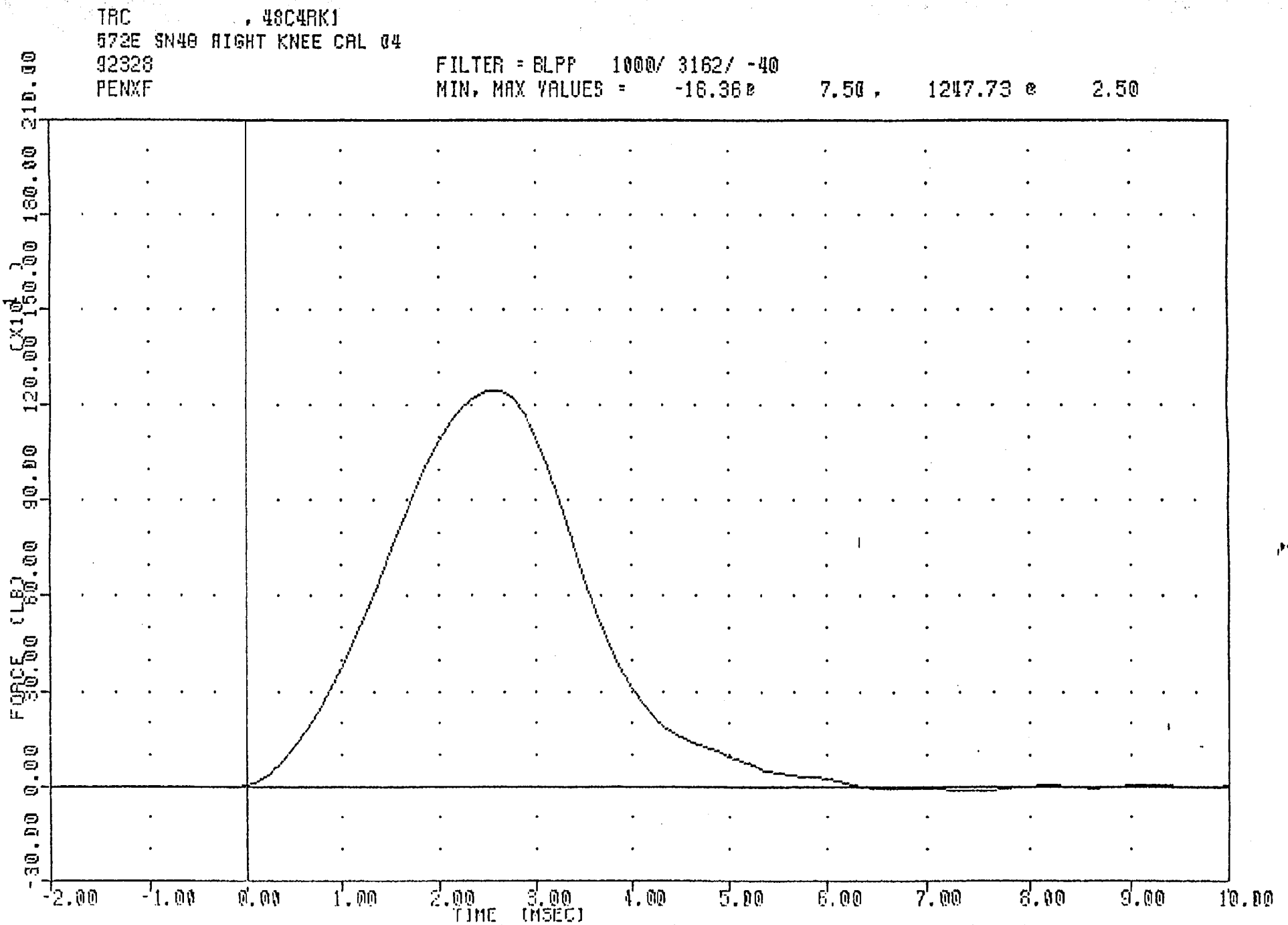
TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.91 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1247.72 LBS
PROBE WEIGHT	11.0 LBS	

TEST MEETS SPECIFICATIONS

TECHNICIAN Peter Foust



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

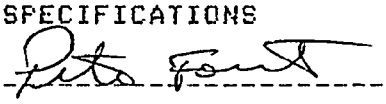
KNEE IMPACT TEST

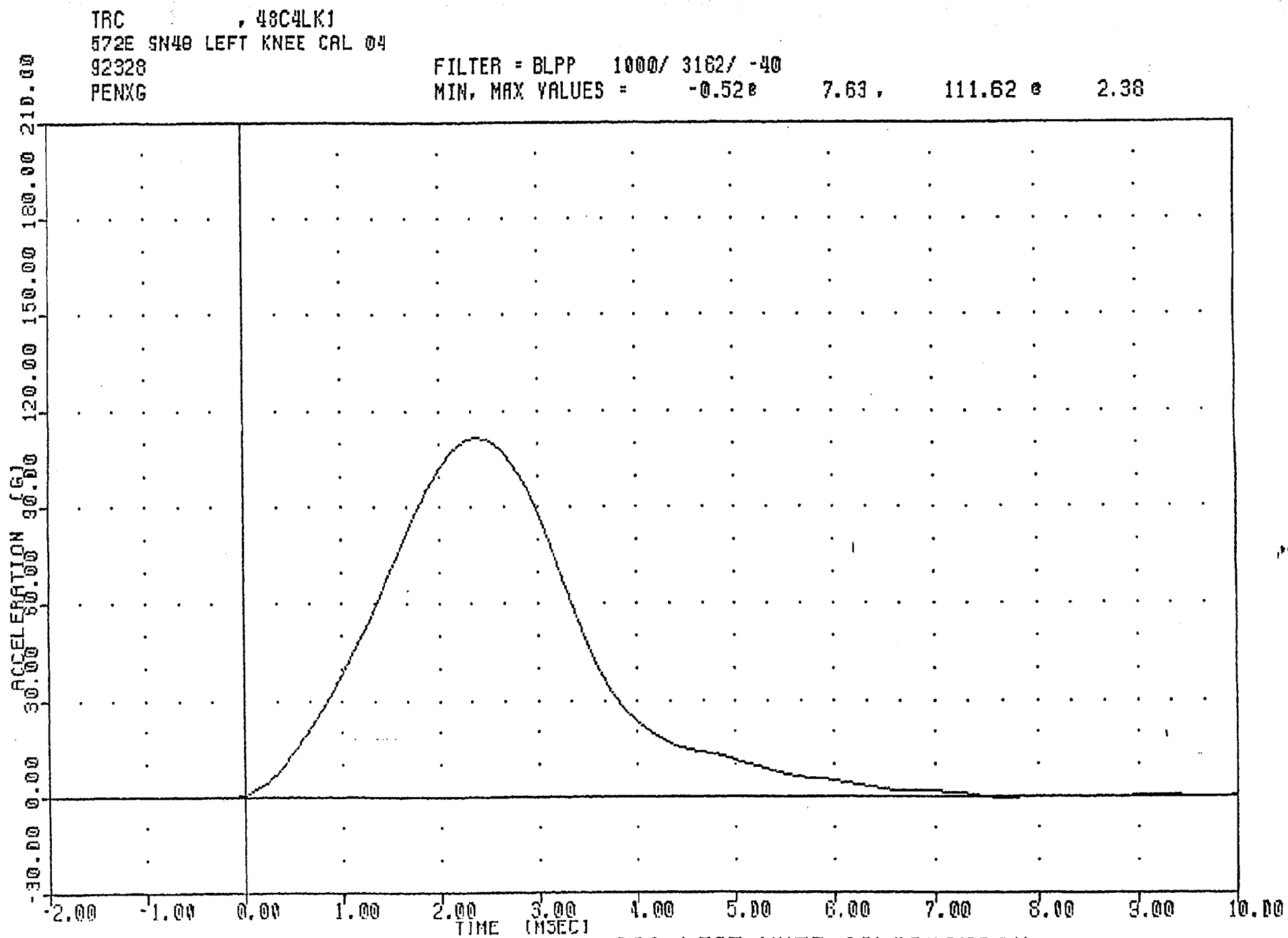
HYBRID III 23-NOV-92

LEFT KNEE
TRC 48C4LK1 572E SN48 LEFT KNEE CAL 04

TEST PARAMETER	SPECIFICATION	TEST RESULTS
TEMPERATURE	66 - 78 DEG. F	70.0 DEG. F
RELATIVE HUMIDITY	10% - 70%	55.0 %
PROBE VELOCITY	6.8 - 7.0 FT/SEC	6.86 FT/SEC
PEAK KNEE IMPACT FORCE	1060 - 1300 LBS	1227.77 LBS
PROBE WEIGHT	11.0 LBS	

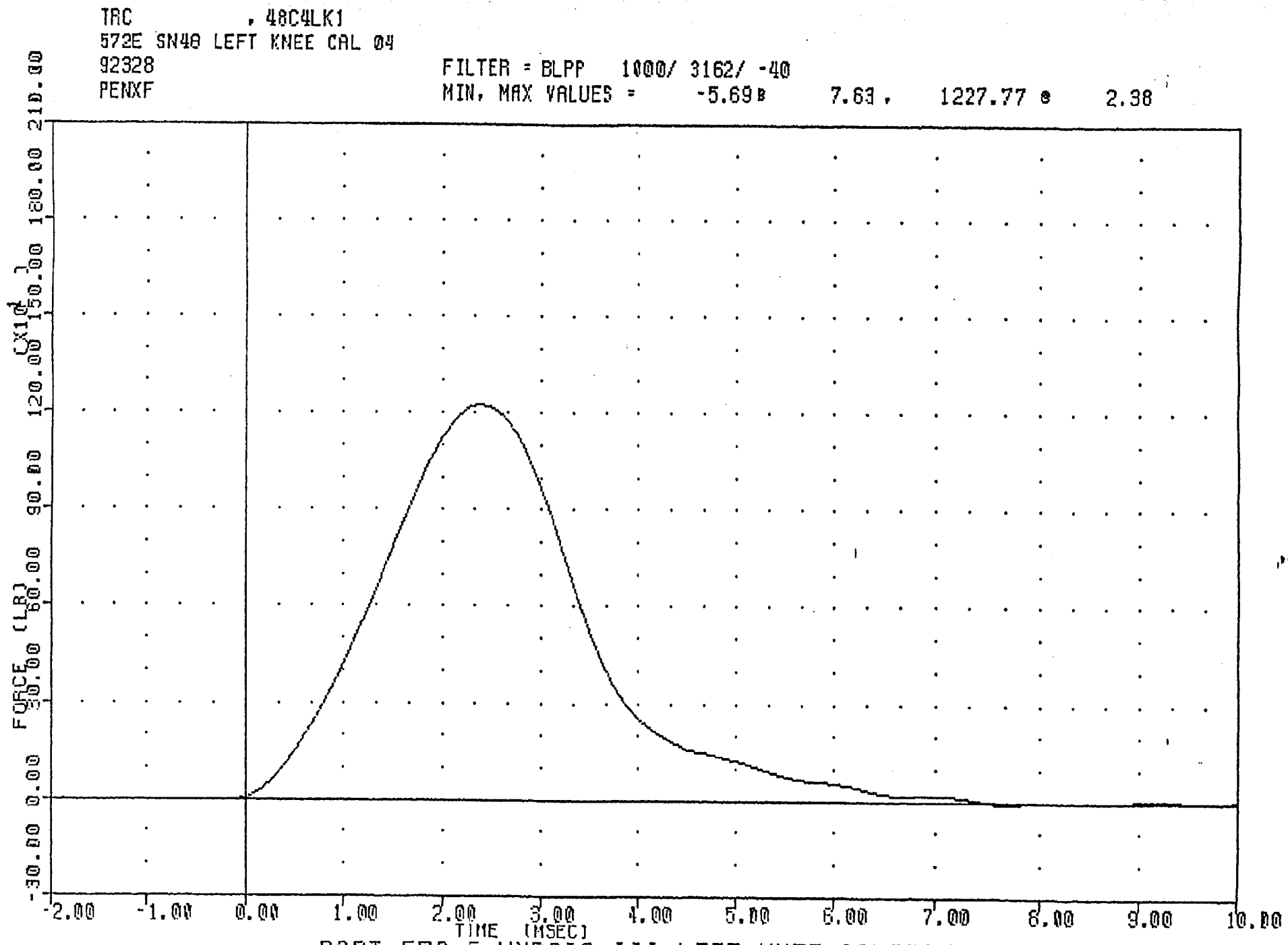
TEST MEETS SPECIFICATIONS

TECHNICIAN 



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 #043

SEATING POSITION: DRIVER

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	FF79J	UP
CHEST DISPLACEMENT	X	BOURNS	NA	043	OUTWARD
PELVIS ACCELERATION	X	ENDEVCO	7264	DM72J	REAR
PELVIS ACCELERATION	Y	ENDEVCO	7264	BG11J	LEFT
PELVIS ACCELERATION	Z	ENDEVCO	7264	BH87J	UP
LEFT FEMUR FORCE		GSE	2430	631	TENSION
RIGHT FEMUR FORCE		GSE	2430	633	TENSION

DUMMY INSTRUMENTATION PLACEMENT

DUMMY MANUFACTURER & S/N: HUMANOID SYSTEMS #048

SEATING POSITION: RIGHT FRONT PASSENGER

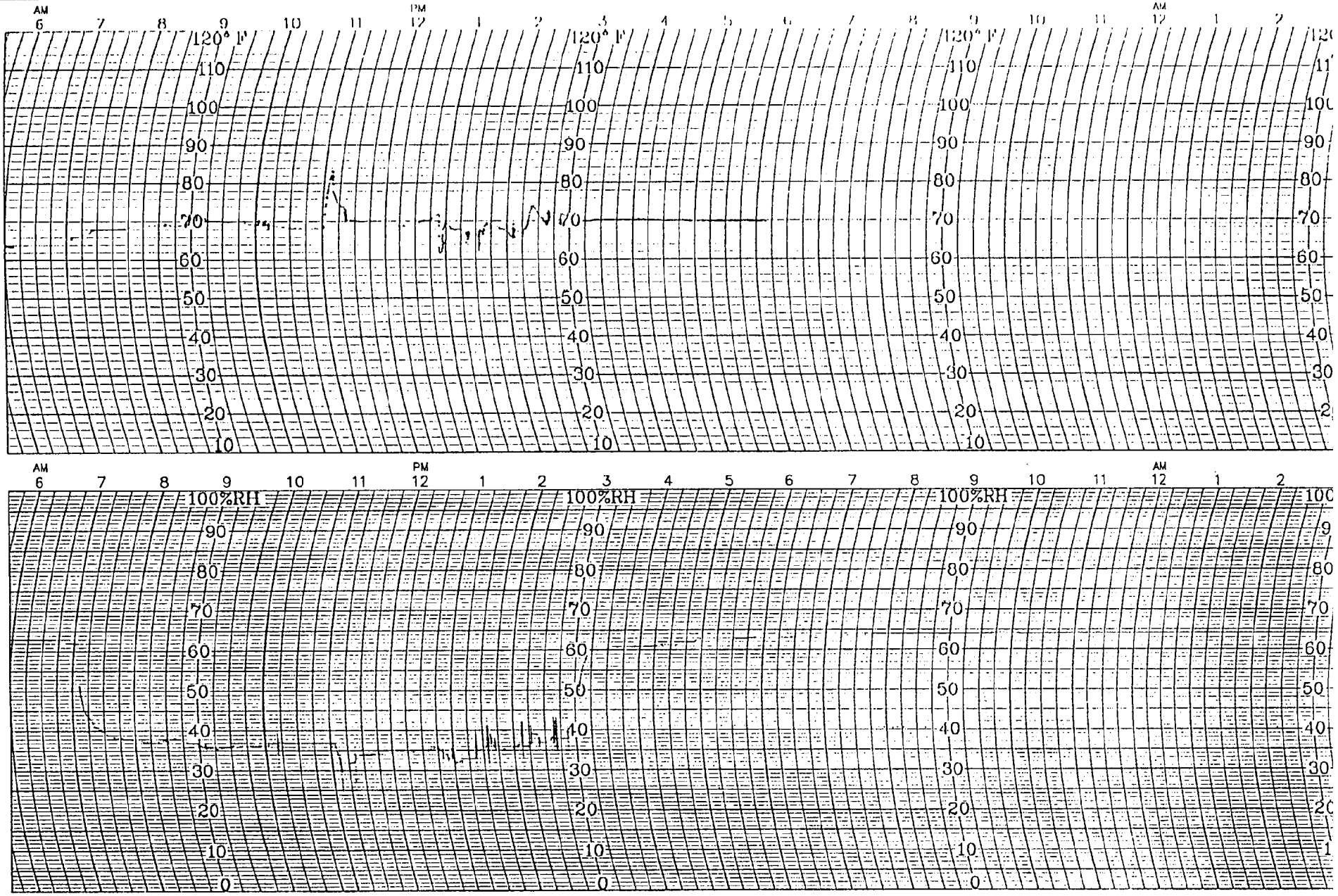
DESCRIPTION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
HEAD ACCELERATION	X	ENDEVCO	7264	EH78J	REAR
HEAD ACCELERATION	Y	ENDEVCO	7264	DH37J	LEFT
HEAD ACCELERATION	Z	ENDEVCO	7264	DD17J	UP
NECK SHEAR FORCE	X	DENTON	1716	0106	HEAD REARWARD
NECK SHEAR FORCE	Y	DENTON	1716	0106	HEAD LEFTWARD
NECK AXIAL FORCE	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	Y	ENDEVCO	7264	FC43J	LEFT
PELVIS ACCELERATION	Z	ENDEVCO	7264	AP87	UP
LEFT FEMUR FORCE		GSE	2430	014	TENSION
RIGHT FEMUR FORCE		GSE	2430	756	TENSION

UNDERRIDE GUARD INSTRUMENTATION PLACEMENT

NO.	LOCATION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
1	BARRIER FRONT	X	ENDEVCO	2264	AS44	REAR
	CROSSMEMBER LEFT	Z	ENDEVCO	2264	AG24	UP
2	BARRIER FRONT	X	ENDEVCO	2264	BB67	REAR
	CROSSMEMBER RIGHT	Z	ENDEVCO	2264	AS76	UP

VEHICLE INSTRUMENTATION PLACEMENT

NO.	LOCATION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
1	LEFT REAR SEAT	X	ENDEVCO	2264	AS29	REAR
		Y	ENDEVCO	2264	AR89	RIGHT
2	RIGHT REAR SEAT	X	ENDEVCO	2264	AR24	REAR
		Y	ENDEVCO	2264	AN40	RIGHT
3	CAR CENTER OF GRAVITY	X	ENDEVCO	2264	AY66	REAR
		Y	ENDEVCO	2264	AS70	RIGHT
		Z	ENDEVCO	2264	AS03	UP
	RIGHT FRONT PASSENGER'S SHOULDER BELT		LEBOW	3419	616	TENSION


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

SIGN CONVENTION

NHTSA DATA TAPE REFERENCE GUIDE

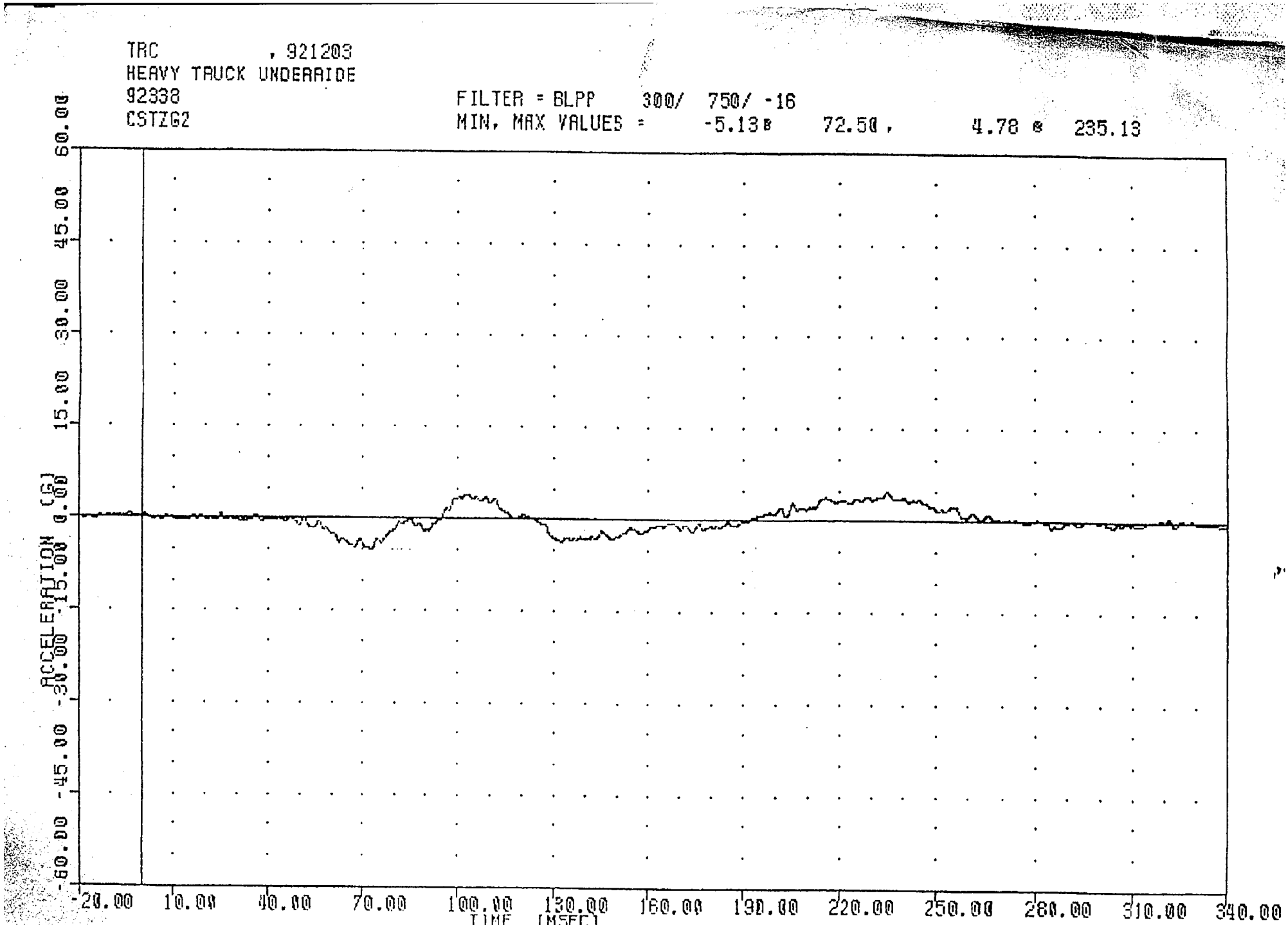
ACCELEROMETERS:	+X:	FORWARD
	+Y:	LEFTWARD
	+Z:	UPWARD
POTENTIOMETERS:	+CHEST LONGITUDINAL DEFLECTION:	OUTWARD
LOAD CELLS:	+FEMUR FORCE:	TENSION
	+SEAT BELT FORCE:	TENSION
NECK LOAD CELLS:	+X FORCE:	HEAD PUSHED FORWARD
	+Y FORCE:	HEAD PUSHED LEFTWARD
	+Z FORCE:	HEAD PULLED UPWARD (TENSION ON NECK)
	+X MOMENT:	RIGHT EAR ROTATING TOWARD RIGHT SHOULDER
	+Y MOMENT:	CHIN ROTATING TOWARD CHEST
	+Z MOMENT:	CHIN ROTATING TOWARD LEFT SHOULDER

FREQUENCY RESPONSE CLASSES

NHTSA LABORATORY PROCEDURE TP-214D-01

TYPICAL TEST MEASUREMENTS	CHANNEL CLASS
Vehicle Structural Accelerations for use in:	
Total vehicle comparison	60
Collision simulation input	60
Component analysis	600
Integration for velocity or displacement	180
Anthropomorphic Test Device	
Head accelerations (linear and angular)	1000
Thorax	
Spine accelerations	180*
Rib accelerations	180*
Deflections	180
Pelvis	
Accelerations	180*

*The Channel Class 180 data is further processed by subsampling to a 1600 Hz sample rate, removing bias, and filtering with the Finite Impulse Response (FIR100) filter program.



1993 FORD TEMPO INTO TRUCK UNDERRIDE GUARD

RIGHT FRONT PASSENGER CHEST Z-AXIS ACCELERATION