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MEMORANDUM REPORT BRL-MR-3838

BRL

AD-A223 356

COMPARISON OF 155-MM GUN TUBE HEAT INPUT
WITH SOLVENTLESS AND SOLVENT PROPELLANT

ARTHUR A. KOSZORU
IRVIN C. STOBIE

JUNE 1990

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U.S. ARMY LABORATORY COMMAND

BALLISTIC RESEARCH LABORATORY
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13. ABSTRACT (Maximum 200 words) A test to measure wall temperatures of a 155-mm howitzer cannon was conducted at the Ballistic Research Laboratory as part of a Product Improvement Program (PIP) which was formulated and conducted under the auspices of the Armament Research, Development, and Engineering Center. The main objective of this ballistic study was to determine if the projected gun tube wear from an alternative, ballistically equivalent, 155-mm, M203A1 propelling charge containing solventless stick propellant is comparable to the wear produced by the standard M203A1 containing M31A1E1 solvent based propellant. The results of this study indicate that the solventless propellant charge does not appear to be more erosive than the standard M203A1 charge. Additionally, the effects of several of the charge constituents on the amount of heat transferred to the tube were investigated, with a particularly dramatic increase seen in heat transferred to the tube when the case was removed.				
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I. INTRODUCTION

The M203A1, shown in Figure 1, is a 155-mm, single increment, top zone propelling charge. The charge contains approximately 11.79 kg of M31A1E1 triple base, slotted single perforated stick propellant and a lead foil/wax/TiO₂ liner which acts as a decoppering agent and wear reducing additive. The propellant and liner are contained in a rigid nitrocellulose combustible case which contains talc in its composition for wear reduction purposes. Ignition is accomplished with a CBI/black powder basepad held in place by a combustible end cap. The M203A1 propelling charge was type classified on 29 March 1985 to replace the granular M203 (bag) propelling charge. A PIP is currently being conducted on this 155-mm, stick propelling charge by the Armament Research, Development, and Engineering Center (ARDEC). This PIP would provide an alternate solventless stick propellant for the M203A1 propelling charge. An ARDEC-developed solventless propellant, XM41, was selected as the candidate for the PIP, which will complete full scale evaluation and result in type classification of the alternative propellant in the M203A1 configuration. The charge expected to result from this PIP is shown in Figure 2.

ARDEC initiated several investigations to determine the applicability of solventless propellants to the M203A1 charge configuration and performance level. Such a charge, manufactured at currently under-utilized facilities, would significantly contribute to the number of charges available to support mobilization requirements. Additionally, solventless propellants retain their extruded dimensions with less distortion than solvent propellants, leading to better physical uniformity, thus reducing the labor and cost of blending propellants to obtain the required ballistic uniformity. ARDEC-sponsored investigations include propellant producibility, ballistic acceptability, safety and other charge design related areas. As part of this series of investigations, ARDEC requested that the Ballistic Research Laboratory (BRL) examine the effect on wear of the substitution of the solventless propellant for the standard M31A1E1 propellant.

In the BRL portion of the evaluation of the M203A1 solventless stick propelling charge, gun tube wall temperatures were measured to determine if the heat input into the cannon with this charge was comparable to that with the 155-mm, M203A1, stick propelling charge. From previous ballistic data, it was determined that eliminating the combustible case¹ and additive liner² lowers pressure but increases the heat input into the cannon near the origin of rifling, thus increasing wear and erosion. Utilizing this information, possible charge variations were developed to examine the effect of several charge components on the heat transferred to the gun tube.

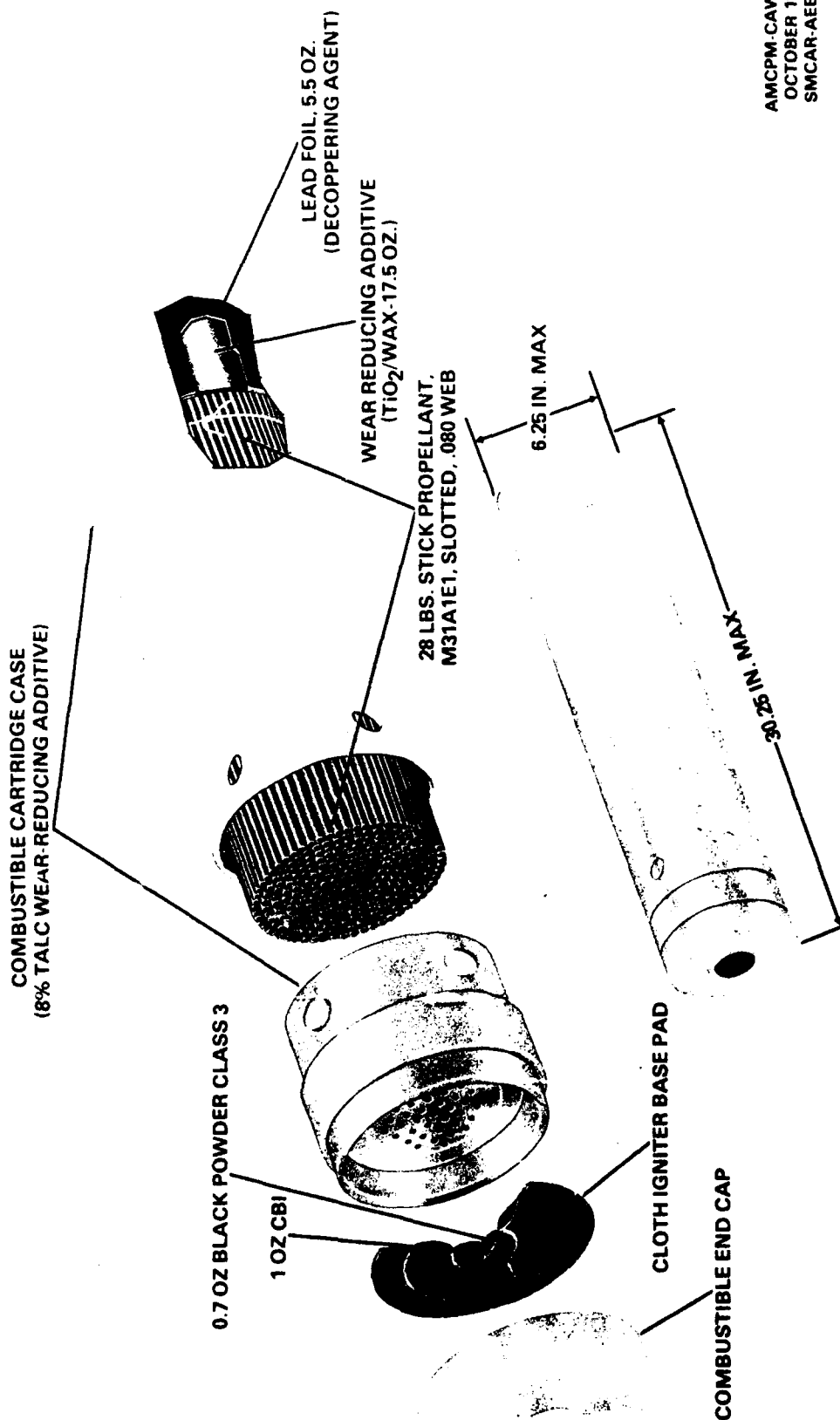
II. EXPERIMENTAL

A charge test matrix was developed by ARDEC and BRL to compare heat input from a solventless charge with similar components to that from a standard M203A1 charge. Further, an attempt was made to determine what effect the addition of flash-reducing agents and the removal of the wear-reducing liner or combustible case would have on the heat input to the gun wall.

A. Test Matrix

The ballistic test consisted of fourteen, control, M203A1, *solvent* stick propelling charges, Lot IND85M738-1B-3 and twenty eight, experimental, M203A1, *solventless* stick propelling charges. ARDEC-

CHARGE, PROPELLING, 155MM, M203A1 (TC-STD) (COMMENCE PRODUCTION FY86)



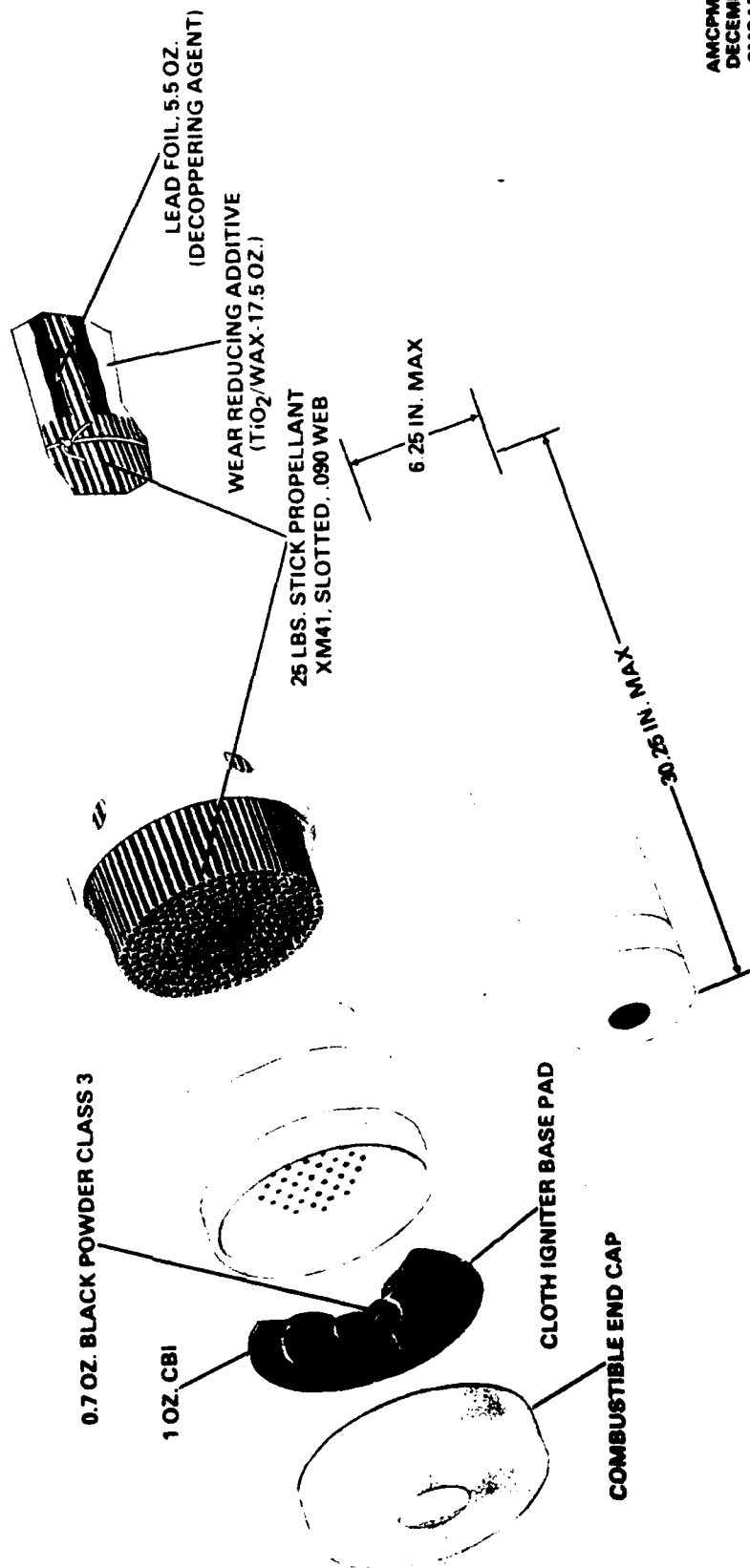
AMCPM-CAWS-A
OCTOBER 1985
SMCAR-AEE-8P

Figure 1. 155-mm, M203A1 Propelling Charge

CHARGE, PROPELLING, 155MM, M203A1 SOLVENTLESS STICK PROPELLANT ALTERNATE

(PIP 1-83-09-7801)

COMBUSTIBLE CARTRIDGE CASE
(8% TALC WEAR-REDUCING ADDITIVE)



AMCPM-CAWS-A
DECEMBER 1985
SMCAR-AEE-BP

Figure 2. 155-mm, M203A1 Solventless PIP Propelling Charge

developed XM41, solventless, slotted stick propellant, Lot RAD-PD-736-8C was used in all the solventless experimental charges. PXR6325 projectiles, Lot IOP86D002S067, were used with both the solventless and solvent charges. All charges were conditioned at twenty one degrees Celsius for twenty four hours prior to firing.

The solventless charges were subdivided into five sets, consisting of the following components:

1. **Variation 1.** Seven charges contained 11.39 kg of solventless propellant, a combustible case, basepad, and TiO_2 /wax liner.
2. **Variation 2.** Seven charges contained 11.39 kg of solventless propellant, a combustible case, and basepad.
3. **Variation 3.** Six charges contained 11.39 kg of solventless propellant, a combustible case, basepad, TiO_2 /wax liner, and a 0.113-kg KNO_3 flash reducer.
4. **Variation 4.** Seven charges contained 11.39 kg of solventless propellant, a combustible case, basepad, TiO_2 /wax liner, and a 0.113-kg K_2SO_4 flash reducer.
5. **Variation 5.** One charge contained 11.39 kg of solventless propellant and a basepad.

B. Test Firings

The gun firings were conducted at the Ballistic Research Laboratory's Sandy Point Firing Facility (R-18), in a 155-mm, M199 cannon, serial no. 32000. The M199 cannon was modified to accept two Kistler 607C4 piezoelectric pressure transducers and five thermocouples. Chamber pressure measurements were made by modifying the M199 cannon's spindle to accept one pressure transducer and machining a threaded port 904.2 mm from the rear face of the tube (RFT) at the 12 o'clock position to accommodate the second pressure transducer in the tube sidewall. A schematic showing the gage and thermocouple locations is given in Figure 3.

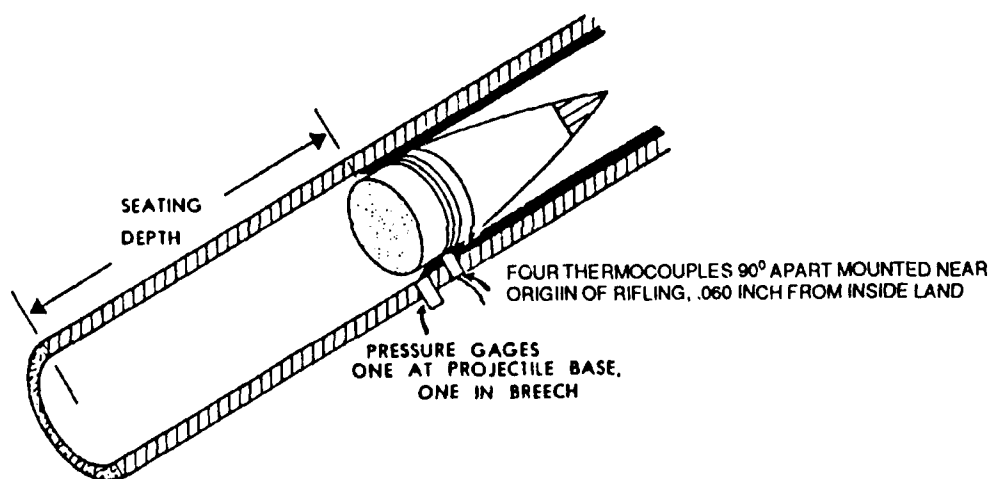


Figure 3: Gage and Thermocouple Schematic

To obtain the heat input measurements, holes were drilled in the gun tube sidewall at the desired thermocouple locations to a depth at 1.59 mm from the bore surface. Constantan wires 0.13 mm in diameter were welded to the bottoms⁶ of the holes using a capacitive discharge technique to form constantan-gun steel thermocouples near the bore surface. Four thermocouples were located at 3, 6, 9, and 12 o'clock positions at a distance of 1060 mm from the RFT at the origin of rifling. An additional downbore thermocouple was located at 12 o'clock at 1524 mm from the RFT. This technique was initially developed by Brosseau³ to measure wall temperatures in 37-mm guns. The technique was modified for this M199 cannon to determine the extent of asymmetric heating in a 155-mm howitzer.⁴ The asymmetric heating study provided a reasonable data base for the evaluation of solventless heating.

A calibration factor of 52 microvolts per degree Kelvin was used to compare known voltage calibration steps to the response of the thermocouples. The maximum temperature change for each thermocouple was noted for each round. The heating effects of the various rounds in this study, as well as in Reference 4, were expressed in the maximum temperature change. The maximum temperature change at each thermocouple is a reasonable measure of heat input from the various charges since all the rounds had similar maximum pressures and pressure durations. Given the pressure similarities, the assumption was made that the heat input took place in the same amount of time for all of the rounds.

A 15-GHz continuous wave doppler radar and discriminator were used to obtain on-line velocity/time records.

The maximum breech and forward pressures, differential pressure, projectile velocity and change in temperatures were recorded and reduced by the Ballistic Data Acquisition System (BALDAS) under the control of a PDP 11/45 minicomputer.

III. RESULTS

The maximum pressures, muzzle velocities and sample sizes for all the firings are summarized in Table 1. The maximum temperature changes for the thermocouples at three positions at the origin of rifling are summarized in Table 2. The two other thermocouple positions - origin of rifling at 9 o'clock and downbore - are not included due to the failure of the thermocouple junction at these positions for most of the rounds.

Variation 1 was the substitution of solventless propellant for the standard M31A1E1 stick propellant. Breech pressure-time and pressure difference (forward - rear gages) plots are given for the standard M203A1 and the solventless propellant M203A1 in Figures 4 and 5 respectively. A complete record of the pressure-time curves and thermocouple plots are contained in Appendix B. The maximum pressure and muzzle velocity were higher for the solventless variation in comparison to the standard M203A1 charge. The cause of these higher values was attributed to the fact that the solventless charges were fired with 0.3 kg more propellant than was required to ballistically match the M203A1 charge. The maximum change in temperatures with these charges agreed within the scatter of the data with the standard charge, indicating no effect on thermal erosion produced by substitution of the solventless propellant for the solvent propellant. The temperature-time traces for a solventless M203A1 firing are given in Figure 6. These traces are typical of all those obtained in this study.

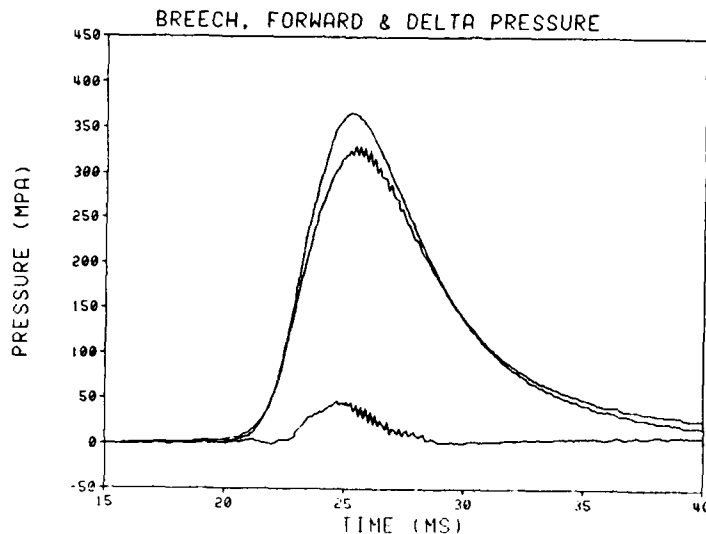


Figure 4: Breech Pressure and Pressure Difference, Standard M203A1

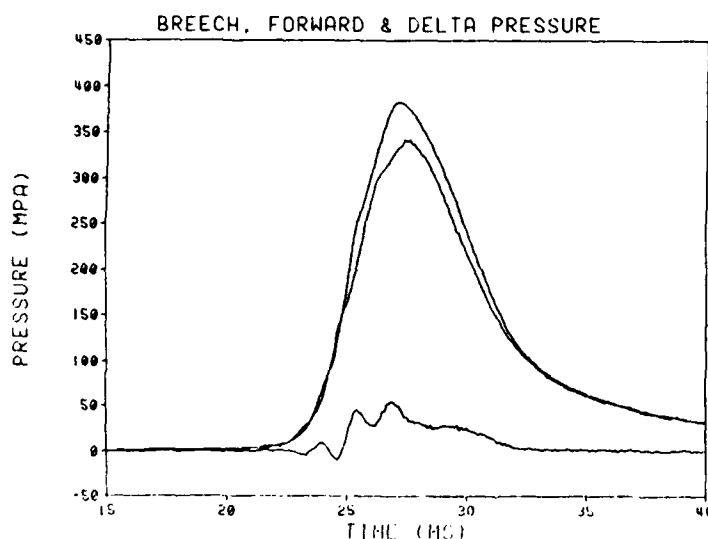


Figure 5: Breech Pressure and Pressure Difference, Solventless M203A1

Charge	Sample Size	Breech Pressure (MPa)	Forward Pressure (MPa)	Muzzle Velocity (m/s)
M203A1	14	366	325	827
Solventless/ liner	7	380	334	839
Solventless/ wo liner	7	364	321	835
Solventless/ KNO ₃	6	384	350	844
Solventless/ K ₂ SO ₄	7	382	340	841
Solventless/ no case	1	297	262	794

Table 1. Pressures and Velocity

Charge	Sample Size	Max Temp Rise (°C)			Avg at Origin
		12	3	6	
M203A1	14	113±8	81±3	108±3	101±5
Solventless/ liner	7	116±8	82±3	114±4	104±3
Solventless/ wo liner	7	119±6	87±2	120±3	110±4
Solventless/ KNO ₃	6	115±5	83±2	113±2	105±3
Solventless/ K ₂ SO ₄	7	116±8	82±2	111±2	105±5
Solventless/ no case	1	139	--	138	133±10

Table 2. Thermocouple Data

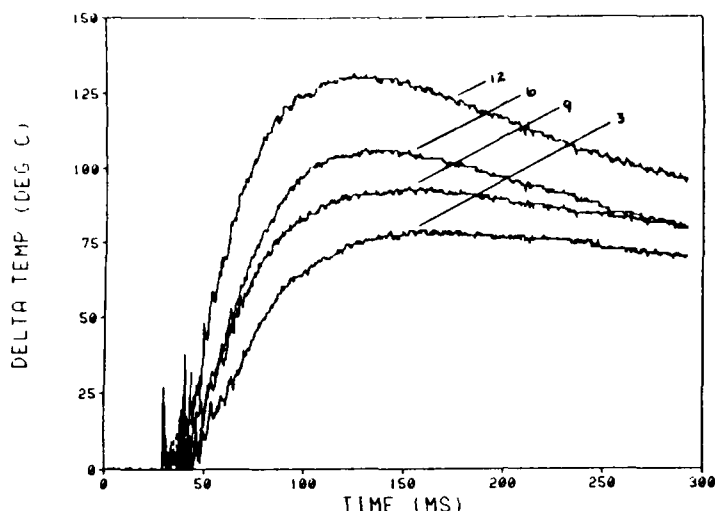


Figure 6: Temperature Changes at Thermocouple Locations 1-4

Variation 2 was the solventless charge without the TiO_2 /wax/lead liner. As expected from previous experience with the M203A1, this variation resulted in reduced pressures and velocities in comparison to those from Variation 1. This reduction should be expected, since the elimination of the liner effectively increased the chamber volume. The temperature measurements were slightly higher at all of the thermocouple positions. The temperature results indicate the minimal effect of the wear reducing additive in this charge.

Variations 3 and 4 were the solventless charges with flash reducers of KNO_3 or K_2SO_4 . Higher pressures and velocities were seen with the flash reducer shots when compared with other solventless rounds due to the reduction of free chamber volume. The flash reducers produced no effect on the temperature increases.

Variation 5 consisted of a solventless charge without the combustible cartridge case. The pressures and velocities were less than the other solventless rounds due to reduction of the amount of energetic material in the charge and the effective increase in chamber volume due to the elimination of the case and parasitic components. The maximum temperature at the two measured positions increased dramatically over the other solventless charges. These results were anticipated because the combustible case has a flame temperature near 2200 K while the flame temperature of the solventless propellant is approximately 2737 K. The combustible case not only reduces the effective flame temperature of the entire charge, but has an added cooling effect in that gases from its combustion are produced near the boundary layer, the characteristics of which govern the heat input to the tube.

IV. CONCLUSIONS

From the data gathered in this study, we can draw several conclusions regarding the effect several of the charge constituents have on the amount of heat transferred to the gun tube during the interior ballistic cycle.

A combustible-cased charge containing solventless XM41 propellant does not appear to be more erosive than the standard M203A1 charge containing M31A1E1 stick propellant, based on the amount of heat input at the origin of rifling.

The wear reducing additive in the solventless charge reduces the maximum temperature change, and thus the heat input, at the origin of rifling. The magnitude of the reduction appears small; however, testing performed during the M203A1, product improvement program predicted a wear life significantly lower without the liner.

The addition of a flash reducer in the amount typical of that in a fielded charge (0.113 kg) does not affect the amount of heat transferred to the gun tube. It does, however, increase the maximum chamber pressure to the degree expected.

The elimination of the combustible cartridge case significantly increases the heat input at the origin of rifling, as expected. The cooling effect of the entrainment of the case gases, which are cooler than those of the propellant, into the boundary layer was dramatically demonstrated by the the comparison of the temperature rise in the vicinity of the origin of rifling with cased and uncased charges.

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2. F.A. Vassallo, "An Evaluation of Heat Transfer and Erosion in the 155-mm M185 Cannon," Technical Report No. VL-5337-5-1, Calspan Corporation, Buffalo, NY, July 1976.
3. T.L. Brosseau, "An Experimental Method of Accurately Determining the Temperature Distribution and Heat Transferred in Gun Barrels," BRL-R-1740, US Army Ballistic Research Laboratory, Aberdeen Proving Ground, MD, September 1974.
4. D.L. Kruczynski, "Gun Tube/Charge/Projectile Interactions and Gun Tube Wear," BRL-TR-3004, US Army Ballistic Research Laboratory, Aberdeen Proving Ground, MD, June 1989.

ACKNOWLEDGEMENTS

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APPENDIX A

Description Sheets for XM41 and M31A1E1 Propellants

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PROPELLANT DESCRIPTION SHEET						DRAFT	REPORT CONTROL SYMBOL EXEMPT-PARA 7-20 AR 335-15	
APPROXIMATION XM41 Slotted Stick				DA LOT NUMBER RAD-PE-736- 8C				
SPECIFICATION COR Ltr SMCRA-EN dated 10/11/85				PACKED AMOUNT 3720 lb				
MADE AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.				CONTRACT NUMBER DAAA09-77-C-4007				
NITROCELLULOSE								
ACCEPTED BLEND NUMBERS B-95057				NITROGEN CONTENT		KI STARCH (68.8°C)		STABILITY (134.3°C)
				MAX _____ %		MIN _____ MIN		MIN _____ MIN
				MIN _____ %		45+ MIN		30+ MIN
				AVG 13.06 %				EXPLOSION NR
MANUFACTURE OF SOLVENTLESS								
PERCENTAGE REMIX TO WHOLE _____ OZ								
PROCESS- DRYING								
TEMPERATURE °		DATE						TIME
FROM	TO	LOADING						HOURS
Ambient	120	Curing						4
120	Ambient	Unload						
TESTS OF FINISHED PROPELLANT								
PROPELLANT COMPOSITION			PERCENT TOLERANCE				STABILITY AND PHYSICAL TESTS	
CONSTITUENT	PERCENT FORMULA	PERCENT TOLERANCE	PERCENT MEASURED	HEAT TEST 120°C		FORMULA		ACTUAL
Nitrocellulose	42.68		40.9	No Fumes				60+
Nitroguanidine	20.00	± 1.0	21.0	FORM OF PROPELLANT		Cyl Slotted Stick		1 hr
Nitroglycerin	26.50		26.7	Talliani - Slope				
Di-normal-propyl-adipate	8.00		8.6	of P-T 100 min		<1.0		0.493
Ethyl Centralite	1.40	± 0.1	1.4	HOE		855±12		860.5
Carbon Black	0.10		0.2	Ignition Temp		Flame +C		103.1
Candelilla Wax	0.10		0.1	Absolute Density g/cc				1.58
Potassium Sulfate	1.22		1.1					
Moisture	0.4	Max	0.11					
CLOSED BOMB Dynamic								
TEST	LOT NUMBER	TEMP °F	RELATIVE GUNNESS	RELATIVE FORCE	SPORIFICATION		FINISHED	
	PE-736-8C	+145	113.56	103.57	LENGTH (L)		29.125±0.125	
	PE-736-8C	+90	103.99	102.94	DIAMETER (D)		0.278±0.004	
	PE-736-8C	-40	91.86	101.56	PERF. DIA (d)		0.110	
STANDARD	070077	+90	100.00%	100.00%	Web		0.084±0.002	
REMARKS					Web Diference /Std. Dev. in % of Web Avg.		TEST FINISHED	
0.15 gm/cc loading density in the 700 cc closed bomb					L/D		4/22/86	
					D:d		4/23/86	
					N/A		104.5	
					N/A		2.50	
TYPE OF PACKING CONTAINER Barrier Bag and Wooden Boxes								
REMARKS								
Per scope of work: Box 1 to 14 unblended (840 lb)								
Box 15 to 62 blended (2880 lb)								
Nitroglycerin manufactured by RAAP; Nitroguanidine manufactured by Sunflower AAP								
SIGNATURE OF CONTRACTOR'S REPRESENTATIVE					SIGNATURE OF GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE			
C. J. Norris								

ARRCOM FORM 214R 10 AUG 77

PROPELLANT DESCRIPTION SHEET				EXEMPT PARA 7-30 AR 225-15		
COMPOSITION M31A1E1 Slotted Stick Propellant			SA LOT NUMBER RAD PE-738-1B			
DESCRIPTION COR Letter SARRA-EN dated 27 September 1983			PACKED AMOUNT 29,760 pounds			
MFG AT RADFORD ARMY AMMUNITION PLANT, RADFORD, VA.			CONTRACT NUMBER DAAA09-77-C-4007			
NITROCELLULOSE						
ACCEPTED BLEND NUMBERS M31.147 M31.322 M31.359 B 31.361 B 31.362 B 31.369 B 31.372 B 31.377 B 31.384 B 31.386 B 31.388			NITROGEN CONTENT		STABILITY (24.5°C)	
			MAX 12.70 %		MIN	
			MIN 12.53 %		MIN	
			AVG 12.59 %		30.4 MIN	
			EXPLOSION		NR	
MANUFACTURE OF SOLVENT PROPELLANT						
18.16 POUNDS SOLVENT PER POUND NC/DTY WEIGHT INGREDIENTS CONSISTING OF 60 POUNDS ALCOHOL AND 40 POUNDS ACETONE PER 100 POUNDS SOLVENT PERCENTAGE REMAIN TO WHOLE 13.25						
PROCESS-SOLVENT RECOVERY AND DRYING						
TEMPERATURE °F	TIME	REMARKS	DATE	TIME		
ambient	ambient	Ambient hold		48		
ambient	100	Increase at 5°F per hour		25		
100	100	Hold on temperature		4		
100	ambient	Cool down for processing				
TESTS OF FINISHED PROPELLANT						
CONSTITUENT		PERCENT FORMULA	PERCENT ANALYSIS	STABILITY AND PHYSICAL TESTS	FORMULA	ACTUAL
Nitrocellulose		21.50	± 1.30	21.60	HEAT TEST	40' CC 60' +
Nitroglycerin		18.00	± 1.00	18.08	No fumes	60' NF 1 hr
Nitroguanidine		54.70	± 1.00	54.70	FORM OF PROPELLANT	Slotted Stick
Dibutylphthalate		3.00	± 0.30	2.95	No. of Perfs	1
Ethyl Centralite		1.50	± 0.30	1.50	Avg St. Wt., g	n/a 33.16
Potassium Sulfate		1.25	± 0.30	1.09	HOE, cal/g	n/a 852.9
Carbon Black		0.05	± 0.02	0.05	Abs. dens., g/cc	n/a 1.67
Ash				0.03		
TOTAL		100.00		100.00		
Total Volatiles (TV)		0.30	MAX	0.06		
SPECIFICATIONS						
LOT NUMBER	TEMP °F	STRENGTH	WEIGHT	PERCENT	PERCENT	PERCENT
TEST RAD-PE-738-1B	+90	95.73	101.94			
STANDARD	70077	+90	100.00%	100.00%		
REMARKS				Web		
Tested in a 700 cc closed bomb, at a 0.2 g/cc loading density.				0.082 0.088 0.0833		
				PACKED 12/22/83		
				SAMPLED 12/22/83		
				TEST PERFORMED 1/11/84		
				CHARGED		
				PERSCRIPTION SHEET FORWARDED 23 Mar 84		
TYPE OF PACKING CONTAINER				496 Boxes 860 lbs. each.		
REMARKS						
This lot meets specification requirements.						
SIGNATURE OF CONTRACTOR'S REPRESENTATIVE				SIGNATURE OF GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE		
J. C. COKER				J. E. BLAND		

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SEQUENCE No. 373

APPENDIX B

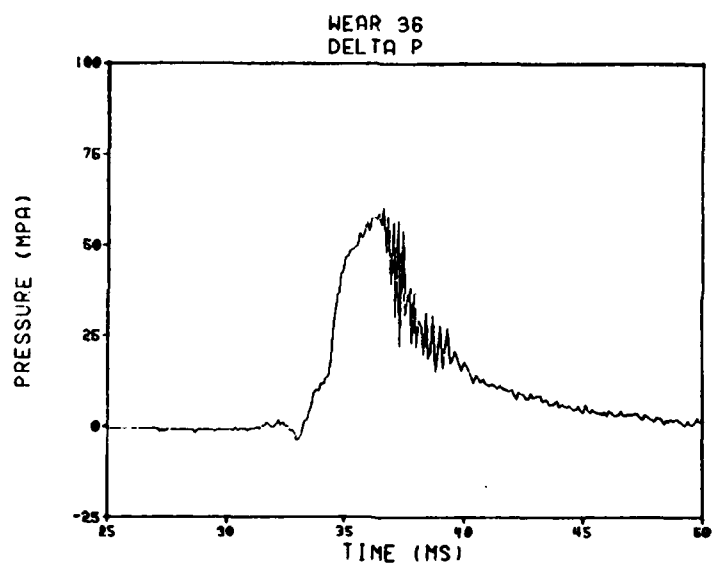
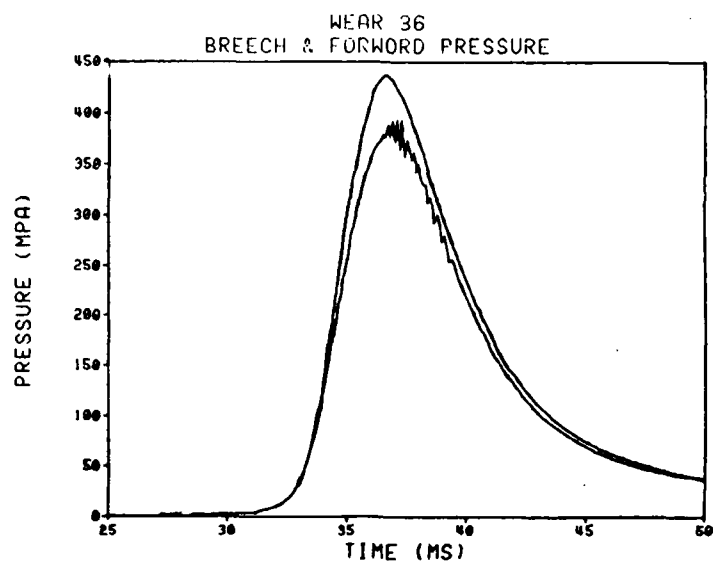
Computer generated plots of breech, forward, and delta (breech minus forward) pressures, and thermocouple output.

(Plots are in order of firing).

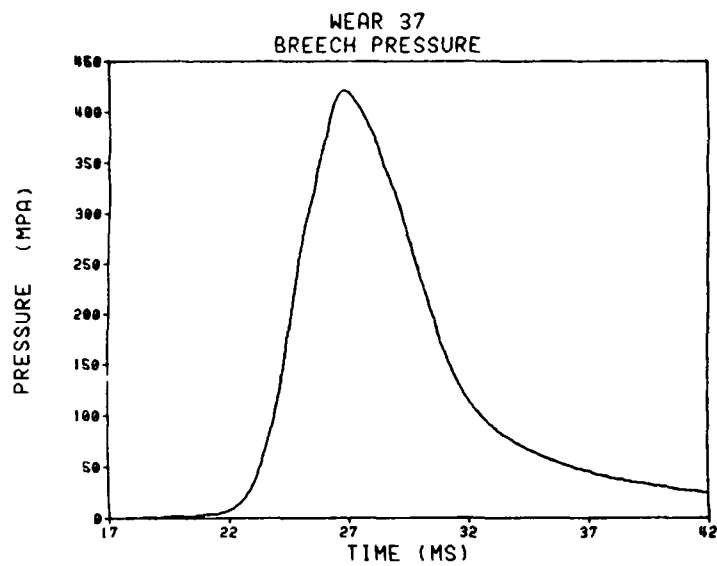
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RD #	PROPELLANT TYPE	LINER Yes/No	FLASH REDUCER
36	M31A1E1	Y	---
37	XM41	Y	---
38	M31A1E1	Y	---
39	XM41	N	---
40	M31A1E1	Y	---
41	XM41	N	---
42	XM41	Y	---
43	M31A1E1	Y	---
44	M31A1E1	Y	---
45	XM41	Y	---
46	XM41	N	---
47	M31A1E1	Y	---
48	XM41	Y	K_2SO_4
49	XM41	Y	KNO_3
50	M31A1E1	Y	---
51	XM41	Y	K_2SO_4
52	XM41	Y	KNO_3
53	M31A1E1	Y	---
54	XM41	Y	K_2SO_4
55	XM41	Y	KNO_3
56	M31A1E1	Y	---
57	XM41	Y	K_2SO_4
58	XM41	Y	KNO_3
59	M31A1E1	Y	---
60	XM41	Y	---
61	XM41	N	---
62	M31A1E1	Y	---
63	XM41	Y	---
64	XM41	N	---
65	XM41	Y	---

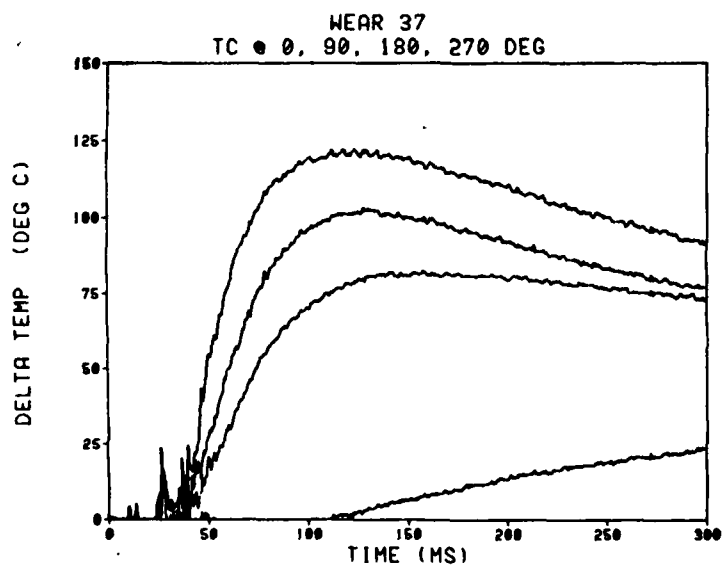
RD #	PROPELLANT TYPE	LINER Yes/No	FLASH REDUCER
66	XM41	N	---
67	XM41	Y	---
68	XM41	N	---
69	M31A1E1	Y	---
70	XM41	Y	---
71	XM41	N	---
72	XM41	Y	K ₂ SO ₄
73	XM41	Y	KNO ₃
74	M31A1E1	Y	---
75	XM41	Y	K ₂ SO ₄
76	XM41	Y	KNO ₃
77	M31A1E1	Y	---
78	XM41	Y	K ₂ SO ₄



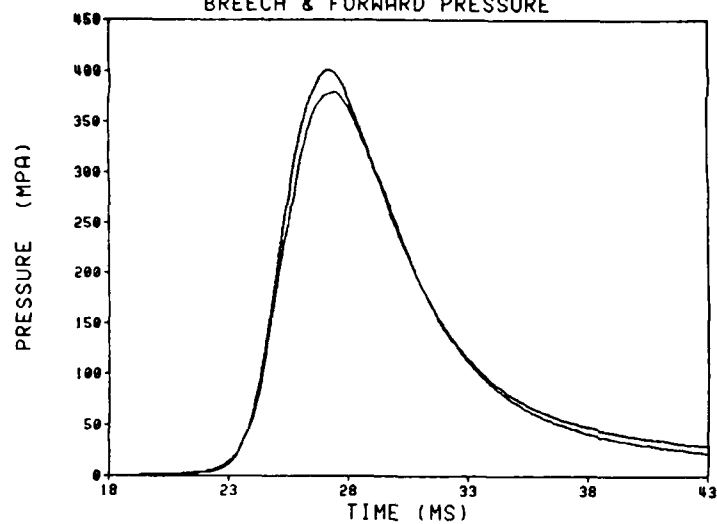
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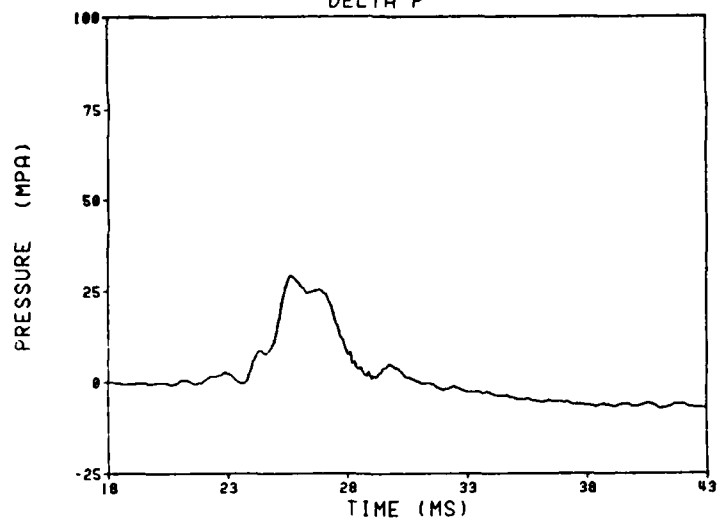
DATA LOST



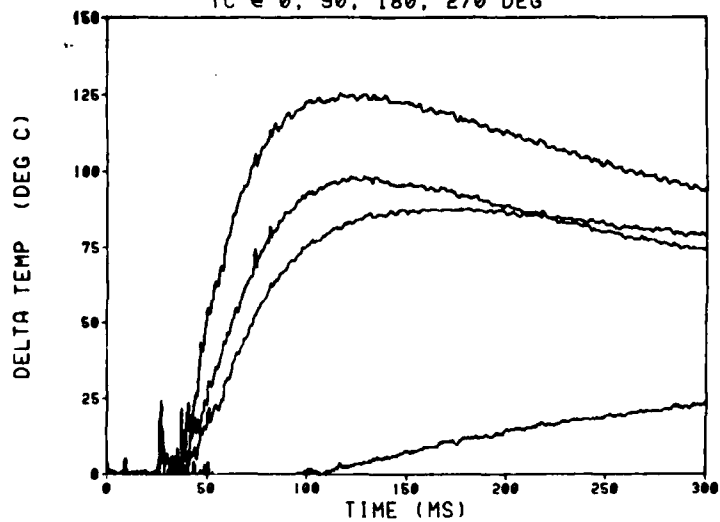
WEAR 38
BREECH & FORWARD PRESSURE

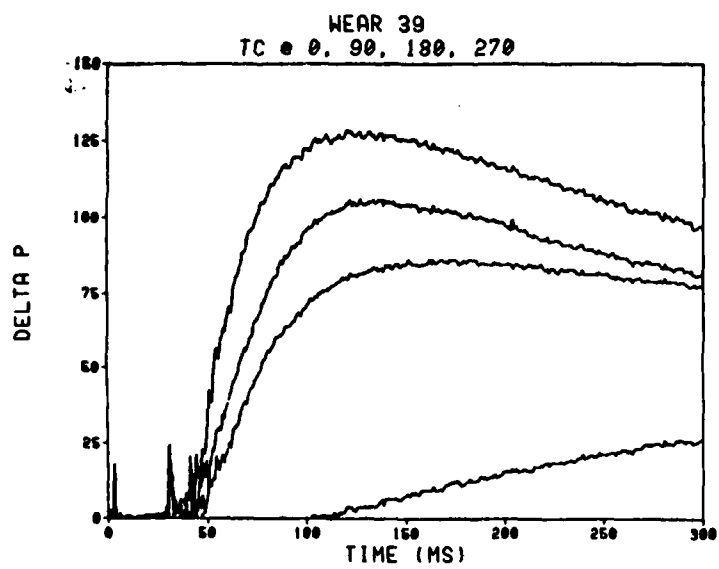
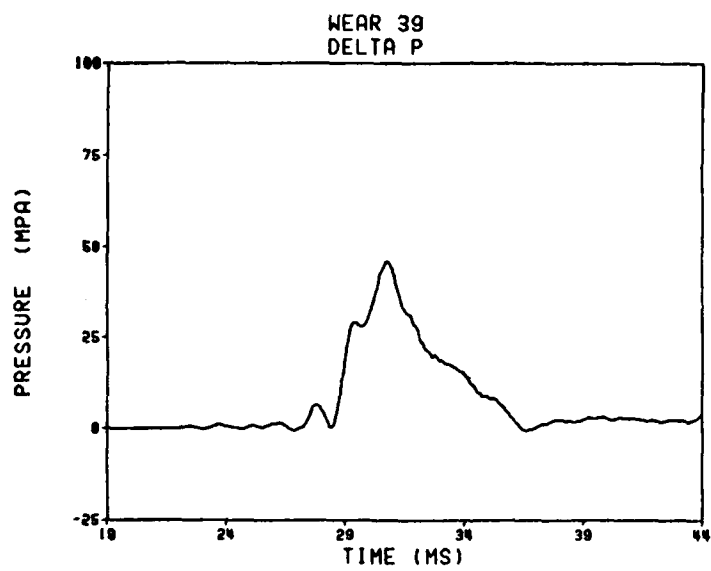
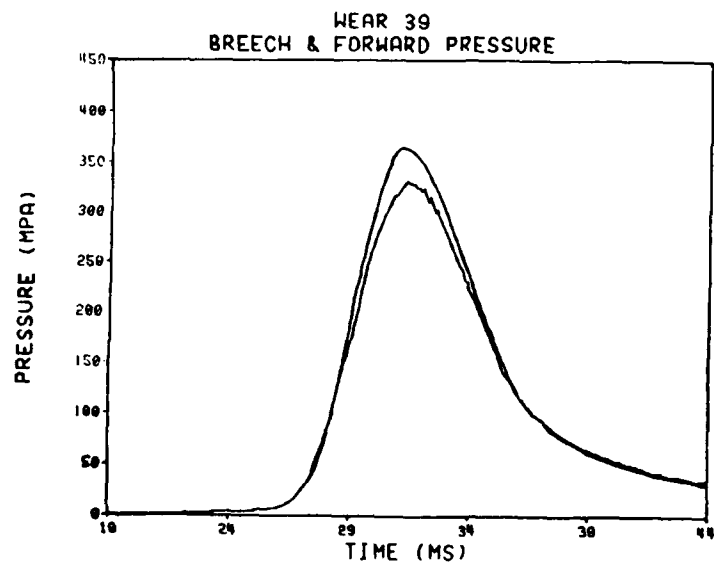


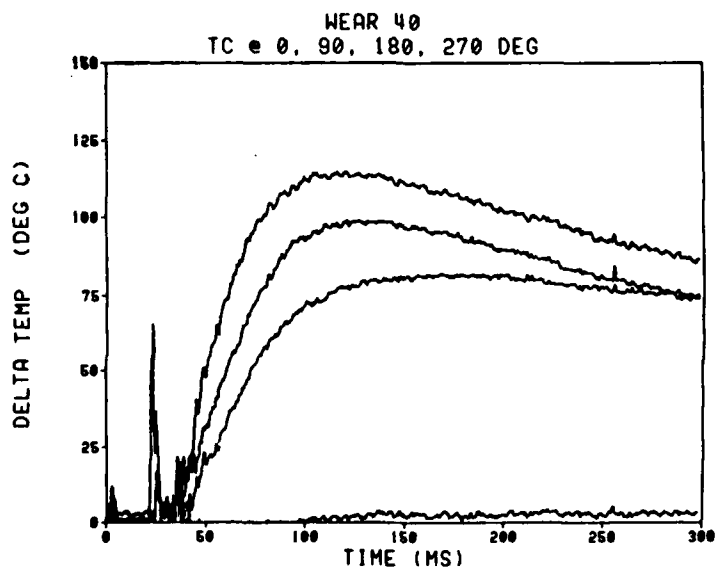
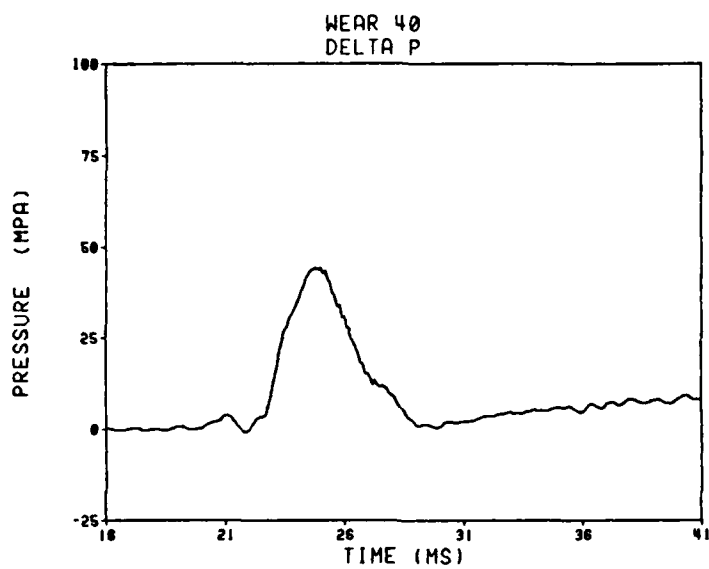
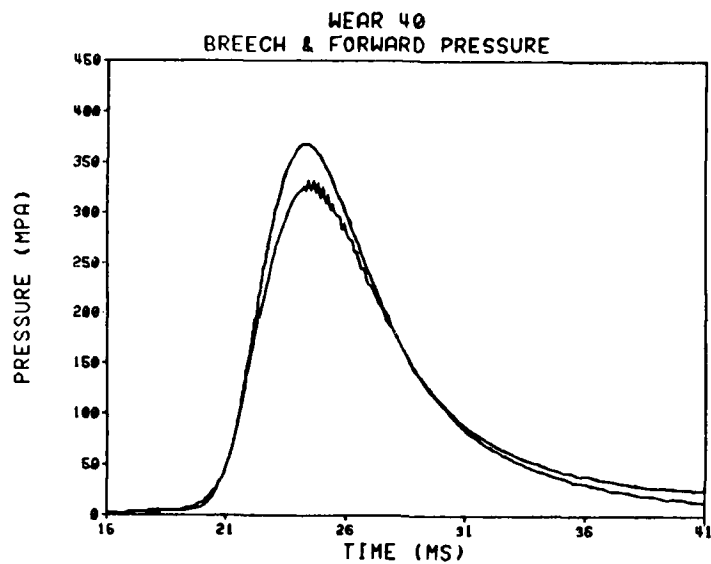
WEAR 38
DELTA P

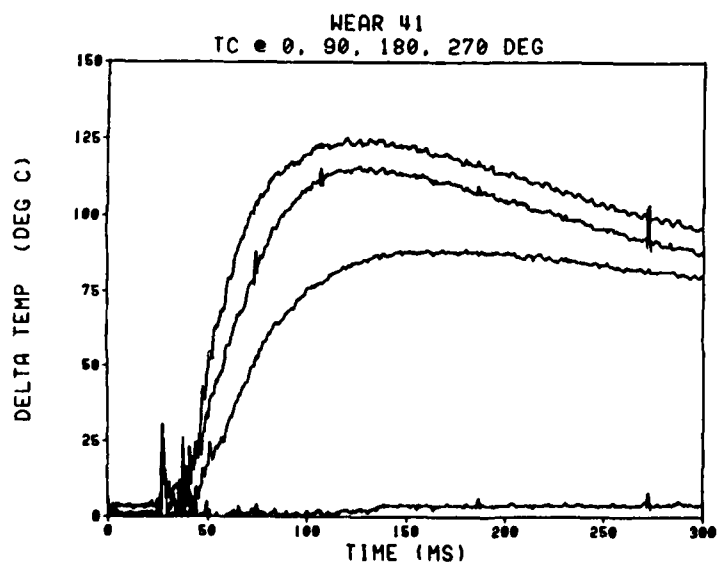
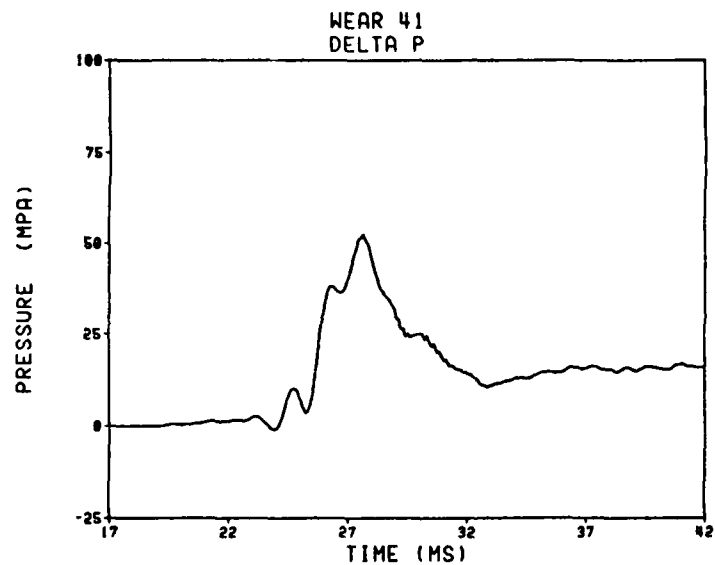
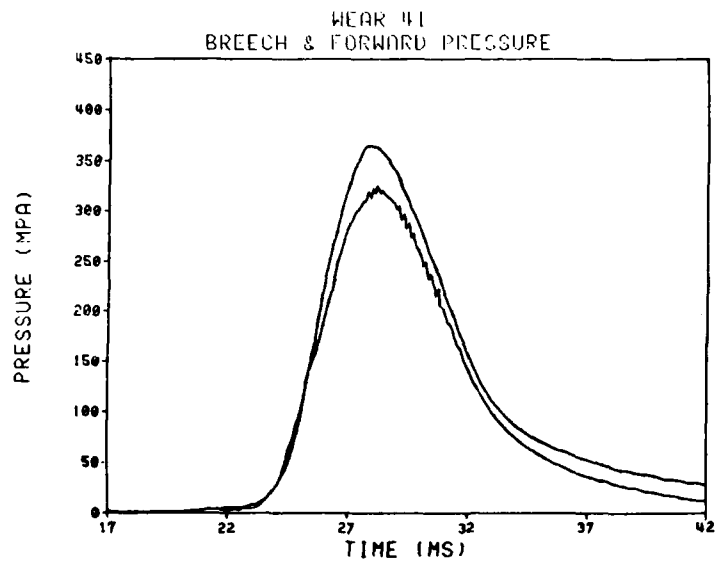


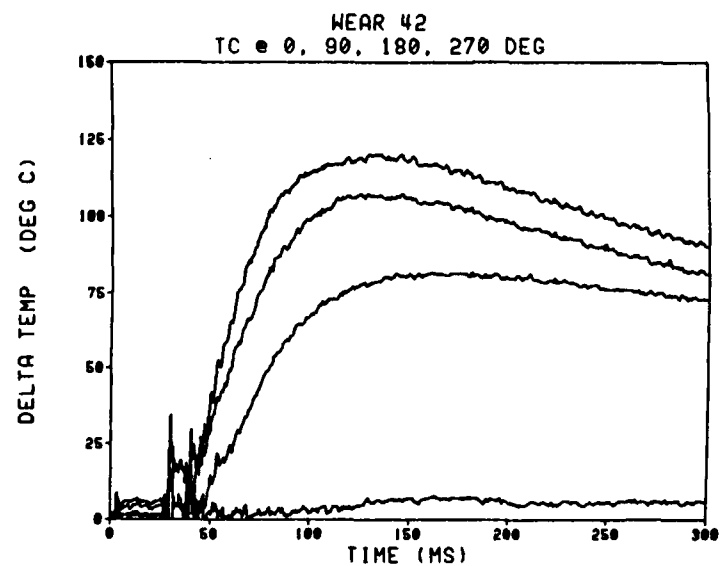
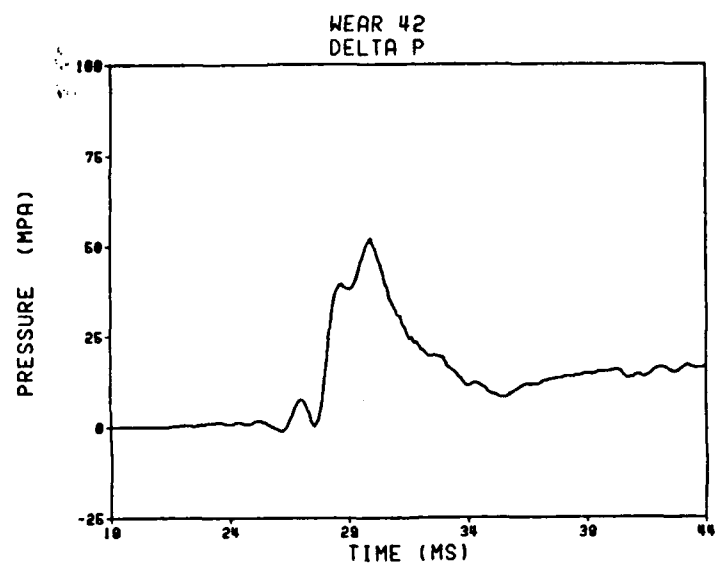
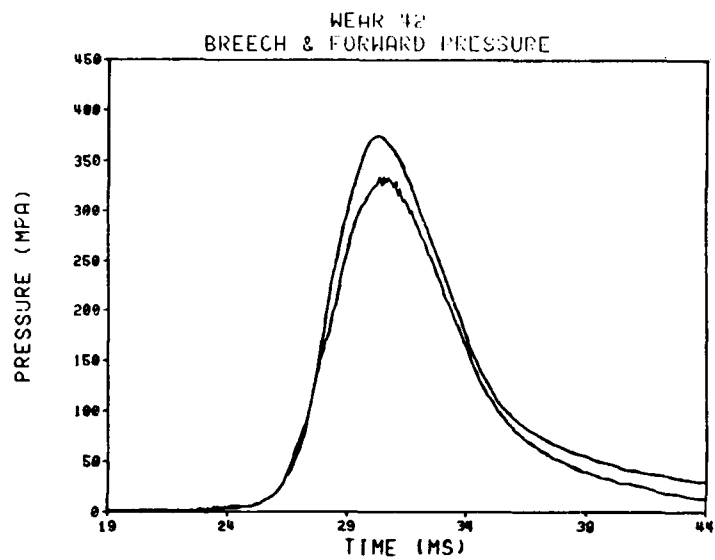
WEAR 38
TC @ 0, 90, 180, 270 DEG

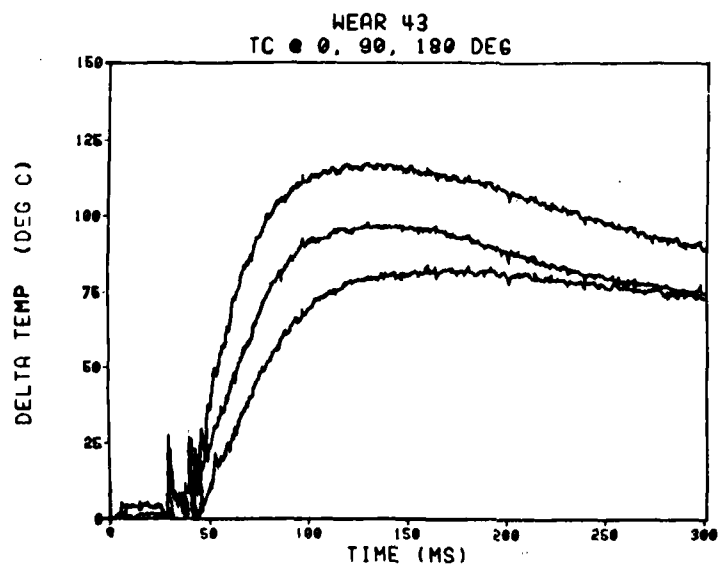
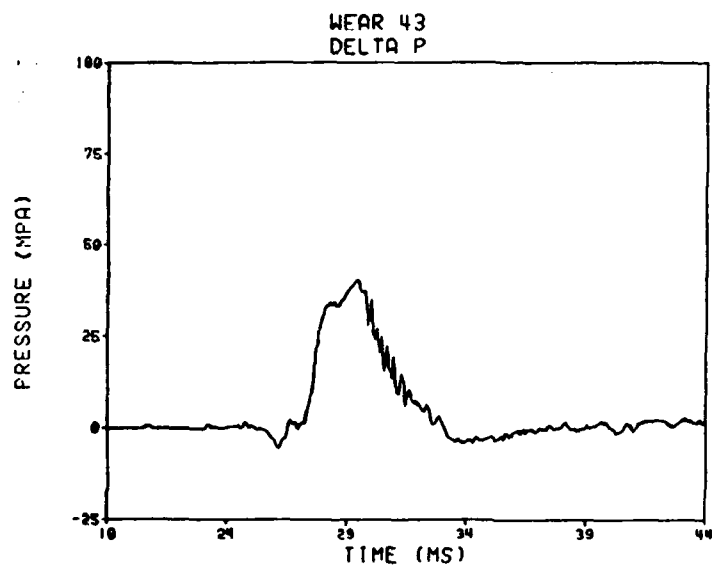
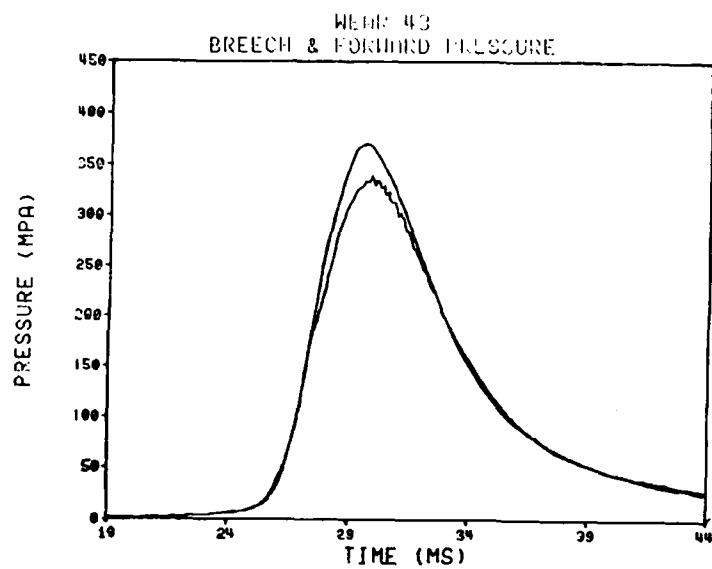


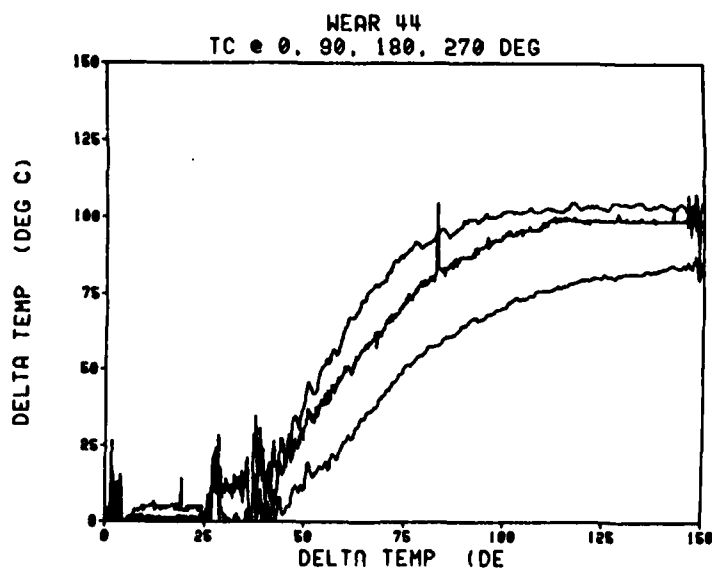
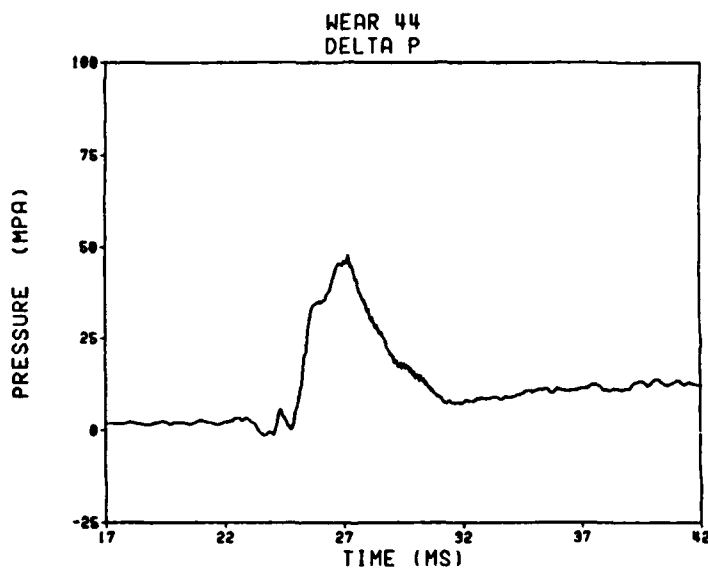
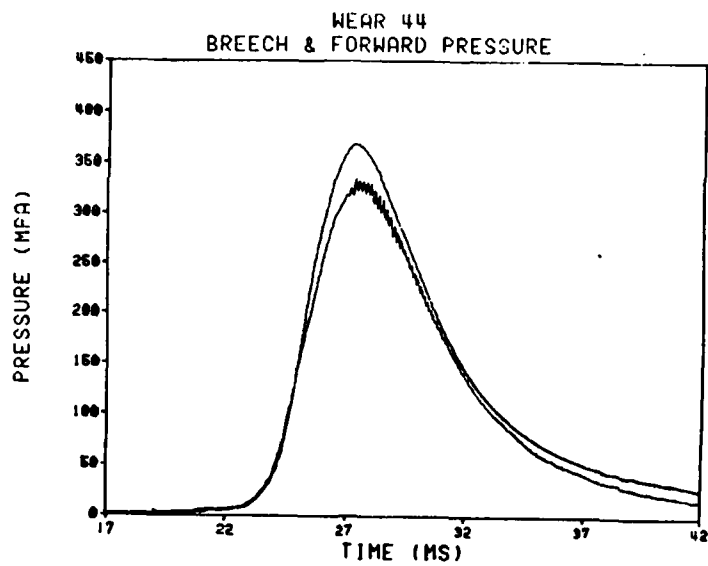


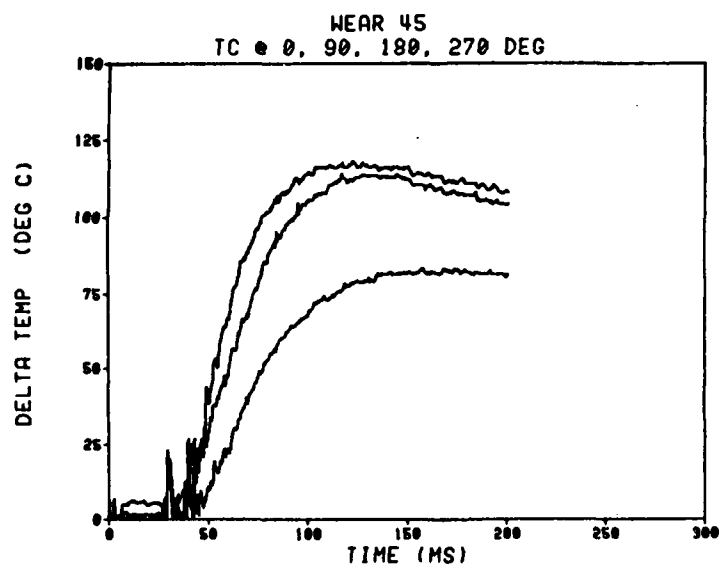
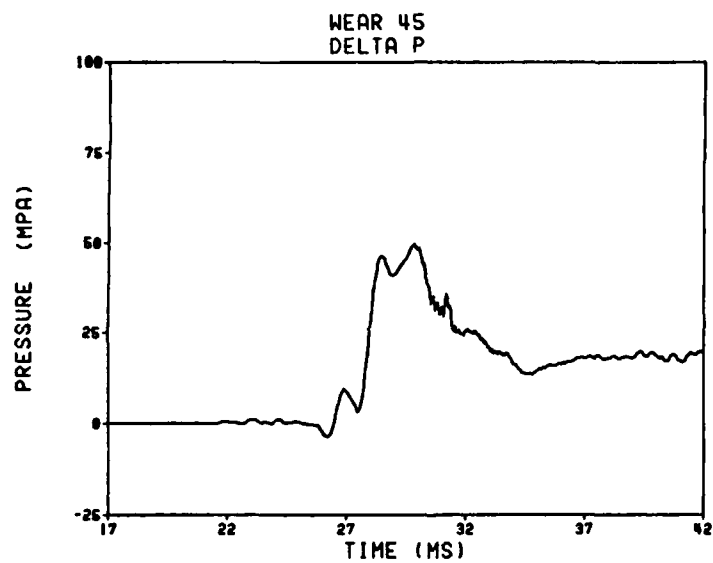
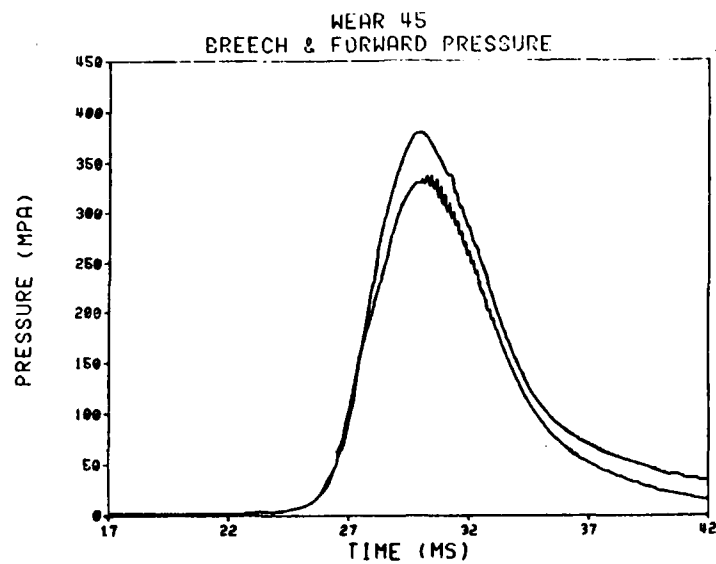


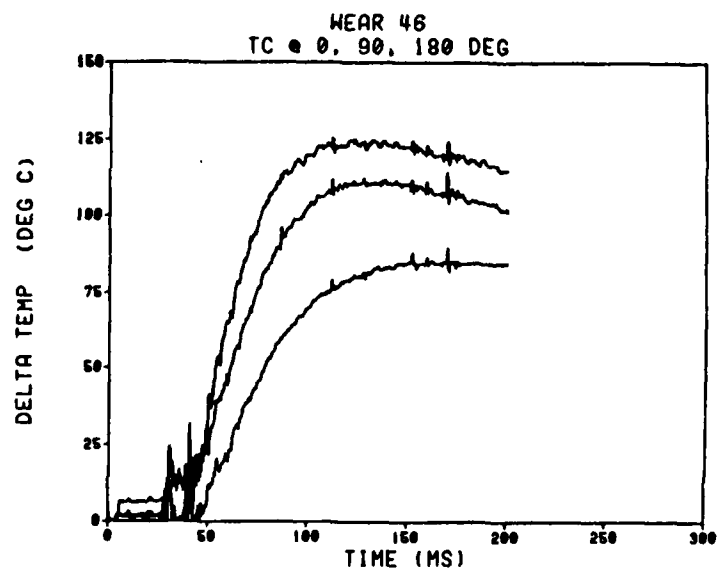
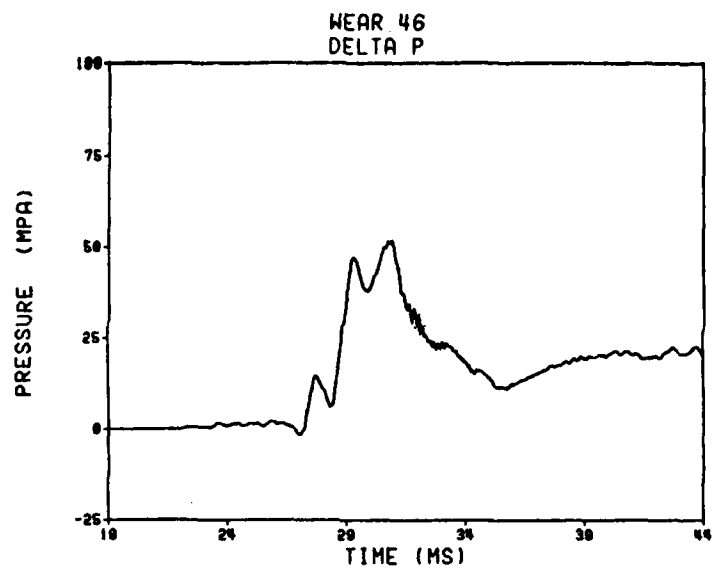
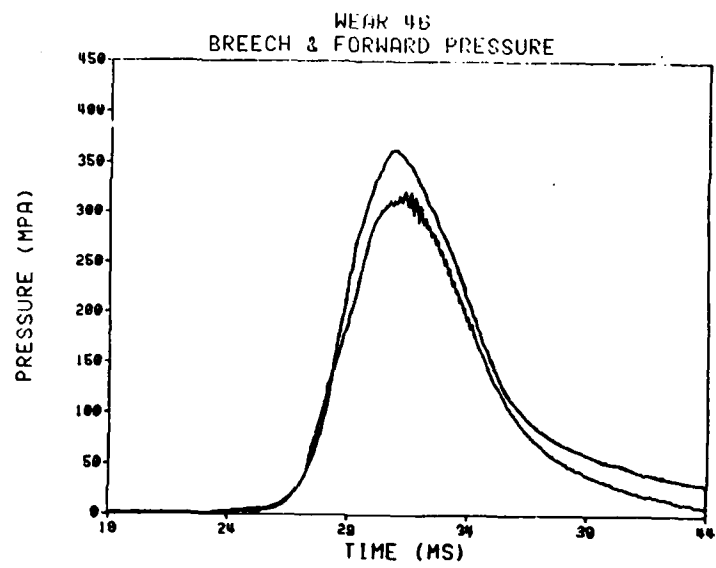


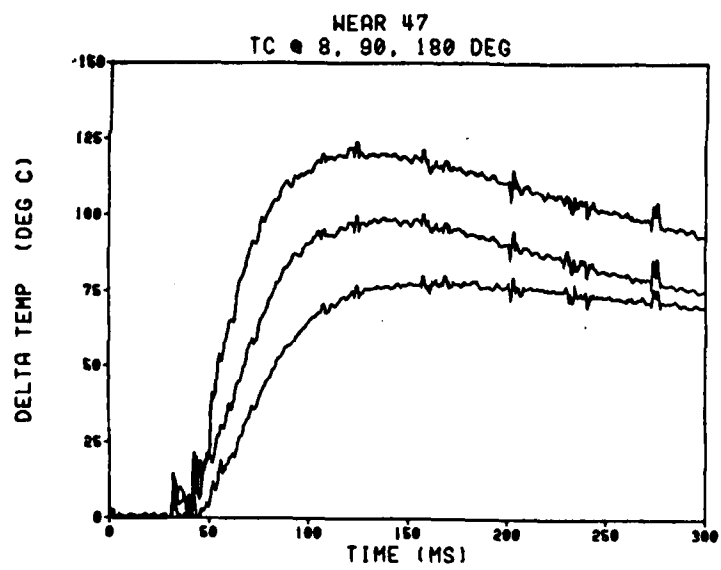
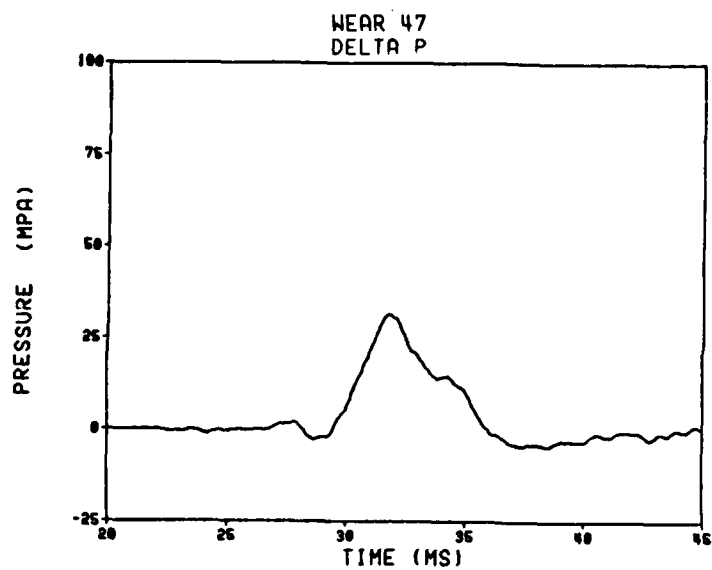
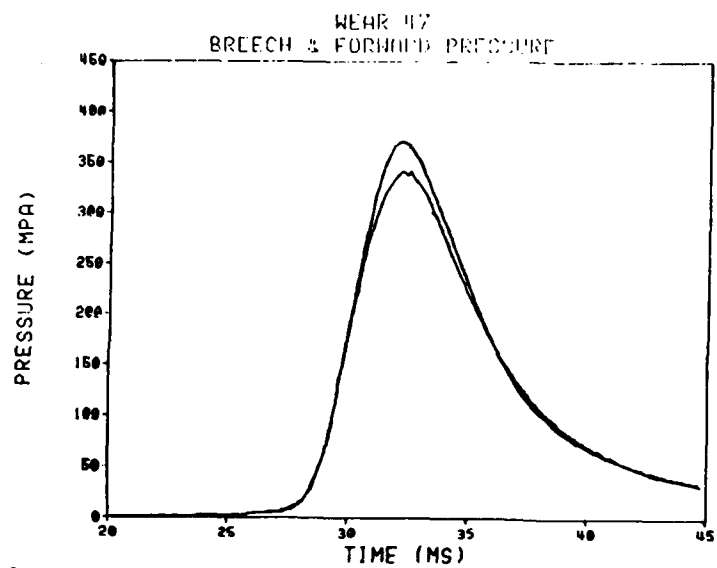


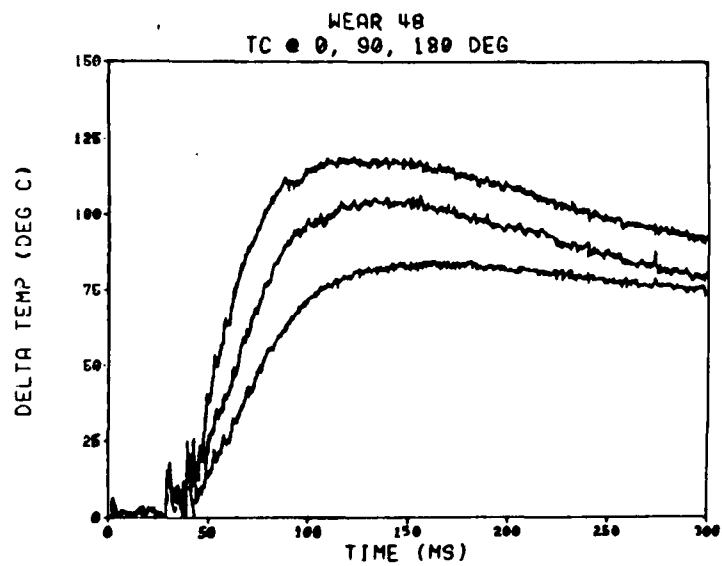
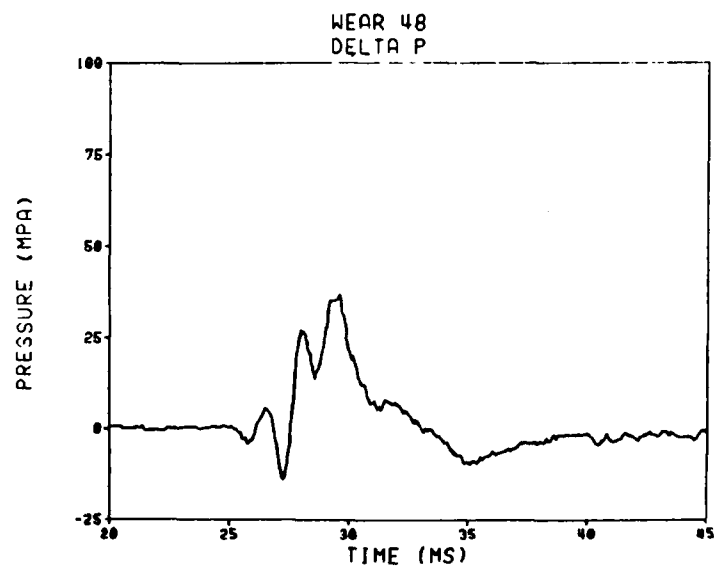
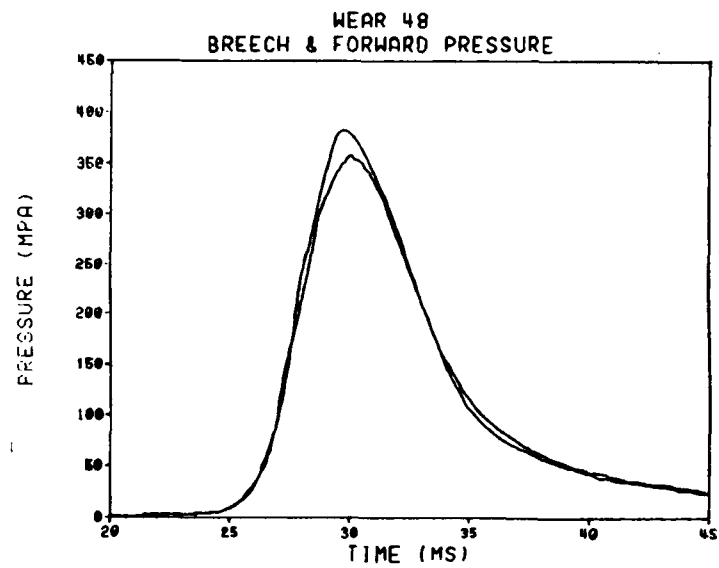


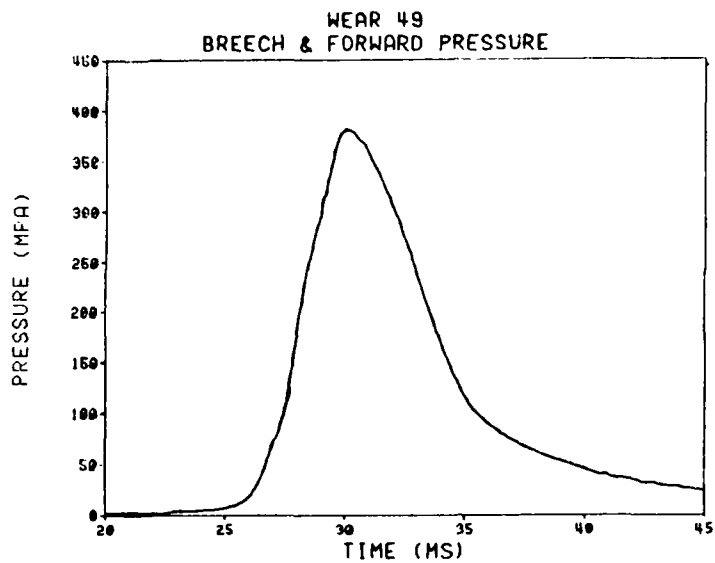




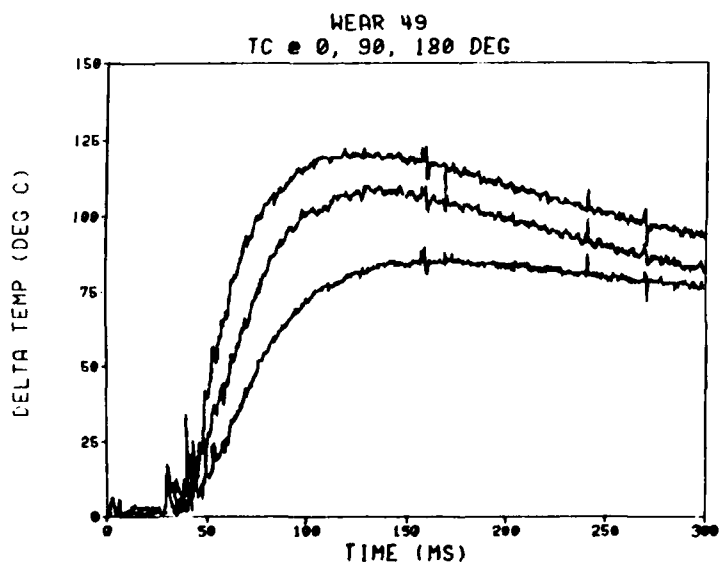


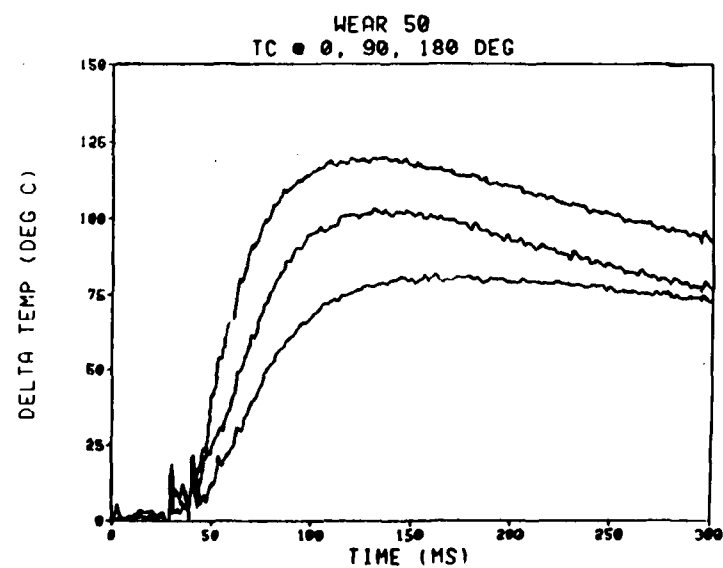
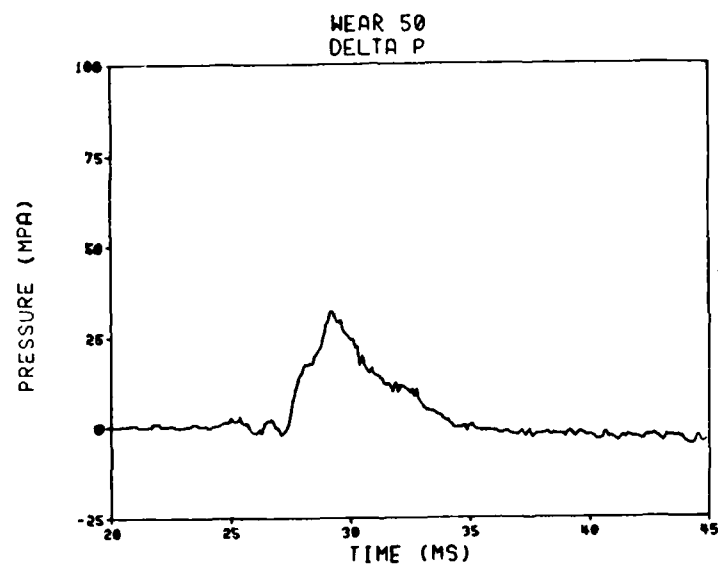
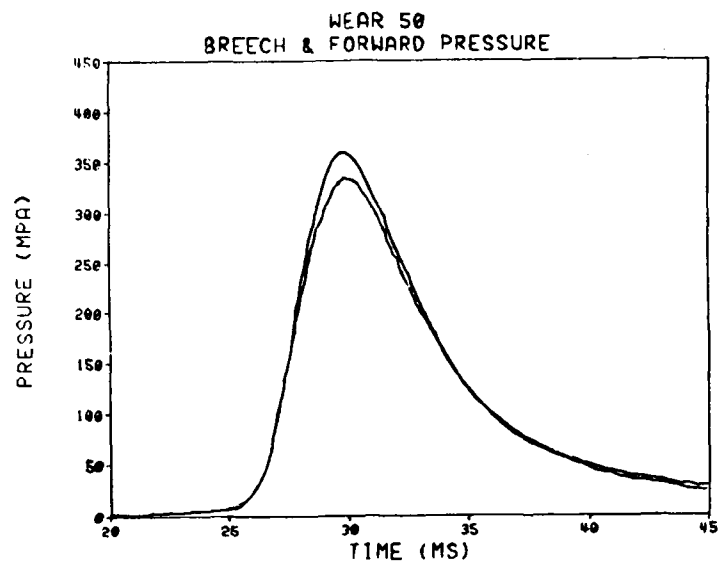


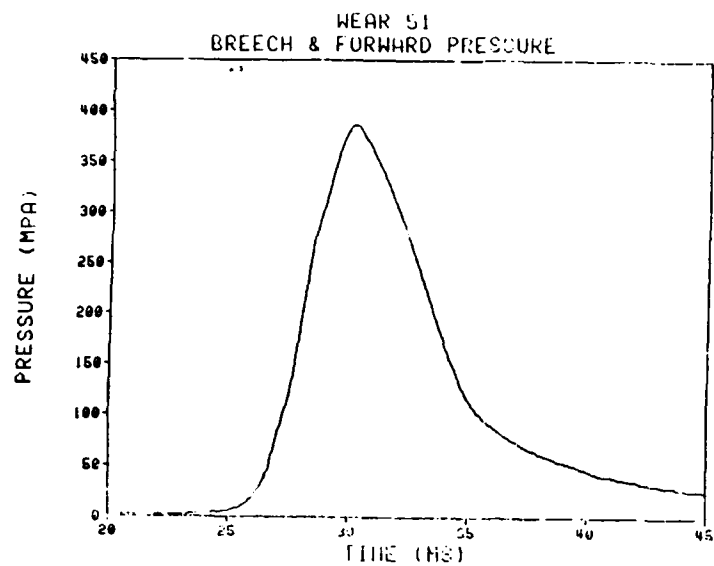




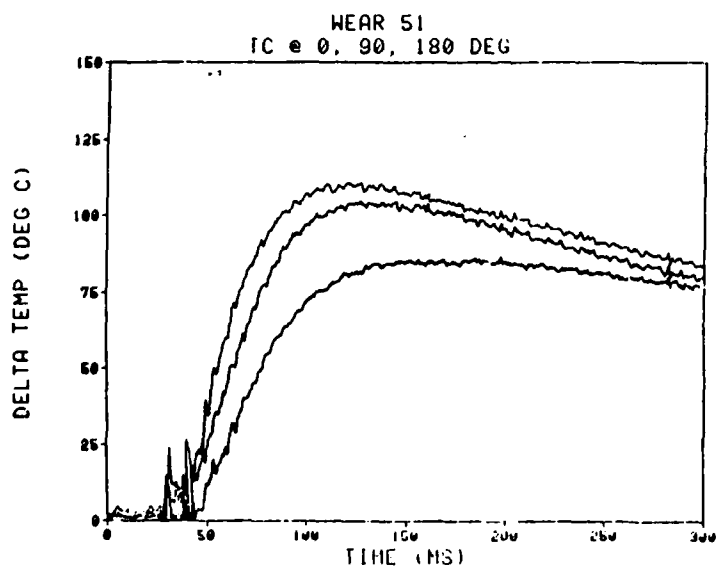
DATA LOST

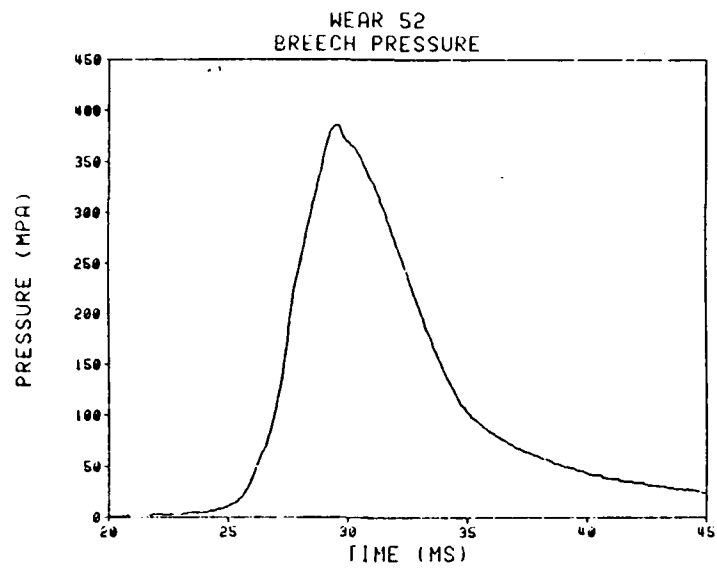




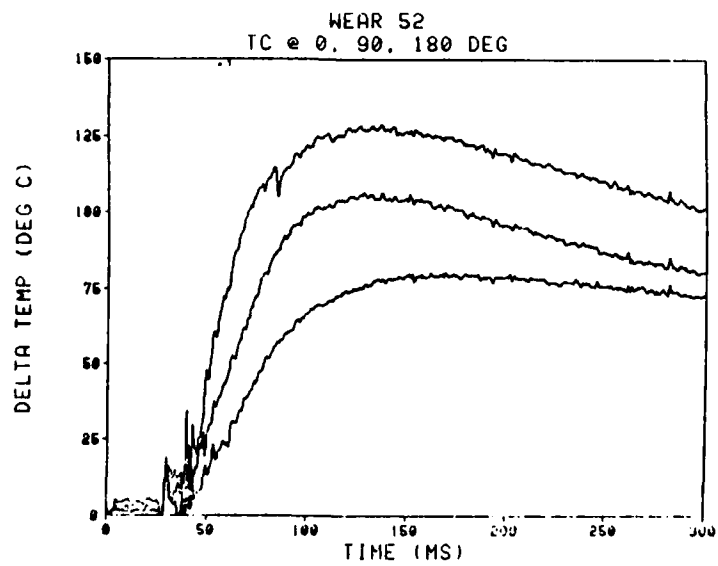


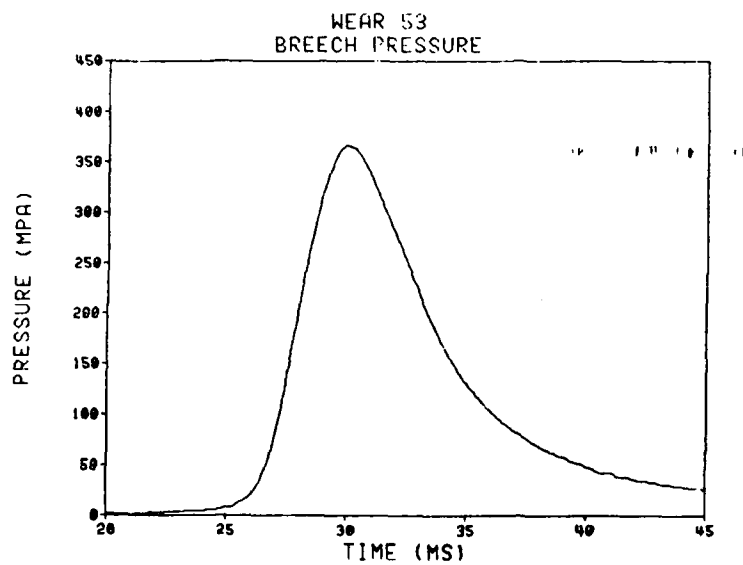
DATA LOST



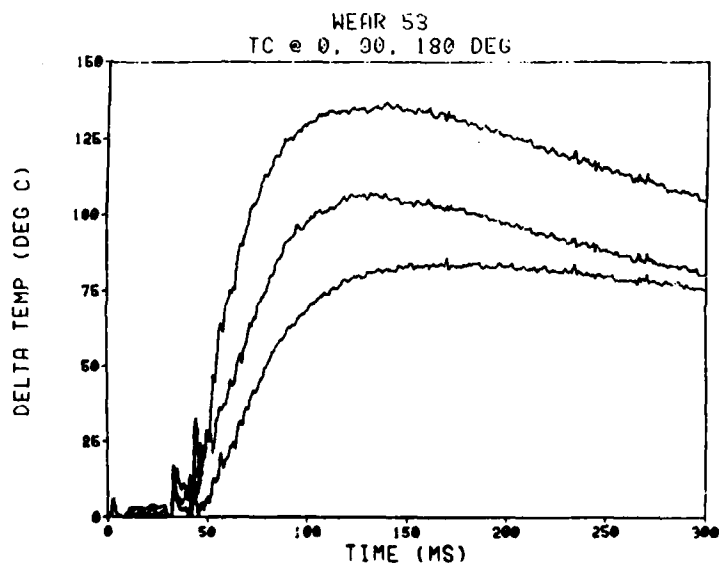


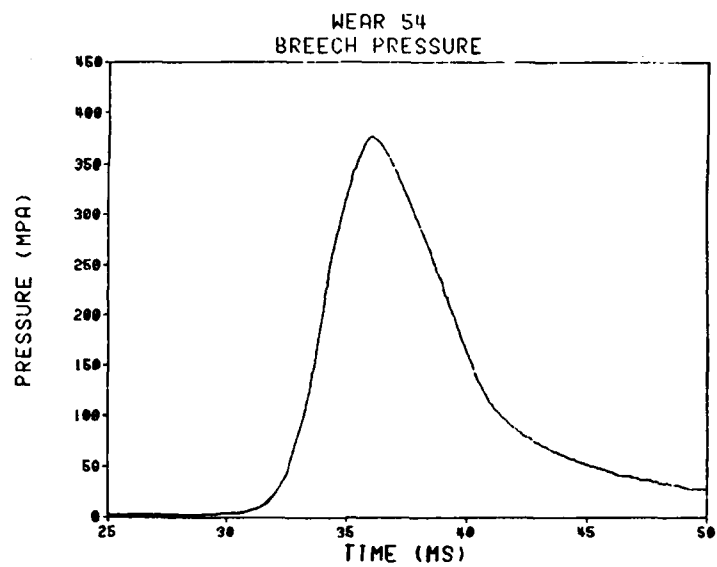
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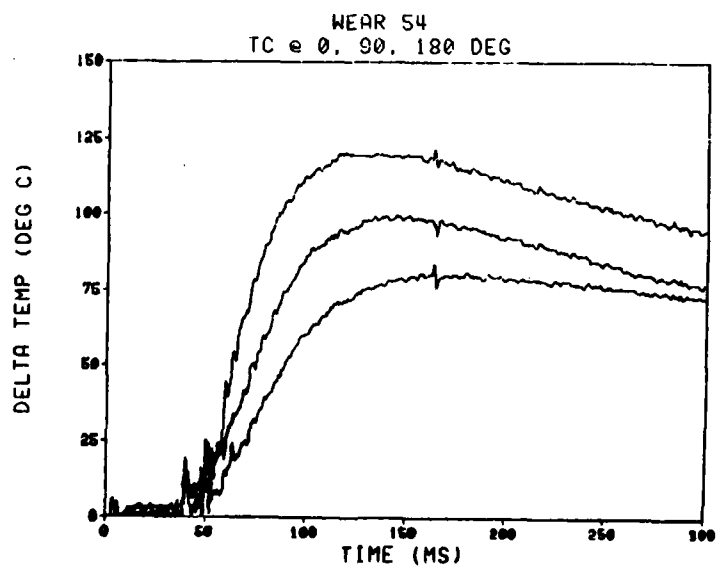


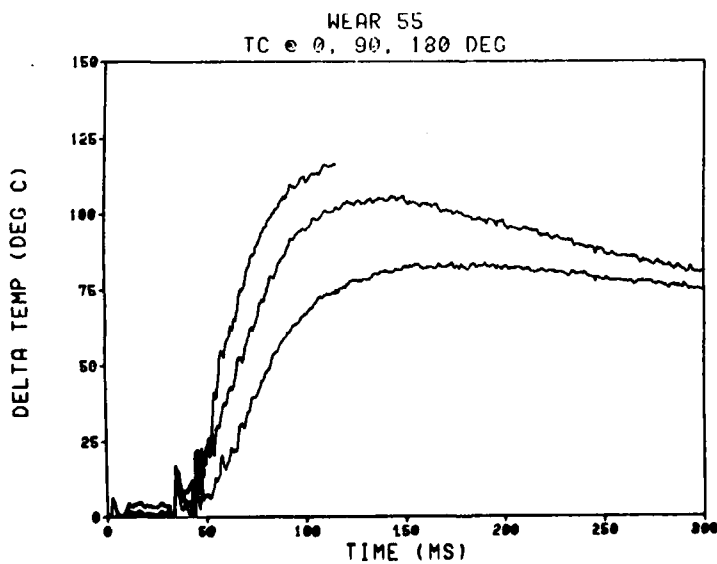
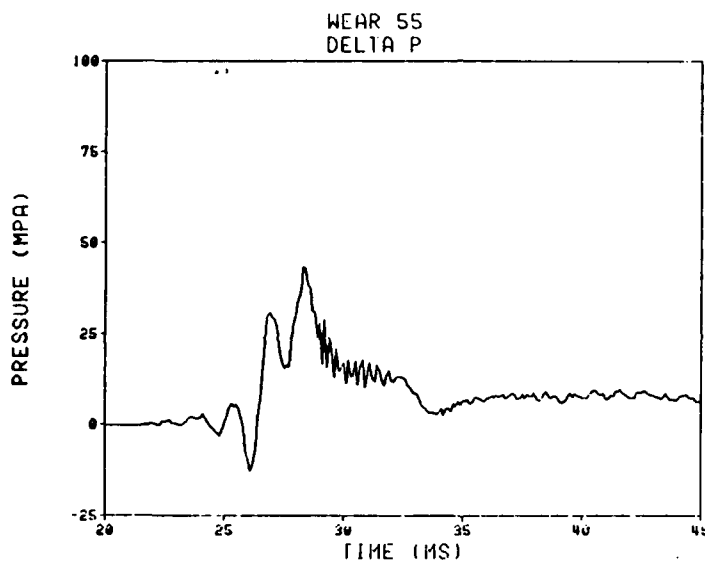
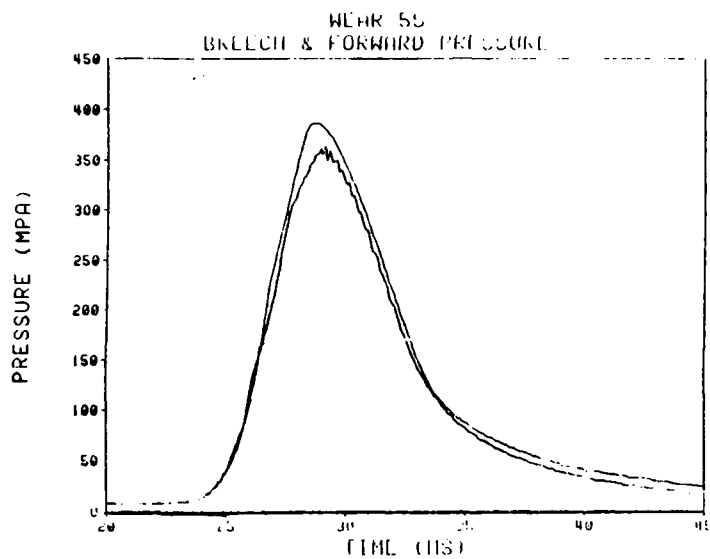
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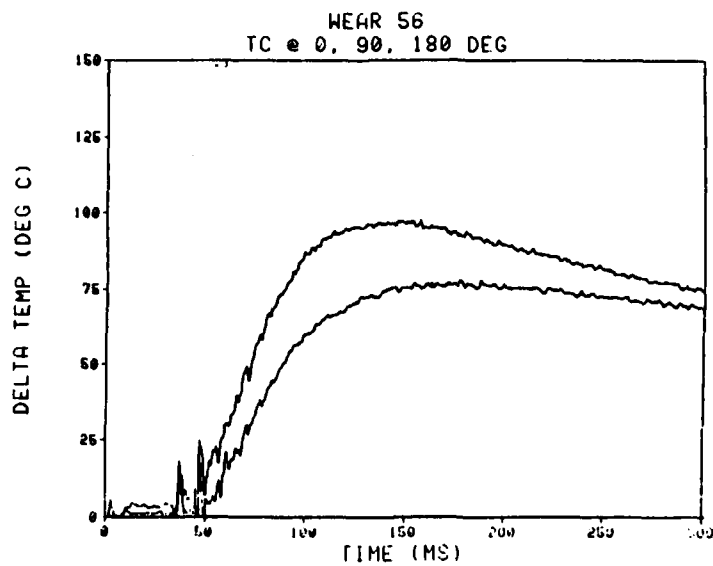
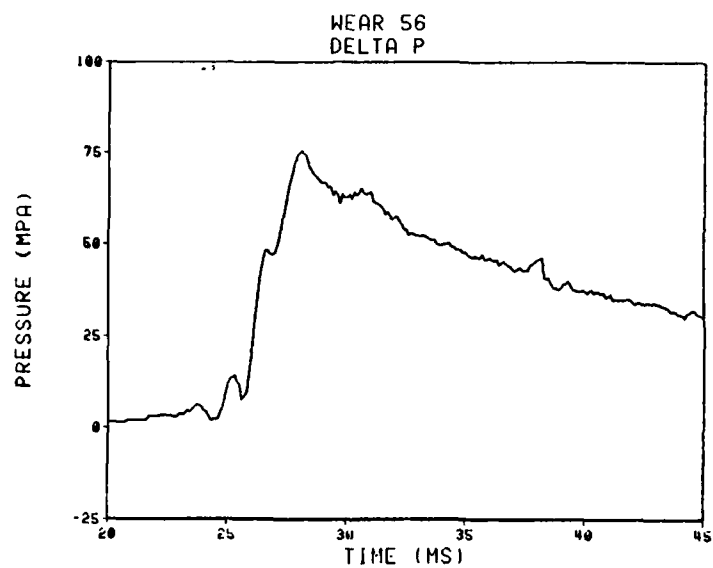
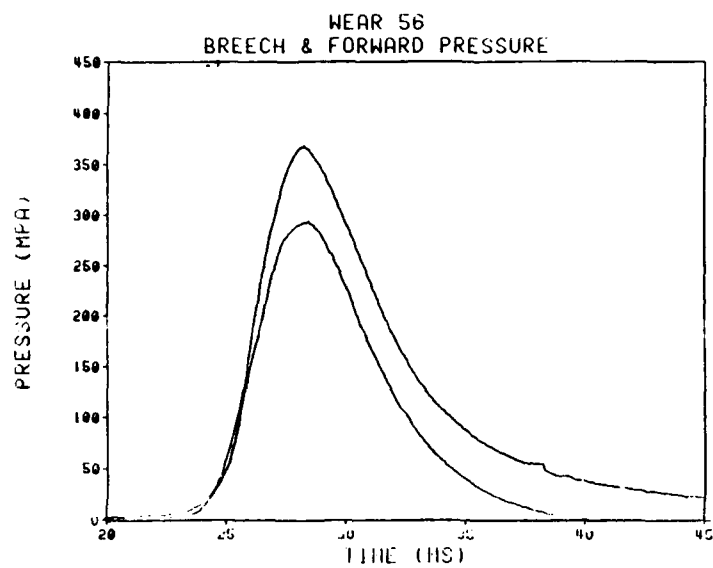


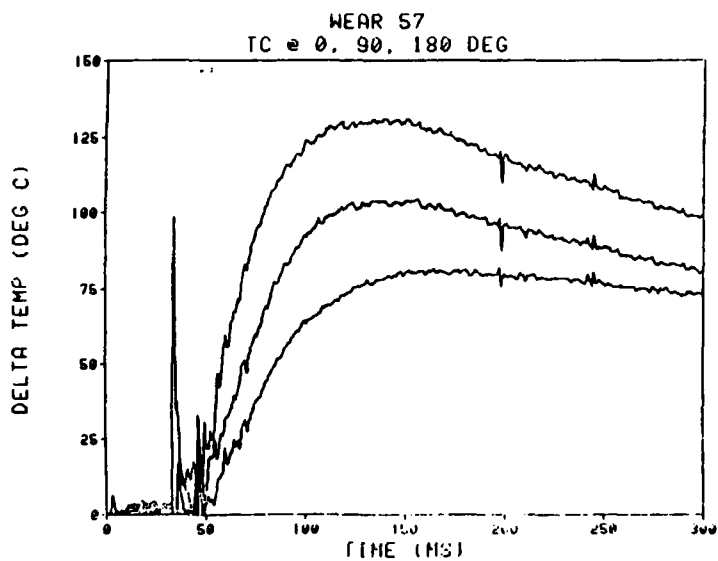
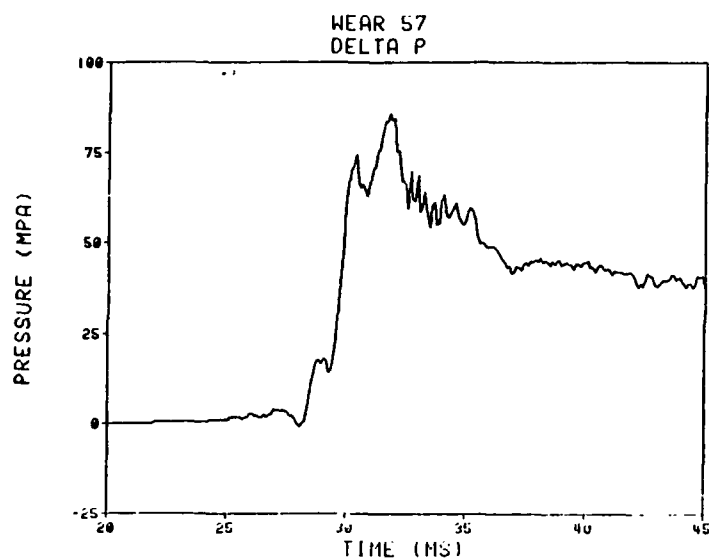
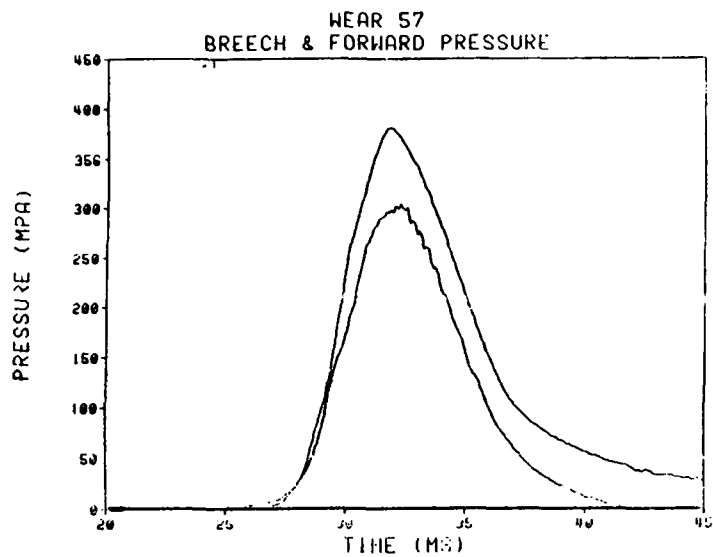


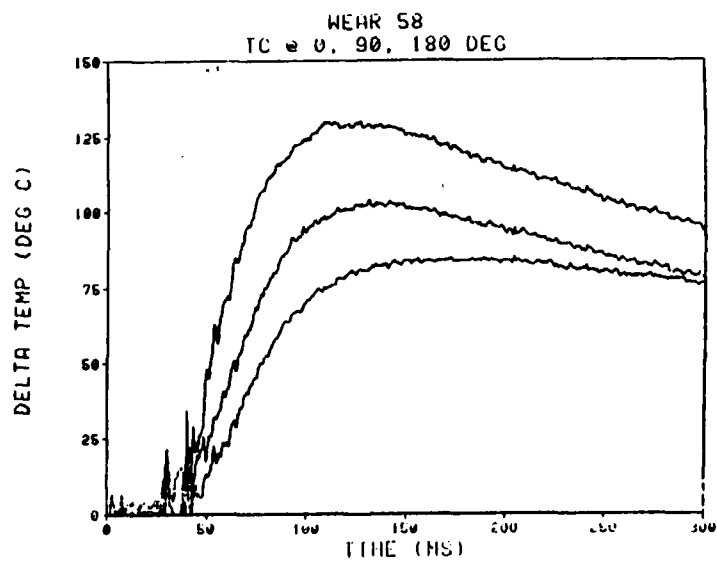
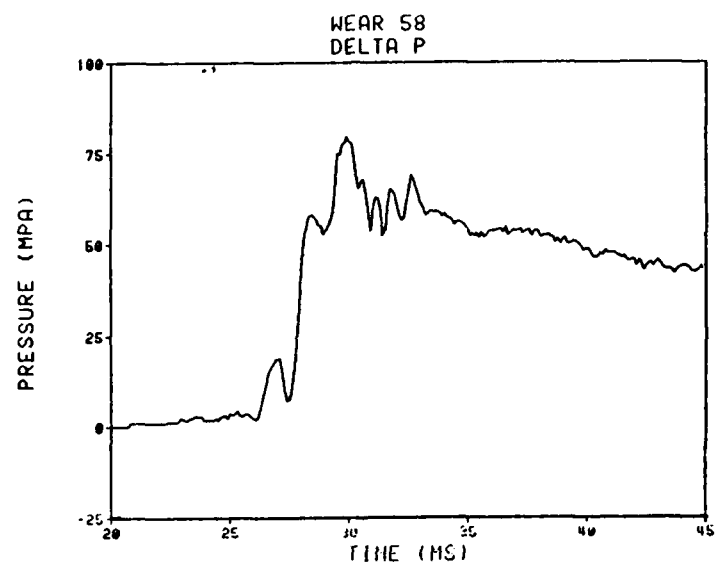
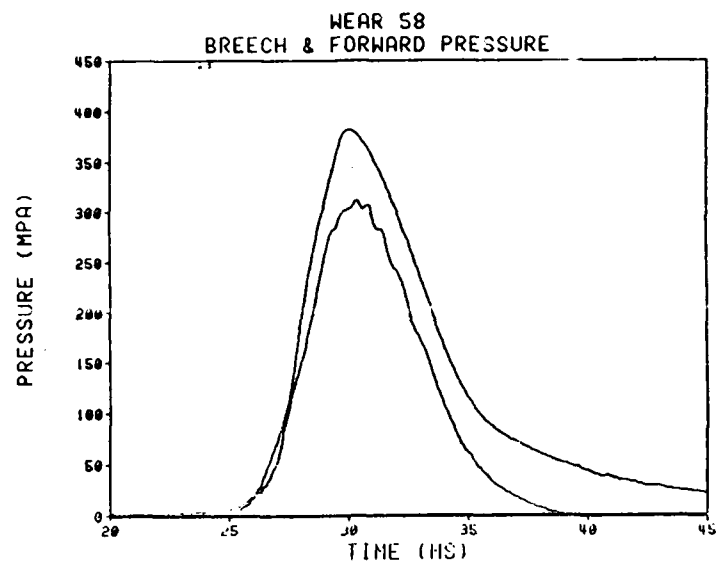
DATA LOST

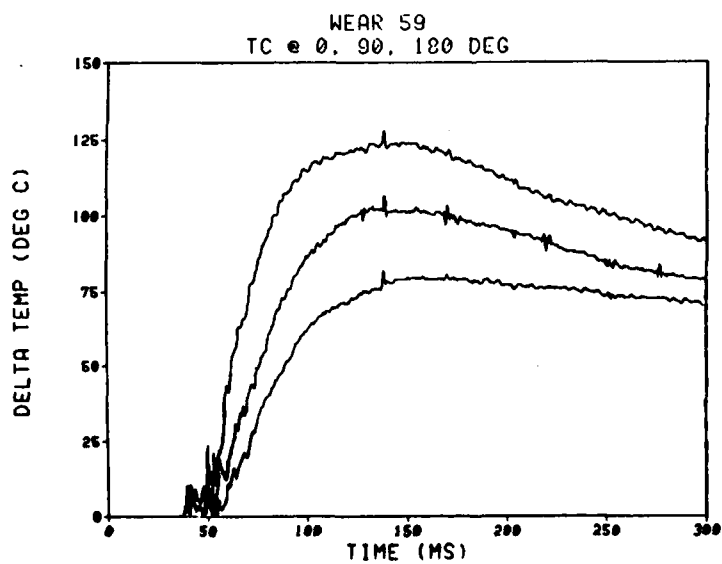
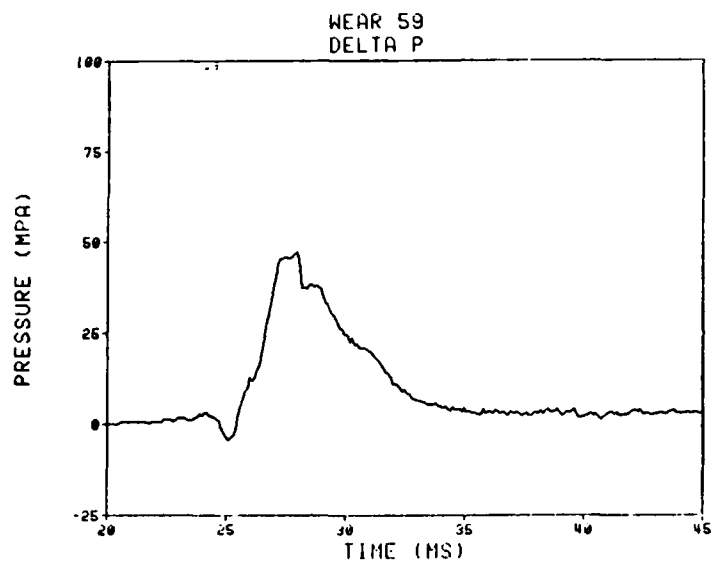
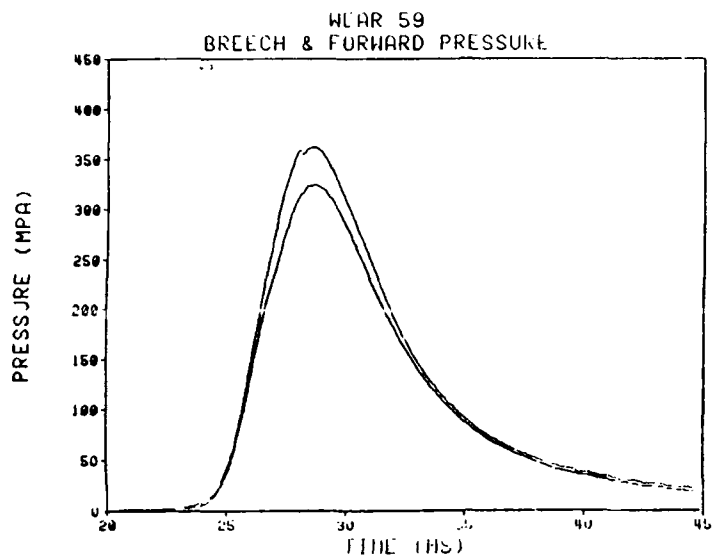


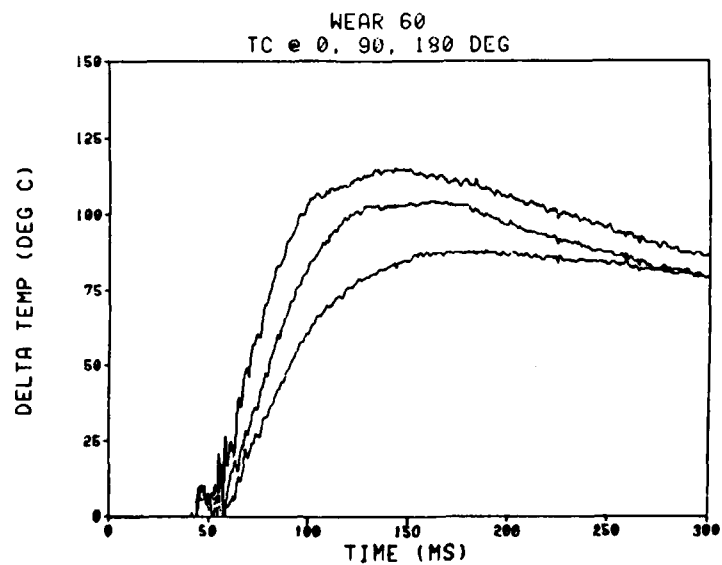
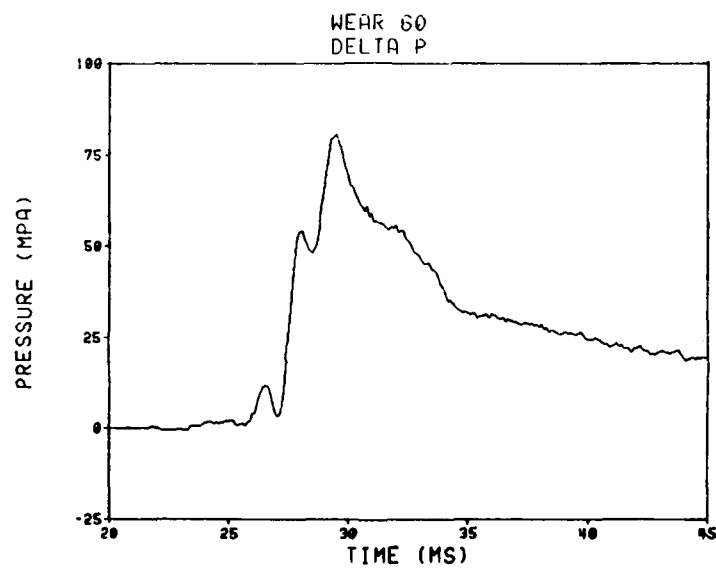
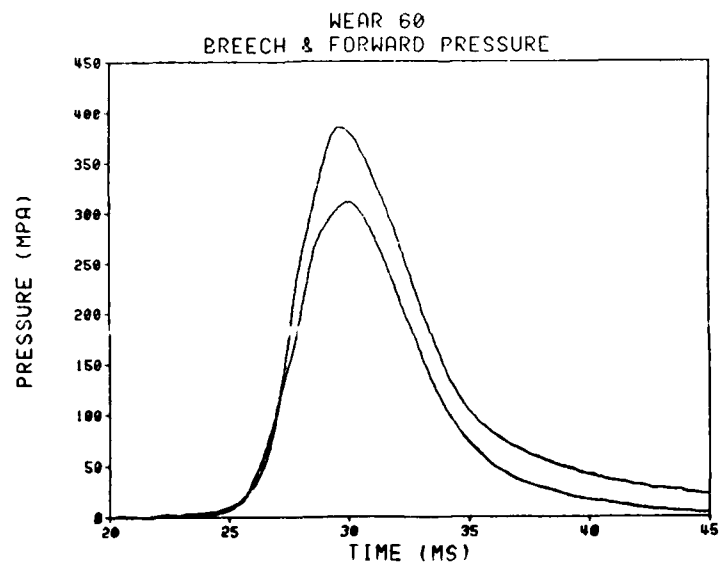


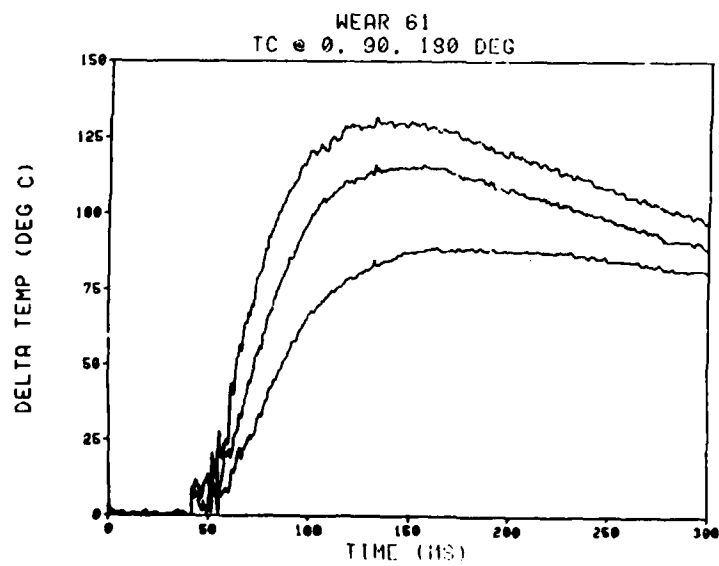
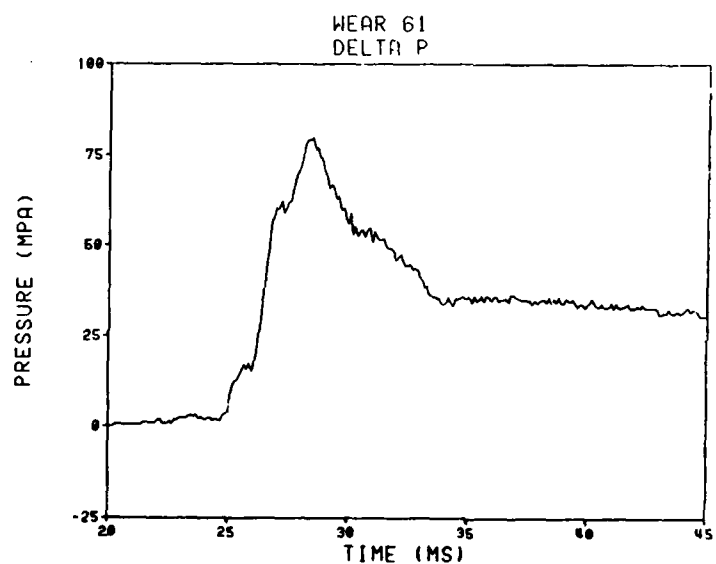
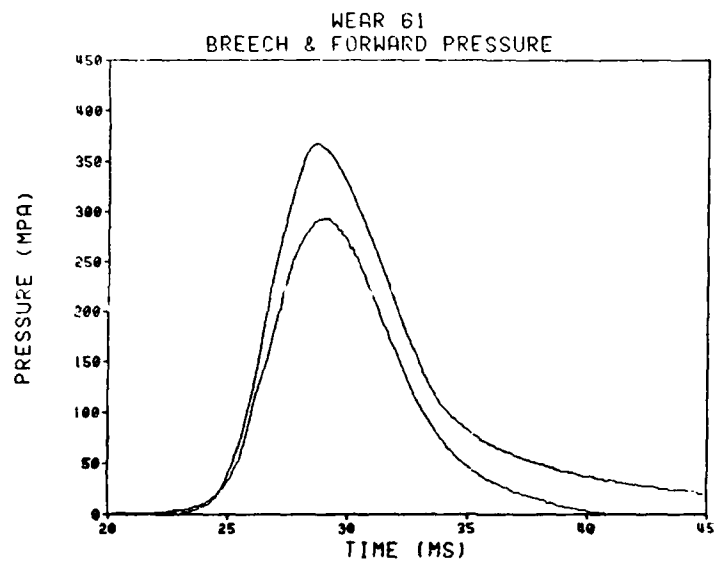


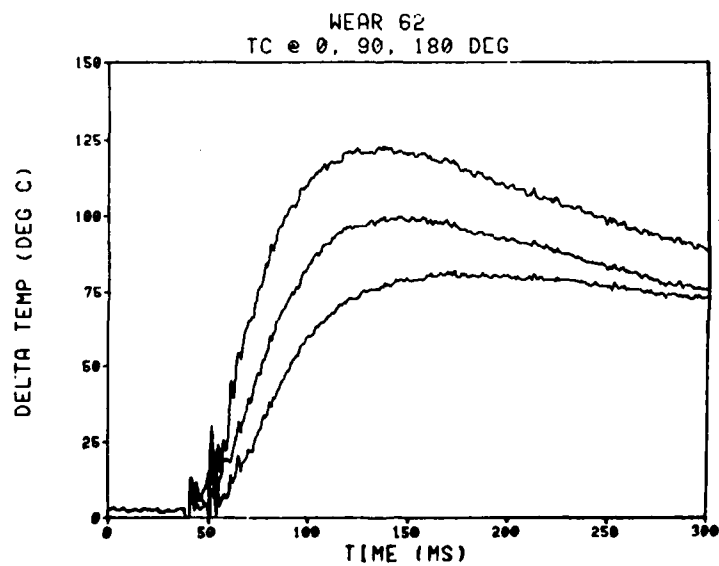
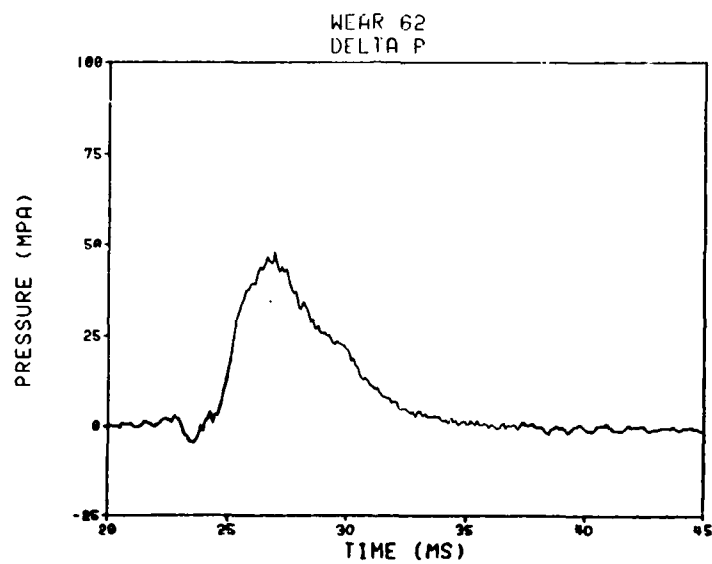
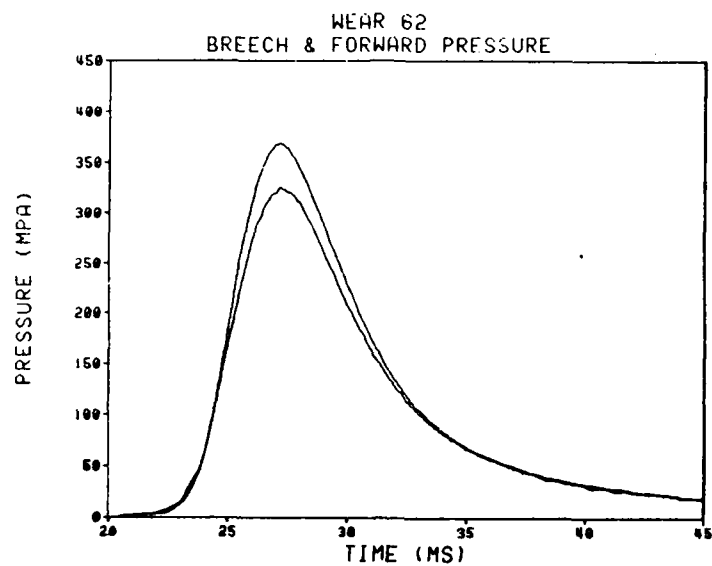


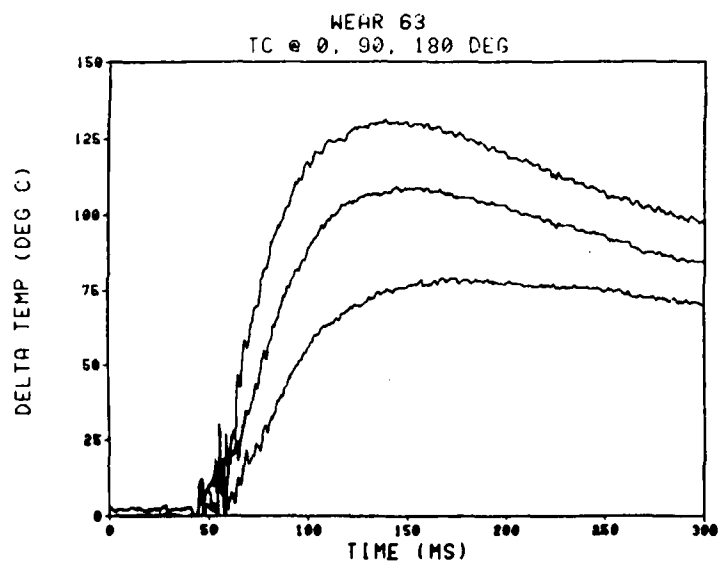
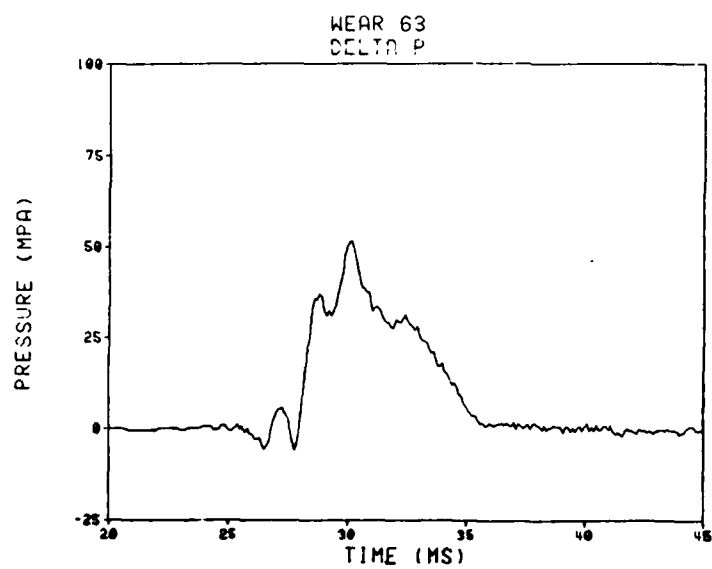
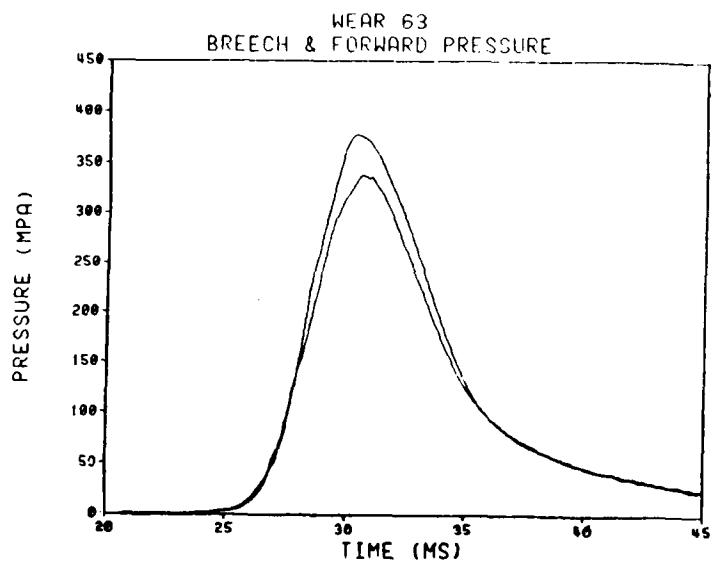


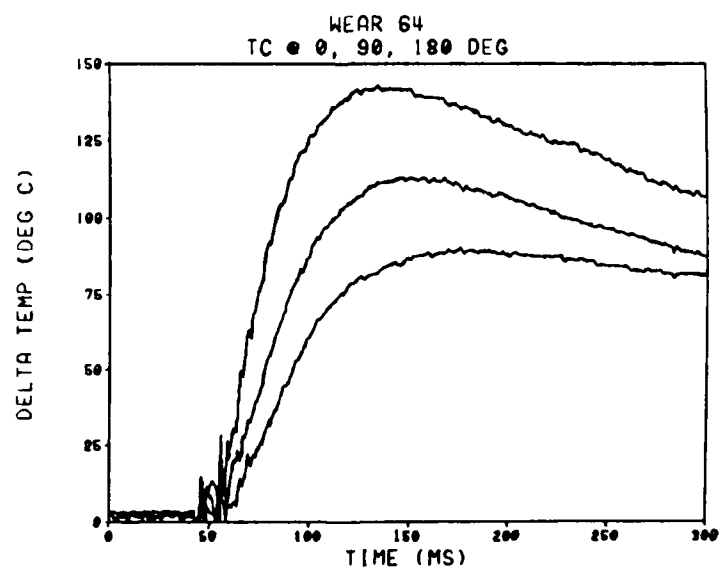
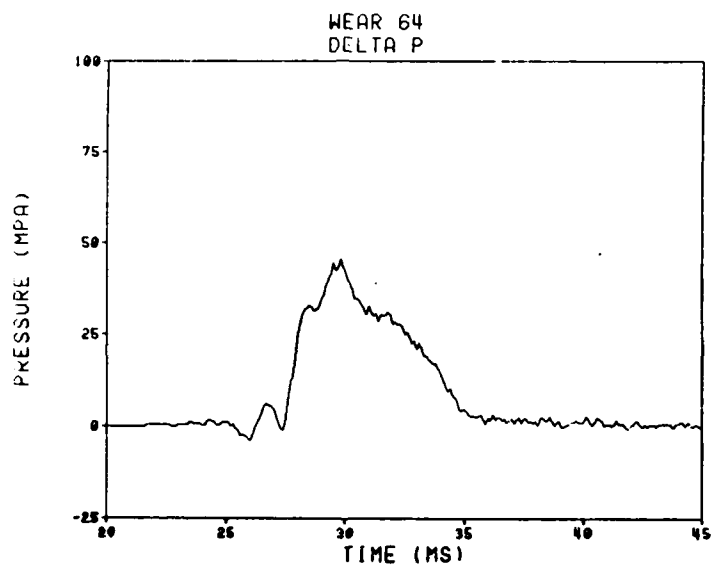
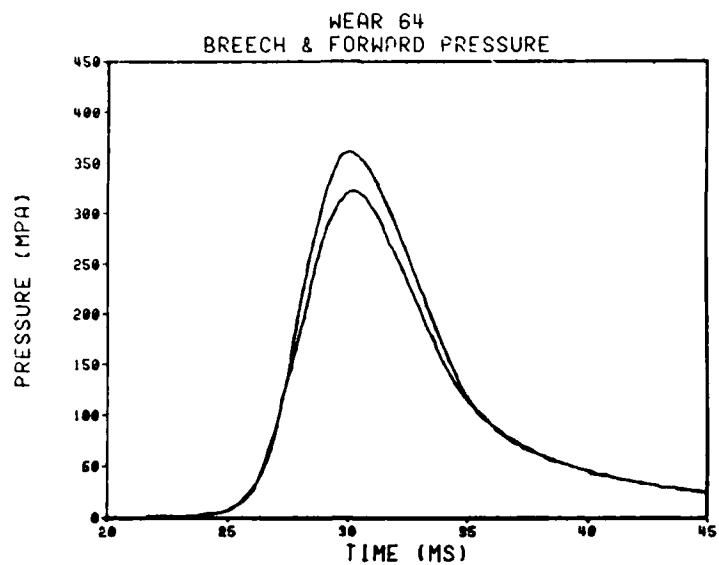


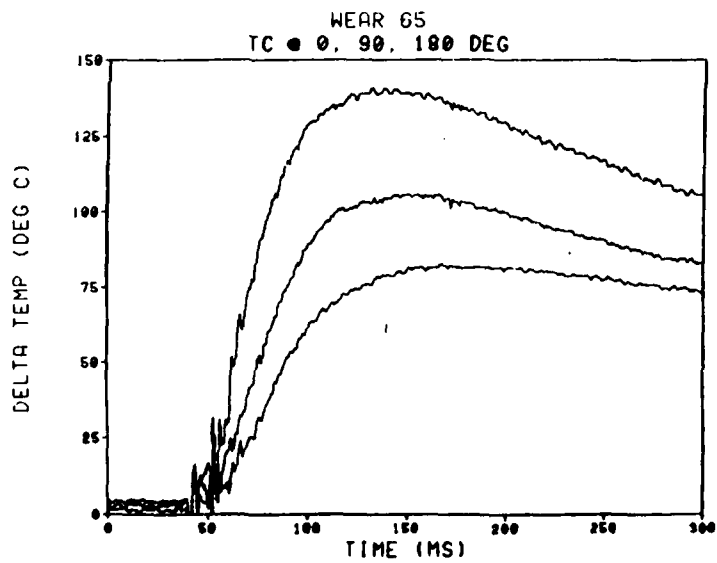
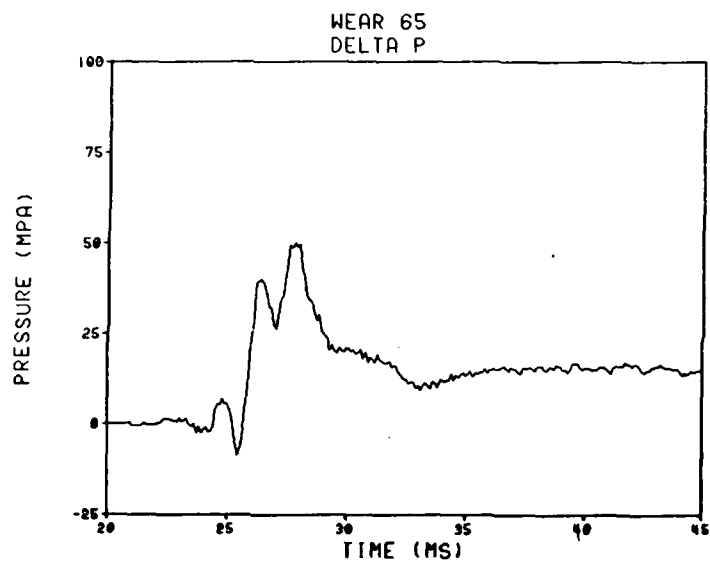
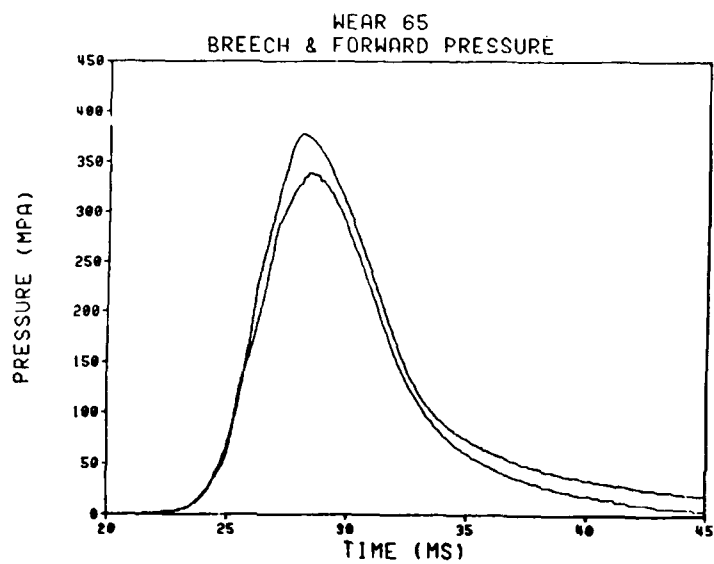


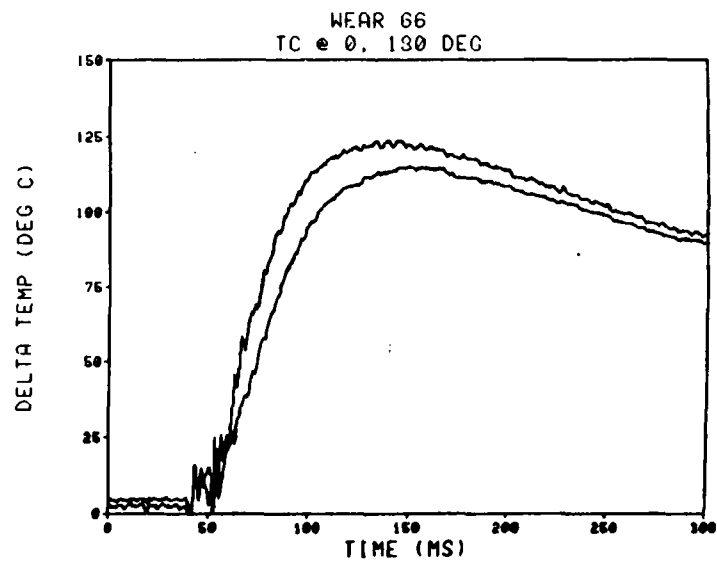
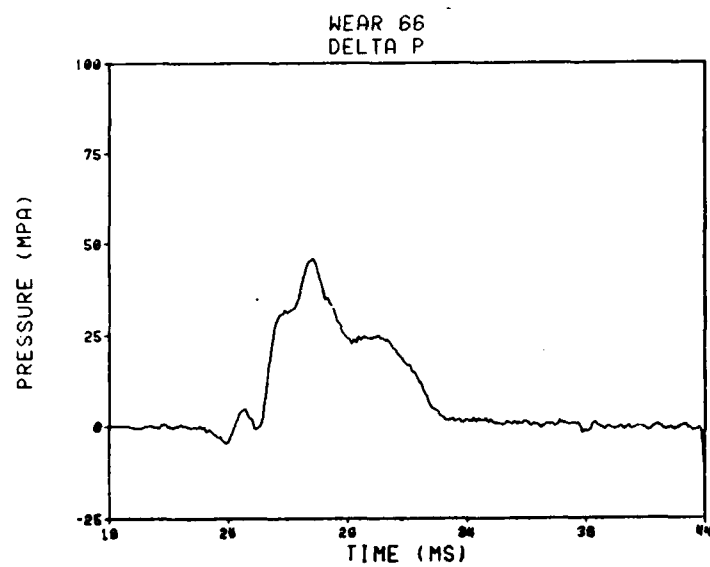
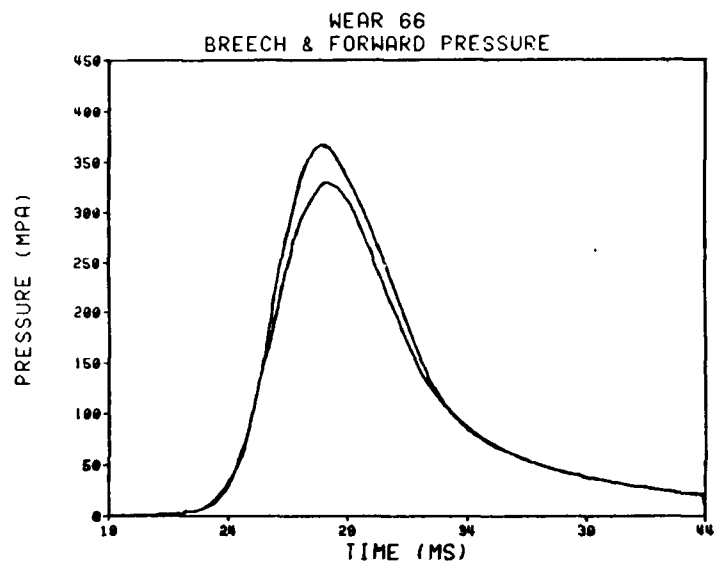


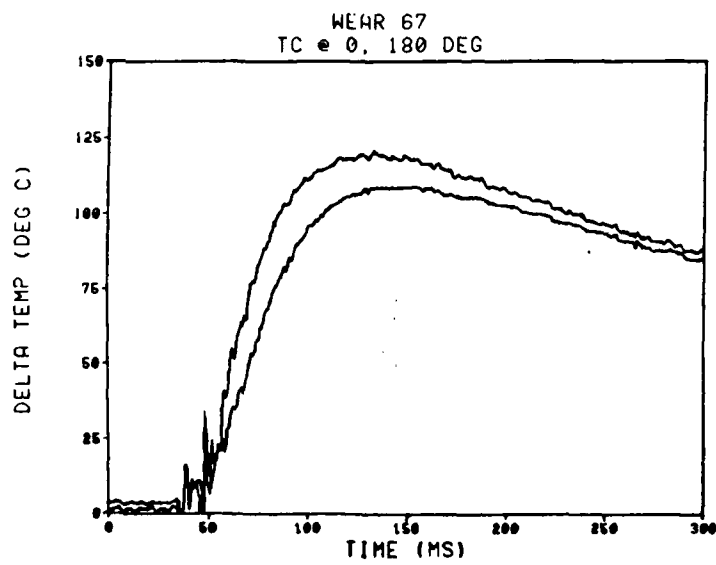
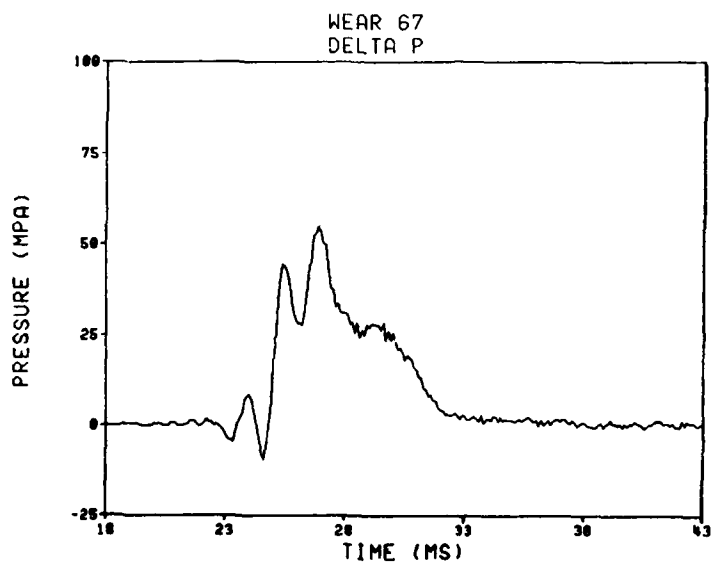
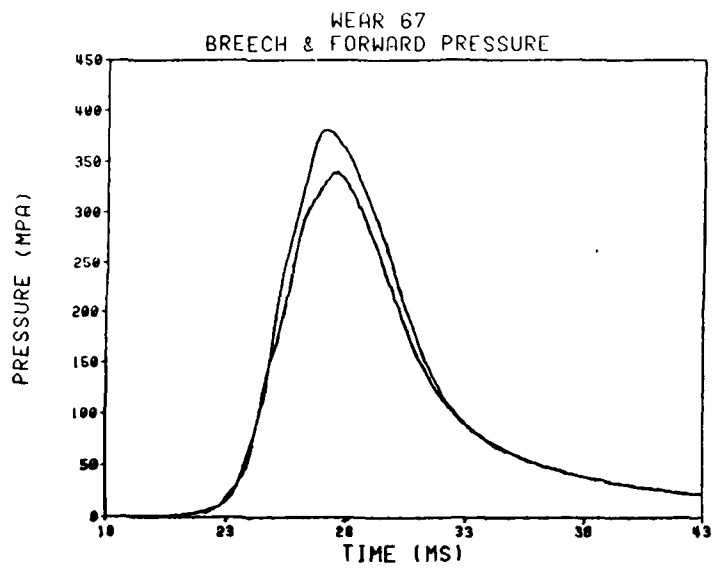


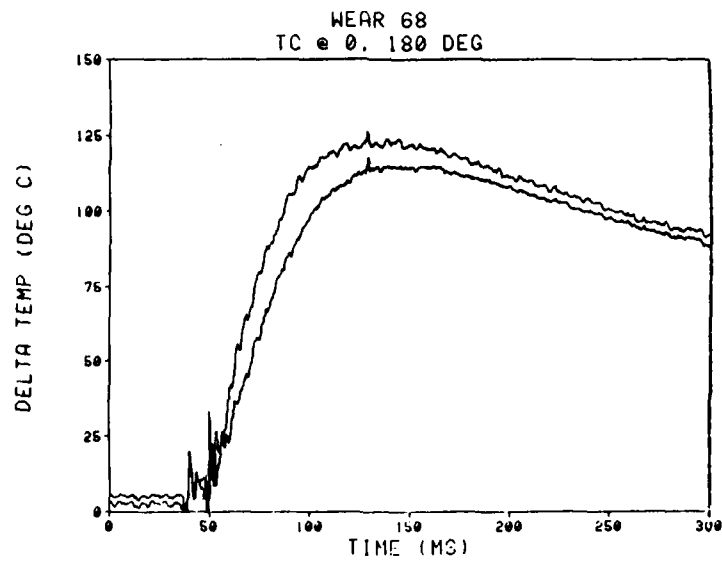
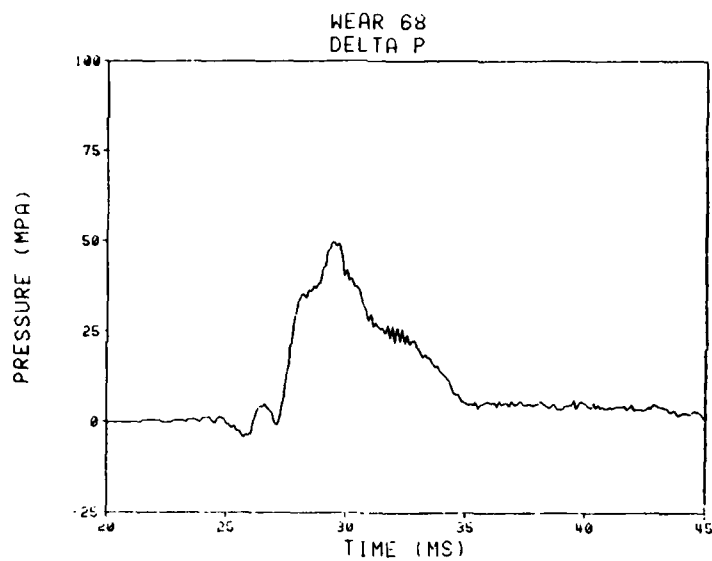
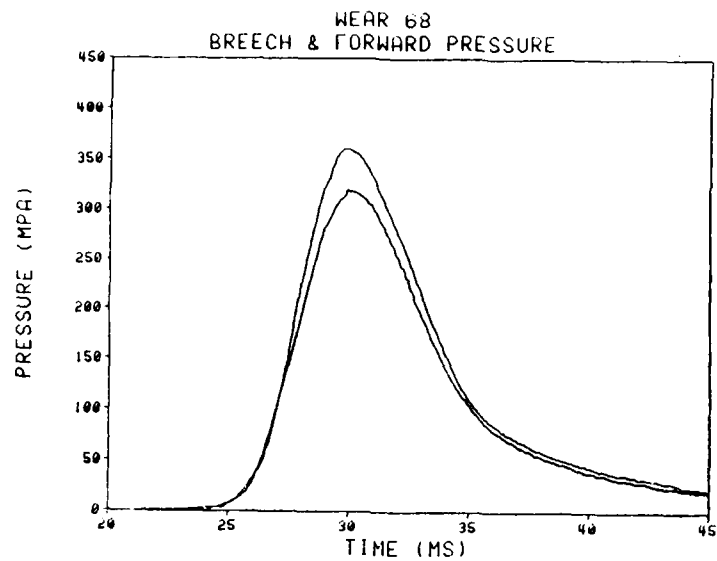


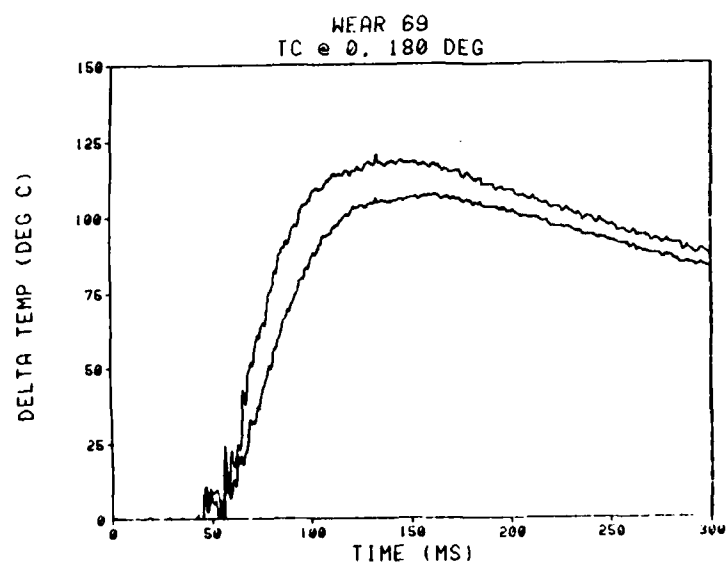
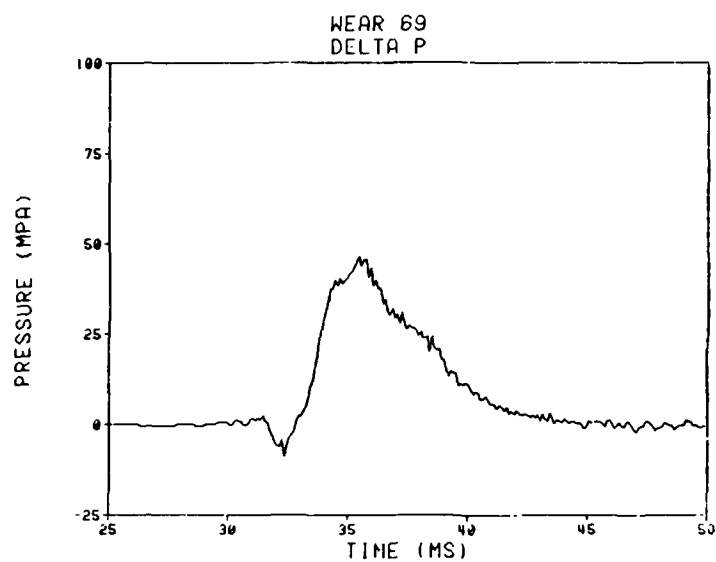
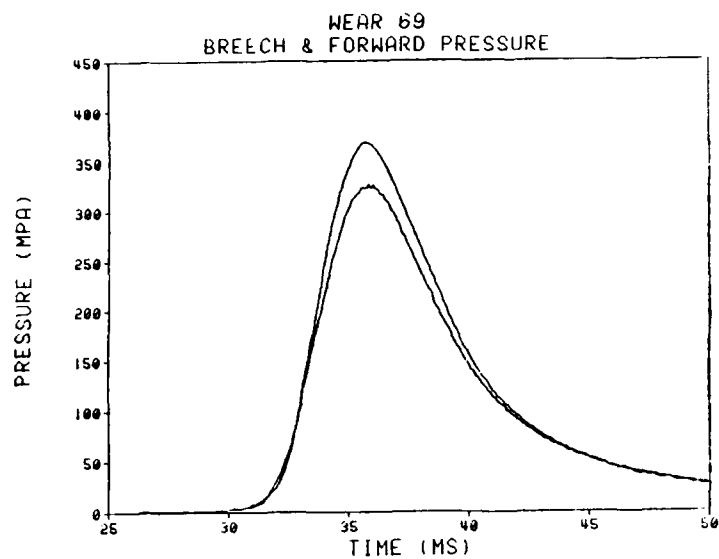








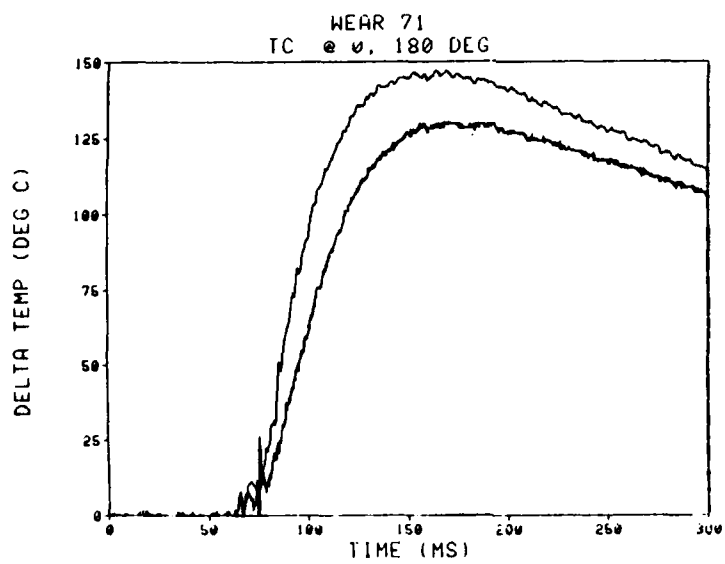
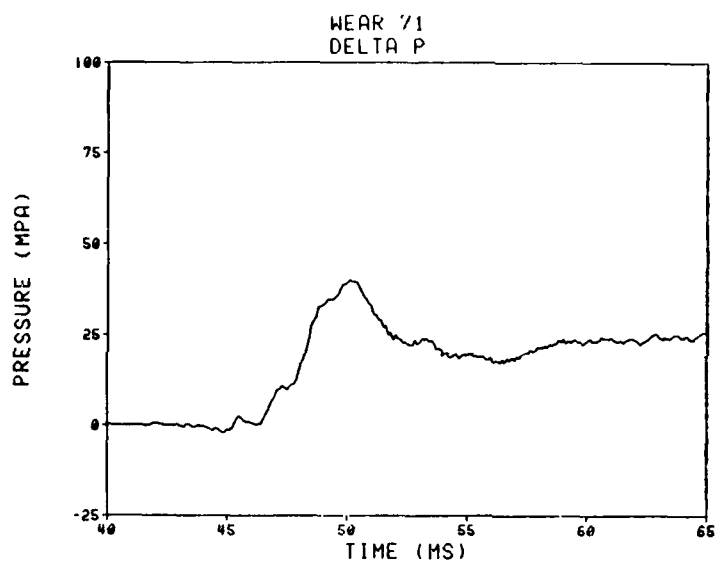
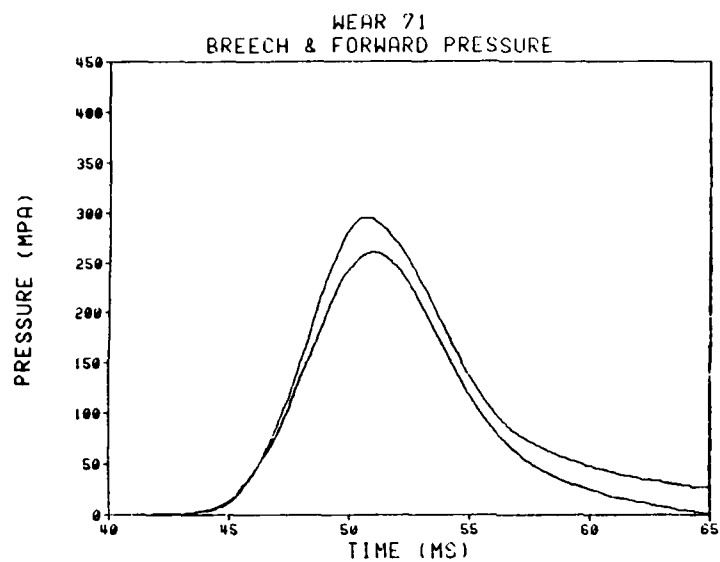


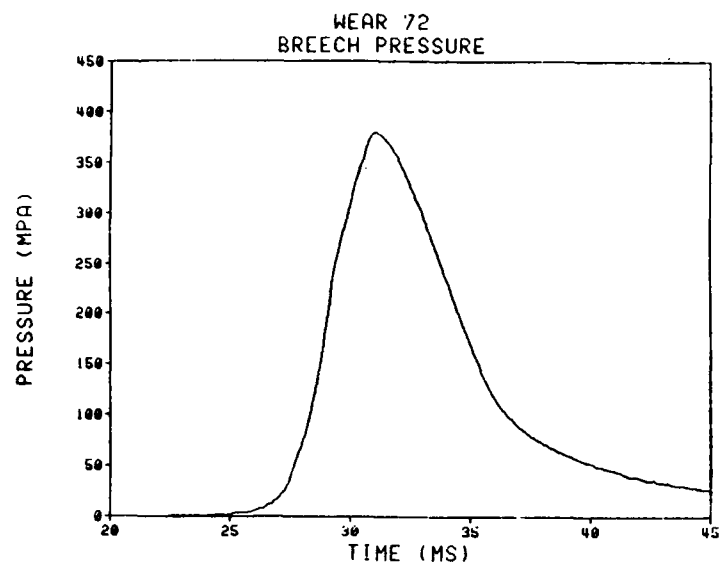


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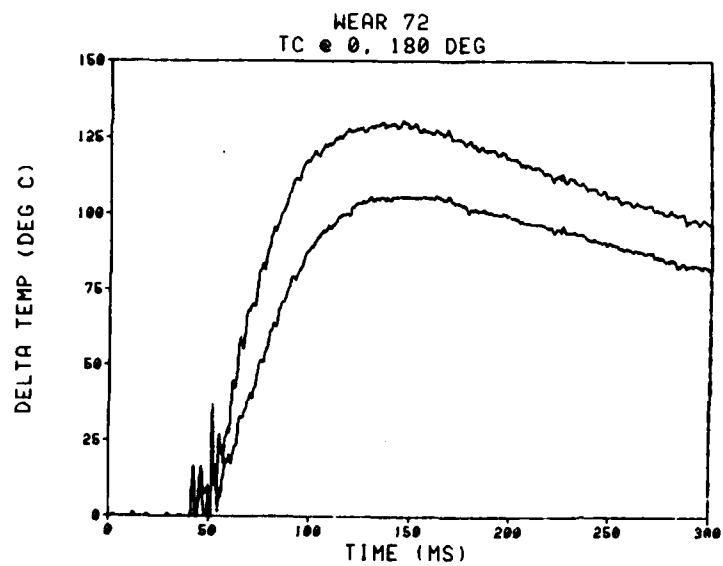
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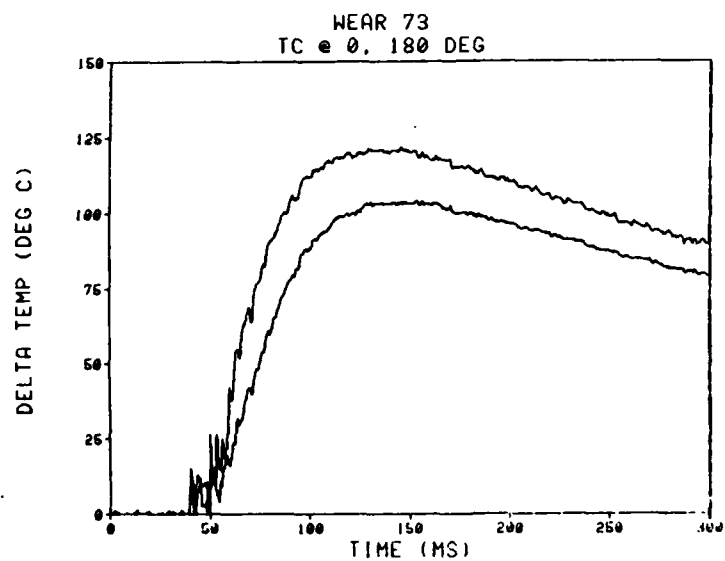
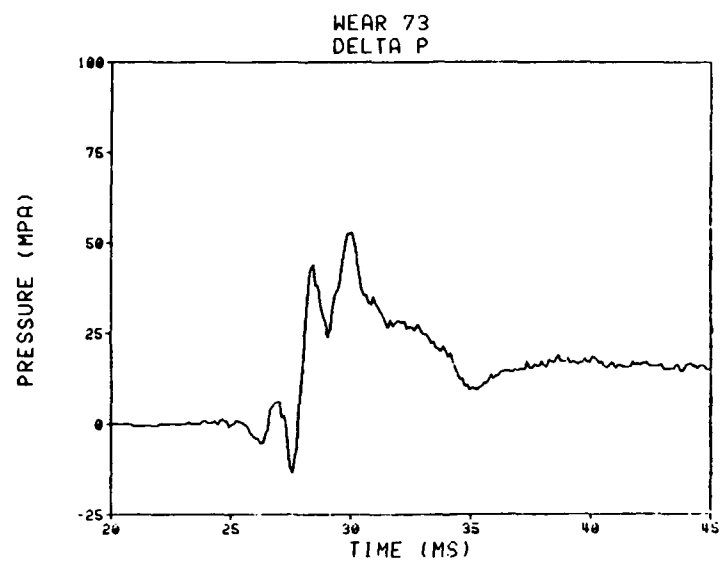
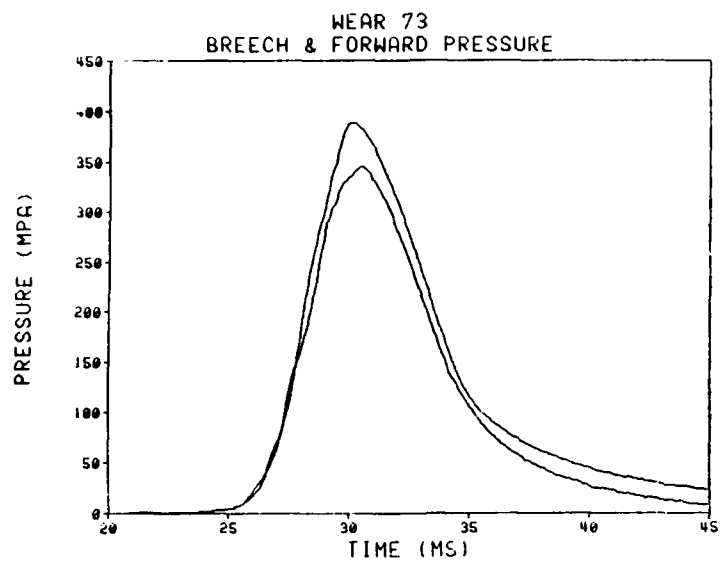
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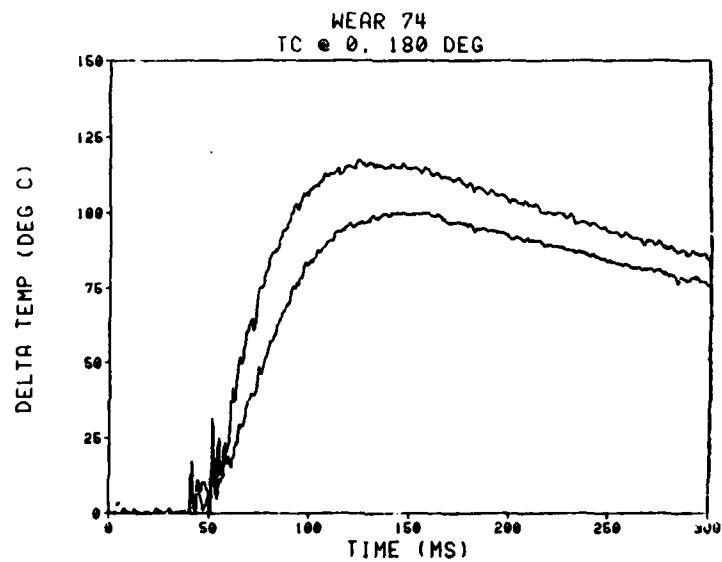
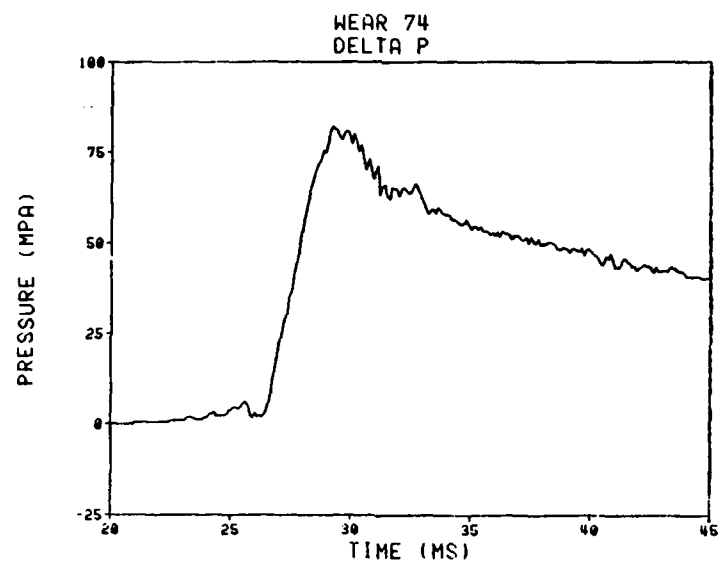
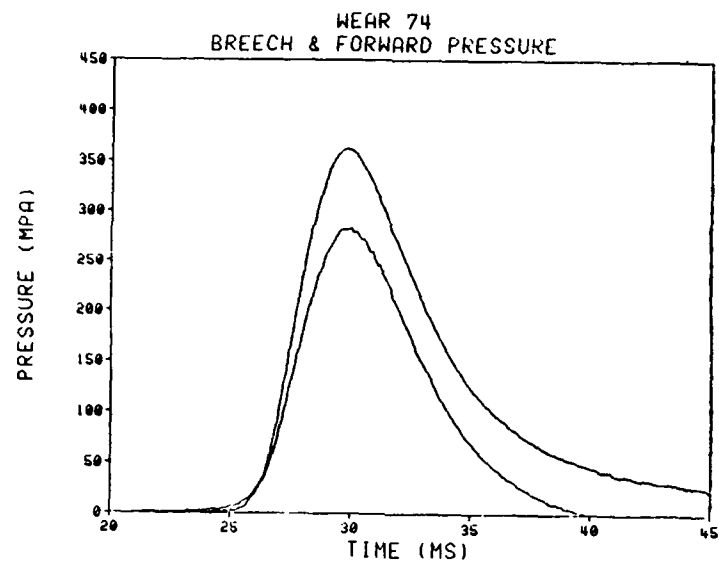


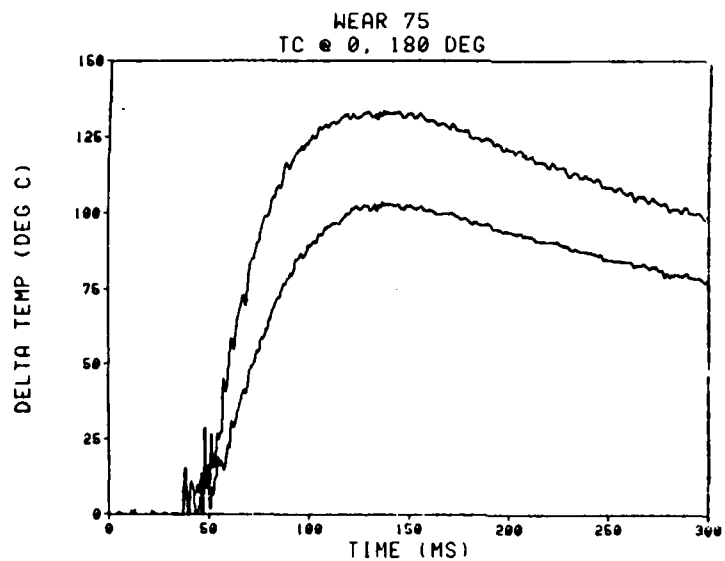
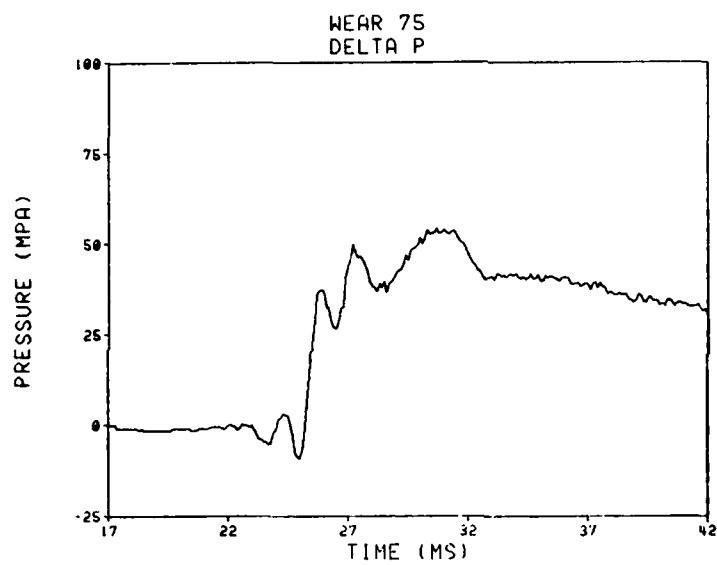
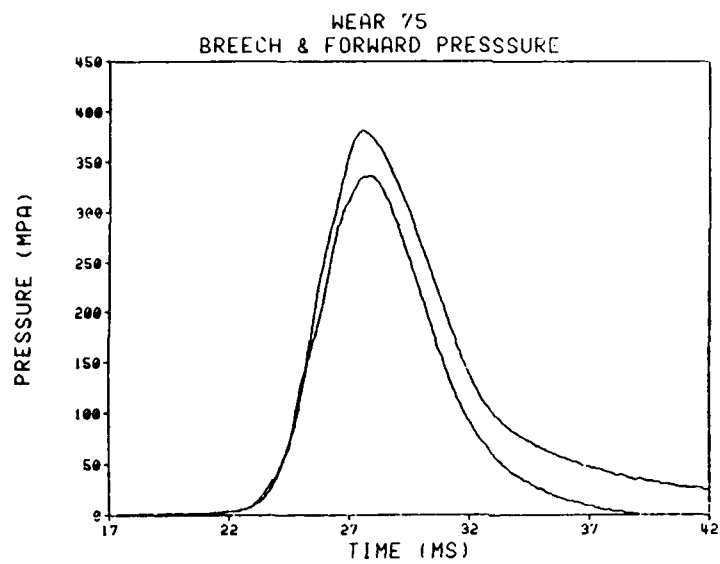


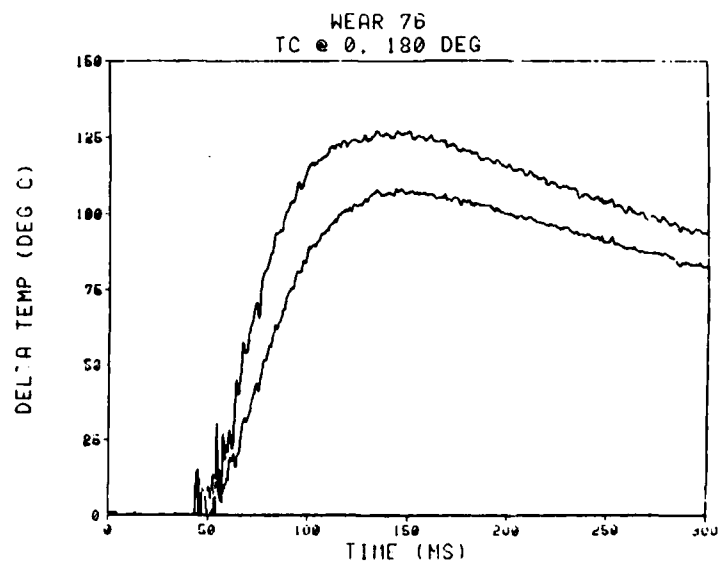
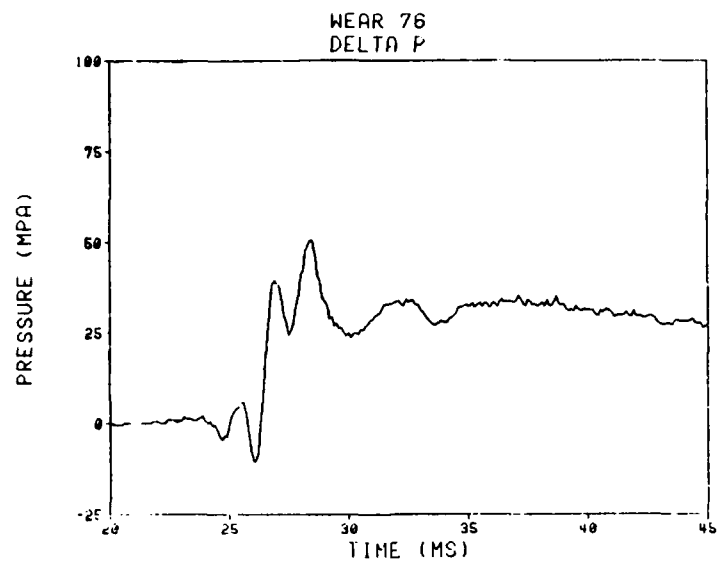
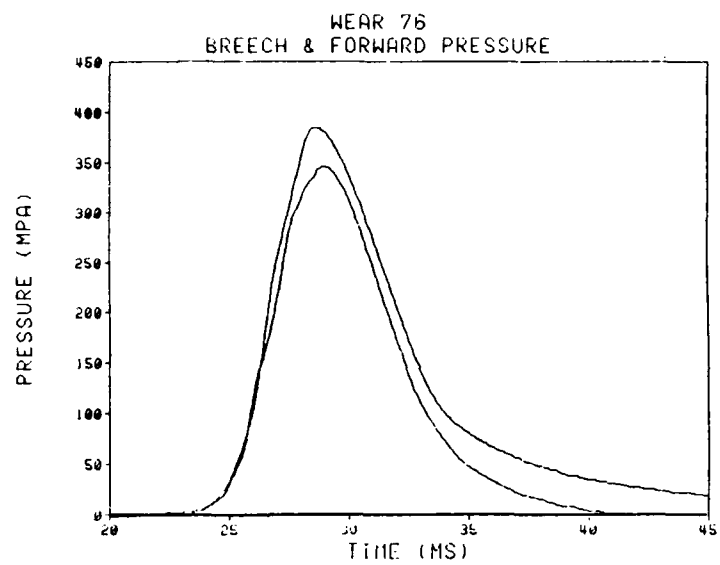
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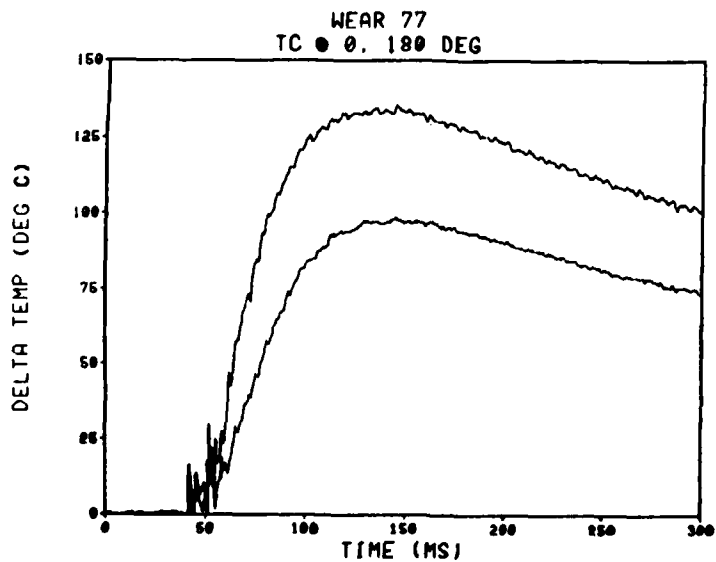
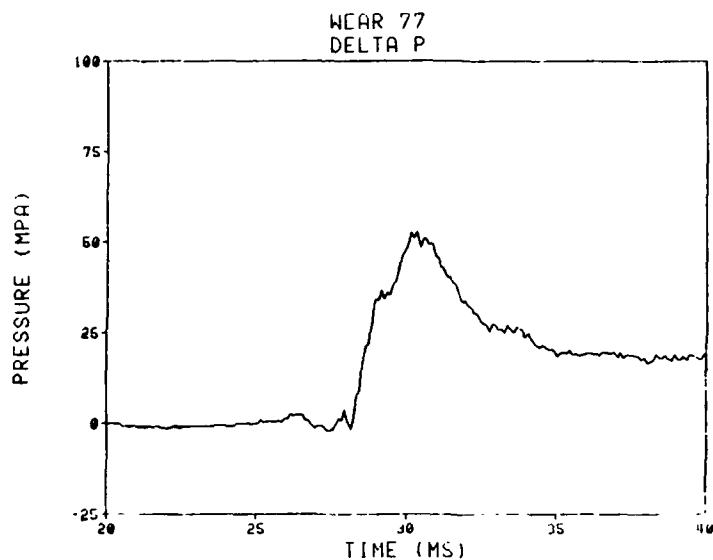
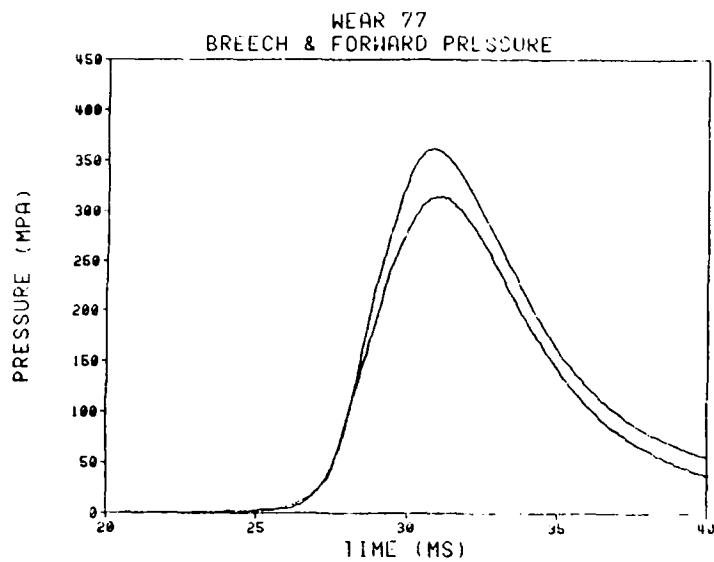


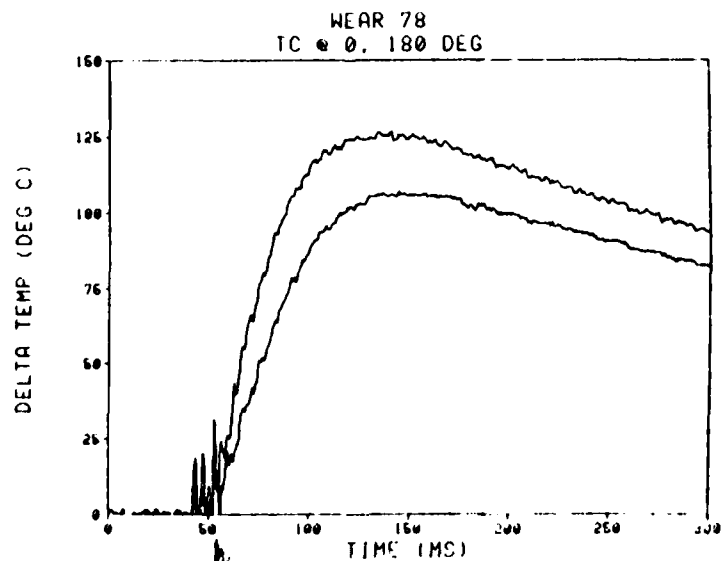
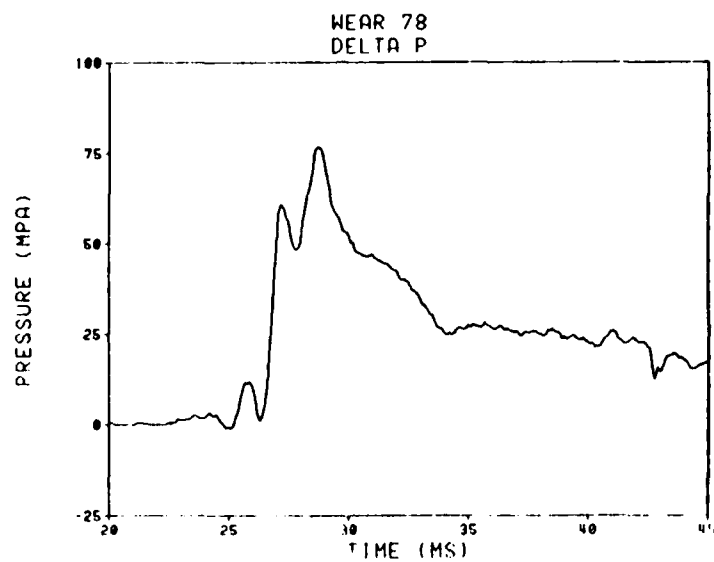
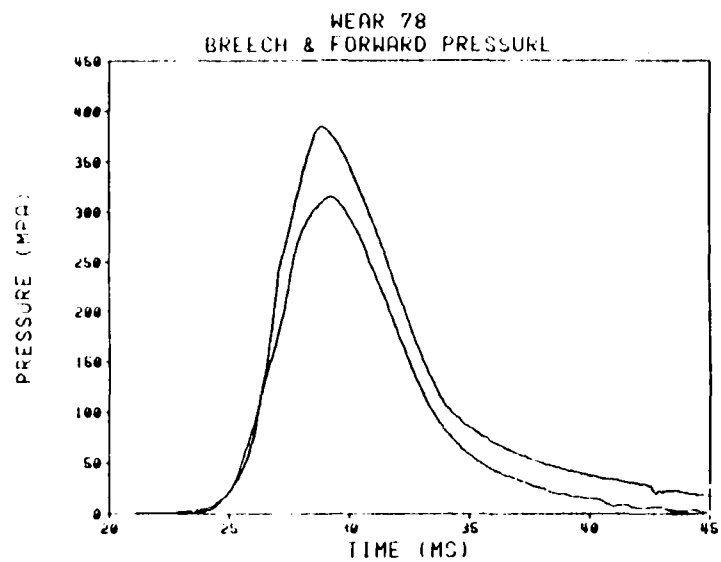












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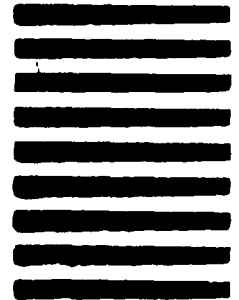


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