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Final Report

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US Department of Transportation
National Highway Traffic Safety Administration

CHILD SEAT RETENTION TESTS

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16. Abstract

Static tests and two sled tests were performed using a Century 200 child seat mounted in the rear center position of a 1982 Plymouth Gran Fury using General Motors seat belts. These tests were performed to determine whether the belt will hold the child seat under various load conditions.

The purpose of the static tests was to determine the most failure prone belt/buckle interface angle and to determine belt/buckle interaction under low G load conditions. The first sled test was to determine whether a retention problem exists under high G load conditions when the belt/buckle is installed at the previously determined angle. Since no retention problem was found, a second test was performed to verify the results of the first test.

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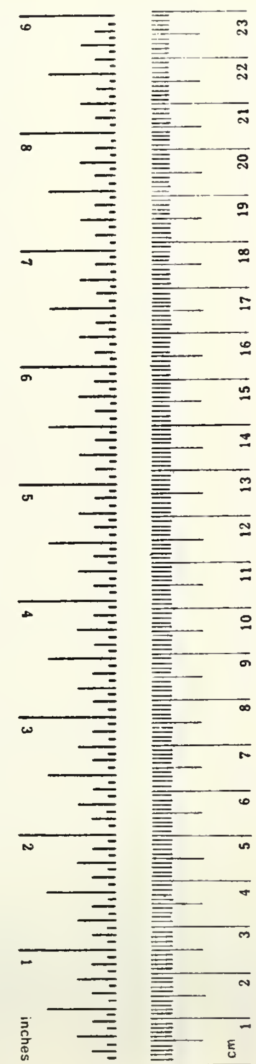
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

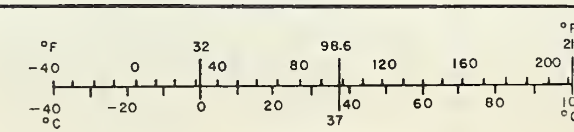
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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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1.0 Introduction

The National Highway Traffic Safety Administration maintains that a forward facing child seat installed in the rear seat of a vehicle should be mounted in the center position when center seat belts are provided. It has been alleged that due to the combination of the construction of many child seats, including the Century 200 child seat, and the length of certain seat belts, mounting the seat in the rear center position allows the seat belt to slide through the buckle under high G loadings. This condition would allow the child seat to move during high G situations such as an accident which would defeat the purpose of the child seat. The alleged failure mode requires the position of the buckle to be such that the belt exiting the male end of the buckle through the child seat, pulls at a ninety degree angle to the buckle instead of the 180 degree angle at which the belt/buckle interface was designed to operate. (Fig.1) Credence to this alleged failure mode is lent by the fact that ninety degrees is the angle which must be maintained in order to adjust the buckle on the belt to vary its length. On the other hand, analysis indicates that under dynamic loading associated with a crash, the alleged problem may not exist. The belt stretch, initial slack and additional length created by the first movement through the buckle may allow the belt to pull at the required 180 degree angle and thus allow the buckle to lock. To test these possibilities, it was decided to experimentally determine the likelihood of retention failure. Two test phases were planned. The first was to examine the mechanism and conditions leading to belt slipping by examining a typical installation and pulling on the child seat in various directions. At the same time, it would be possible to determine the belt lengths, positions, etc. that would most likely lead to failure. The second phase was a dynamic test using a Hy-Gee sled simulating a frontal crash

2.0 Test Procedures

Prior to sled testing, static tests were performed to determine the most failure-prone belt/buckle interface angle. Having determined this angle to be ninety degrees, the length of the female half of the seat belt was purposely adjusted to the least optimum i.e., most failure-prone position. This belt length was determined by inserting the male half of the buckle into the female half and adjusting the belt length of the female half so that the belt exiting the male half of the buckle did so at the pre-determined ninety degree angle when the belt was installed across the back of the child seat per the instructions supplied with it. The static tests that were performed involved installing the child seat in both fully reclined and fully upright positions and pulling the belted child seat straight forward, 90 degrees to both the left and right, 45 degrees to both the left and right and rotating the seat both clockwise and counterclockwise. The seat belt halves were marked in one inch increments so that if slippage actually occurred during testing, it could be detected and measured. A video tape was made to document these tests. Two sled tests were then performed using a Century 200 child seat mounted in the rear center position of a 1982 Plymouth Gran Fury body buck (Fig. 2) using a General Motors seat belt. A three-year old child dummy was strapped into the seat to simulate an actual load situation. (Figs. 3 & 4) Both tests were performed at a nominal 30 MPH with a nominal acceleration of 20 G's. High speed motion pictures documented both the right and left sides during sled testing. The purpose of the first test was to demonstrate whether a retention problem existed. The second test verified the findings of the first test.

2.1 Test Results

The static tests as shown on the video tape showed that the only situations in which the buckle allowed the belt to slide through it in the reclined position were when the child seat was rotated about the buckle (clockwise), when the seat was pulled 90 degrees to the left, and when the seat was pulled 45 degrees to the right. In the upright position, the only situation which allowed the the belt to slide though the buckle was the clockwise rotation. Since the sled tests were to be demonstration type tests, no instrumentation was used on the sled other than acceleration. Through photographic evidence, both high-speed motion pictures during the sled tests and 35mm still photos before and after the sled tests, slippage of the belt through the buckle under dynamic loading was determined to be no more than one half (1/2) inch (Figs. 5 & 6) for the initial test and approximately one quarter (1/4) inch (Figs. 7 & 8 for the second test. Results are shown in the pictures in Appendix I and in the accompanying video tape and high speed films.

Appendix I

Photographs

Fig. 1

90 degree belt/buckle interface.

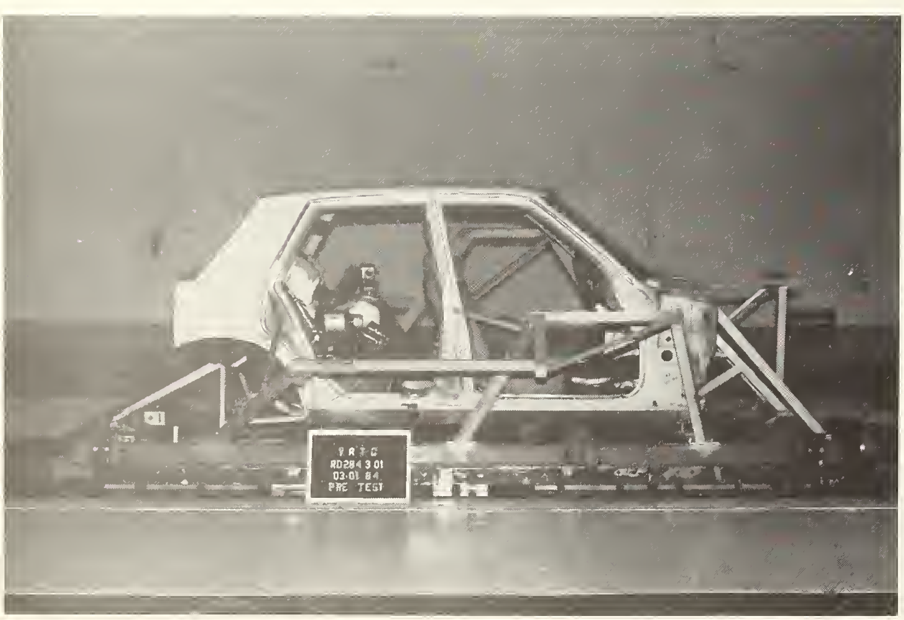


Fig. 2

Plymouth Body Buck

Fig. 3

Child Seat Mounting

Test 1, Left Side View

Fig. 4

Child Seat Mounting

Test 1, Right Side View

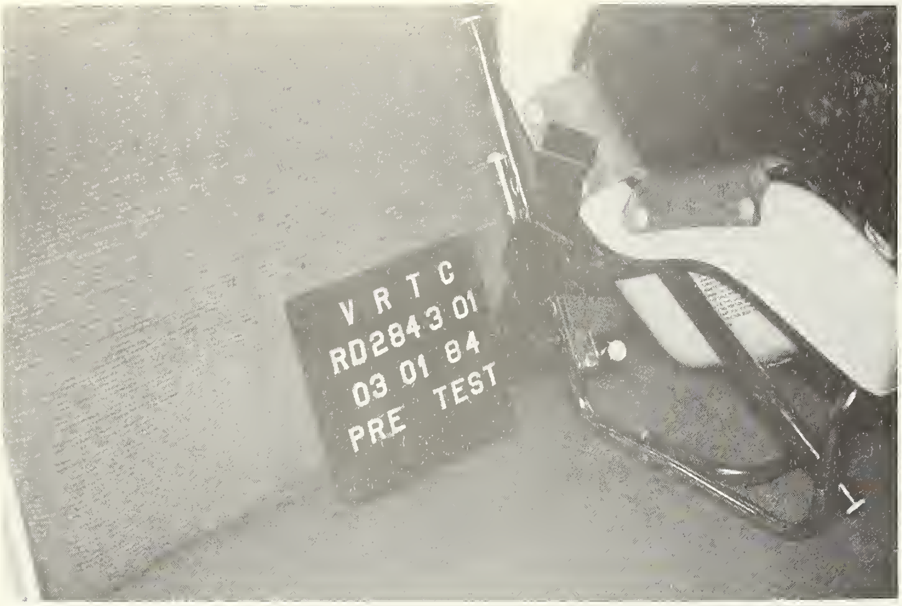


Fig. 5

Seat Belt Positioning

Pre Test 1

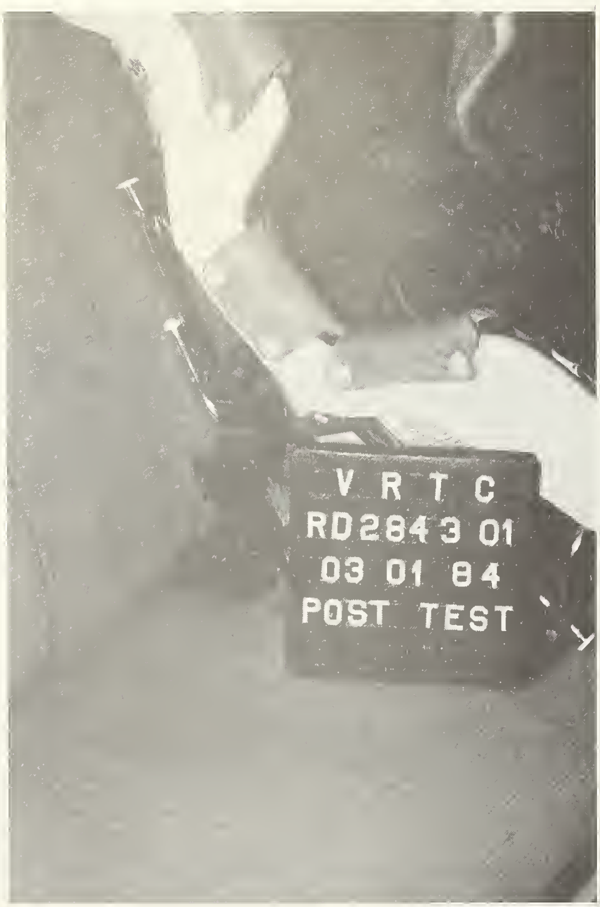


Fig. 6

Seat Belt Positioning

Post Test 1

Fig. 7

Seat Belt Positioning

Pre Test 2

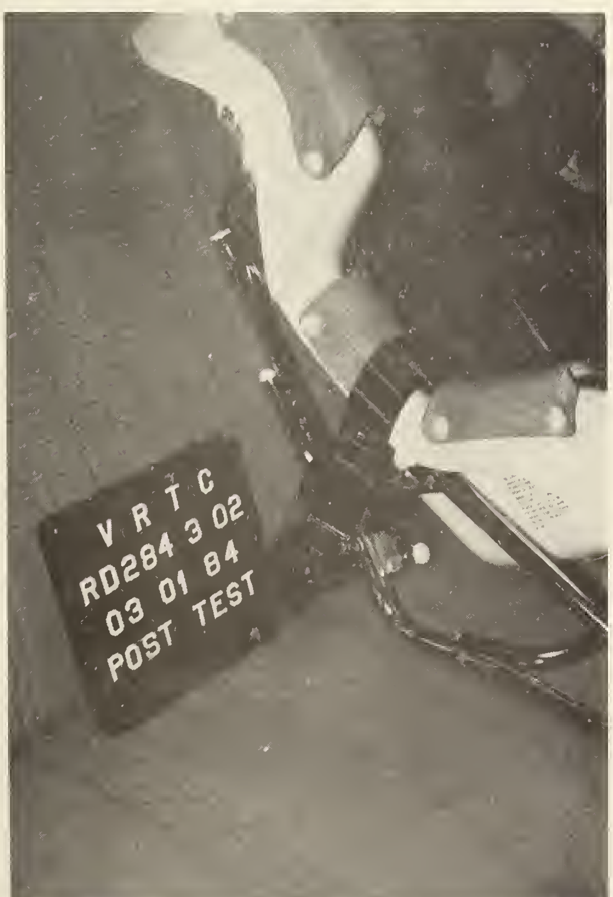


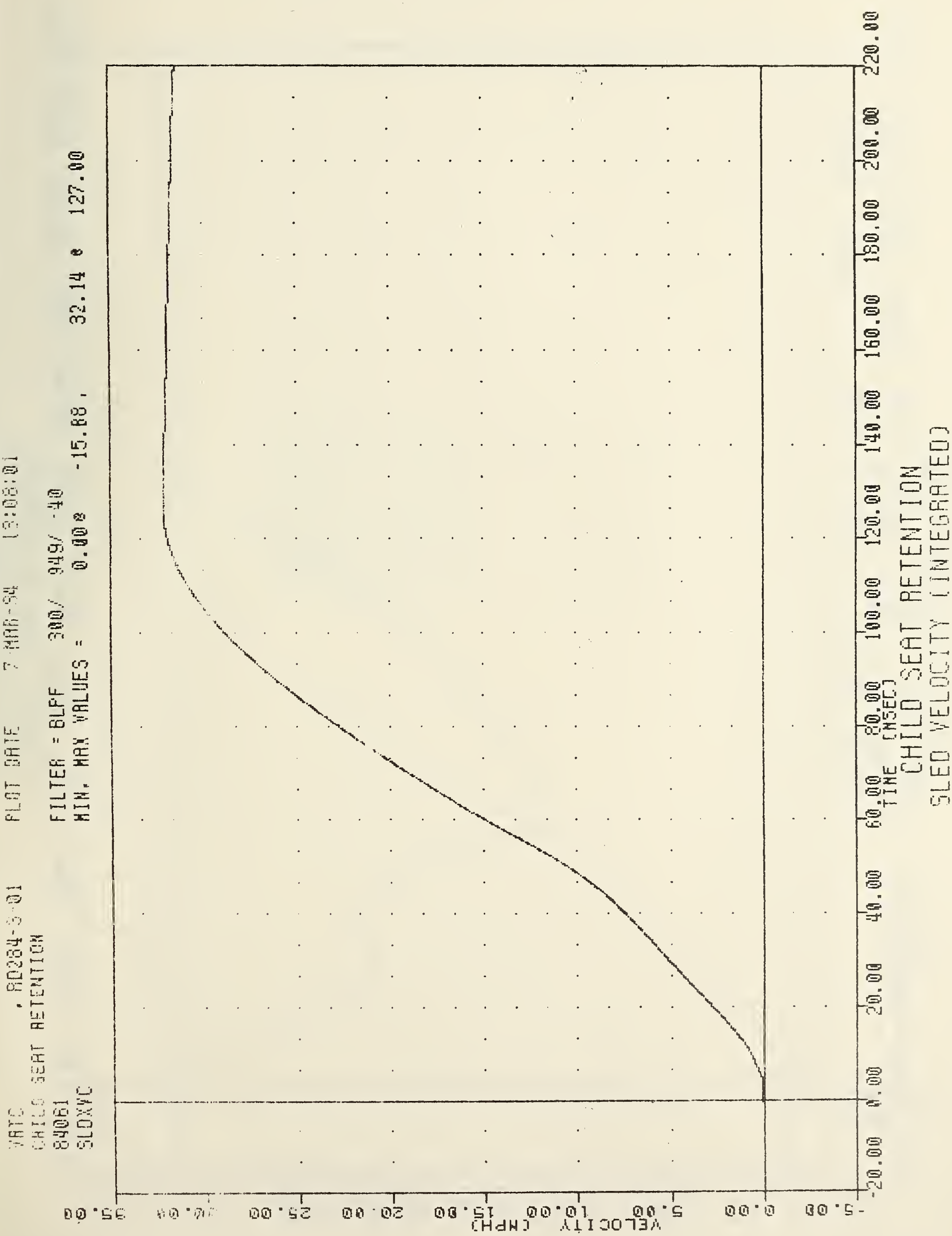
Fig. 8

Seat Belt Positioning

Post Test 2

Appendix II

Data Plots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CHILD SEAT RETENTION
89061
SLDXVC
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VELOCITY (MPH)
TIME (MSEC)
CHILD SEAT RETENTION
SLED VELOCITY (INTEGRATED)

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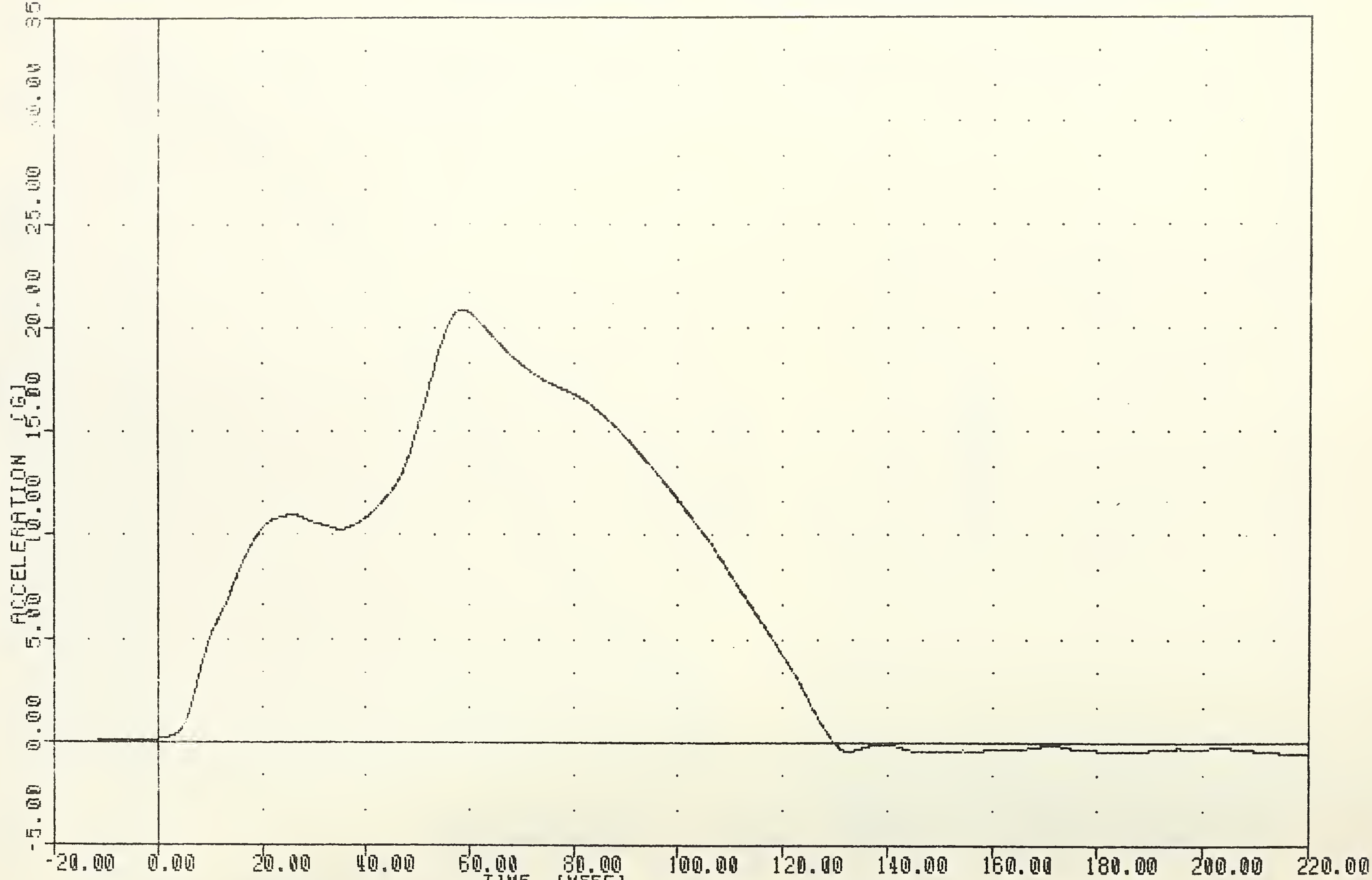
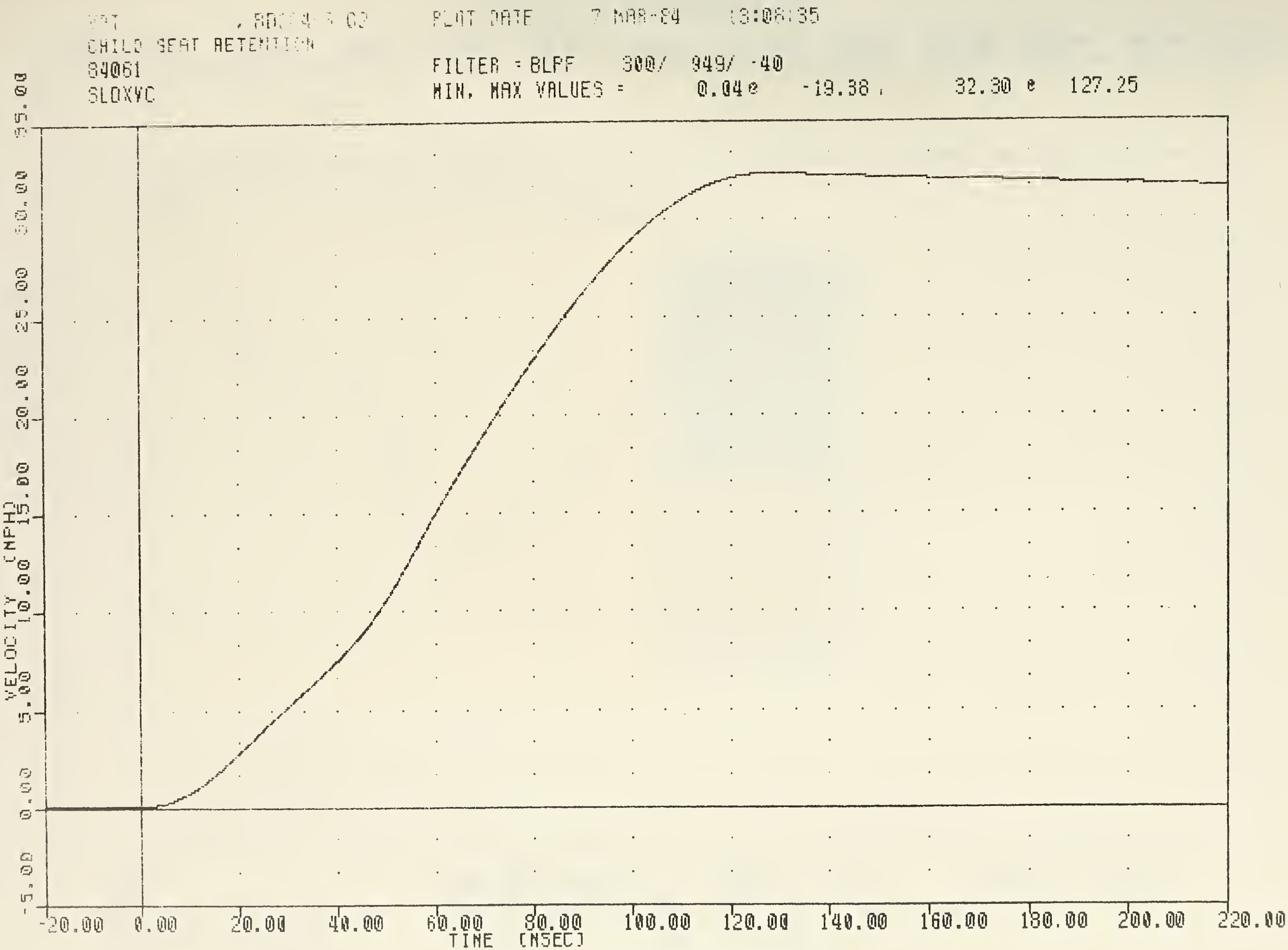


CHILD SEAT RETENTION
SLED ACCELERATION X AXIS



CHILD SEAT RETENTION
SLED VELOCITY (INTEGRATED)

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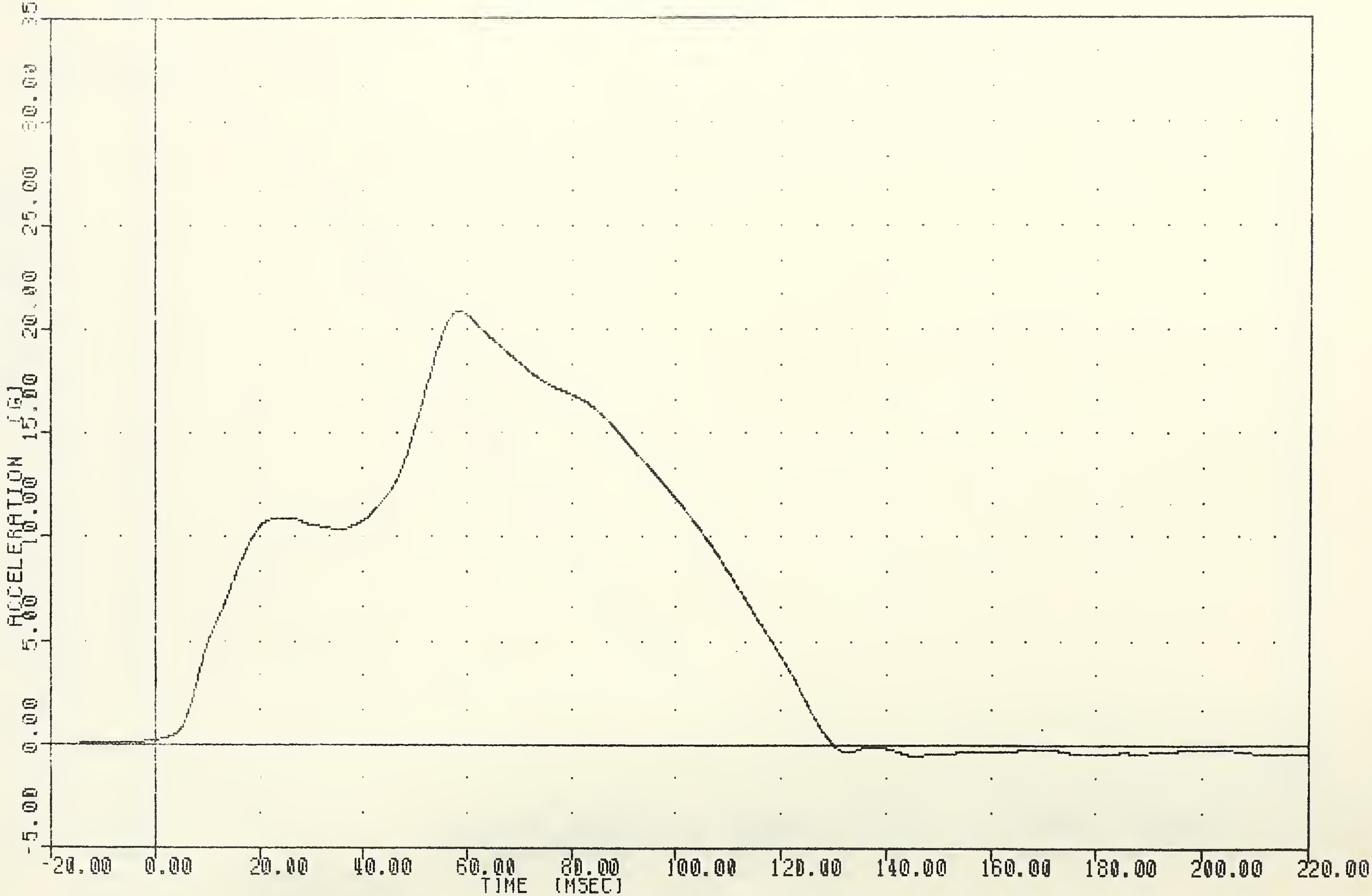

CHILD SEAT RETENTION
SLED ACCELERATION X AXIS