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People Saving People

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Final Report

Evaluation of Devices To Improve Shoulder Belt Fit

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16. Abstract

Dynamic HYGE sled tests were conducted to evaluate devices which are designed to reposition the shoulder belt to provide for improved fit or comfort. Three different devices, representative of those being marketed, were tested using the 3 and 6 year old and the 5th percentile female dummies. The FMVSS No. 213, "Child Restraint Systems", test seat and test pulse/velocity were used. Tests comparing the use of a belt positioning booster seat with and without one of the devices was also conducted.

HIC values greater than 1000 were observed with the Child-Safer™ and the SafeFit™ devices during all tests with the 3 year old dummy, and during 5 of the 6 tests with the 5th percentile female dummy. 3 ms chest clip values exceeded 60 g's during 2 of the 3 tests with the Child-Safer™ used on the 6 year old dummy. Use of the SafeFit™ device resulted in 1 of 2 tests with the 3 year old dummy exceeding 60 g's. All tests met the head and knee excursion criterion. The 3 year old in the booster seat/Child-Safer™ combination exceeded both the HIC and chest injury criterion. Some of the belt fit devices kinematically effected the various sized occupants differently - one resulted in more torso rotation about the lap belt, one tended to delay submarining by the small female dummy until later in the crash event and, under certain test conditions, all devices contributed to the dummy's torso "rolling-out" of the shoulder belt.

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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	metric ton	t
	VOLUME			
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in^3	cubic inches	16	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	degrees Fahrenheit	5/9 (after subtracting 32)	degrees Celsius	°C

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	metric ton (1000 kg)	1.1	short tons	
	VOLUME			
mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in^3
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
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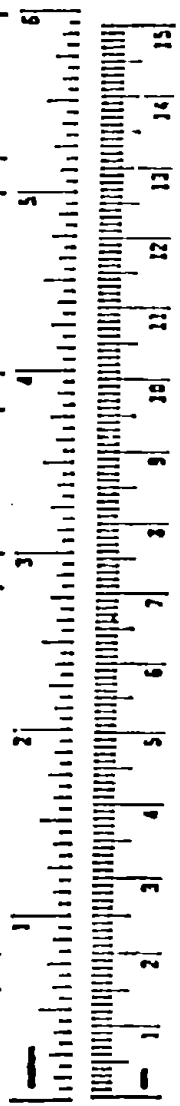

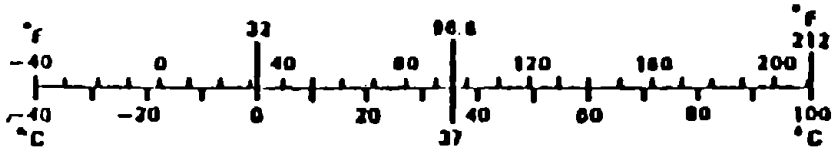

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TECHNICAL SUMMARY

Report Title:	Date:
Evaluation of Devices to Improve Shoulder Belt Fit	August 1994
Report Author(s):	
Lisa K. Sullivan and Fletcher K. Chambers	

A series of 35 HYGE sled tests were conducted to evaluate devices which are designed to reposition the shoulder belt in an effort to improve fit/comfort. Three devices - Child-Safer™, SafeFit™ and Seatbelt Adjuster™ - were tested using the 3 and 6 year old and 5th percentile female dummies. Baseline (no device) tests were also conducted. The FMVSS No. 213 test seat fixture and test pulse/velocity were used. The fixture was oriented to simulate a full frontal, a 15° clockwise oblique and 15° counterclockwise oblique impact. The FMVSS No. 213 compliance criteria were used as a bench mark, although the belt fit devices are not required to comply with FMVSS No. 213. The manufacturer of the Child-Safer™ device states that it can be used in conjunction with a booster seat to improve shoulder belt fit - tests were conducted to evaluate this configuration using the 3 year old dummy in the Century CR-3 belt positioning booster seat.

In 5 of the 8 tests with the 3 year old dummy HIC values exceeded 1000, and the 3 ms resultant chest acceleration exceeded 60 g's during 1 test. HIC $\leq$ 1000 and chest acceleration $\leq$ 60 g's are the injury criteria used in FMVSS No. 213. HIC values were below 1000 for the 12 tests conducted with the 6 year old dummy; however, the chest acceleration exceeded 60 g's in two tests. For the 5th percentile female dummy, 5 of the 12 tests resulted in HIC values greater than 1000 and all chest accelerations were below 60 g's. Review of the dummy kinematics, comparing baseline (no device) and the 3 devices, showed several interesting phenomenon. The Child-Safer™ with the 3 year old allowed for more forward rotation of the dummy's torso as compared to the other belt configurations. This appears to be primarily due to the release of the approximately 51 mm of webbing that is initially routed through the device. With the 6 year old dummy tested in the counterclockwise orientation, use of the 3 devices resulted in noticeably more dummy "roll-out" from the shoulder belt as compared to the baseline condition. When tested in the frontal and clockwise orientation, the SafeFit™ device had a pronounced effect on the rebound characteristics of the 5th percentile female dummy. The device delayed the complete submarining of the lap/shoulder belt until later in the event, as compared to the 3 other belt configurations.

From the comparison tests of the belt positioning booster seat with and without the belt fit device, the HIC value for the 3 year old dummy was 1575 and the 3 ms chest acceleration was 61.6 g's when the booster was used with the Child-Safer™ device. The booster only test resulted in a HIC value of 906 and a chest acceleration of 48.8 g's. The amount of head and knee excursion did not appear to be affected by the use of the belt fit device. As in the group of tests described above, the release of the belt webbing from the Child-Safer™ during impact allowed sufficient slack for the 3 year old dummy's torso to significantly rotate forward, almost to the point of the head contacting the lower extremities.

1.0 INTRODUCTION

The National Highway Traffic Safety Administration (NHTSA) is conducting ongoing research in the child restraint area. The Office of Research and Development is currently addressing some of the issues identified in the agency's "Planning Document on Potential Standard 213 Upgrade." This report will detail research and HYGE sled tests to evaluate belt fit devices, which are designed to reposition the shoulder portion of a lap/shoulder safety belt away from the occupant's neck. Although these devices are not regulated under FMVSS No. 213, it is believed that the agency should periodically evaluate these types of devices (using FMVSS No. 213 procedures) to ensure that none of the devices are resulting in circumstances where the occupant may be injured due to the use of the device.

2.0 TEST CONDITIONS

A series of 35 HYGE sled tests were conducted to evaluate belt fit devices. The FMVSS No. 213 crash pulse and velocity were used in the standard frontal condition as well as a 15° offset, clockwise and counterclockwise, to simulate an oblique impact. The 15° offset was one of a small number of modifications made to the FMVSS No. 213 test procedure. The seat back of the 213 test fixture was rigidly fixed to minimize any motion which could affect the performance of the belt fit devices. Because the belt fit devices are not restraint systems in and of themselves, they are not required to comply with FMVSS No. 213. Thus, the tests documented in this report are for research purposes only and should not be considered as compliance tests.

Three different types of belt fit devices were chosen to be used with the 3 year old and 6 years old dummies and the 5th percentile female dummy. The devices chosen were (1) the Child-Safer™, a plastic strip which attaches to the lap belt and has three different openings through which the shoulder belt can be routed, (2) the SafeFit™, a pouch design through which the lap/shoulder belt is routed, and (3) the Seatbelt Adjuster™, a plastic clip which attaches to the lap

belt and the shoulder belt is positioned under a flange to reroute the belt. These three are representative of the types of devices which are currently being marketed. Artist renderings of the belt fit devices are contained in Figures 1 through 3. The three devices are intended to react under dynamic conditions as follows:

Child-Safer™: The bottom end of the device remains attached to the lap belt. The shoulder belt disengages from the 2 slots it is routed through at the upper end of the device when a certain amount of occupant loading on the belt occurs, allowing the belt to repositioning itself on the occupant.

SafeFit™: The device remains attached to the belt restraint and maintains its structural integrity. The shoulder belt tends to remain where initially positioned on the occupant.

Seatbelt Adjuster™: The base of the device remains attached to the lap belt. The flange that reroutes the shoulder belt breaks away from the device, allowing the shoulder belt to reposition itself on the occupant.

One additional test was performed with the Child-Safer™ using the 3 year old dummy seated in the Century CR-3 booster seat. The manufacturer of this device states in its literature that the device can be used in conjunction with a booster seat to improve shoulder belt fit. Baseline (no belt fit device) tests were also conducted with the 3 year old, 6 year old, 5th percentile female, and 50th percentile male adult dummies for comparative purposes. All tests used 3-point safety belts with the anchorage locations defined by a Notice of Proposed Rulemaking (NPRM) dated September 3, 1993.[*1] These anchorage locations were defined during a previous study conducted to support this rulemaking.[2] A complete test matrix is contained in Table 1.

[*]Numbers in parentheses indicate references at end of text.

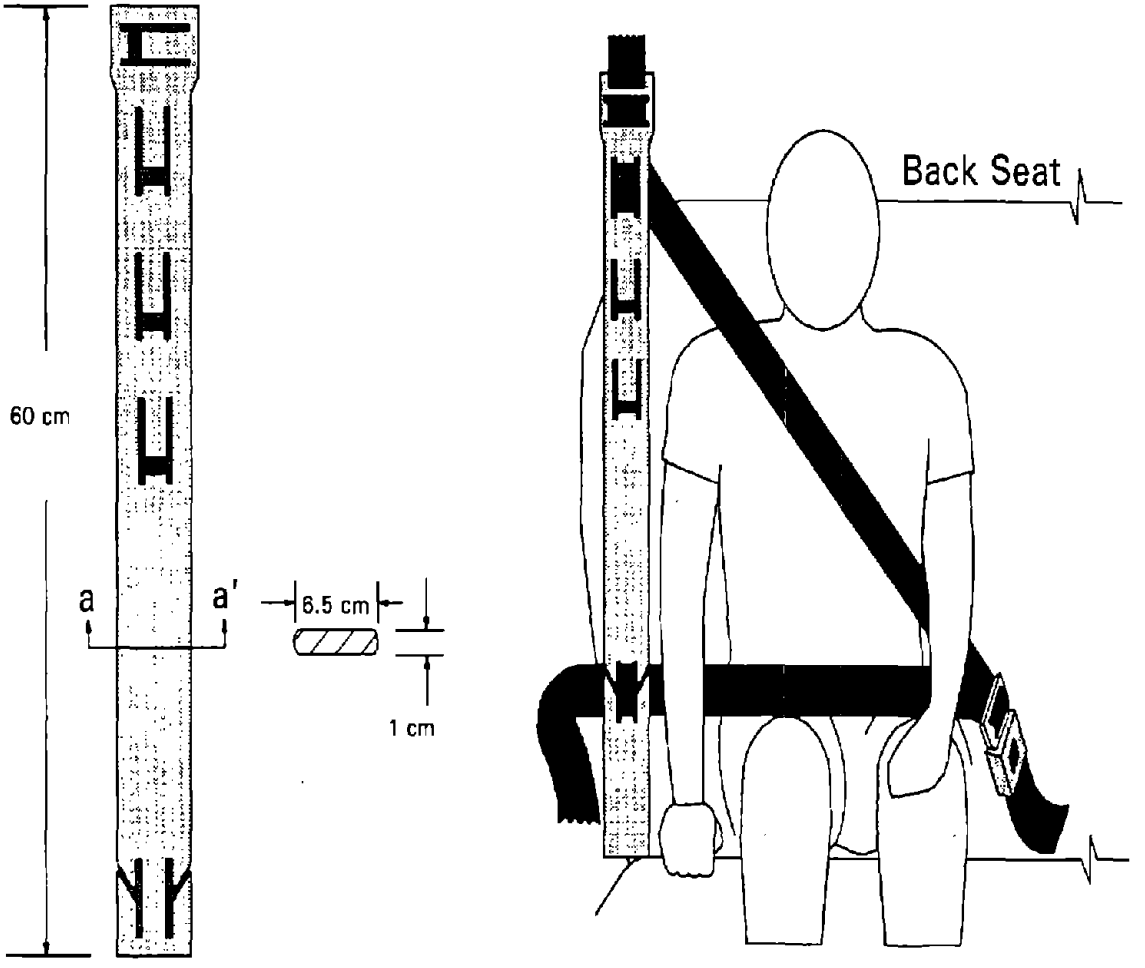


Figure 1 - Artist's Rendering of Child-Safer™ Device

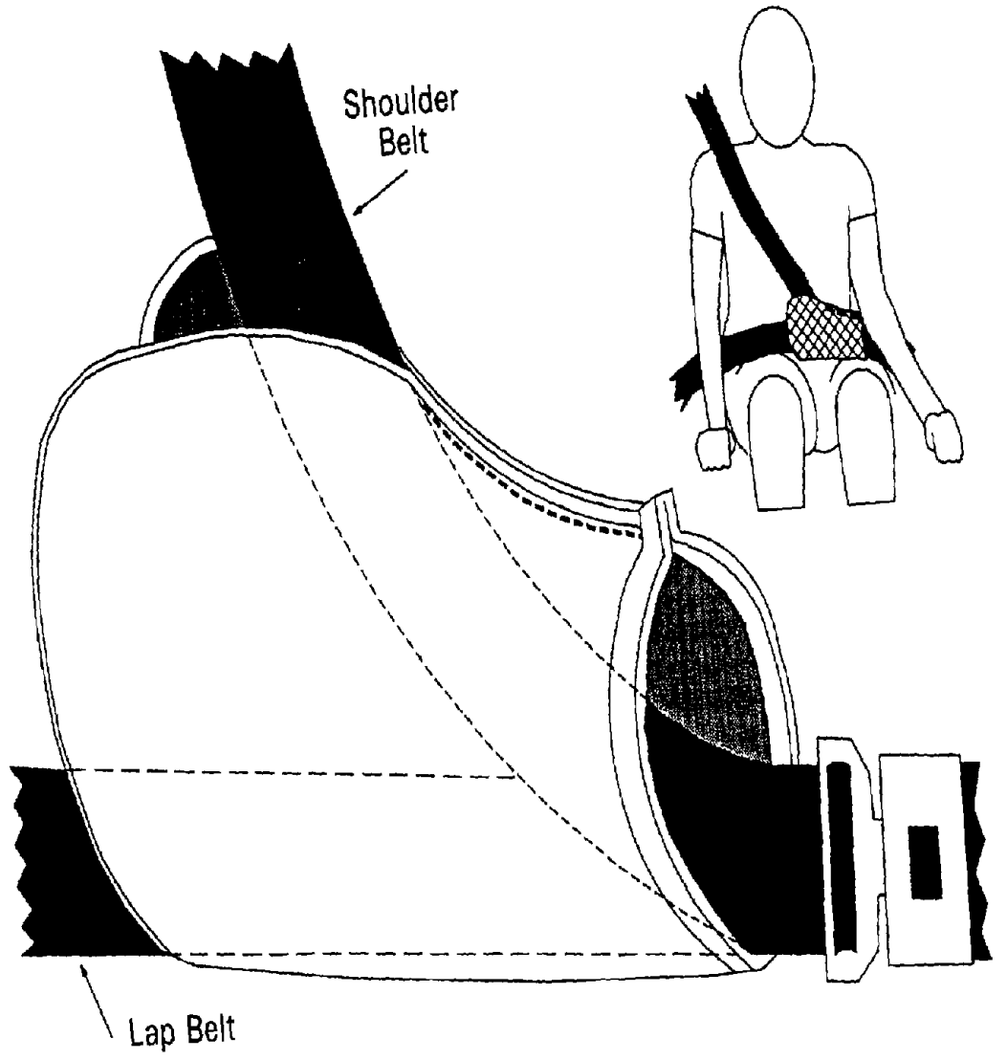


Figure 2 - Artist's Rendering of SafeFit™ Device

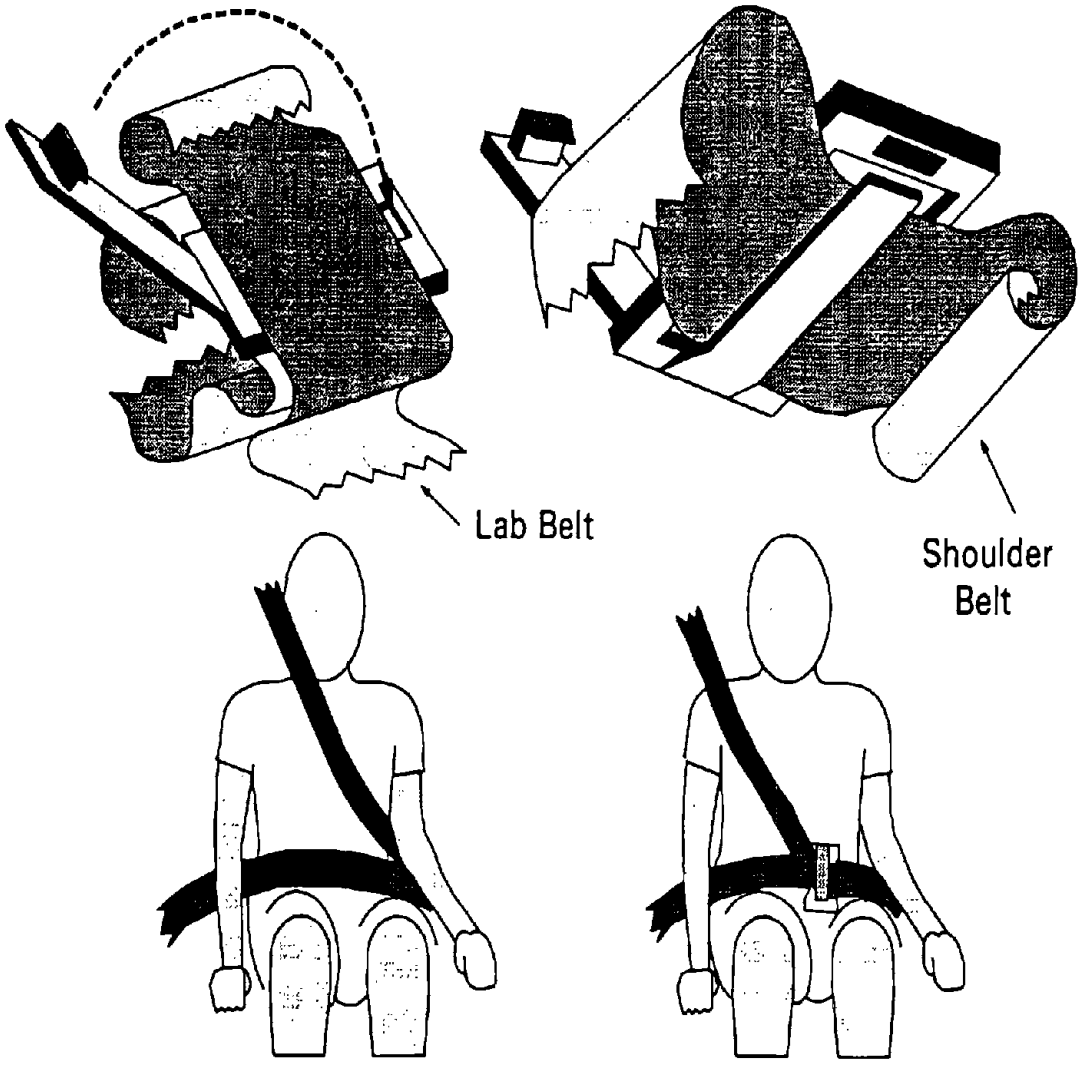


Figure 3 - Artist's Rendering of Seatbelt Adjuster™ Device

Table 1 Test Matrix for Evaluation of Belt Fit Devices

Restraint Device	Dummy Size	Test Condition	Test Number
Child-Safer™	3 year old	Standard 213	V296CS03ST
		15° into belt	V296CS03OB
		Standard 213 Century CR-3	V296CS03CB
	6 year old	Standard 213	V296CSR6ST
		15° into belt	V296CS06OB
		15° out of belt	V296CS06CC
	5th Percentile Female	Standard 213	V296CS5FST
		15° into belt	V296CS5FOB
		15° out of belt	V296CS5FCC
SafeFit™	3 year old	Standard 213	V296SF03ST
		15° into belt	V296SF03OB
	6 year old	Standard 213	V296SF06ST
		15° into belt	V296SF06OB
		15° out of belt	V296SF06CC
	5th Percentile Female	Standard 213	V296SF5FST
		15° into belt	V296SF5FOB
		15° out of belt	V296SF5FCC
Seatbelt Adjuster™	3 year old	Standard 213	V296SA03ST
		15° into belt	V296SA03OB
	6 year old	Standard 213	V296SA06ST
		15° into belt	V296SA06OB
		15° out of belt	V296SA06CC
	5th Percentile Female	Standard 213	V296SA5FST
		15° into belt	V296SA5FOB
		15° out of belt	V296SA5FCC
Baseline (no device)	3 year old	Standard 213	V296BL03ST
		15° into belt	V296BL03OB
	6 year old	Standard 213	V296BL06ST
		15° into belt	V296BL06OB
		15° out of belt	V296BL06CC
	5th Percentile Female	Standard 213	V296BL5FST
		15° into belt	V296BL5FOB
		15° out of belt	V296BL5FCC
	50th Percentile Male	Standard 213	V296BL50ST
		15° into belt	V296BL50OB

Requirements from the manufacturers differ as to who should or should not be using the different belt devices. The manufacturer of the Child-Safer™ device suggests that it fits occupants between the heights of 96.5 cm and 152.4 cm. The SafeFit™ device is recommended for children with a mass between 22.7 kg and 31.8 kg. The manufacturer of the Seatbelt Adjuster™ does not give any specification for who can use their product, but their literature suggests that it "works great with children" and their packaging shows an adult female using the product. The 3 year old dummy has a mass of 15.1 kg and stands 97.5 cm high. This puts the dummy in the height range for the Child-Safer™ device. The 6 year old dummy has a mass of 21.5 kg and stands 120.1 cm. Therefore it meets the height requirement for the Child-Safer™ and is 1.2 kg below the mass requirement for the SafeFit™. The 5th percentile female dummy has a mass of 46.3kg and is 149.9 cm high. Therefore she meets the height requirement for the Child-Safer™ device. The 5th percentile female dummy is outside the weight requirement for the SafeFit™ device, but the package suggests that "anyone who is unable to wear shoulder belts properly can benefit from "SafeFit™, including moms and grandmas." The Seatbelt Adjuster™ device has no requirement.

The 3 year old dummy was instrumented with triaxial accelerometer arrays in the head and thorax. The 6 year old was instrumented with triaxial accelerometer arrays in the head and thorax and had femur load cells. Instrumentation for the 5th percentile female dummy included triaxial accelerometer arrays in the head, thorax, and pelvis, femur load cells, chest displacement potentiometer, load cells in the neck, thorax and lumbar spine, and sensors on the ilium to detect occupant submarining. The 50th percentile male dummy was instrumented with triaxial accelerometer arrays in the head, thorax, and pelvis, femur load cells, chest displacement potentiometer and neck load cell. Each test had a load cell on the lap portion of the safety belt near the lap belt outboard anchor. There was also a load cell on the shoulder belt portion of the safety belt near the D-ring.

3.0 SLED TEST RESULTS

The Head Injury Criterion (HIC), resultant 3 ms chest acceleration, head excursion and knee excursion were calculated for each of the tests. These criteria were used for comparative purposes only. Due to the amount of data collected in these tests, all results cannot be presented in this report. Specific data plots (resultant head and chest accelerations, lap and shoulder belt loads, etc.) from each test can be found in the appendices, and complete data files can be found in the NHTSA's Biomechanics database. Figure 4 shows an example sled acceleration curve used for testing.

It is noted here that the 3 year old dummy was not tested in the counterclockwise oblique configuration("15° out of belt"), because of the results observed in the clockwise oblique tests. It is believed that the results from tests in a counterclockwise configuration would not show significant differences than were observed in the frontal and clockwise configurations. The second reason for only conducting the clockwise orientation with the 3 year old dummy was because only one of the belt fit devices (Child-Safer™) even mentions usage by children as small as 3 years old.

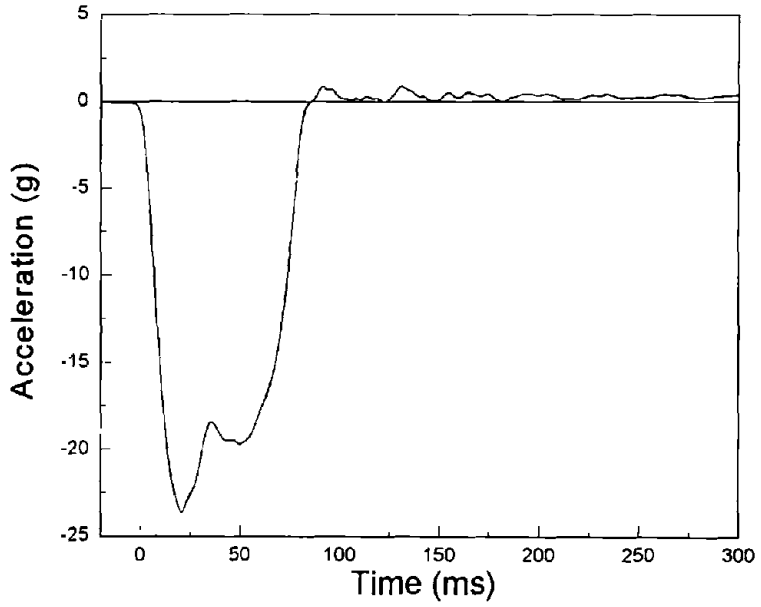


Figure 4 Sled Acceleration Curve for Test Number V296BL06ST

3.1 Head Injury Criterion (HIC), 3 ms Resultant Chest Acceleration

Injury criteria and head and knee excursions derived for the tests using the 3 and 6 year old dummies are contained in Table 2. Similar test results for the 5th and 50th percentile dummies are contained in Table 3.

HIC values less than 1000 were observed for all four dummies when tested in the baseline (no device) configuration, regardless of impact orientation. The HIC value for the 3 year old dummy in the baseline/clockwise orientation was marginal at 995.

HIC values for the 3 year old dummy tested with the Child-Safer™ device exceeded 1000 in both the frontal (1309) and clockwise (1565) orientations. When the Child-Safer™ was used with the 6 year old dummy, HIC values were below 1000 for all tests; however, the clockwise orientation result was marginal at a value of 947. In all of the tests conducted with the 5th percentile female dummy using the Child-Safer™, the HIC values exceeded 1000 (1356 - frontal, 1253 - clockwise, 1188 - counterclockwise).

Using the SafeFit™ device with the 3 year old dummy resulted in HIC values greater than 1000 (1095 - frontal, 1435 - clockwise). The HIC values were less than 1000 for all of the tests conducted on the 6 year old dummy with the SafeFit™. For the 5th percentile female dummy tested with the SafeFit™ device in the counterclockwise oriention, the HIC value was less than 1000. Tested at the other two buck orienations with the SafeFit™, the 5th percentile female's HIC values exceeded 1000 (1178 - frontal, 1069 - clockwise).

During tests with the Seatbelt Adjuster™ device, the HIC value for the 3 year old in the frontal orientation was 999. For the clockwise orientation test, the HIC value was 1238. For both the 6 year old and the 5th percentile female dummies, HIC values were less than 1000 during all tests with the Seatbelt Adjuster™.

Table 2 Injury Criteria and Excursions for 3 and 6 Year Old Dummies

	fit device	HIC	Chest Clip (g)	Head Excursion (mm)	Knee Excursion (mm)
3 year old Standard	BL*	874	48.7	477	553
	CS	**1309**	55.1	560	615
	SF	**1095**	56.5	496	618
	SA	999	48.1	551	583
3 year old 15° Offset Clockwise	BL	995	48.5	411	535
	CS	**1565**	52.3	564	665
	SF	**1435**	**62.1**	486	639
	SA	**1238**	45.4	452	580
6 year old Standard	BL	657	50.4	481	628
	CS	769	**65.2**	567	674
	SF	427	49.1	566	649
	SA	634	50.8	473	604
6 year old 15° Offset Clockwise	BL	595	54.3	435	602
	CS	947	**67.1**	540	661
	SF	621	57.7	461	580
	SA	794	55.1	493	640
6 year old 15° Offset Counterclockwise	BL	409	48.5	516	607
	CS	509	50.1	628	605
	SF	386	42.8	577	589
	SA	374	45.7	554	559

Numbers in bold exceed FMVSS No. 213 criteria which are: HIC shall not exceed 1000, 3 ms chest resultant acceleration shall not exceed 60 g's, head excursion shall not exceed 813 mm, and knee excursion shall not exceed 914 mm.

*BL - baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™

clockwise - occupant rides into shoulder portion of safety belt
counterclockwise - occupant rides out of shoulder portion of safety belt

Table 3 Injury Criteria for 5th Female and 50th Male Dummies

	fit device	HIC	Chest Clip (g)
5th Female Standard	BL*	713	54.2
	CS	**1356**	56.9
	SF	**1178**	43.7
	SA	862	48.8
5th Female 15° Offset Clockwise	BL	772	56.5
	CS	**1253**	57.5
	SF	**1069**	36.2
	SA	852	57.3
5th Female 15° Offset Counterclockwise	BL	771	48.4
	CS	**1188**	53.9
	SF	672	42.3
	SA	893	51.4
50th Male Standard	BL	837	43.7
50th Male 15° Offset Clockwise	BL	618	39.3

*BL - baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™

clockwise - occupant rides into shoulder portion of safety belt
counterclockwise - occupant rides out of shoulder portion of safety belt

The high HIC values observed with the 3 year old and 5th percentile female dummies will be discussed in greater detail in section **3.5 Dummy Kinematics.**

Regardless of impact orientation, the 3 ms resultant chest acceleration clips for the dummies tested in the baseline configuration were below 60 g's (ranging from 39.3 to 56.5 g's).

For the 3 year old dummy tested with the Child-Safer™ device, the chest clip values were less than 60 g's (55.1 - frontal, 52.3 - clockwise). Only the counterclockwise orientation resulted in the chest clip being less than 60 g's (50.1) for the 6 year old dummy when tested with the Child-Safer™. For the remaining tests with the 6 year old dummy, the clip values were 65.2 g in the frontal and 67.1 in the clockwise orientations. All tests conducted with the 5th percentile female dummy using the Child-Safer™ device resulted in chest clip values less than 60 g's (56.9 - frontal, 57.5 - clockwise, 53.9 - counterclockwise).

Using the SafeFit™ device, the chest clip results for the 3 year old dummy were divided based on impact orientation - the result for the frontal test was less than 60 g's (56.5); for the clockwise test, it was greater than 60 g's (62.1). For the 6 year old dummy using the SafeFit™ device, all chest clip values were less than 60 g's (49.1 - frontal, 57.7 - clockwise, 42.8 - counterclockwise). Similar chest clip results were observed for the 5th percentile female dummy (43.7 g - frontal, 36.2 - clockwise, 42.3 - counterclockwise).

Using the Seatbelt Adjuster™ device with the 3 year old dummy resulted in chest clip values less than 60 g's (48.1 - frontal, 45.4 - clockwise). Chest clip results were also less than 60 g's for the 6 year old dummy (50.8 - frontal, 55.1 - clockwise, 45.7 - counterclockwise). As with the child dummies, the chest clip values for the 5th percentile female/Seatbelt Adjuster™ were less than 60 g's (48.8 - frontal, 57.3 - clockwise, 51.4 - counterclockwise).

Time histories for the resultant head and chest accelerations are contained in Appendices A and B, respectively.

3.2 Head and Knee Excursion

The FMVSS No. 213 head excursion limit is 813 mm forward of point Z on the standard seat fixture and the knee excursion limit is 914 mm forward of point Z. The 3 year old and 6 year old dummies did not exceed either of these limits during any of the tests series. Head and knee excursions were not evaluated for the 5th percentile female and the 50th percentile male dummies because excursion criteria are not required for the adult dummies.

Of all of the dummy/device configurations, the least amounts of head excursion for the 3 and 6 year old dummies were observed when tested without a belt fit device, except for when the 6 year old was tested in the standard frontal configuration. Use of the Child-Safer™ device resulted in the largest amounts of head excursion for the 3 and 6 year old dummies. In 4 of 5 tests with the child dummies, the second highest amounts of head excursions were observed when the SafeFit™ was used. Comparing only tests using the belt fit devices, the least amounts of head excursion observed in 4 of 5 tests were with the Seatbelt Adjuster™. There were no distinct trends observed for the amounts of knee excursion for the two child dummies - no one specific belt fit device and/or test buck orientation produced the largest or smallest amount of excursion.

3.3 Lap/Shoulder Belt Forces

In addition to computing the FMVSS No. 213 injury and excursion criteria, other measurements and analyses were used to compare the different belt fit devices. Table 4 contains the peak lap and shoulder belt forces for the tests conducted with the 3 and 6 year old dummies. Corresponding responses for the tests conducted with the 5th percentile female and 50th percentile male dummies are contained in Table 5. Appendices C and D contain the shoulder belt and lap belt load time histories, respectively.

Table 4 Lap and Shoulder Belt Forces for 3 and 6 Year Old Dummies

	fit* device	Shoulder Belt Peak Force (N)	Lap Belt Peak Force (N)
6 Year Old Standard	BL	4683	2618
	CS	5466	3385
	SF	4683	2432
	SA	4387	2509
6 Year Old 15° Offset Clockwise	BL	4756	2202
	CS	3353**	2759
	SF	4545	2685
	SA	5052	2440
6 Year Old 15° Offset Counterclockwise	BL	4794	3563
	CS	4493	3966
	SF	4089	3689
	SA	3694	3589
3 Year Old Standard	BL	3746	1854
	CS	3767	1954
	SF	3548	1947
	SA	3438	1830
3 Year Old 15° Offset Clockwise	BL	3391	1660
	CS	3865	1919
	SF	3697	1932
	SA	3540	1341

*BL - baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™

** Load cell misplaced on shoulder belt

clockwise - occupant rides into shoulder portion of safety belt
counterclockwise - occupant rides out of shoulder portion of safety belt

Table 5 Lap and Shoulder Belt Forces for 5th and 50th Percentile Dummies

	fit* device	Shoulder Belt Peak Force (N)	Lap Belt Peak Force (N)
5th Female Standard	BL	7736	6932
	CS	8092	6440
	SF	7514	5432
	SA	7303	6103
5th Female 15° Offset Clockwise	BL	7261	7035
	CS	7852	7270
	SF	7052	5276
	SA	7931	9187
5th Female 15° Offset Counterclockwise	BL	7266	5732
	CS	7501	5984
	SF	7043	4311
	SA	6757	5201
50th Male Standard	BL	8178	8172
50th Male 15° Offset Clockwise	BL	7724	6623

*BL - baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™

clockwise - occupant rides into shoulder portion of safety belt
counterclockwise - occupant rides out of shoulder portion of safety belt

Generally lap/shoulder belt forces depended on dummy size; the larger the dummy, the higher the safety belt forces. The highest safety belt forces were for the 50th male dummy in the standard frontal condition. The forces were 8178 N for the shoulder belt and 8172 N for the lap belt. One exception to this was the lap belt force for the 5th female dummy using the Seatbelt

Adjuster™ device tested in the clockwise oblique test; peak force was 9187 N. On review of the high speed films, it appears that the dummy did not submarine until relatively late in the event (at approximately 60 ms), which allowed for the belt to reach its peak loading on the hard pelvic structure prior to going over the iliac crests into the abdomen. Generally, the 5th female dummy began to submarine under the lap belt at approximately 40 ms into the event, which resulted in peak lap belt loads occurring when the belt was is the softer abdominal area. The shoulder belt forces for the 5th female dummy ranged from 6757 N to 8092 N, while the lap belt forces ranged from 4311 N to 9187 N.

Peak shoulder belt forces ranged from 3694 N to 5466 N and lap belt forces ranged from 2202 N to 3966 N for tests with the 6 year old dummy. For tests with the 3 year old dummy, shoulder belt forces ranged from 3391 N to 3865 N and lap belt forces ranged from 1341 N to 1954 N. No apparent trends of the baseline configuration or use of any particular belt fit device having a discernible effect on shoulder or lap belt loads were observed.

The test with the 6 year old, clockwise 15° offset into the belt (V296CS06OB), using the Child-Safer™ had an unusually low shoulder belt force of 3353 N. The eleven other tests using the 6 year old had shoulder belt forces of 3694 N or higher. Review of the high speed films showed that the shoulder belt load cell was misplaced for the test with the 6 year old in the clockwise 15° offset with the Child-Safer™. Instead of placing the load cell between the D-ring and shoulder of the dummy, it was positioned next to the retractor. This likely influenced the results.

3.4 Neck Loads for 5th Percentile Female Dummy

The only dummy instrumented with a neck load cell and tested with and without the belt fit devices was the 5th percentile female dummy. The load cell was installed at the dummy's upper neck and measured forces along the x- and z-axes, and the moment about the y-axis. Table 6 contains a summary of the neck loads and moments for the 5th percentile female dummy, with the

time histories contained in Appendix E. Load and moment values summarized in the table were analyzed for comparative purposes only - no attempt was made to determine potential injury levels based on the values.

Use of a belt fit device generally resulted in increased load and moment values, compared to the baseline tests, when the female dummy was tested in both the standard frontal and 15° clockwise offset ("into belt") configurations. The presence of the belt fit devices appeared to have minimal effect on load and moment responses when the dummy was tested in the 15° counterclockwise offset ("out of belt") configuration. This is primarily due to the fact that the direction of the impact forces exerted on the dummy caused a reduction in the dummy's interaction with the shoulder belt, which in turn tended to reduce the apparent effect(s) that a belt fit device might have on the dummy responses when compared to the results from the other two impact orientations.

It is of interest to note that use of the Child-Safer™ device resulted in increased neck load and moment values for all impact orientations. The sole exception to this trend was the neck x-axis load when tested in the 15° counterclockwise orientation (virtually identical to the baseline result). The amounts of increased neck loading ranged from 12% to 51.5%, while the neck extension responses ("-" values) increased between 40% and 83% when using this device as compared to the baseline configuration. Use of the SafeFit™ device resulted in mixed responses - in some configurations it either lowered the neck load results, or was virtually identical, while in other configurations the neck loads increased between 3% and 41.5%, when compared to baseline tests. For the neck extension responses, the SafeFit™ produced either a slight reduction, no influence or increased results by 45.5%, depending on impact orientation. Similar effects were observed when the Seatbelt Adjuster™ was used - some neck loads were reduced slightly as compared to baseline tests, while neck loads increased between 12.5% and 32.5% in other test configurations. There was an 14.3% decline in neck extension response for the 15° counterclockwise ("out of belt") test, while the moment response increased between 15% and 21% for the other two impact orientations.

Table 6 Neck Loads and Moments for 5th Percentile Female Dummy

	fit device*	Neck x-axis Load (N)	Neck z-axis Load (N)#	Neck y-axis Moment (Nm)@
Standard	BL	1556	2463	-34.7 / +35.9
	CS	1745	3697	-63.5 / +32.6
	SF	1608	2995	-50.5 / +29.7
	SA	1460	2771	-42 / +21.9
15° Offset Clockwise	BL	1416	2987	-39 / +41.3
	CS	2143	3830	-54.8 / +18.3
	SF	2002	2724	-38.1 / +17.7
	SA	1877	3523	-45 / +29.5
15° Offset Counterclockwise	BL	1143	2780	-35 / +30.3
	CS	1145	4124	-56.9 / +37.4
	SF	1158	2661	-32 / +33
	SA	1101	3146	-30 / +27.5

*BL - baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™
#Neck z-axis load is tension
@ Negative value is extension; positive value is flexion

clockwise - occupant rides into shoulder portion of safety belt
counterclockwise - occupant rides out of shoulder portion of safety belt

3.5 Dummy Kinematics

The 50th male dummy submarined in both of the tests. The thick, soft cushion of the FMVSS No. 213 seat allowed the dummy to compress the foam, creating significant slack in the safety belt. This allowed the dummy to slide underneath the lap portion of the safety belt (submarine). In its final position, the lap belt was sandwiched between the stomach insert and the ribs. This caused the chest potentiometer rod to "pop" from the carrier in the clockwise oblique test.

As stated previously, the 5th female dummy also submarined during its 12 tests. The combination of seat cushion stiffness and dummy size was the primary factor influencing the 5th female dummy to submarine, as it was for the 50th male dummy. Table 7 contains a summary of the iliac loads and moments for the 5th percentile female. The final position of the lap belt on the small female was also between the rib cage and the abdomen. This resulted in the chest displacement potentiometer to "pop" from its carrier in 3 of the 12 tests (baseline and Seatbelt Adjuster™ in the standard frontal orientation and the baseline in the counterclockwise oblique orientation). It is noted that all of the chest potentiometer readings for the 2 adult dummies were below the Hybrid III injury criterion of 76.2 mm which is currently used in FMVSS No. 208, "Occupant Crash Protection". Table 8 contains a summary of the peak chest displacements for the 50th male and 5th female dummy tests.

Submarining was not a problem with the 3 year old or 6 year old dummies. However, during the test with the 3 year old dummy in the standard frontal condition using the Seatbelt Adjuster™, the shoulder belt slipped off the shoulder. In this test, the Seatbelt Adjuster™ device did not break loose, as in the other tests. This caused the belt to remain further away from the neck than if there had been no belt fit device, and allowed the dummy to slip around the shoulder belt.

Table 7 Abdominal Loads and Moments for 5th Percentile Female Dummy

	fit device*	Rt. Iliac x-axis Load (N)	Rt. Iliac y-axis Moment@ (N · m)	Left Iliac x-axis Load (N)	Left Iliac y-axis Moment@ (N · m)
Standard	BL	3724	-24.1	4958	+27.9
	CS	3577	-24.6	4603	+74.3
	SF	3418	+73.3	962	+14.4
	SA	5133	+84.2	2697	+42.2
15° Offset Clockwise	BL	3715	-20.4	5169	+54.3
	CS	3974	-19.4	5388	+64.5
	SF	2864	+50.5	2393	+39.2
	SA	4290	+20.9	5008	+61.7
15° Offset Counterclockwise	BL	4917	+33.8	3369	+56.9
	CS	5037	+50.5	2895	+51.4
	SF	4026	+49.3	2631	+48.6
	SA	5071	+67.3	1346	+22.7

*BL - Baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™

@ Negative moment is forward motion of anterior supior iliac spine; postive moment is rearward motion

clockwise - occupant rides into shoulder portion of safety belt
counterclockwise - occupant rides out of shoulder portion of safety belt

Table 8 Peak Chest Displacement for 5th and 50th Percentile Dummies

	fit* device	Peak Chest Displacement (mm)
5th Female Standard	BL	NA**
	CS	52.0
	SF	59.0
	SA	NA**
5th Female 15° Offset Clockwise	BL	34.2
	CS	52.0
	SF	52.7
	SA	41.1
5th Female 15° Offset Counterclockwise	BL	NA**
	CS	57.4
	SF	60.3
	SA	61.2
50th Male Standard	BL	25.2
50th Male 15° Offset Clockwise	BL	NA**

*BL - baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™

** Potentiometer "popped" from carrier during test.

clockwise - occupant rides into shoulder portion of safety belt
counterclockwise - occupant rides out of shoulder portion of safety belt

The 3 year old dummy had a tendency to strike his forearms with his forehead. This sometimes caused a higher HIC than normal. As the tests began, the head and thorax rotated forward about the hip. The arms extended and rotated upward. At approximately 85 to 95 ms the forehead and the forearms contacted. In some tests the forehead would hit one forearm and

then bounce to the other forearm. This bouncing of the head between the forearms can be recognized on the data plot for acceleration of the head in the y direction. The data plot for the 3 year old using the Child-Safer™ device in the standard frontal condition (V296CS03ST) can be seen in Figure 5. Review of high speed films reveals that the head strikes the right arm at about 93 ms and then strikes the left arm at about 95 ms.

In all of the tests with the 3 year old, the dummy's head hit his forearms. However, evidence of the dummy hitting the forearm, such as spikes in the data plots, is not present in all of the tests. This suggests that in some tests the forehead hit the forearm more severely than in other tests. The tests in which there was a definite spike in the data plots caused by the forehead striking the forearm were the baseline test and the tests using the Child-Safer™ and the Seatbelt Adjuster™ devices in the standard frontal condition. The tests using the Child-Safer™ and the SafeFit™ devices in the clockwise 15° offset also had spikes in the data plots when the forehead hit the forearm.

An analysis was made to determine an estimate of the influence on HIC values when the forehead strikes the forearm. Table 9 shows the approximate time that the 3 year old hit its forehead on its forearm, and the time intervals for which the HIC values were calculated. The forehead hit the forearms late in the calculation of the HIC value, and for two of the tests, it actually occurred after the HIC had been calculated.

In test number V296CS03ST (3 year old, using the Child-Safer™ in the frontal condition) the forehead of the dummy hit his right forearm at approximately 93 ms. As shown in Figure 5 there was a spike in the head y-acceleration when the dummy's head contacted the arm. Spikes can also be seen in the resultant head acceleration at the time of contact (Figure 6). Figure 7 shows the resultant head acceleration for the same test, but with a few of the spikes removed. This was done to estimate the possible influence on HIC when the forehead contacts the forearm. The HIC value for the revised curve in Figure 7 is 1236 calculated from 62.75 ms to 93.25 ms. Even though the head contacts the arm in the last 2 ms of the HIC calculation, by taking out the

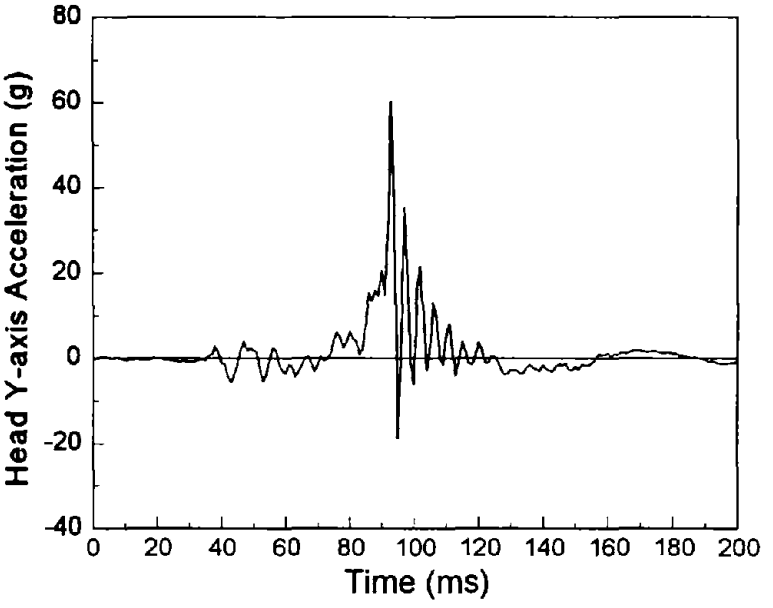


Figure 5 Head Y-axis Acceleration, Test No. V296CS03ST

Table 9 Time of Head-to-Arm Contact Compared to HIC Computation Times

	fit device*	Time (ms) when forehead contacts forearm	Time interval (ms) for HIC calculation
3 Year Old Standard	BL[1]	87	52.5 to 88.5
	CS[1]	93	62.75 to 94.25
	SF	85	54.0 to 90.0
	SA[1]	98	58.5 to 93.375
3 Year Old 15° Offset Clockwise	BL	88	51.25 to 87.25
	CS[1]	90	64.875 to 94.375
	SF[1]	85	55.5 to 91.5
	SA	85	52.375 to 87.875

*BL - baseline, no device CS - Child-Safer™ SF - SafeFit™ SA - Seatbelt Adjuster™

[1] These tests had spikes in the data plots when forehead contacts forearm

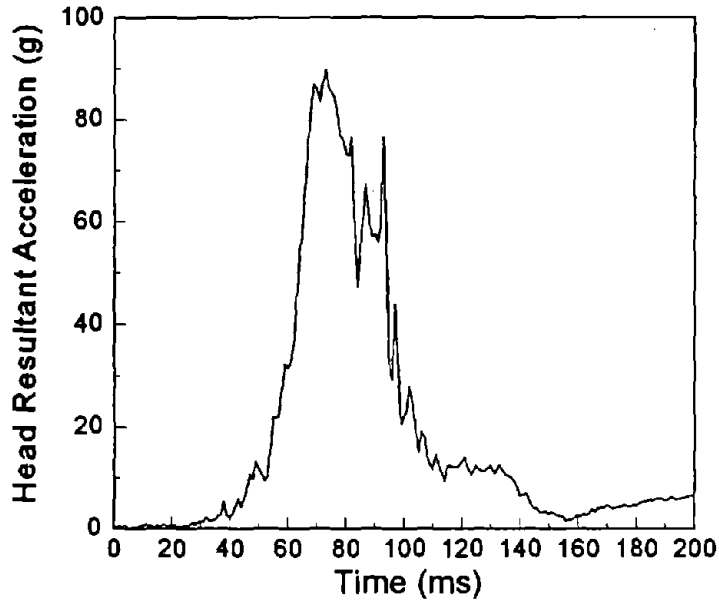


Figure 6 **Head Resultant Acceleration for Test No. V296CS03ST**

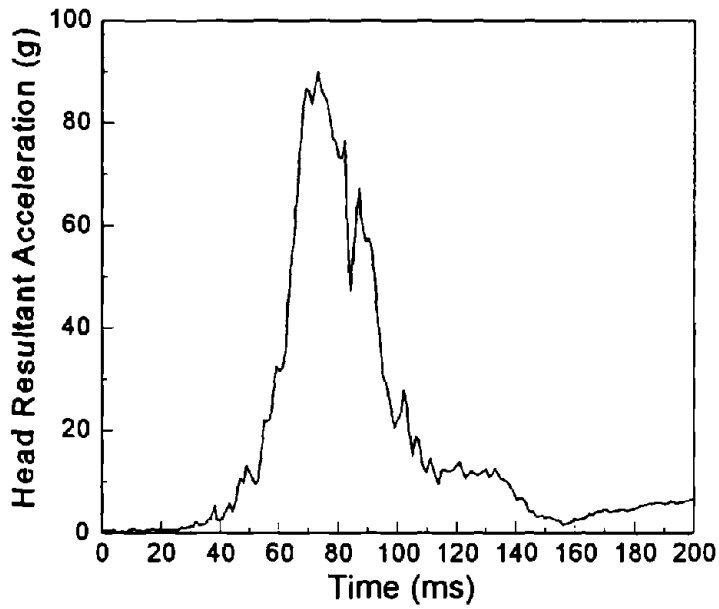


Figure 7 **Revised Head Acceleration for Test No. V296CS03ST**

spike in the resultant acceleration, HIC was reduced from 1309 to 1236, or 5.9%. Applying the same principal of removing some of the spikes which occurred when the head contacted the arm during the last 2 to 6 ms of the HIC calculation to the remaining tests, and using an average 6% reduction in HIC value, the results would still remain above the criterion value of 1000. The high HIC values observed for the 5th percentile female dummy were not due to head to arm contact, as with the 3 year old dummy, nor any other head contacts. Thus, the high values for the small female dummy appear to be valid, non-contact HIC responses.

3.6 Belt Fit Device Used With Belt Positioning Booster Seat

The manufacturer of the Child-Safer™ device states in their literature that the device may be used in conjunction with a booster seat to help position the shoulder belt. It was of interest to see what effect, if any, the belt fit device had on the dummy responses compared to using a belt positioning booster seat alone. The Century CR-3 booster seat was used with the 3 year old dummy. The set-up (belt anchorage locations, etc.) was identical to that for the test with the CR-3 seat during the research conducted to evaluate the effectiveness of belt positioning booster seats[3], with the exception of the addition of the Child-Safer™. The test is also directly comparable to the tests conducted during this evaluation of belt fit devices, with the exception of the addition of the booster seat.

Table 10 contains a summary of the HIC values, 3 ms resultant chest accelerations and head and knee excursion values for the belt positioning booster tests with and without the Child-Safer™ device. Note that the HIC and 3 ms chest acceleration values for the test with the belt fit device exceeded the criterion of 1000 and 60 g's, respectively. The amounts of head excursion for the two tests were within 10 mm of one another and well below the FMVSS No. 213 criterion of 813 mm. Knee excursion for the test with the belt fit device was not numerically determined due to the inability to accurately locate the knee pivot during digitization of the film. It appears, from film coverage, that the amount would be similar to the test without the belt fit device and that both tests would be well below the criterion value of 914 mm.

Table 10 Comparison of 3 Year Old Dummy Responses for Belt Positioning Booster Seat With and Without Belt Fit Device

	HIC	Chest Clip (g)	Head Excursion (mm)	Knee Excursion (mm)
Century CR-3 without Child-Safer™	906	48.8	511	643
Century CR-3 with Child-Safer™	**1575**	**61.6**	582	NA

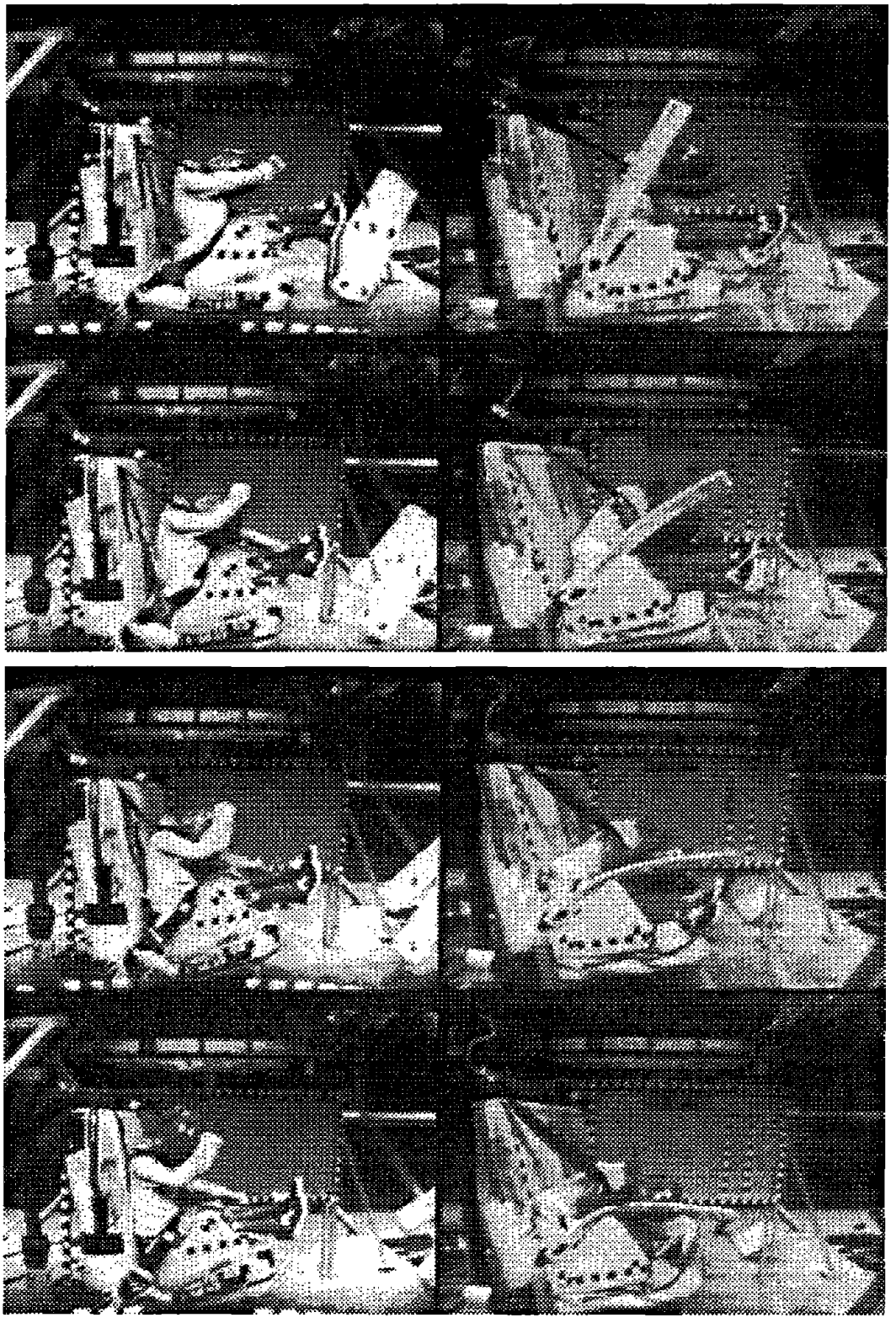
Numbers in bold exceed FMVSS No. 213 criteria which are: HIC shall not exceed 1000, 3 ms chest resultant acceleration shall not exceed 60 g's, head excursion shall not exceed 813 mm, and knee excursion shall not exceed 914 mm.

Not only did two of the injury criteria show detrimental effects when using the Child-Safer™ device in combination with the Century CR-3 booster seat, the dummies kinematically performed differently in the two tests. Figures 8 and 9 are timed sequences, from the side view and from the front view, respectively, of the two tests showing the kinematics of the 3 year old dummy. The test without the belt fit device is on the left while the test with the belt fit device is on the right. Each frame is a 20 ms increment, with the first frame being t=0 ms and the last frame sequence being t=140 ms.

The most noticeable difference between the two tests was that the 3 year old dummy was still experiencing forward and rotational motion, when tested with the Child-Safer™, at the corresponding time that the dummy tested without the belt fit device was in its rebound motion. This appears to be primarily due to the extra webbing (approximately 51 mm) that is required to weave through the belt fit device, which allowed for more forward and rotational motion of the dummy than in the "baseline" condition. In fact, with the belt fit device attached, there was

Figure 8 - Effect of Using Belt Fit Device with Belt Positioning Booster Seat - Side View

Booster Only **Booster With Child-Safer™**



t=80 ms

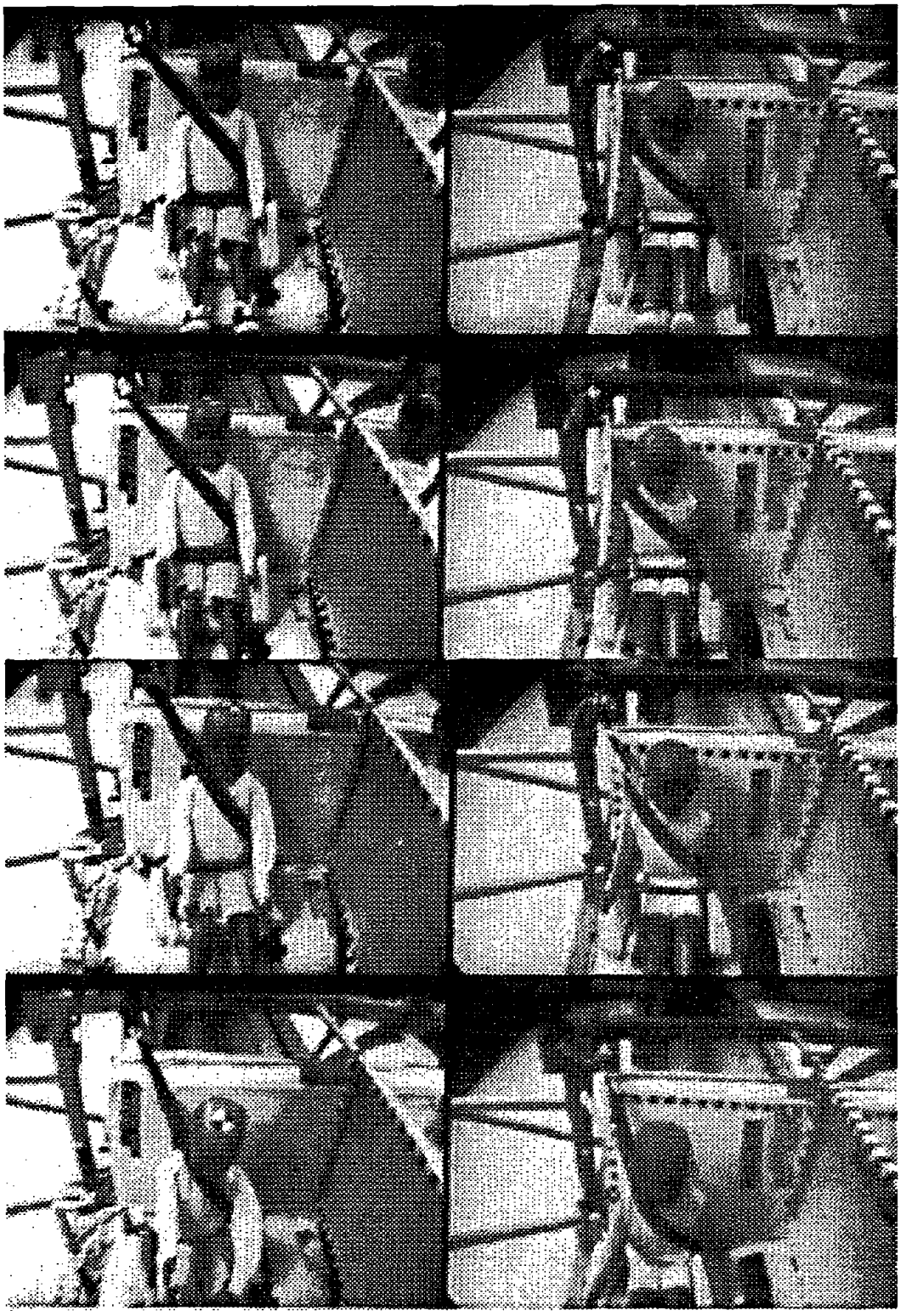
t=100 ms

t=120 ms

t=140 ms

Figure 8 (Continued) - Effect of Using Belt Fit Device with Belt Positioning Booster Seat - Side View

Booster Only **Booster With Child-Safer™**



t=0 ms

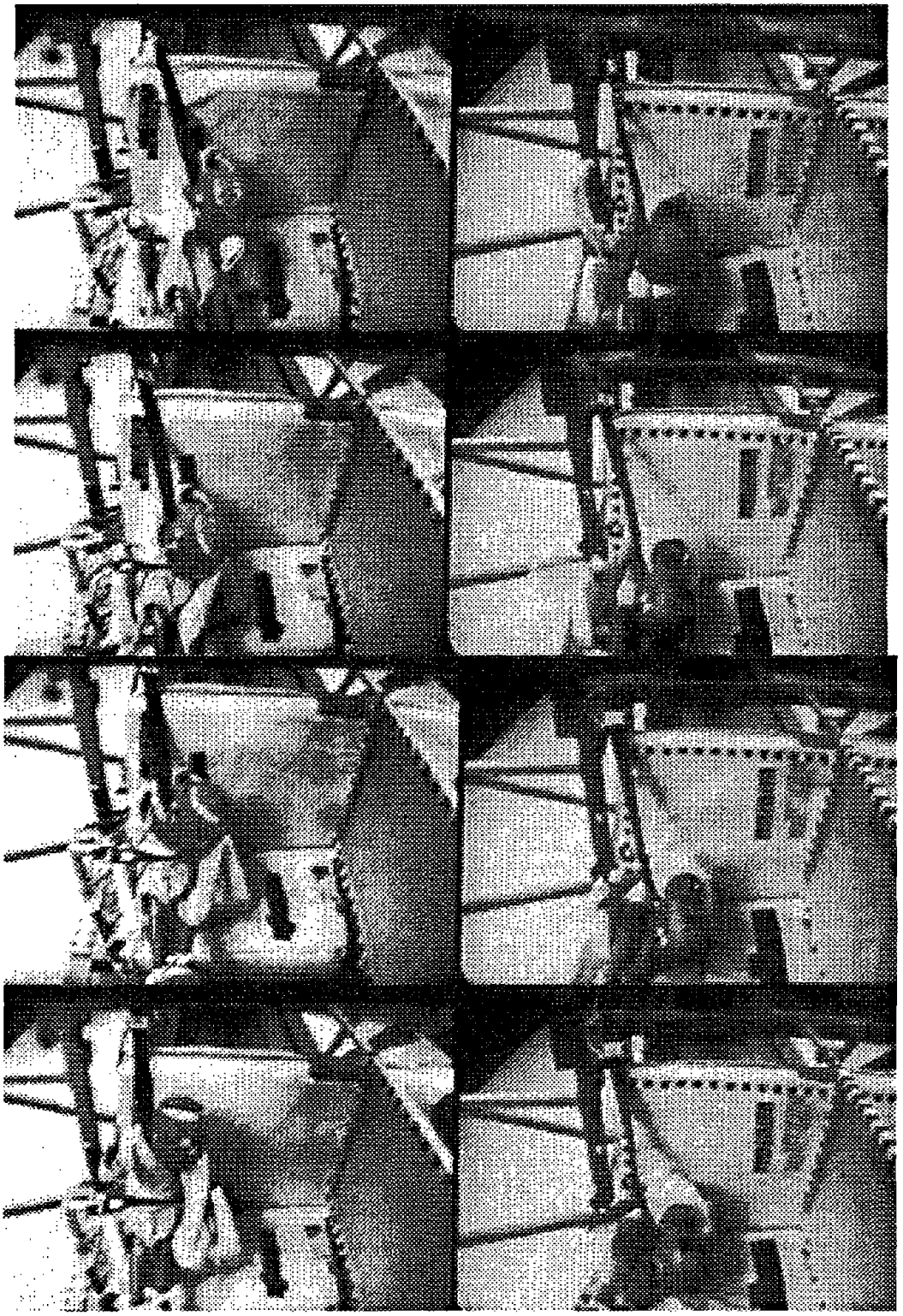
t=20 ms

t=40 ms

t=60 ms

Figure 9 - Effect of Using Belt Fit Device with Belt Positioning Booster Seat - Front View

Booster Only **Booster With Child-Safer™**



t=80 ms

t=100 ms

t=120 ms

t=140 ms

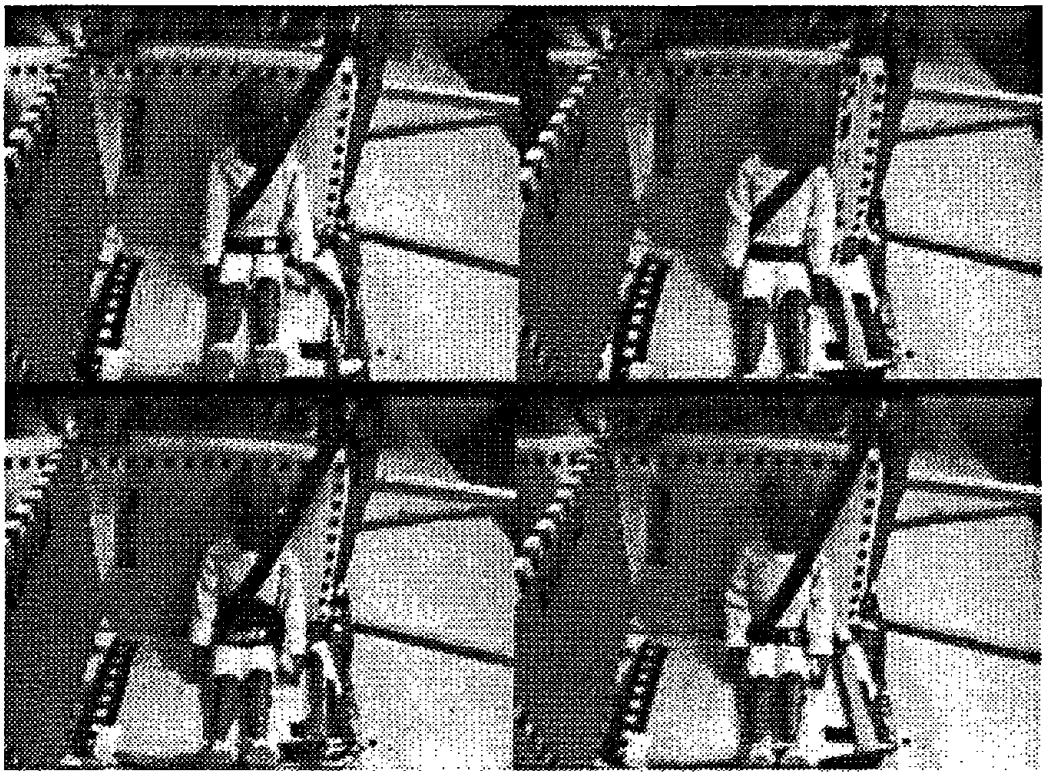
Figure 9 (Continued) - Effect of Using Belt Fit Device with Belt Positioning Booster Seat - Front view

sufficient extra webbing that the dummy's head almost contacted its lower extremities. This type of dummy motion was observed when belt positioning booster seats were tested with lap only belts to evaluate what would occur if the boosters were not properly used with a lap/shoulder belt restraint[3].

3.7 Belt Fit Device Performance

In addition to using the dummies' response data to evaluate the performance of the three types of belt fit devices, the high speed films were analyzed to compare the dummies' kinematics. For this analysis, the baseline test and tests with each of the devices were compared at 40 ms intervals, from t=0 to t=120 ms, for each dummy size/test buck orientation. The timed sequence for the 3 year old in the standard frontal test condition is shown in Figure 10. At each time interval, the baseline and the Child-Safer™ photos are on the top row, left and right side, respectively, while the SafeFit™ and Seatbelt Adjuster™ are on the bottom row, left and right side, respectively. A brief summary of each comparison will be given here in the body of the report. However, due to quantity, the remaining kinematic comparison sequences for the 3 year old, 6 year old and 5th percentile female dummies are contained in Appendix G.

Using Figure 10 to compare the 3 year old in the standard frontal orientation, one observes that the dummy began its rebound motion earlier for the baseline test condition than when tested with the belt fit devices, except for the SafeFit™. Also, the Child-Safer™ and the Seatbelt Adjuster™ devices allowed for more forward rotation and "roll-out" of the shoulder belt. These two motions appear to be primarily attributed to (1) the slack in the shoulder belt introduced with the Child-Safer™ routing and (2) the initial positioning of the shoulder belt with the Seatbelt Adjuster™ (very little belt support on the inboard side of the lower torso, as observed in the other tests).



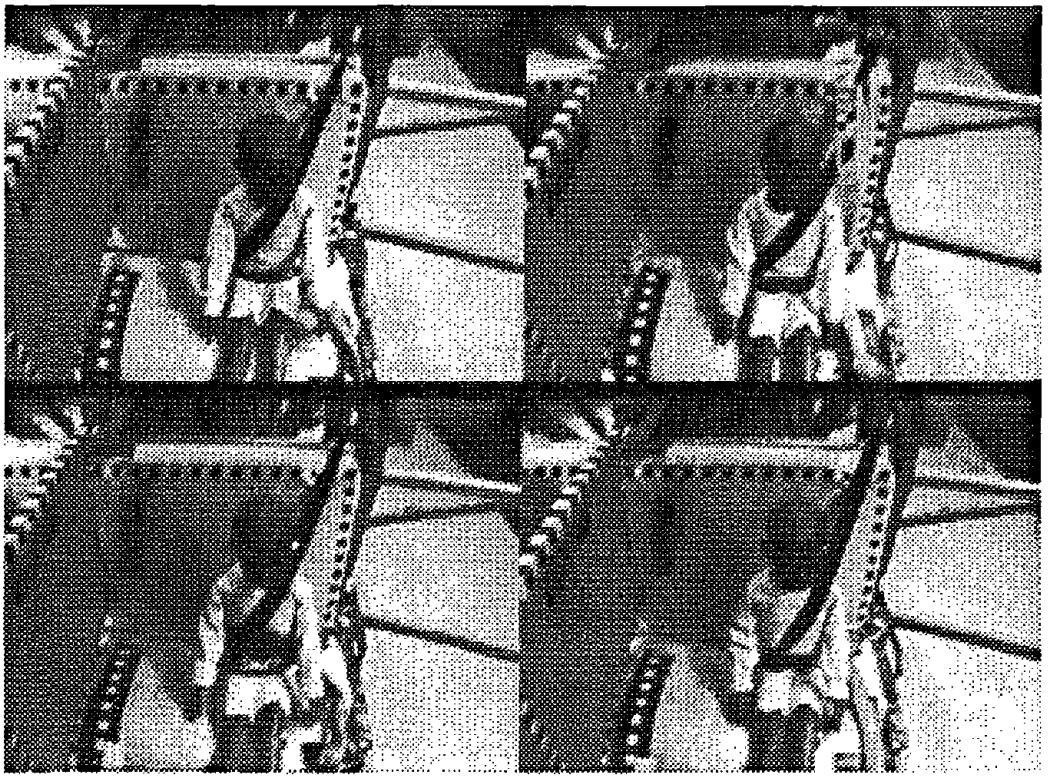


Figure 10 - Kinematic Comparison of 3 Year Old in Standard Frontal Orientation -- Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

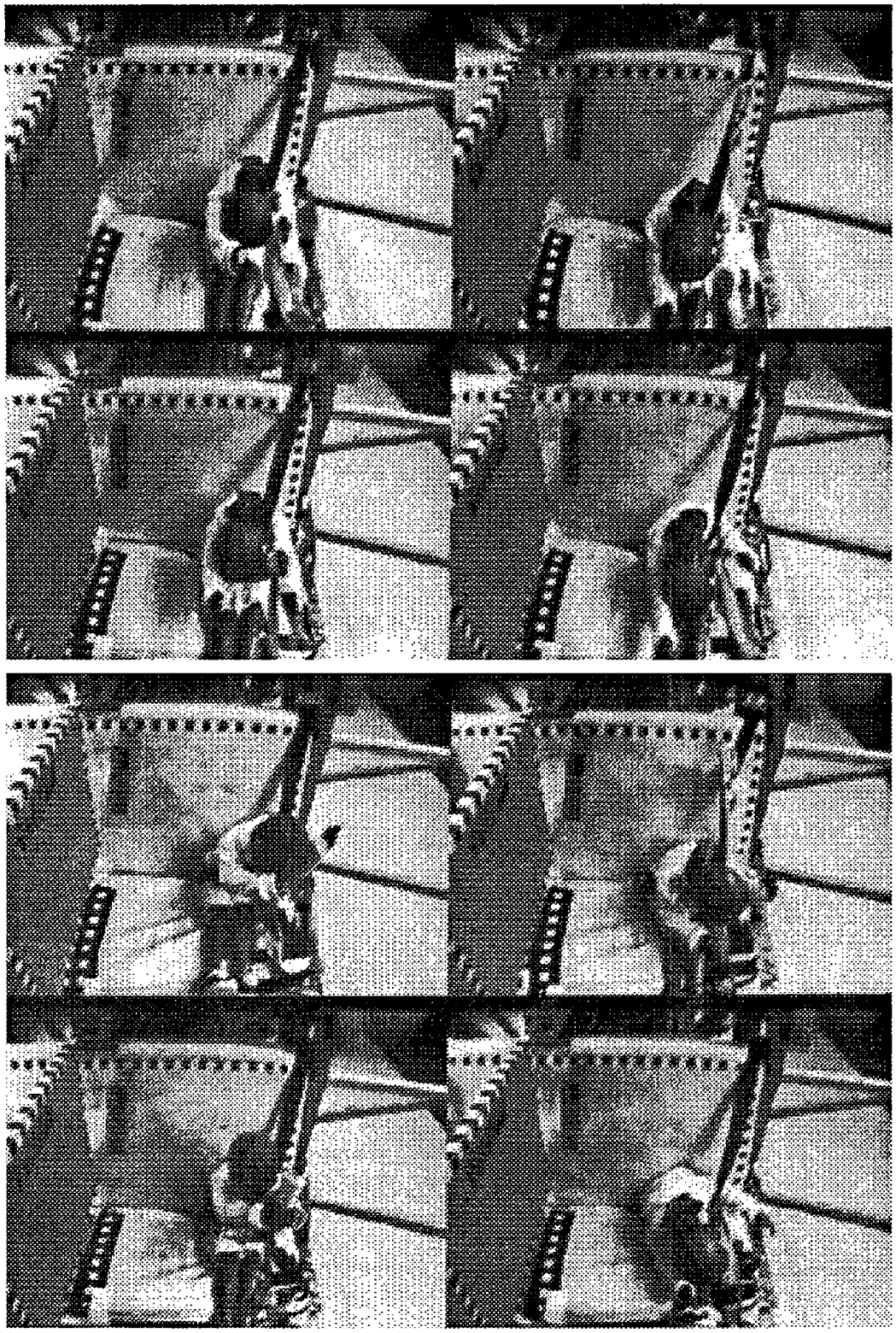


Figure 10 (Continued) - Kinematic Comparison of 3 Year Old in Standard Frontal Orientation -- Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

For the 3 year old in the clockwise oblique orientation (pages G-1 & G-2), the baseline and belt fit devices exhibited similar kinematics throughout the 120 ms. One variation was that the dummy exhibited slightly more forward rotation with the Child-Safer™, which in turn caused its rebound to be slightly later than for the other three test conditions.

For the standard frontal orientation, the 6 year old dummy exhibited similar kinematics for the baseline and belt fit devices up through 40 ms (pages G-3 & G-4). At 80 ms, the dummy's forward rotation in the tests with the Child-Safer™ and the SafeFit™ devices was more pronounced than for the other tests, which led to less rebounding action observed at the 120 ms time frame. The 6 year old also tended to "roll-out" of the SafeFit™ device more than under the other three conditions.

During the tests with the 6 year old dummy and the buck oriented 15° clockwise ("into belt"), the kinematic responses for the dummy were quite similar for the baseline and belt fit devices (pages G-5 & G-6). With the 6 year old in the counterclockwise orientation (pages G-7 & G-8), the belt fit devices resulted in more dummy "roll-out" of the shoulder belt than was observed in the baseline test. This phenomenon resulted in significant rotation of the head about the z-axis, which again, was not observed in the baseline condition.

For the 5th percentile female dummy in the standard frontal orientation (pages G-9 & G-10), the kinematics were quite similar for the baseline and the three belt fit devices up through 80 msec. At the 120 ms time frame, the test with the SafeFit™ device exhibited a different rebound motion than for the baseline and other two devices. The SafeFit™ device kept the lap belt from pulling over the abdominal region in as pronounced a manner as the belt did in the baseline and with the other two devices. This difference allowed the torso to rebound faster, which in turn caused complete submarining of the small female dummy to occur later in the event.

For both the clockwise oblique (pages G-11 & G-12) and the counterclockwise oblique (G-13 & G-14) tests with the 5th percentile female, the kinematics for each orientation were quite

similar for the baseline and the three belt fit devices up through 80 ms. In fact, the kinematics observed for the four test conditions in the counterclockwise orientation were similar through the 120 ms time frame. The main difference at the 120 ms time frame for the clockwise orientation was that the SafeFit™ device appeared to affect the rebound characteristics - the dummy rebounded sooner than it did in the baseline test and the tests with the other two devices. It appeared that the device again kept the lap belt from riding up over the abdominal region completely until later in the event, as it did in the standard frontal orientation.

In reviewing the performance of each individual type of belt fit device, the following observations were made:

- In six of the eight tests using the Child-Safer™, it performed as designed. The shoulder belt slipped out of the top portion of the slots, which allowed the device to fall away from the dummy. This also introduced slack in the shoulder belt. In tests with the 3 year old and the 5th percentile female dummies in the standard frontal condition the Child-Safer™ did not fully disengage from the shoulder belt. However, review of the high speed films showed that the dummies did not make contact with the device. No problems were observed as a result of the device not disengaging.

- Review of the high speed films showed that in all eight tests the SafeFit™ device remained in place and did not rip or tear. Because the device did not rip, no slack was introduced into the shoulder belt.

- In seven of the eight tests using the Seatbelt Adjuster™ device, it performed as expected. Upon loading of the safety belt, the device split apart, which introduced slack into the shoulder belt. There was one test where the device did not break apart, the test with the 3 year old in the standard frontal condition. This contributed to the shoulder belt slipping off the shoulder of the dummy.

4.0 CONCLUSIONS

Based on the research and results of 35 HYGE sled tests to evaluate the performance of safety belt comfort devices the following conclusions are made:

- Use of the Child-Safer™ device resulted in a general increase in dynamic responses, regardless of occupant size.

  - HIC values greater than 1000 were observed in 63% of the tests conducted with the Child-Safer™, while the 3 ms chest acceleration clip exceeded 60 g's in 25% of the tests. Head and knee excursion amounts during tests conducted with the child dummies were below the FMVSS No. 213 specified values of 813 and 914 mm, respectively. Tests conducted with the Child-Safer™ did result in average increases in head excursion (27.3%) and knee excursion (17.8%) as compared to the baseline configuration for the 3 year old dummy, regardless of impact orientation. Use of the Child-Safer™ with the 6 year old dummy resulted in an average increase of 21.2% in the amount of head excursion and an average increase of 5.6% in the amount of knee excursion, as compared to baseline tests.

  - In the three tests conducted with the 5th percentile female dummy using the Child-Safer™ device, the device resulted in increased (0% to 51.5% higher) x- and z-axis upper neck loads. Use of the device also resulted in increased moments about the y-axis (40.5% to 83% higher) as compared to the baseline condition. Impact orientation did not appear to be a factor in this phenomenon.

  - In six of the eight tests using the Child-Safer™ device, it performed as designed. The shoulder belt slipped out of the top portion of the slots,

allowing the device to fall away from the dummy. This also introduced slack in the shoulder belt. In tests with the 3 year old and the 5th percentile female dummies in the standard frontal condition the Child-Safer™ did not fully disengage from the shoulder belt. No problems were observed as a result of the device not disengaging.

- The manufacturer of the Child-Safer™ states in the literature that the device can be used in conjunction with a booster seat to aid in improving shoulder belt fit. The HIC value was 1575 and the 3 ms resultant chest acceleration was 61.6 g's for the 3 year old dummy tested in the booster/belt fit device configuration, while the booster seat only test resulted in a HIC value of 906 and chest acceleration of 48.8 g's. In addition to the booster/belt fit device exceeding FMVSS No. 213 injury criteria, it resulted in severely different dummy kinematics. Due to the introduction of excess shoulder belt webbing (approximately 51 mm used to route the belt through the device) during the impact, the dummy's torso significantly rotated around the lap belt and almost contacted its lower extremities. The amount of head and knee excursion did not appear to be affected by the use of the belt fit device. Although the manufacturer states that the device can be used by people between 96.5 and 152.4 cm tall (the 3 year old stands 97.5 cm), it is believed that a child at the lower height range is sufficiently small enough to still be using a toddler or booster seat. As for using the device with a booster seat, if the child cannot properly wear the shoulder belt without the device the child should still be using a toddler seat or, if using a small shield booster seat, the shoulder belt should be routed behind the child's torso.

- Increases in dynamic responses were observed in approximately half of the tests conducted with the SafeFit™ device.

  - HIC values greater than 1000 were observed in 50% of the tests conducted with the SafeFit™, while the 3 ms chest acceleration clip exceeded 60 g's in 12.5% of the tests. As with the Child-Safer™ device, all head and knee excursion values were below the FMVSS No. 213 criteria. Use of the device with the 3 year old dummy resulted in average increases of 11.1% and 15.6% in head and knee excursions values, respectively, in comparison to baseline tests. When the SafeFit™ was used with the 6 year old dummy, an average increase of 11.8% in the amount of head excursion and an average decrease of 1.1% in the amount of knee excursion were observed.

  - In the tests conducted with the 5th percentile female dummy using the SafeFit™ device, the device resulted in a 41.5% increase in the x-axis neck load and a 22% increase in the z-axis upper neck load when tested in the 15° clockwise offset ("into belt") and the standard frontal configurations, respectively. All other combinations of neck load/impact configurations resulted in either a slight reduction, or no change, in neck loads as compared to the baseline tests. Use of the device also resulted in an increased moment about the y-axis (45.5% higher) when tested in the standard frontal configuration. For both offset tests, use of the SafeFit™ had little effect on the neck moment results in comparison to the baseline tests.

  - In all eight tests using the SafeFit™, the device remained in place and did not rip or tear. Therefore, no slack was introduced into the shoulder belt.

- Minimal increases in dynamic responses for the three sizes of dummies when tested with the Seatbelt Adjuster™ were observed.

  - HIC values greater than 1000 were observed in 12.5% of the tests conducted with the Seatbelt Adjuster™, while 3 ms chest acceleration clip values did not exceed 60 g's in any of the tests. Use of the device resulted in average increases of 12.8% and 6.9% of head and knee excursion amounts, respectively, for the 3 year old dummy. With the 6 year old dummy, use of the device resulted in an average increase of 6.3% in the amount of head excursion and an average decrease of 1.8% in the amount of knee excursion as compared to baseline tests.

  - In all three tests conducted with the 5th percentile female dummy using the Seatbelt Adjuster™ device, the device resulted in slight increases (12.5% to 18%) in the z-axis neck loads. The x-axis neck load increased by 32.5% when tested in the 15° clockwise offset ("into belt") configuration. Use of the device also resulted in increased moments about the y-axis (15% to 21% higher) when tested in the 15° clockwise offset and standard frontal configurations, respectively, but resulted in a decreased moment (14.3%) when tested in the 15° counterclockwise configuration.

  - In seven of the eight tests using the Seatbelt Adjuster™ it split apart, which introduced slack into the shoulder belt. There was one test where the device did not break apart, the test with the 3 year old in the standard frontal condition. This contributed to the shoulder belt slipping off the shoulder of the dummy.

- Review of the kinematic responses for the 3 and 6 year old and 5th percentile female dummies, from time t=0 to t=120 ms, reveals the following:

- Use of all three belt fit devices tended to increase the amount of forward rotation for both the 3 and 6 year old dummies as compared to the baseline tests, regardless of impact orientation.

- The Child-Safer™ and the Seatbelt Adjuster™ devices allowed for more "roll-out" of the shoulder belt when tested with the 3 year old dummy. This motion appears to be primarily attributed to (1) the slack in the shoulder belt introduced by the belt routing required for the Child-Safer™, and (2) the initial positioning of the shoulder belt with the Seatbelt Adjuster™ (very little belt support on the inboard side of the torso, as observed in the other tests). During the standard frontal test with the Seatbelt Adjuster™, the shoulder belt slipped off of the 3 year old dummy's shoulder. This was due to the flange not breaking away from the clip as it is designed to do, which allows the shoulder belt to reposition itself during loading.

- The SafeFit™ device tended to cause the 6 year old dummy to "roll-out" of the shoulder belt to a greater extent than when tested in the baseline configuration or with the other 2 devices.

- The SafeFit™ device had the most significant effect on the kinematics of the 5th percentile female dummy. The device tended to keep the lap belt from pulling over the abdominal region in as a pronounced manner as the belt did in the baseline test and with the other two devices. This difference allowed the torso to rebound faster, which in turn delayed complete submarining of the small female dummy until later in the event.

- The HIC and chest acceleration 3 ms clip values were below the criterion values of 1000 and 60 g's, respectively, for the 50th percentile male dummy tested in the baseline configuration. As expected, the lap and shoulder belt loads were generally highest for the 50th percentile male dummy in comparison to the results for the three smaller size dummies.

The apparent leading motivation behind the development of these types of devices is to improve lap/shoulder belt fit on the occupant. It is the authors' opinion that, although this is a worthwhile intent, the performance of the vehicle's restraint system should not be detrimentally affected by the use of such a device. All of the devices evaluated in this study produced some degradation in the performance of the lap/shoulder belt system as compared to baseline conditions, depending on the size of the occupant and the impact orientation.

With the promulgation of the final rule on FMVSS No. 208, "Occupant Crash Protection" (59 FR 39472, August 3, 1994) requiring that Type 2 safety belts be either (1) integrated with adjustable vehicle seats, or (2) equipped with a means of adjustability to improve belt fit and comfort, it is anticipated that increased belt usage will occur, particularly among those occupants who currently find wearing their belts uncomfortable. With the increase in belt comfort due to OEM equipment, it is anticipated that the need for aftermarket belt fit devices will decrease.

5.0 REFERENCES

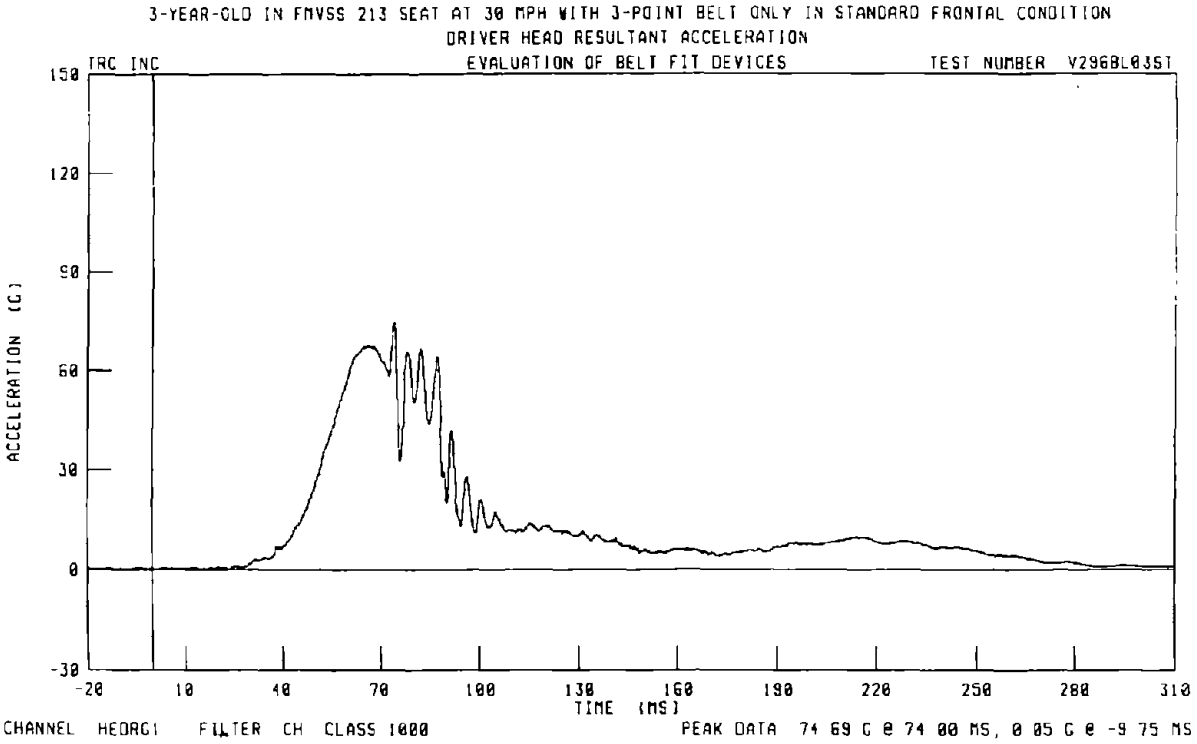
1. Federal Register / Vol. 58, No. 170 / Friday, September 3, 1993 / Proposed Rules, pg. 46936-7

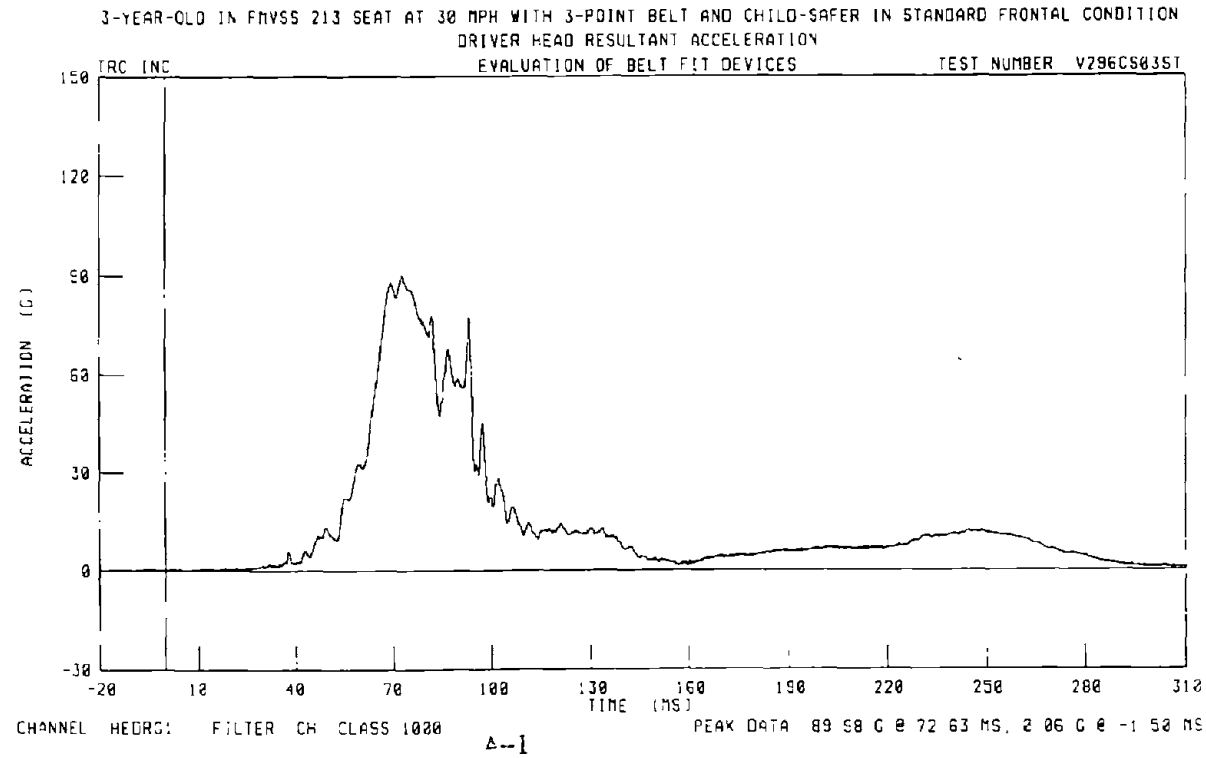
2. Howe, J. Gavin, Chambers, Fletcher K., and Sullivan, Lisa K., "Assessment of Vehicle Interior Dimensions and Lap/Shoulder Belt Fit", NHTSA Final Report, DOT HS 808 003, October 1992

3. Howe, J. Gavin, and Sullivan, Lisa K., "Evaluation of Belt Positioning Booster Seats and Lap/Shoulder Belt Test Procedures", NHTSA Final Report, DOT HS 808 005, October 1992

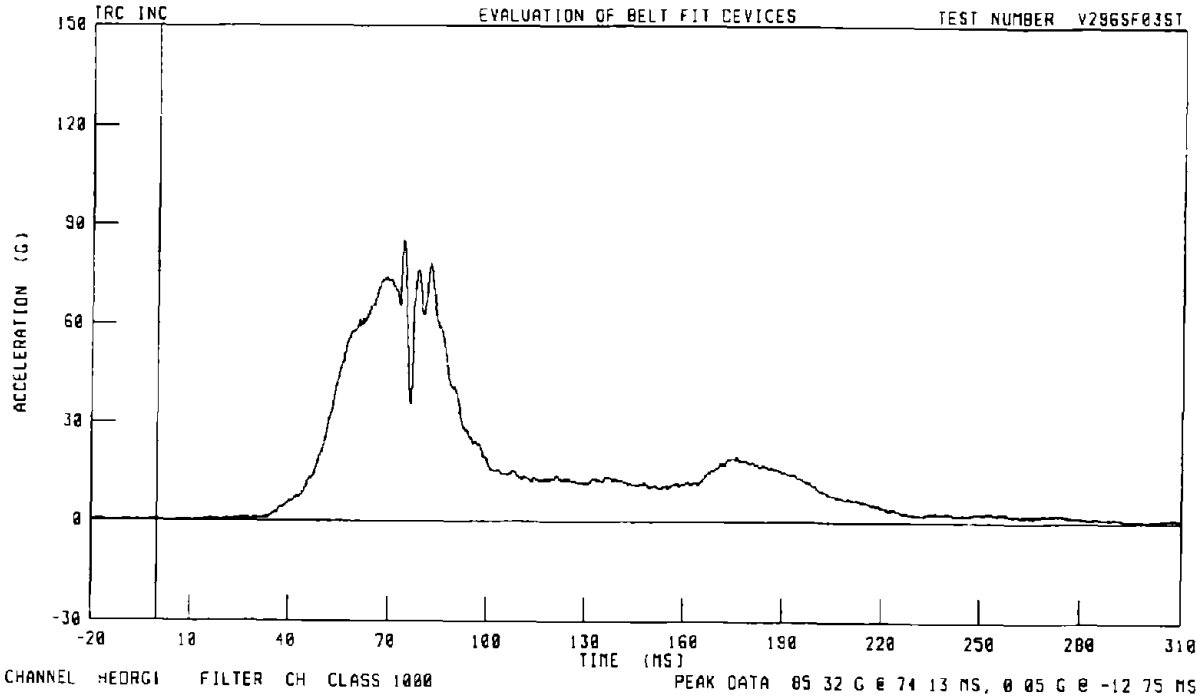
Appendix A

Resultant Head Acceleration Time Histories


3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL03ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 74 69 G @ 74 00 MS, 0 05 G @ -9 75 MS


3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS03ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 89 58 G @ 72 63 MS, 2 06 G @ -1 50 MS

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION



CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 85 32 G @ 74 13 MS, 0 05 G @ -12 75 MS

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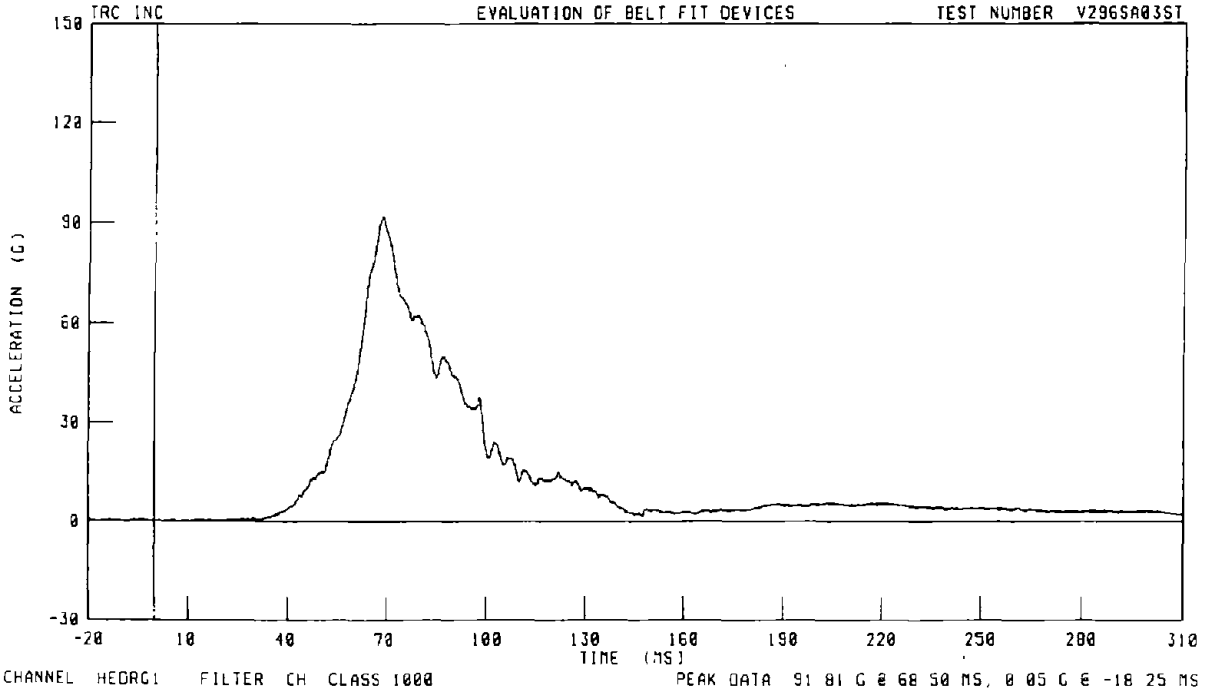
DRIVER HEAD RESULTANT ACCELERATION



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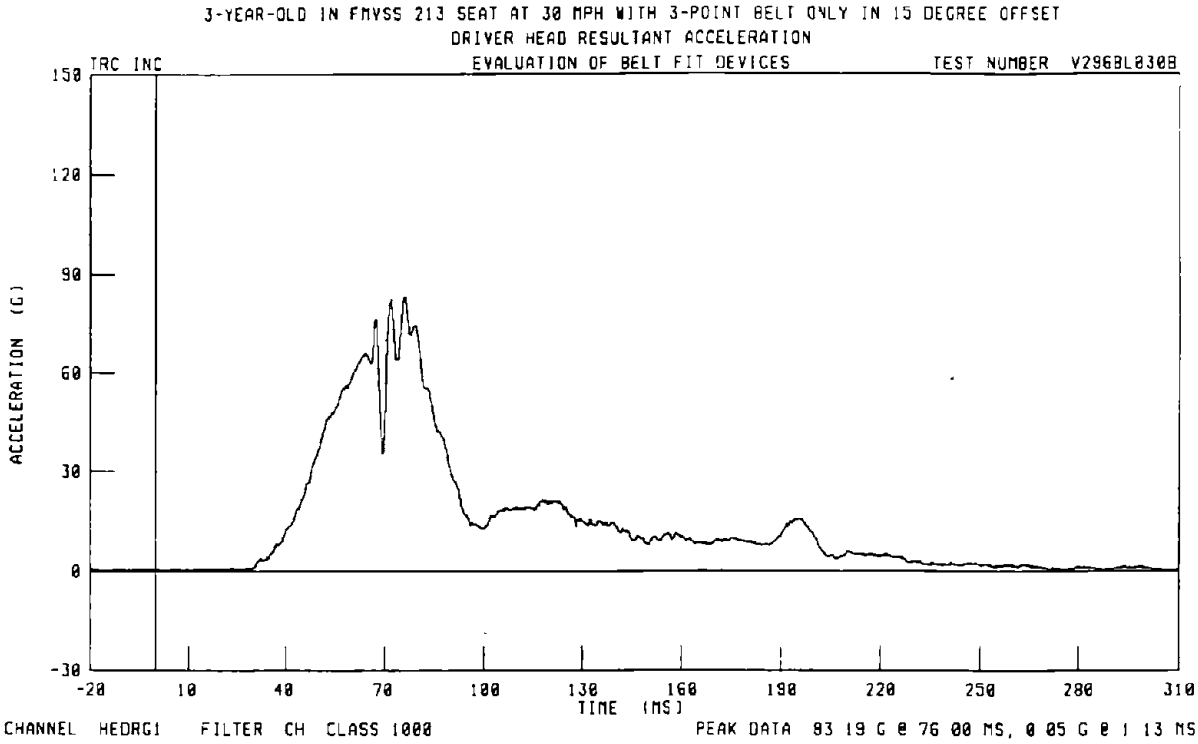
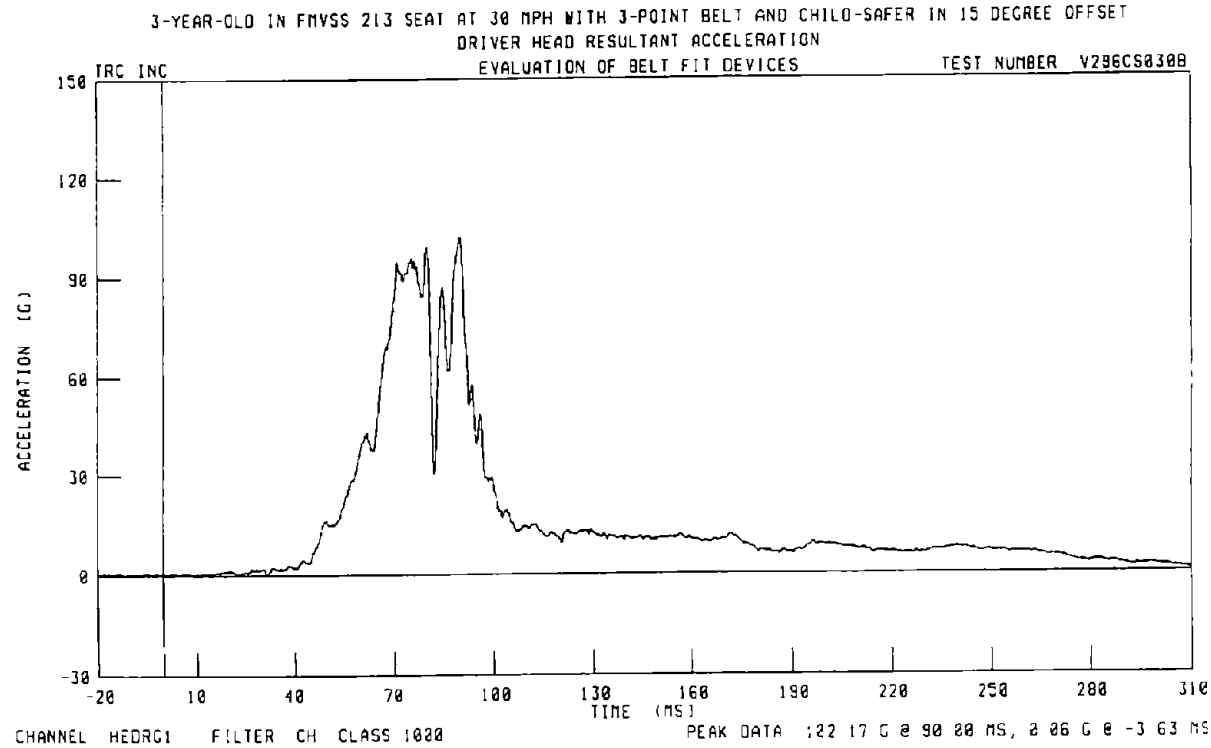
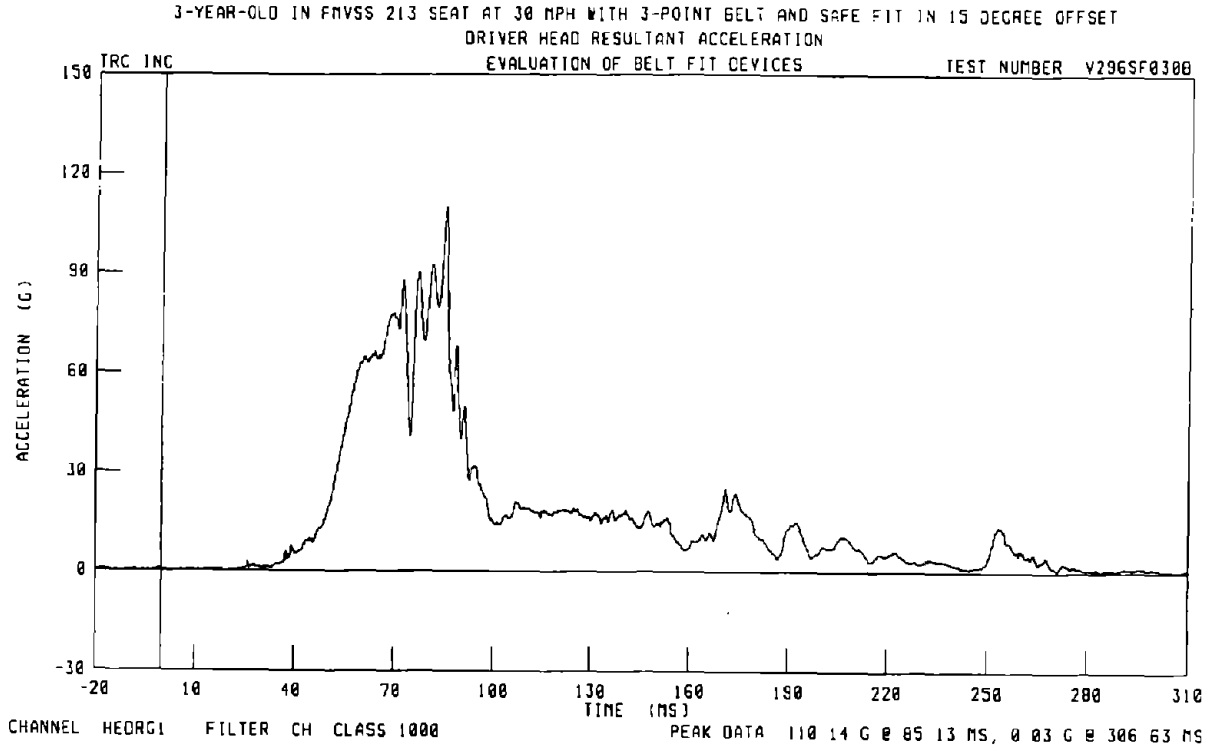
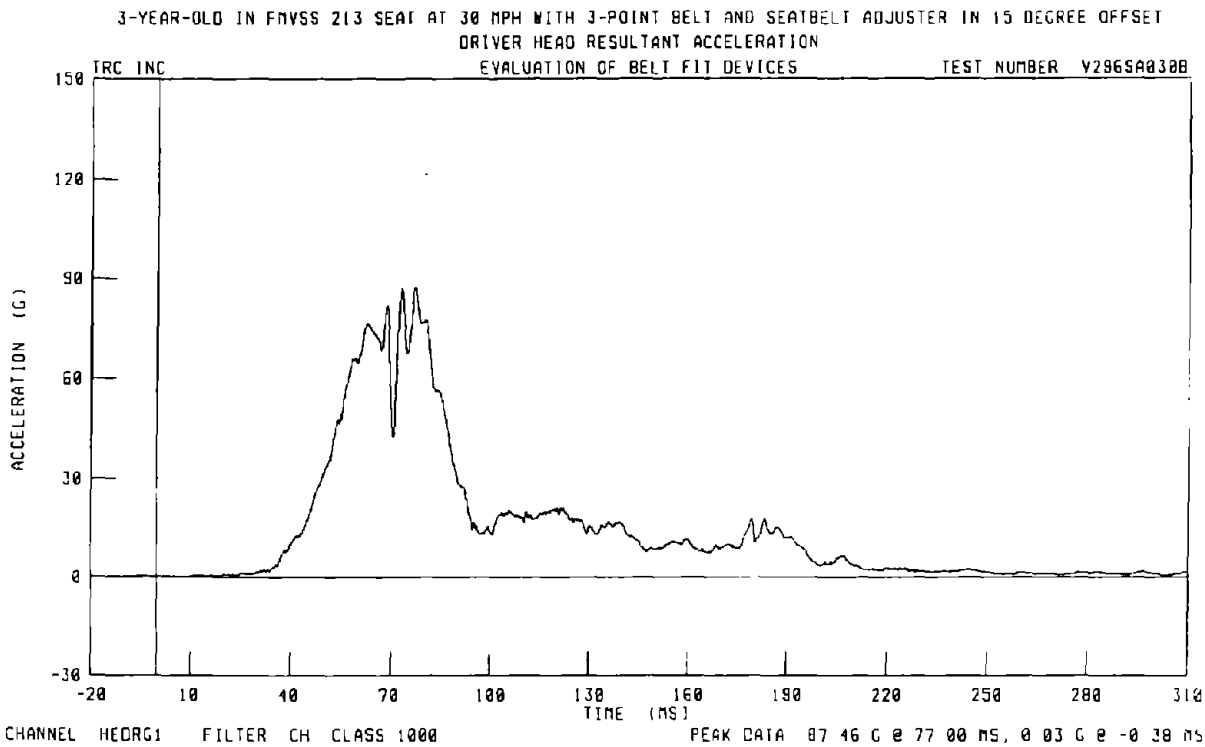
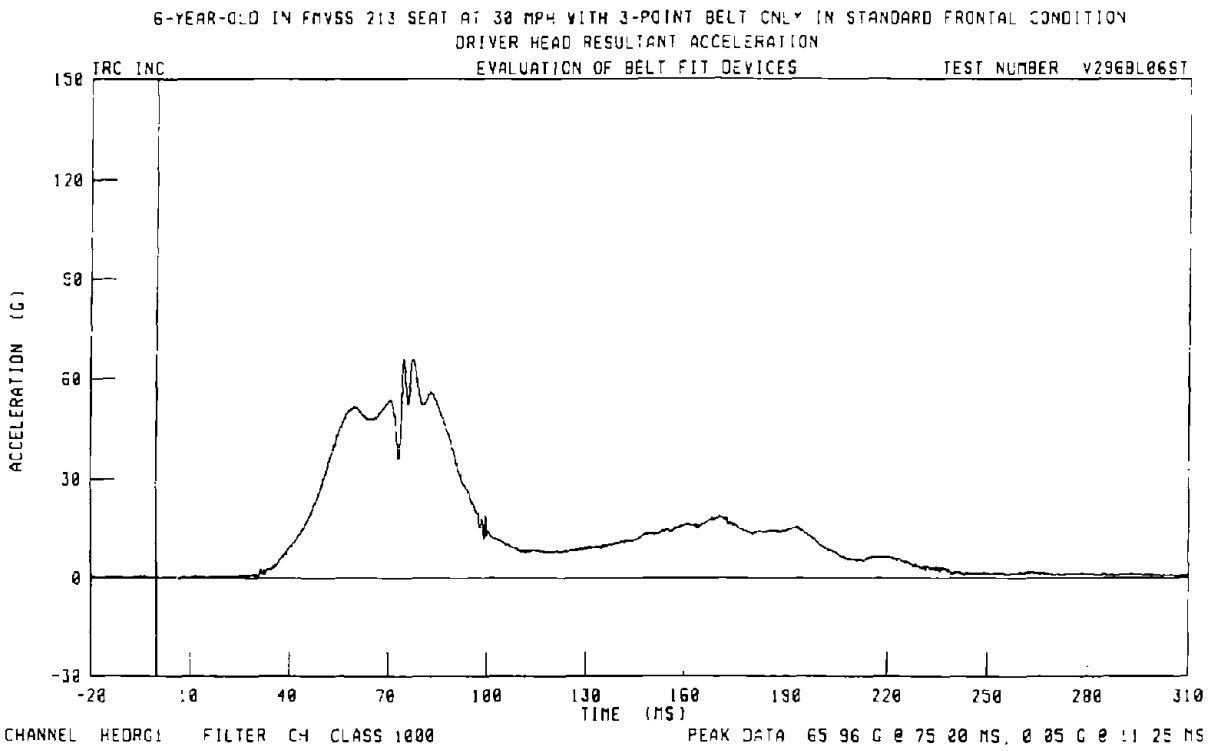
PEAK DATA 91 81 G @ 68 50 MS, 0 05 G @ -18 25 MS

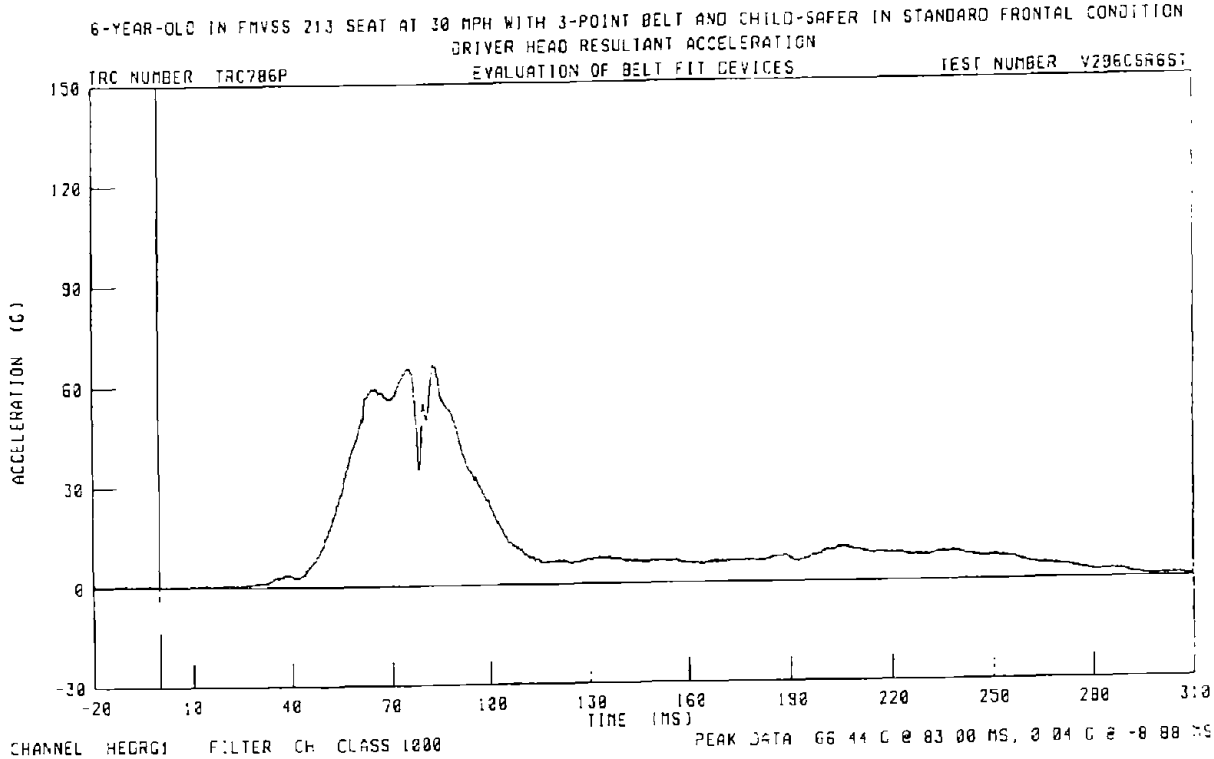

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL0308
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 83 19 G @ 76 00 MS, 0 05 G @ 1 13 MS


3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS0308
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 122 17 G @ 90 00 MS, 0 06 G @ -3 63 MS


3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF0300
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 110 14 G @ 85 13 MS, 0 03 G @ 306 63 MS


3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA0308
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 87 46 G @ 77 00 MS, 0 03 G @ -0 38 MS


6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL06ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 65 96 G @ 75 20 MS, 0 85 G @ 11 25 MS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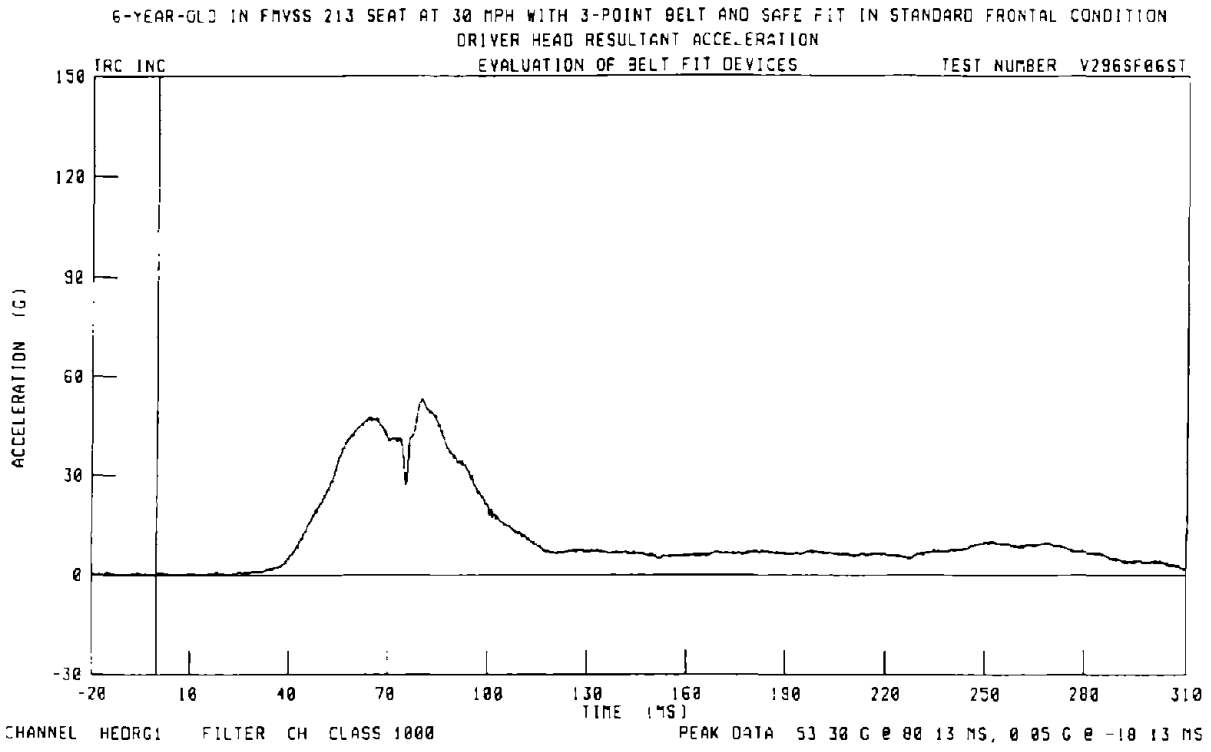
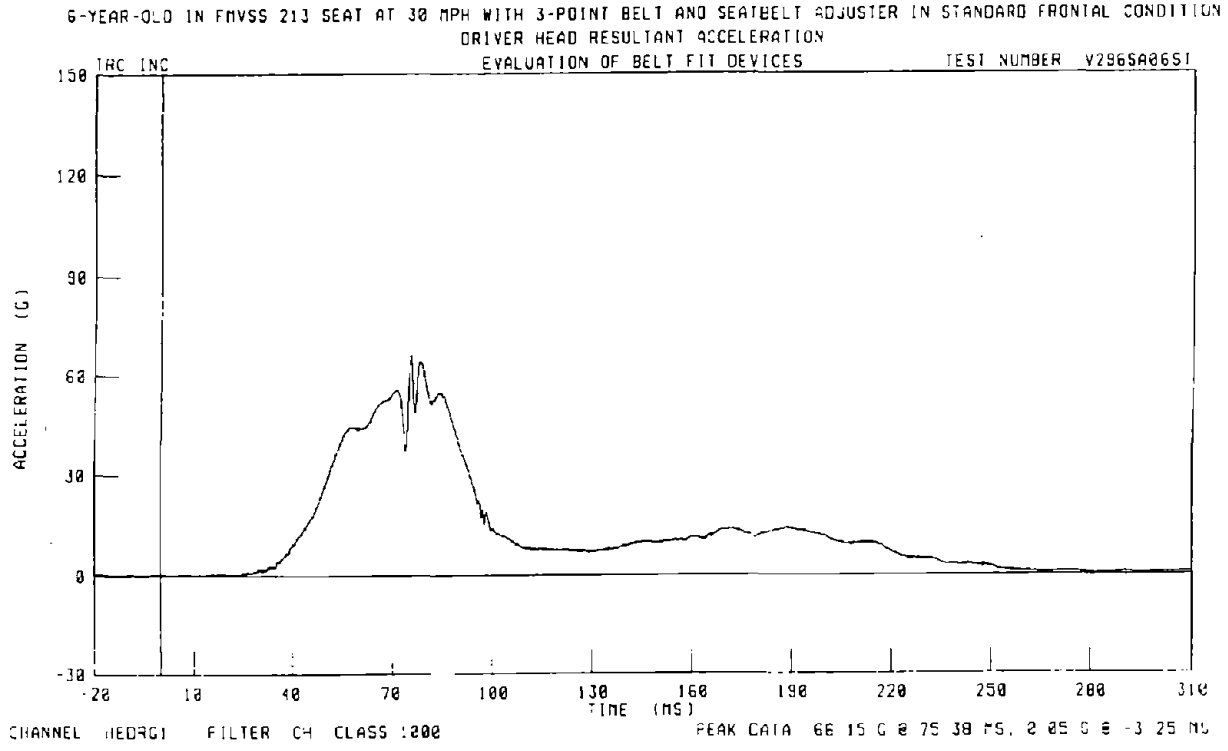
DRIVER HEAD RESULTANT ACCELERATION
IRC NUMBER TRC786P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CSR6ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 66 44 G @ 83 00 MS, 0 04 G @ -8 88 MS


6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF06ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 53 30 G @ 80 13 MS, 0 05 G @ -10 13 MS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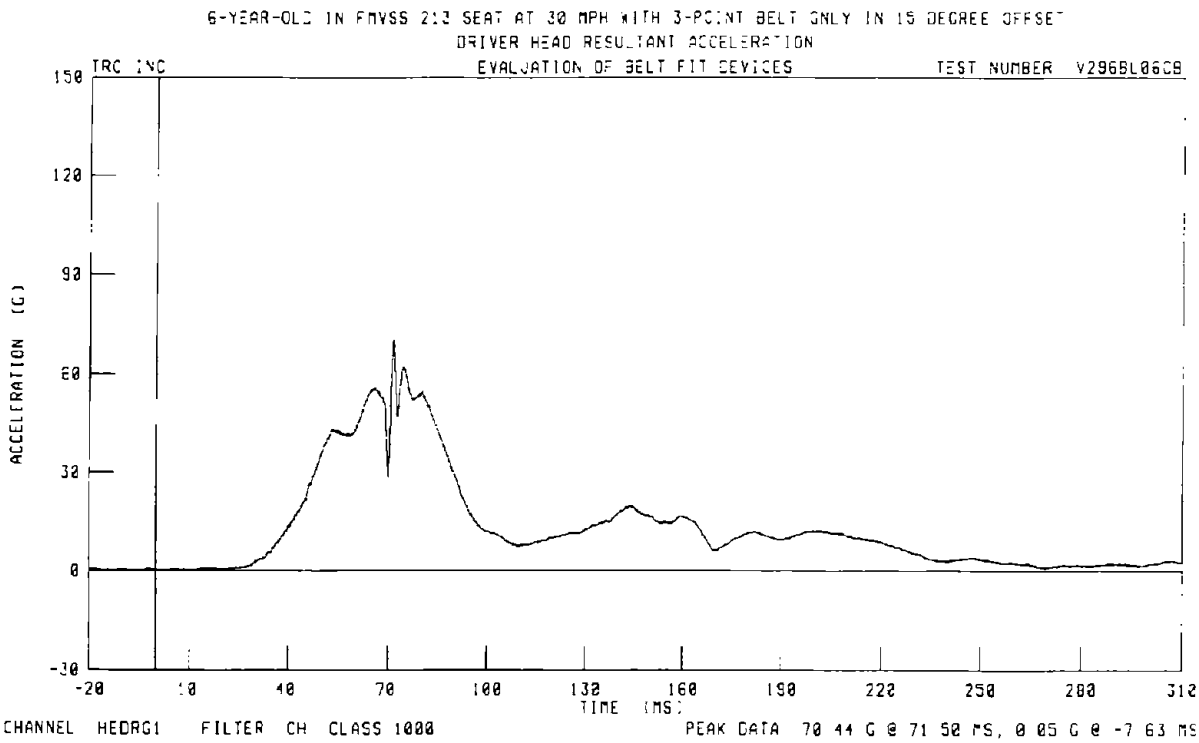
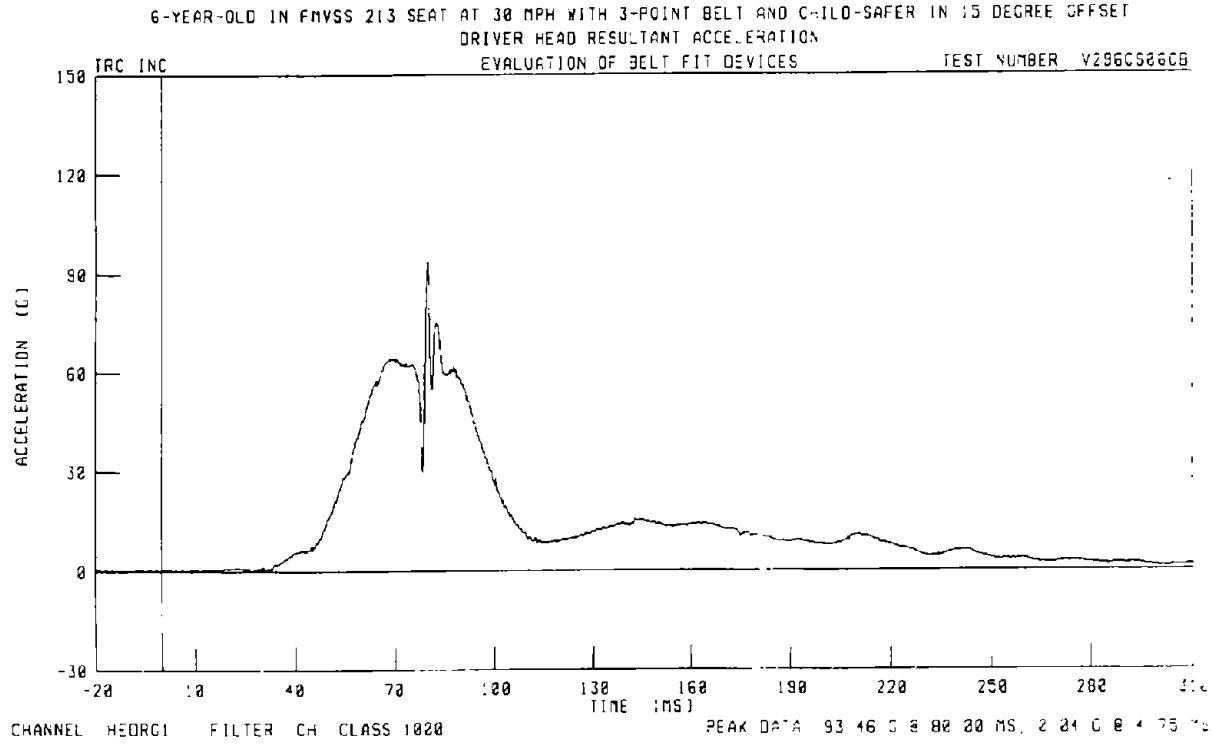
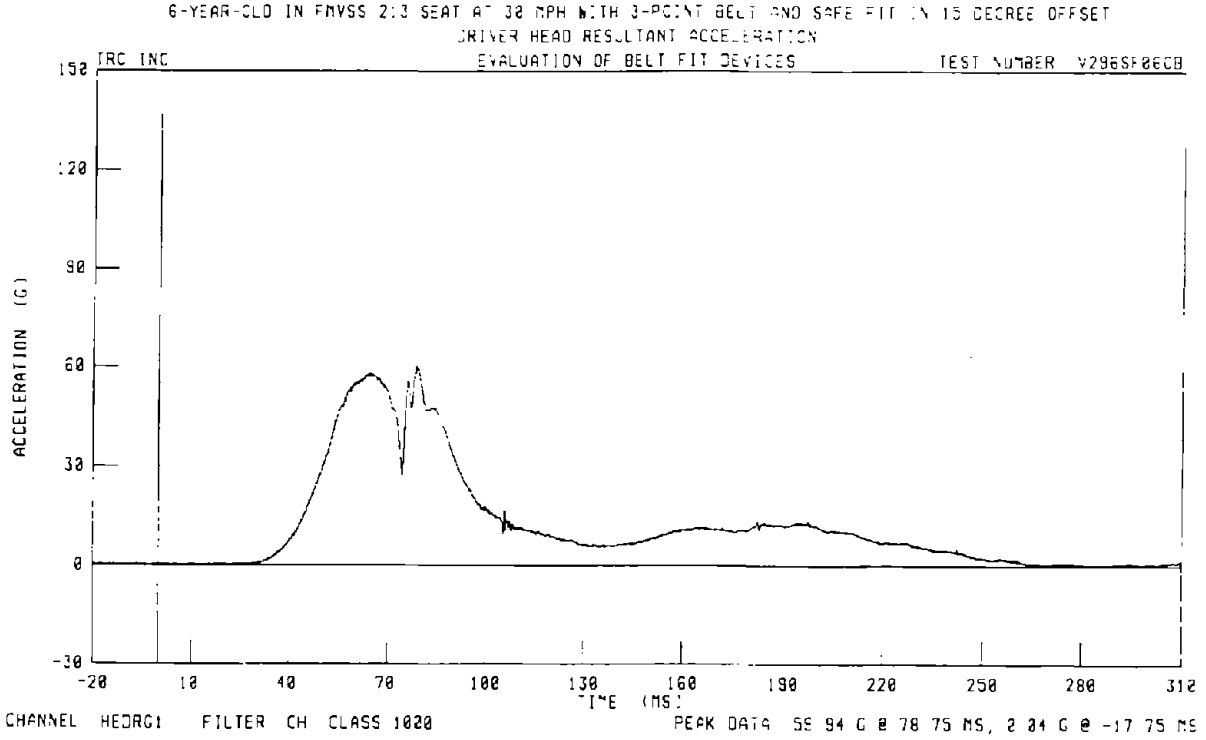
DRIVER HEAD RESULTANT ACCELERATION
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA06ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 66 15 G @ 75 38 MS, 2 05 G @ -3 25 MS


6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL06CB
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 70 44 G @ 71 50 MS, 0 05 G @ -7 63 MS


6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS06CB
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 93 46 G @ 80 20 MS, 2 84 G @ 4 75 MS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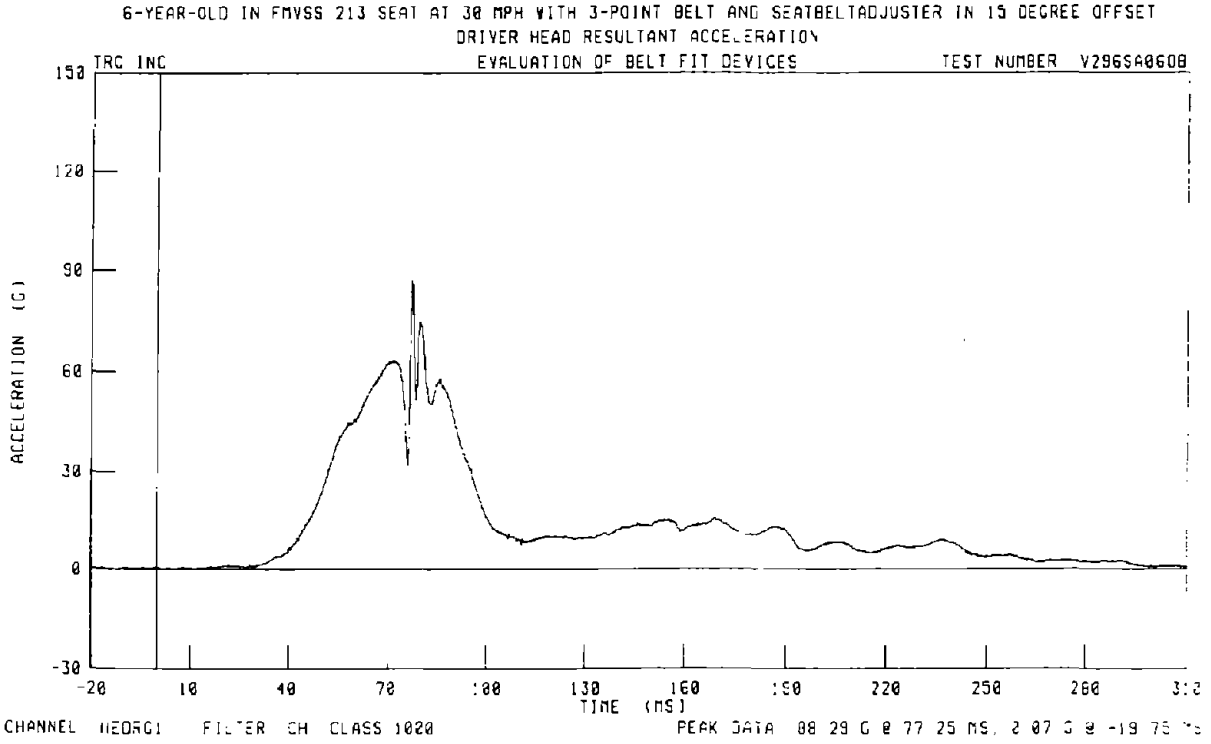
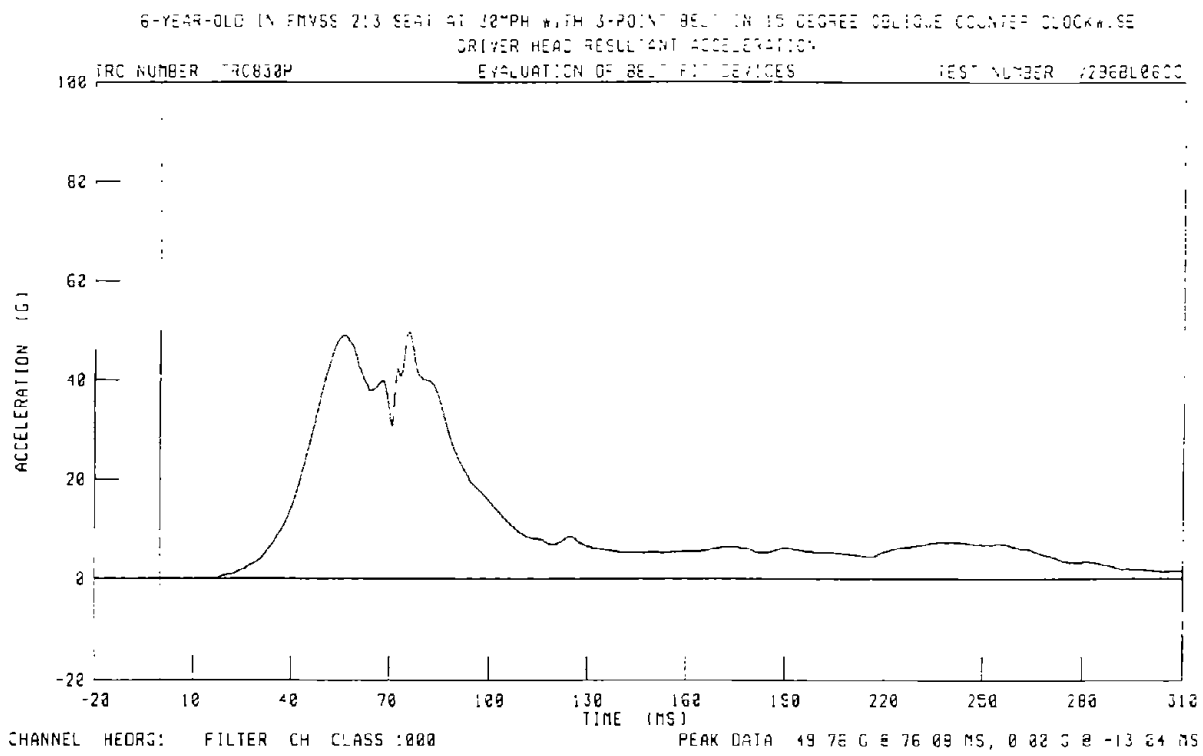
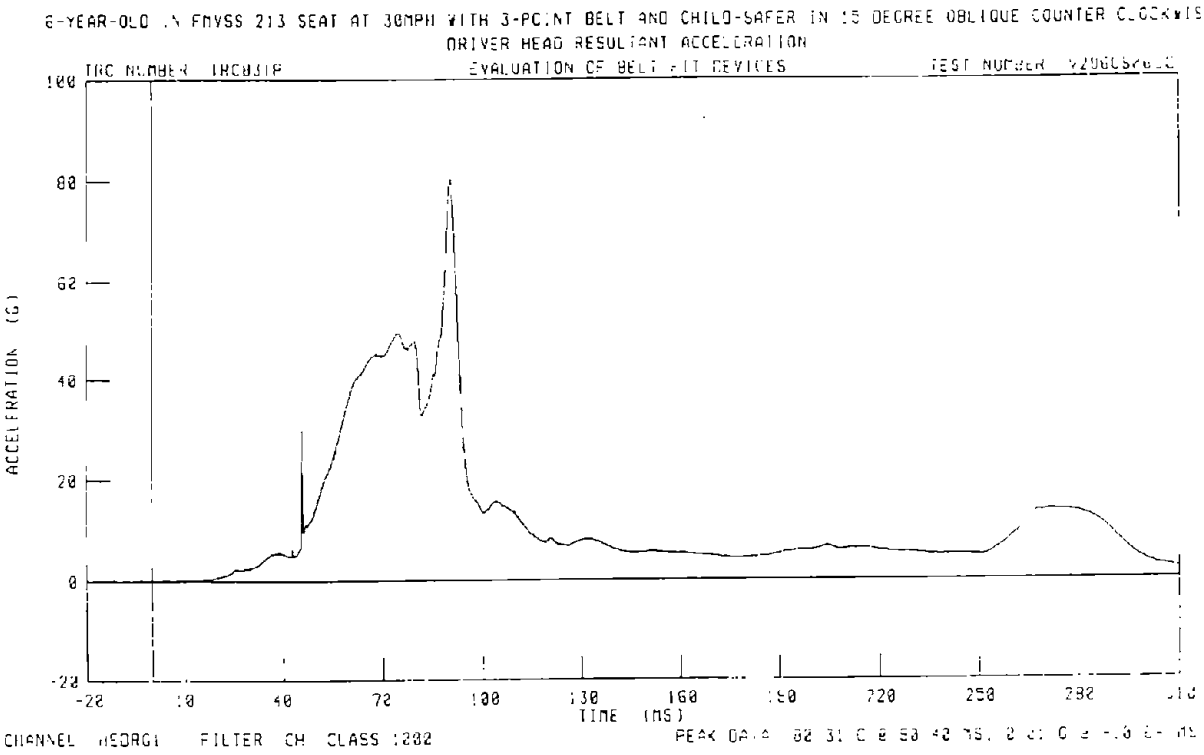
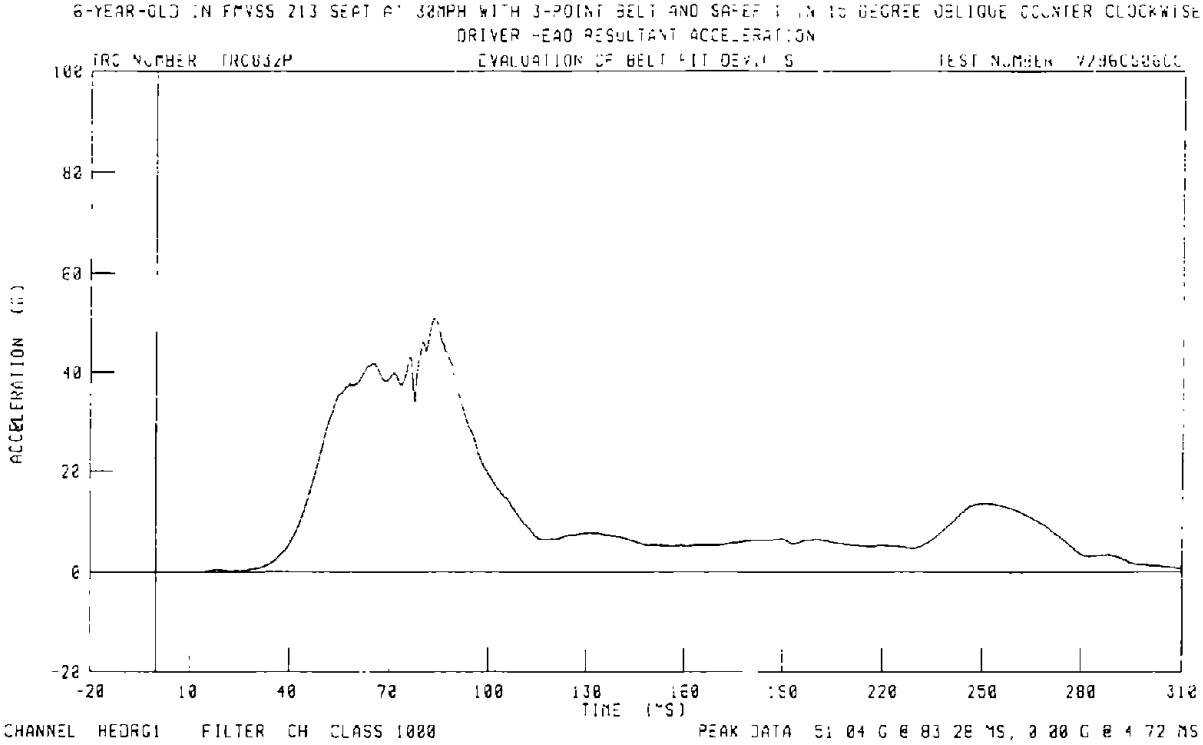
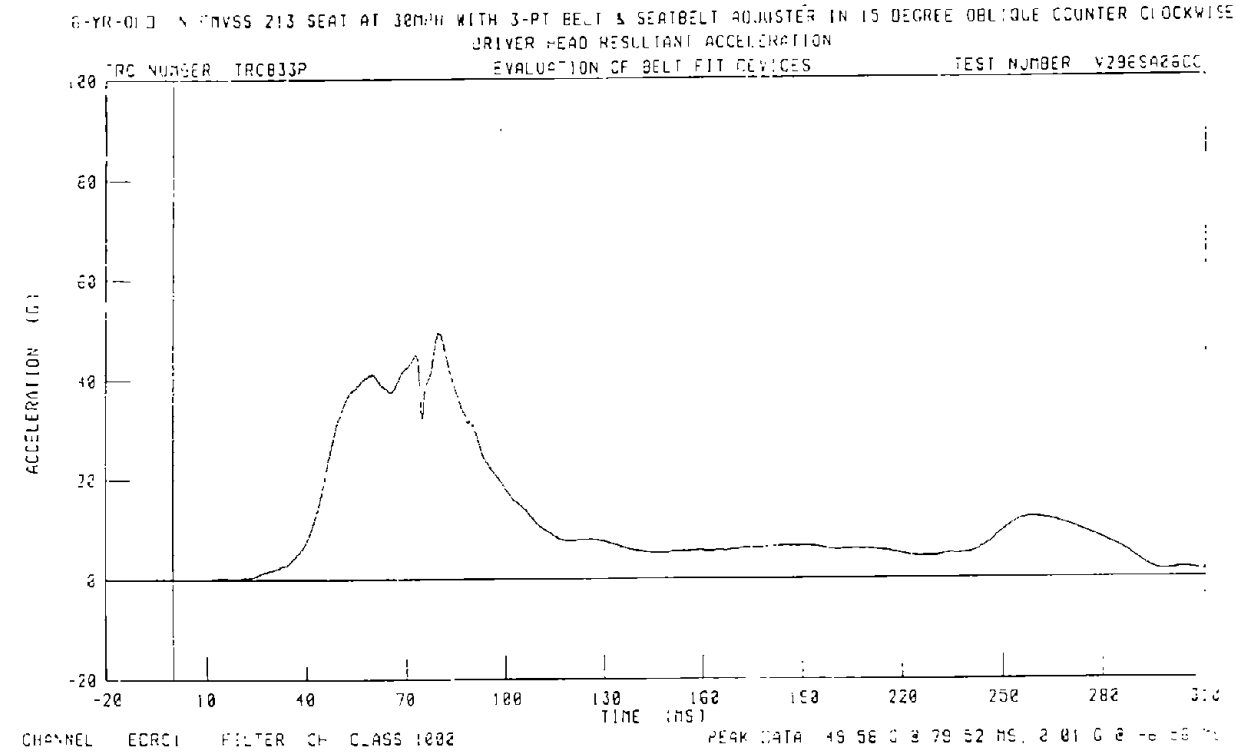
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF06CB
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
312
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1020
PEAK DATA 59 94 G @ 78 75 MS, 2 04 G @ -17 75 MS

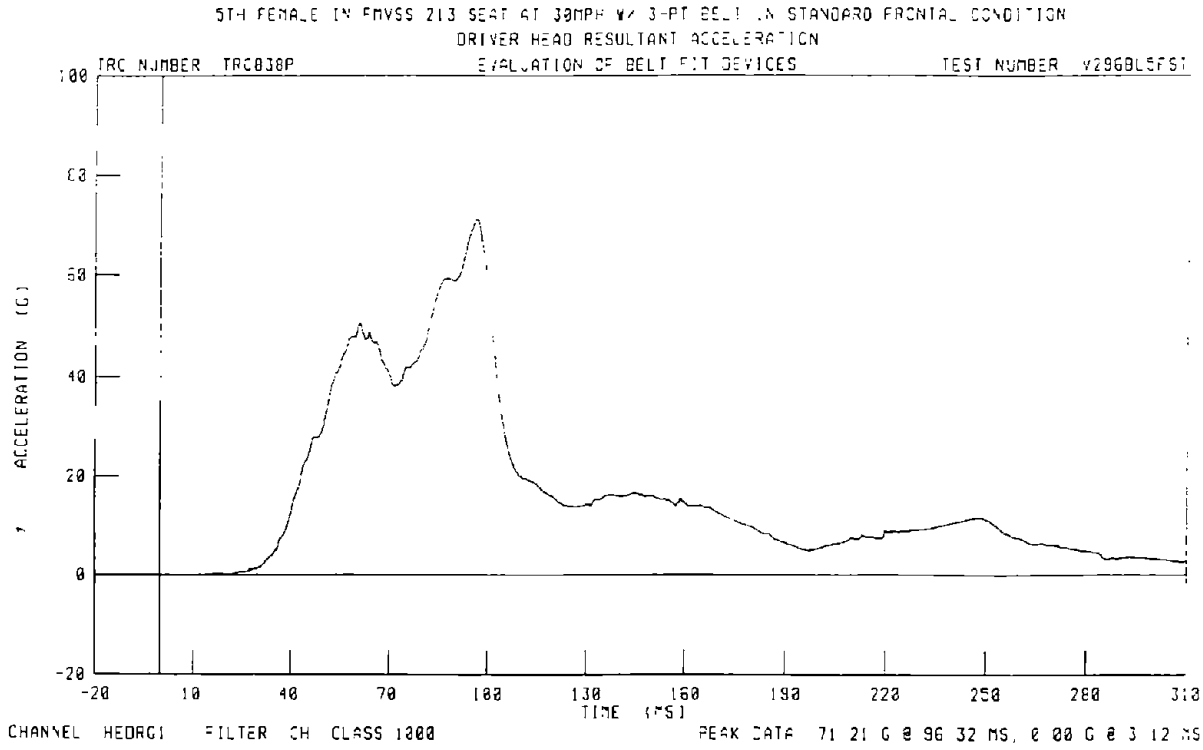

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELTADJUSTER IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA06CB
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
312
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1020
PEAK DATA 88 29 G @ 77 25 MS, 2 07 G @ -19 75 MS

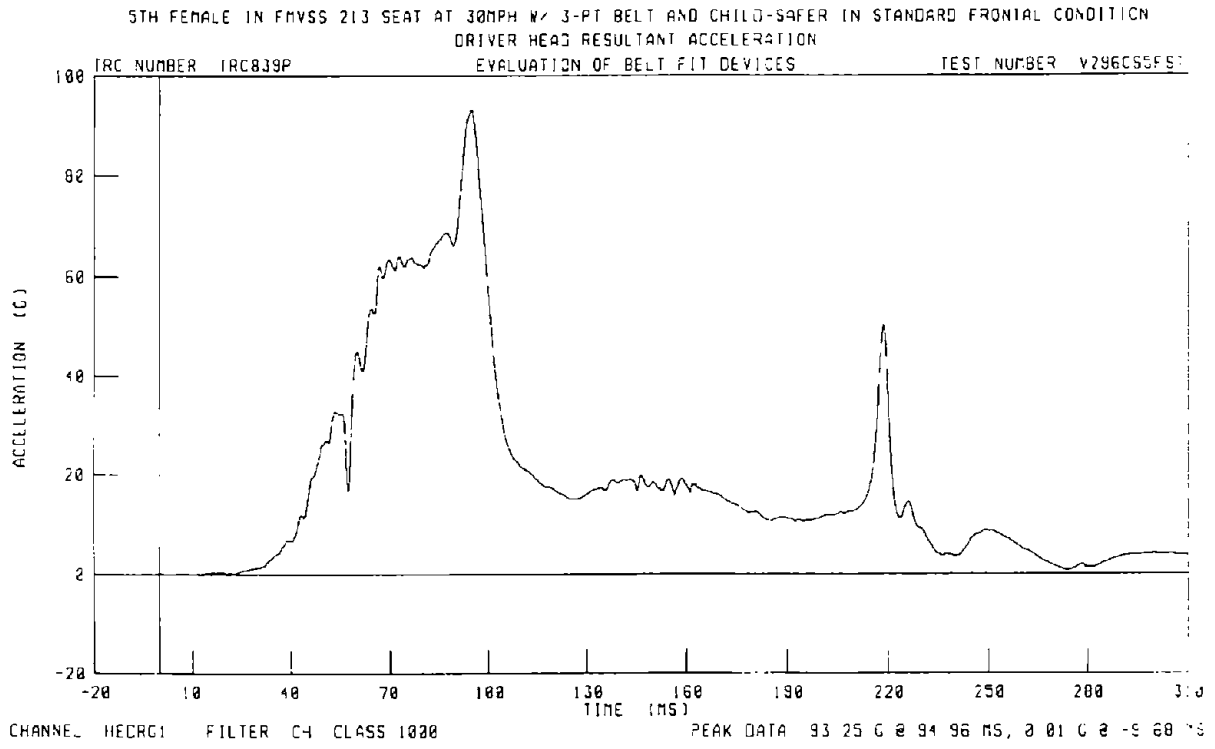

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC830P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 49.78 G @ 76.09 MS, 0.00 G @ -13.84 MS

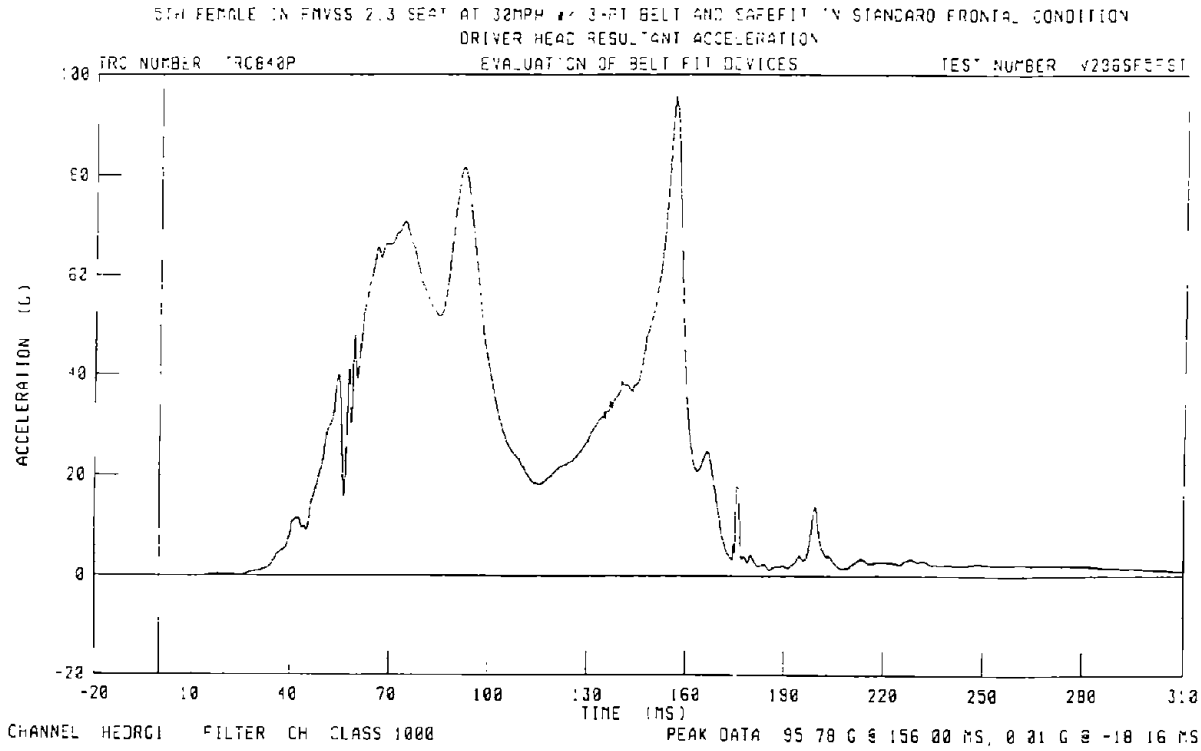

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC831P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 82.31 G @ 80.42 MS, 0.00 G @ -1.60 MS

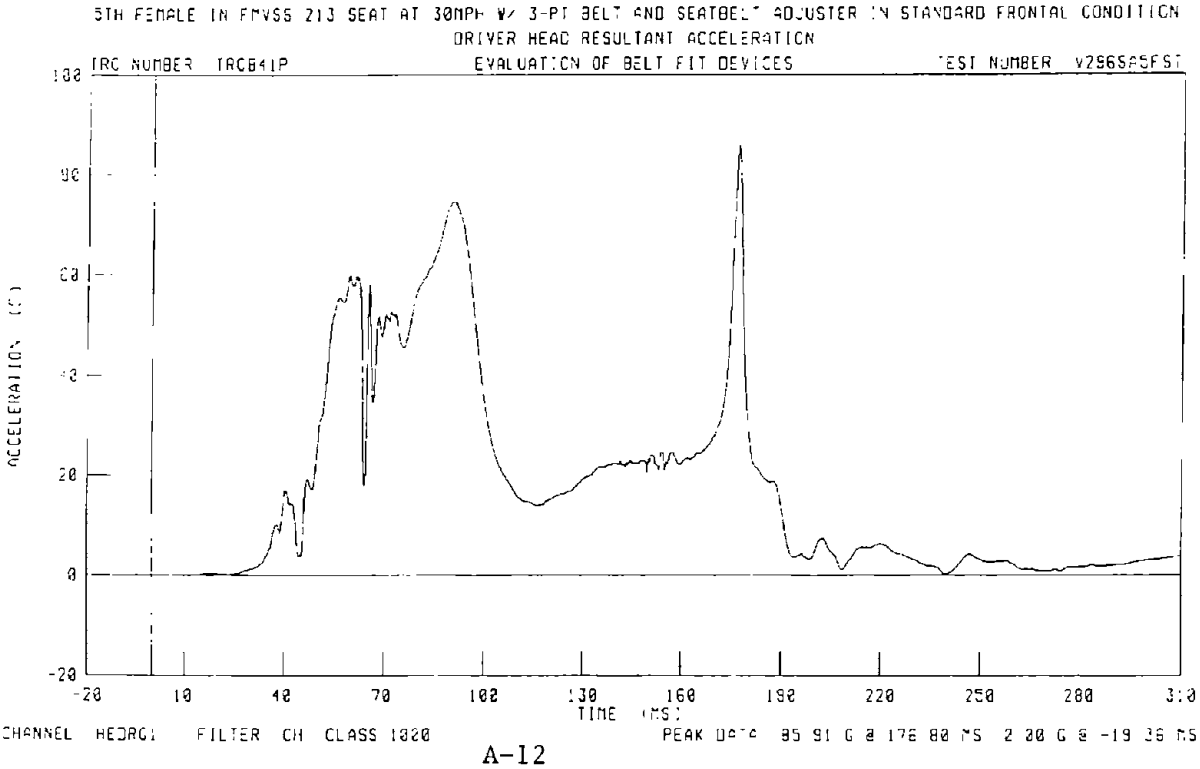

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT AND SAFE T IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC032P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C02CC
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 51.04 G @ 83.28 MS, 0.00 G @ 4.72 MS

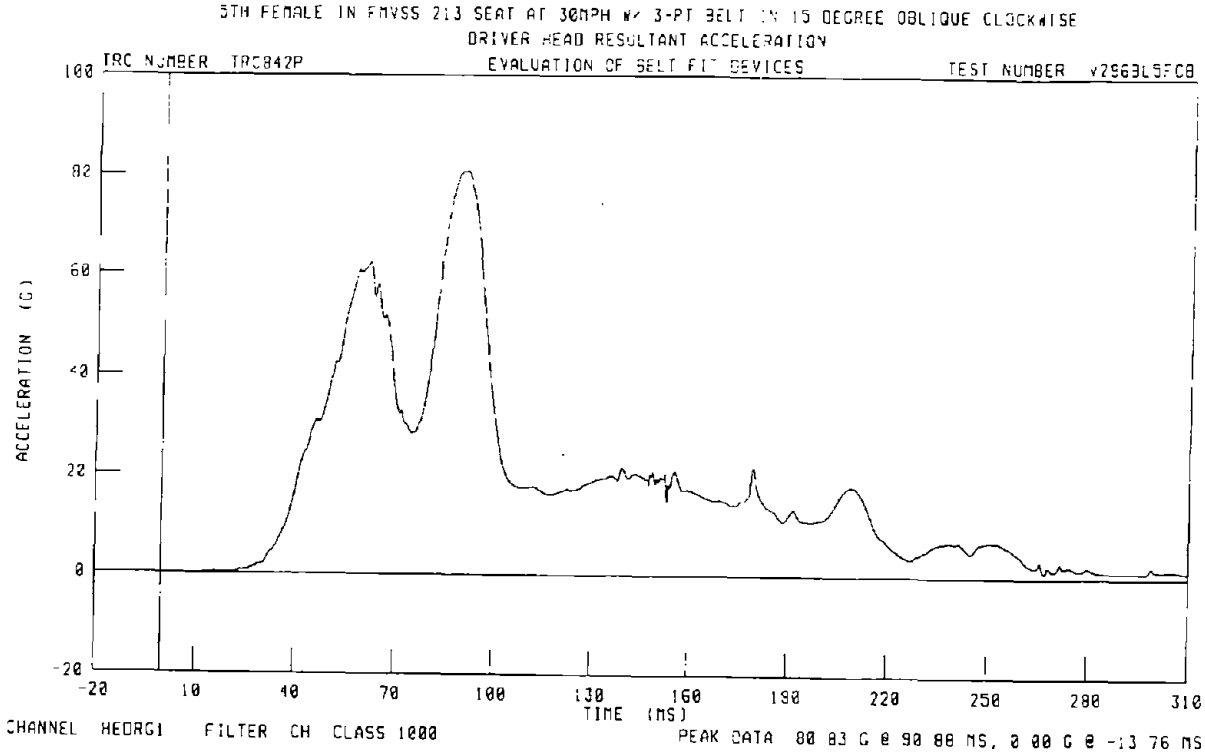

6-YR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT & SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC033P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA26CC
ACCELERATION (G)
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL EDRC1 FILTER CH CLASS 1000
PEAK DATA 49.58 G @ 79.52 MS, 2.01 G @

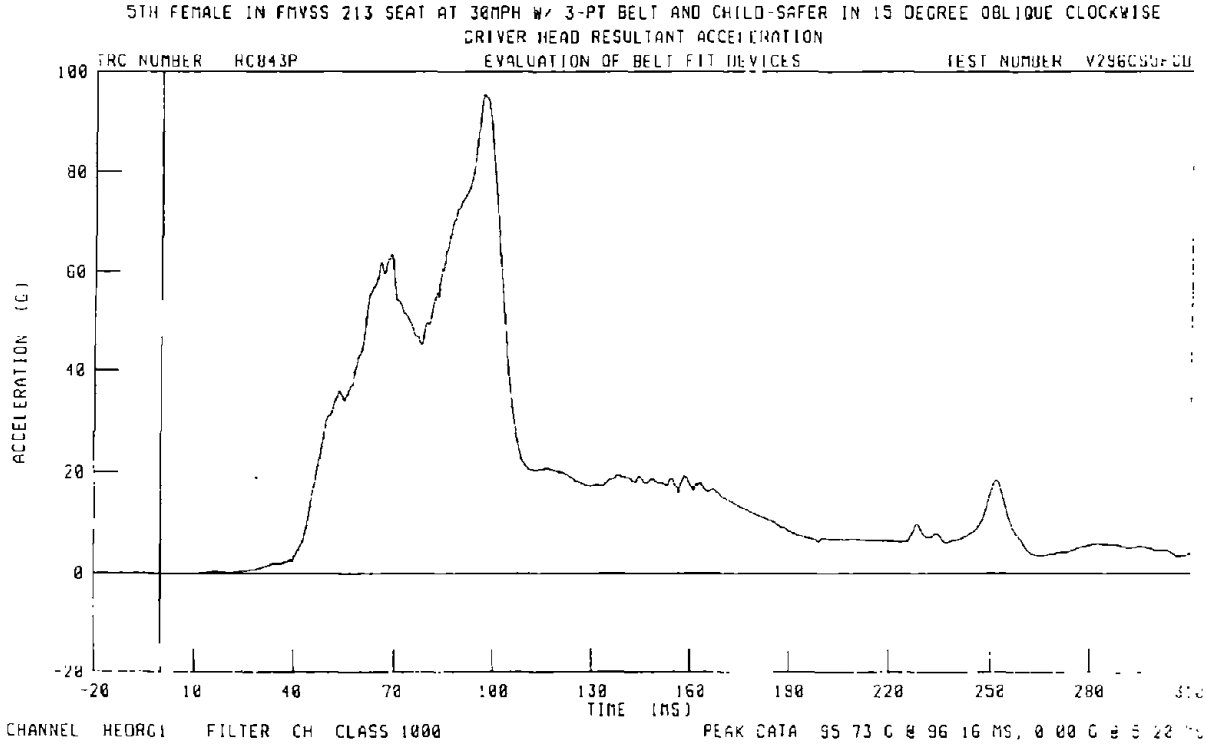

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BLSFST
ACCELERATION (G)
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 71 21 G @ 96 32 MS, 0 00 G @ 3 12 MS

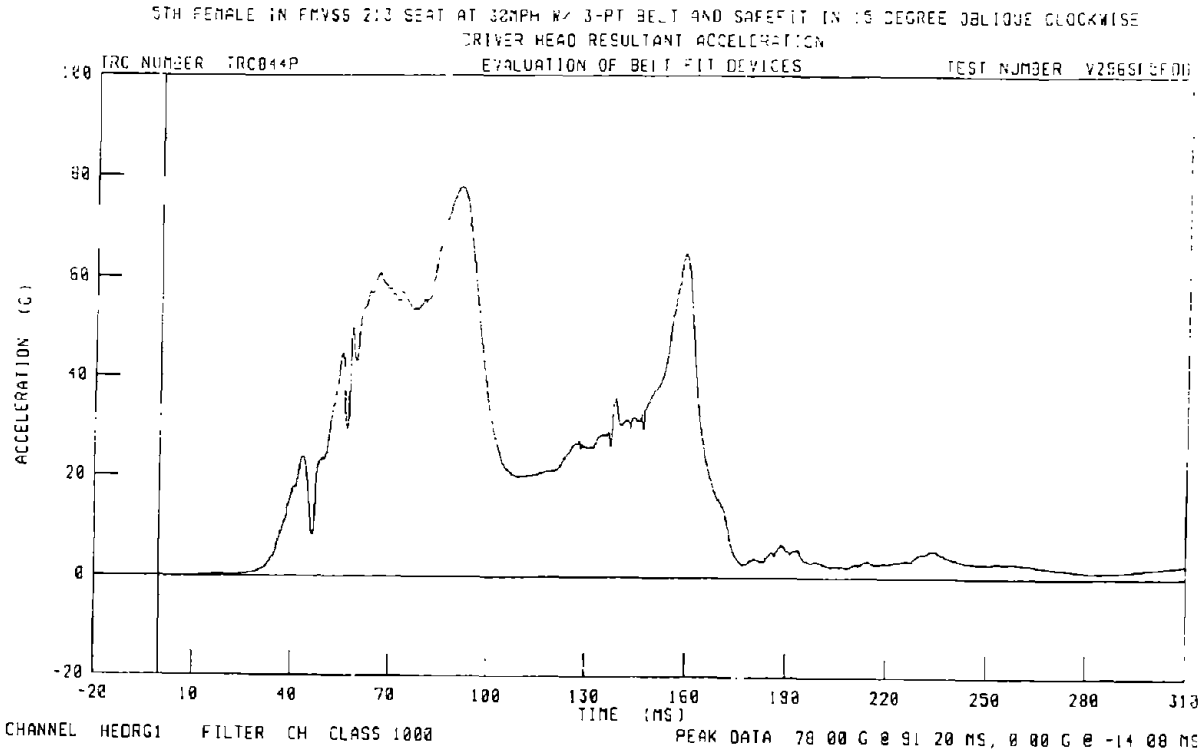

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CSSFST
ACCELERATION (G)
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 93 25 G @ 94 96 MS, 0 01 G @ -9 68 MS

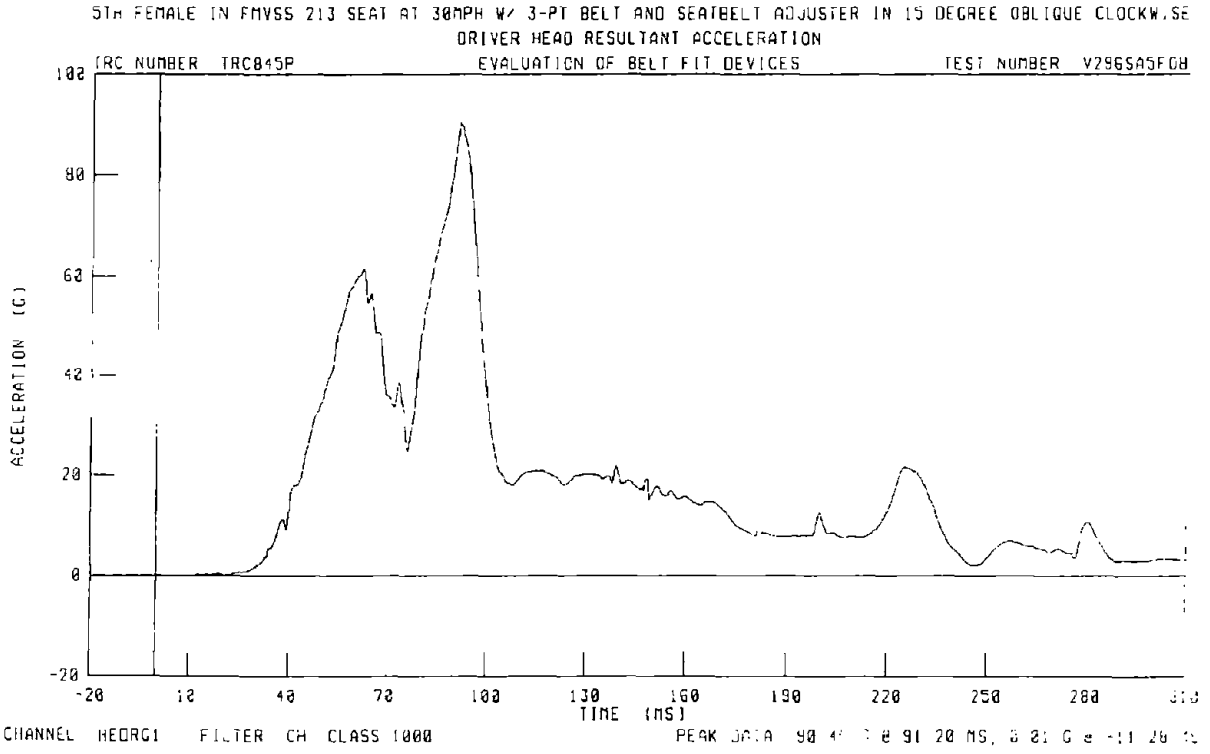

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SFSFST
ACCELERATION (G)
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 95 78 G @ 156 00 MS, 0 01 G @ -18 16 MS

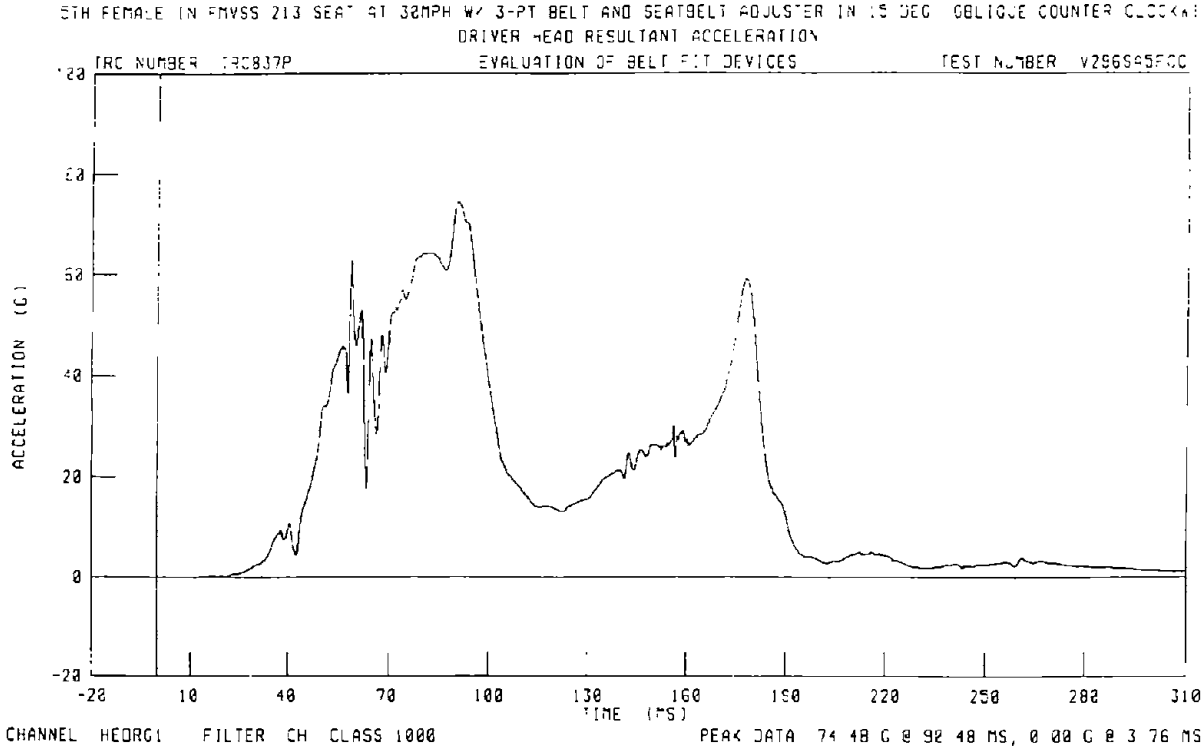

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC841P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SASFST
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 85 91 G @ 176 80 MS 2 00 G @ -19 36 MS

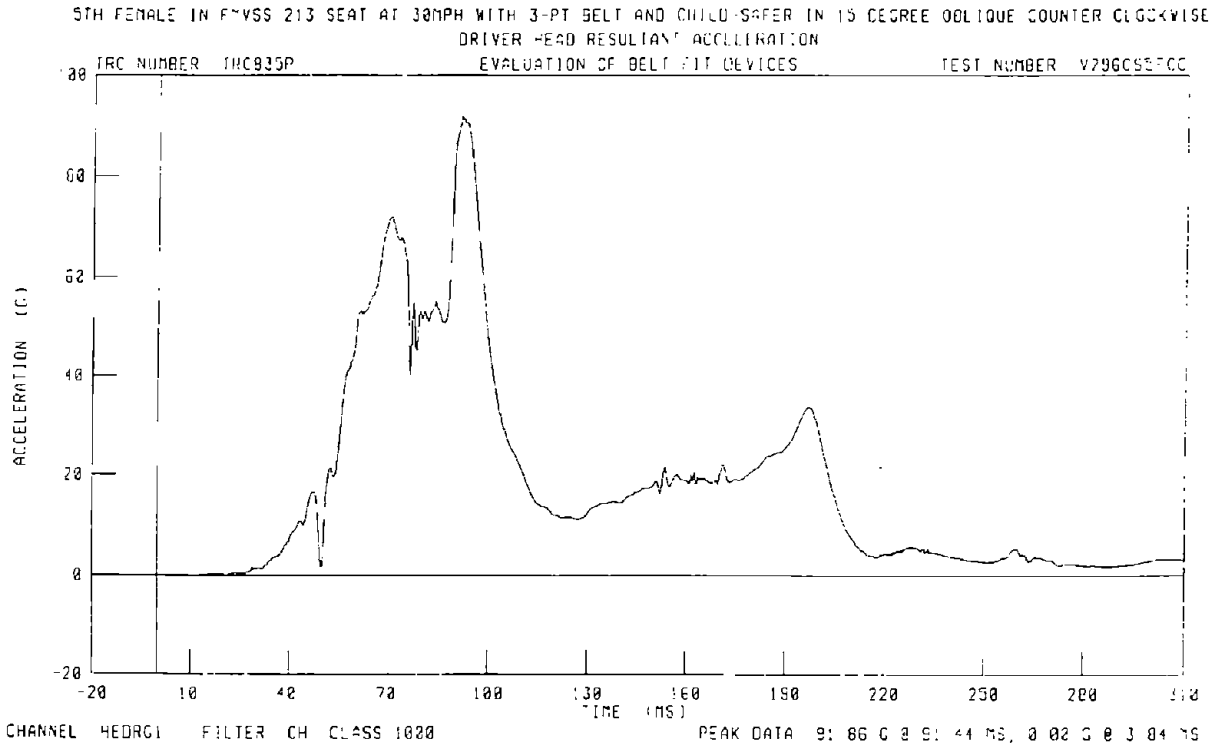

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2963L5FC8
ACCELERATION (G)
100
82
60
40
22
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 80 83 G @ 90 88 MS, 0 00 G @ -13 76 MS

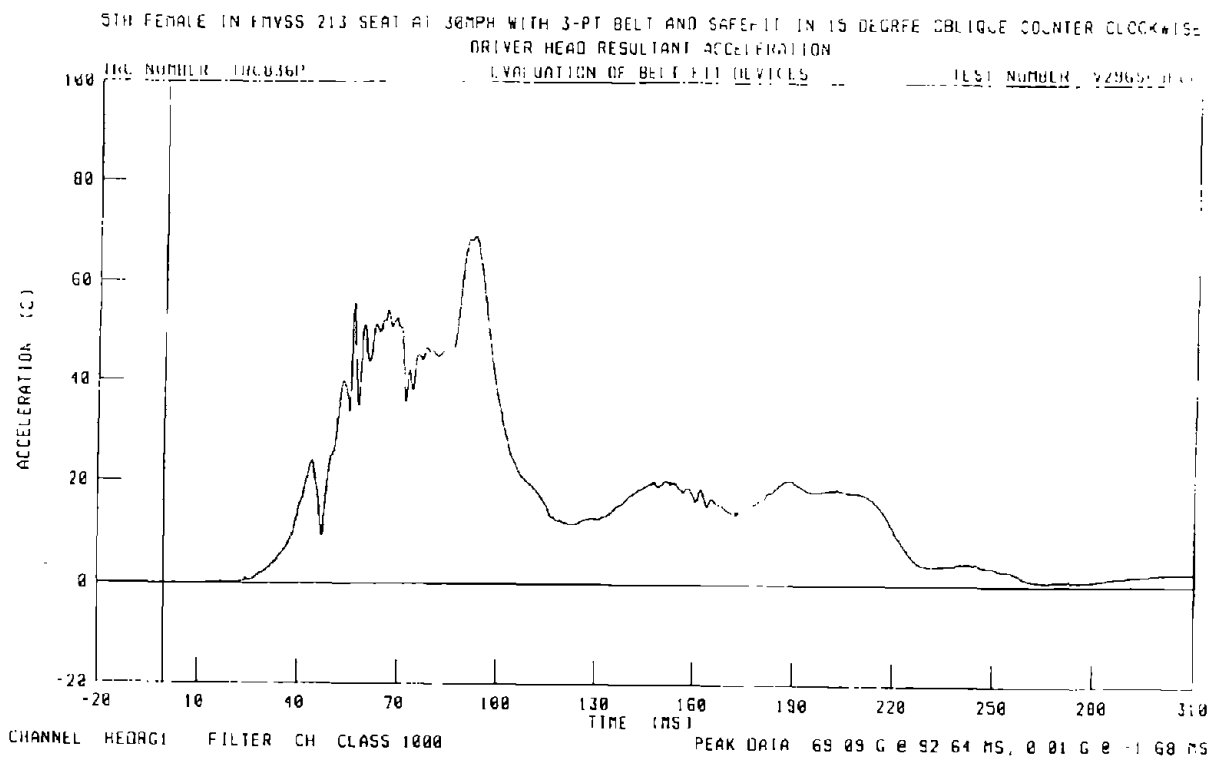

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER RC843P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FC0
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 95 73 G @ 96 16 MS, 0 00 G @ 5 22 MS

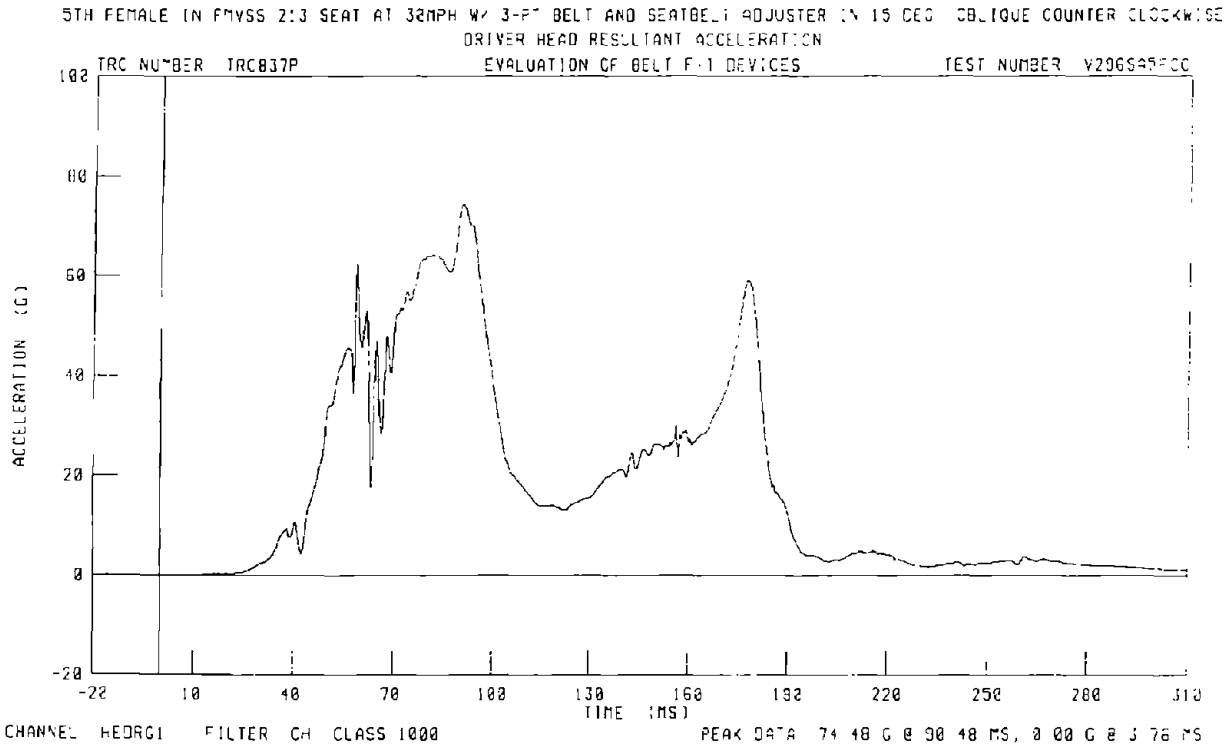

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296S1SF08
ACCELERATION (G)
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 78 00 G @ 91 20 MS, 0 00 G @ -14 08 MS

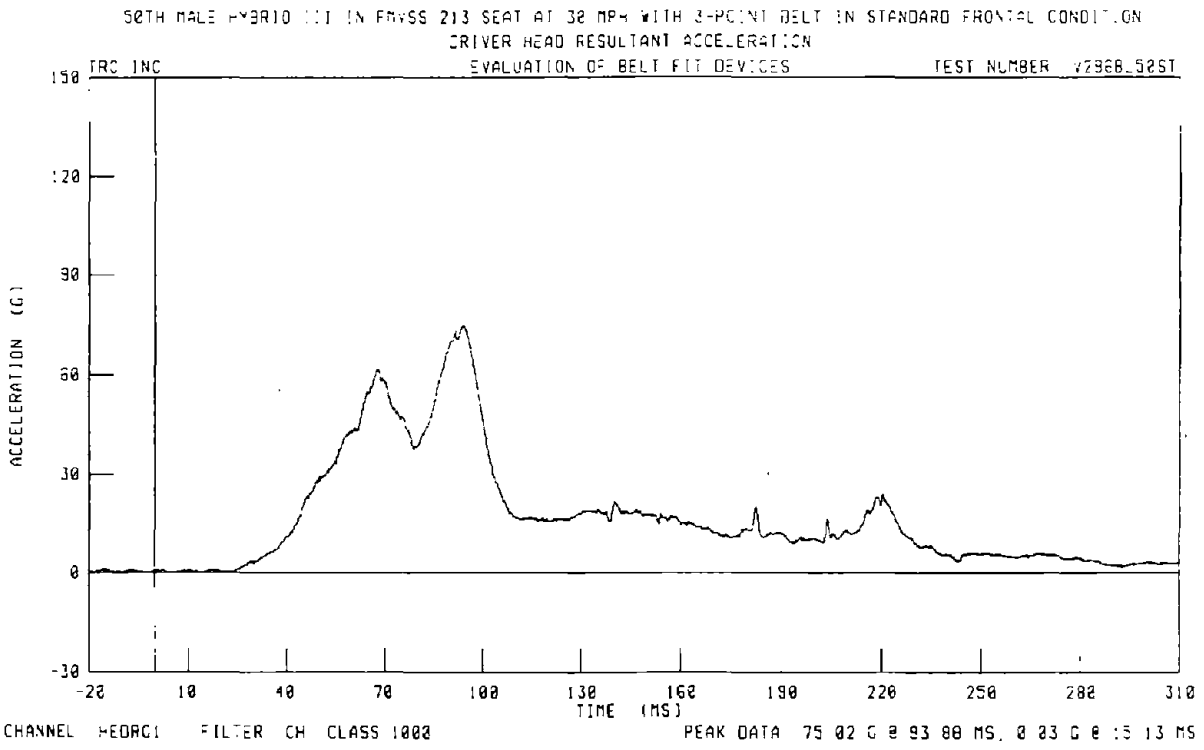

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKW.SE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5F08
ACCELERATION (G)
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000

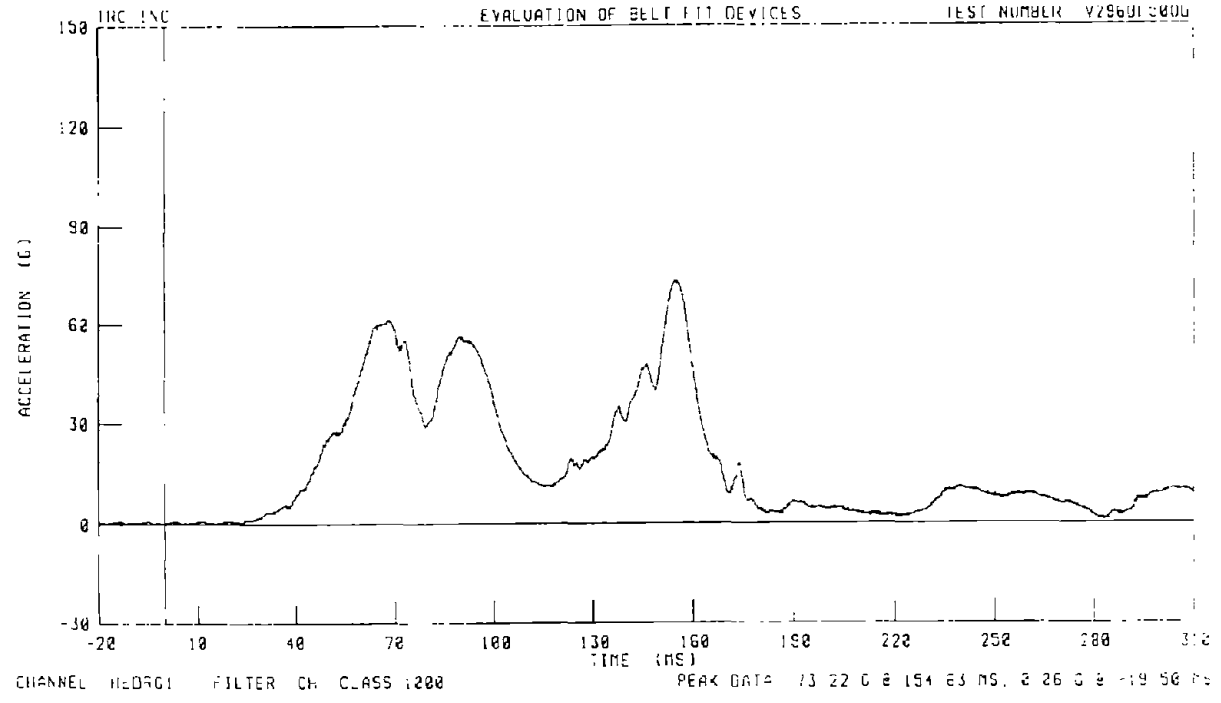

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEG OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC837P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296S45FCC
ACCELERATION (G)
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 74.48 G @ 92.48 MS, 0.00 G @ 3.76 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC835P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CSEFCC
ACCELERATION (G)
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 91.86 G @ 91.44 MS, 0.02 G @ 3.04 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFE-T IT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 69 09 G @ 92 64 MS, 0 01 G @ -1 68 MS

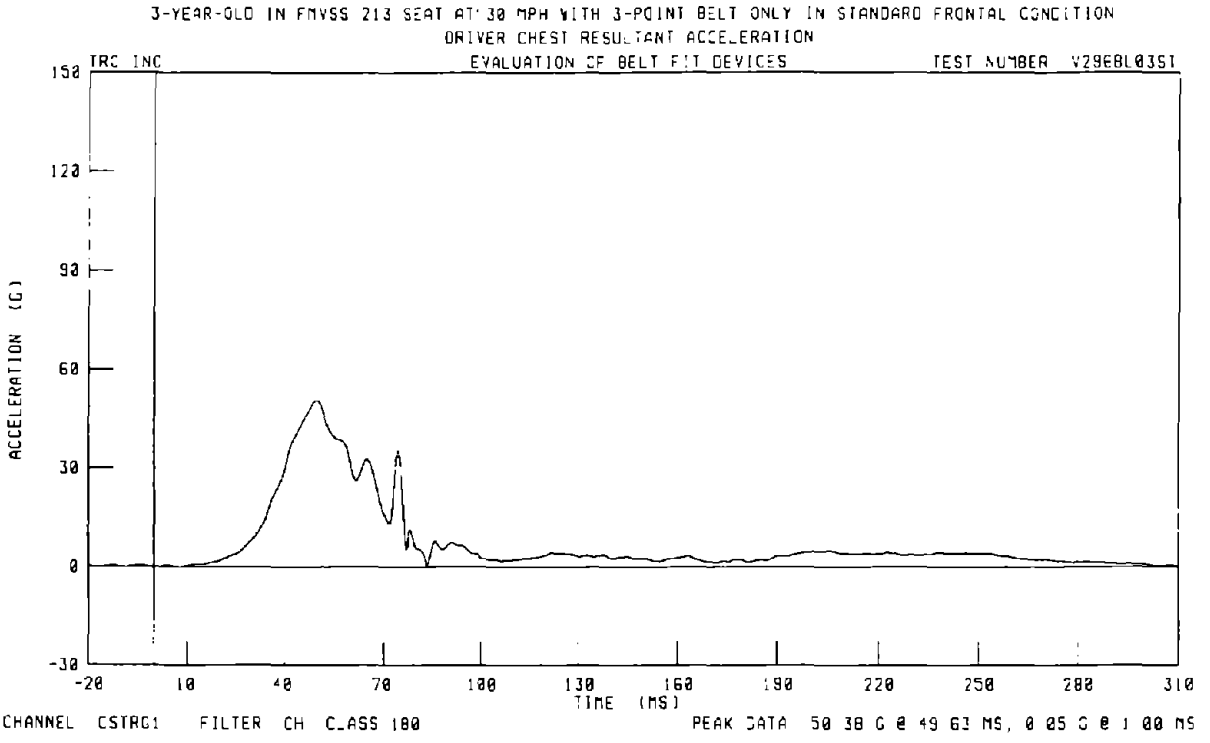

5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEG OBLIQUE COUNTER CLOCKWISE
DRIVER HEAD RESULTANT ACCELERATION
TRC NUMBER TRC837P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V206S85E00
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 74 48 G @ 90 48 MS, 0 00 G @ 3 76 MS

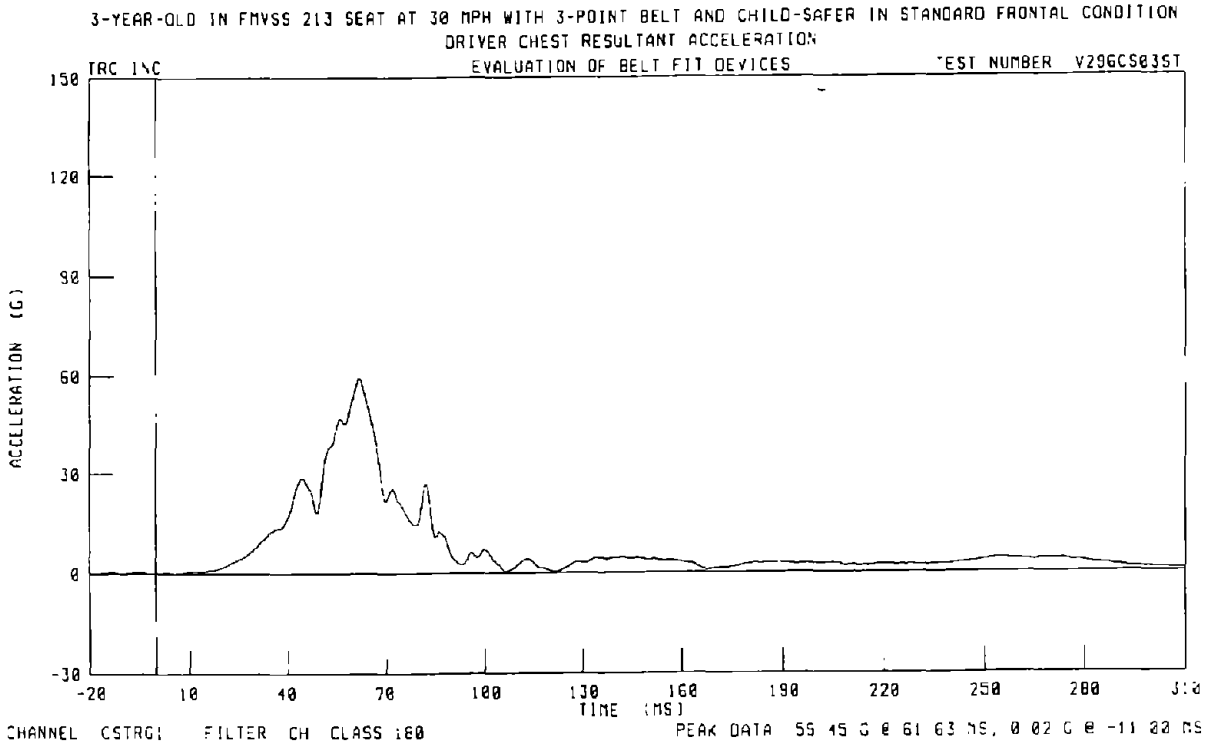

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT IN STANDARD FRONTAL CONDITION
DRIVER HEAD RESULTANT ACCELERATION
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968_50ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 75 02 G @ 93 00 MS, 0 03 G @ 15 13 MS

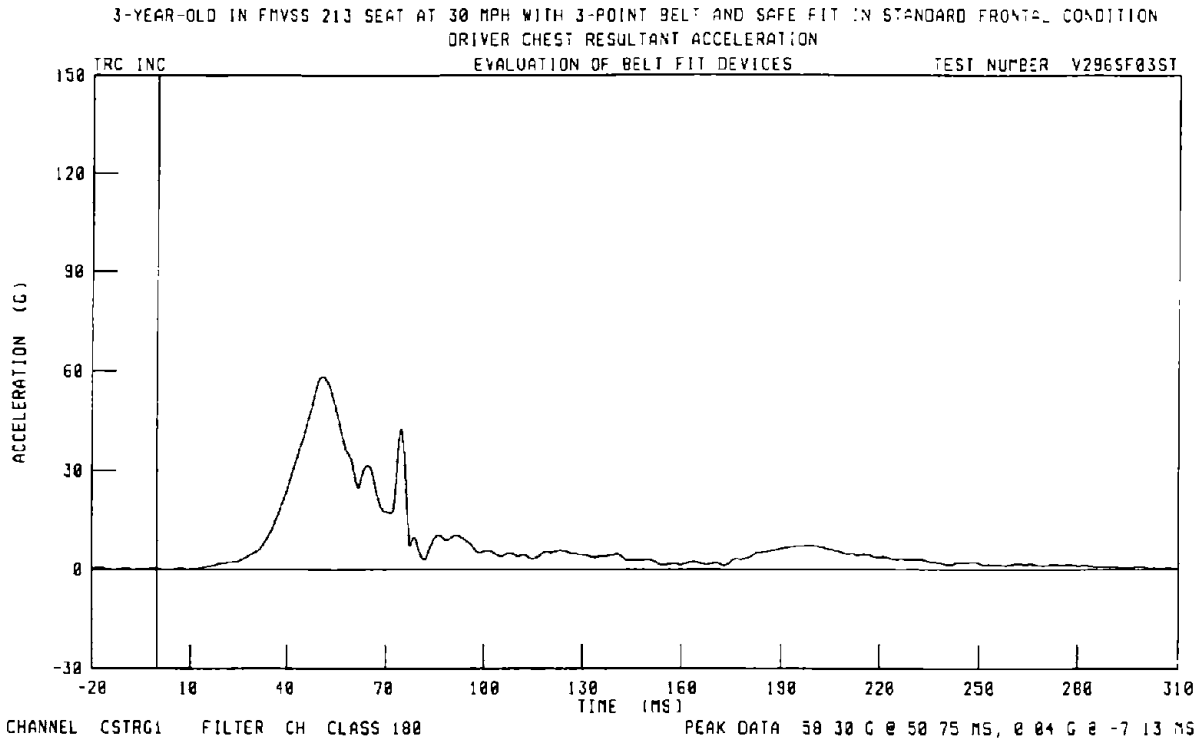

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT IN 15 DEGREE OFFSET
DRIVER HEAD RESULTANT ACCELERATION
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2960
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL HEDRG1 FILTER CH CLASS 1000
PEAK DATA 73 22 G @ 154 00 MS, 0 26 G @ 19 50 MS

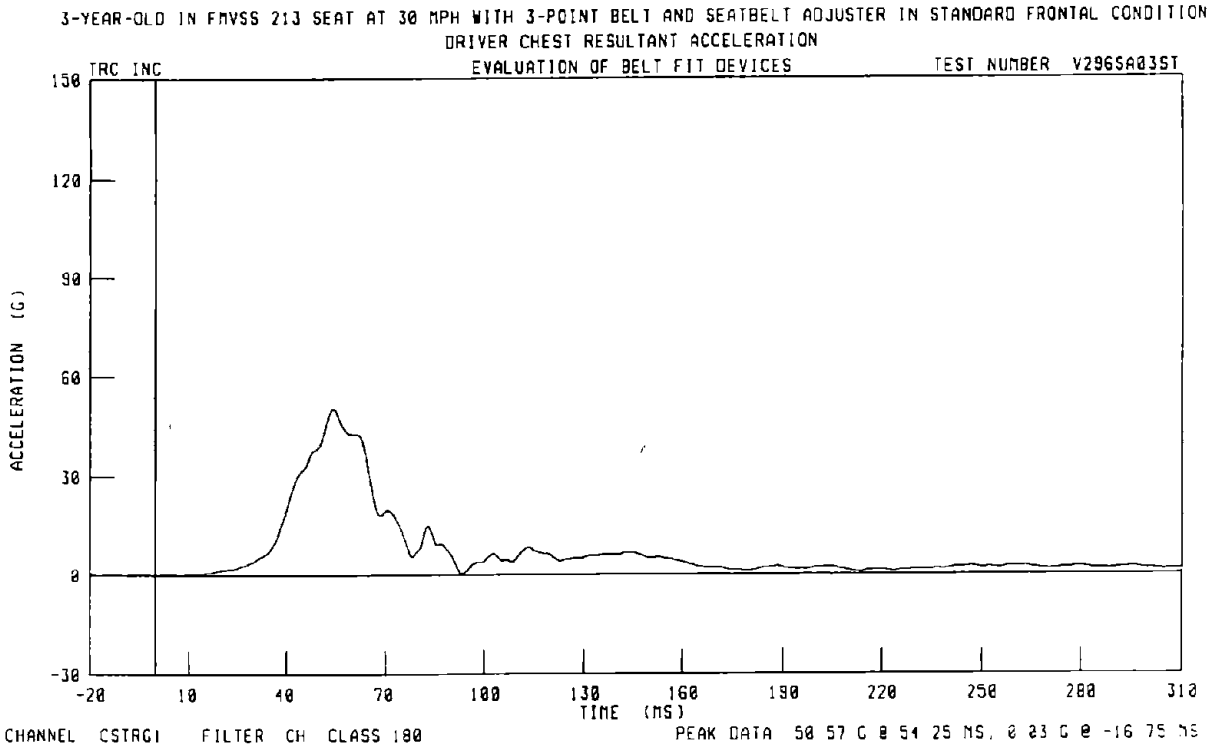
Appendix B

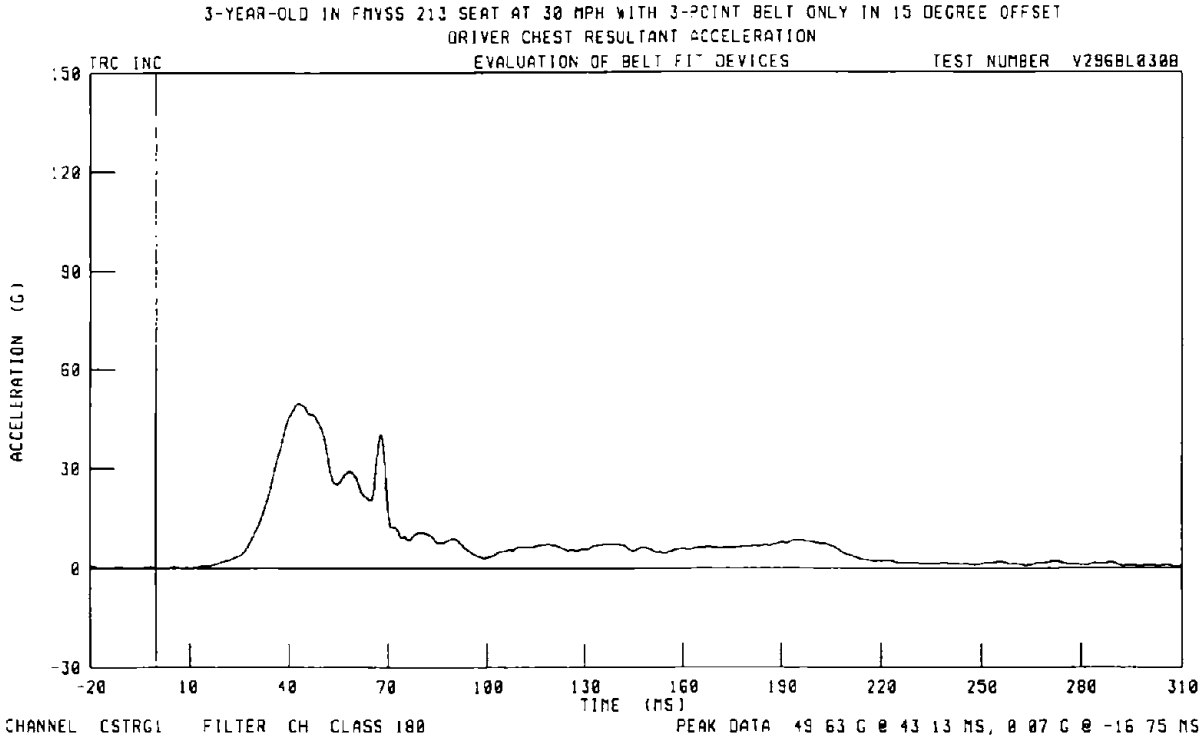
Resultant Chest Acceleration Time Histories

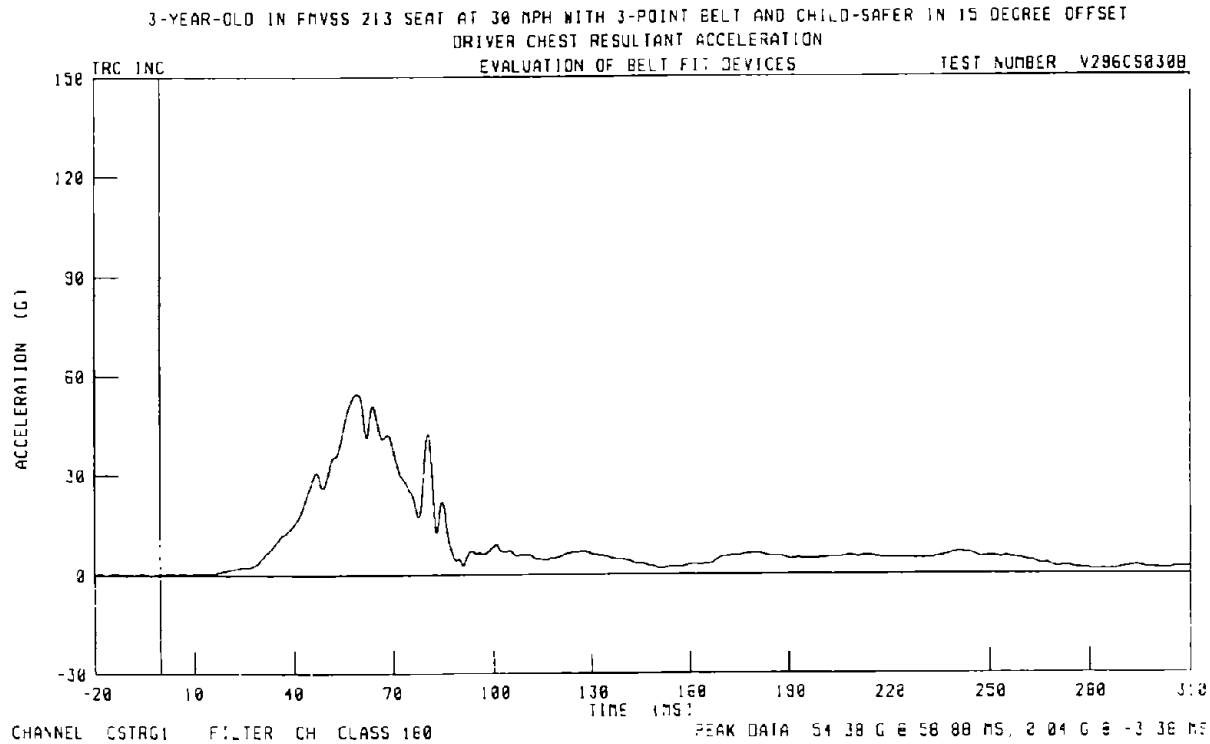

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V29EBL03ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 50 38 G @ 49 61 MS, 0 05 G @ 1 00 MS

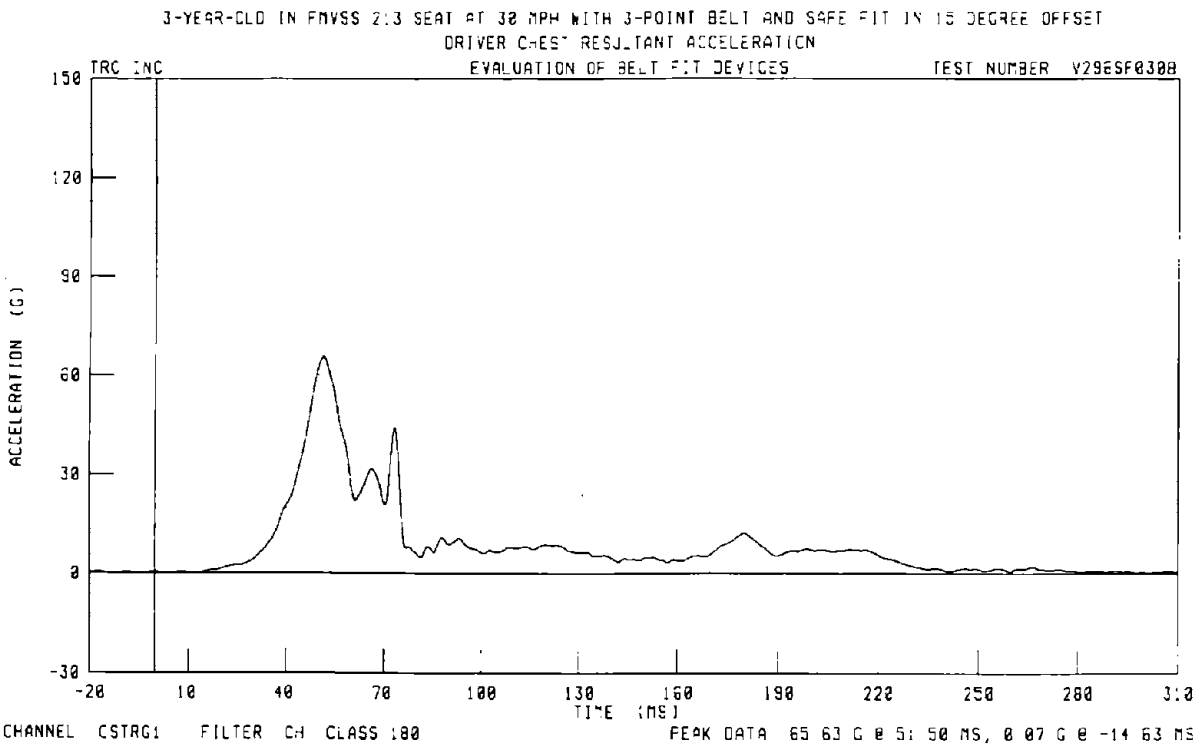

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V29GCS03ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 55 45 G @ 61 63 MS, 0 02 G @ -11 00 MS

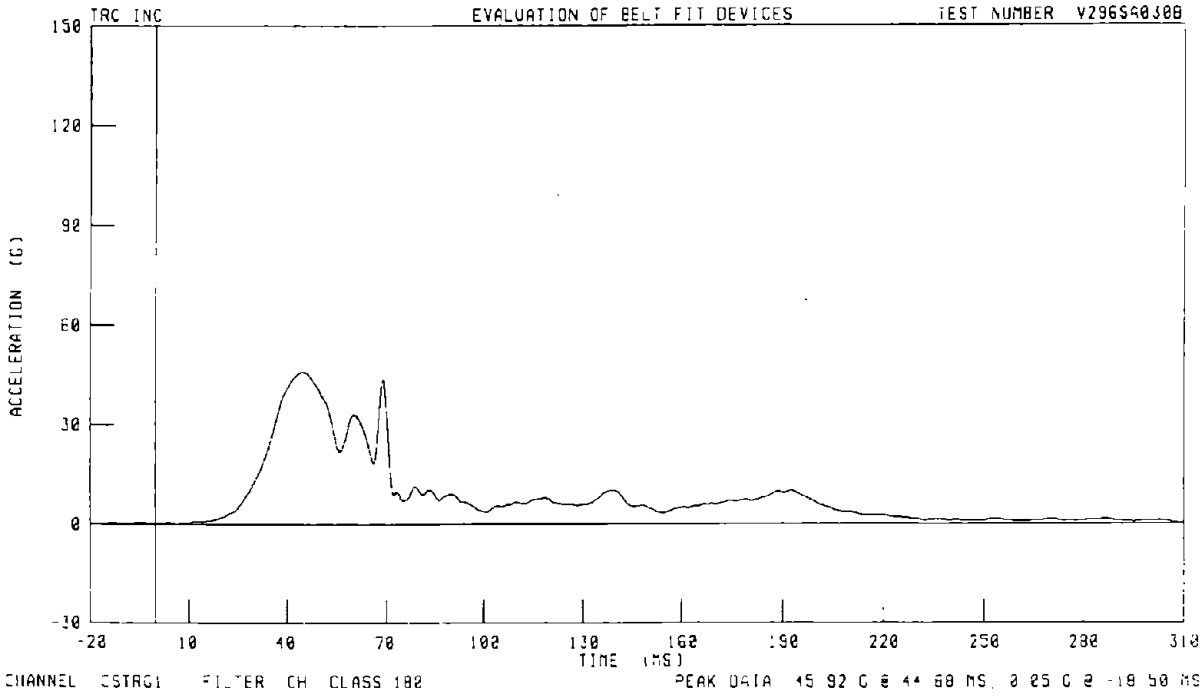

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF03ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 58 30 G @ 50 75 MS, @ 04 G @ -7 13 MS

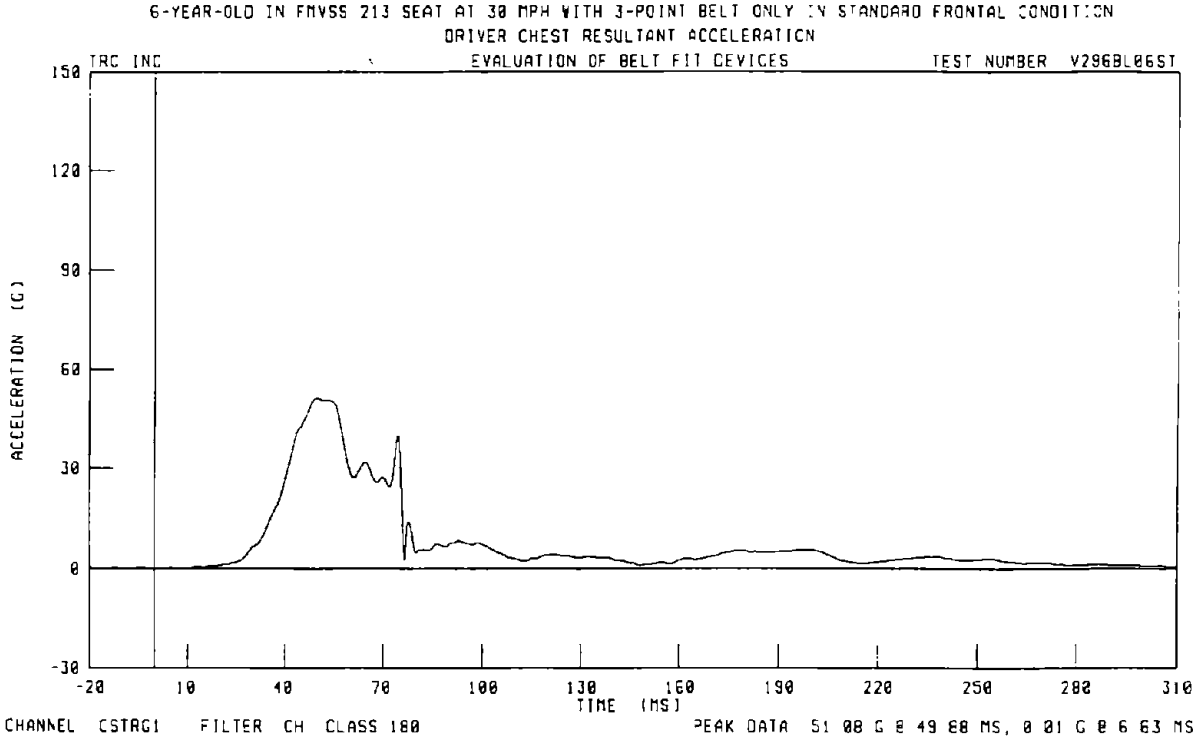

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA03ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 50 57 G @ 54 25 MS, @ 23 G @ -16 75 MS

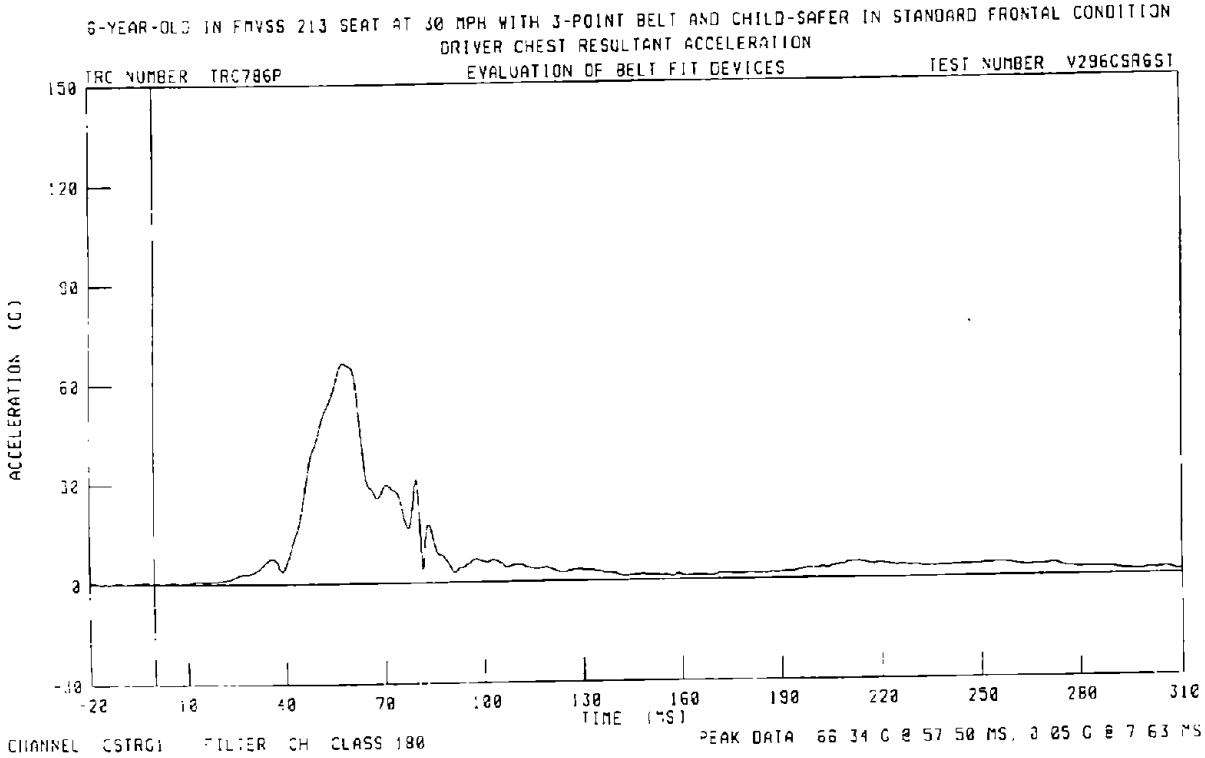

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL0308
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 49 63 G @ 43 13 MS, 0 07 G @ -16 75 MS

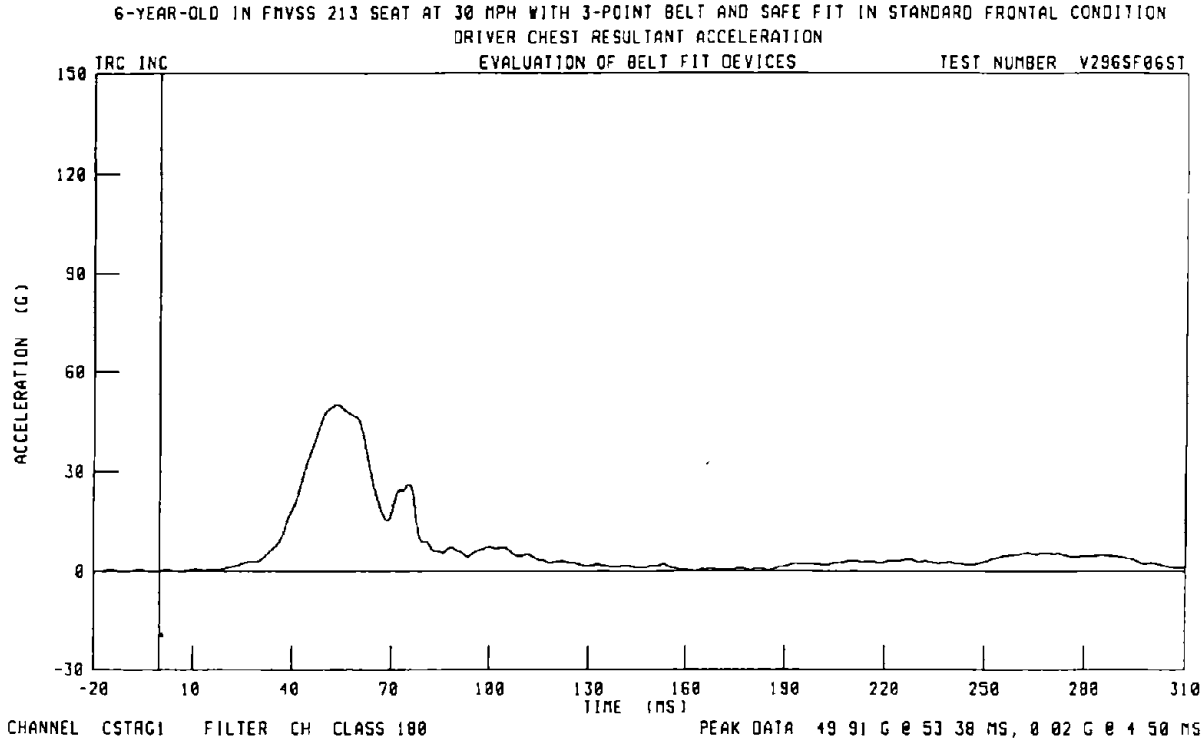

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C50308
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 160
PEAK DATA 54 38 G @ 58 88 MS, 2 04 G @ -3 38 MS

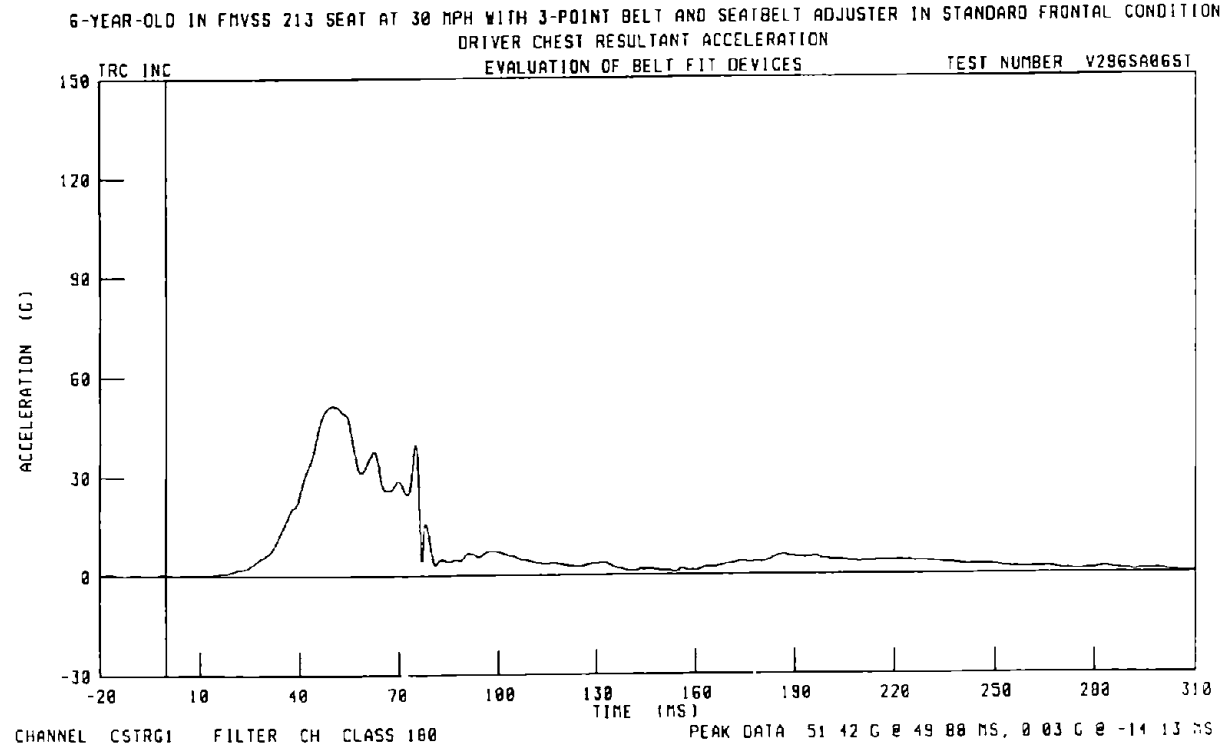

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF0308
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 65 63 G @ 51 50 MS, 0 07 G @ -14 63 MS

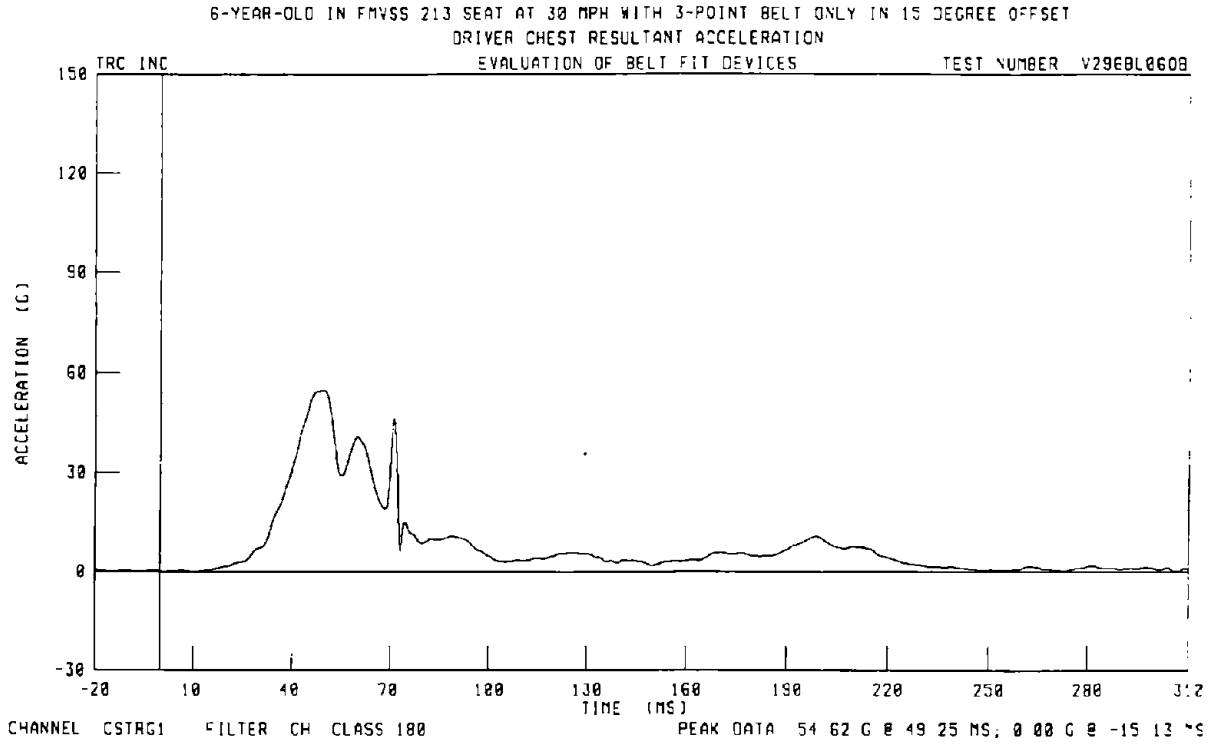

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA0308
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 45 92 G @ 44 60 MS, 0 25 G @ -18 50 MS

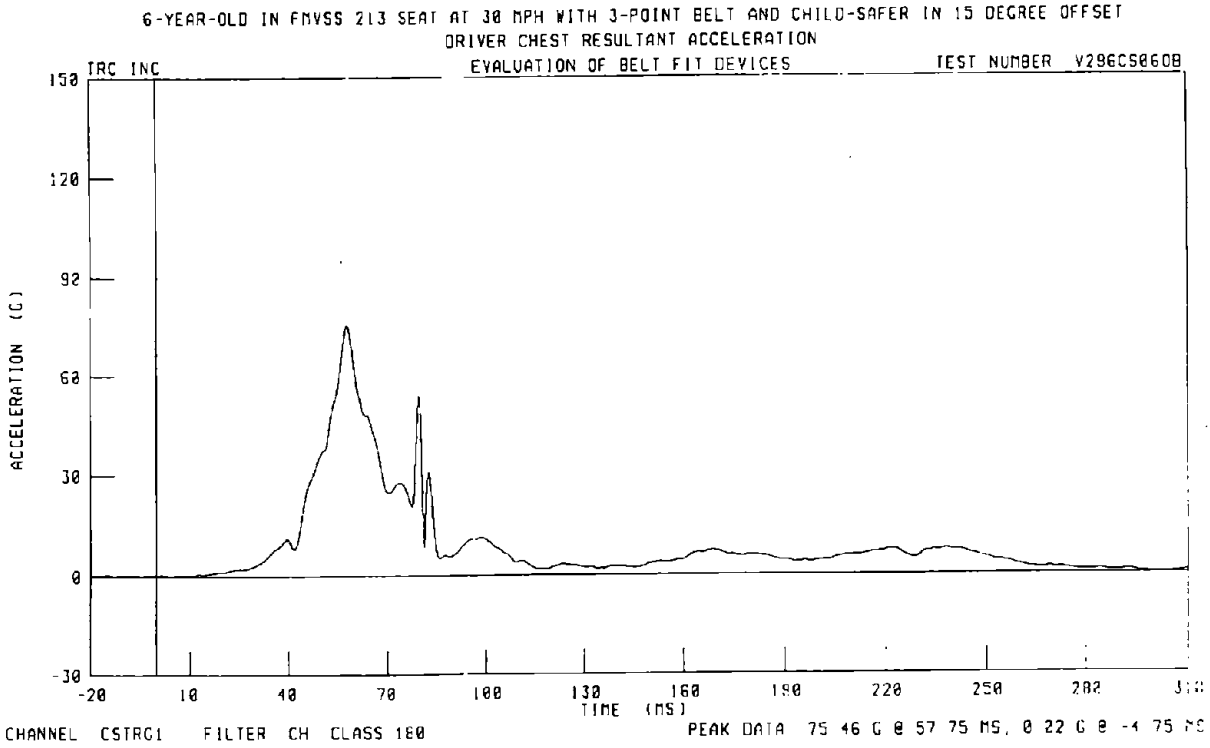

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL06ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 51 08 G @ 49 88 MS, 0 01 G @ 6 63 MS

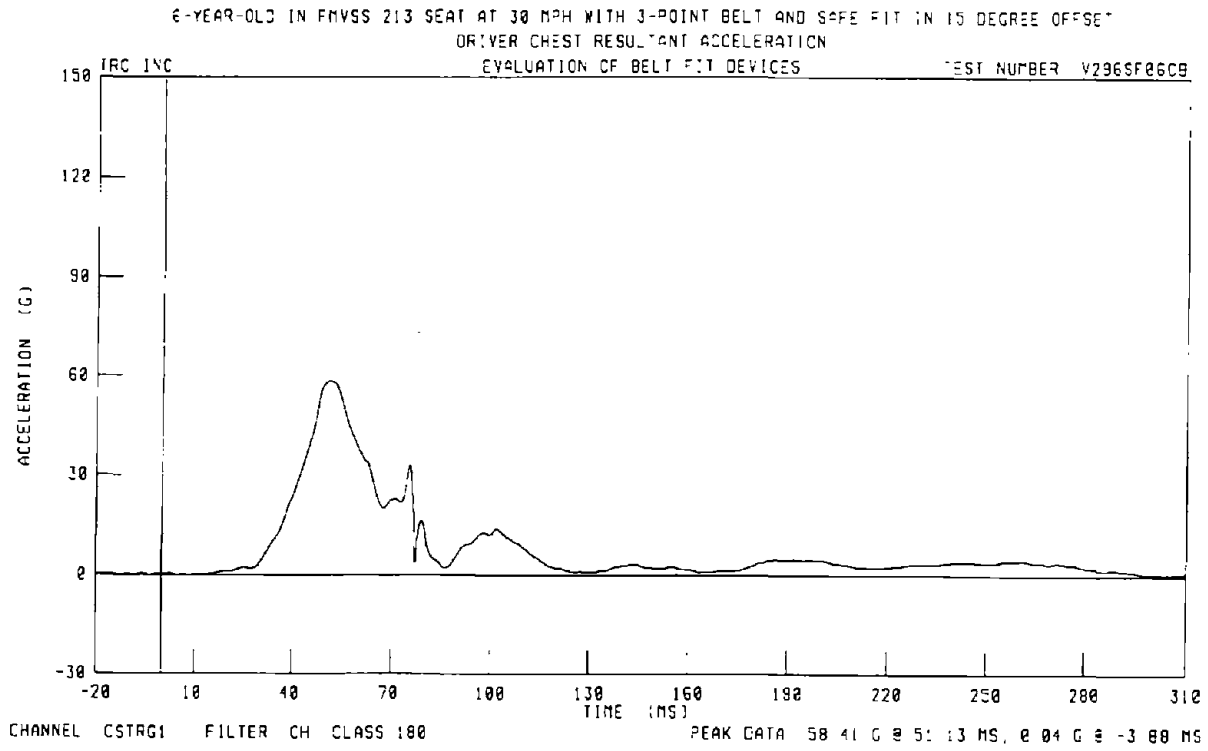

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC786P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CSR6ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-22
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 66 34 G @ 57 50 MS, 3 05 G @ 7 63 MS

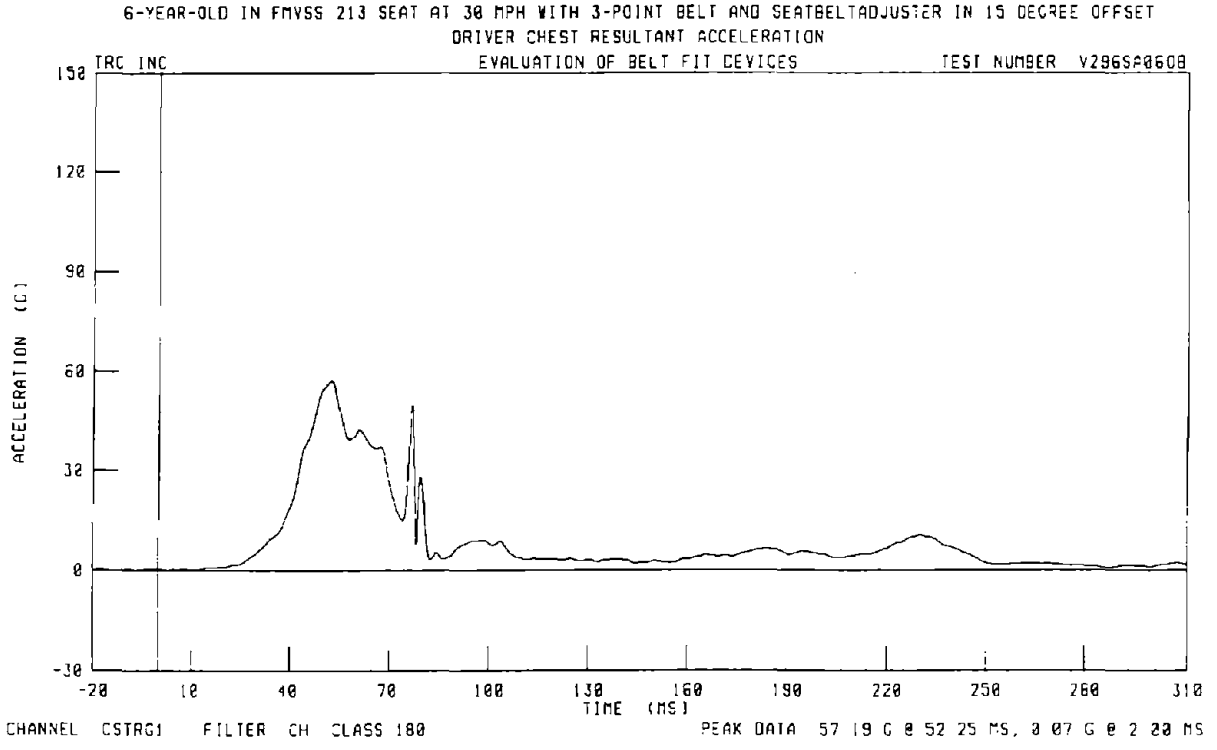

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF06ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 49 91 G @ 53 38 MS, 0 02 G @ 4 50 MS

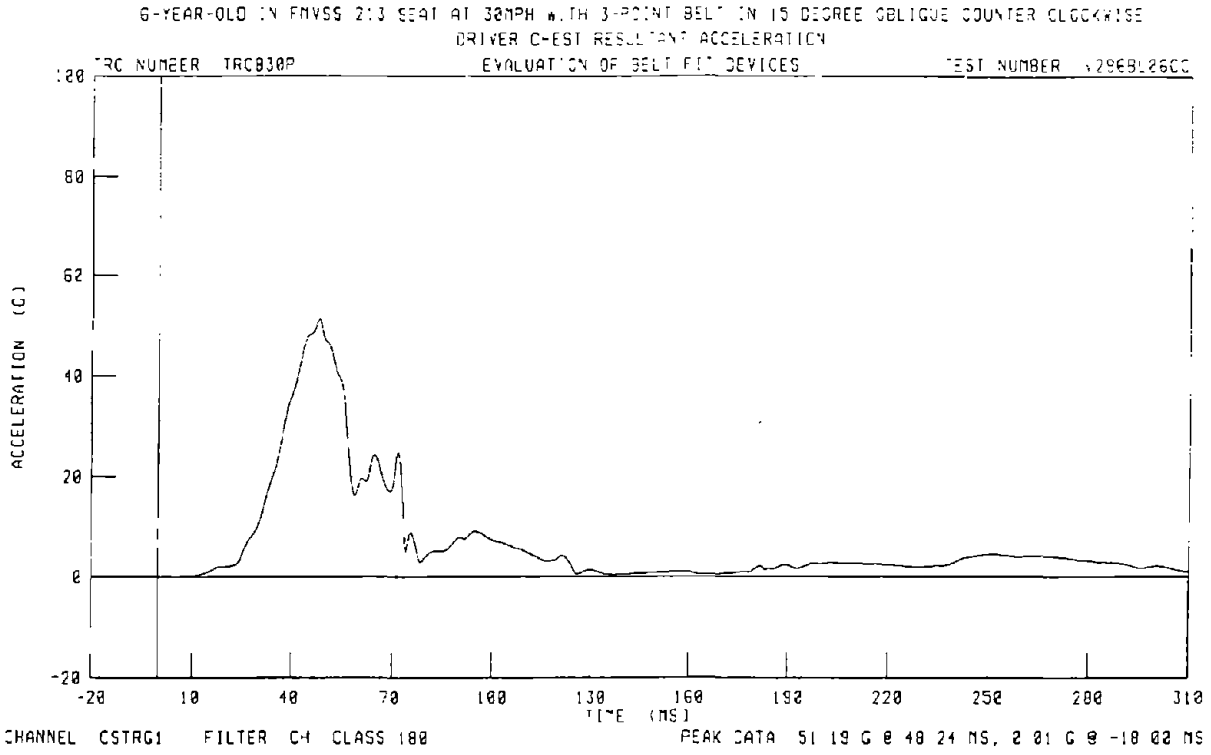

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA06ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 51 42 G @ 49 88 MS, 0 03 G @ -14 13 MS

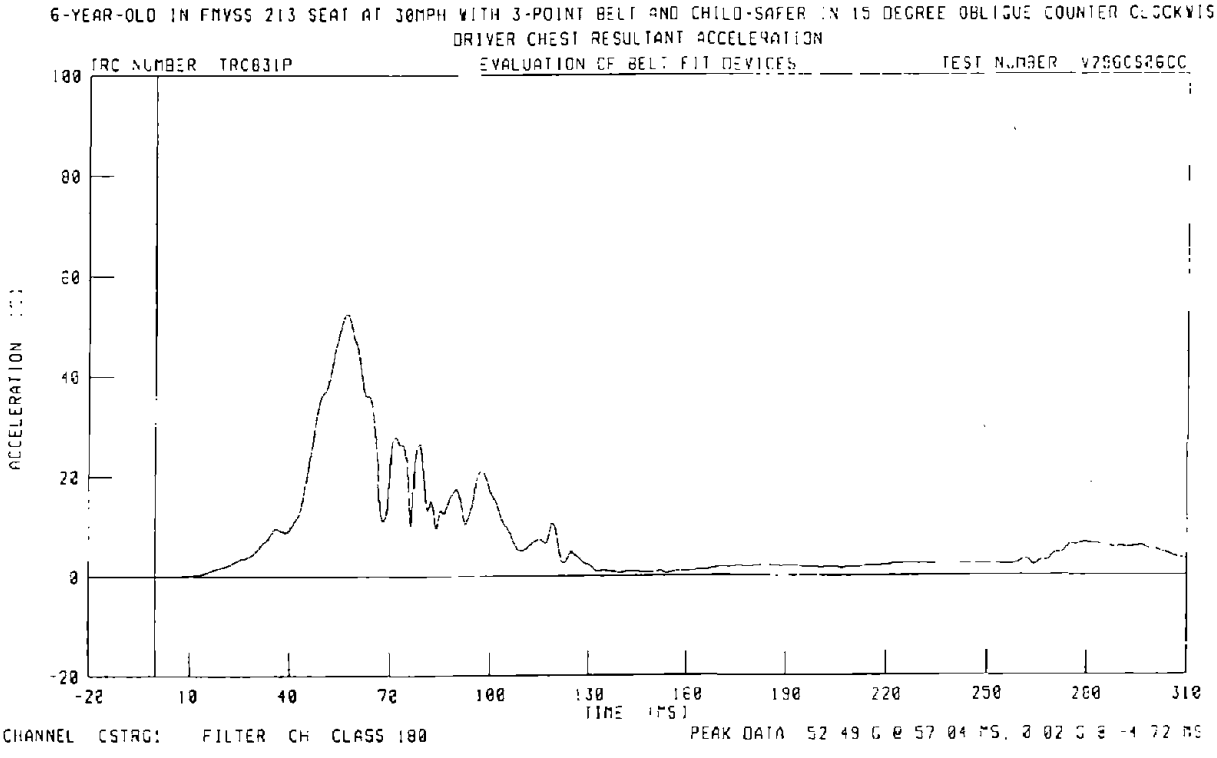

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL0608
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 54 62 G @ 49 25 MS; 0 00 G @ -15 13 MS

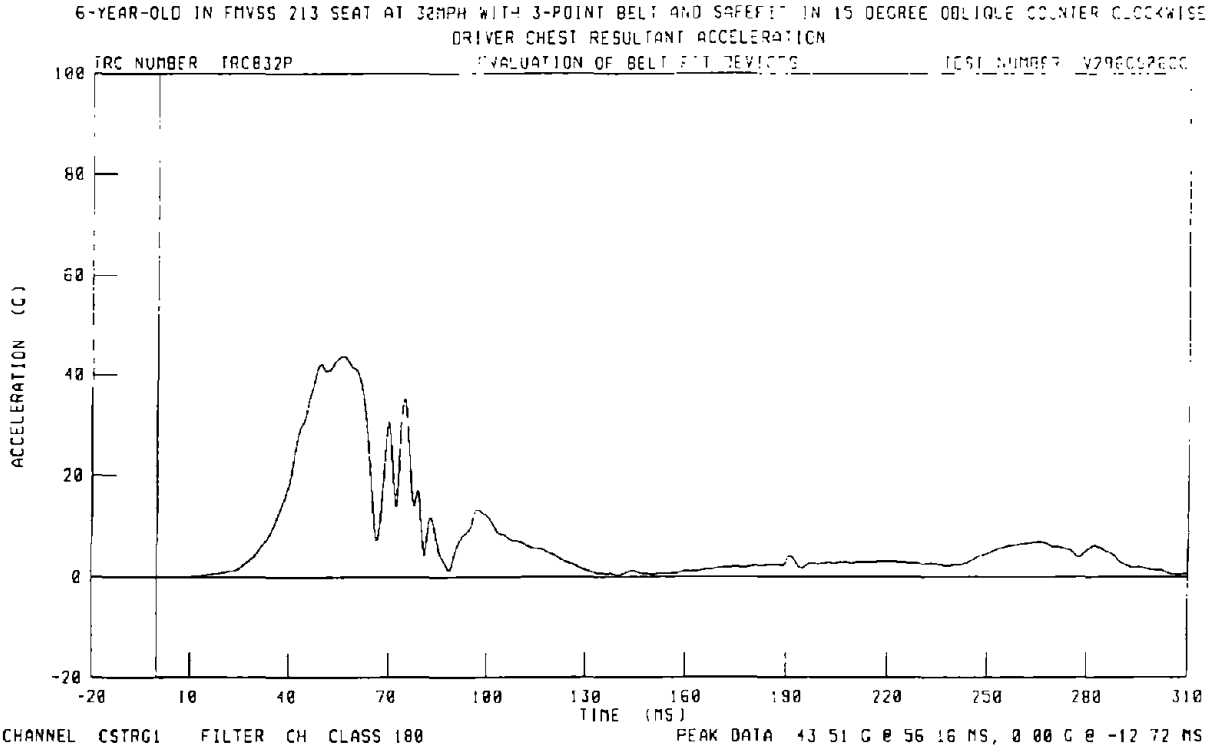

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS0608
ACCELERATION (G)
150
120
92
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 75 46 G @ 57 75 MS, 0 22 G @ -4 75 MS

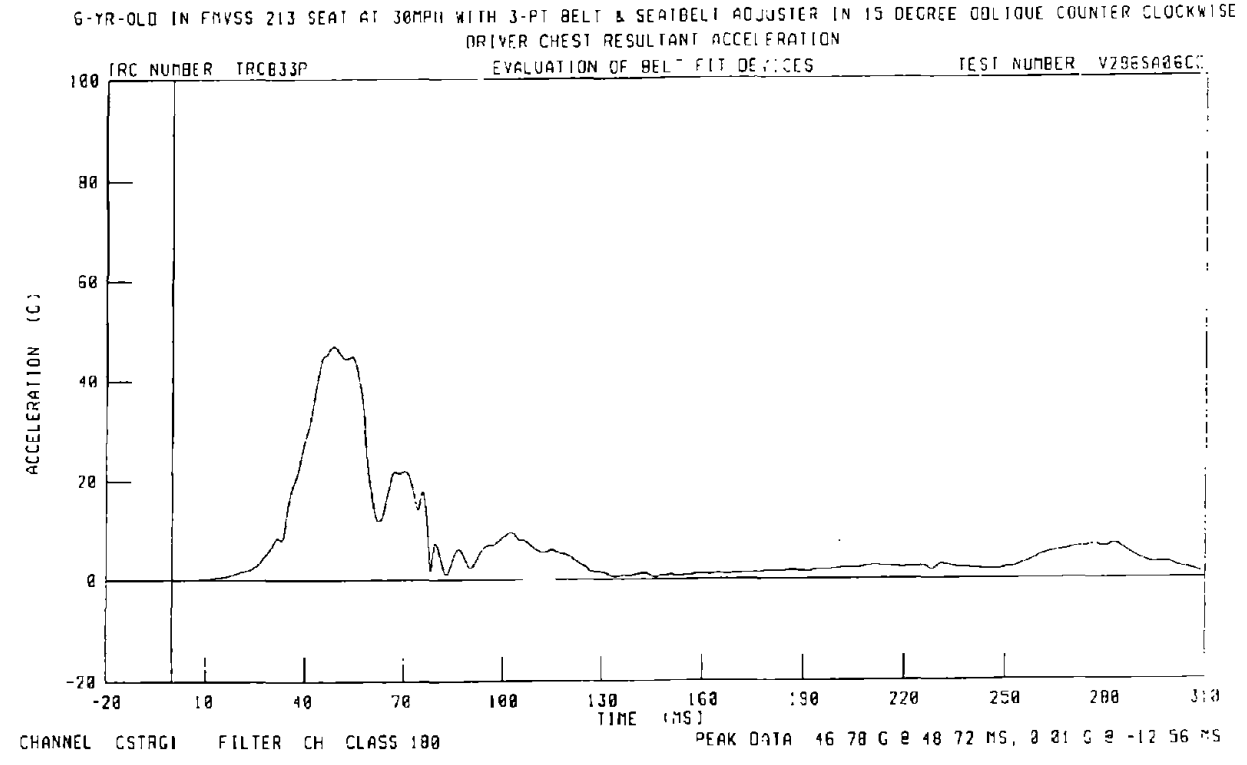

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF0608
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 58.41 G @ 51.13 MS, 0.04 G @ -3.88 MS

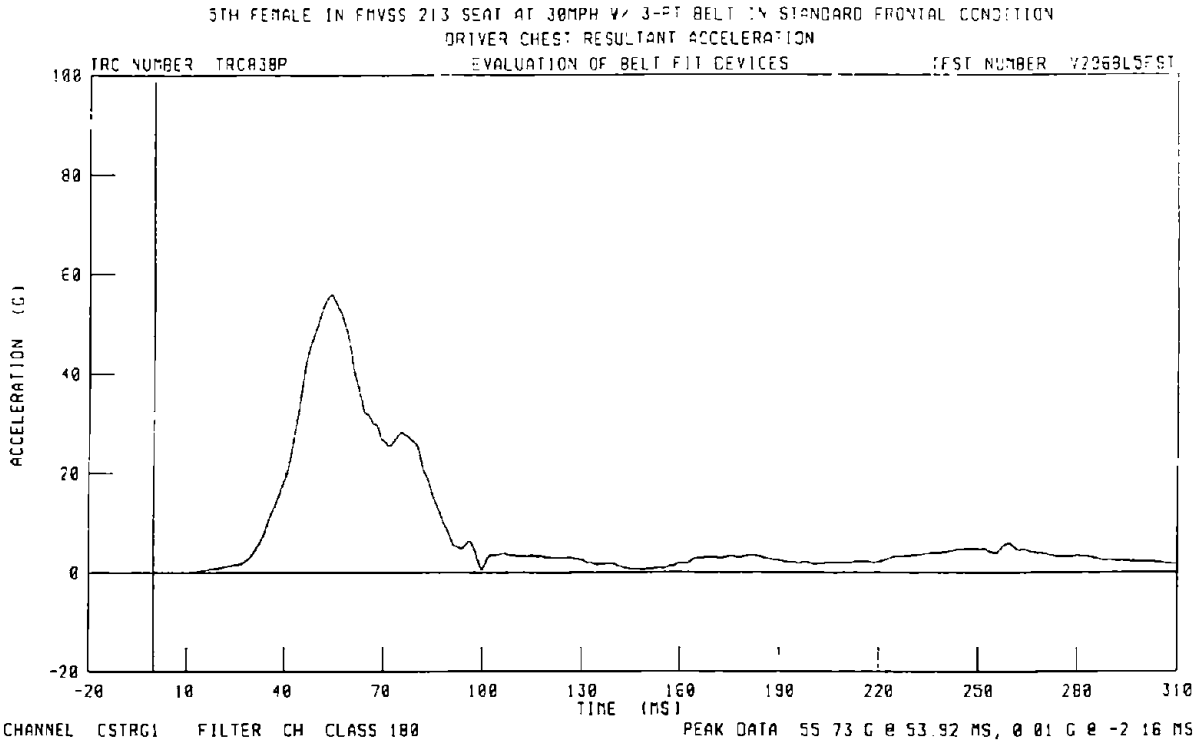

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELTADJUSTER IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA0608
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 57.19 G @ 52.25 MS, 0.07 G @ 2.20 MS

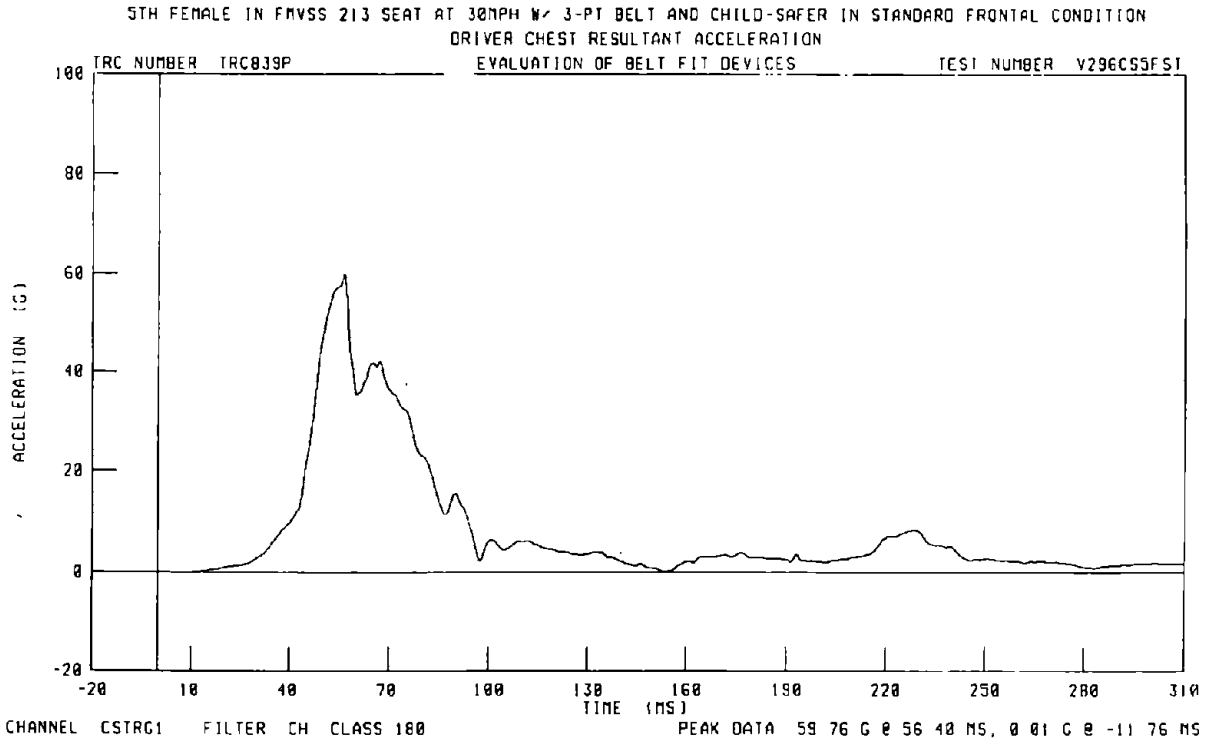

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC830P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BL26CC
ACCELERATION (G)
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 51 19 G @ 40 24 MS, 2 01 G @ -18 02 MS

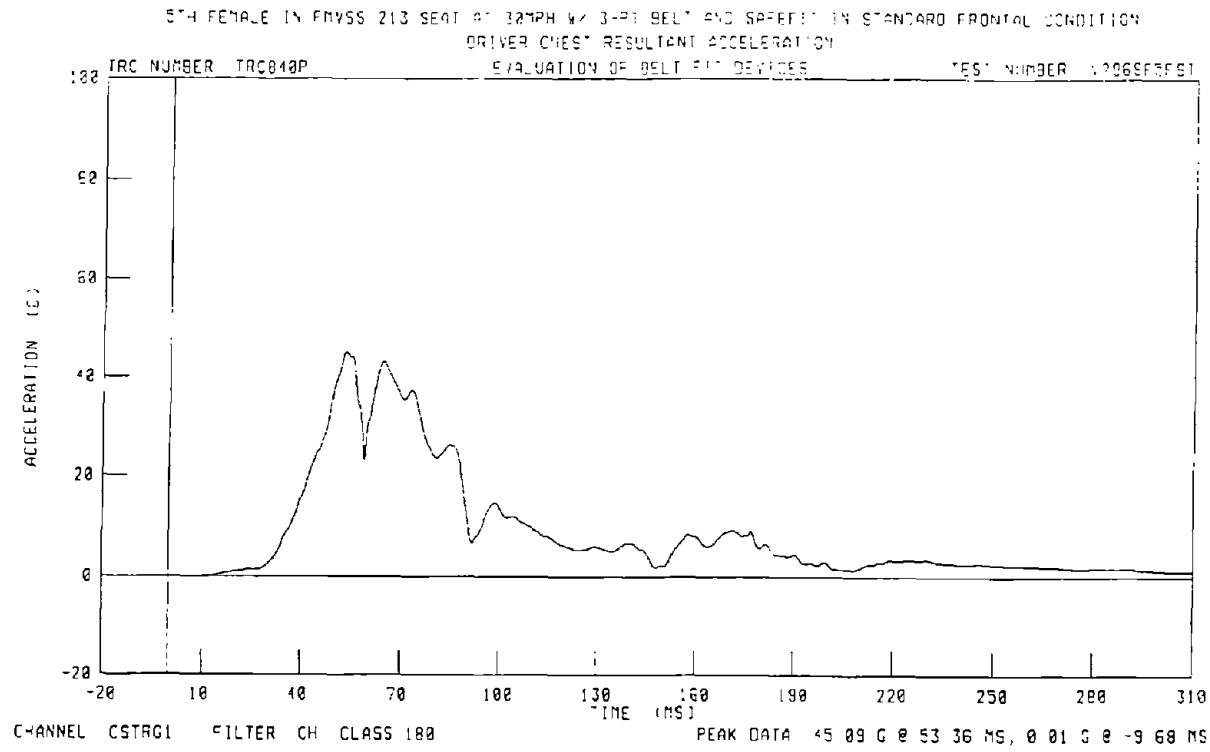

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC831P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V299CS26CC
ACCELERATION (G)
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 52 49 G @ 57 04 MS, 2 02 G @ -4 72 MS

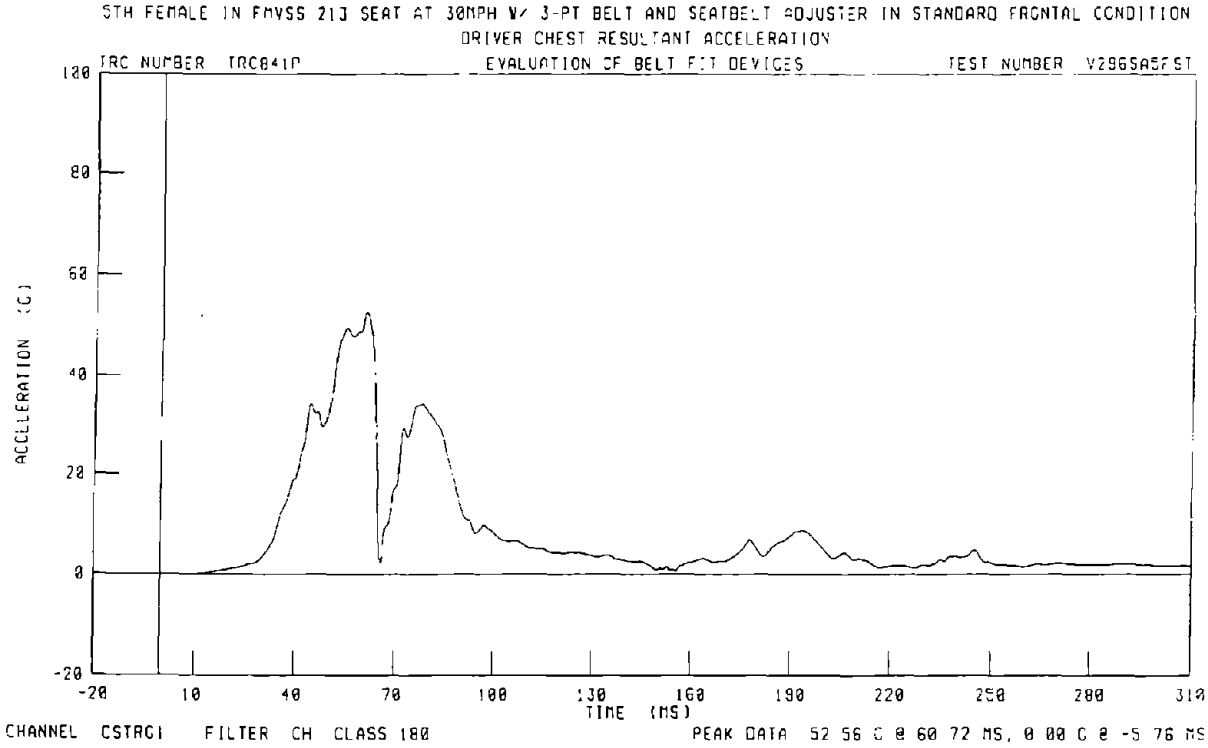

6-YEAR-OLD IN FMVSS 213 SEAT AT 32MPH WITH 3-POINT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC832P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298SA02CC
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 43 51 G @ 56 16 MS, 0 00 G @ -12 72 MS

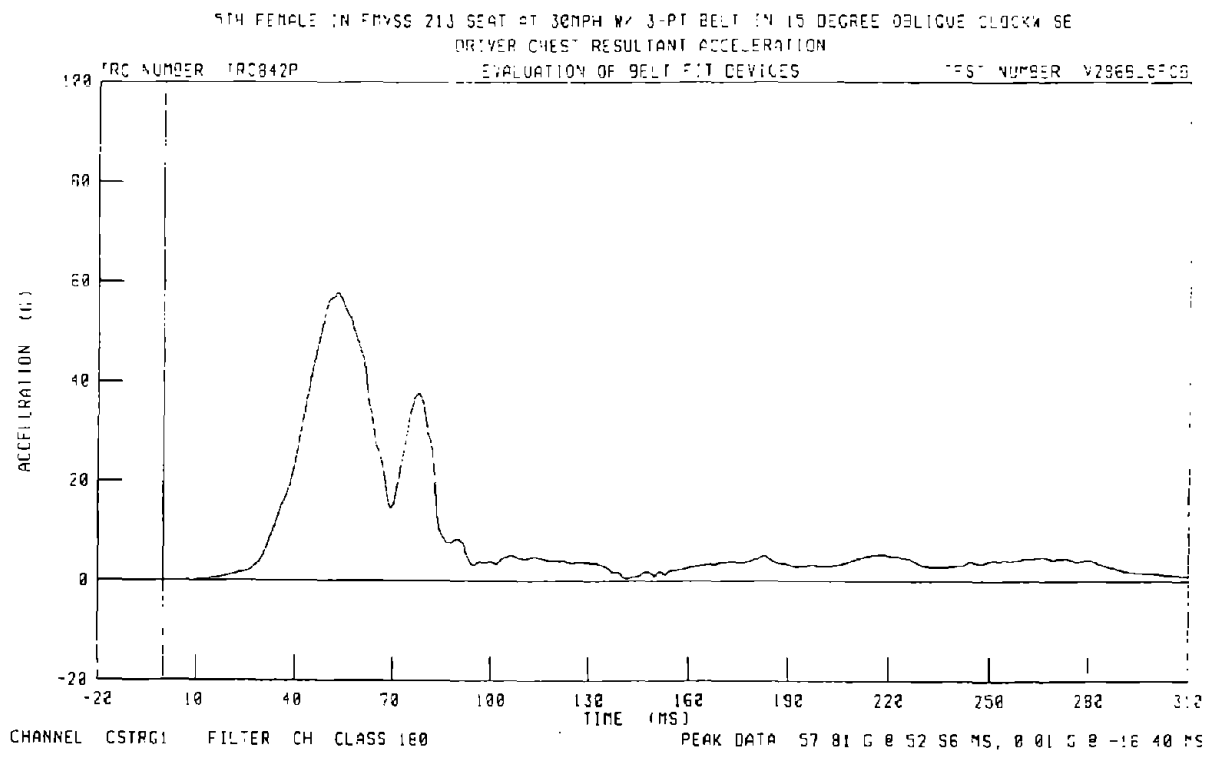

6-YR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT & SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC833P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298SA06CC
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 46 78 G @ 48 72 MS, 0 01 G @ -12 56 MS

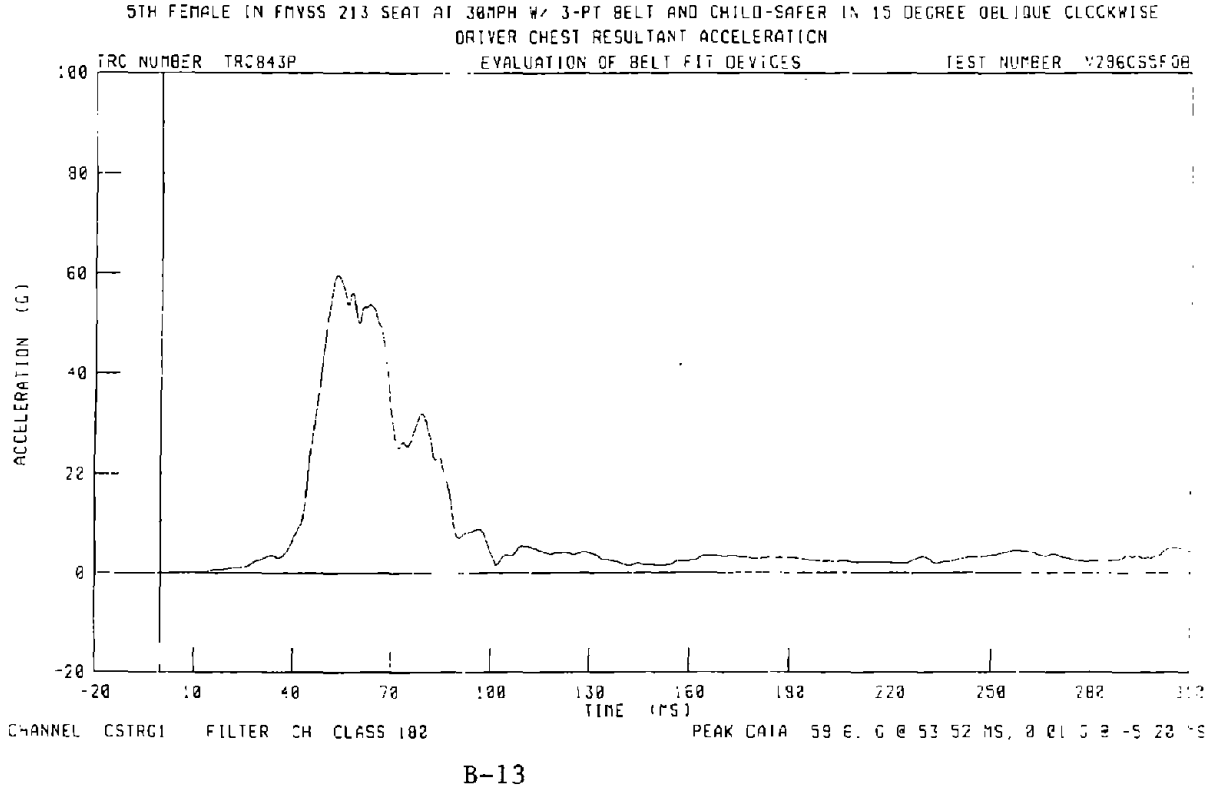

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2368L5FST
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 55 73 G @ 53.92 MS, 0 01 G @ -2 16 MS

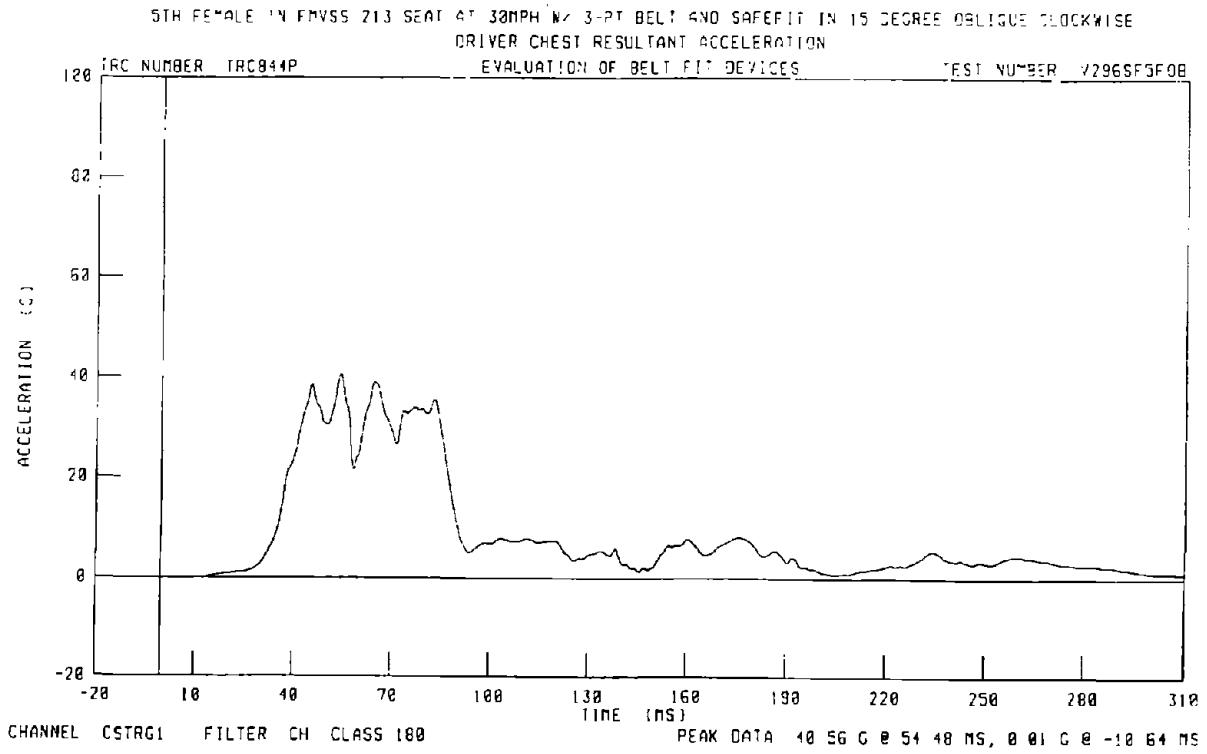

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FST
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 59 76 G @ 56 40 MS, 0 01 G @ -11 76 MS

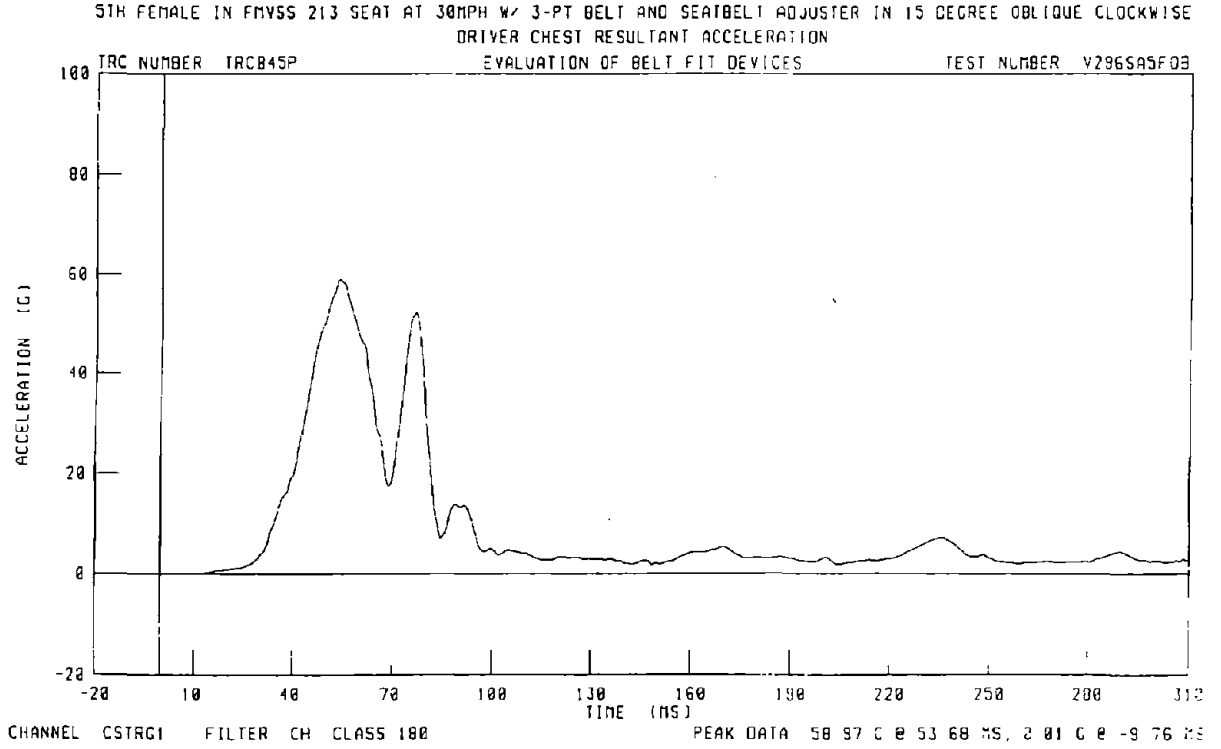

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SBSFST
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 45 09 G @ 53 36 MS, 0 01 G @ -9 68 MS

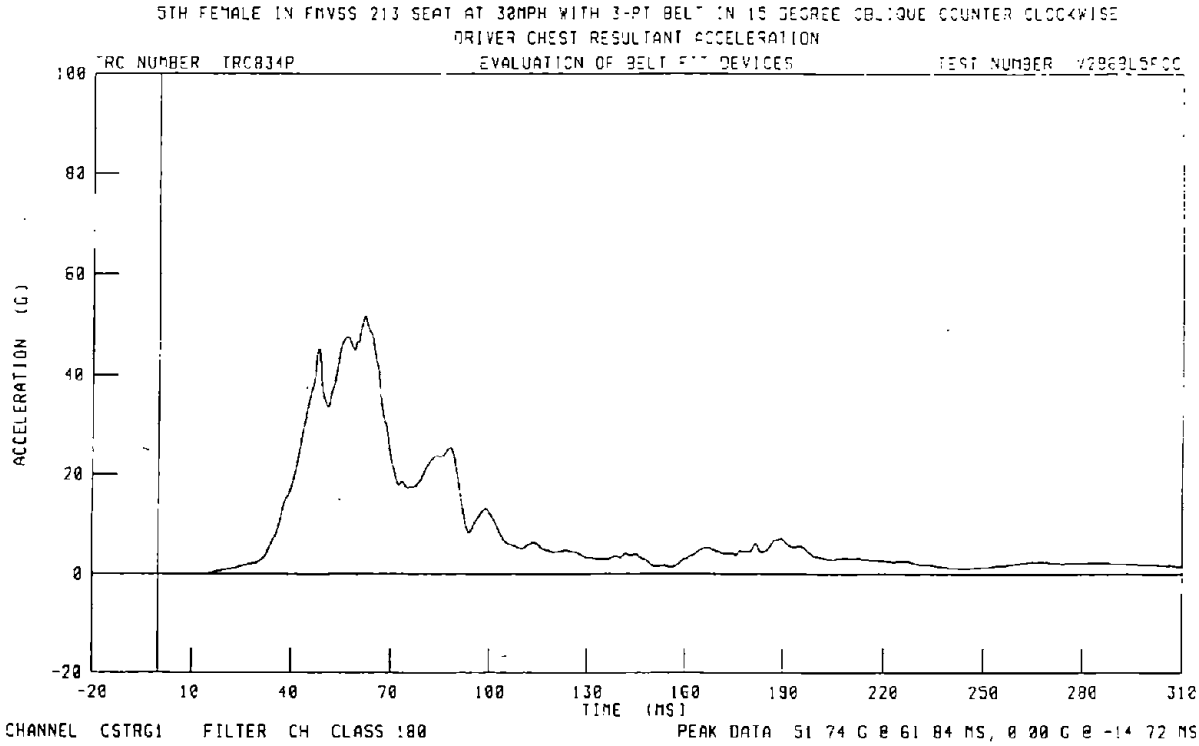

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC841P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SASFST
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 52 56 G @ 60 72 MS, 0 00 G @ -5 76 MS

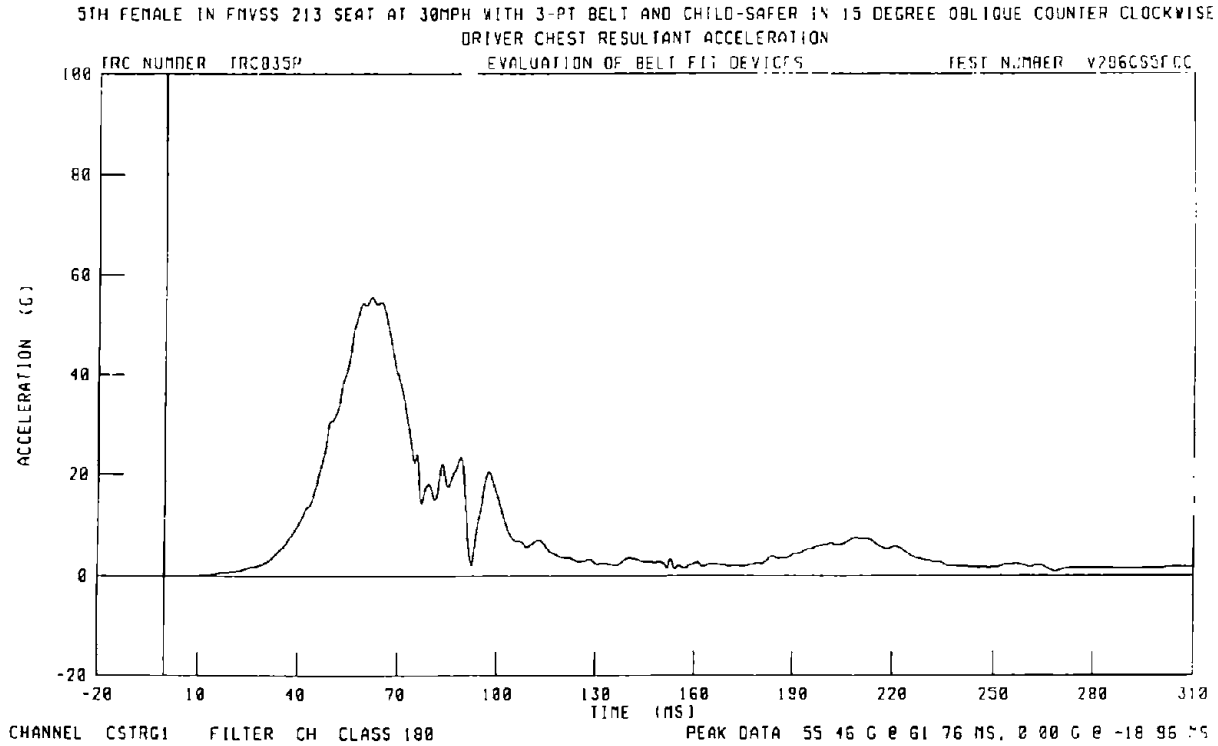

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKW SE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296B_SFCB
ACCELERATION (G)
100
80
60
40
20
0
-20
-22
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 57 81 G @ 52 56 MS, 0 01 G @ -16 40 MS

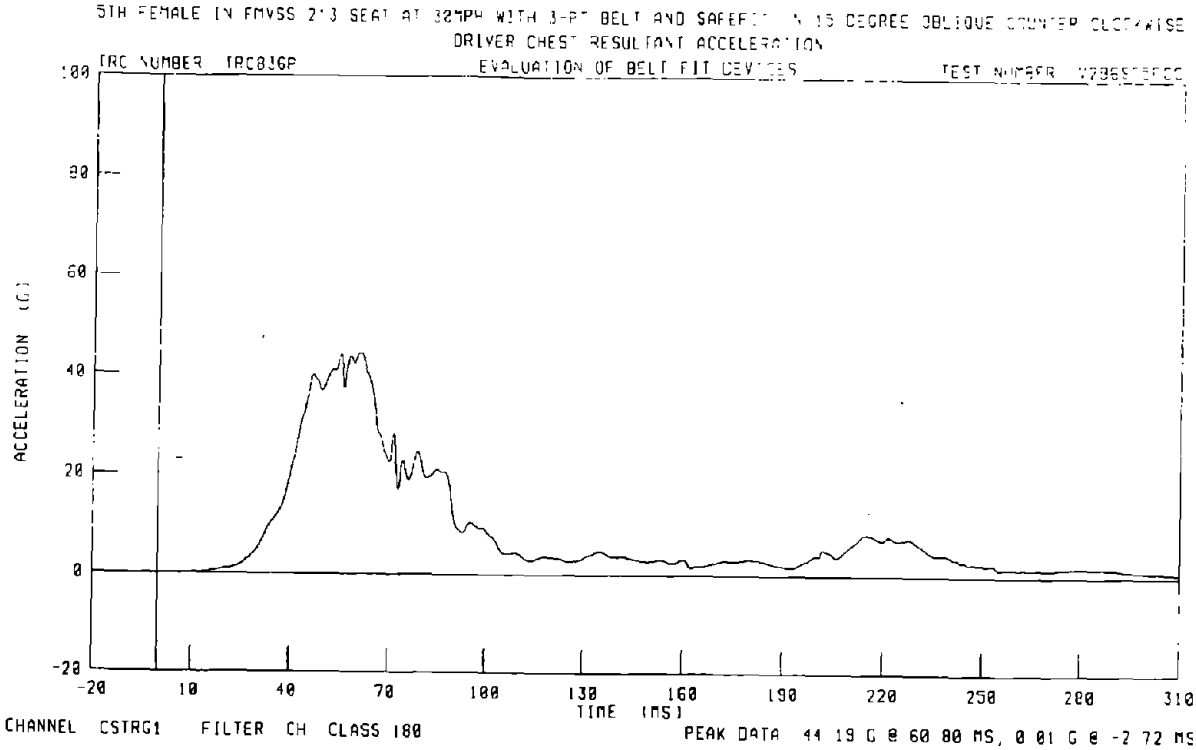

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CSSF0B
ACCELERATION (G)
100
80
60
40
22
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 59 E. G @ 53 52 MS, 0 01 G @ -5 20 MS

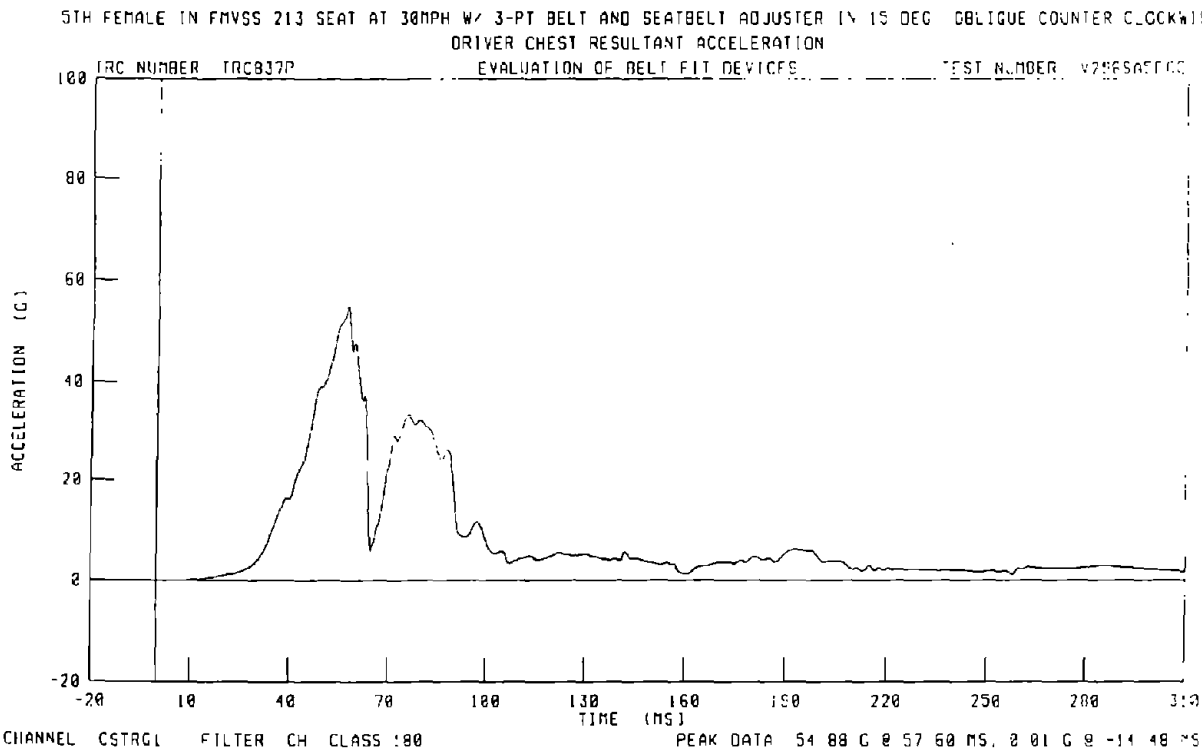

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
IRC NUMBER IRC844P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF3F08
ACCELERATION (G)
120
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 40 56 G @ 54 48 MS, 0 01 G @ -10 64 MS

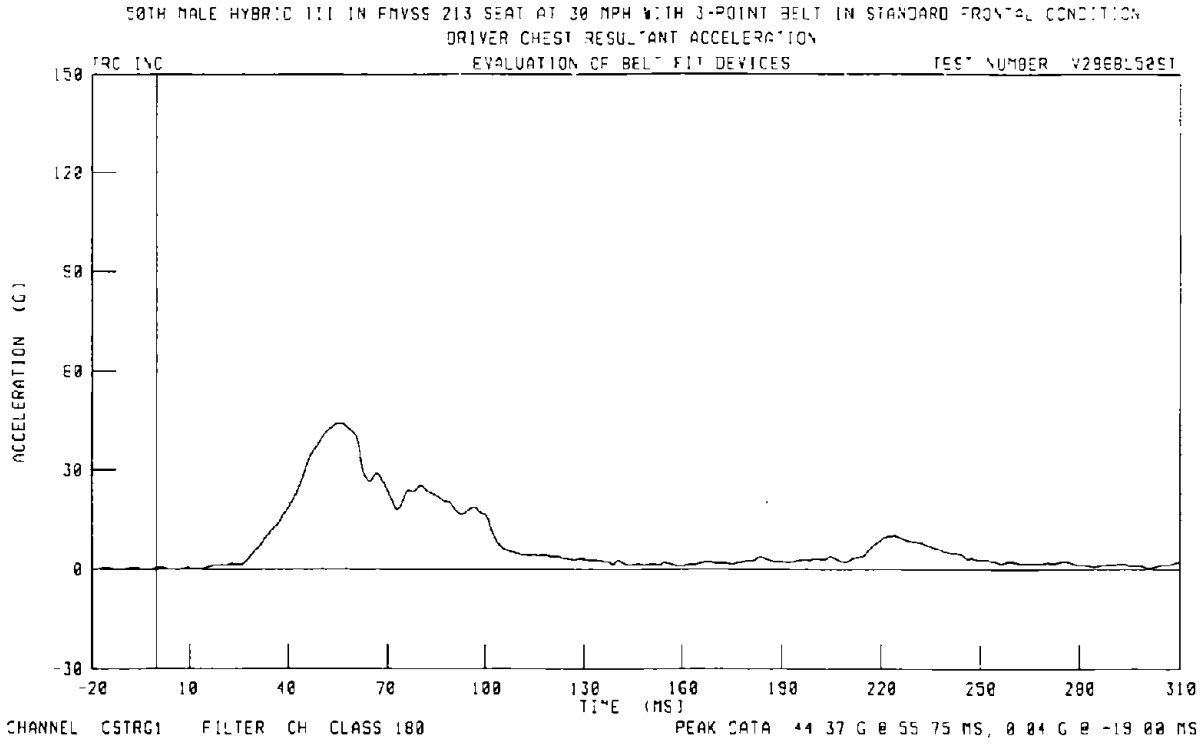

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
IRC NUMBER IRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5F03
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 58 97 G @ 53 68 MS, 2 01 G @ -9 76 MS

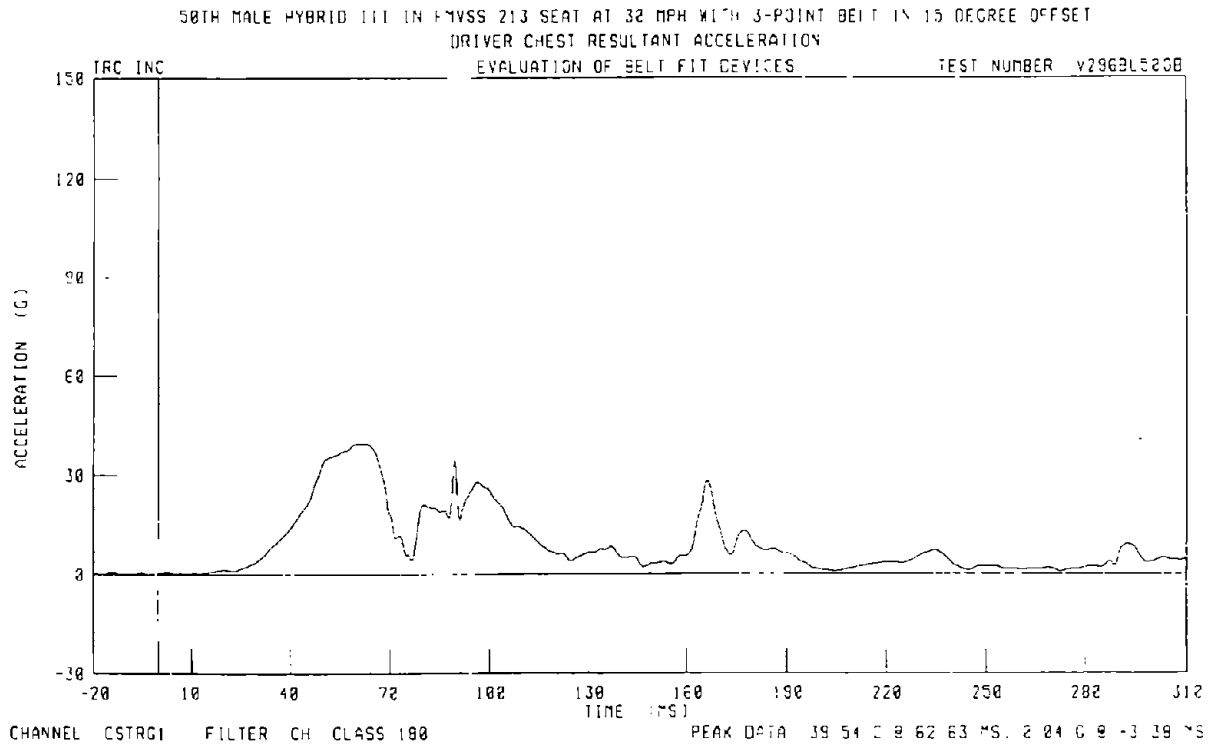

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V286BL5F00
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 51 74 G @ 61 84 MS, 0 00 G @ -14 72 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC835P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V286CSSF00
ACCELERATION (G)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 55 46 G @ 61 76 MS, 0 00 G @ -18 96 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFETY
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
ACCELERATION (G)
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 44 19 G @ 60 80 MS, 0 01 G @ -2 72 MS

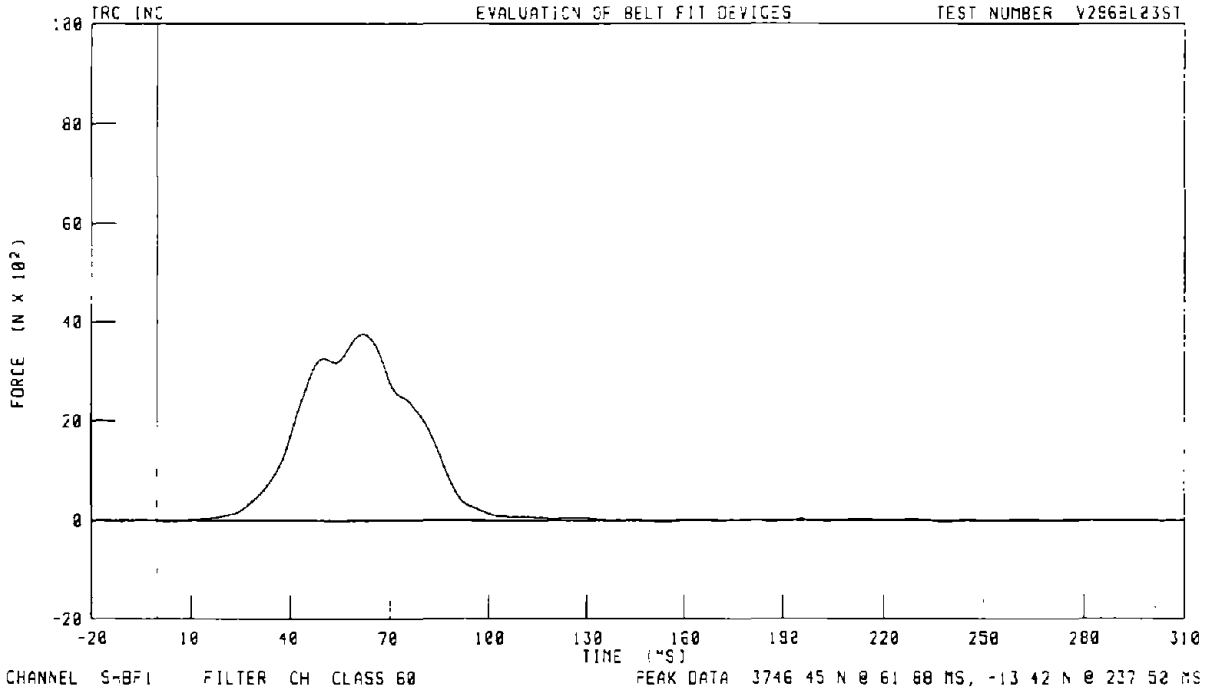

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEG OBLIQUE COUNTER CLOCKWISE
DRIVER CHEST RESULTANT ACCELERATION
TRC NUMBER TRC837P
EVALUATION OF BELT FIT DEVICES
ACCELERATION (G)
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 54 88 G @ 57 60 MS, 0 01 G @ -14 48 MS

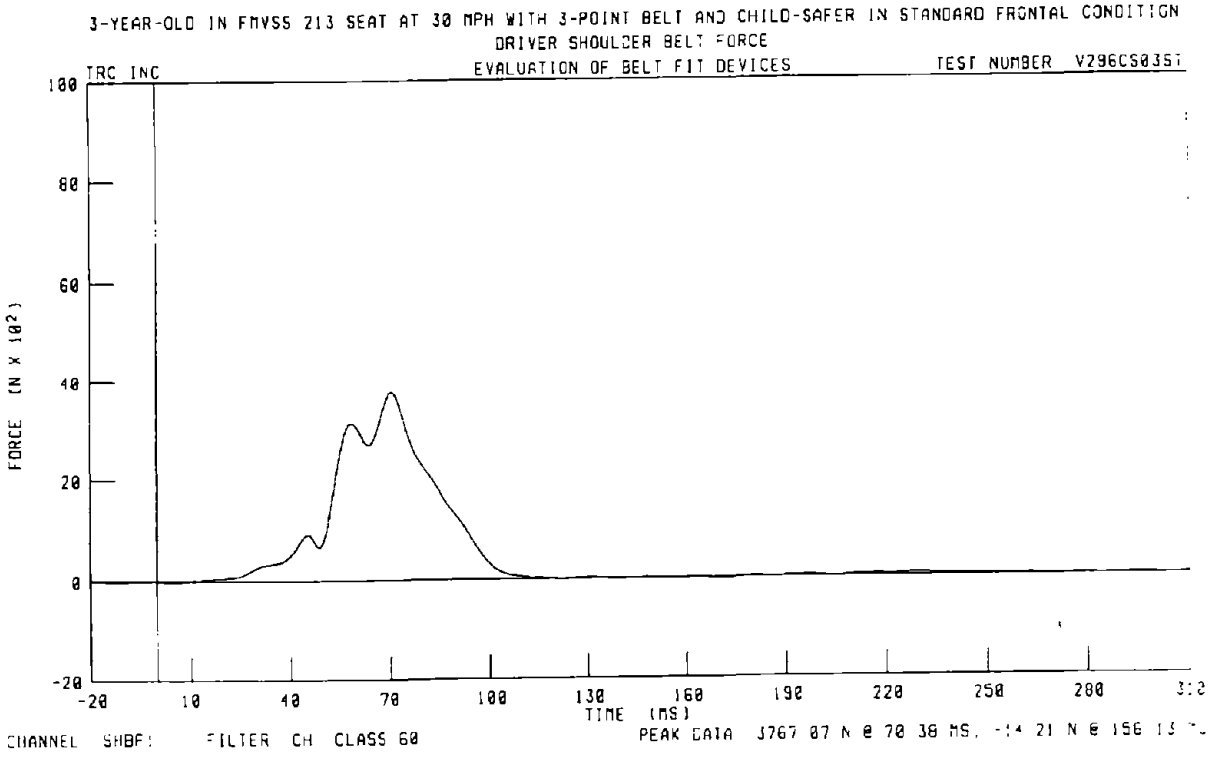

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT IN STANDARD FRONTAL CONDITION
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL52ST
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 44 37 G @ 55 75 MS, 0 84 G @ -19 00 MS

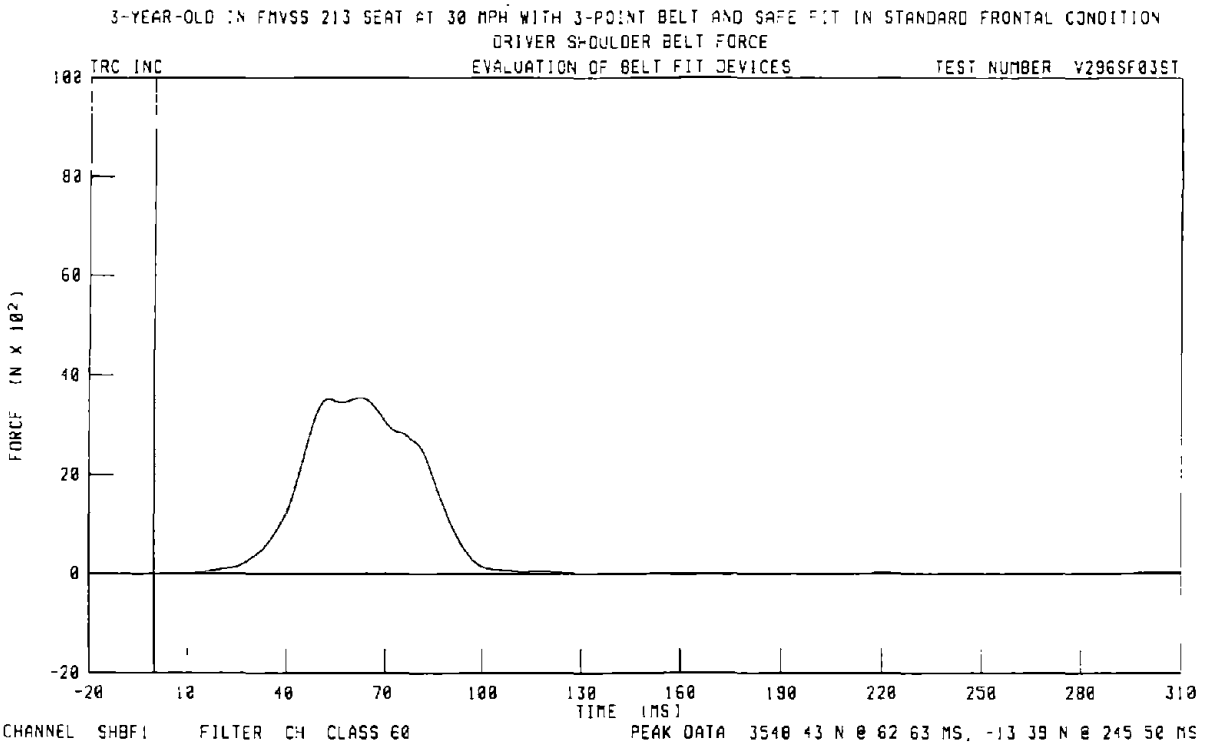

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 32 MPH WITH 3-POINT BELT IN 15 DEGREE OFFSET
DRIVER CHEST RESULTANT ACCELERATION
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL52OB
ACCELERATION (G)
150
120
90
60
30
0
-30
-20
10
40
72
102
130
160
190
220
250
282
312
TIME (MS)
CHANNEL CSTRG1 FILTER CH CLASS 180
PEAK DATA 39 54 G @ 62 63 MS, 2 04 G @ -3 38 MS

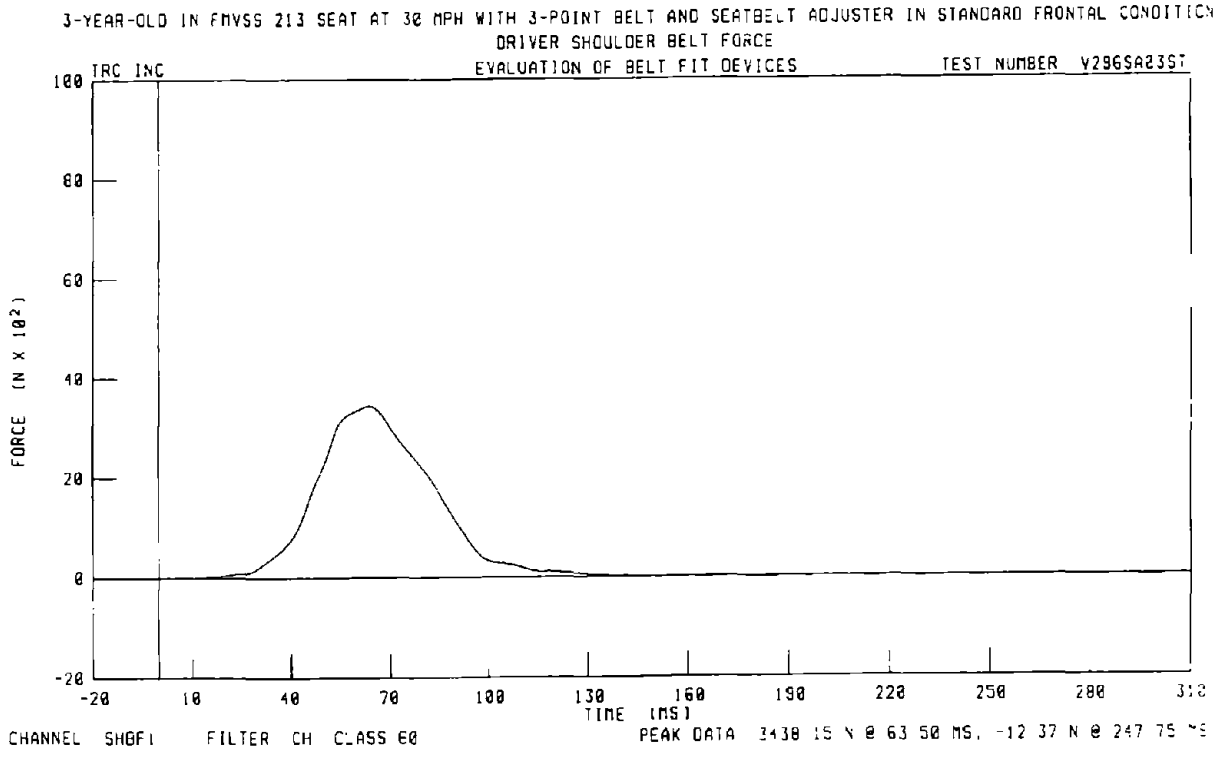
Appendix C

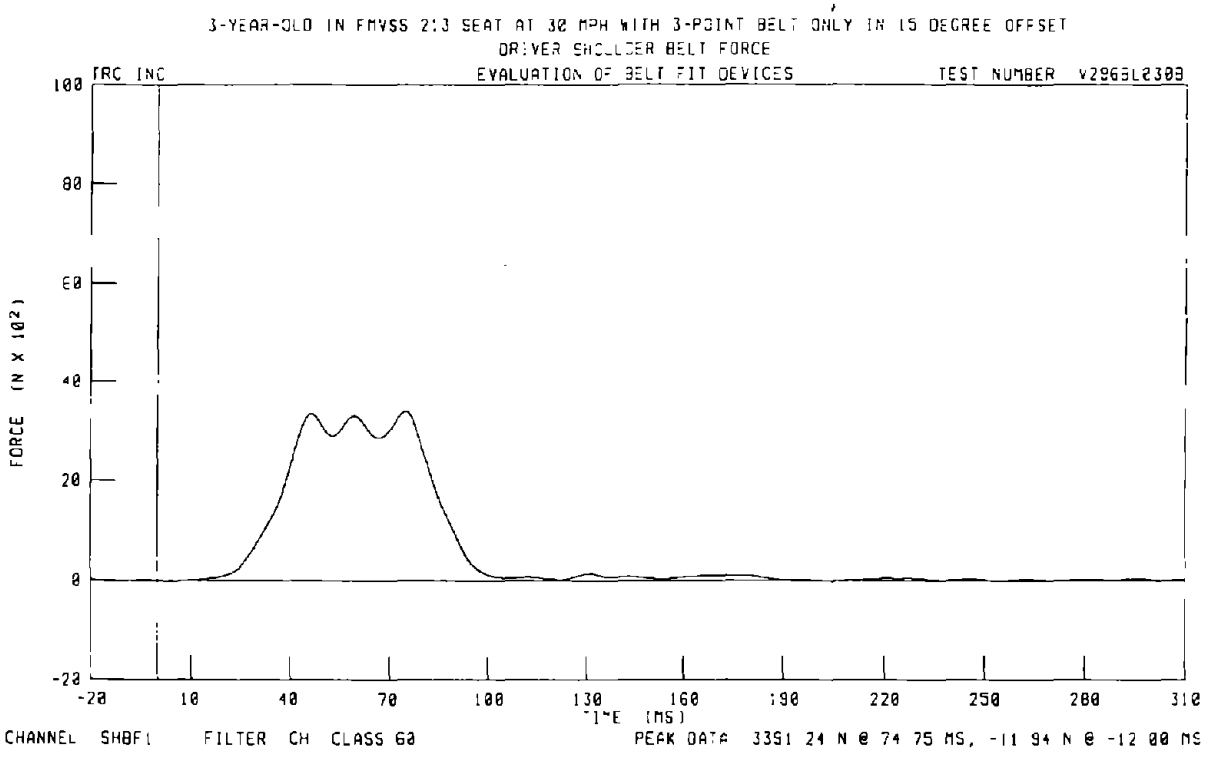
Shoulder Belt Load Time Histories

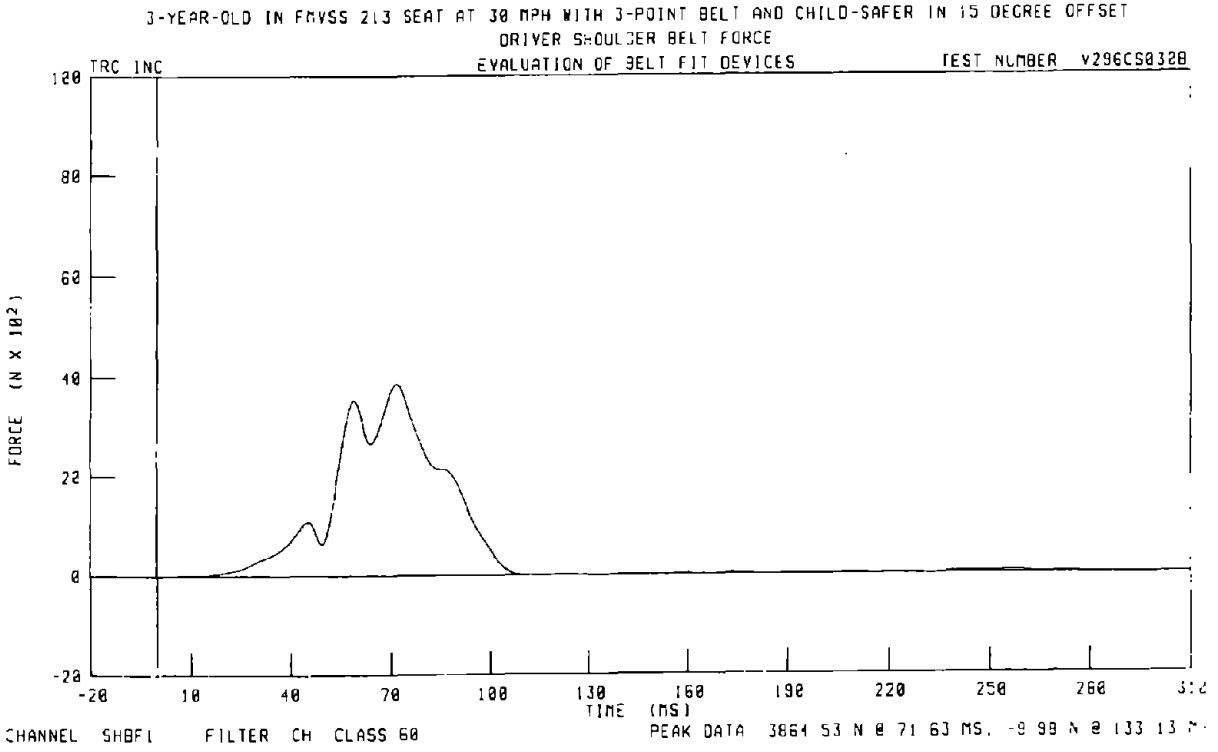

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL23ST
FORCE (N X 10²)
TIME (MS)
CHANNEL S-BF1 FILTER CH CLASS 60
PEAK DATA 3746.45 N @ 61.88 MS, -13.42 N @ 237.52 MS

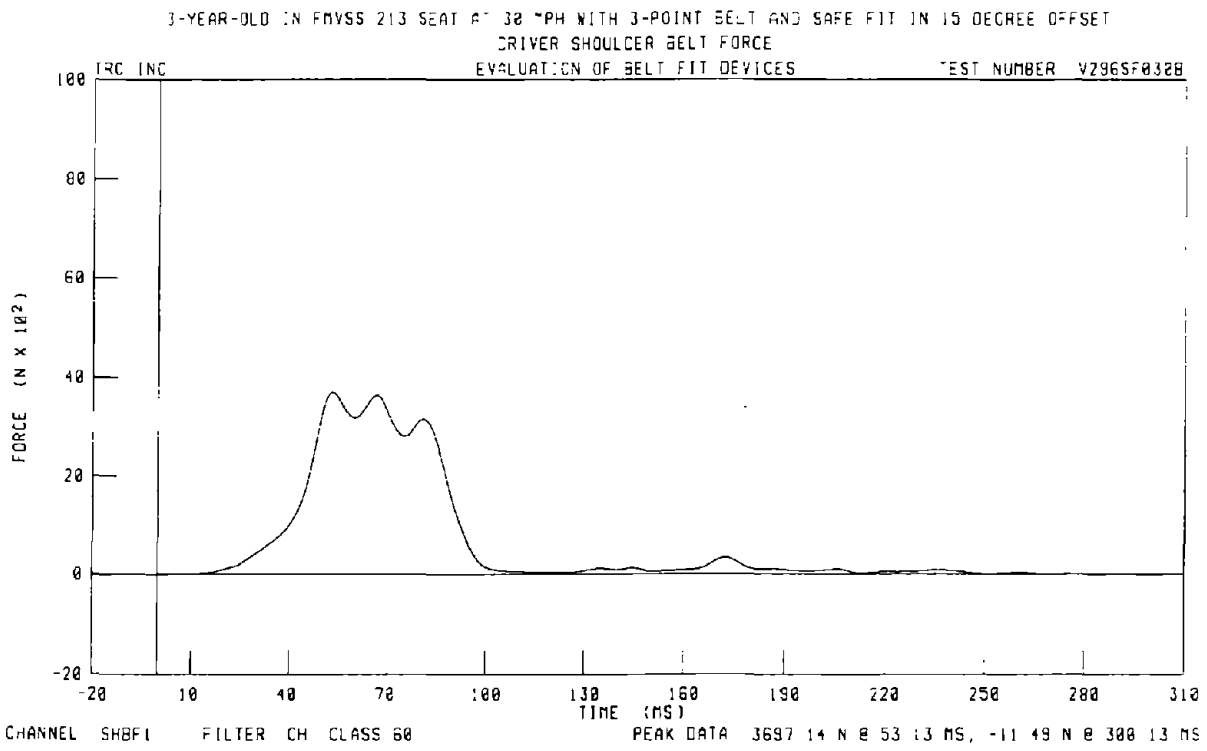

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS03ST
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 3767.87 N @ 70.38 MS,

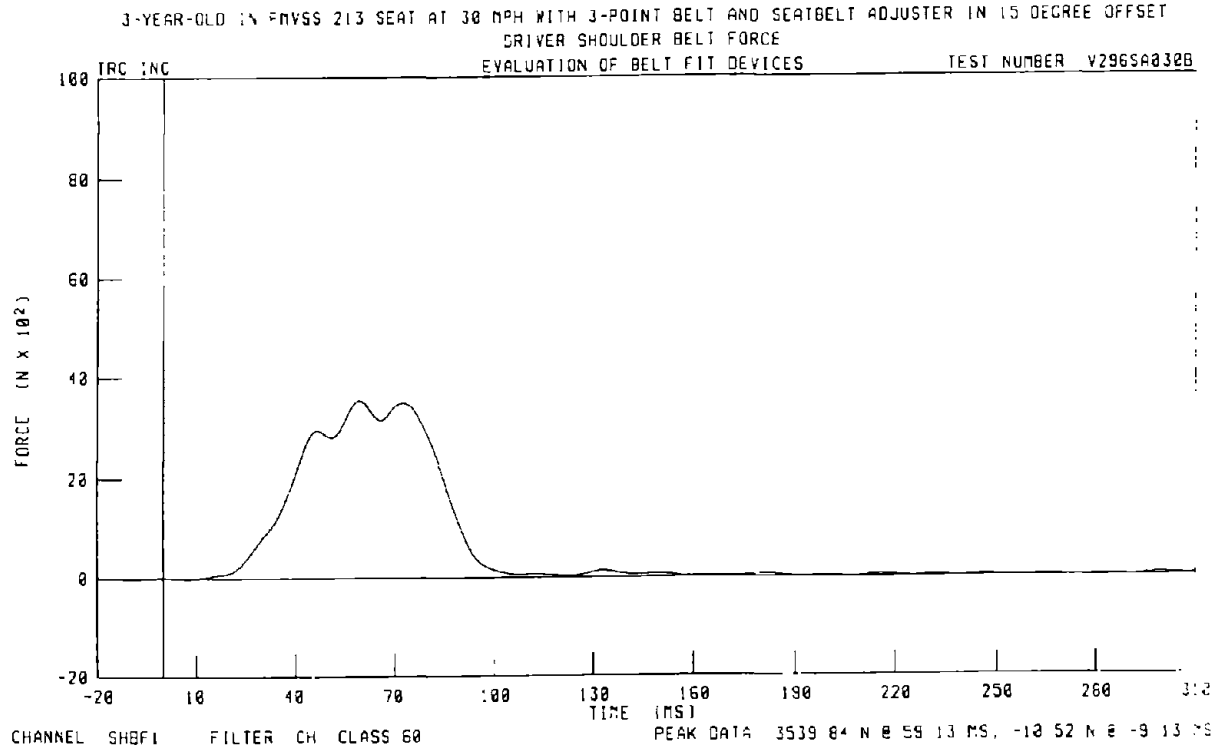

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF03ST
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 3540 43 N @ 62 63 MS, -13 39 N @ 245 50 MS


3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA23ST
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 3438 15 N @ 63 50 MS, -12 37 N @ 247 75 MS

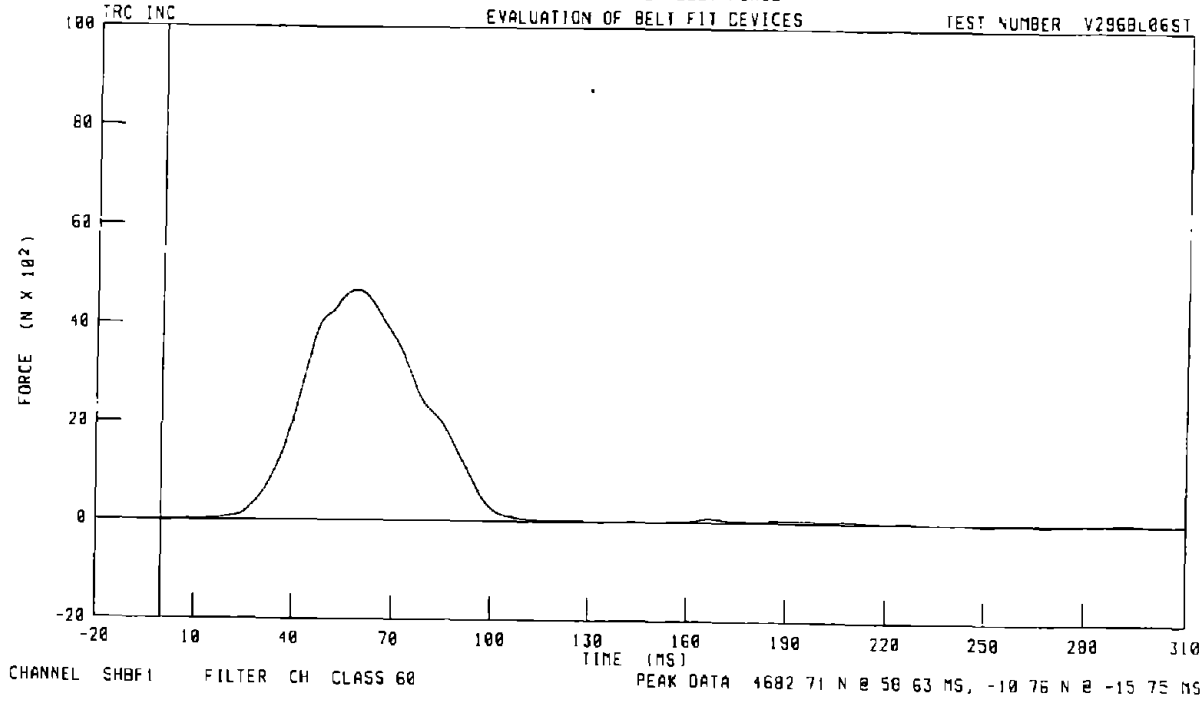

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL0308
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 3391 24 N @ 74 75 MS, -11 94 N @ -12 00 MS


3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS0328
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 3864 53 N @ 71 63 MS, -9 98 N @ 133 13 M

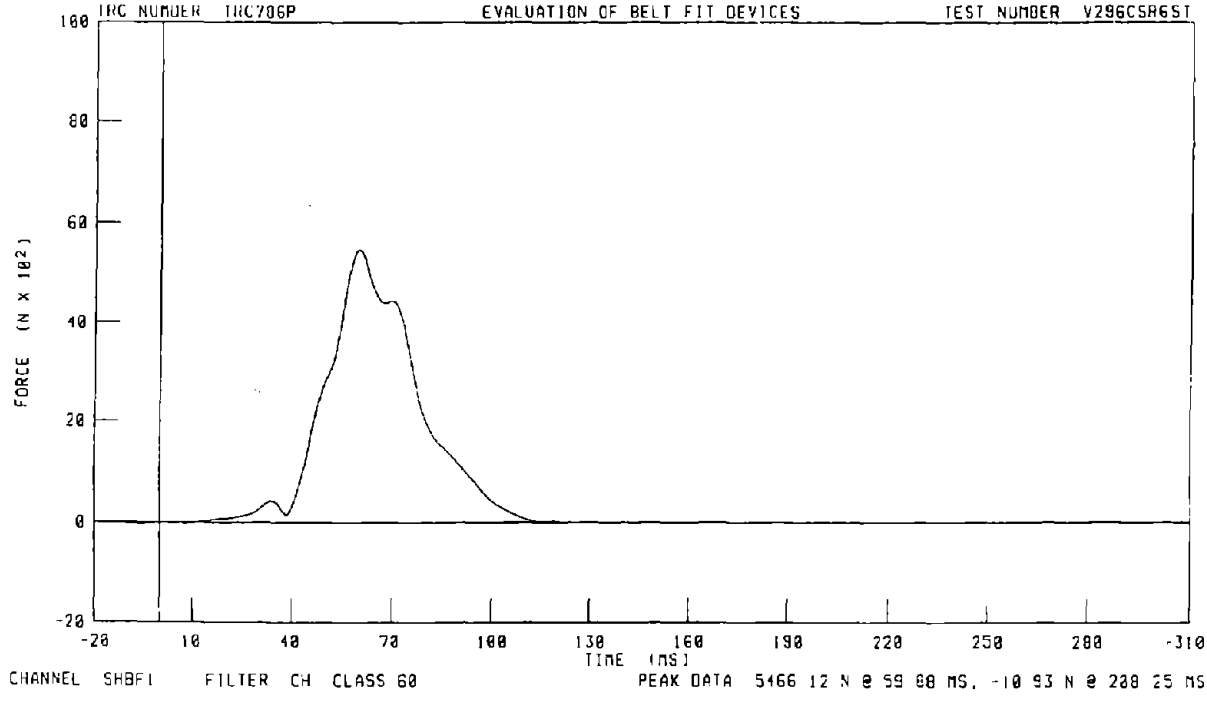

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF030B
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 3697 14 N @ 53 13 MS, -11 49 N @ 300 13 MS

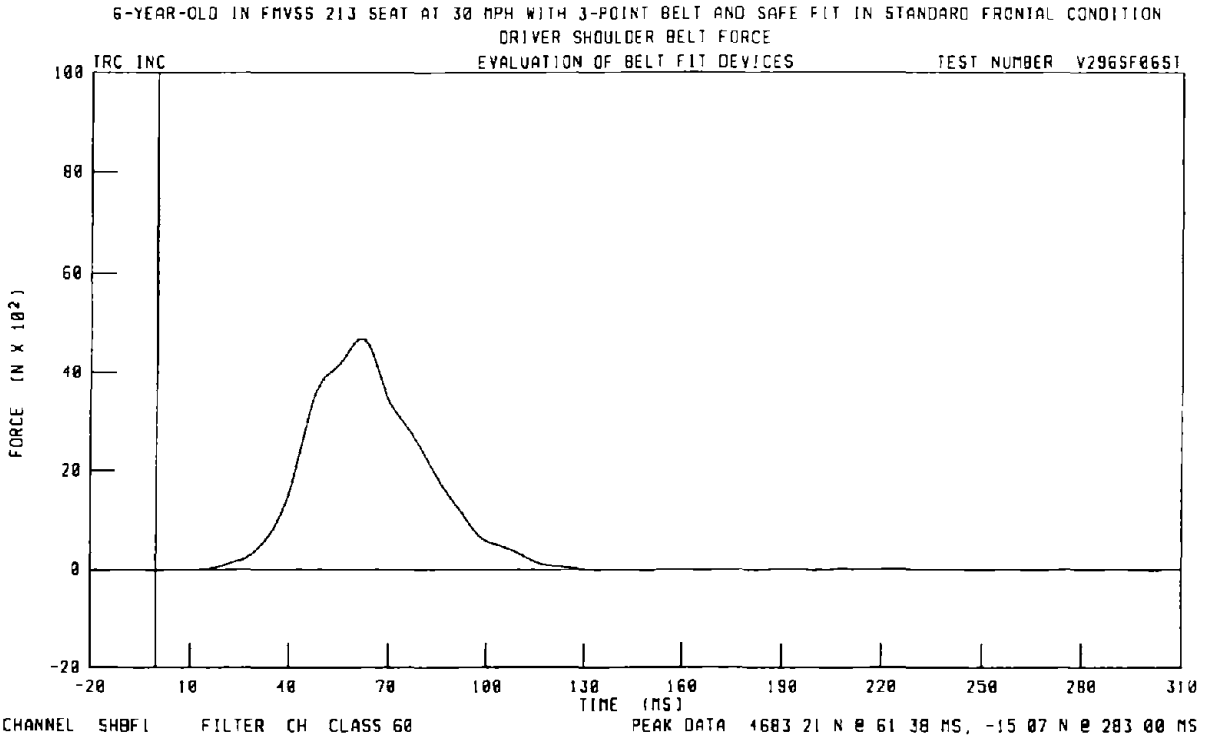

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA030B
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 3539 84 N @ 59 13 MS, -10 52 N @ -9 13 MS

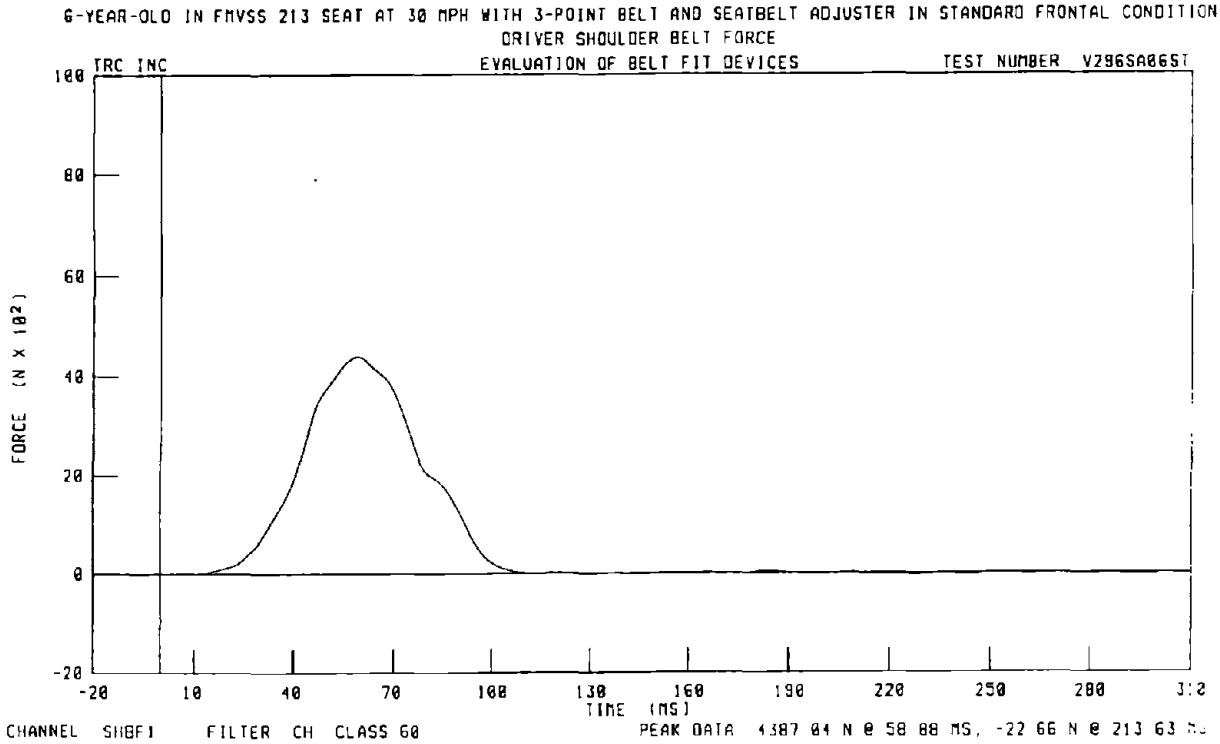
6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION

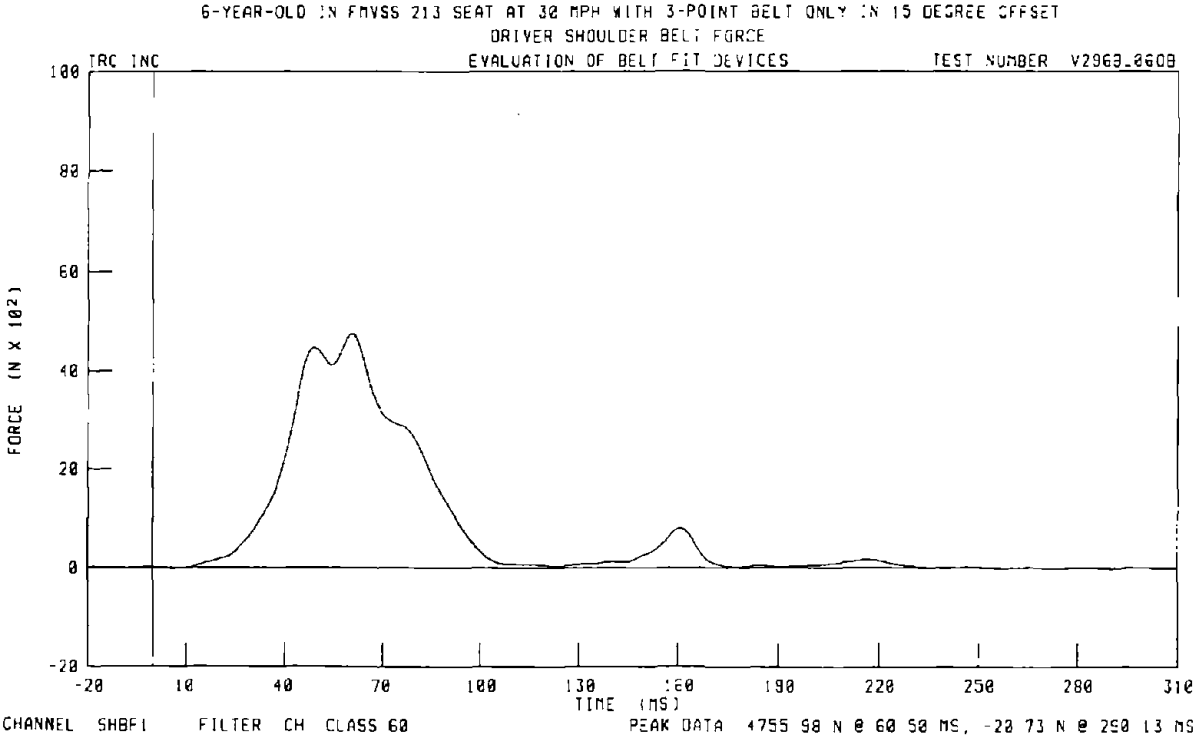


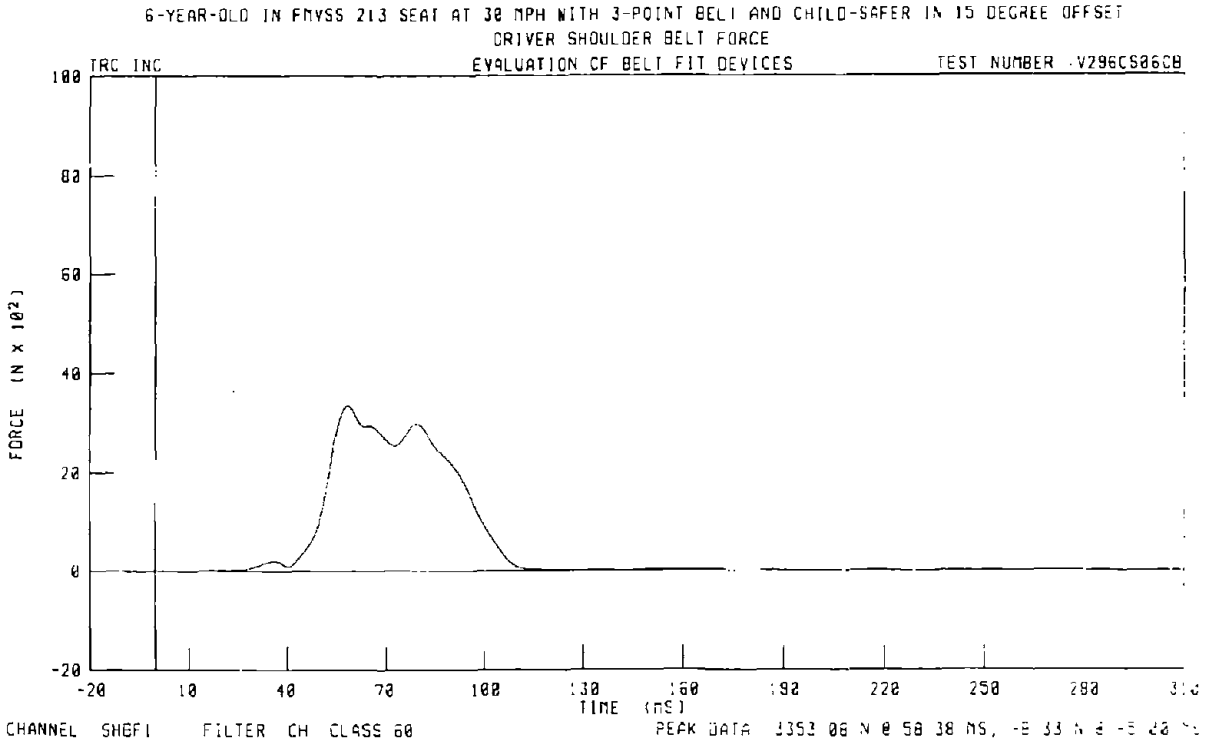
6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION

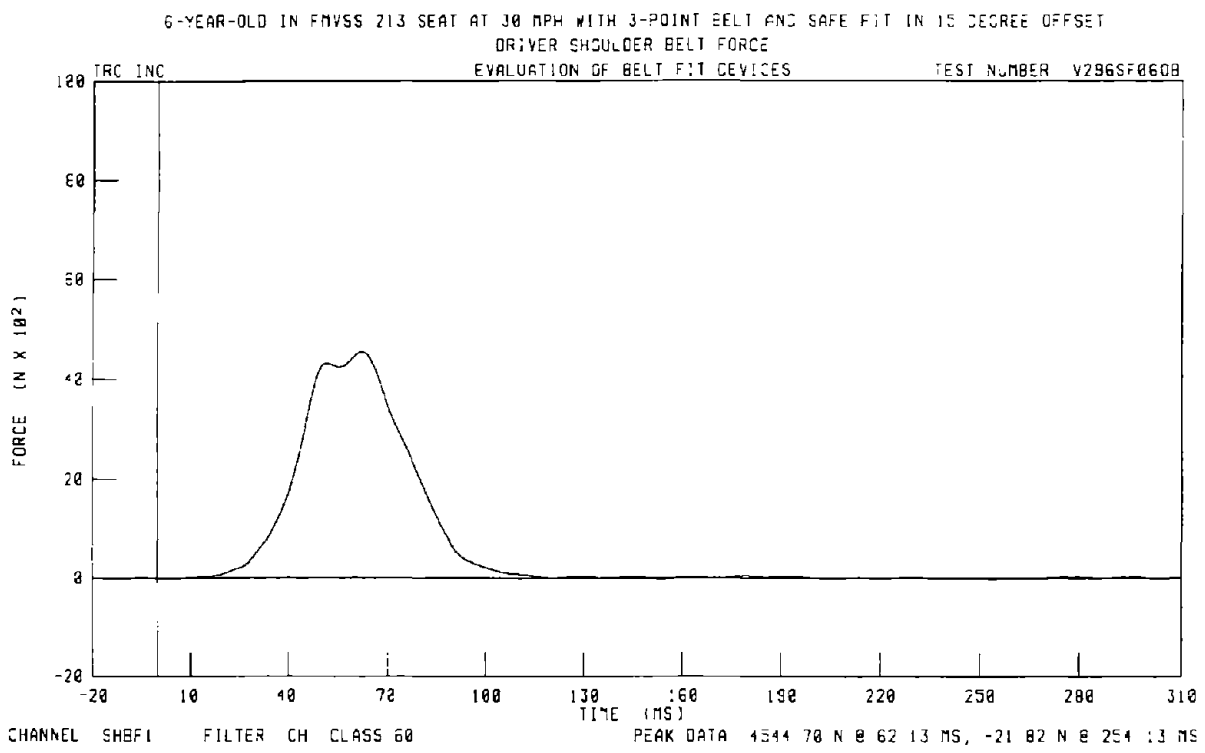


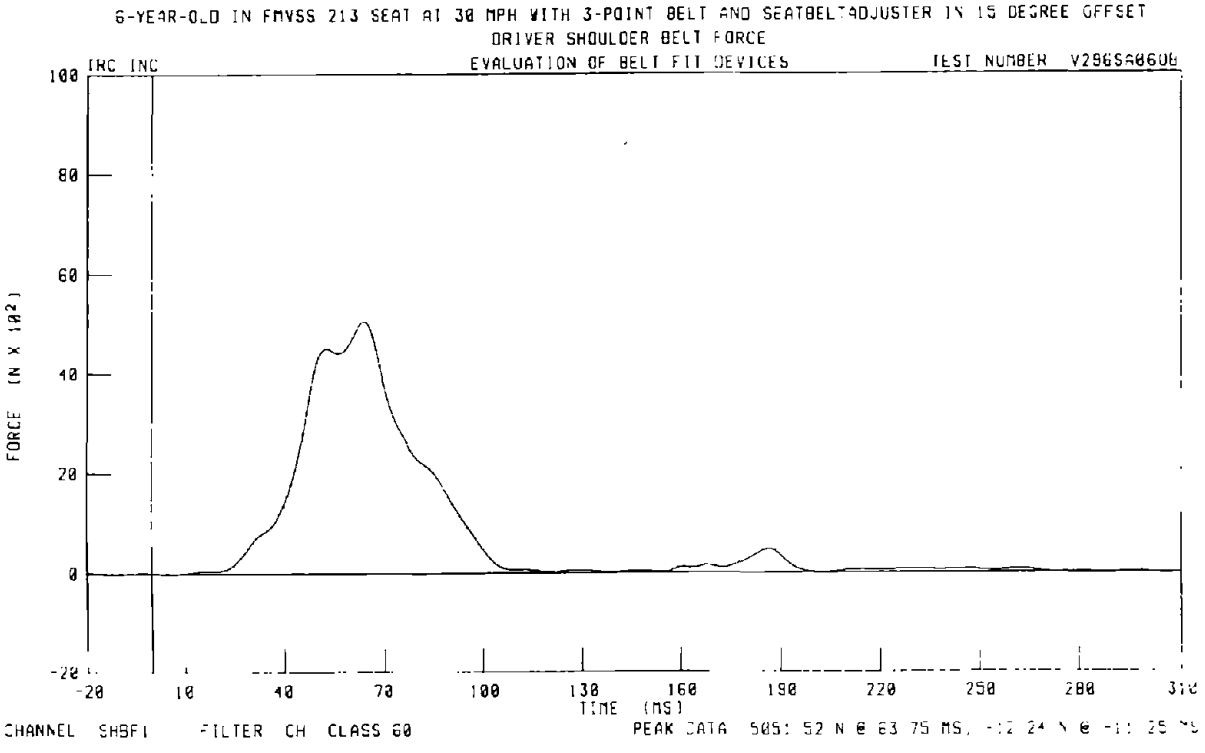

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF06ST
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 4683 21 N @ 61 38 MS, -15 07 N @ 283 00 MS

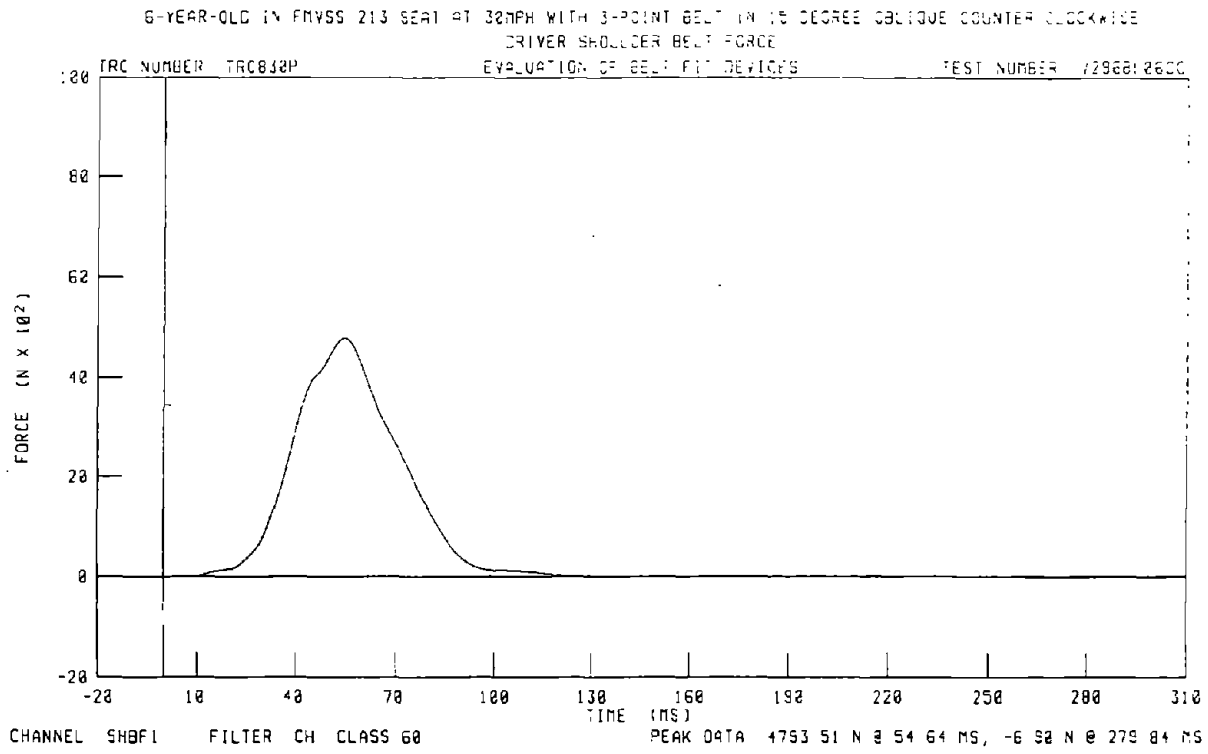

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA06ST
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 4387 04 N @ 58 88 MS, -22 66 N @ 213 63 MS

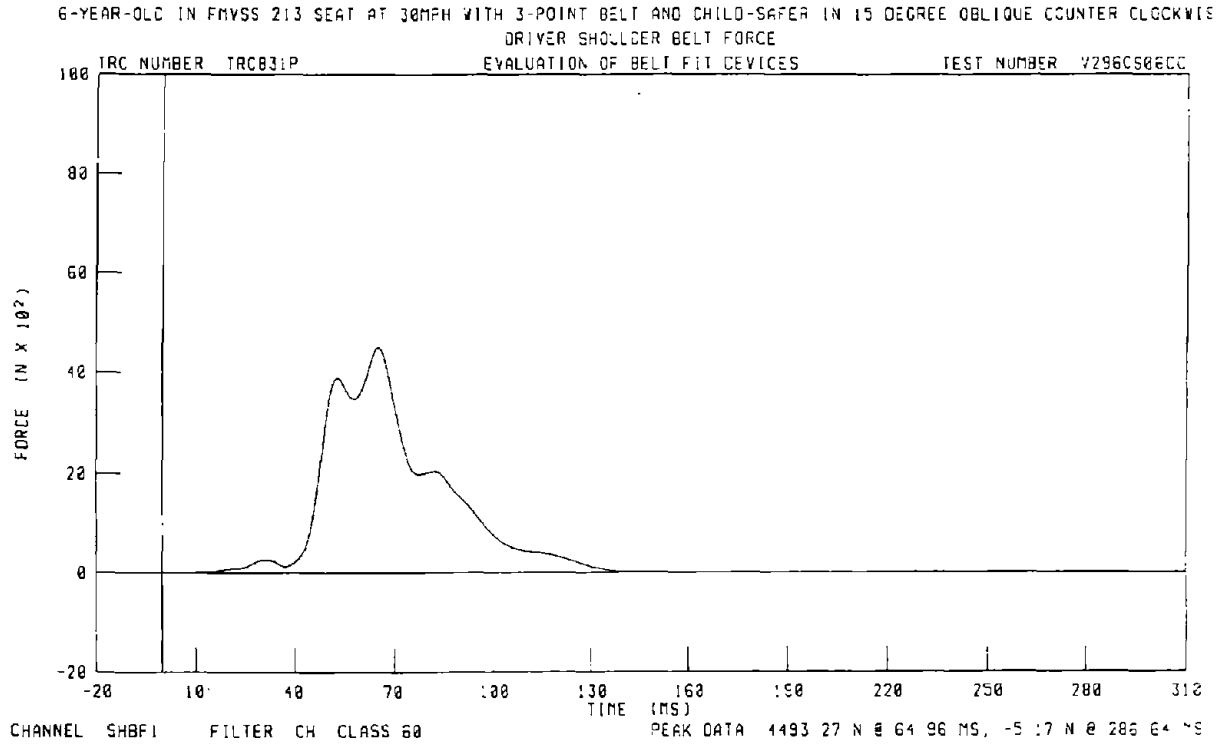

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2969_0608
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 4755 98 N @ 60 50 MS, -20 73 N @ 290 13 MS

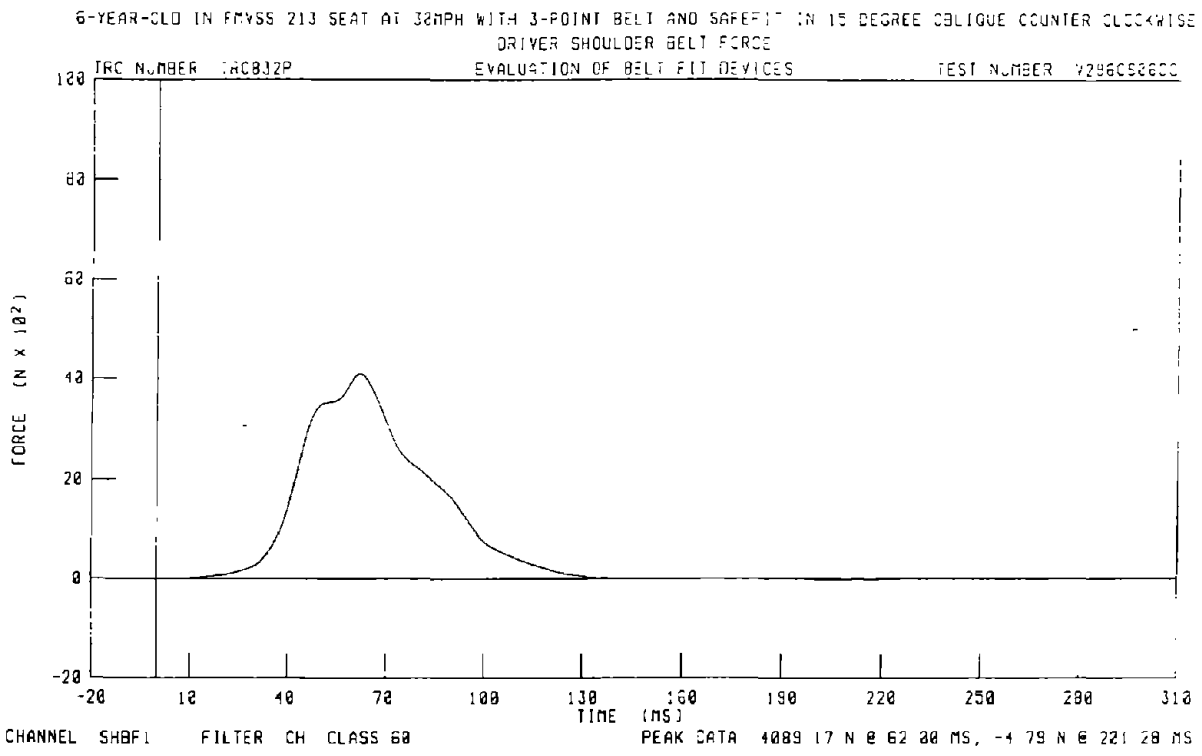

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS06CB
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 1353 08 N @ 58 38 MS,

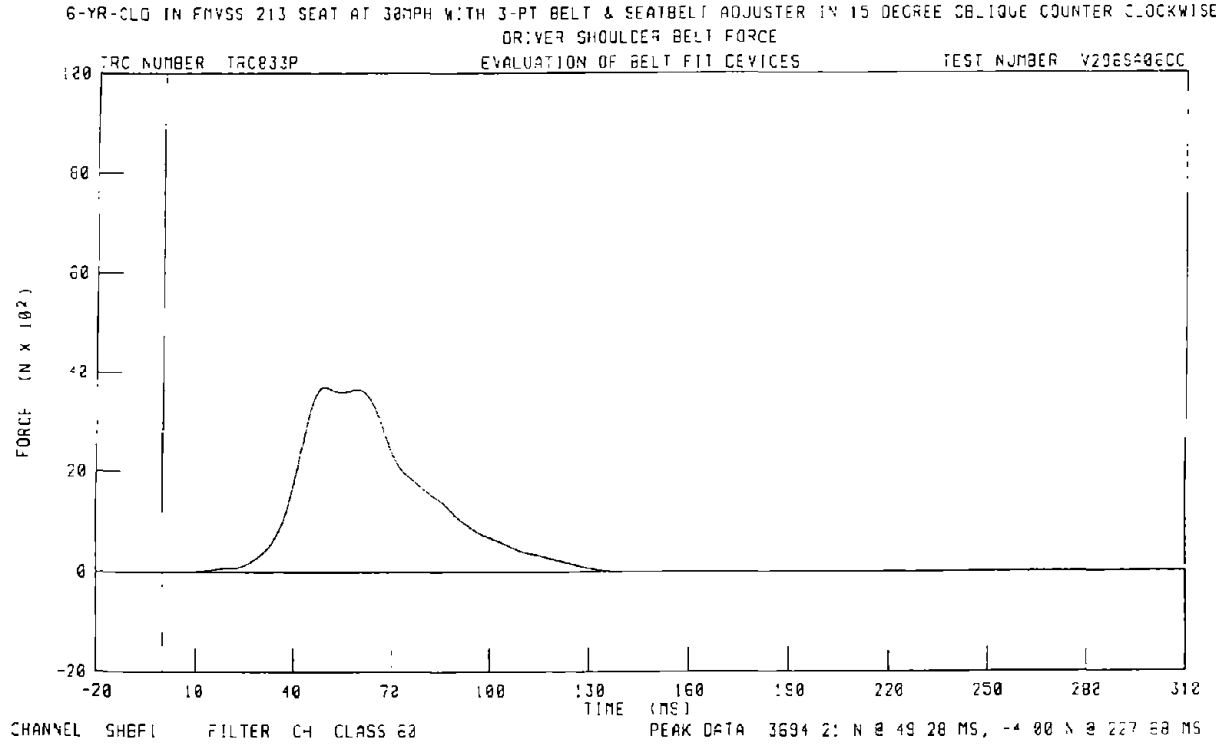

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF0608
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBFI FILTER CH CLASS 60
PEAK DATA 4544 70 N @ 62 13 MS, -21 82 N @ 254 13 MS

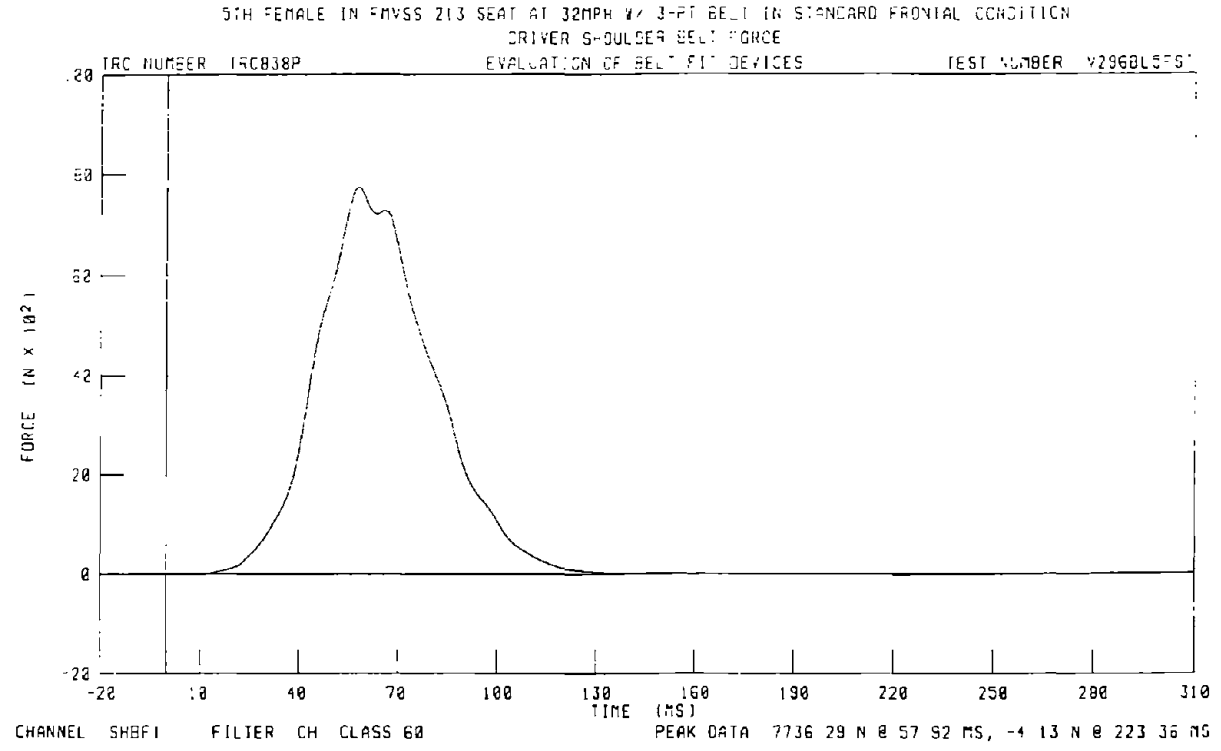

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA0606
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBFI FILTER CH CLASS 60
PEAK DATA 5051 52 N @ 63 75 MS

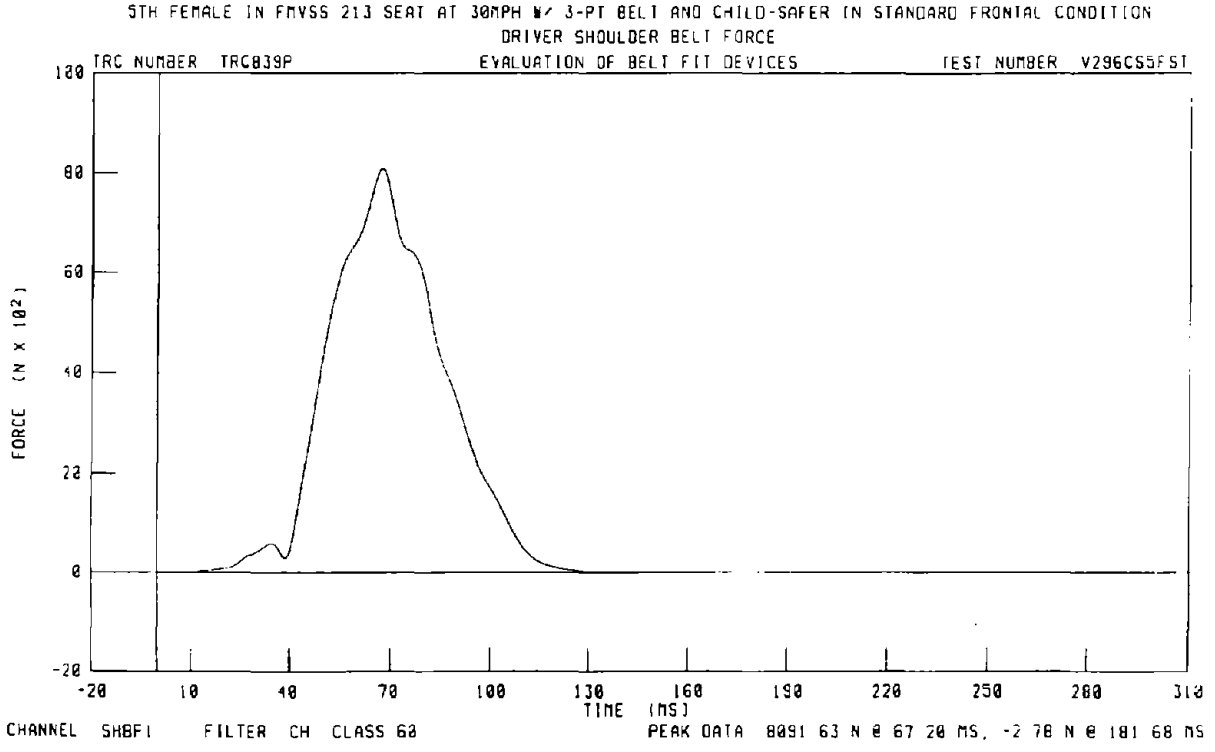

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC830P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C8620
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 4793 51 N @ 54 64 MS, -6 98 N @ 279 84 MS

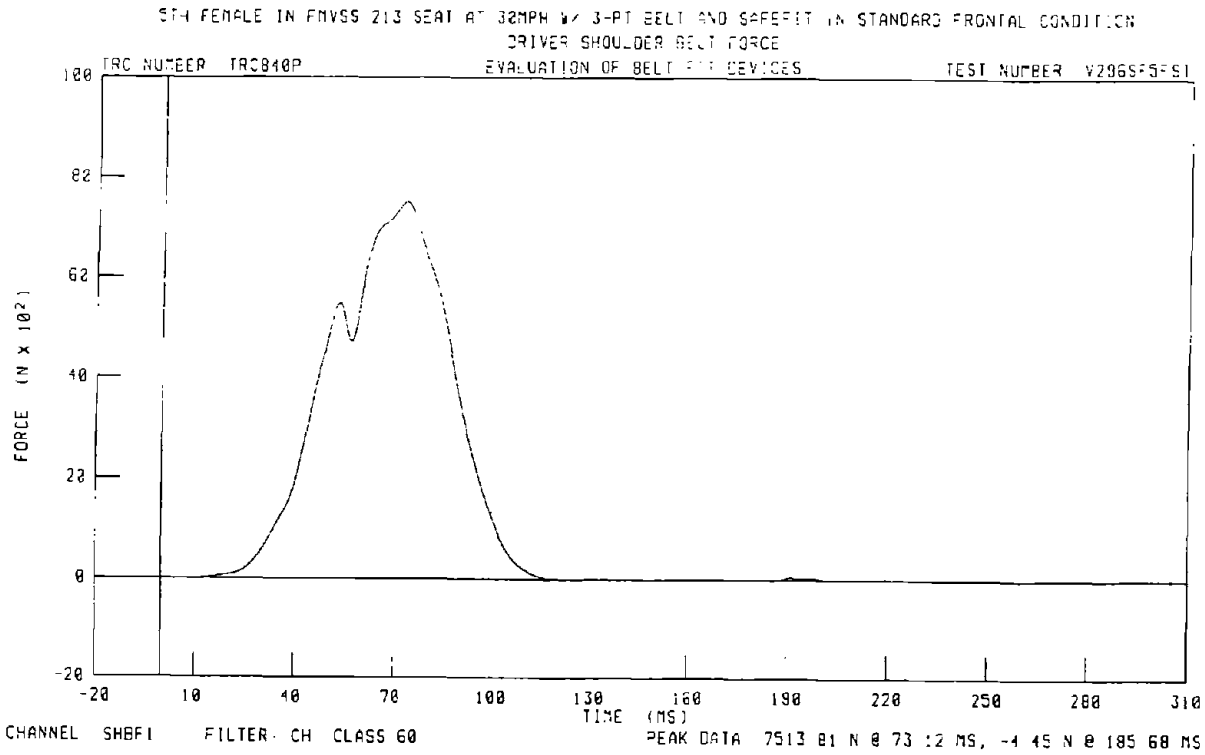

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC831P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C8626C
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 4493 27 N @ 64 96 MS, -5 17 N @ 286 64 MS

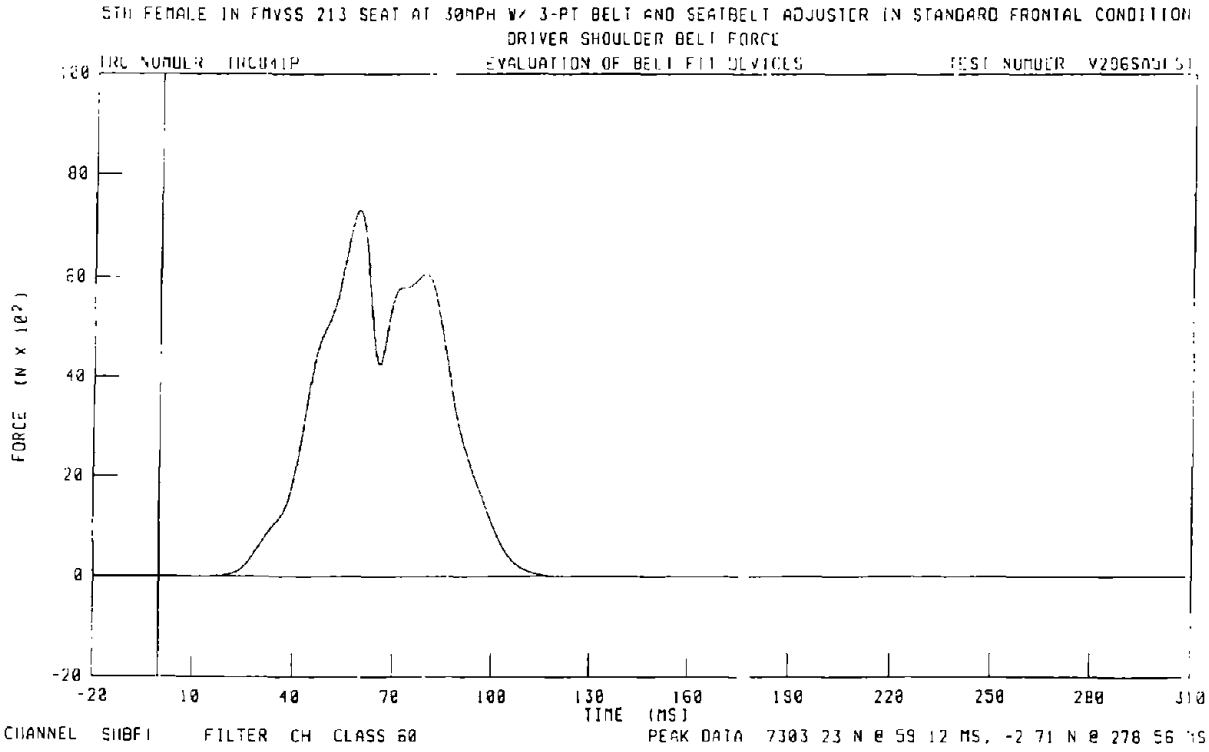

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT AND SAFE-T- IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC832P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C586CC
FORCE (N X 10²)
120
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 4089 17 N @ 62 00 MS, -4 79 N @ 221 28 MS

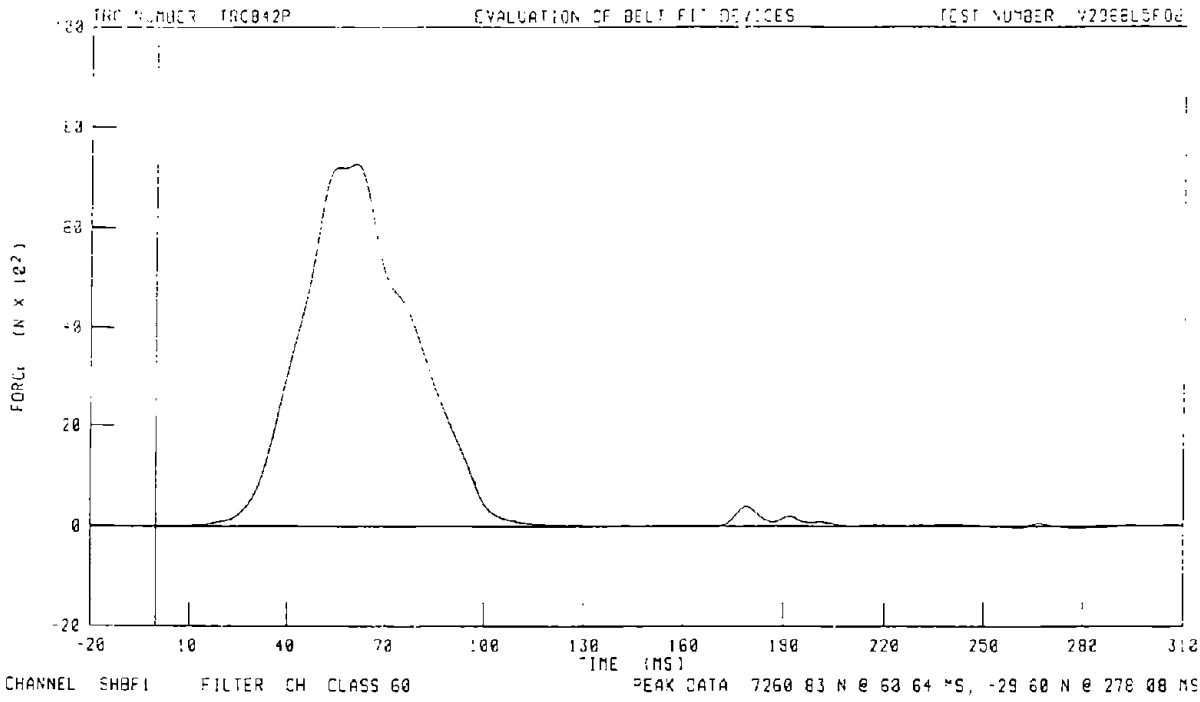

6-YR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT & SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC833P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA86CC
FORCE (N X 10²)
120
80
60
40
20
0
-20
-20
10
40
72
100
130
160
190
220
250
282
312
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 3694 21 N @ 49 28 MS, -4 00 N @ 227 68 MS

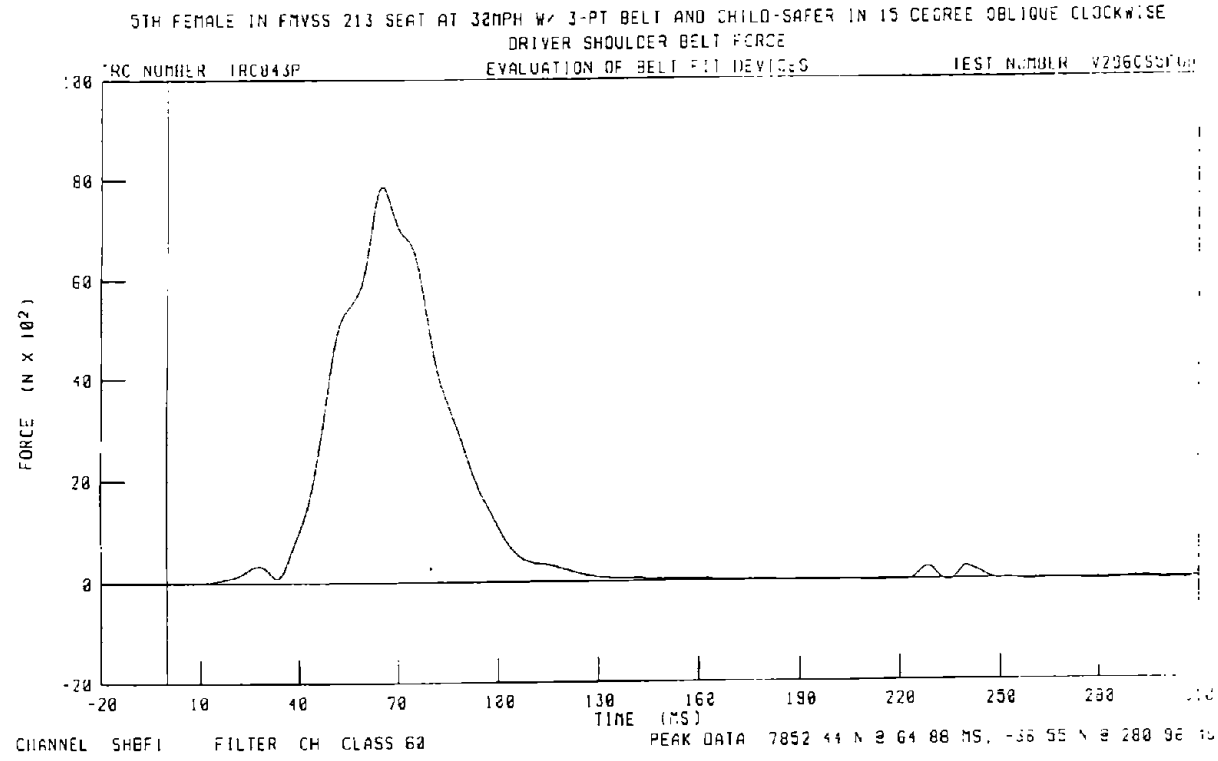

5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL5FST
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 7736 29 N @ 57 92 MS, -4 13 N @ 223 36 MS

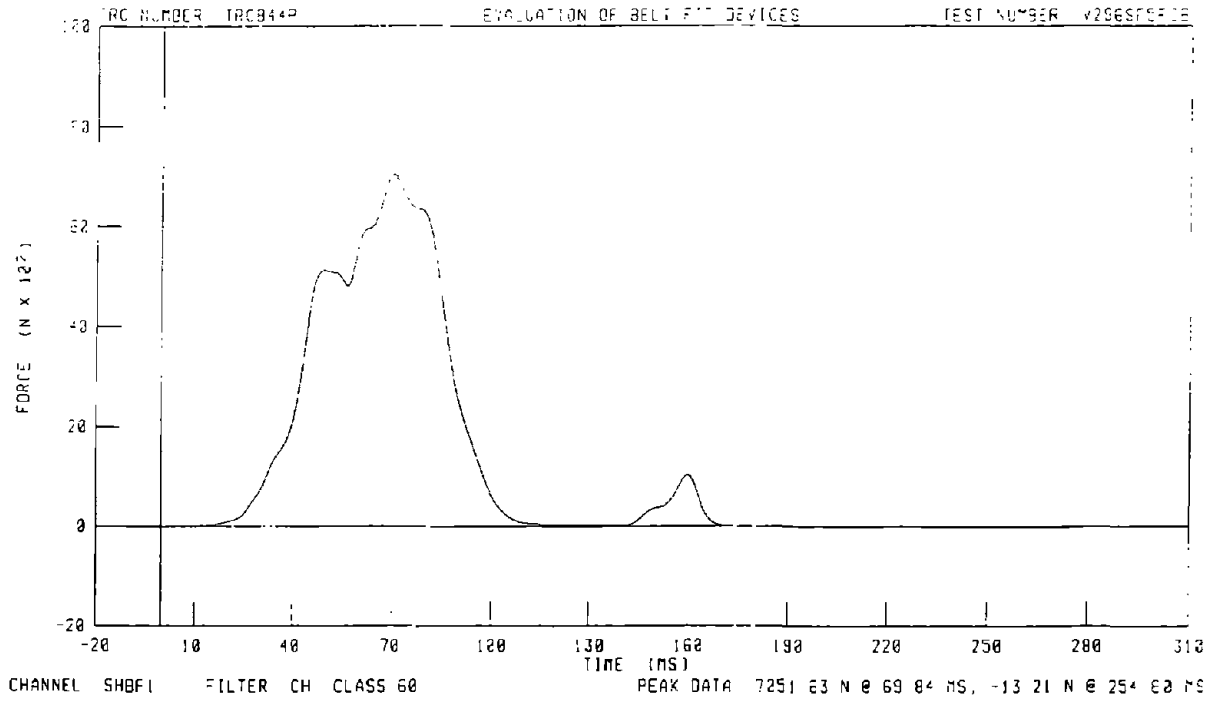

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS5FST
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 8091 63 N @ 67 20 MS, -2 78 N @ 181 68 MS

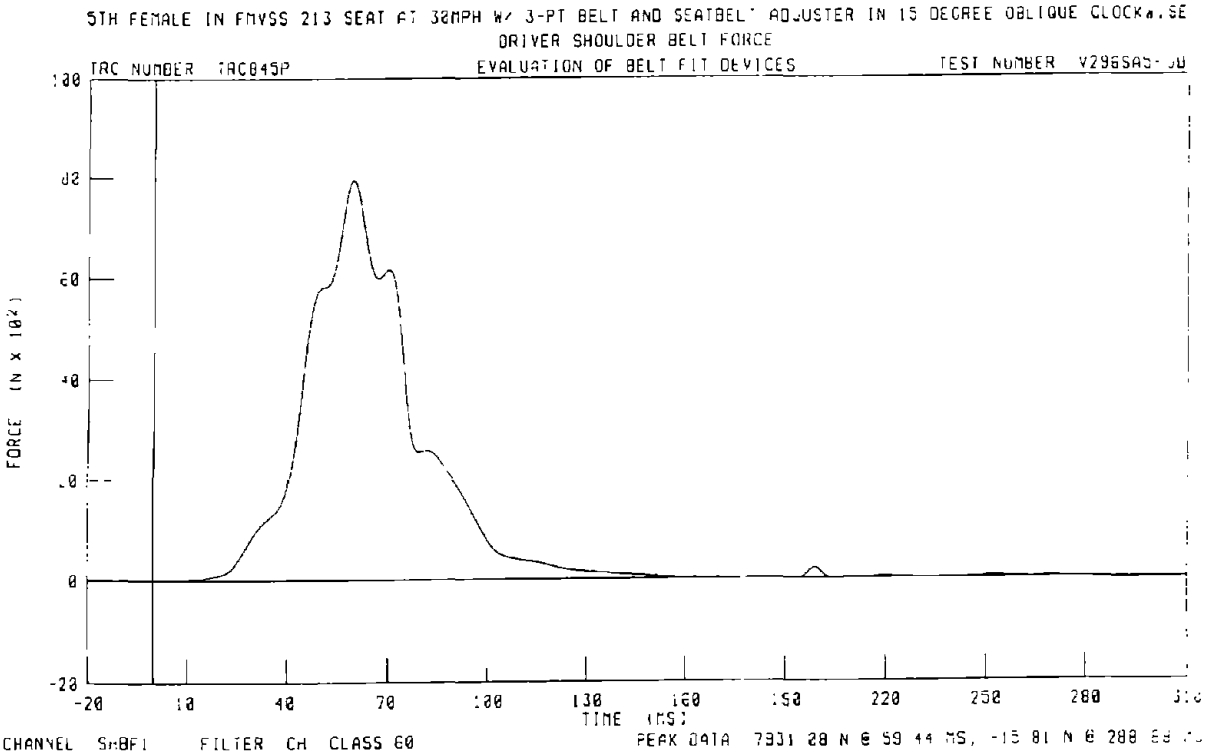

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC NUMBER TR0840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SFSFS1
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBFI
FILTER CH CLASS 60
PEAK DATA 7513 81 N @ 73 12 MS, -4 45 N @ 185 68 MS

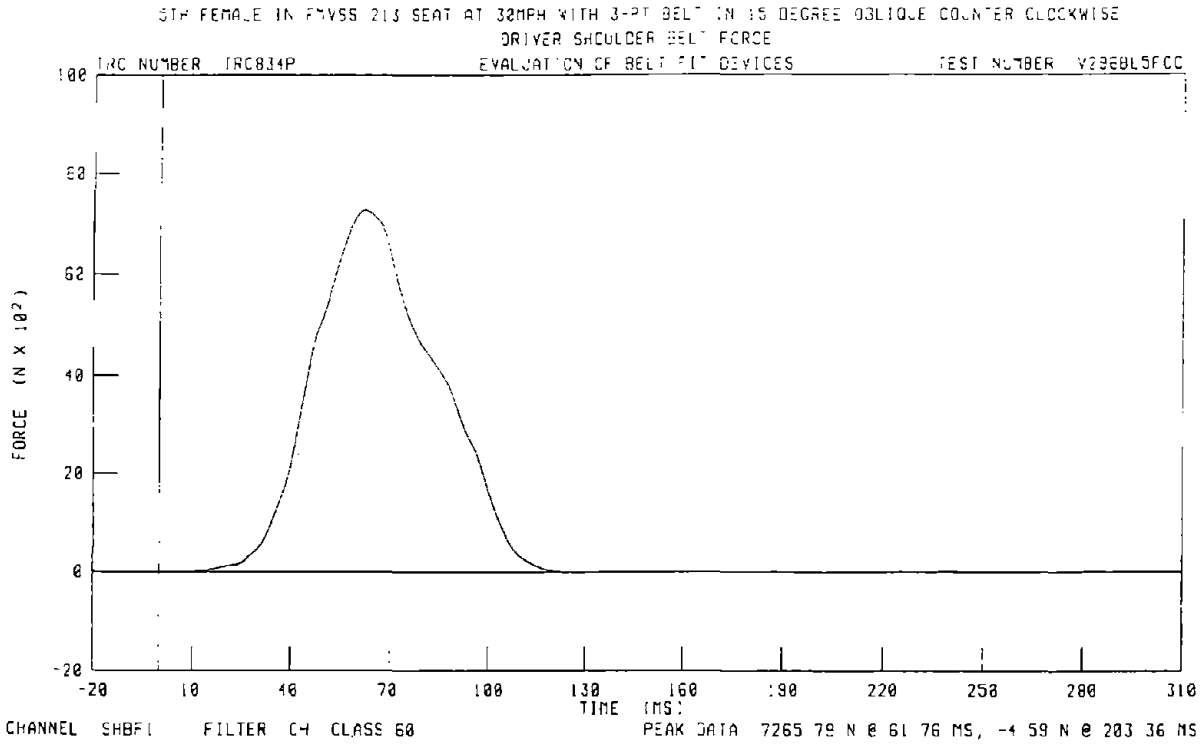

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC NUMBER TR0841P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SADJS1
FORCE (N X 10²)
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBFI
FILTER CH CLASS 60
PEAK DATA 7303 23 N @ 59 12 MS, -2 71 N @ 278 56 MS

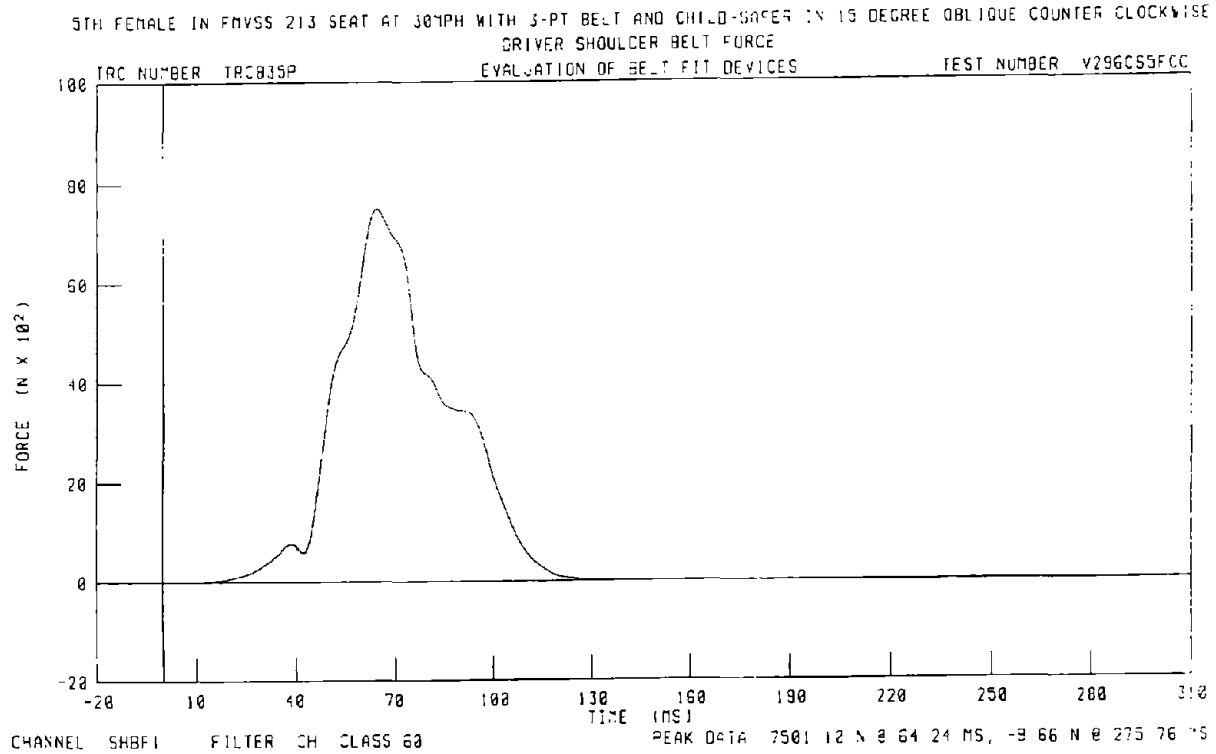

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC042P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V236BL5F02
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 7260.83 N @ 60.64 MS, -29.60 N @ 270.00 MS

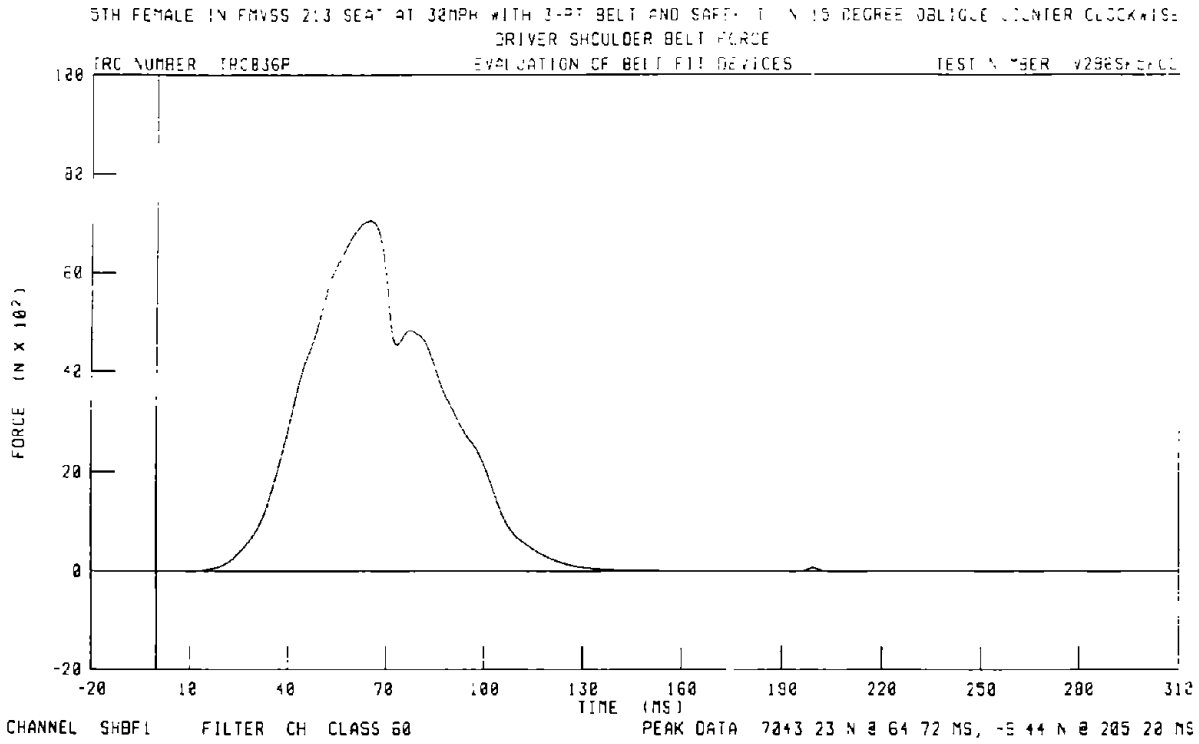

5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC043P
EVALUATION OF BELT FIT DEVICES
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60

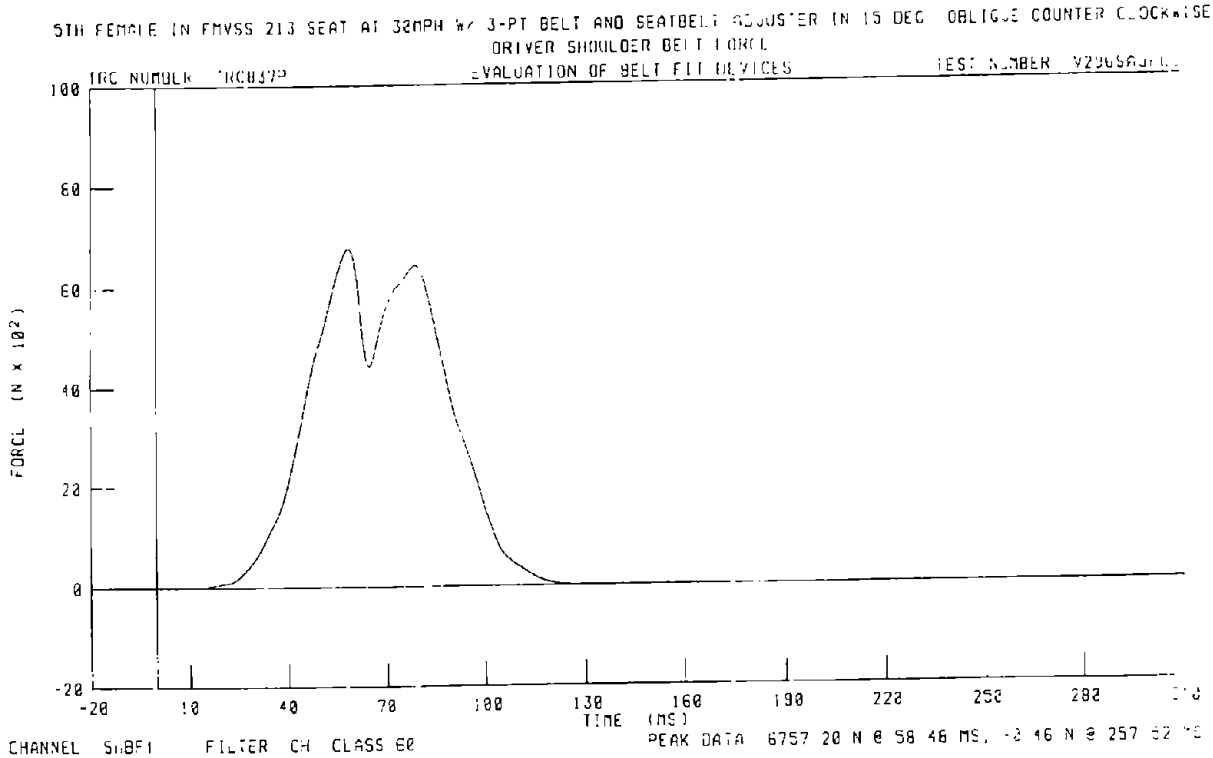

5TH FEMA E IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
FORCE (N x 10²)
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 7251 83 N @ 69 84 MS, -13 21 N @ 254 62 MS

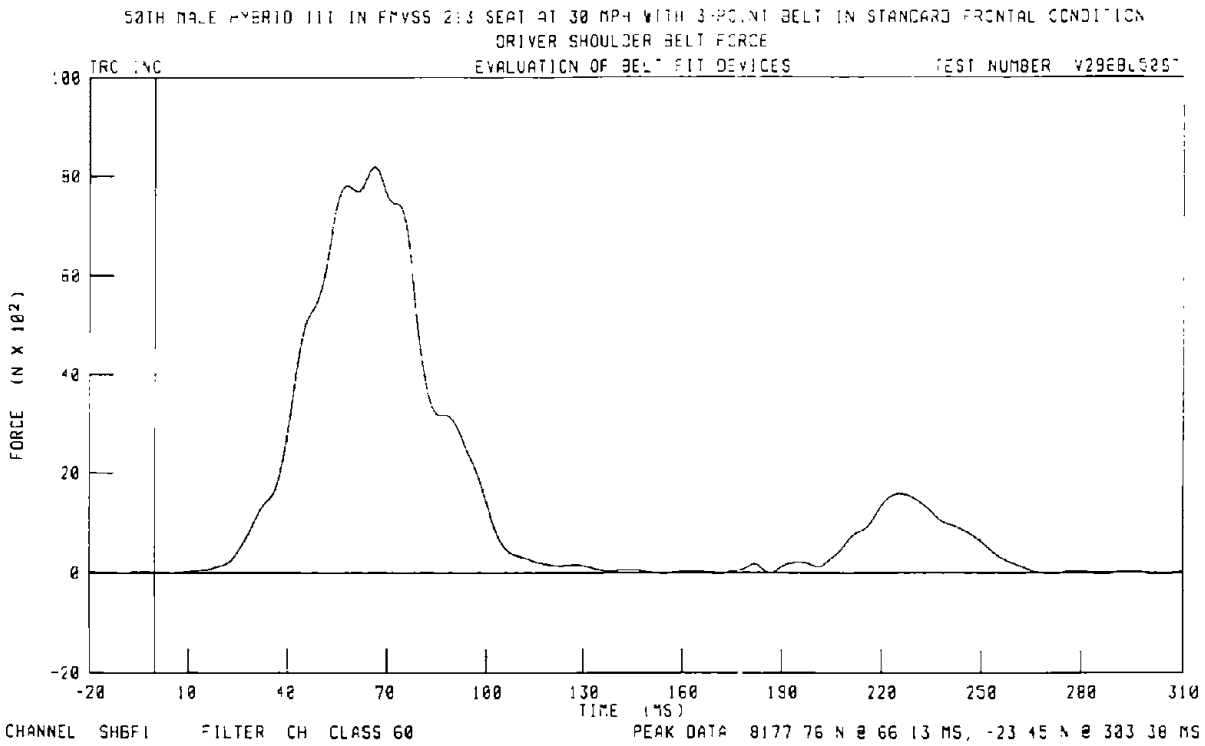

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
FORCE (N x 10²)
TIME (MS)
CHANNEL SHBF1 FILTER CH CLASS 60
PEAK DATA 7931 28 N @ 59 44 MS, -15 81 N @ 288 68 MS

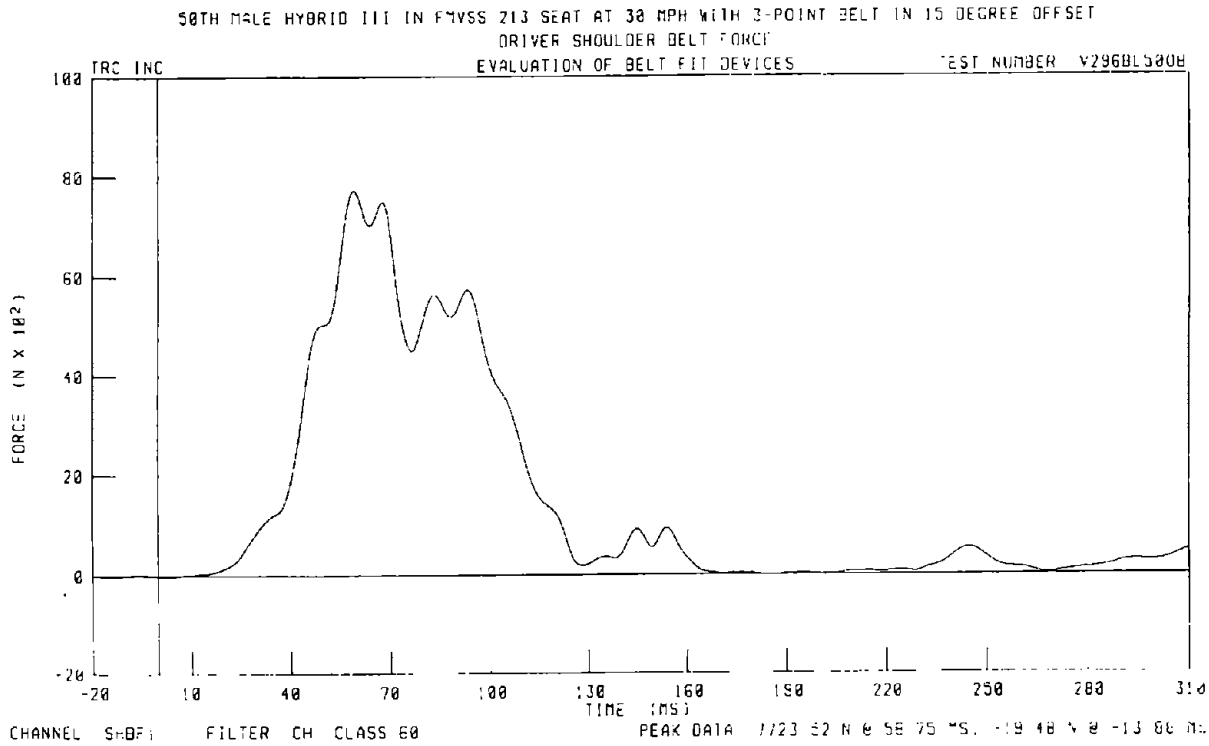

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BL5FCC
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 7265 79 N @ 61 76 MS, -4 59 N @ 203 36 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER SHOULDER BELT FORCE
TRC NUMBER TRC835P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V29GCS5FCC
FORCE (N X 10²)
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 7501 12 N @ 64 24 MS, -8 66 N @ 275 76 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFE- T
DRIVER SHOULDER BELT FORCE
IRC NUMBER IRC836F
EVALUATION OF BELT FIT DEVICES
FORCE (N X 10²)
120
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 7043 23 N @ 64 72 MS, -5 44 N @ 205 20 MS

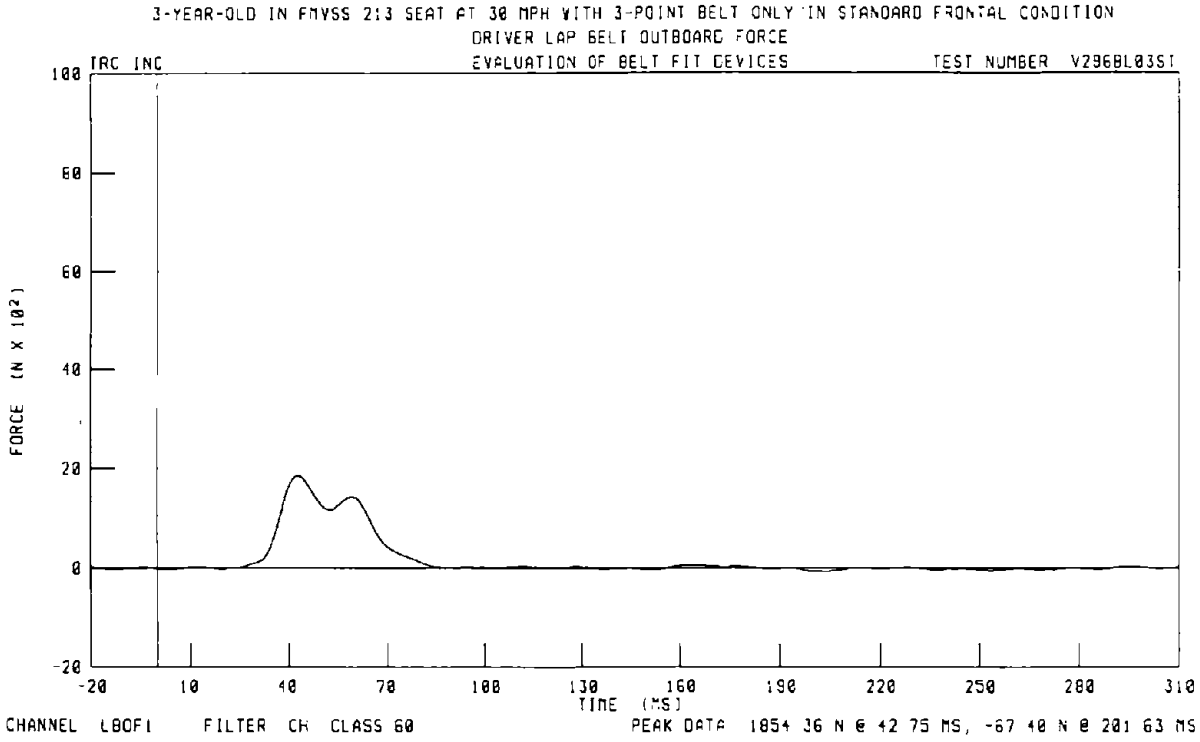

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEG OBLIGE COUNTER CLOCKWISE
DRIVER SHOULDER BELT FORCE
EVALUATION OF BELT FIT DEVICES
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 6757 20 N @ 58 46 MS, -3 46 N @ 257 52 MS

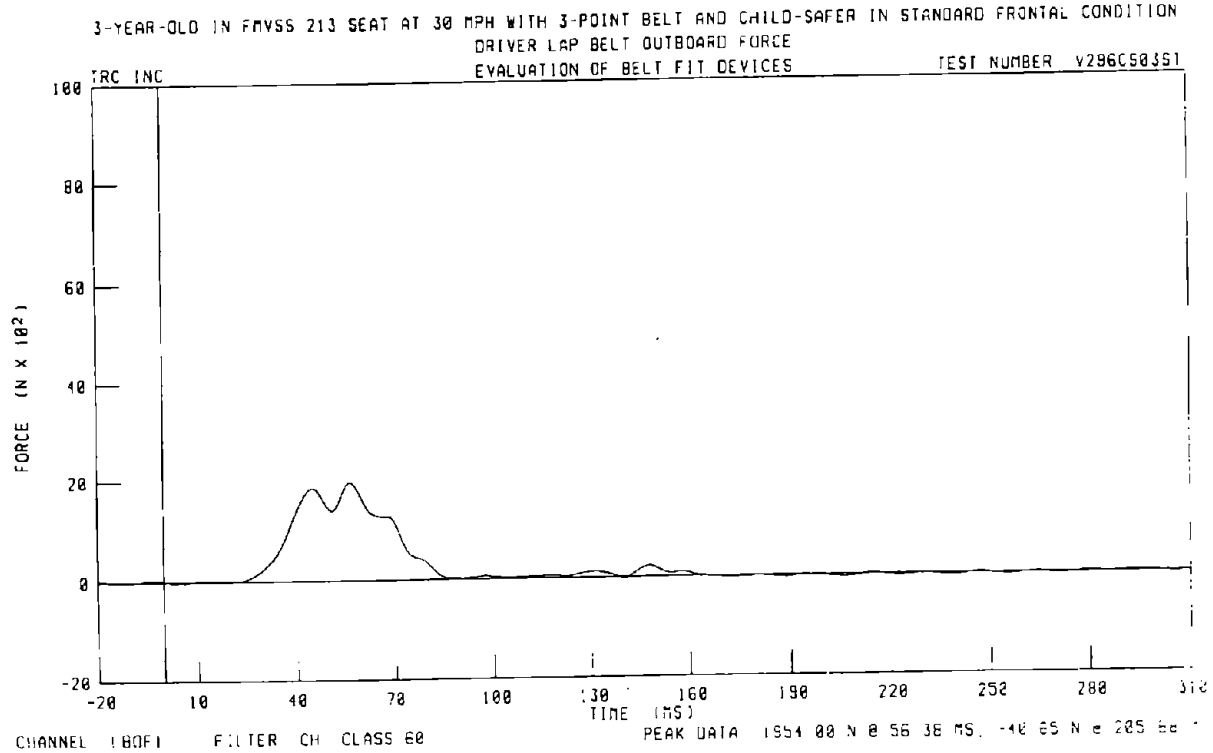

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT IN STANDARD FRONTAL CONDITION
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BL505
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 8177.76 N @ 66.13 MS, -23.45 N @ 303.38 MS

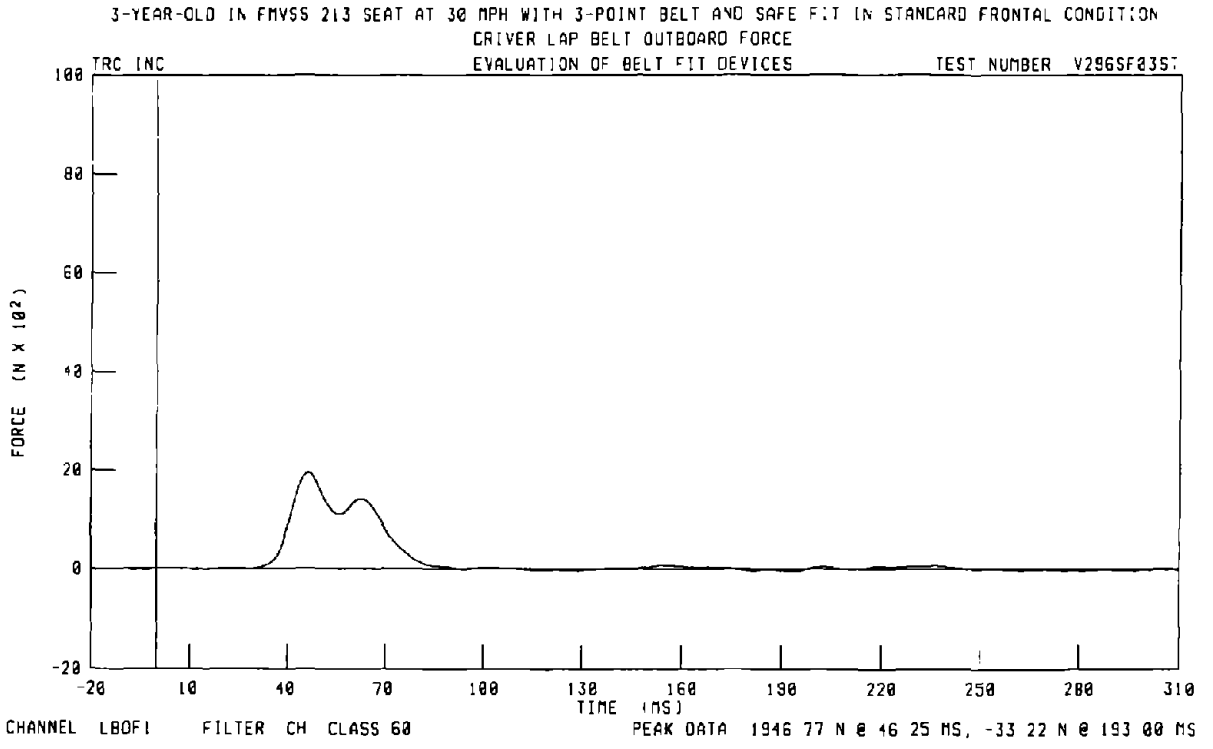

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT IN 15 DEGREE OFFSET
DRIVER SHOULDER BELT FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL508
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL SHBF1
FILTER CH CLASS 60
PEAK DATA 7723.62 N @ 58.75 MS, -19.48 N @ -13.00 MS

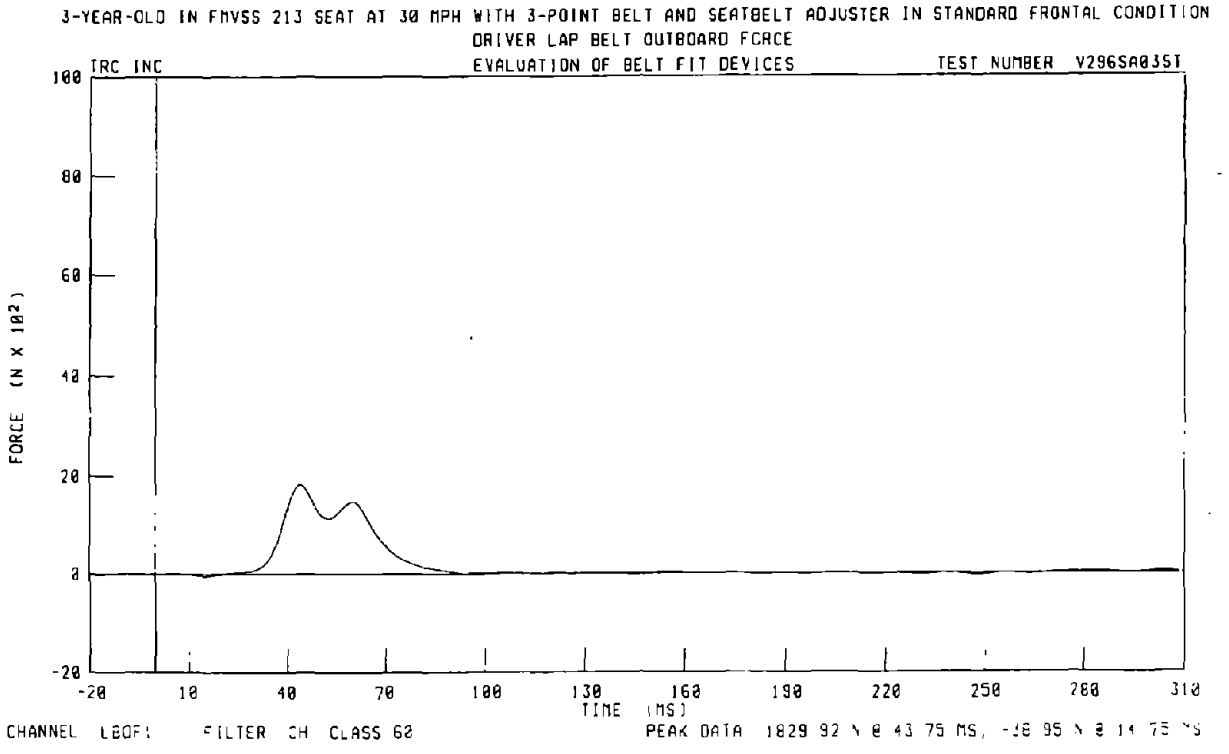
Appendix D

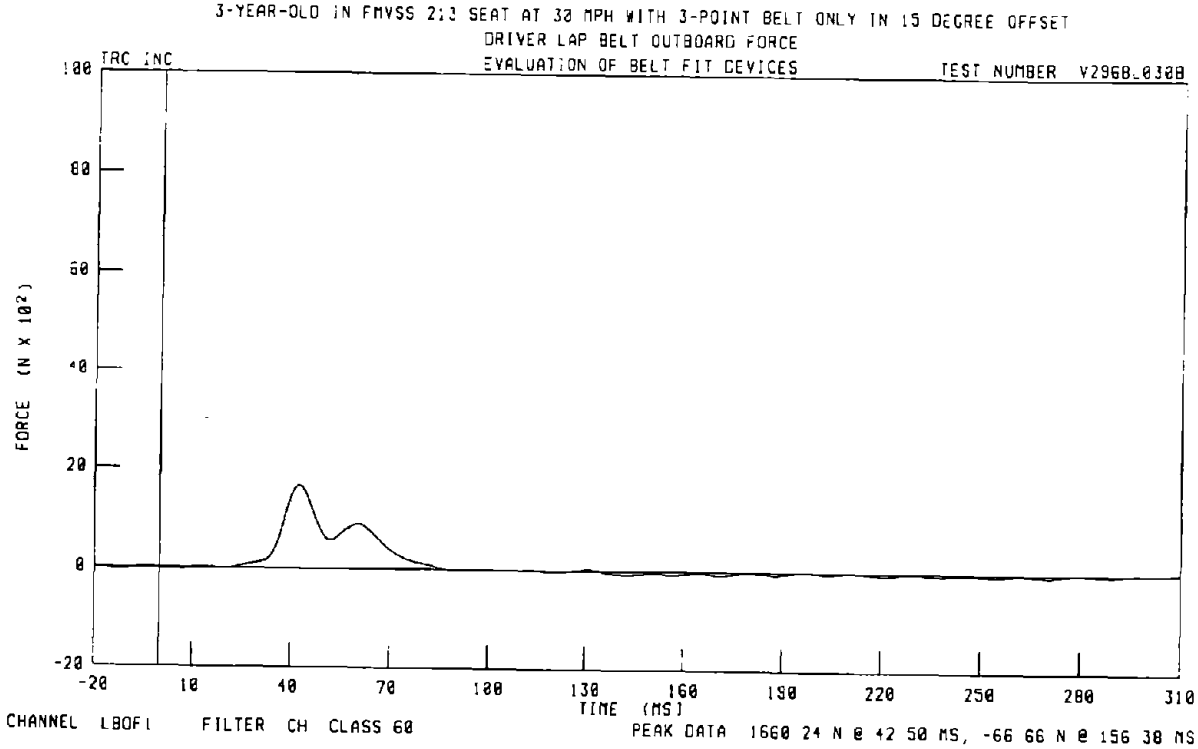
Lap Belt Load Time Histories

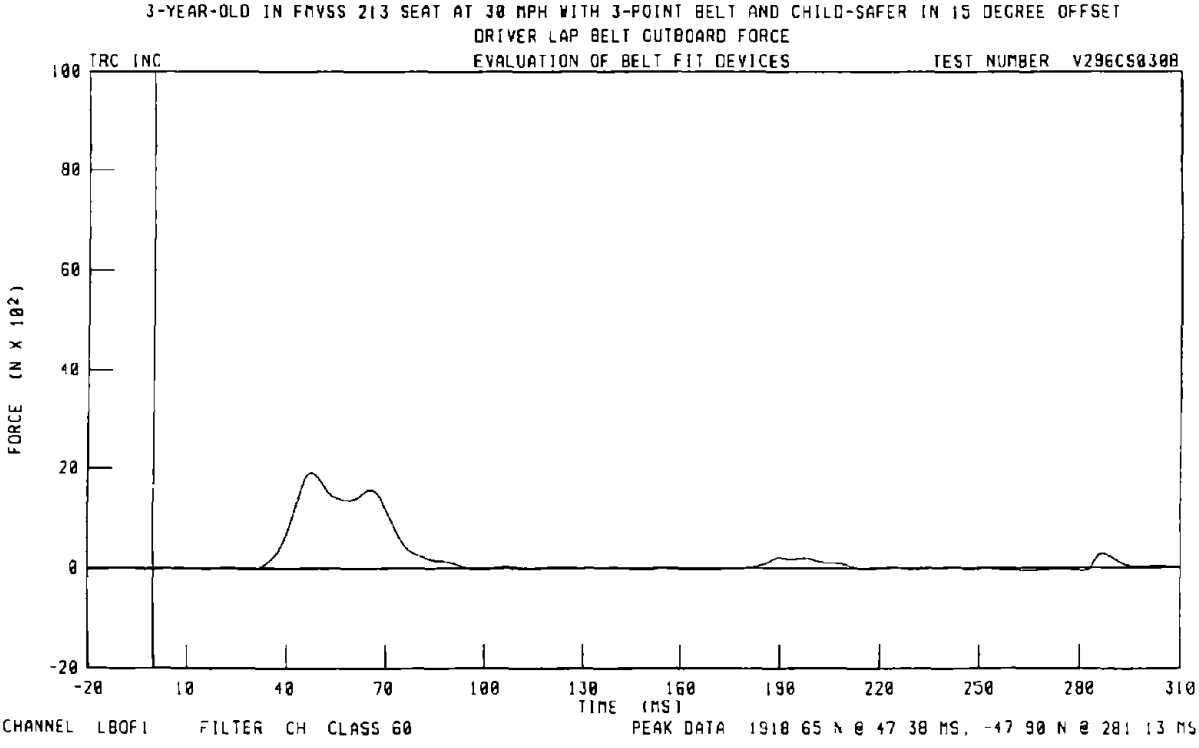

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL03S1
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 1854.36 N @ 42.75 MS, -67.40 N @ 201.63 MS

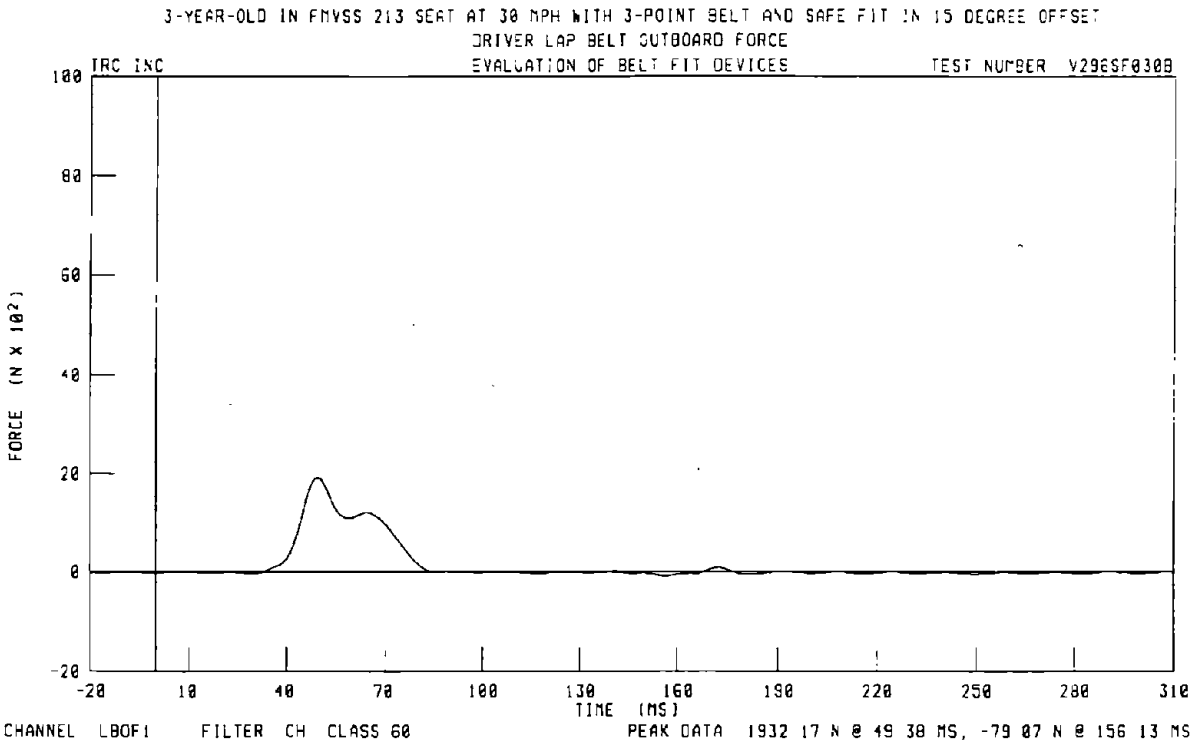

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C503S1
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 1954.00 N @ 56.38 MS, -40.65 N @ 205.6

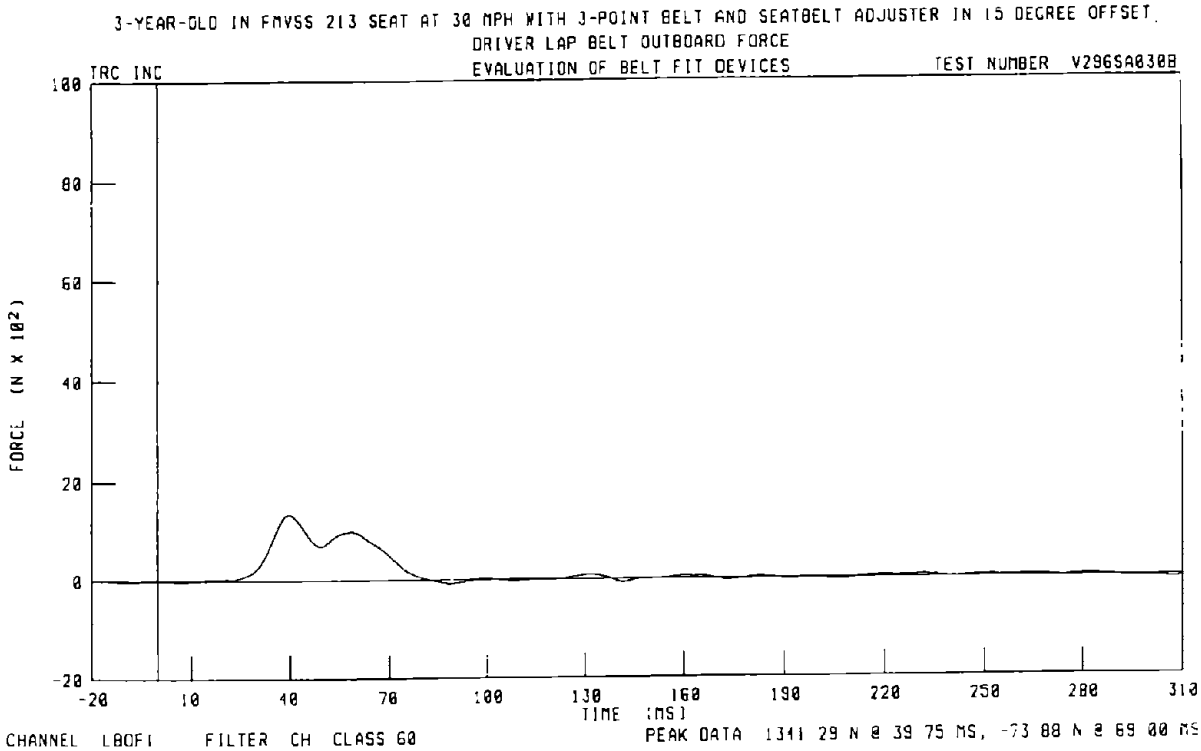

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF035T
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 1946.77 N @ 46.25 MS, -33.22 N @ 193.00 MS

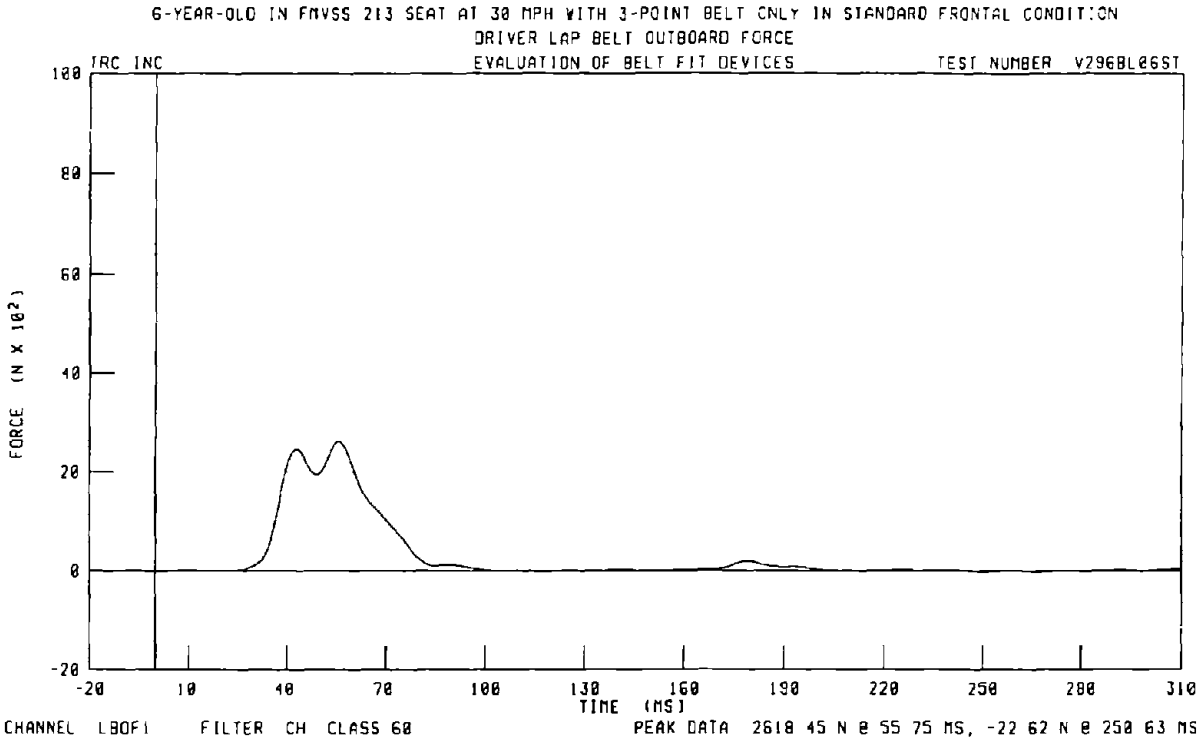

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA035T
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 1829.92 N @ 43.75 MS, -38.95 N @ 14.75 MS

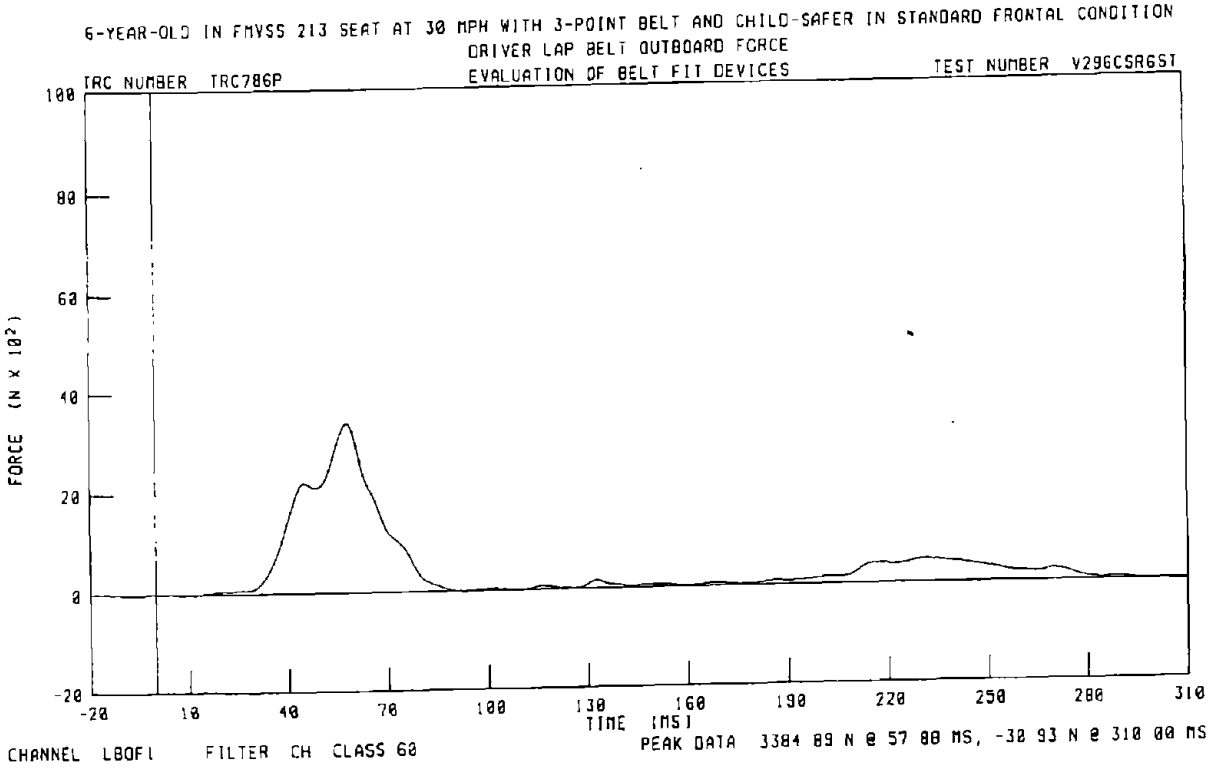

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296B_0308
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 1660 24 N @ 42 50 MS, -66 66 N @ 156 38 MS

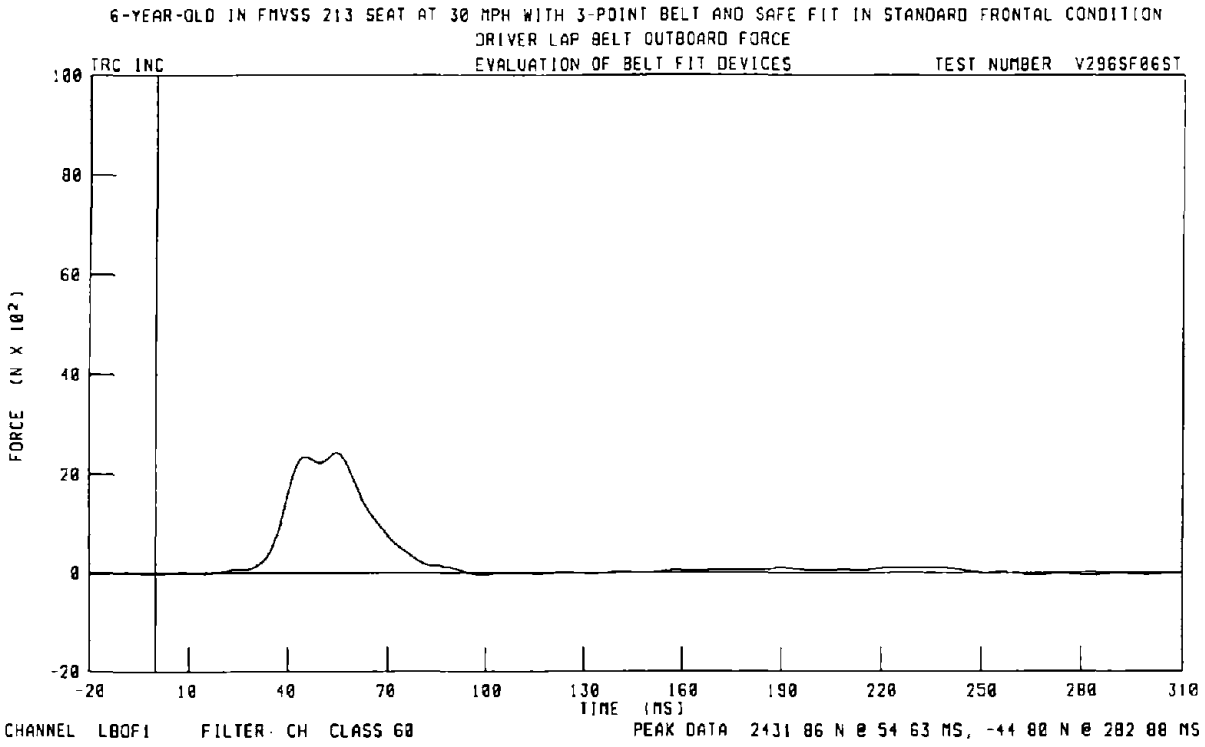

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS0308
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 1918 65 N @ 47 38 MS, -47 90 N @ 281 13 MS

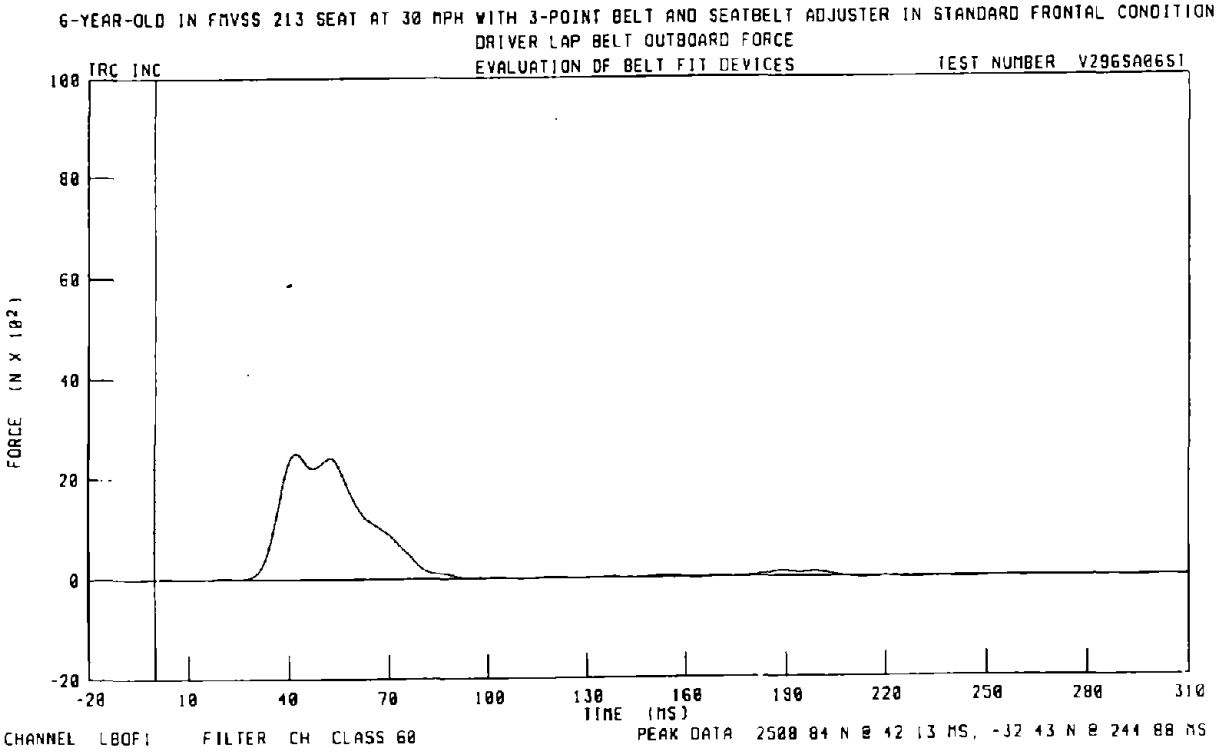

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF0308
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 1932 17 N @ 49 38 MS, -79 07 N @ 156 13 MS

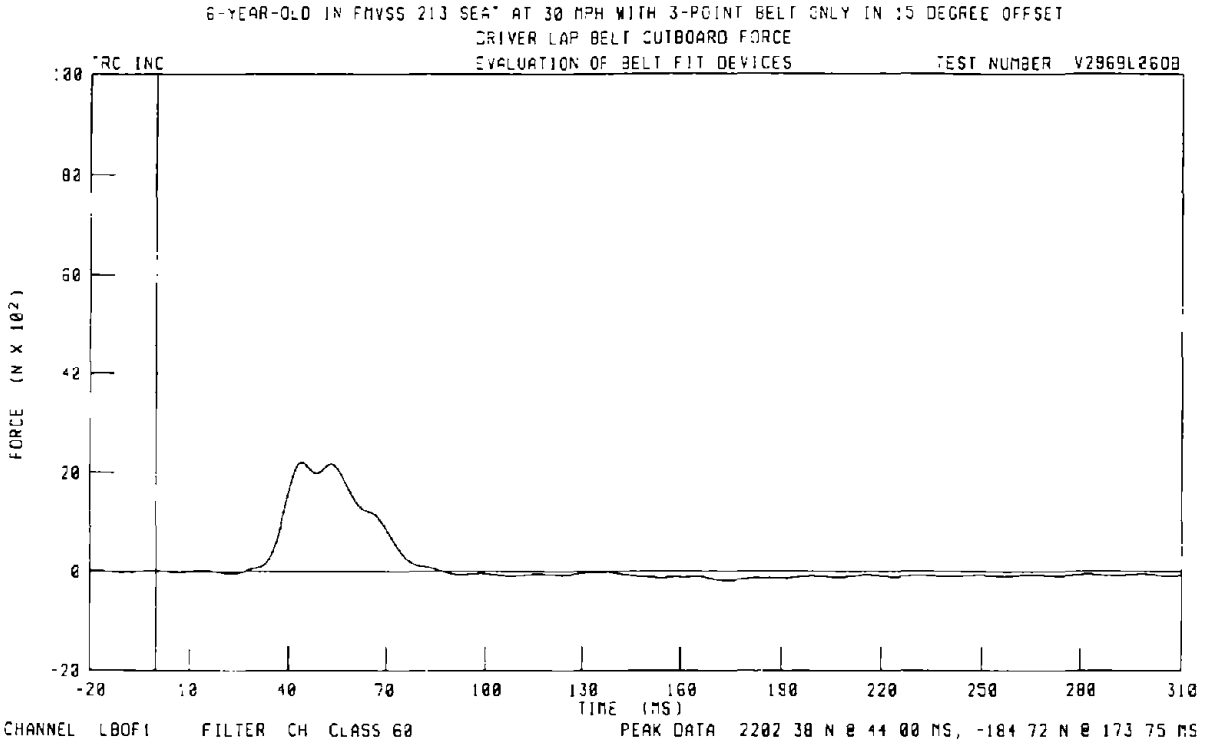

3-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA0308
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 1341 29 N @ 39 75 MS, -73 88 N @ 69 00 MS

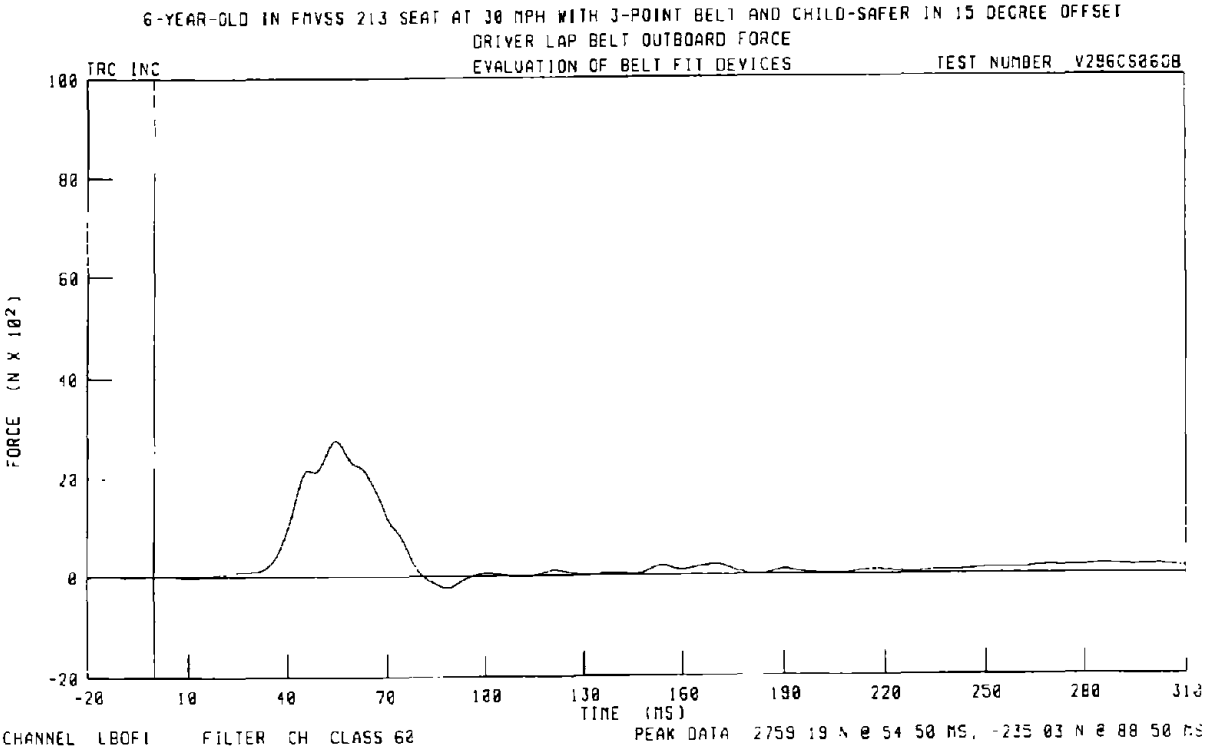

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL@6ST
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 2618 45 N @ 55 75 MS, -22 62 N @ 250 63 MS

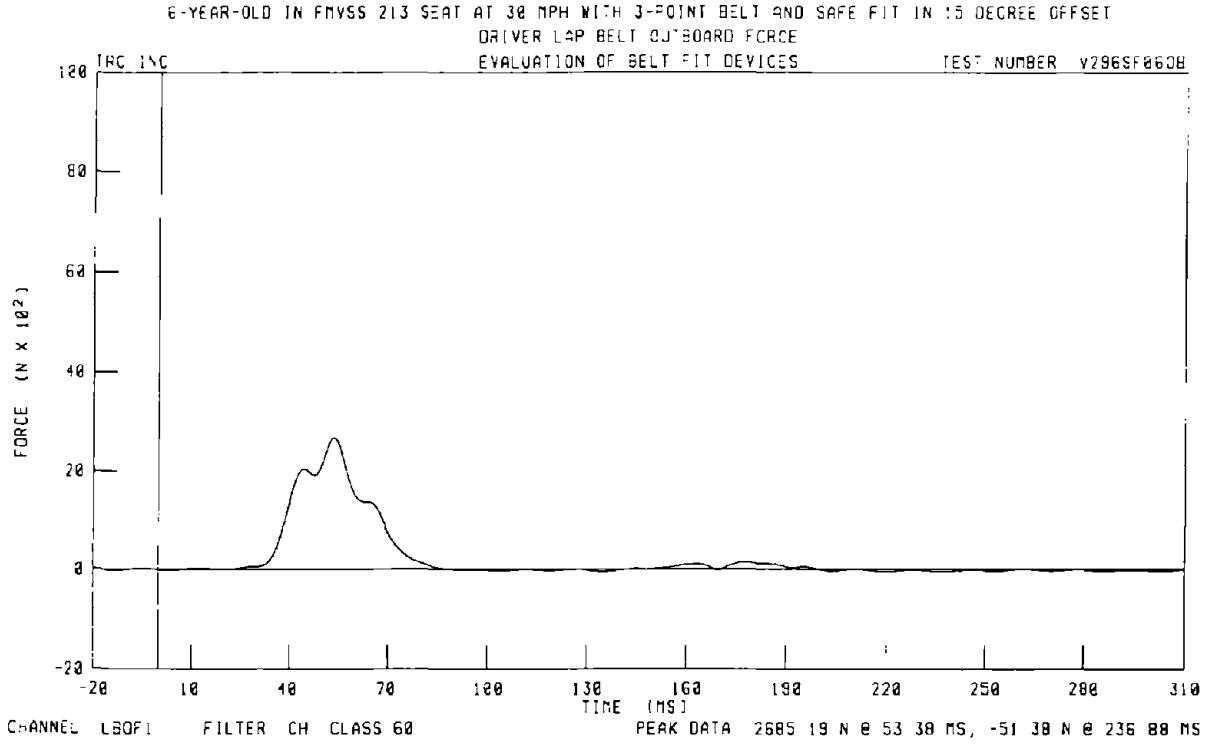

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC786P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CSR6ST
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 3384 89 N @ 57 88 MS, -30 93 N @ 310 00 MS

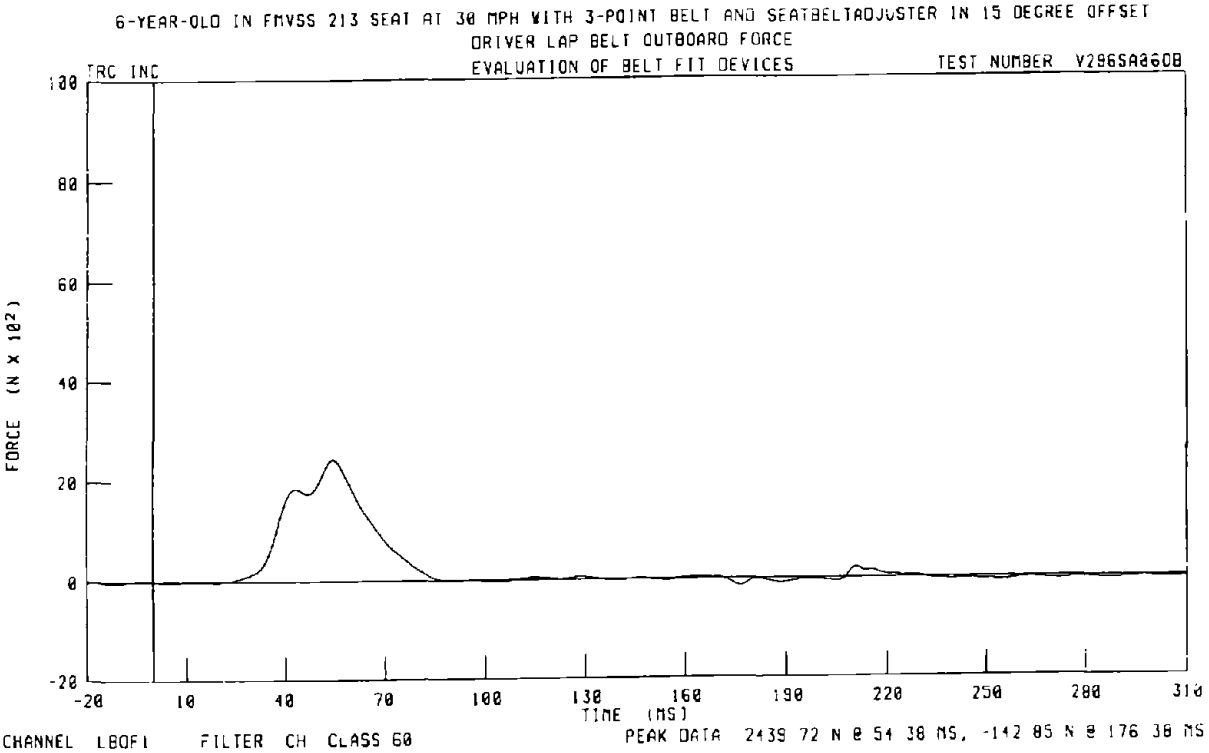

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF06ST
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 2431 86 N @ 54 63 MS, -44 80 N @ 282 88 MS

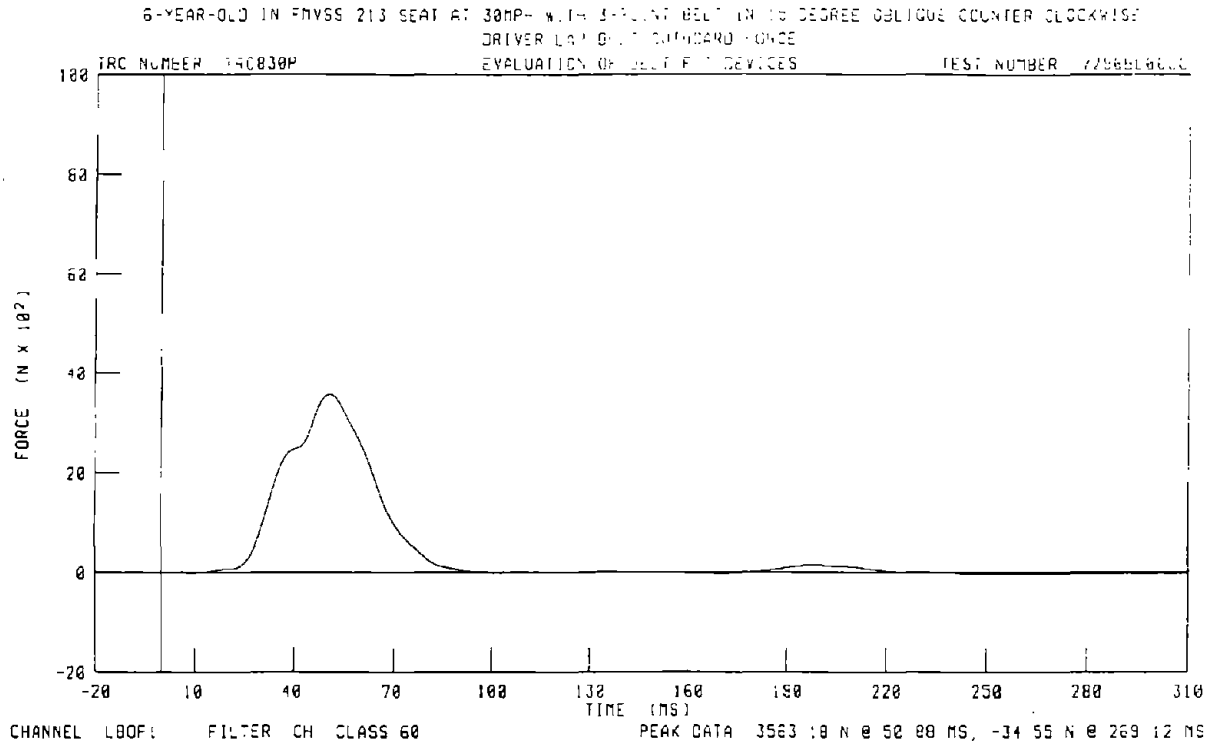

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA06ST
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 2508 84 N @ 42 13 MS, -32 43 N @ 244 88 MS

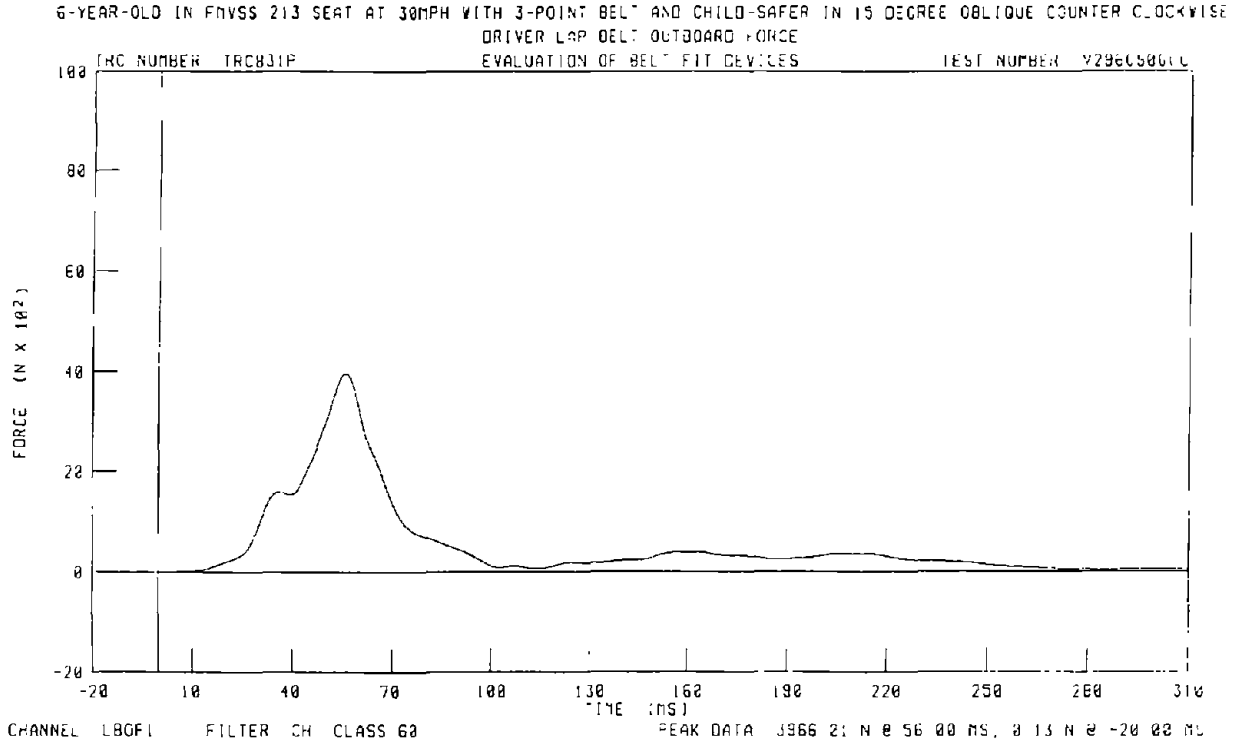

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT ONLY IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2969L2608
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 2202 38 N @ 44 00 MS, -184 72 N @ 173 75 MS

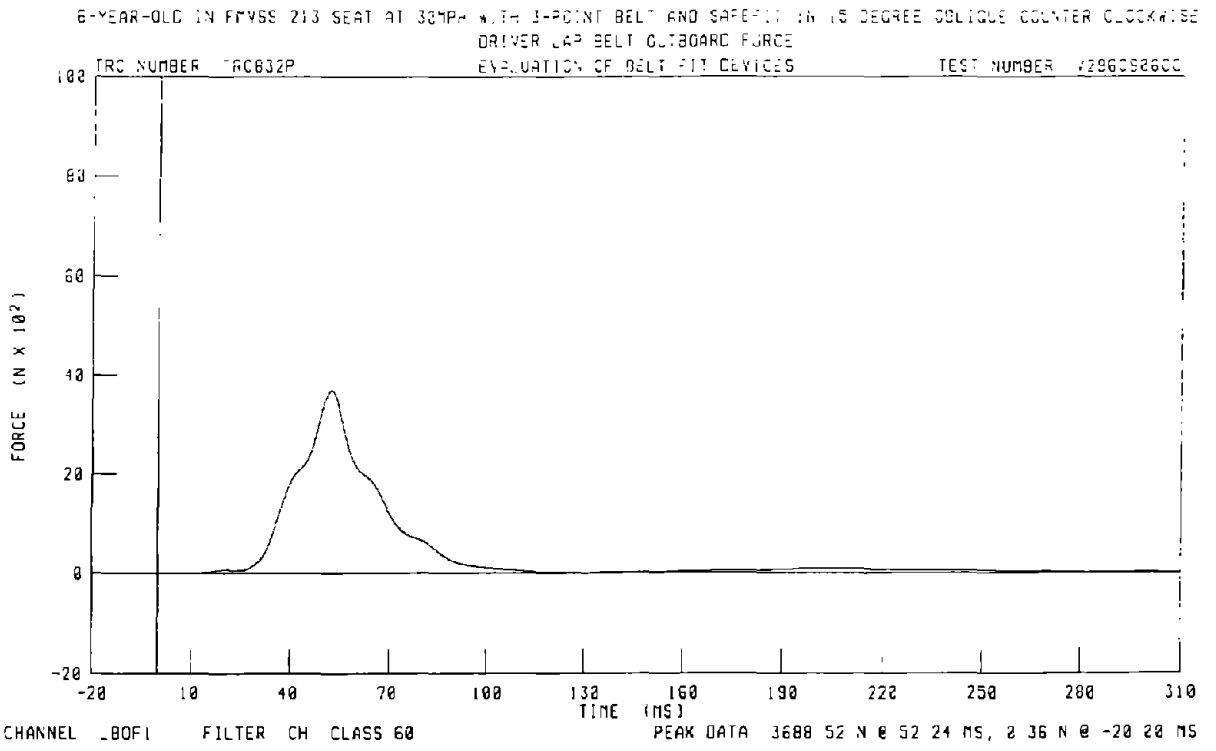

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296CS8608
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 2759 19 N @ 54 50 MS, -235 03 N @ 88 50 MS

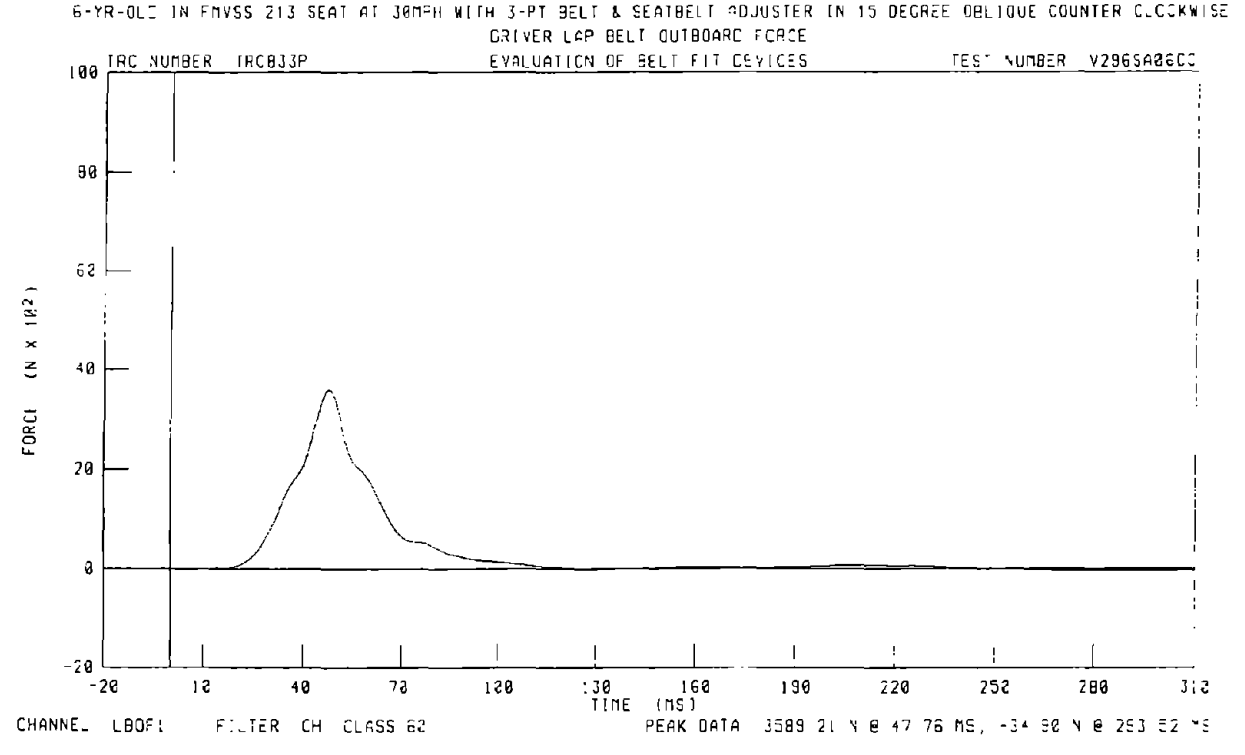

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SAFE FIT IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF860B
FORCE (N X 10²)
120
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 2685 19 N @ 53 38 MS, -51 38 N @ 236 88 MS

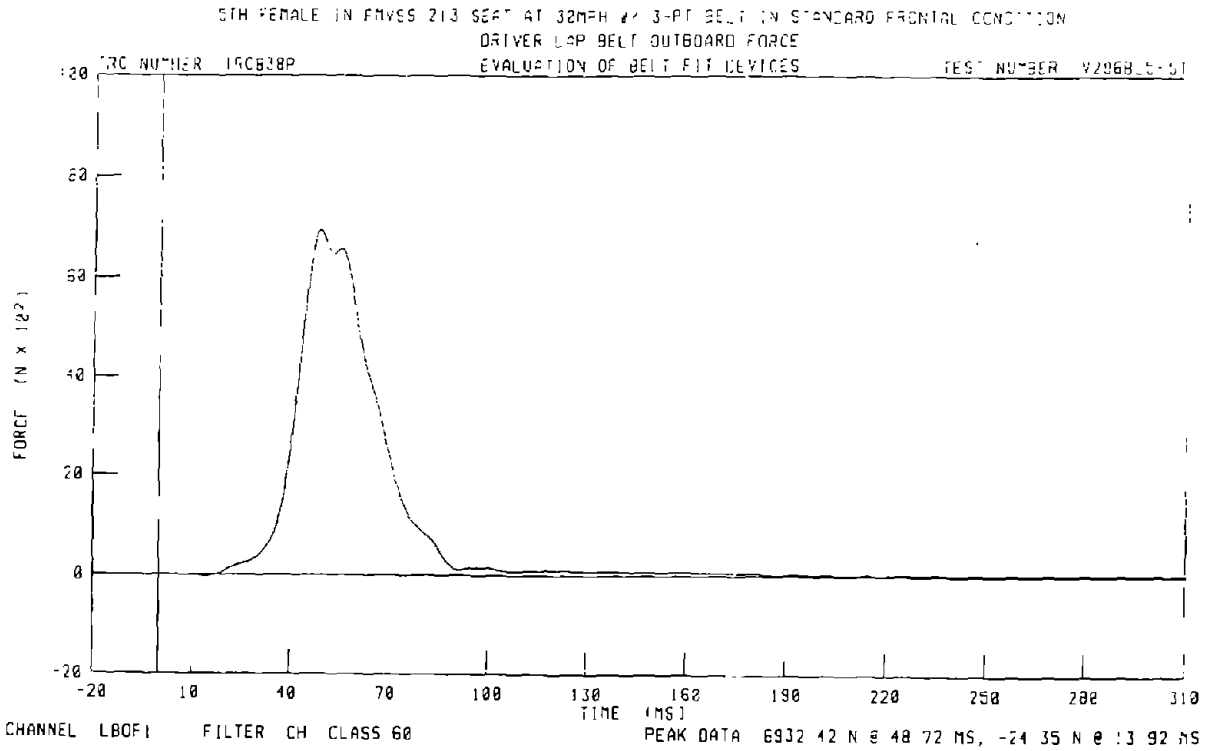

6-YEAR-OLD IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT AND SEATBELTADJUSTER IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
TRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA860B
FORCE (N X 10²)
100
80
60
40
20
0
-20
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 2439 72 N @ 54 38 MS, -142 85 N @ 176 38 MS

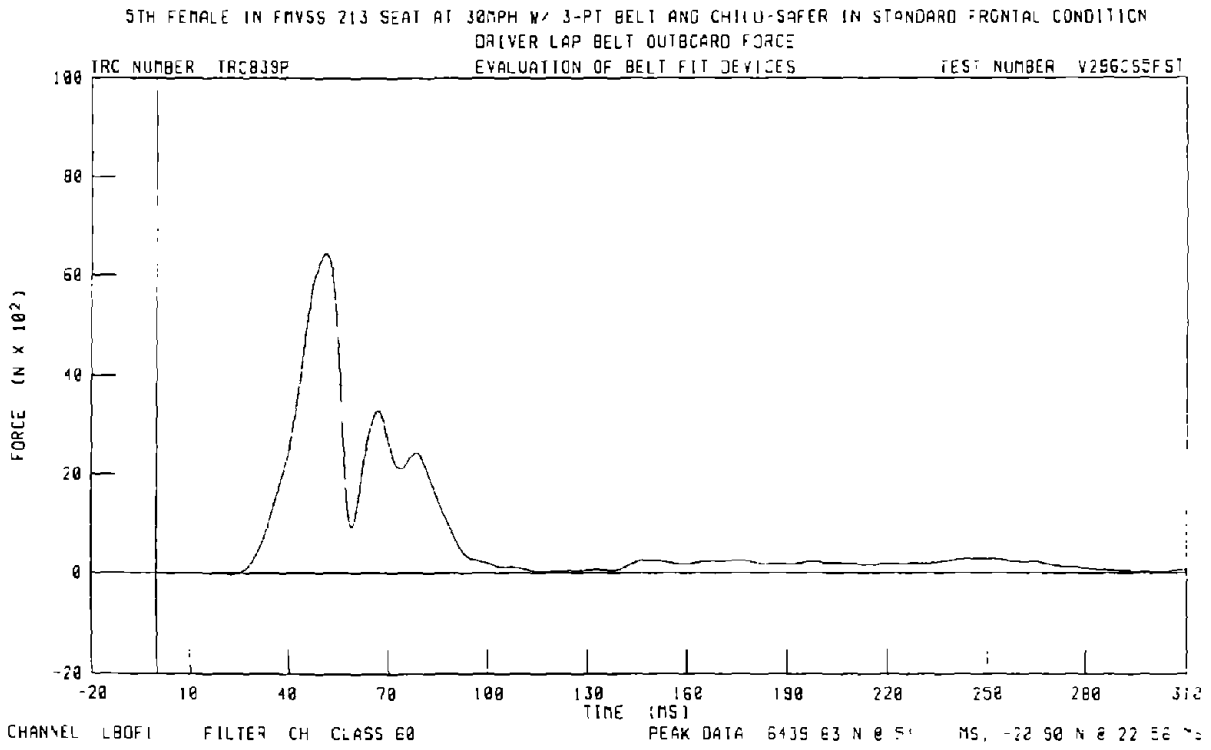

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC830P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER
FORCE (N x 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 3583.18 N @ 50.80 MS, -34.55 N @ 269.12 MS

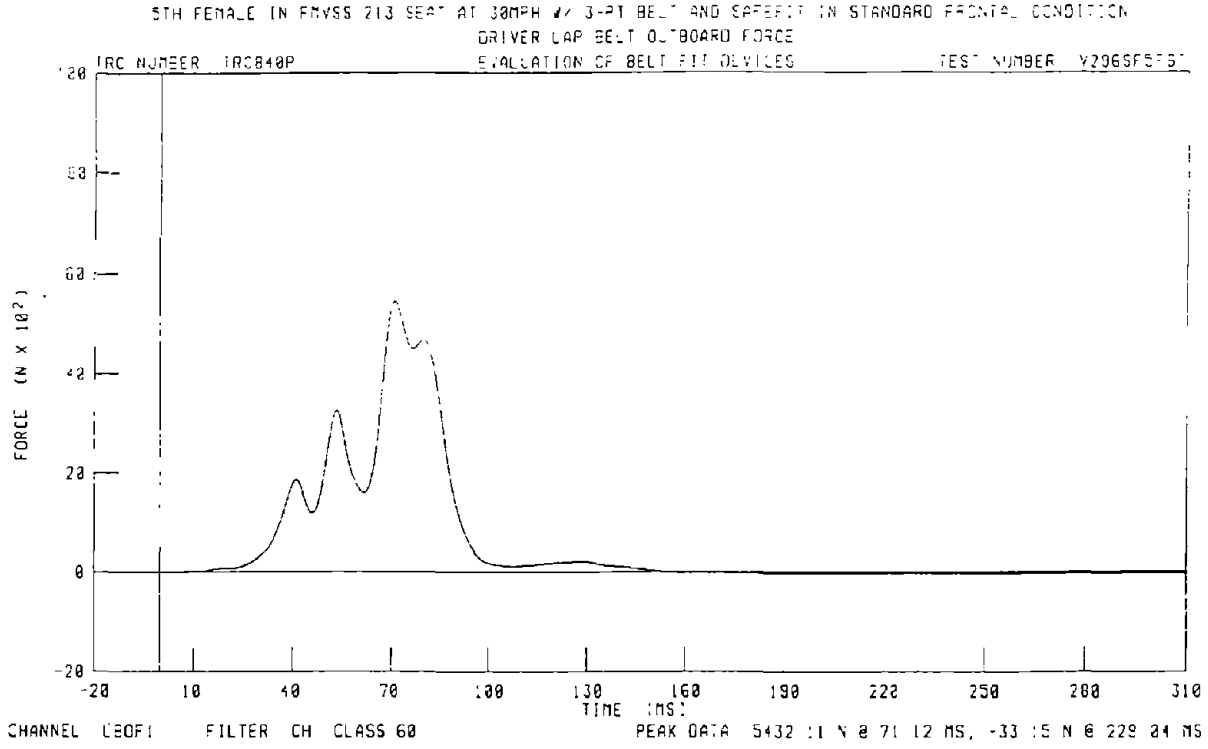

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC831P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER
FORCE (N x 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 3966.21 N @ 56.00 MS, 8.13 N @ -20.00 MS

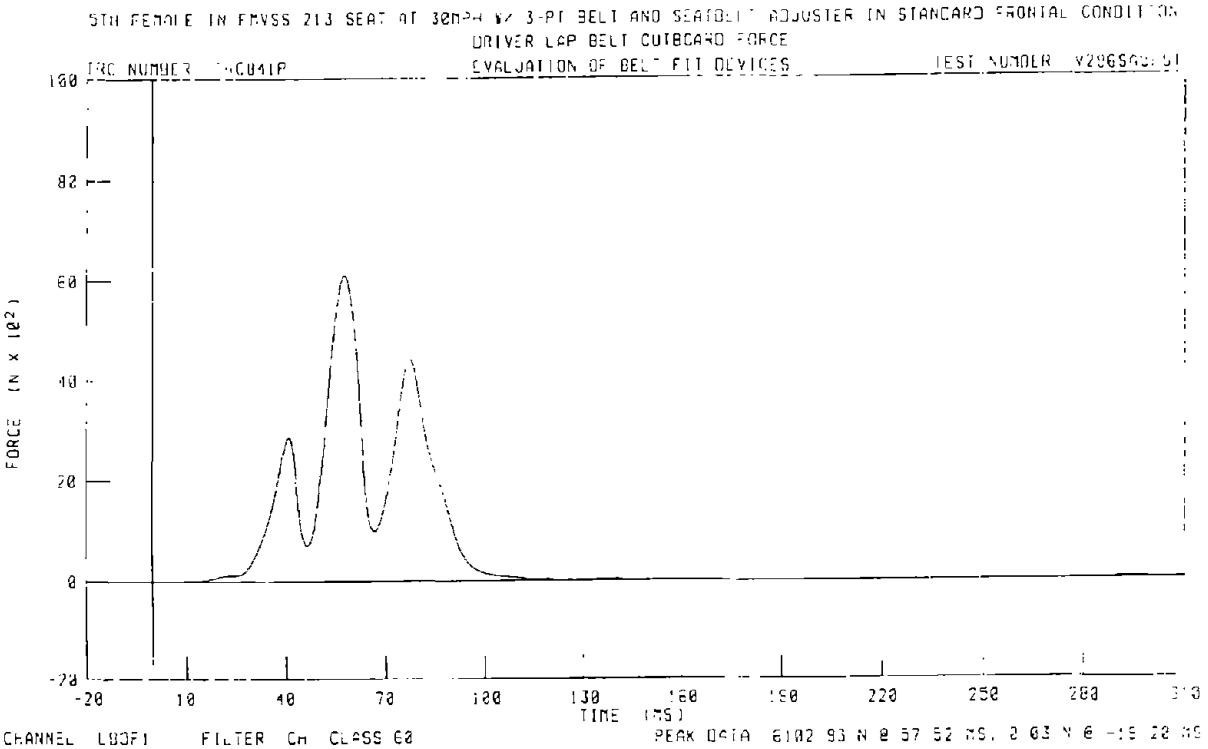

6-YEAR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-POINT BELT AND SAFETY IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC832P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296DS06DC
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 3688 52 N @ 52 24 MS, 2 36 N @ -20 20 MS

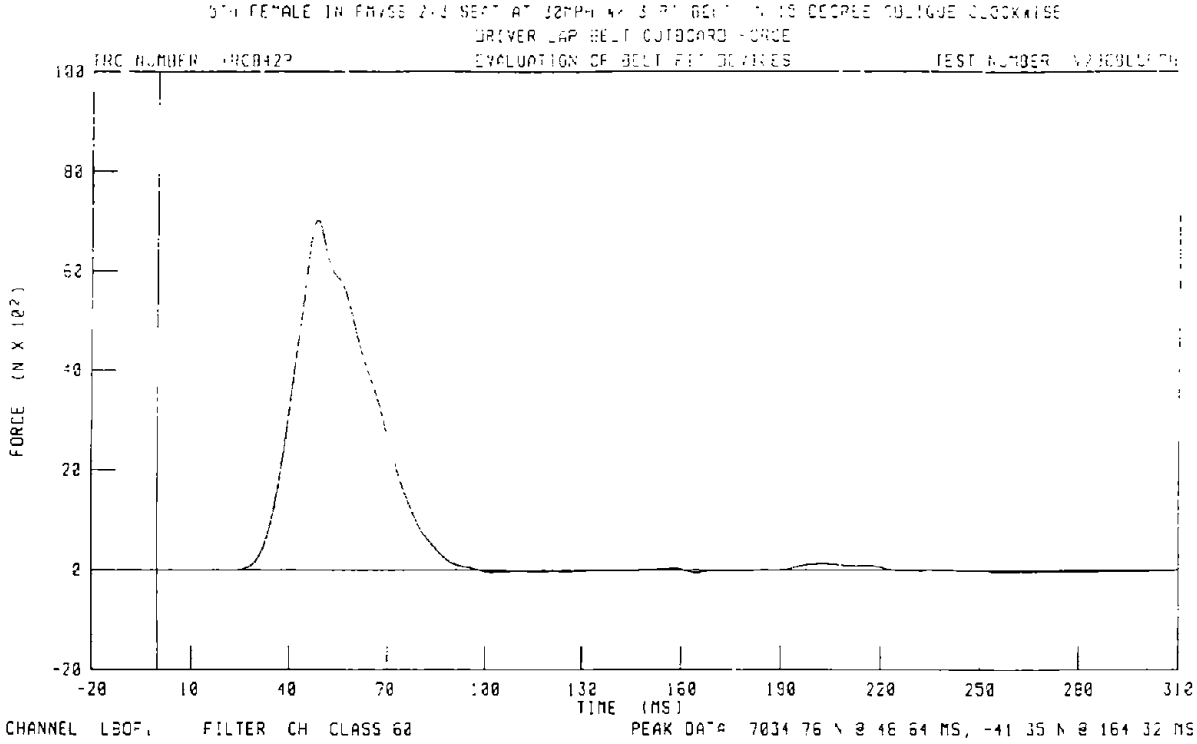

6-YR-OLD IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT & SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC833P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA06DC
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 3589 21 N @ 47 76 MS, -34 80 N @ 253 52 MS

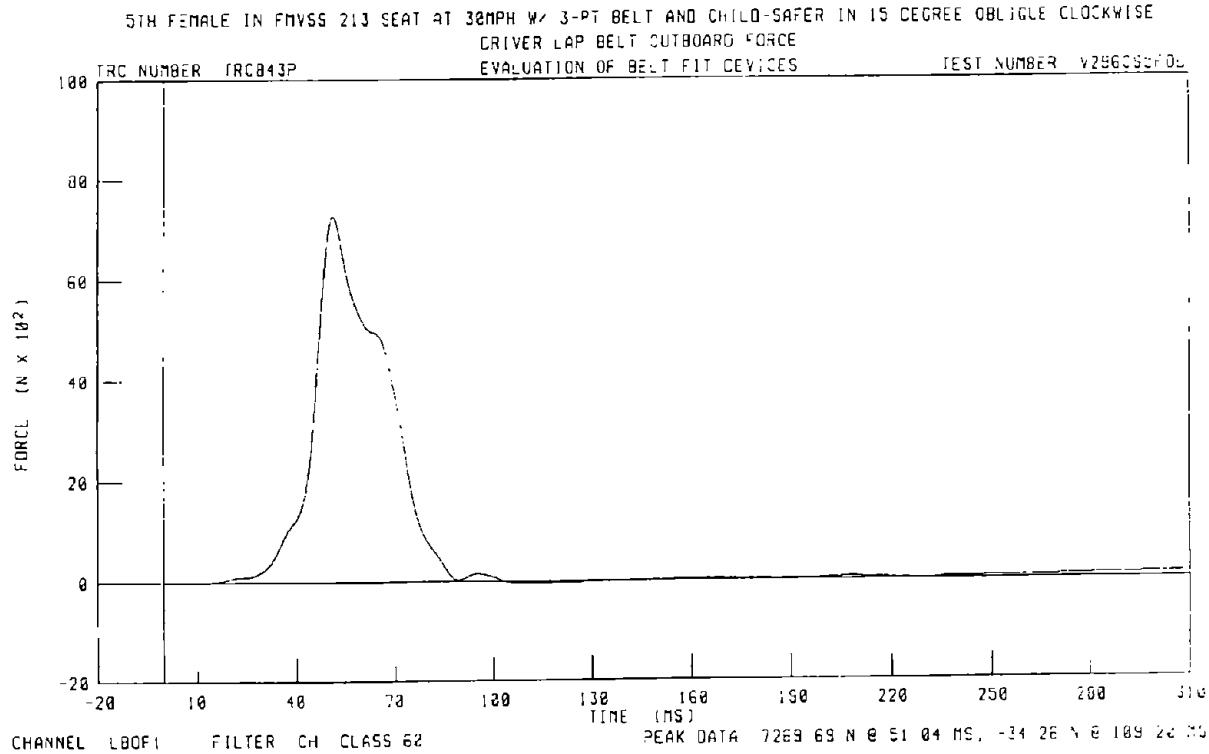

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
IRC NUMBER IRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296B_5-ST
FORCE (N x 10²)
TIME (MS)
CHANNEL LBOFI FILTER CH CLASS 60
PEAK DATA 6932 42 N @ 48 72 MS, -24 35 N @ 13 92 MS

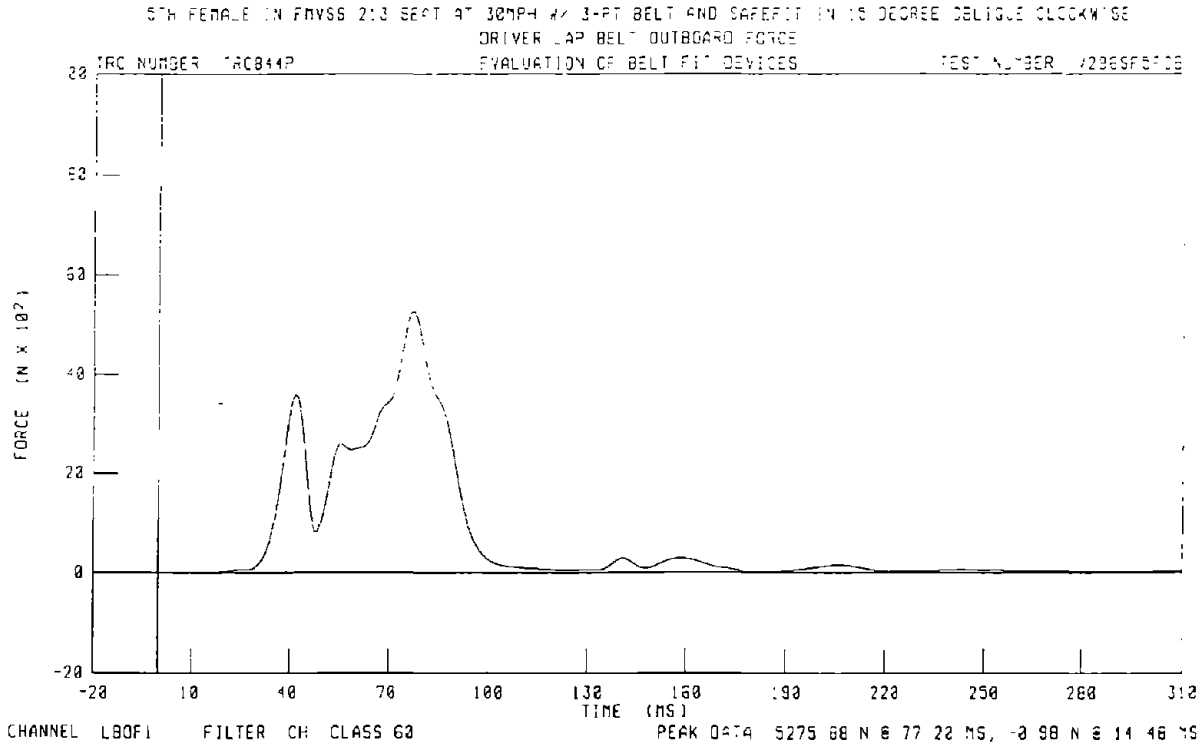

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
IRC NUMBER IRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C5SFST
FORCE (N x 10²)
TIME (MS)
CHANNEL LBOFI FILTER CH CLASS 60
PEAK DATA 6435 83 N @ 5
MS, -22 90 N @ 22 56

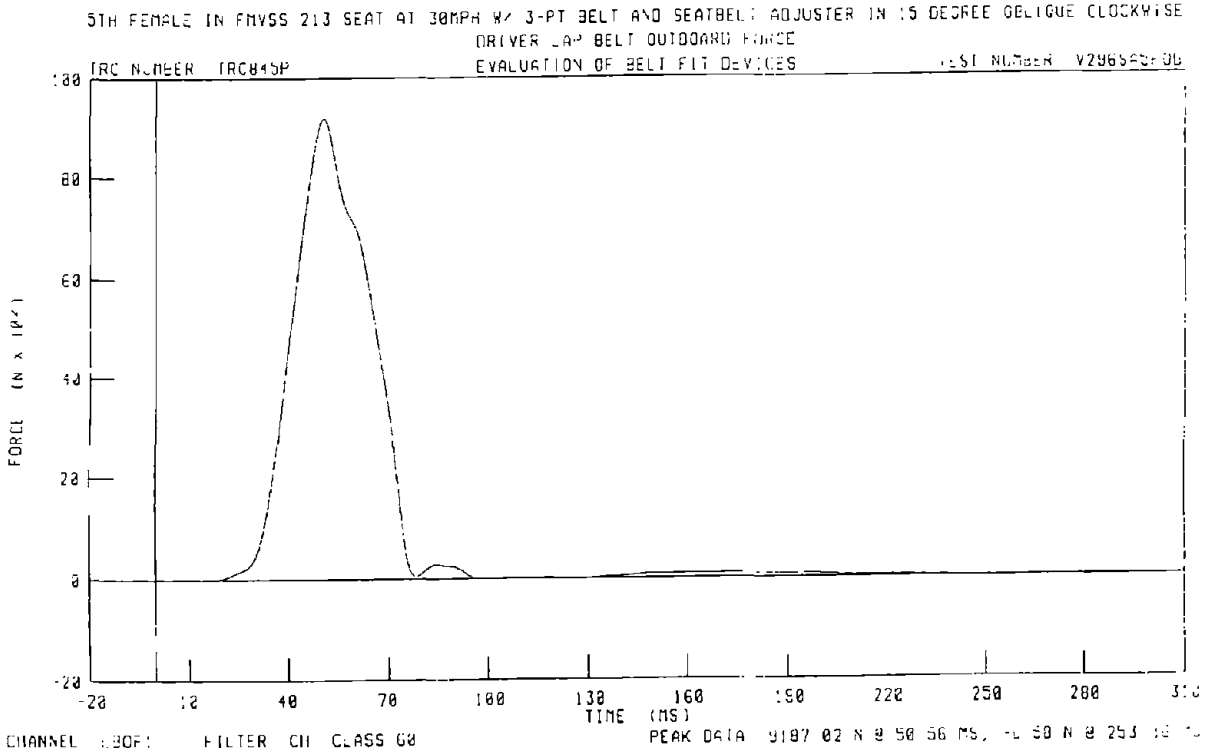

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
IRC NUMBER IRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V206SFEST
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 5432.11 N @ 71.12 MS, -33.15 N @ 229.84 MS

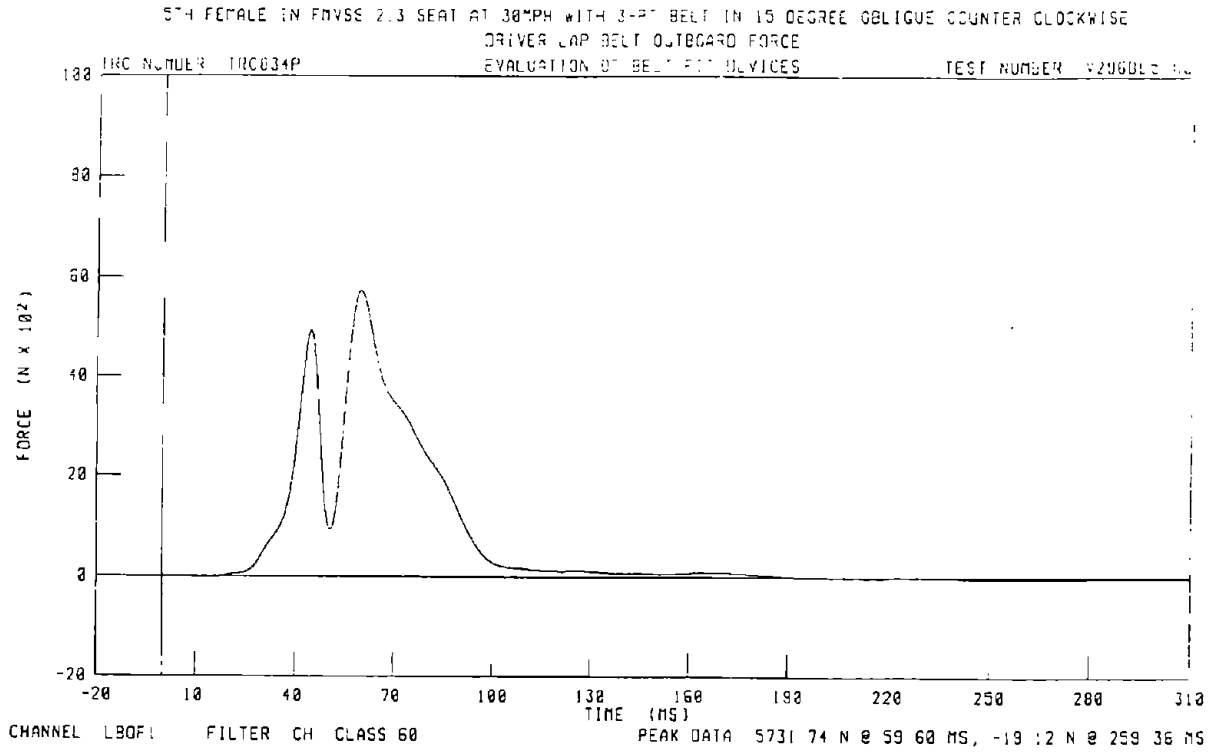

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
IRC NUMBER IRC841P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V206SGEST
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 6102.93 N @ 57.52 MS, 2.03 N @ -19.28 MS

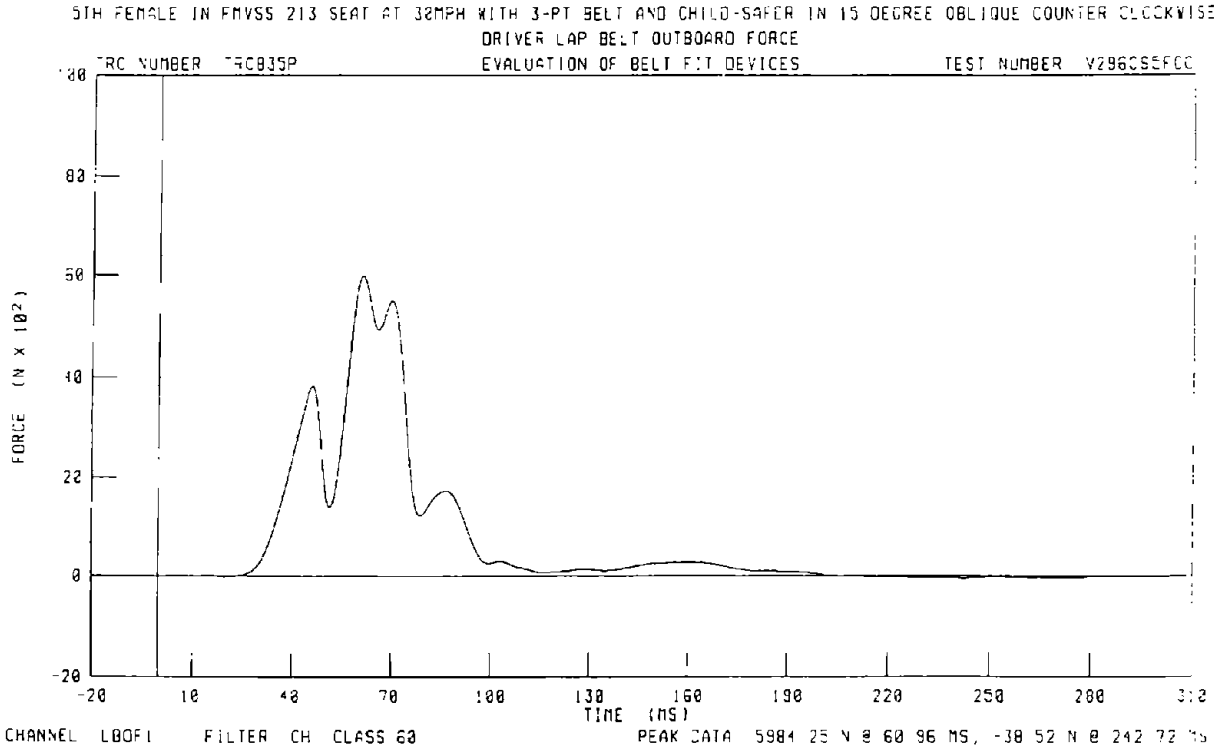

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
100
80
60
40
20
0
-20
FORCE (N X 10²)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 7034.76 N @ 46.64 MS, -41.35 N @ 164.32 MS

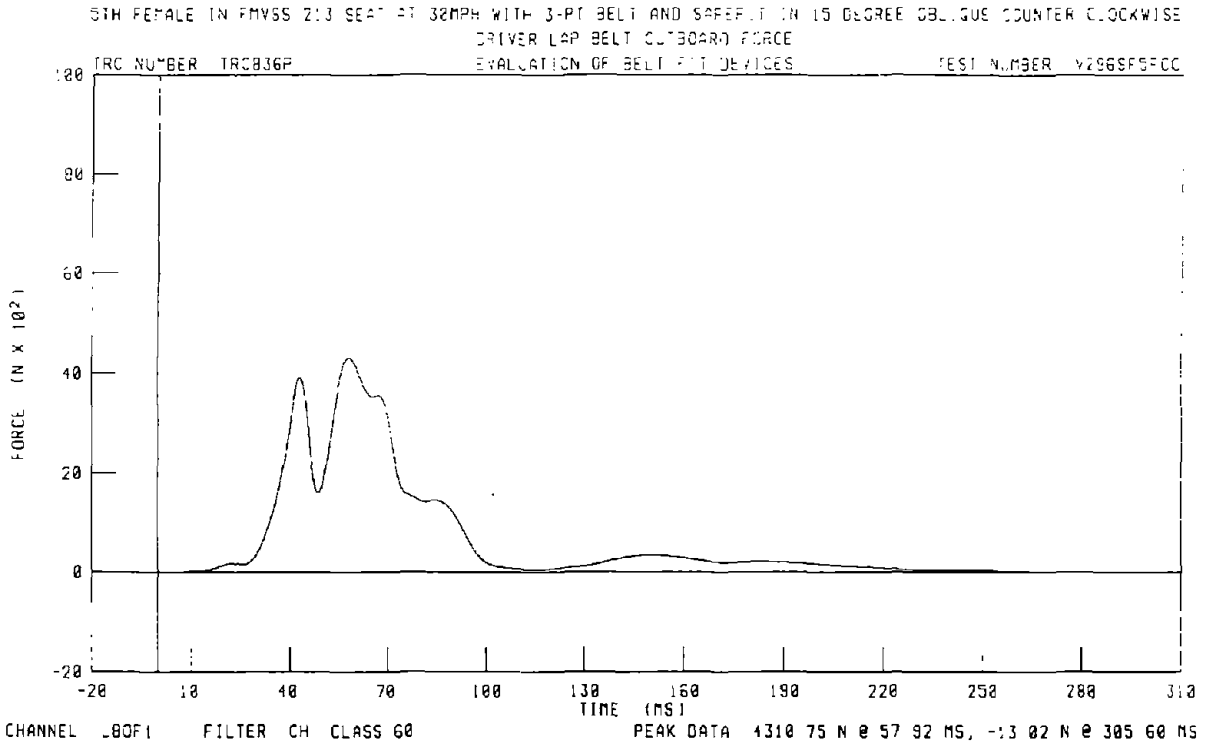

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIGLE CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
100
80
60
40
20
0
-20
FORCE (N X 10²)
-20
10
40
70
100
130
160
190
220
250
280
TIME (MS)
CHANNEL LBOF1
FILTER CH CLASS 60
PEAK DATA 7269.69 N @ 51.04 MS, -34.26 N @ 189.24 MS

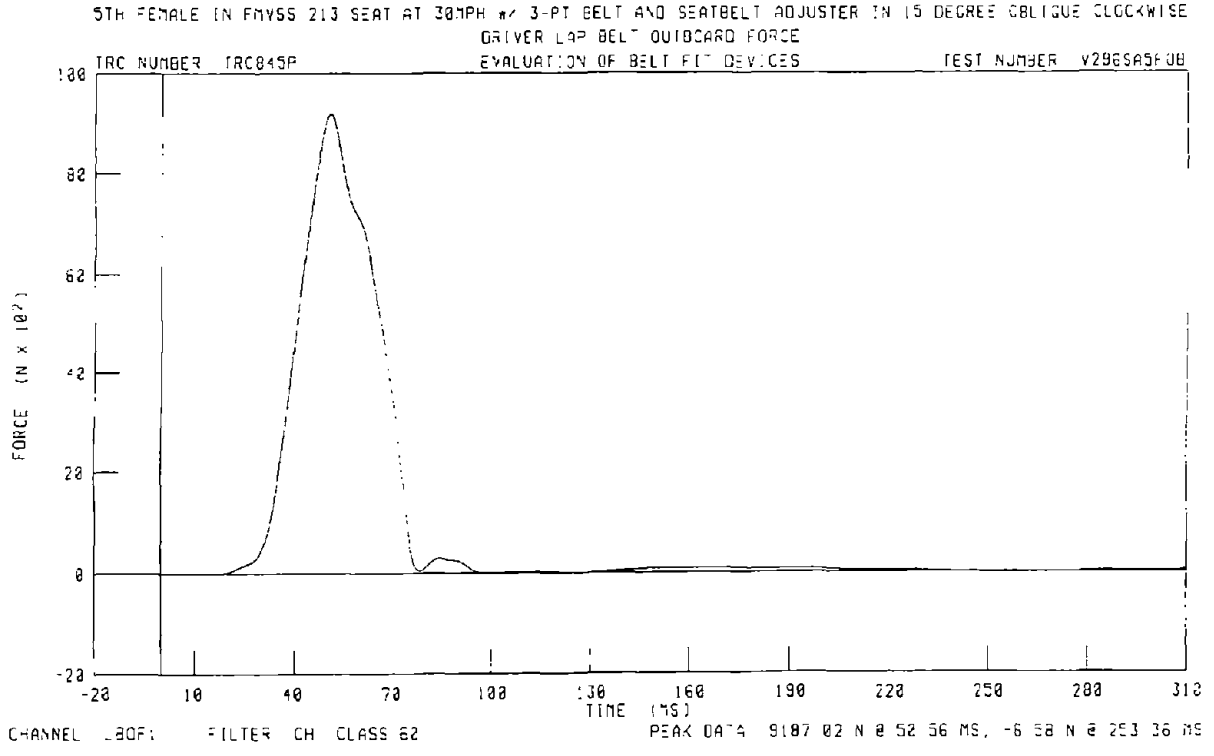

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
IRC NUMBER IRC844P
EVALUATION OF BELT FIT DEVICES
FORCE (N X 10²)
TIME (MS)
CHANNEL L80F1 FILTER CH CLASS 60
PEAK DATA 5275.88 N @ 77.22 MS, -0.98 N @ 14.46 MS

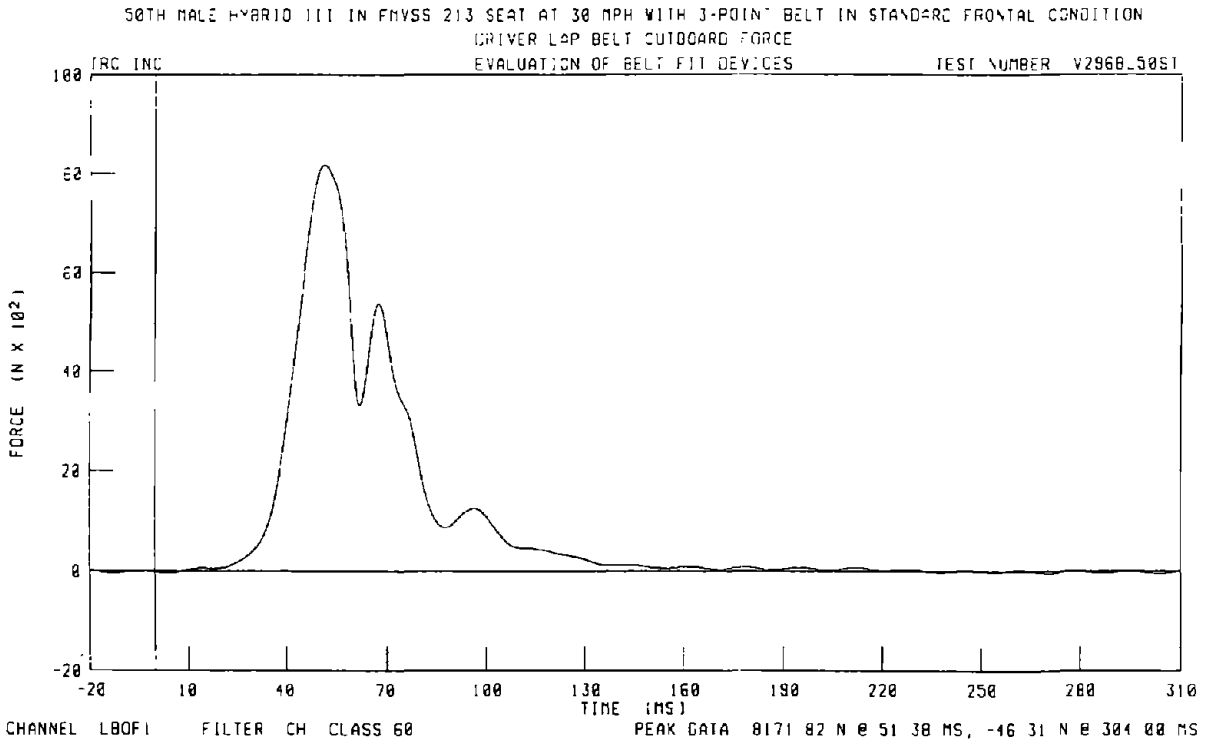

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
IRC NUMBER IRC845P
EVALUATION OF BELT FIT DEVICES
TIME (MS)
CHANNEL L80F1 FILTER CH CLASS 60
PEAK DATA 9187.02 N @ 58.56 MS,

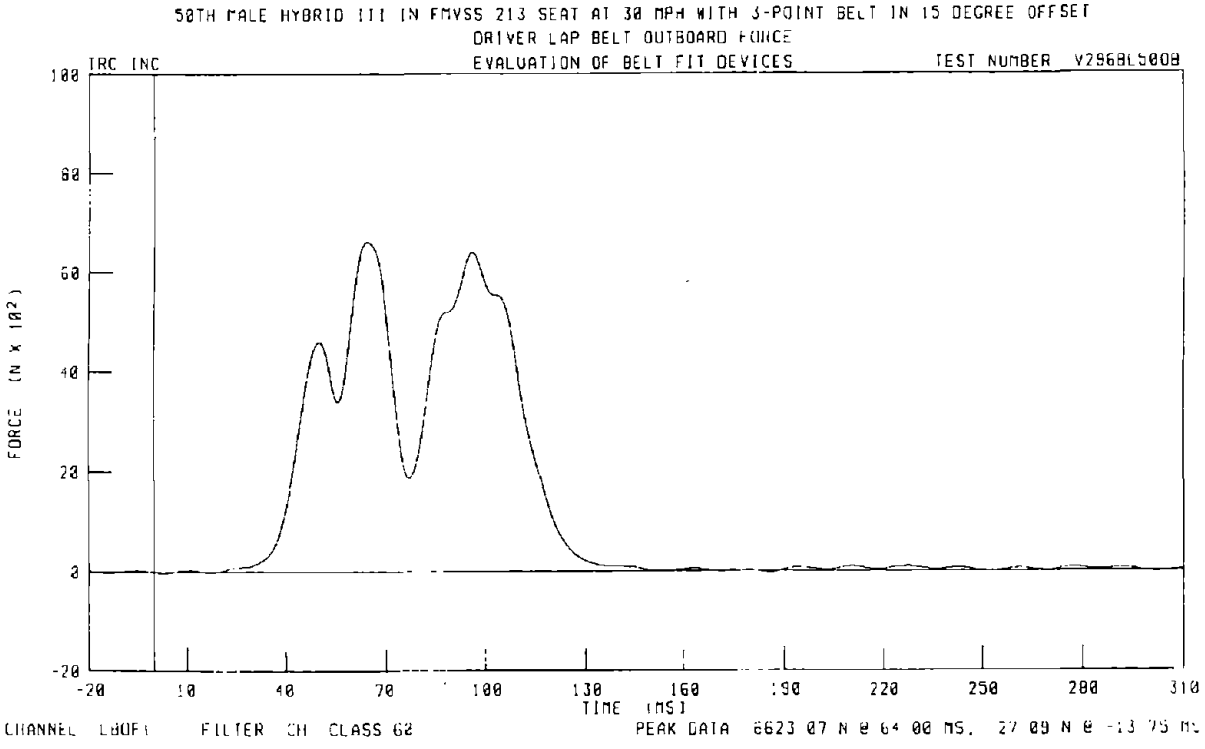

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 5731 74 N @ 59 60 MS, -19 12 N @ 259 36 MS


5TH FEMALE IN FMVSS 213 SEAT AT 32MPH WITH 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC835P
EVALUATION OF BELT FIT DEVICES
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 5984 25 N @ 60 96 MS, -38 52 N @ 242 72 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFLT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF5FCC
FORCE (N X 10²)
TIME (MS)
CHANNEL 180F1
FILTER CH CLASS 60
PEAK DATA 4310 75 N @ 57 92 MS, -13 02 N @ 305 60 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH w/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LAP BELT OUTBOARD FORCE
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5F0B
FORCE (N X 10²)
TIME (MS)
CHANNEL 180F1
FILTER CH CLASS 60
PEAK DATA 9187 02 N @ 52 56 MS, -6 58 N @ 253 36 MS

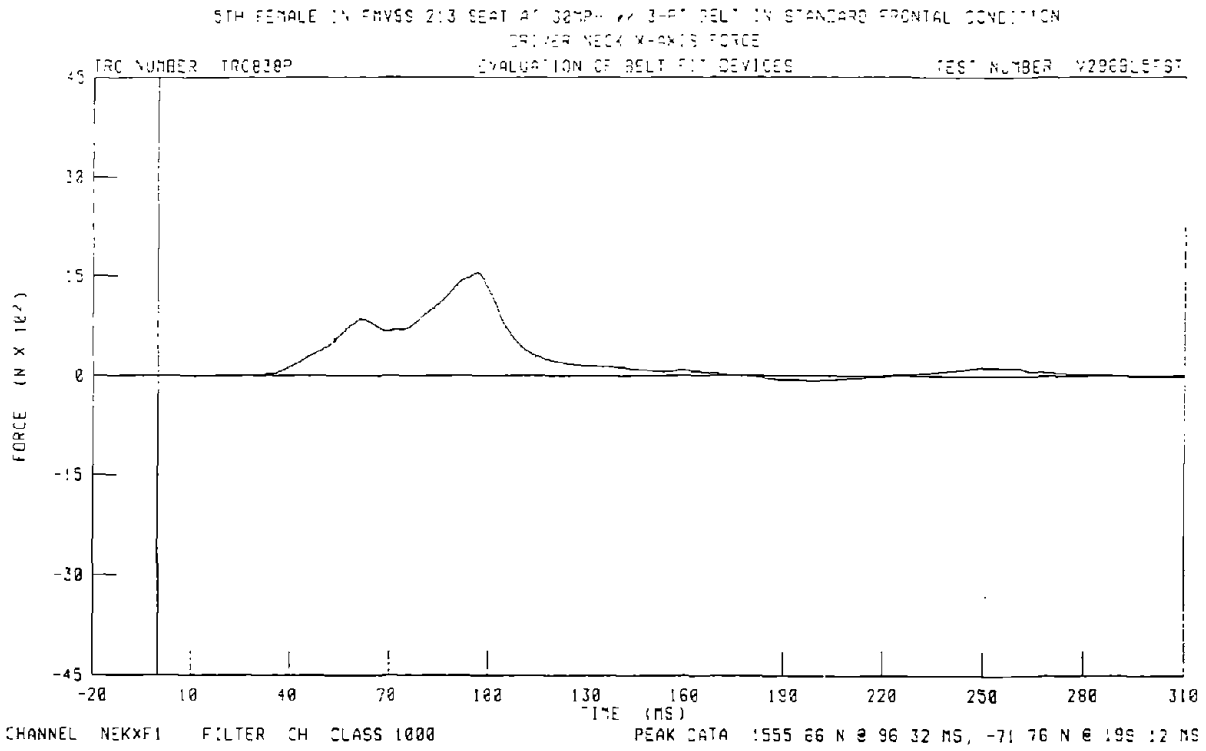

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT IN STANDARD FRONTAL CONDITION
DRIVER LAP BELT OUTBOARD FORCE
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968_5051
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 8171.82 N @ 51.38 MS, -46.31 N @ 304.00 MS

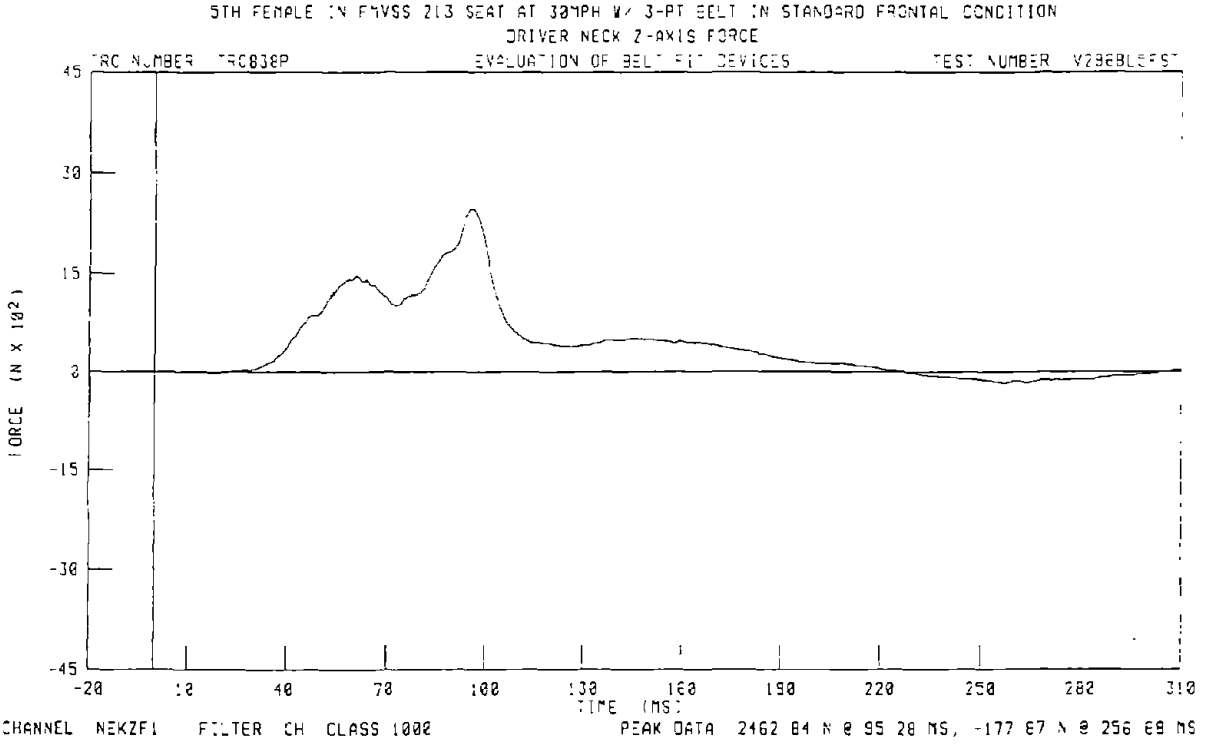

50TH MALE HYBRID III IN FMVSS 213 SEAT AT 30 MPH WITH 3-POINT BELT IN 15 DEGREE OFFSET
DRIVER LAP BELT OUTBOARD FORCE
IRC INC
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968L5008
FORCE (N X 10²)
TIME (MS)
CHANNEL LBOF1 FILTER CH CLASS 60
PEAK DATA 6623.07 N @ 64.00 MS, 27.09 N @ -13.75 MS

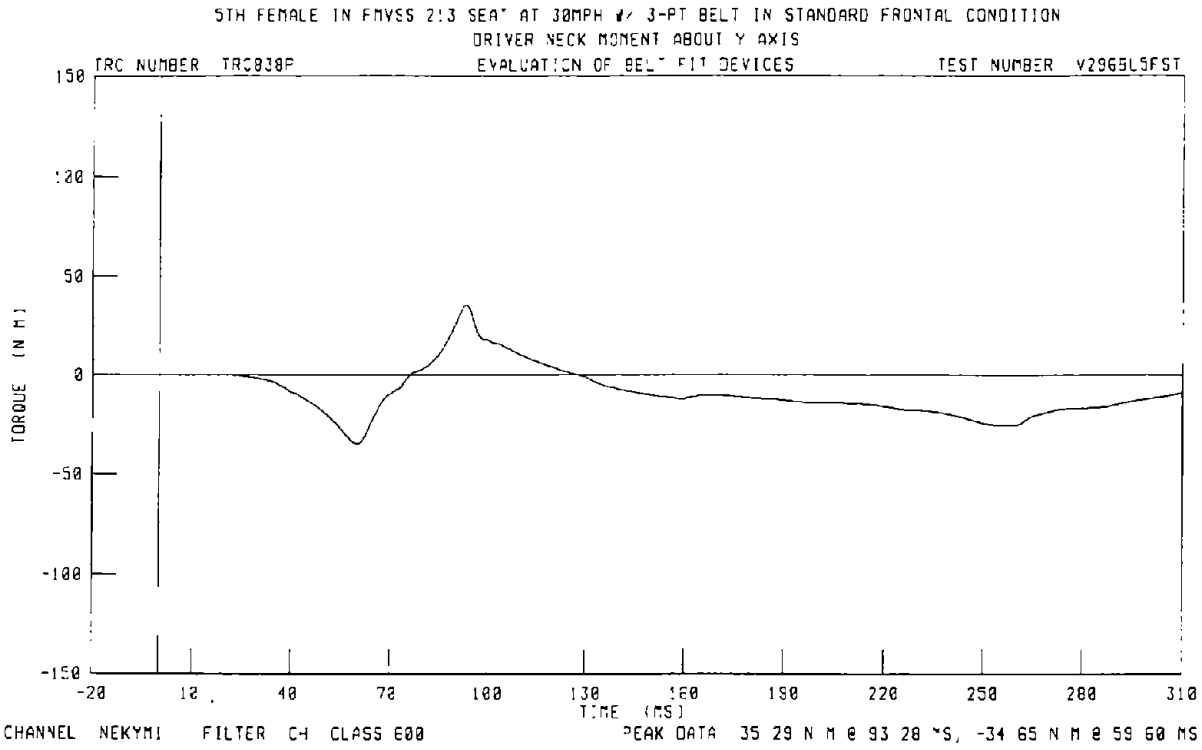
Appendix E

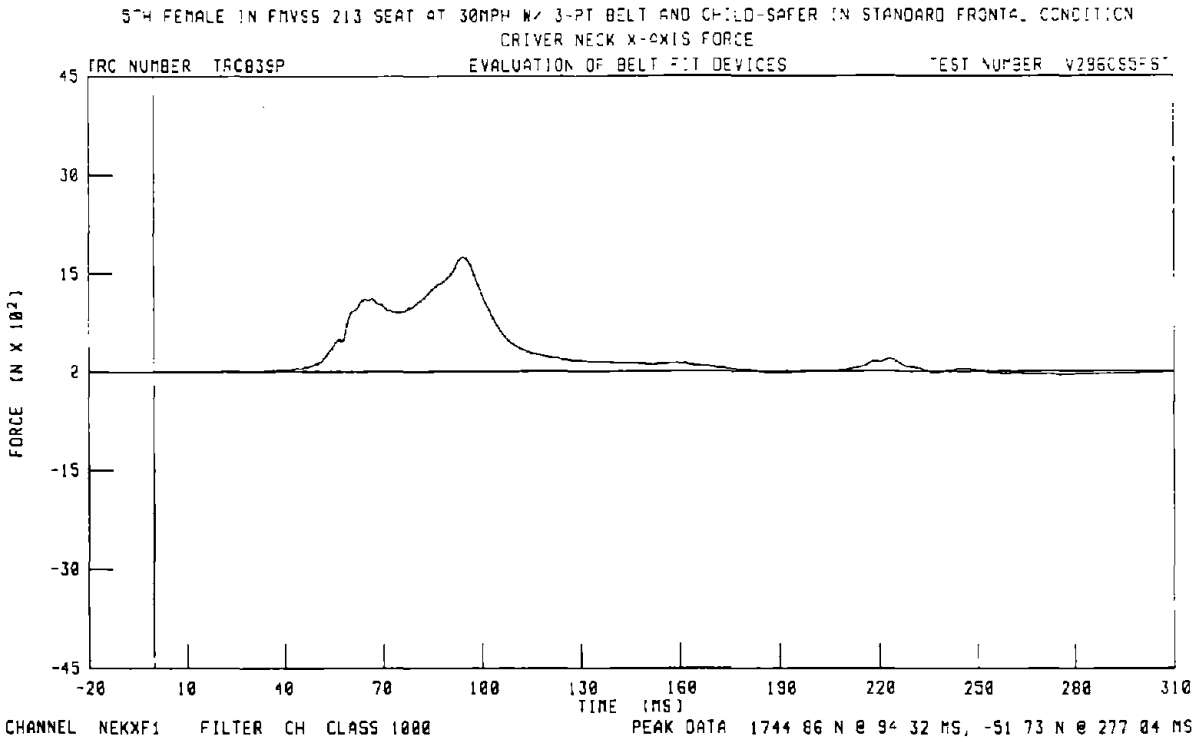
5th Percentile Female Dummy Neck

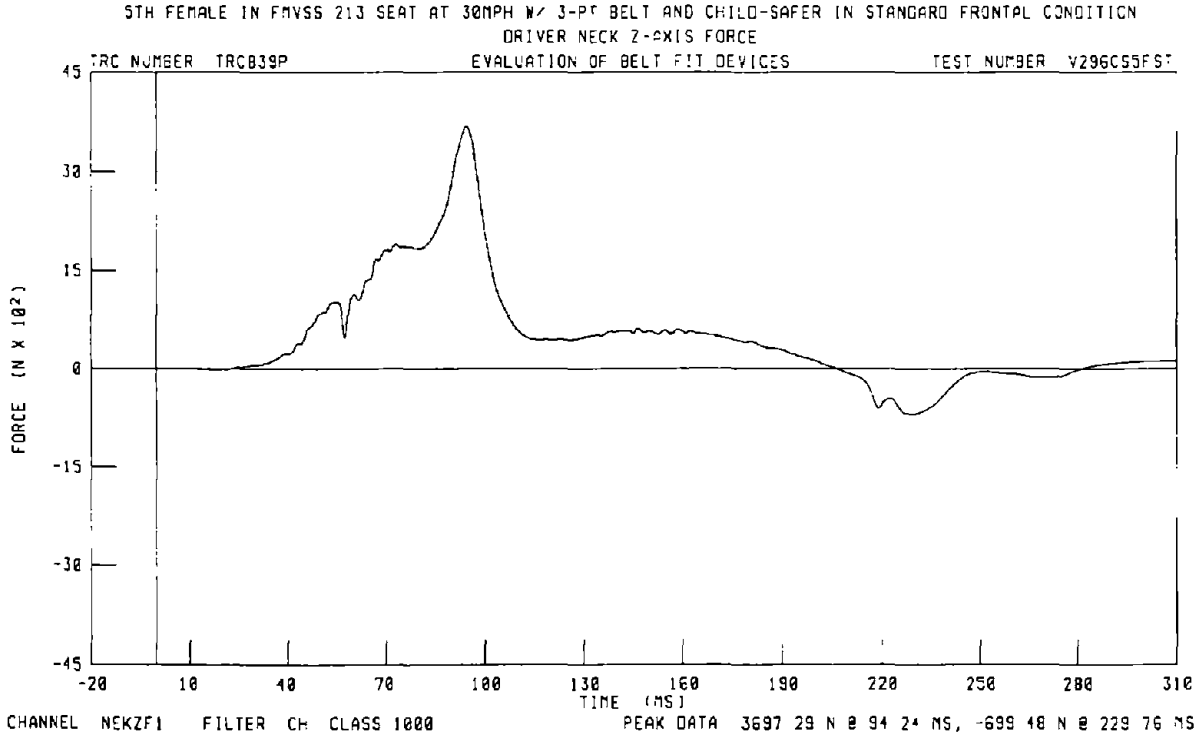
Load and Moment Time Histories

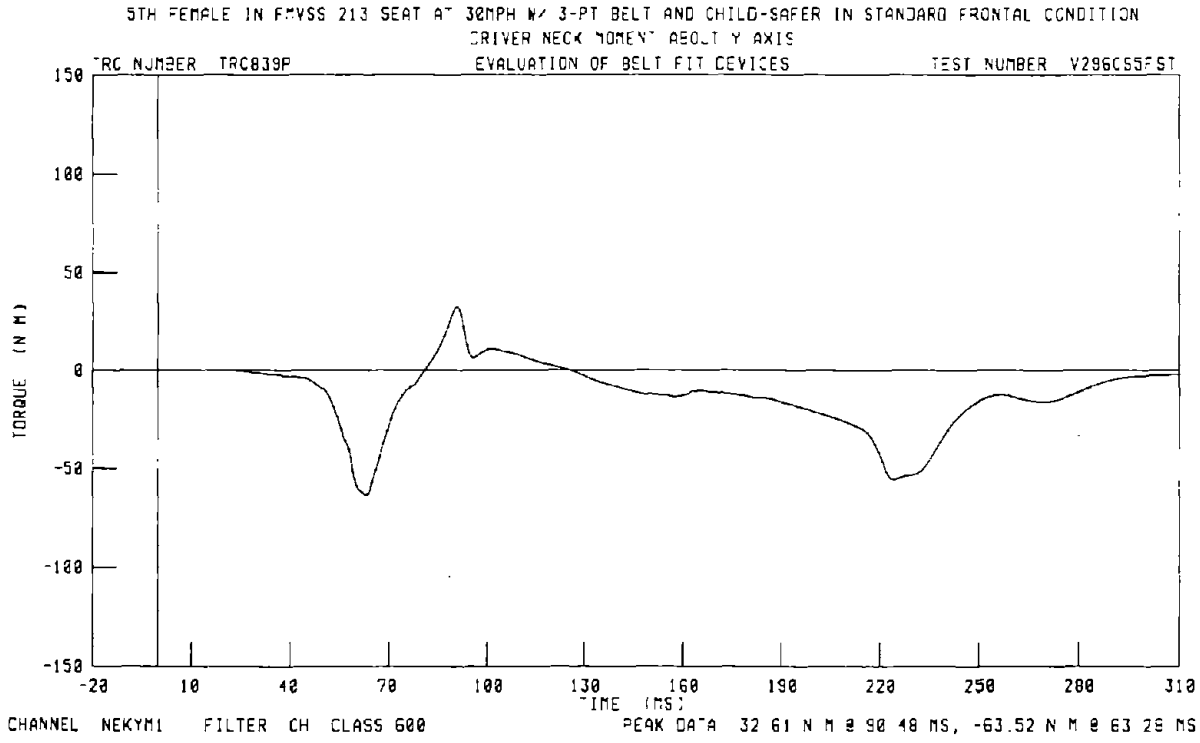

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BLSFST
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1555 66 N @ 96 32 MS, -71 76 N @ 199 12 MS

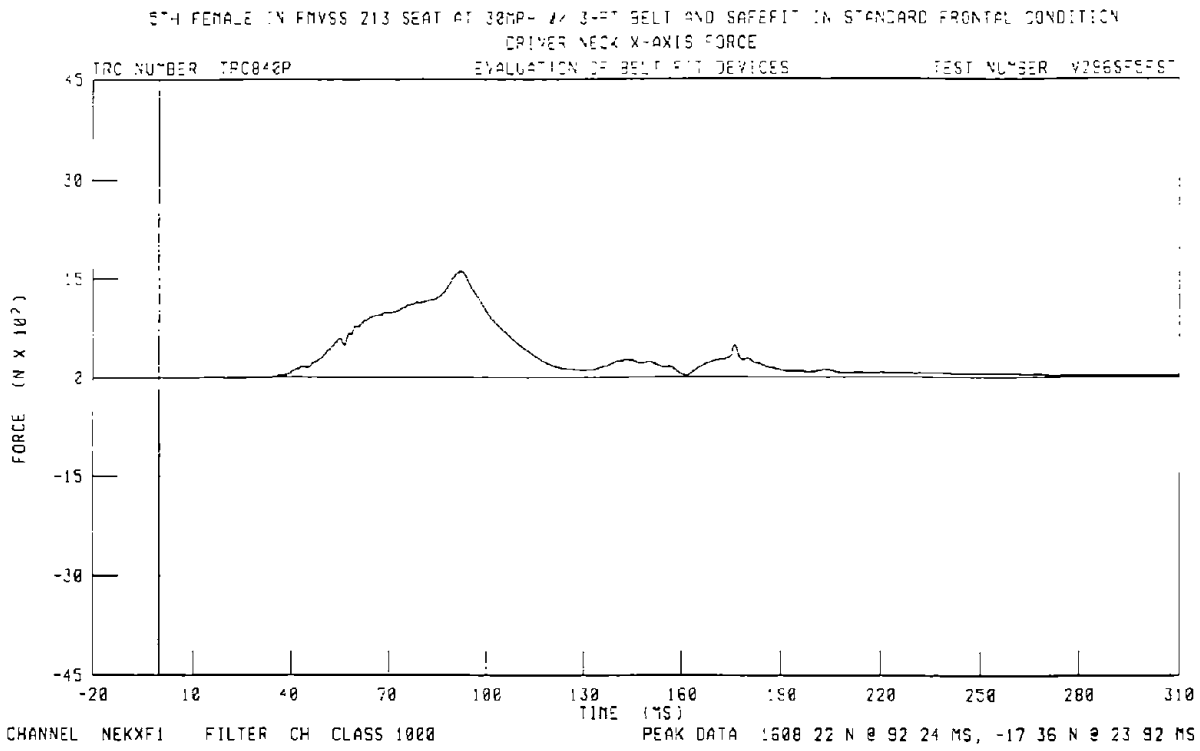

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BLSFST
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 2462 84 N @ 95 28 MS, -177 87 N @ 256 69 MS

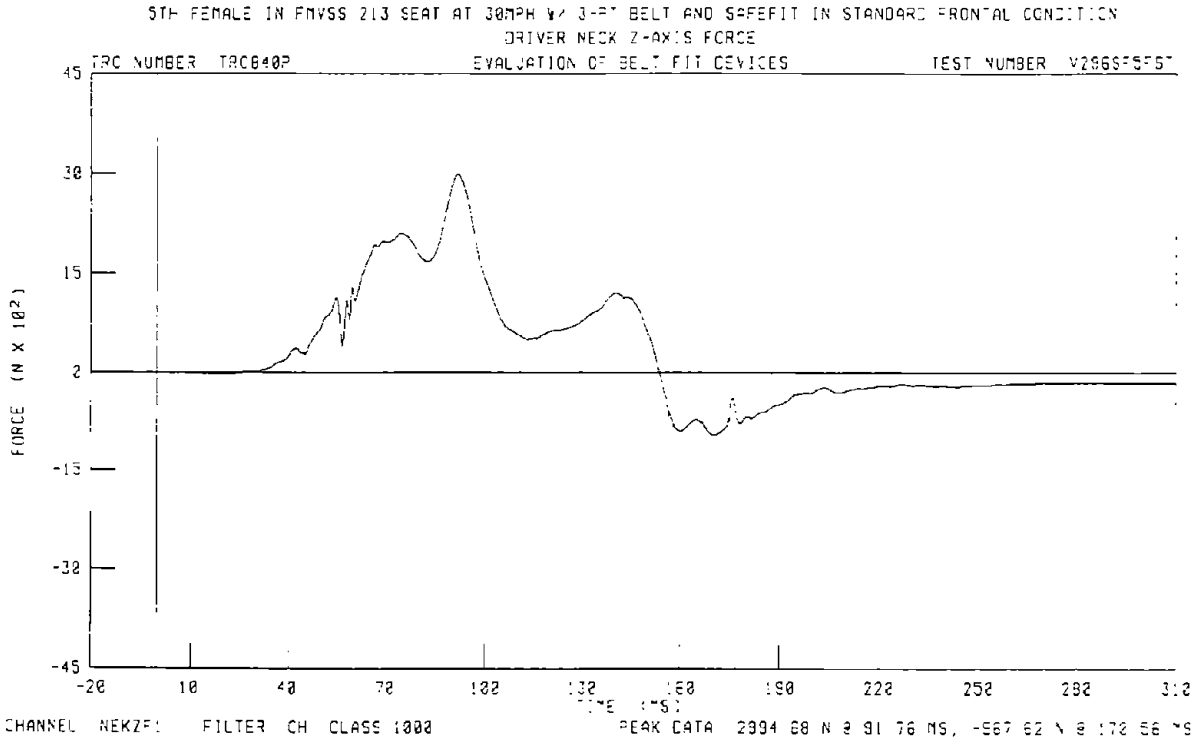

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC038P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2965L5FST
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYMI FILTER CH CLASS 600
PEAK DATA 35 29 N M @ 93 20 MS, -34 65 N M @ 59 60 MS

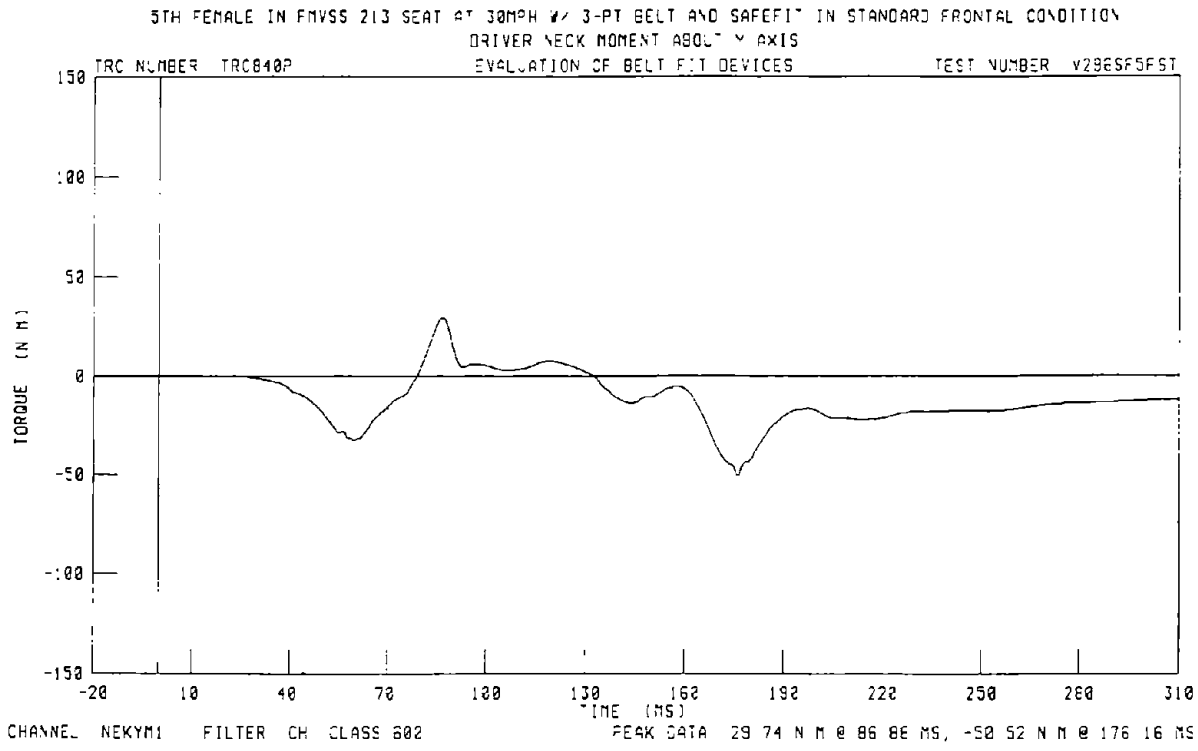

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FST
FORCE (N X 10²)
45
30
15
2
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1744 86 N @ 94 32 MS, -51 73 N @ 277 04 MS

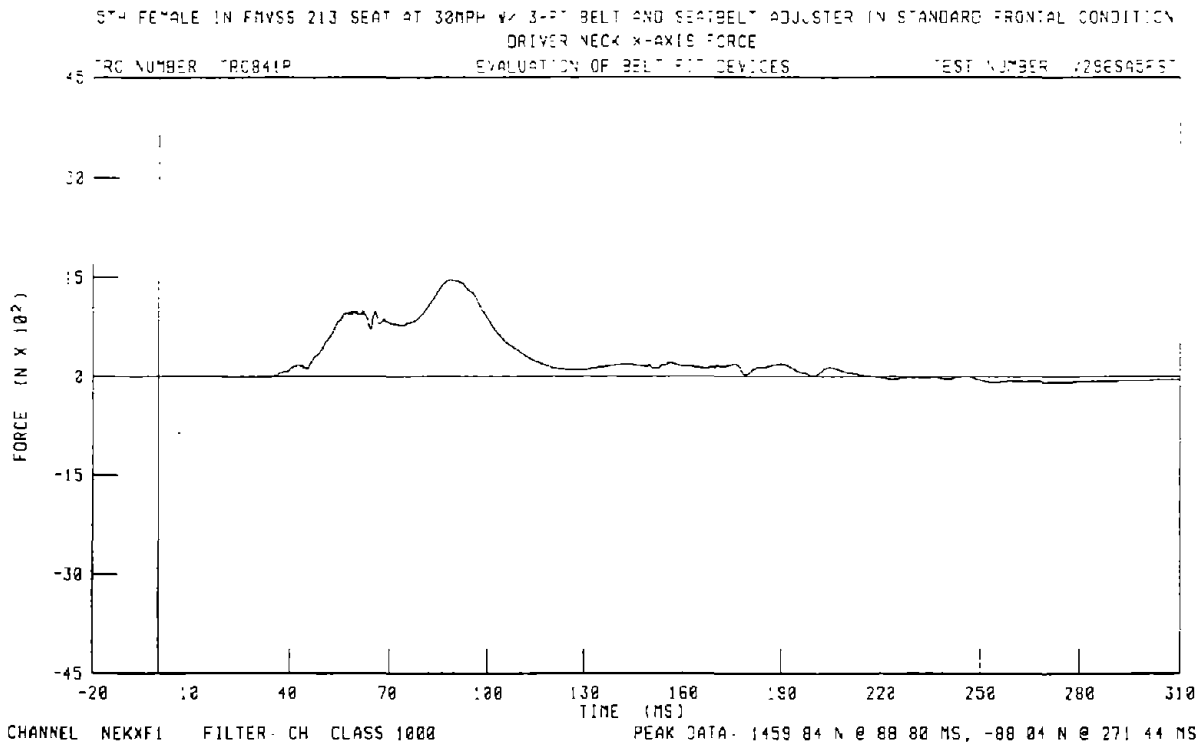

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FST
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 3697 29 N @ 94 24 MS, -699 48 N @ 229 76 MS

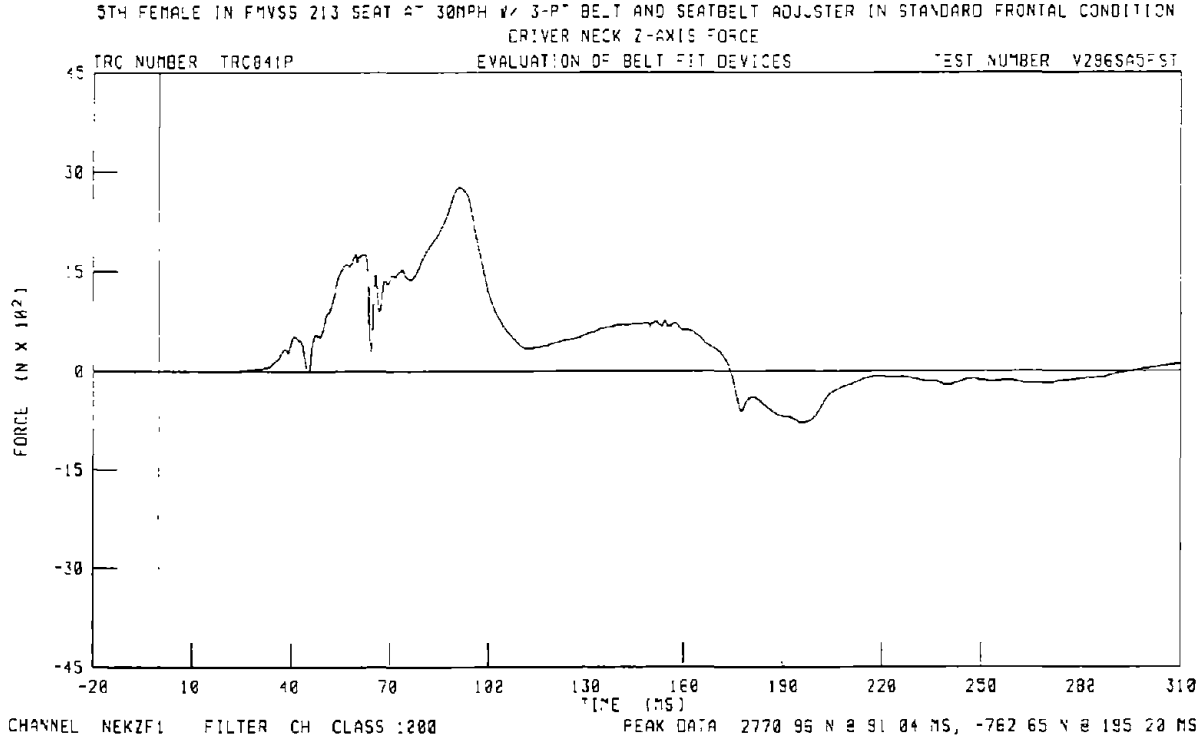

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FST
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYM1 FILTER CH CLASS 600
PEAK DATA 32.61 N M @ 90.48 MS, -63.52 N M @ 63.28 MS

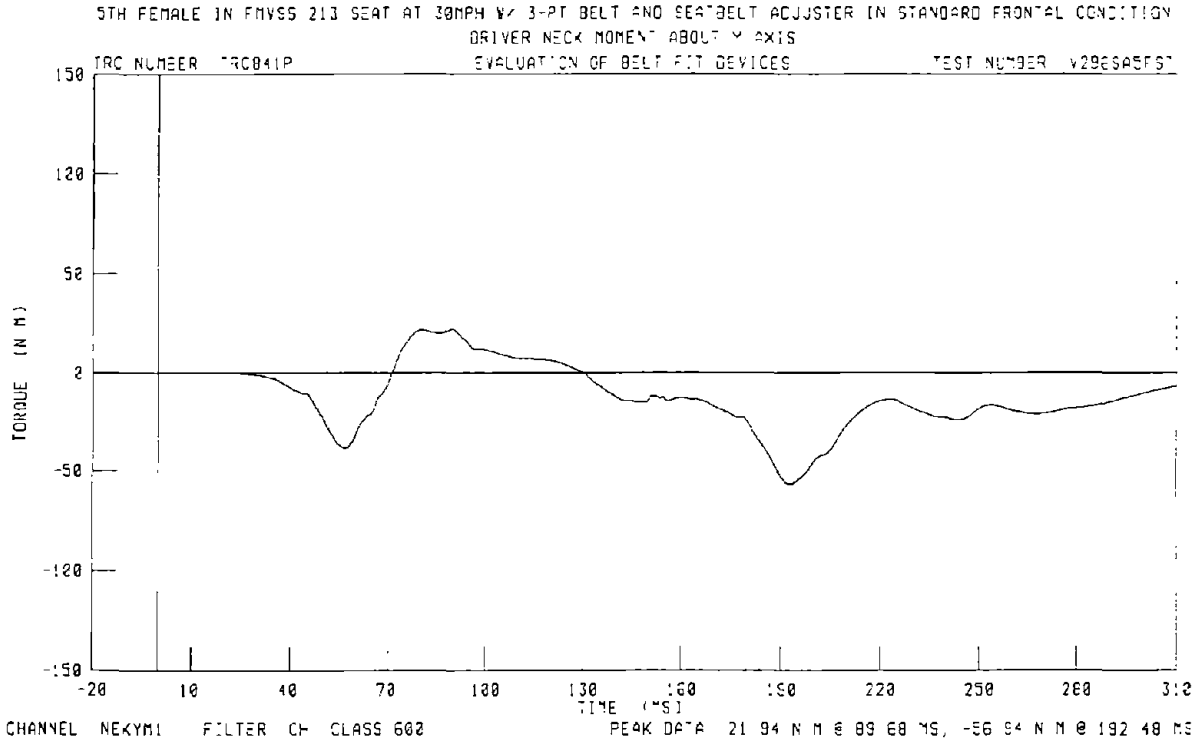

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2966FEFST
FORCE (N X 10²)
45
30
15
2
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1608 22 N @ 92 24 MS, -17 36 N @ 23 92 MS

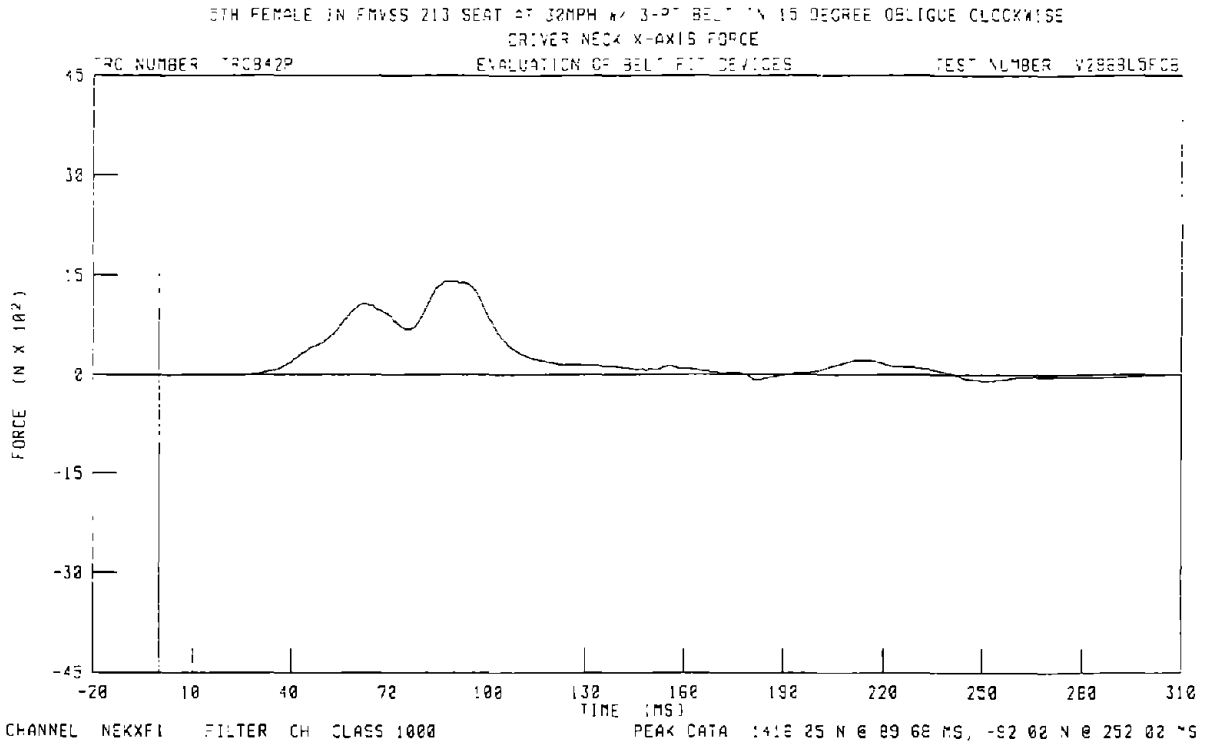

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2966FEFST
FORCE (N X 10²)
45
30
15
2
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 2394 68 N @ 91 76 MS, -867 62 N @ 172 56 MS

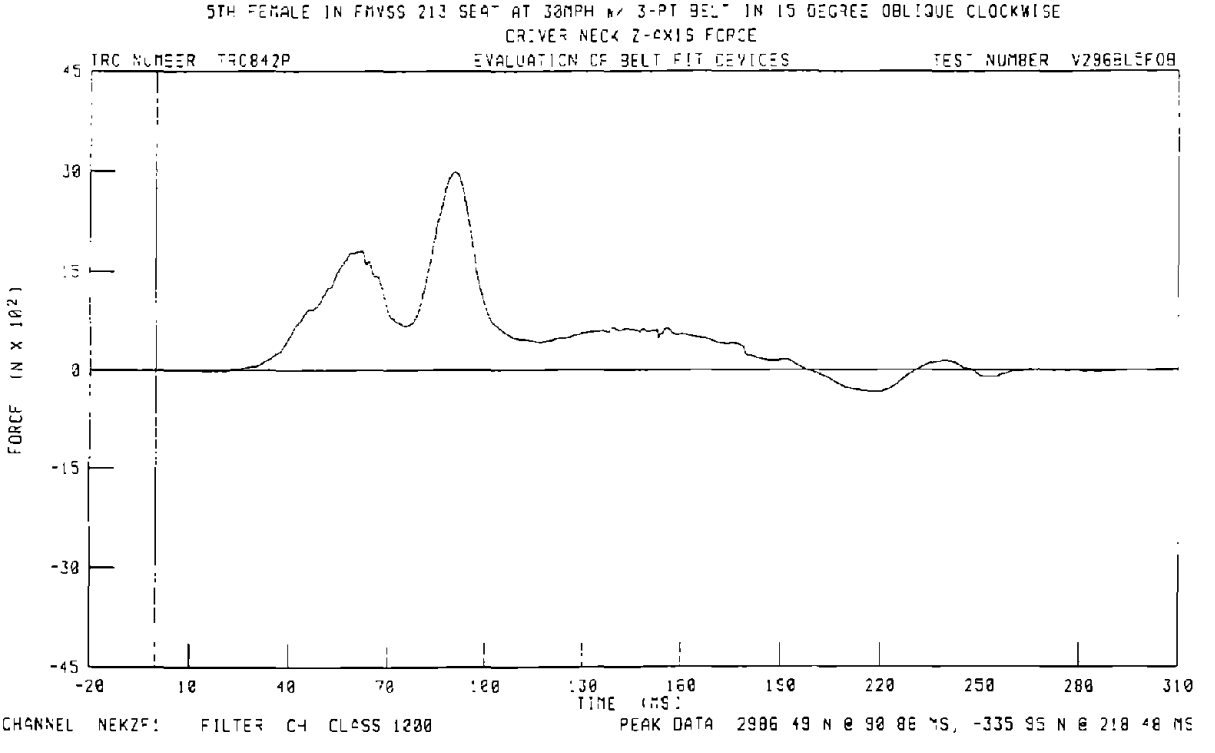

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V286SF5FST
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYM1
FILTER CH CLASS 600
PEAK DATA 29 74 N M @ 86 88 MS, -50 52 N M @ 176 16 MS

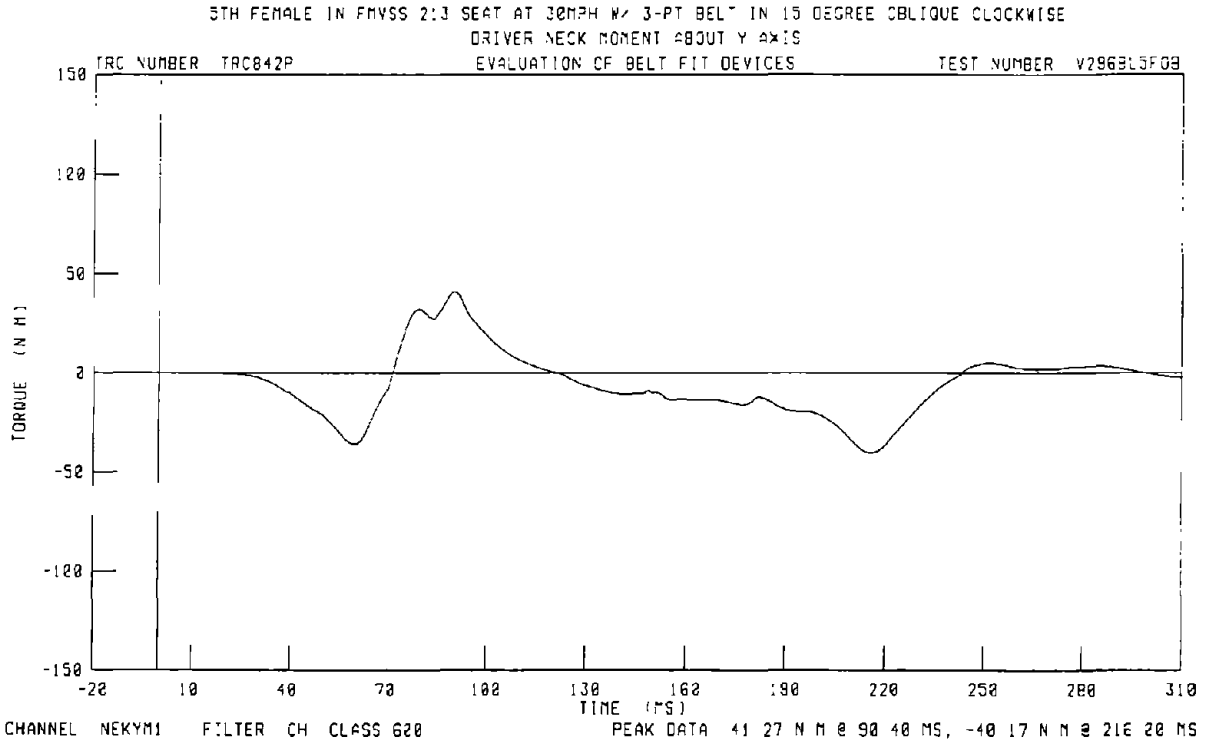

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC841P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5FST
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1459 84 N @ 88 80 MS, -88 04 N @ 271 44 MS

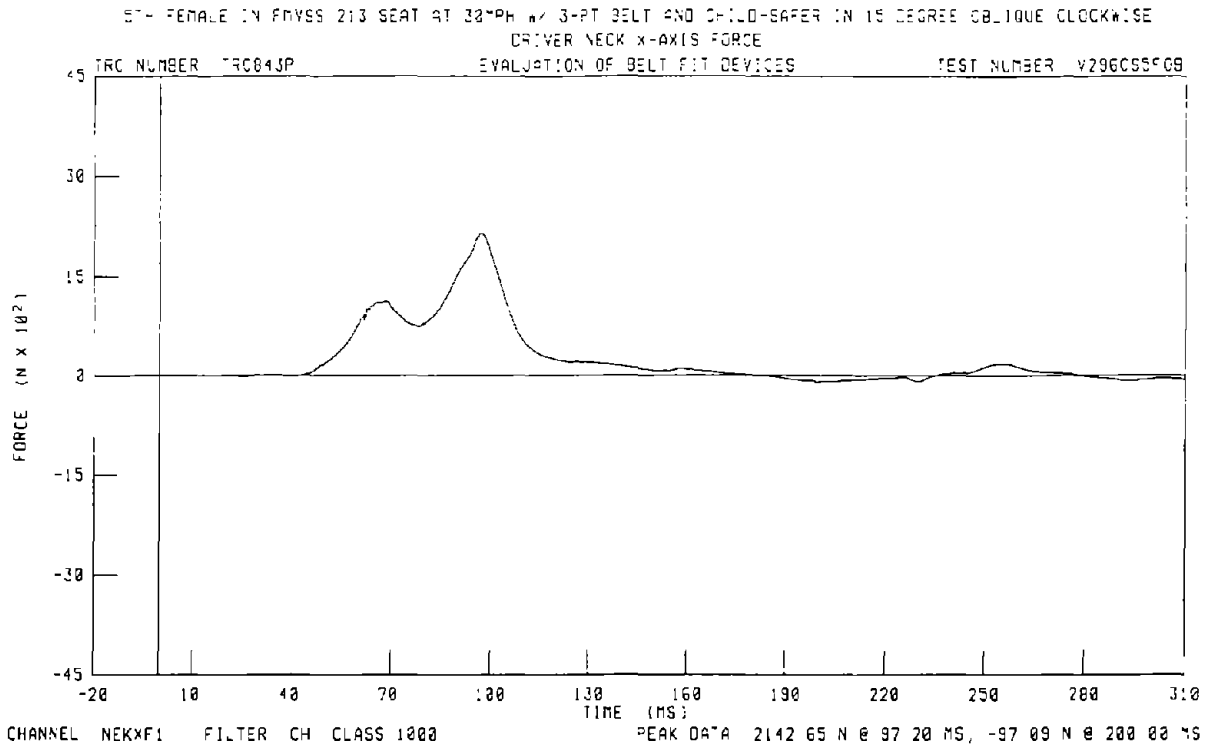

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC841P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5FST
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 2770 95 N @ 91 04 MS, -762 65 N @ 195 20 MS

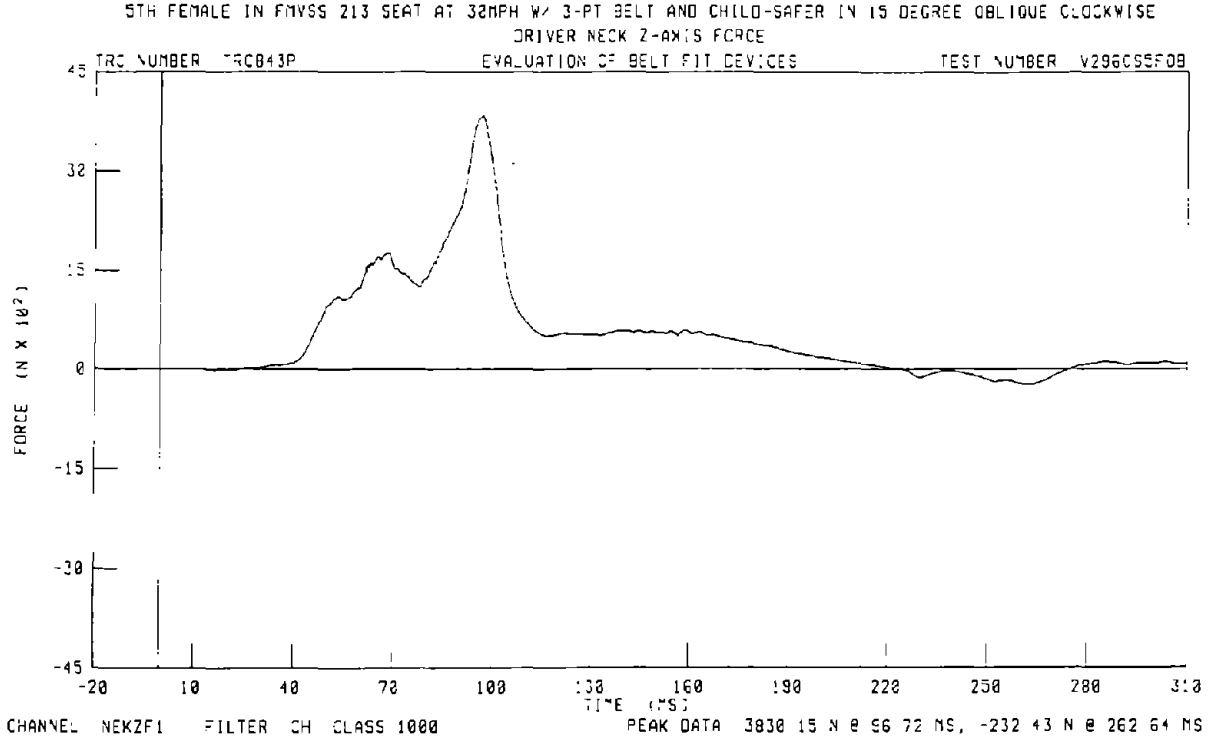

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ACJUSTER IN STANDARD FRONTAL CONDITION
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC041P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298SA5F5T
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYM1 FILTER CH CLASS 600
PEAK DATA 21 94 N M @ 89 68 MS, -56 94 N M @ 192 48 MS

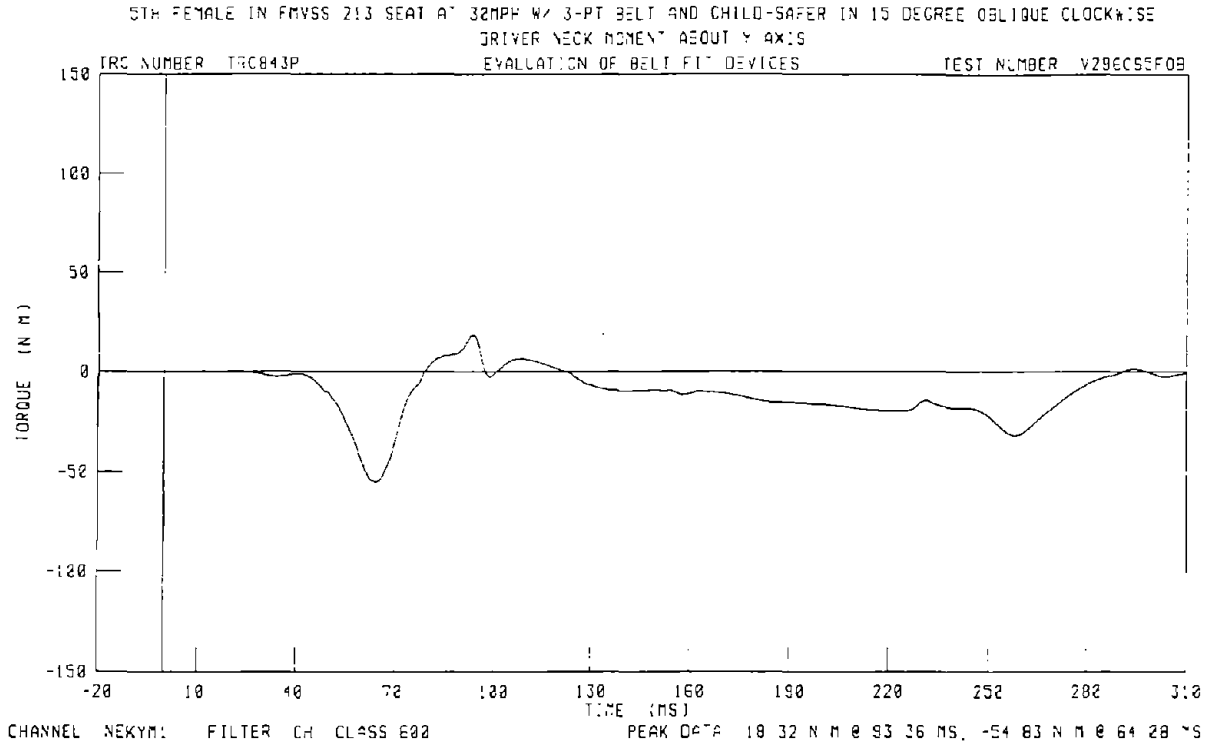

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BL5FCB
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1418 25 N @ 89 68 MS, -92 02 N @ 252 02 MS

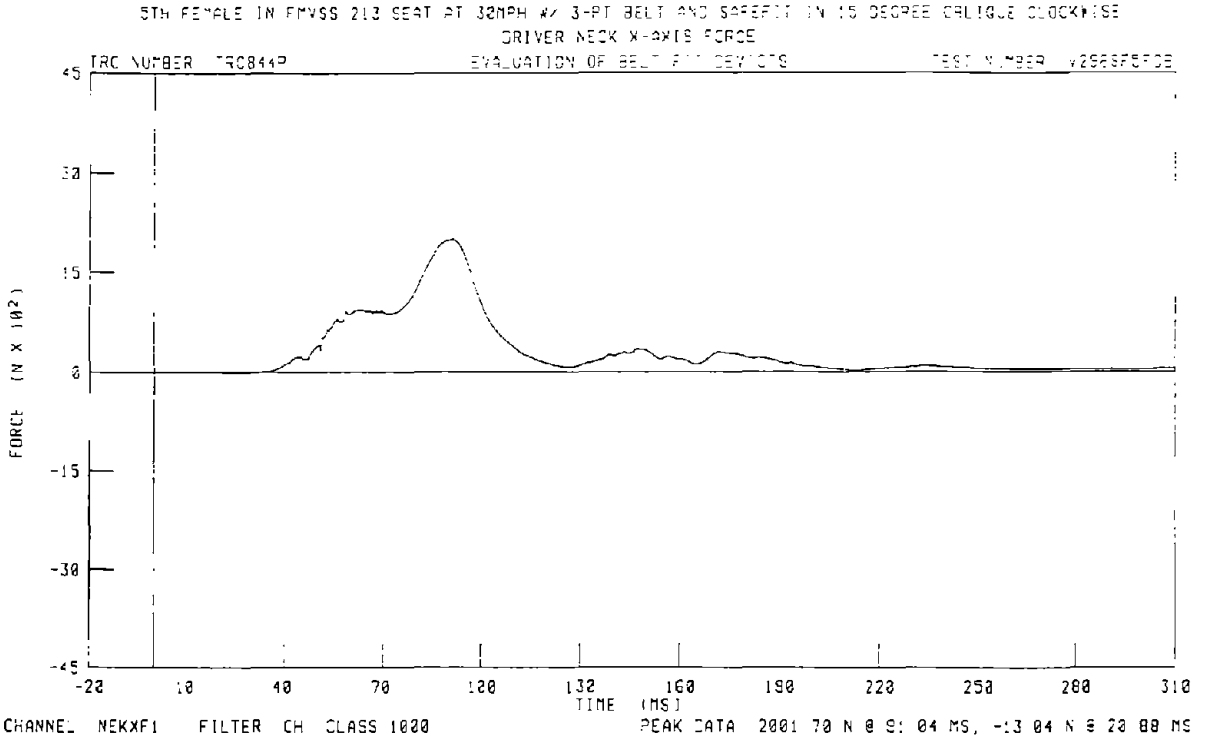

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL5FCB
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1200
PEAK DATA 2986 49 N @ 90 86 MS, -335 95 N @ 218 48 MS

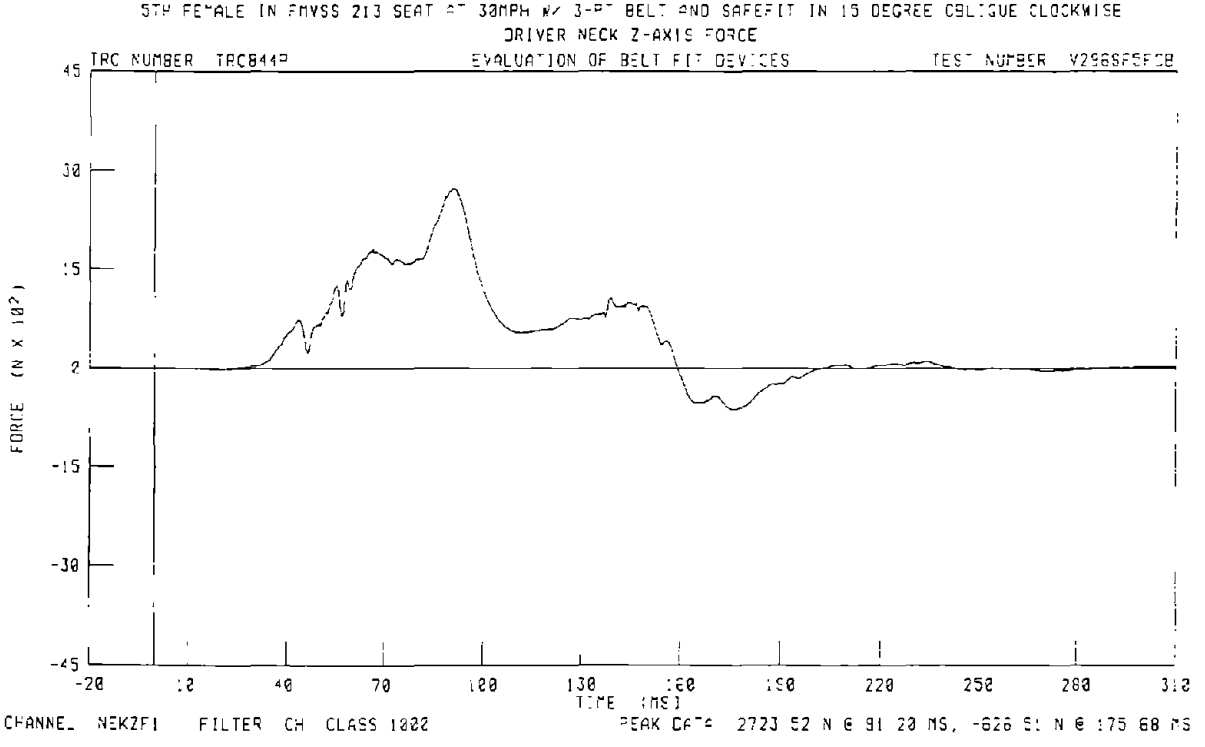

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL5F08
150
120
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYM1 FILTER CH CLASS 600
PEAK DATA 41 27 N M @ 90 40 MS, -40 17 N M @ 216 20 MS

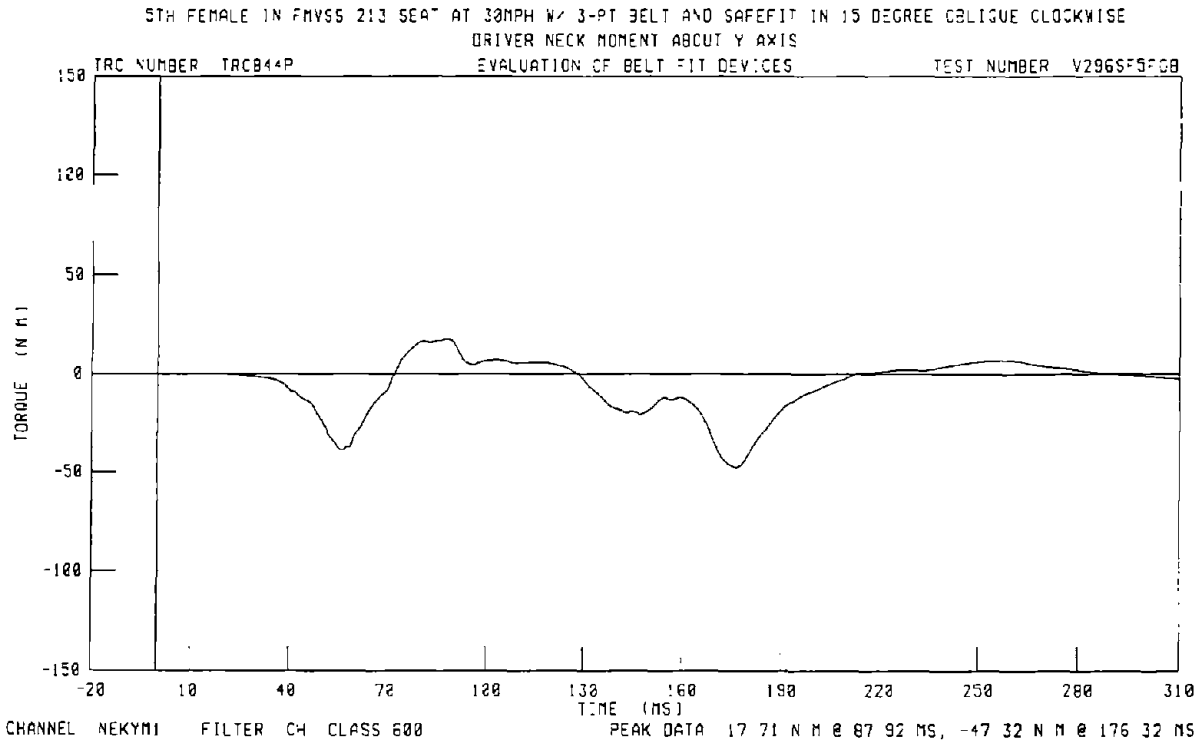

5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC043P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C05F08
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 2142 65 N @ 97 20 MS, -97 09 N @ 200 00 MS

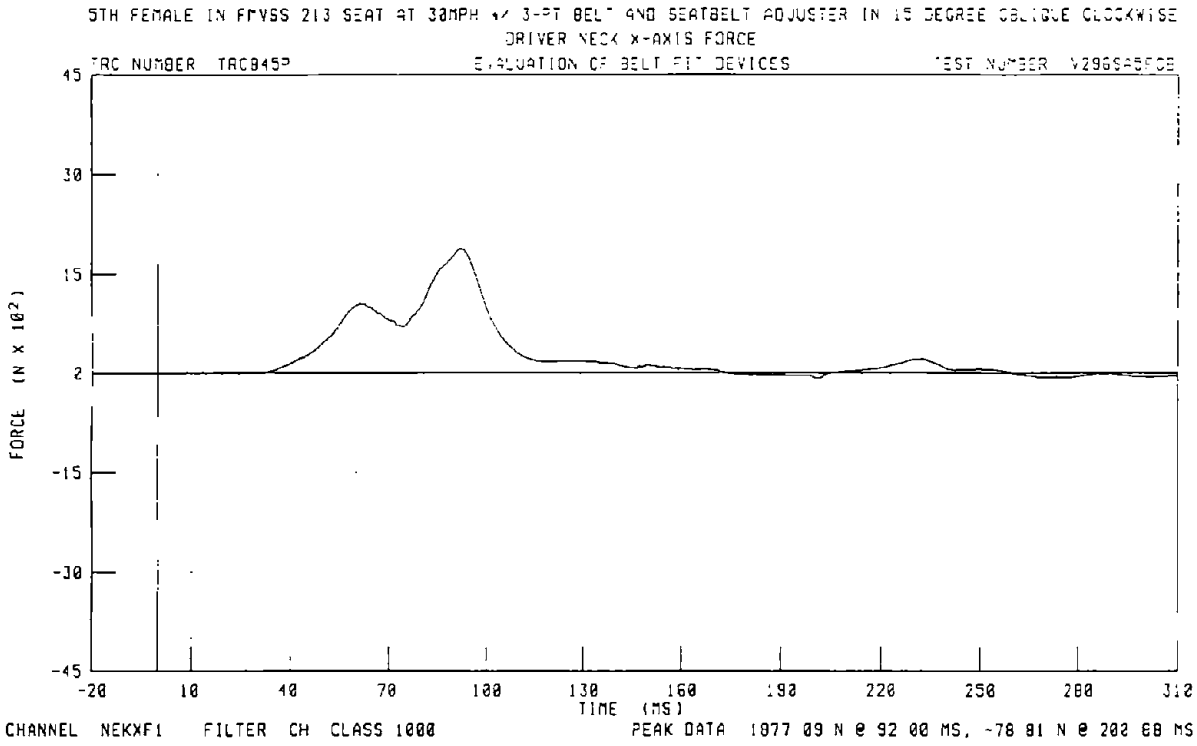

5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC043P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C05F08
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 3830 15 N @ 96 72 MS, -232 43 N @ 262 64 MS

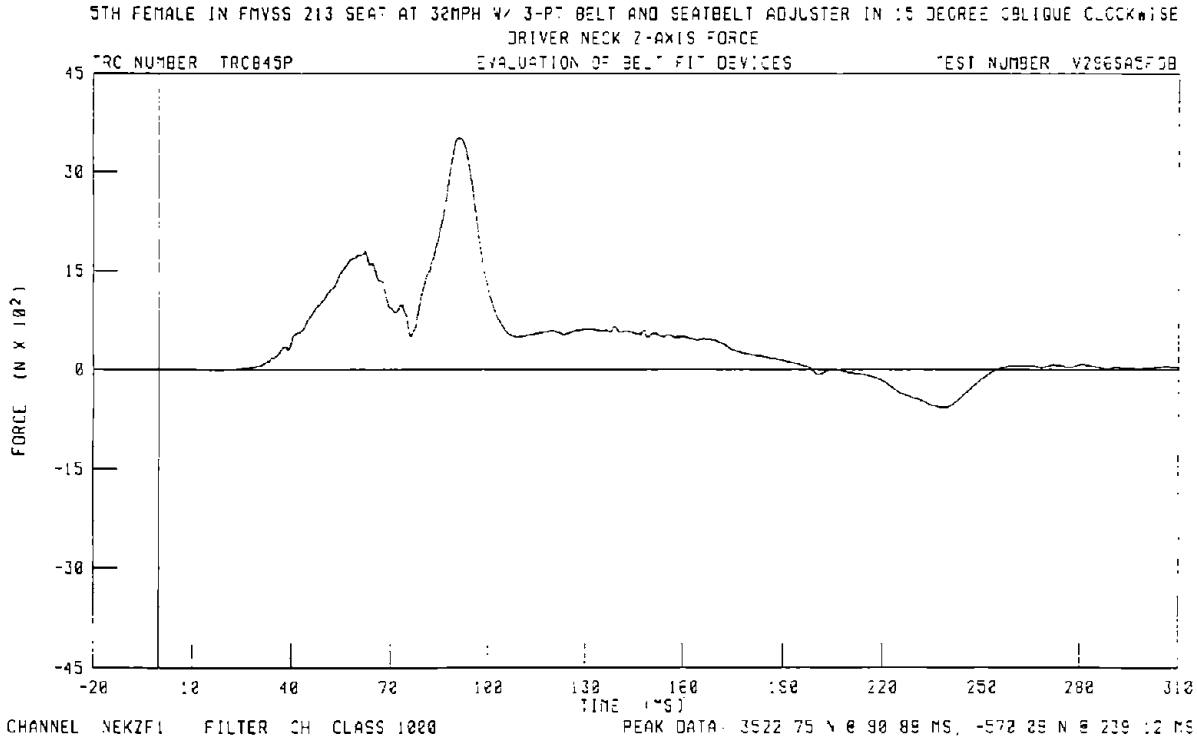

5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
IRS NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V29EC55F08
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
72
100
130
160
190
220
252
282
310
TIME (MS)
CHANNEL NEKYM1 FILTER CH CLASS 600
PEAK DATA 18 32 N M @ 93 36 MS, -54 83 N M @ 64 28 MS

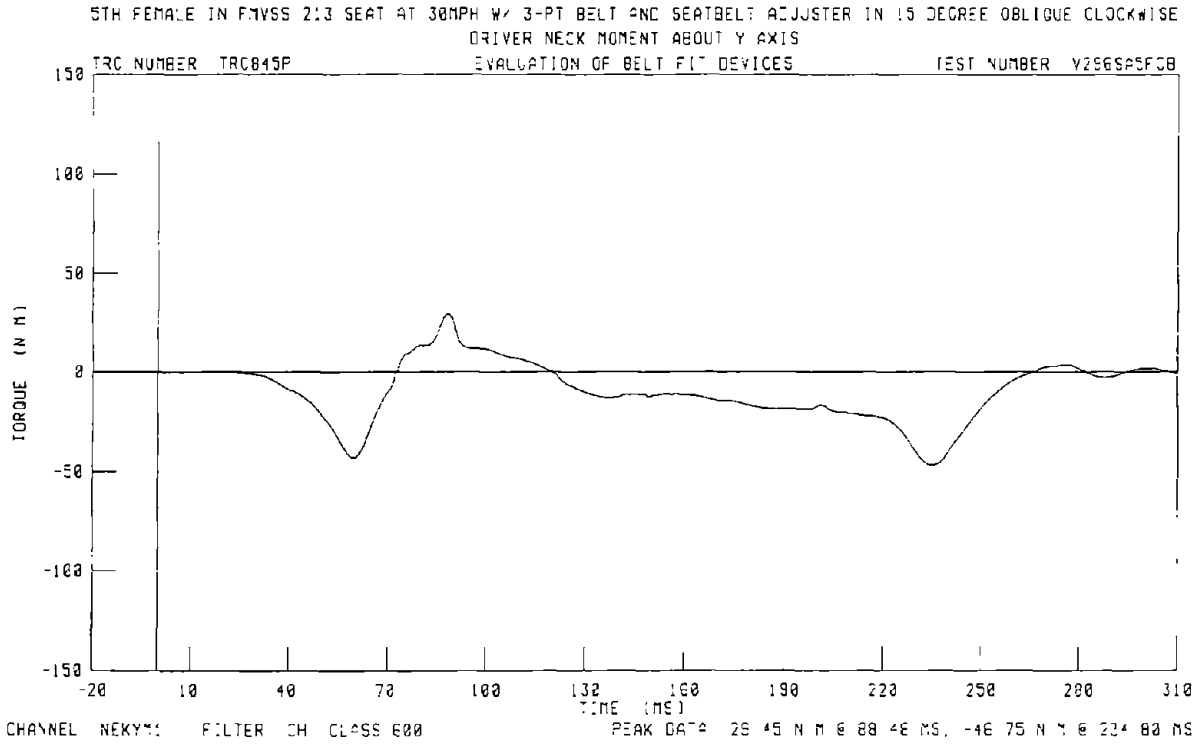

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
45
30
15
0
-15
-30
-45
FORCE (N X 10²)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 2001 70 N @ 91 04 MS, -13 04 N @ 20 88 MS

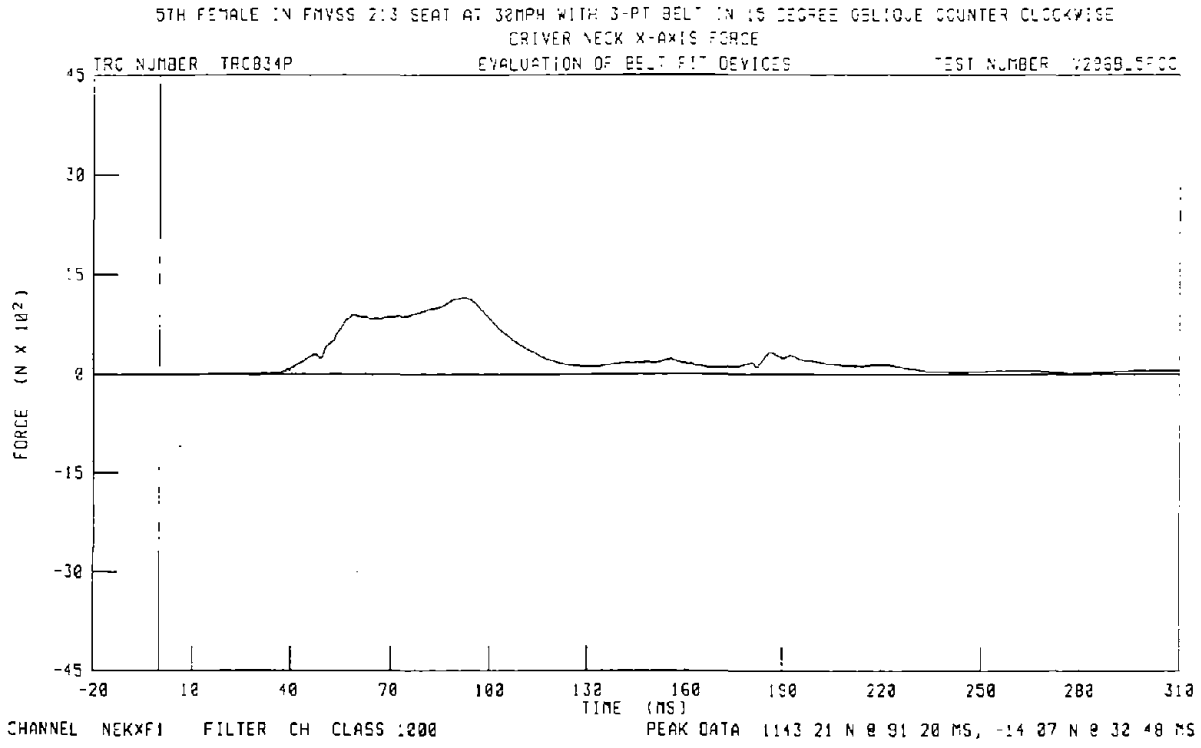

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
45
30
15
0
-15
-30
-45
FORCE (N X 10²)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 2723 52 N @ 91 20 MS, -626 91 N @ 175 68 MS

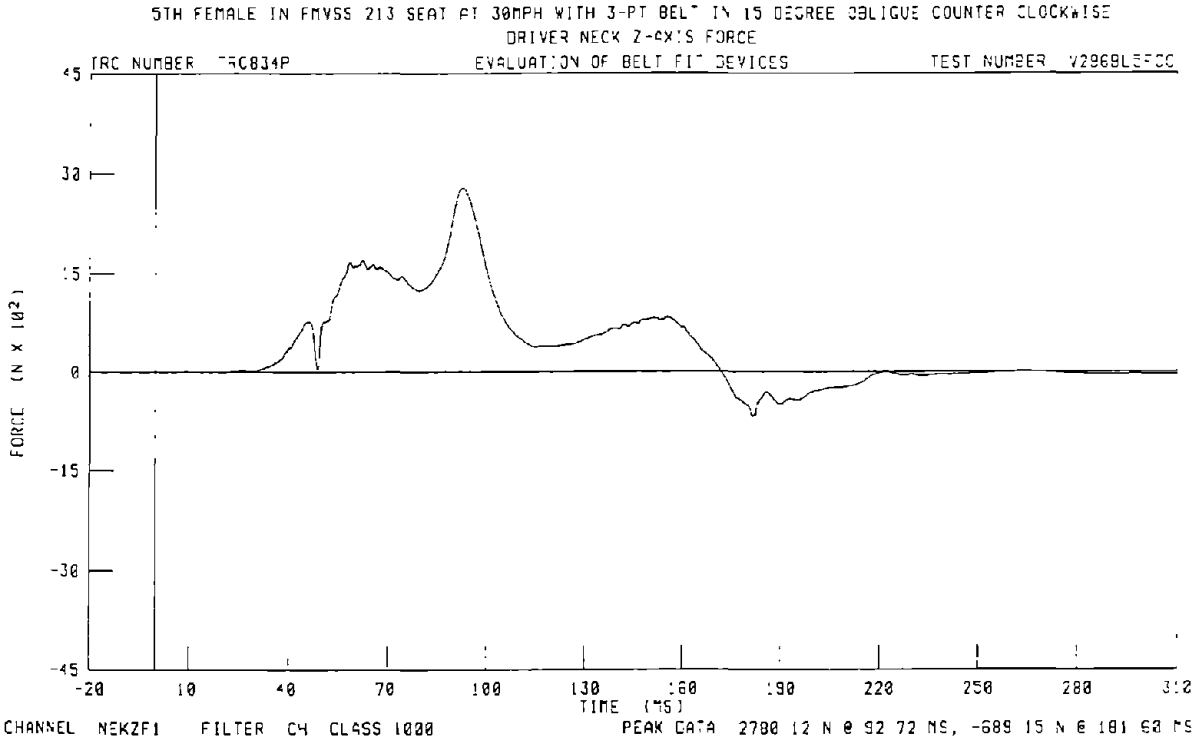

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF5F08
150
120
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
72
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYM1
FILTER CH CLASS 600
PEAK DATA 17 71 N M @ 87 92 MS, -47 32 N M @ 176 32 MS

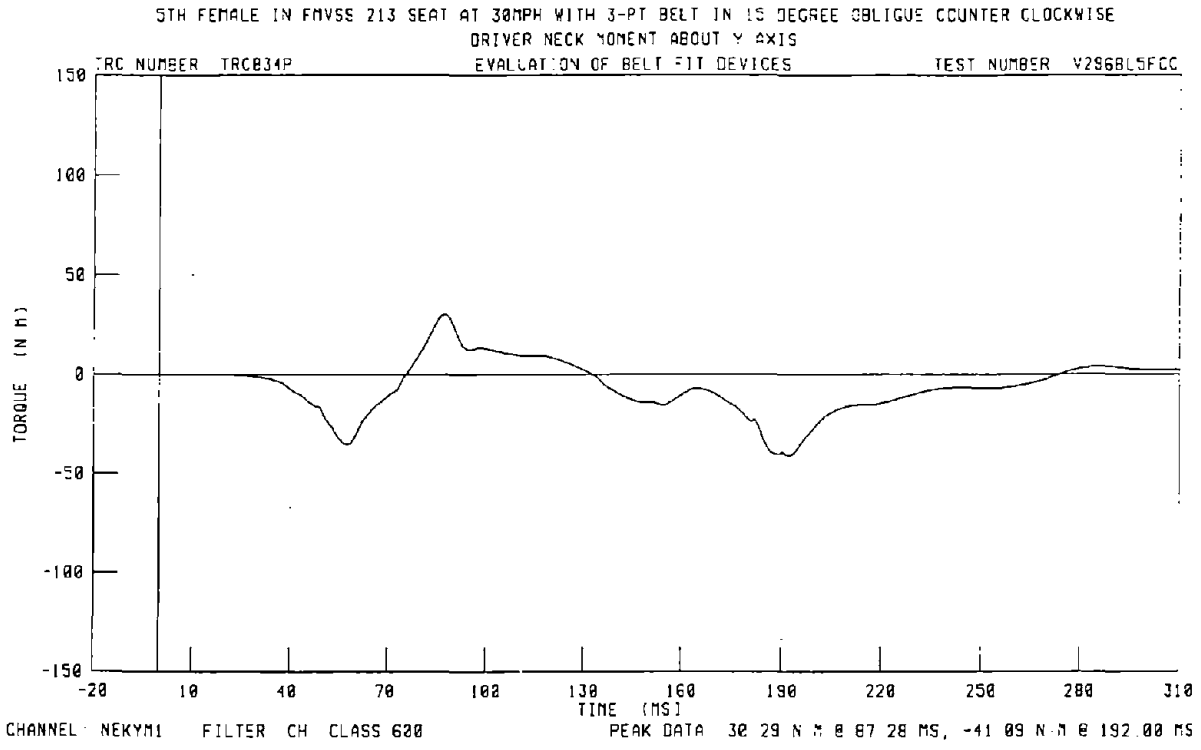

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5F08
FORCE (N X 10²)
45
30
15
2
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1977.09 N @ 92.00 MS, -78.81 N @ 202.68 MS

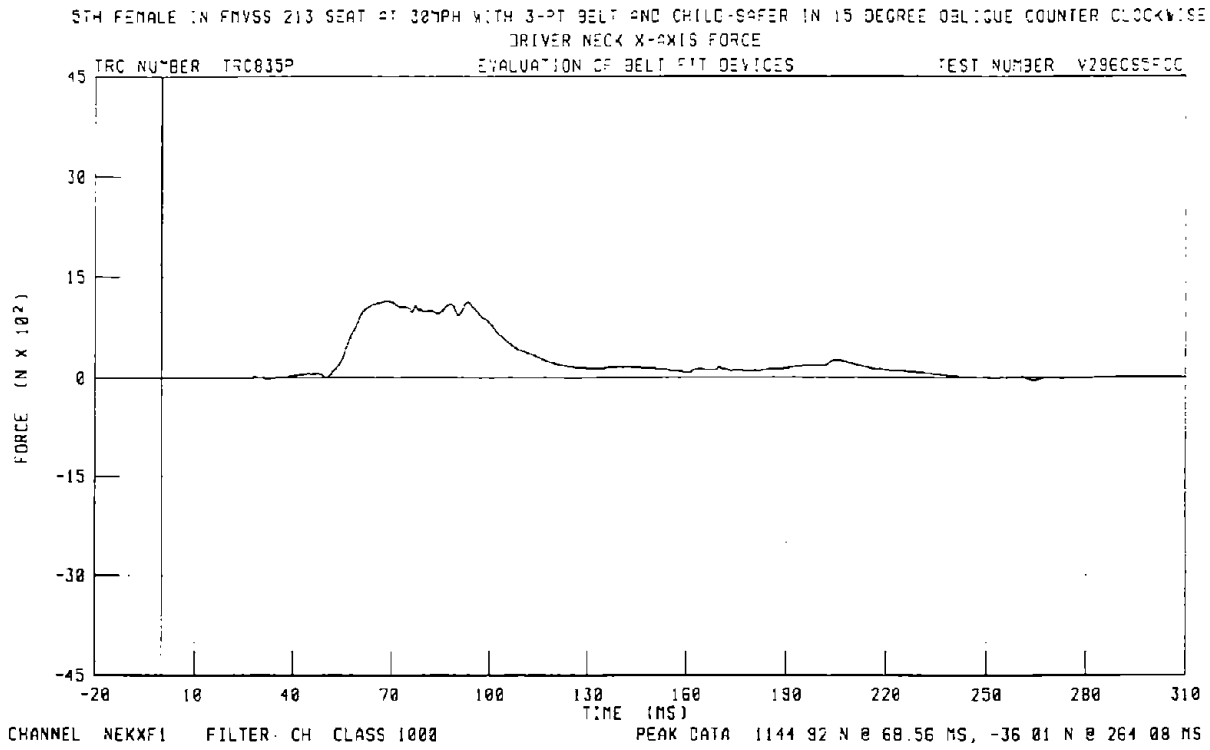

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5F08
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA: 3522.75 N @ 90.89 MS, -572.35 N @ 239.12 MS

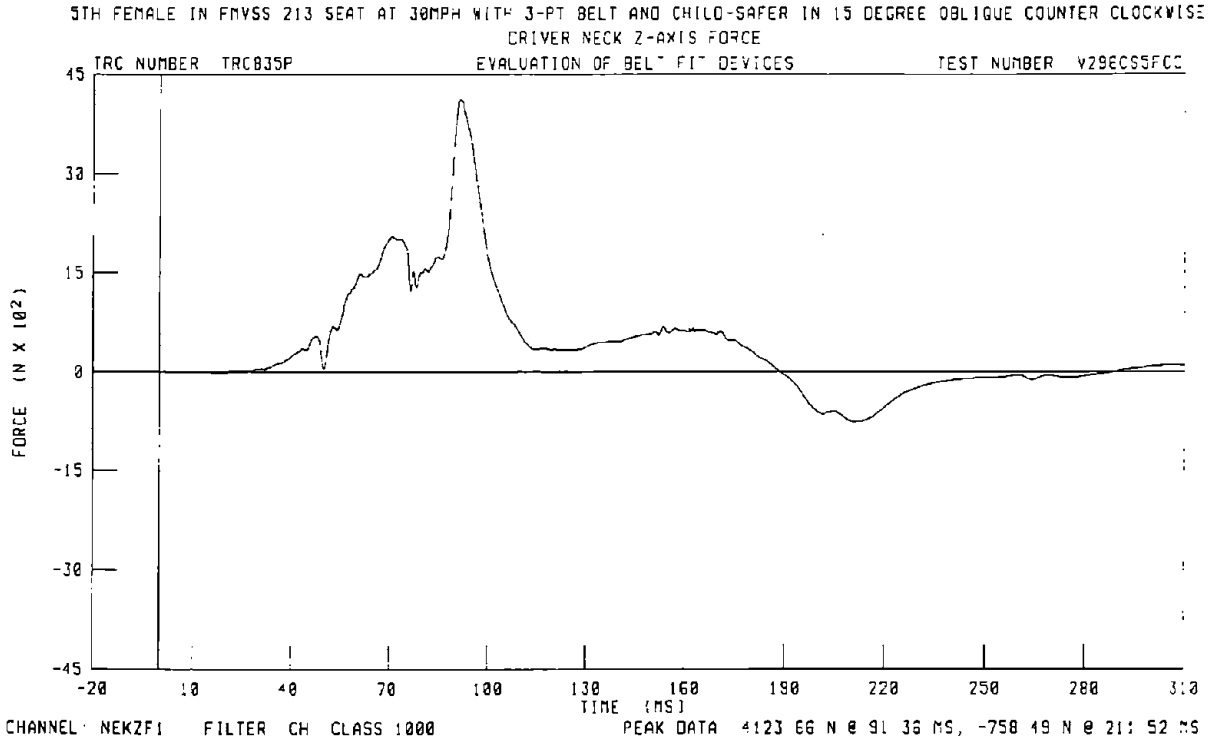

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V256SA5FC8
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYT1 FILTER CH CLASS 600
PEAK DATA 28 45 N M @ 88 48 MS, -46 75 N M @ 224 80 MS

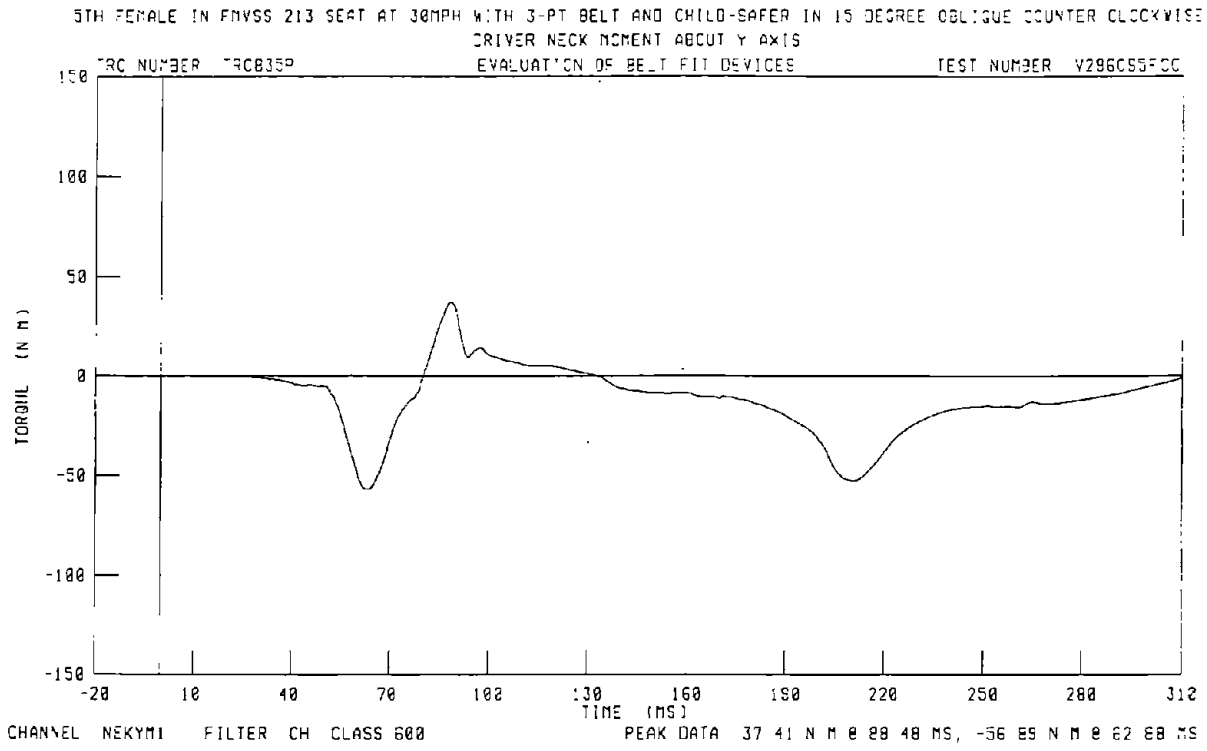

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968LEFCC
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1
FILTER CH CLASS 1200
PEAK DATA 1143 21 N @ 91 20 MS, -14 07 N @ 32 48 MS

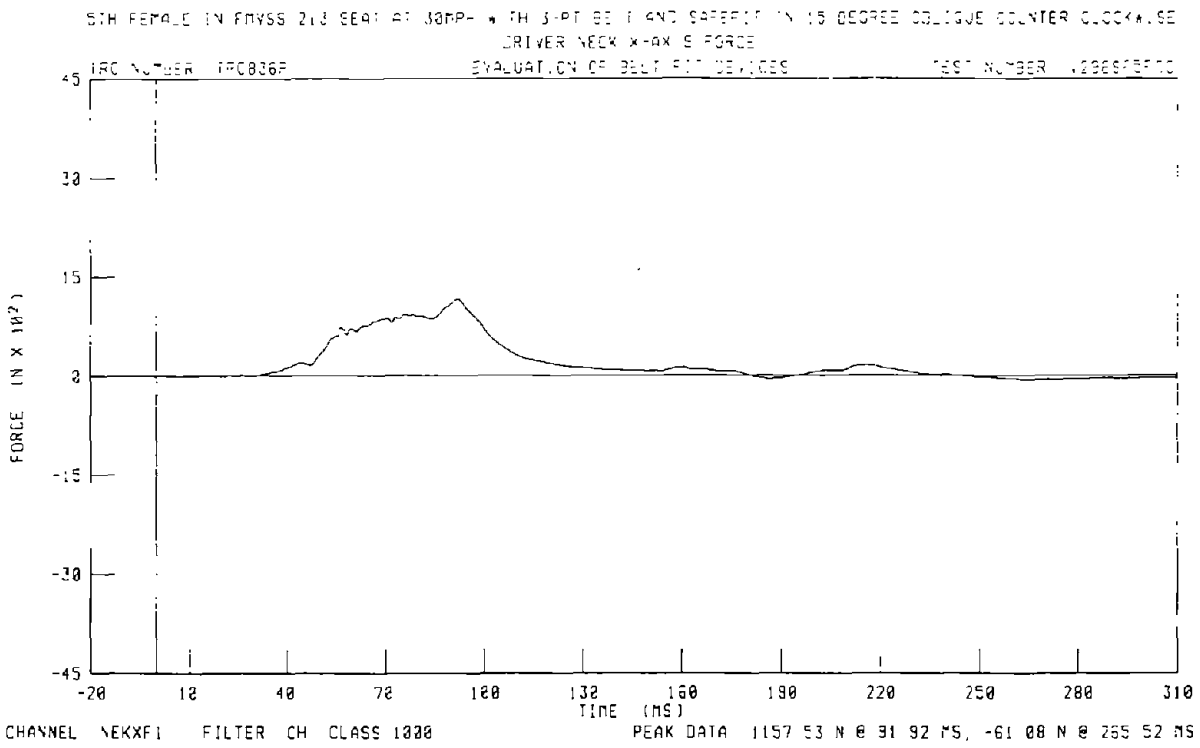

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968LEFCC
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1
FILTER CH CLASS 1000
PEAK DATA 2700 12 N @ 92 72 MS, -689 15 N @ 181 60 MS

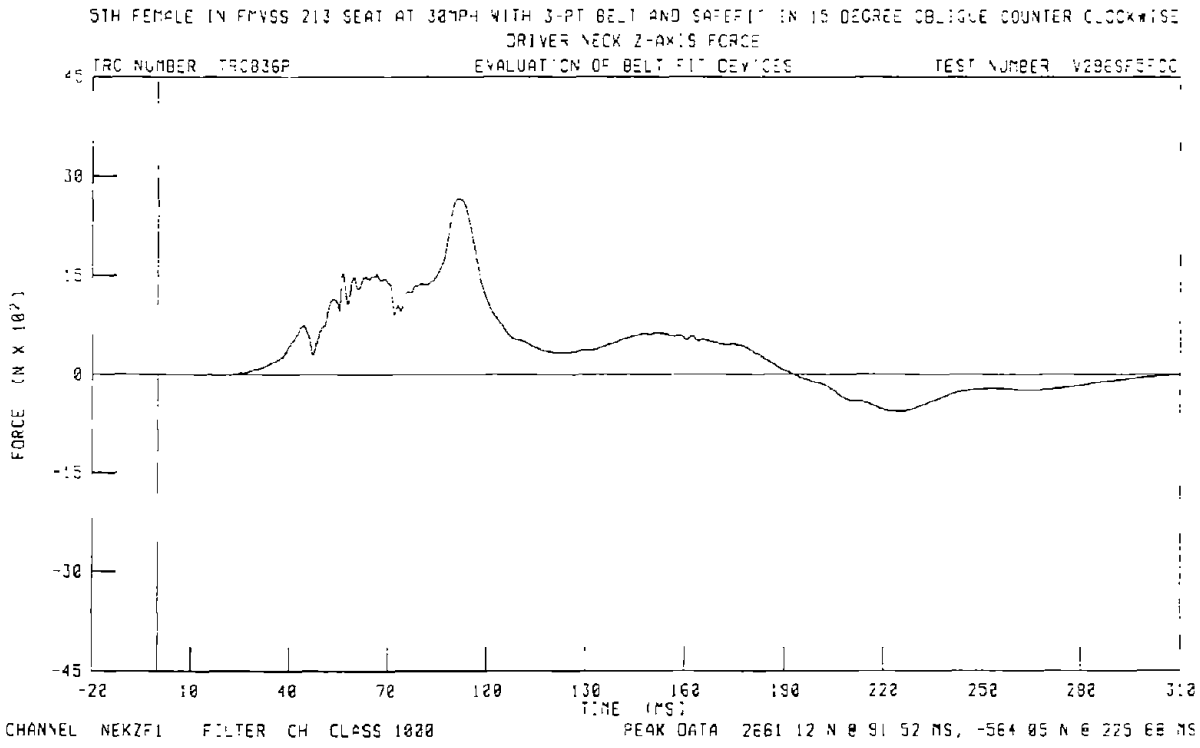

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2S6BL5FCC
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYM1
FILTER CH CLASS 600
PEAK DATA 30 29 N M @ 87 28 MS, -41 09 N M @ 192.00 MS

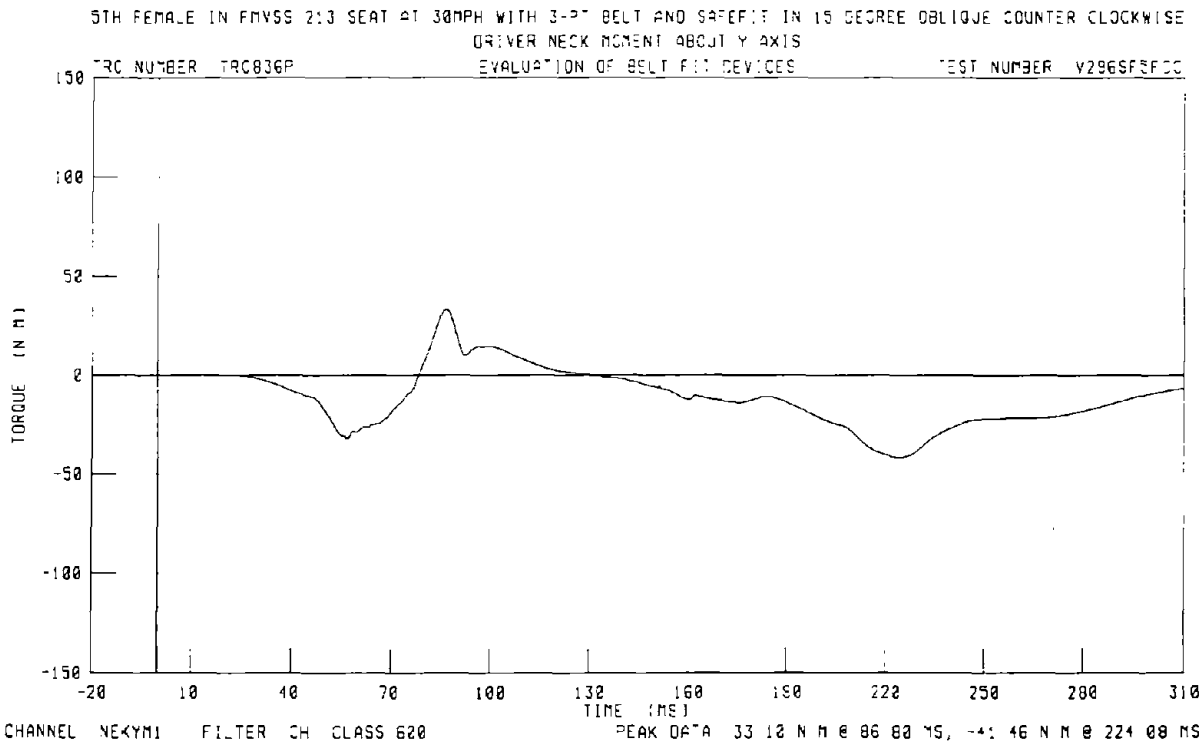

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC835P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298CSSFCC
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1144 92 N @ 68.56 MS, -36 01 N @ 264 08 MS

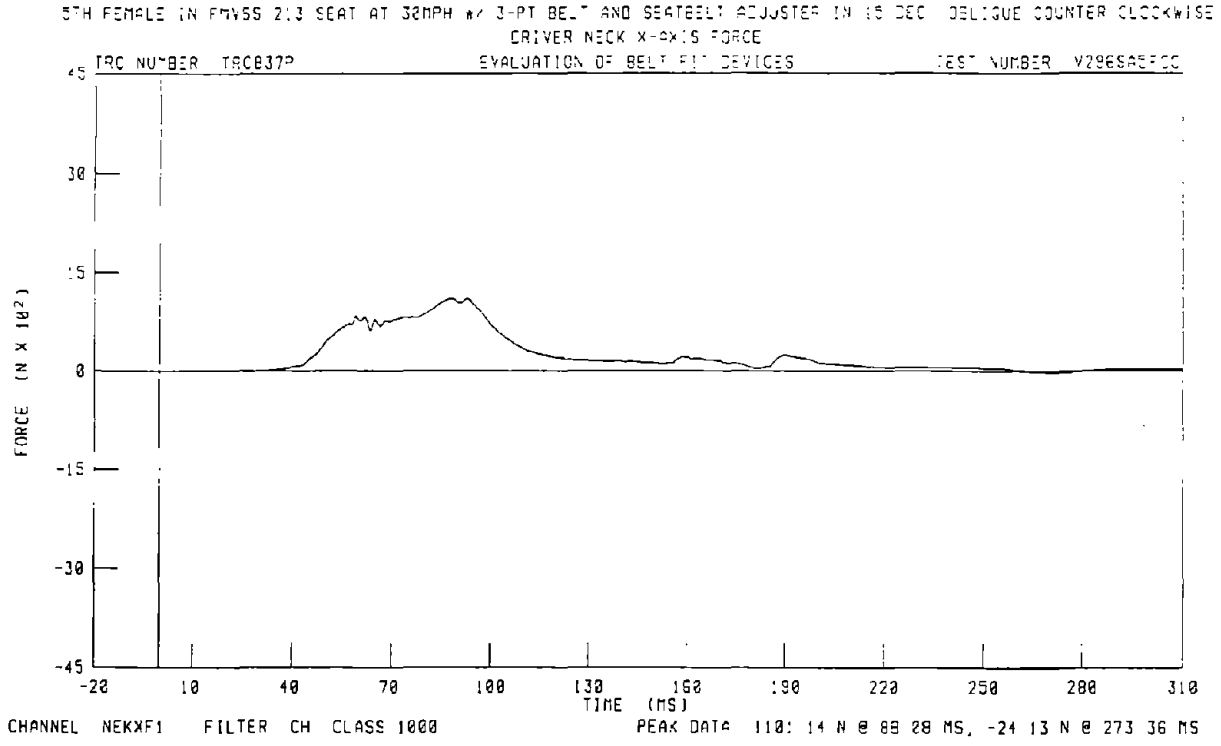

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC835P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298CSSFCC
FORCE (N X 10²)
45
30
15
0
-15
-30
-45
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 4123 66 N @ 91 36 MS, -758 49 N @ 211 52 MS

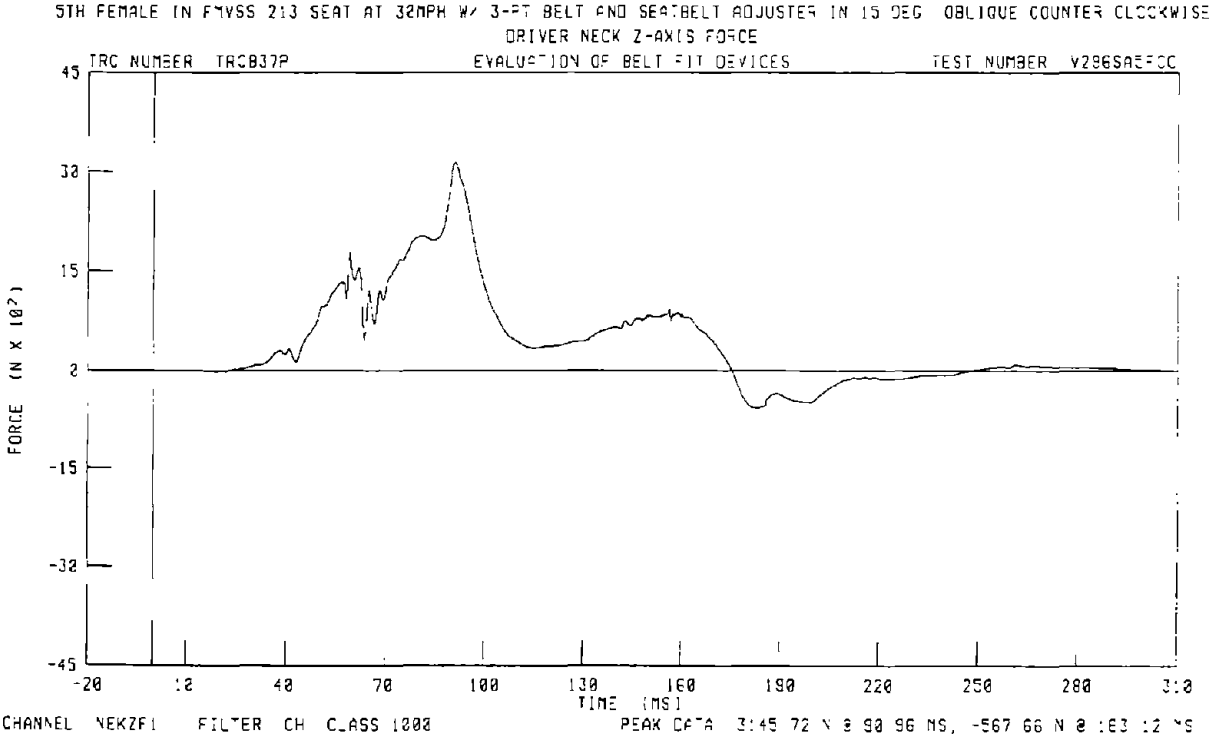

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC835P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FCC
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
312
TIME (MS)
CHANNEL NEKYM1 FILTER CH CLASS 600
PEAK DATA 37 41 N M @ 88 48 MS, -56 89 N M @ 62 68 MS

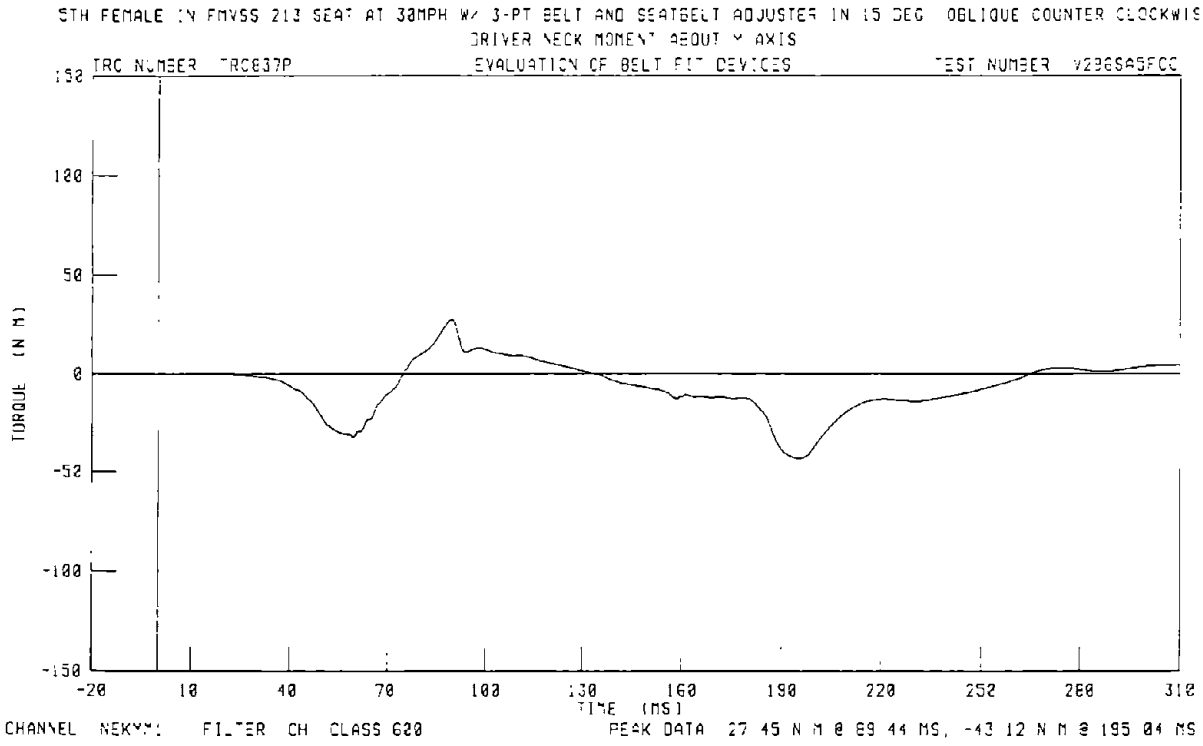

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC036P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2869FEDC
FORCE (N X 10²)
TIME (MS)
CHANNEL NEKXF1 FILTER CH CLASS 1000
PEAK DATA 1157.53 N @ 31.92 MS, -61.08 N @ 265.52 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC036P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2869FEDC
FORCE (N X 10²)
TIME (MS)
CHANNEL NEKZF1 FILTER CH CLASS 1000
PEAK DATA 2661.12 N @ 91.52 MS, -564.05 N @ 225.68 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SFSFCC
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKYM1 FILTER CH CLASS 600
PEAK DATA 33.12 N M @ 86.80 MS, -41.46 N M @ 224.00 MS


5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEG OBLIQUE COUNTER CLOCKWISE
DRIVER NECK X-AXIS FORCE
TRC NUMBER TRC837P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SAEFCC
45
30
15
0
-15
-30
-45
FORCE (N X 10²)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKXF1
FILTER CH CLASS 1000
PEAK DATA 110: 14 N @ 88 28 MS, -24 13 N @ 273 36 MS

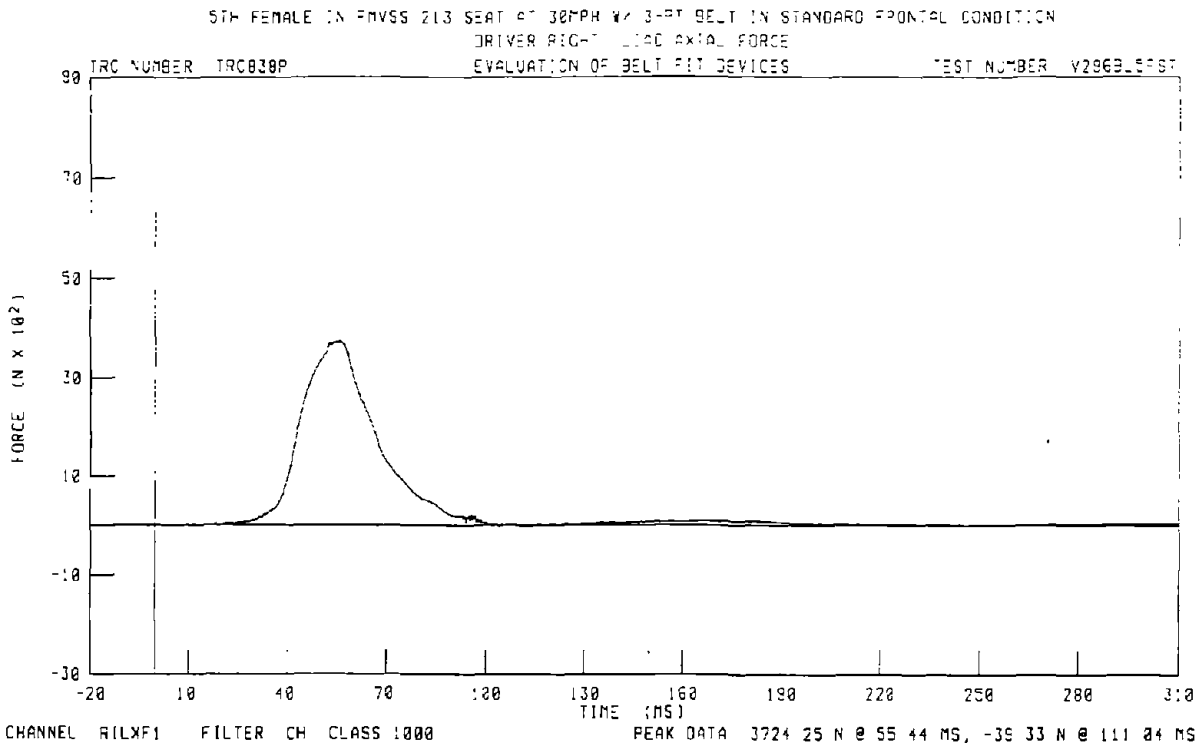

5TH FEMALE IN FMVSS 213 SEAT AT 32MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEG OBLIQUE COUNTER CLOCKWISE
DRIVER NECK Z-AXIS FORCE
TRC NUMBER TRC837P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SAEFCC
45
30
15
0
-15
-30
-45
FORCE (N X 10²)
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL NEKZF1
FILTER CH CLASS 1000
PEAK DATA 3145 72 N @ 90 96 MS, -567 66 N @ 163 12 MS

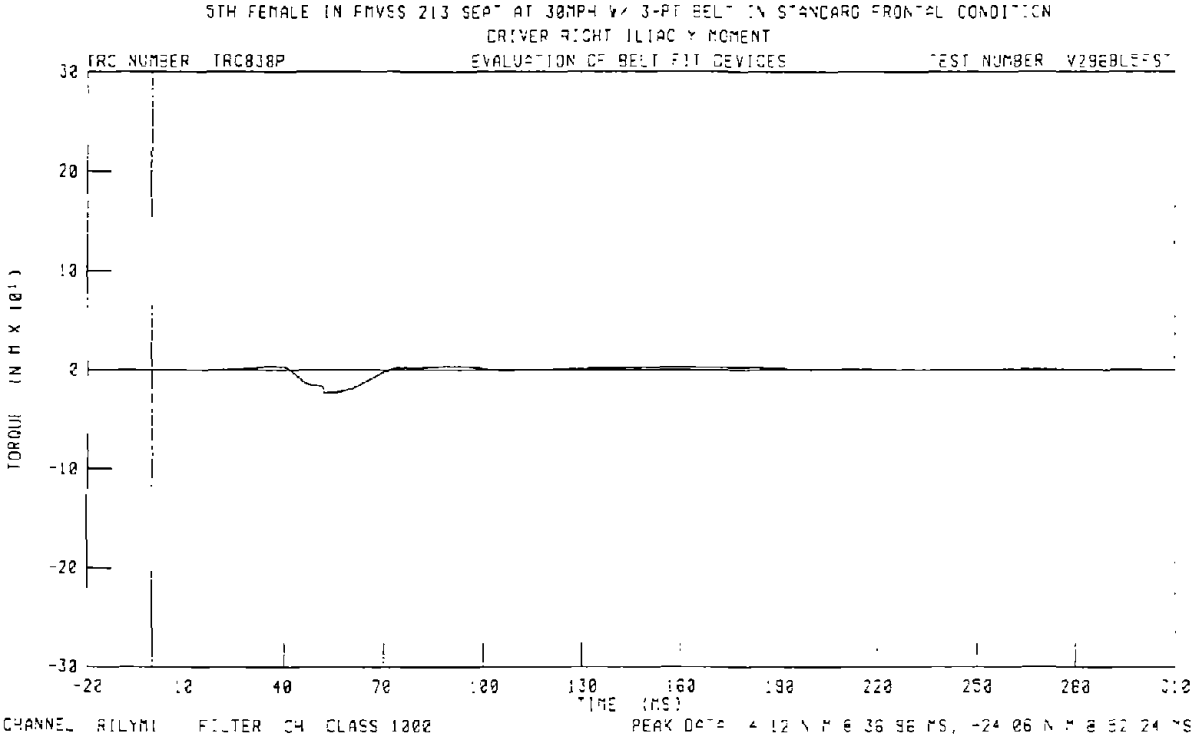

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEG OBLIQUE COUNTER CLOCKWISE
DRIVER NECK MOMENT ABOUT Y AXIS
TRC NUMBER TRC837P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298SA8FCC
150
100
50
0
-50
-100
-150
TORQUE (N M)
-20
10
40
70
100
130
160
190
220
252
280
310
TIME (MS)
CHANNEL NEKYM1 FILTER CH CLASS 600
PEAK DATA 27 45 N M @ 89 44 MS, -43 12 N M @ 195 04 MS

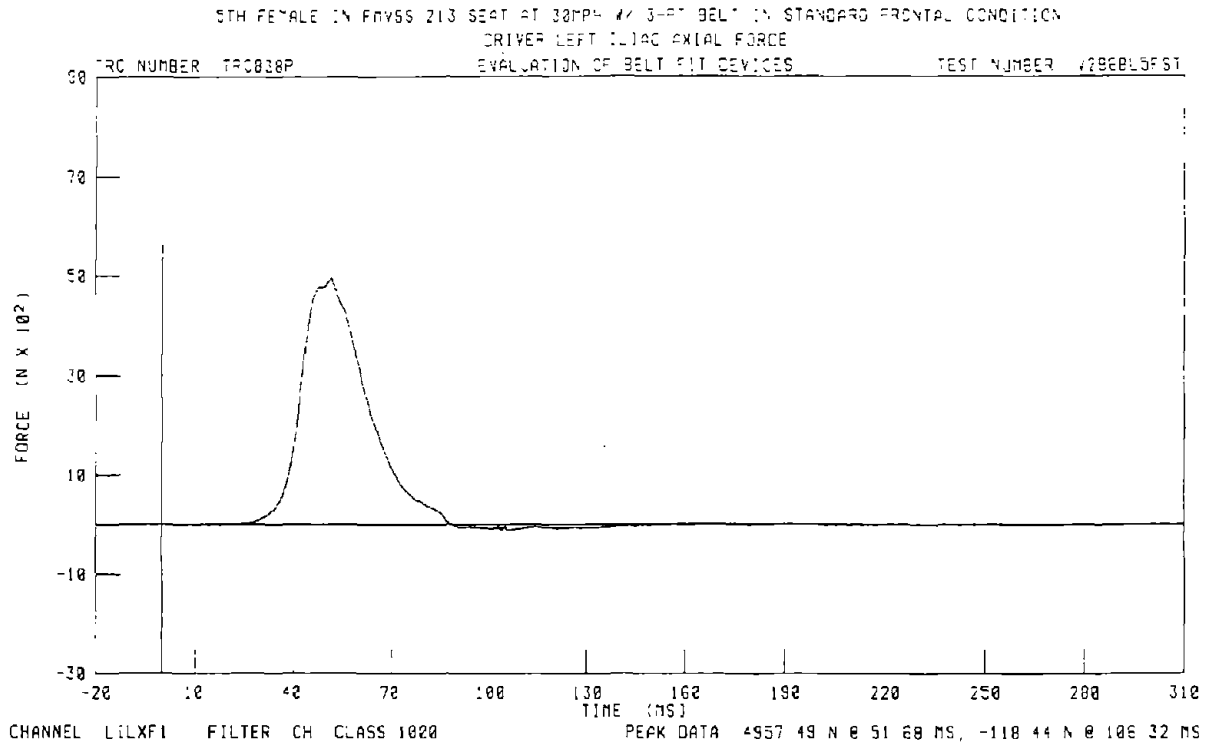
Appendix F

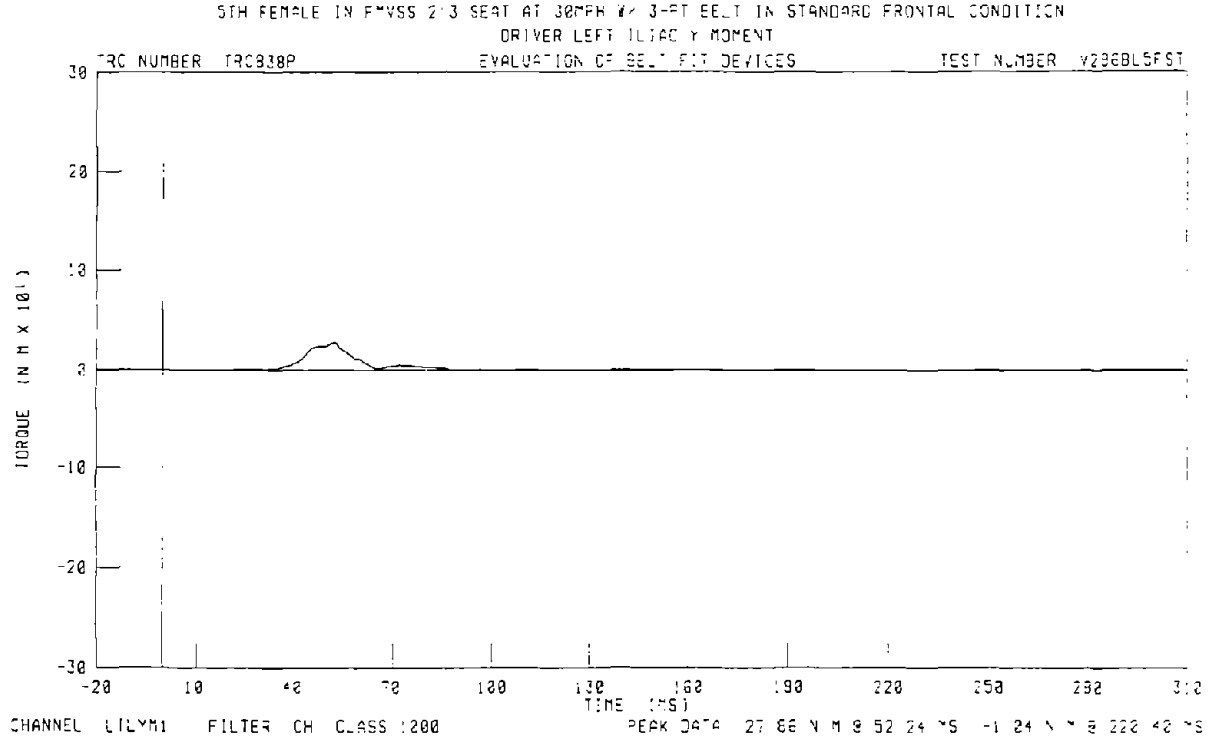
5th Percentile Female Dummy Iliac

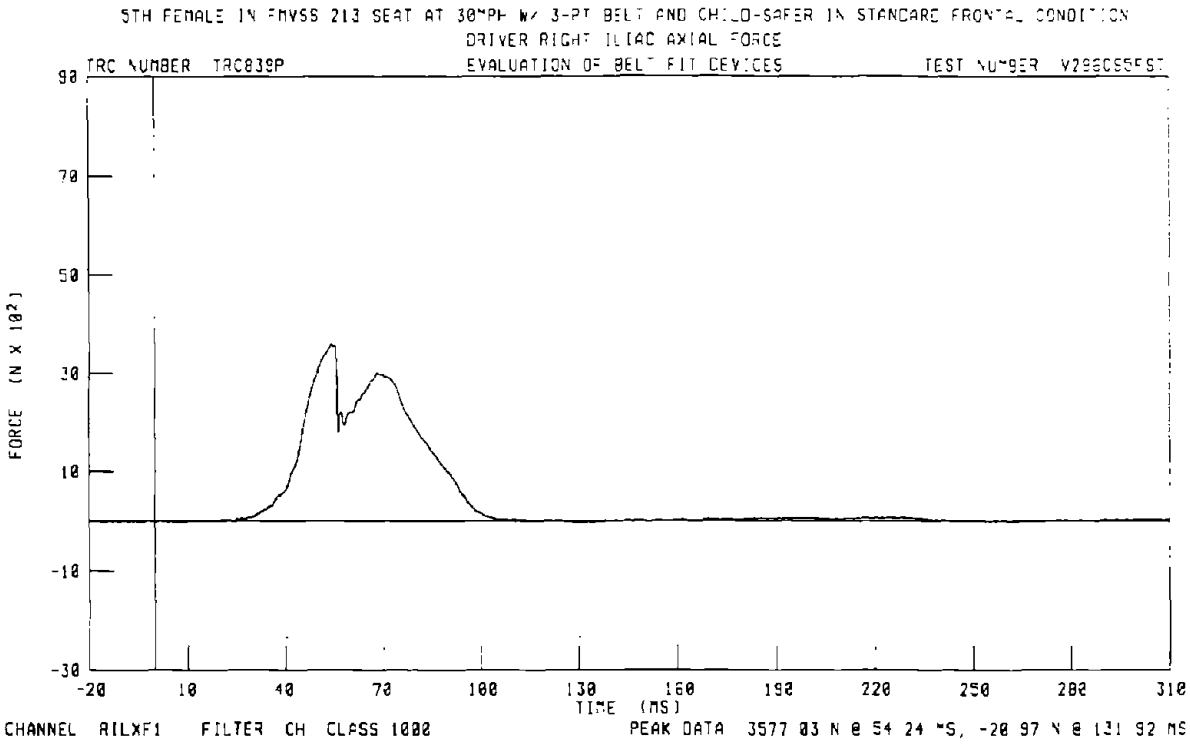
Load and Moment Time Histories

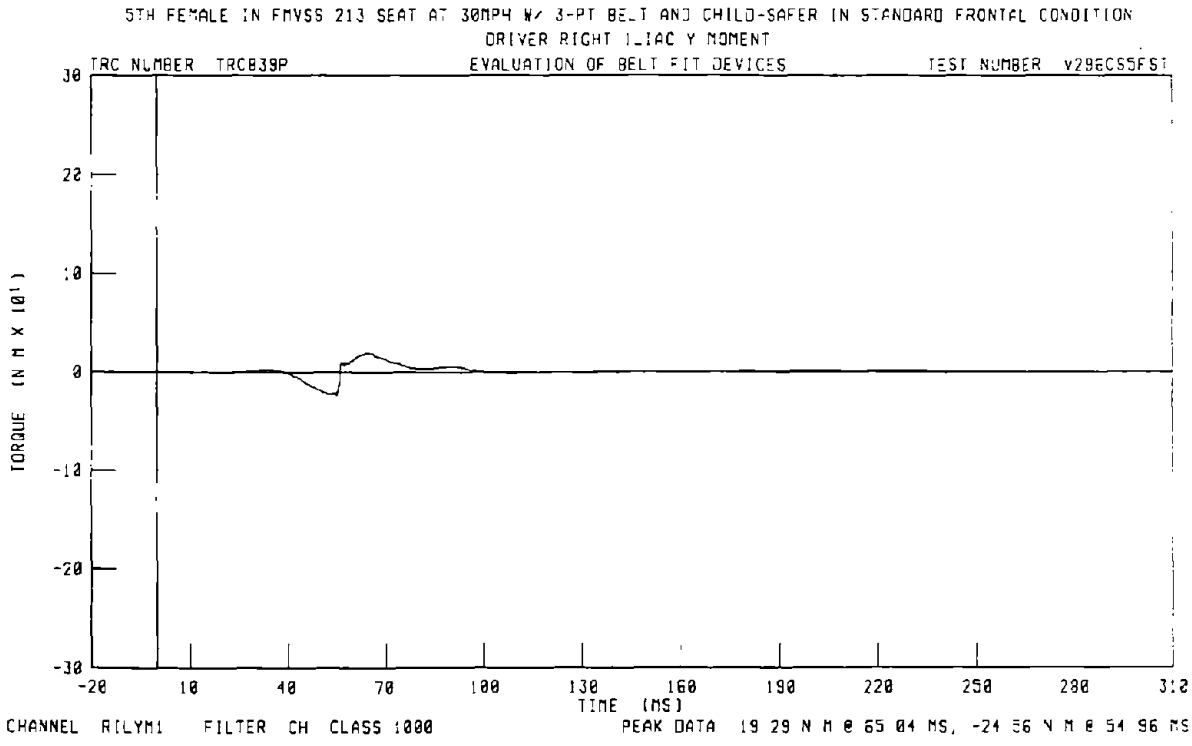

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BLEFST
FORCE (N X 10²)
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 3724.25 N @ 55.44 MS, -39.33 N @ 111.84 MS

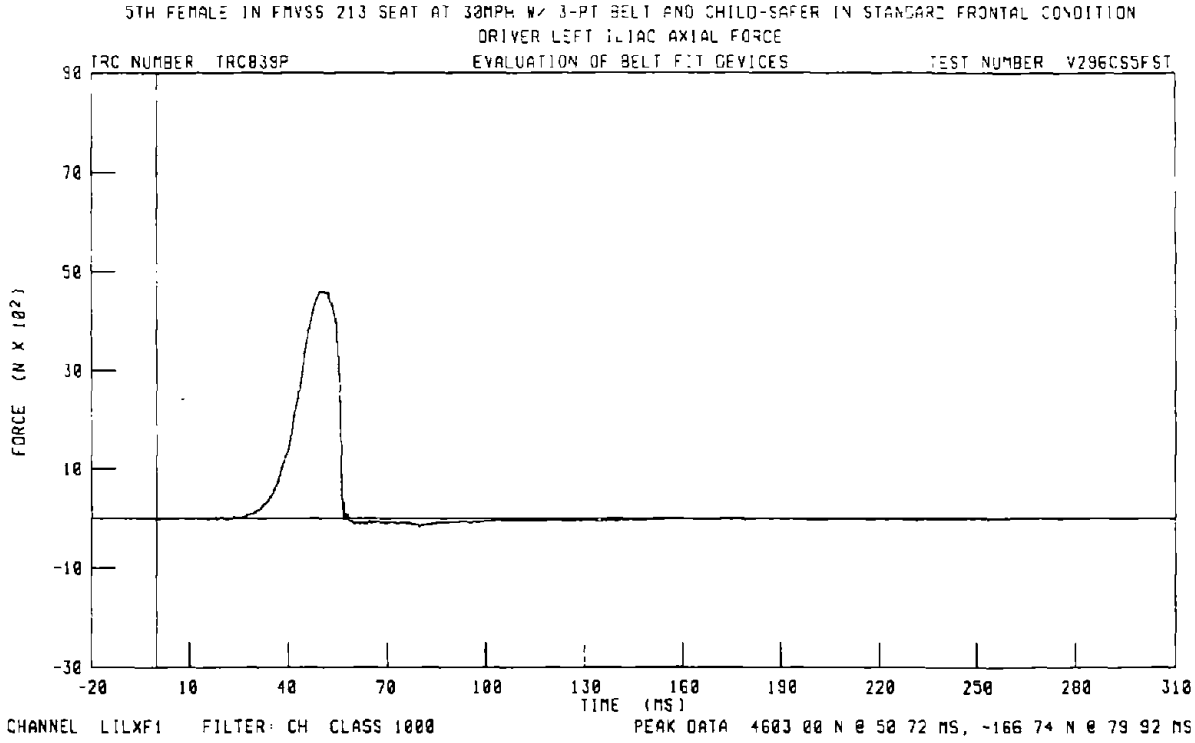

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298BLEFST
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 4.12 N M @ 36.96 MS, -24.06 N M @ 82.24 MS

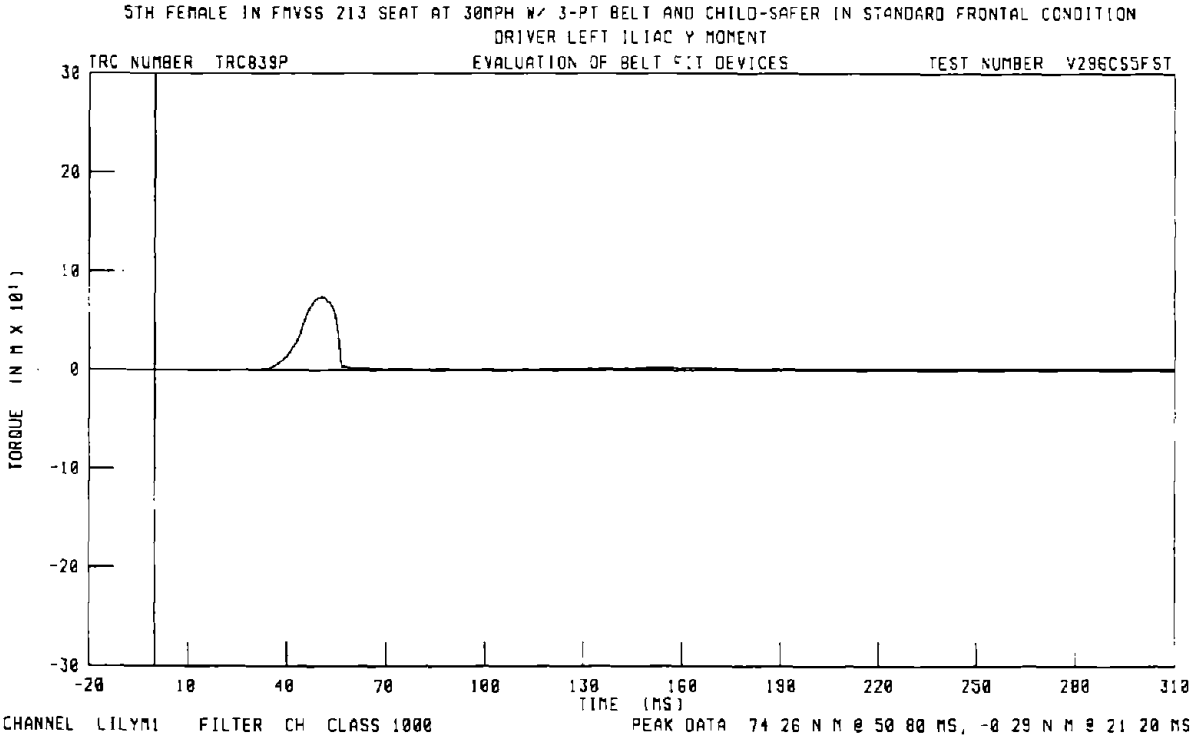

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V238BL5FST
FORCE (N X 10²)
TIME (MS)
CHANNEL LILXF1 FILTER CH CLASS 1000
PEAK DATA 4957.49 N @ 51.68 MS, -118.44 N @ 106.32 MS

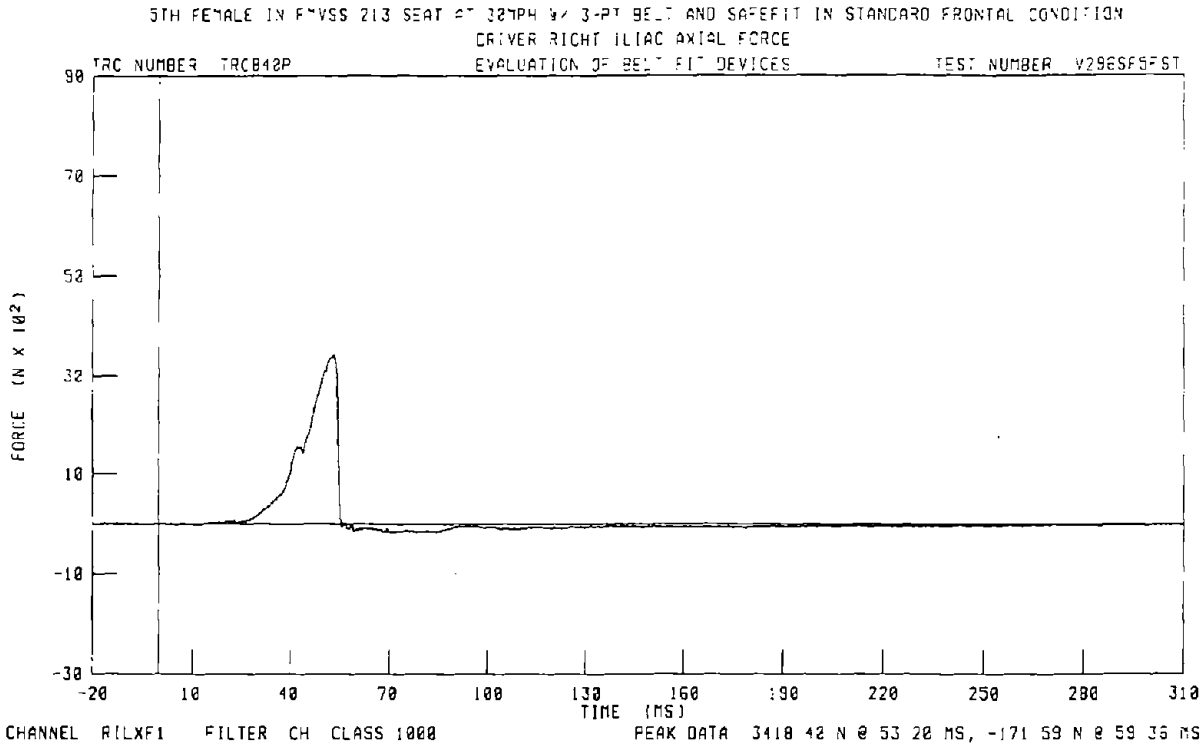

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC838P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V238BL5FST
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL LILYM1 FILTER CH CLASS 1000
PEAK DATA 27.86 N M @ 52.24 MS -1.24 N M @ 222.42 MS

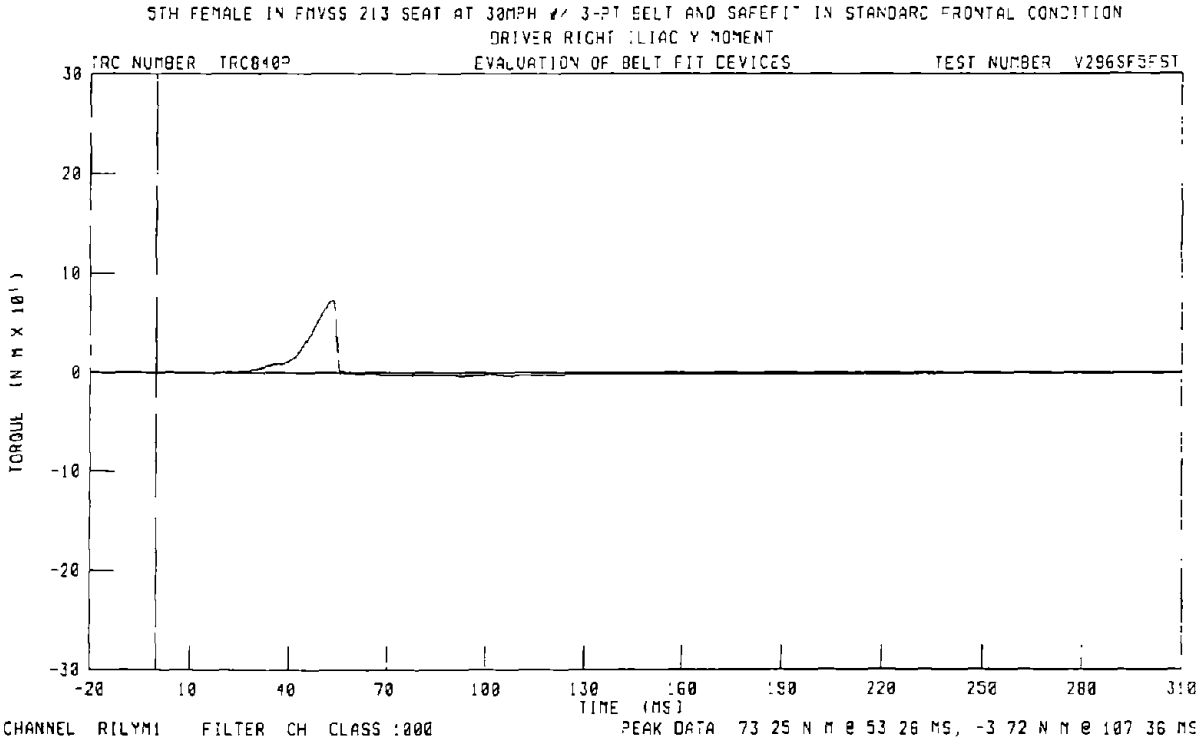

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298C55FST
FORCE (N X 10²)
90
70
50
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 3577 03 N @ 54 24 MS, -20 97 N @ 131 92 MS

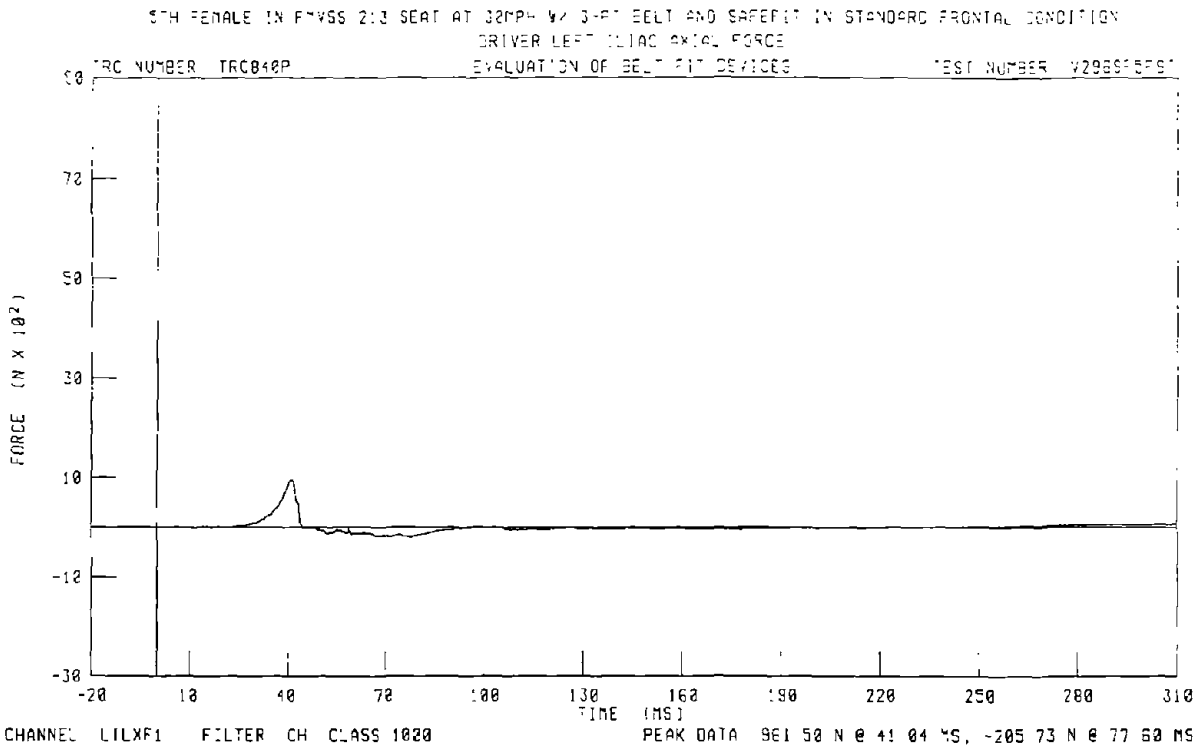

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298C55FST
TORQUE (N M X 10¹)
30
22
10
0
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 19 29 N M @ 65 04 MS, -24 56 N M @ 54 96 MS

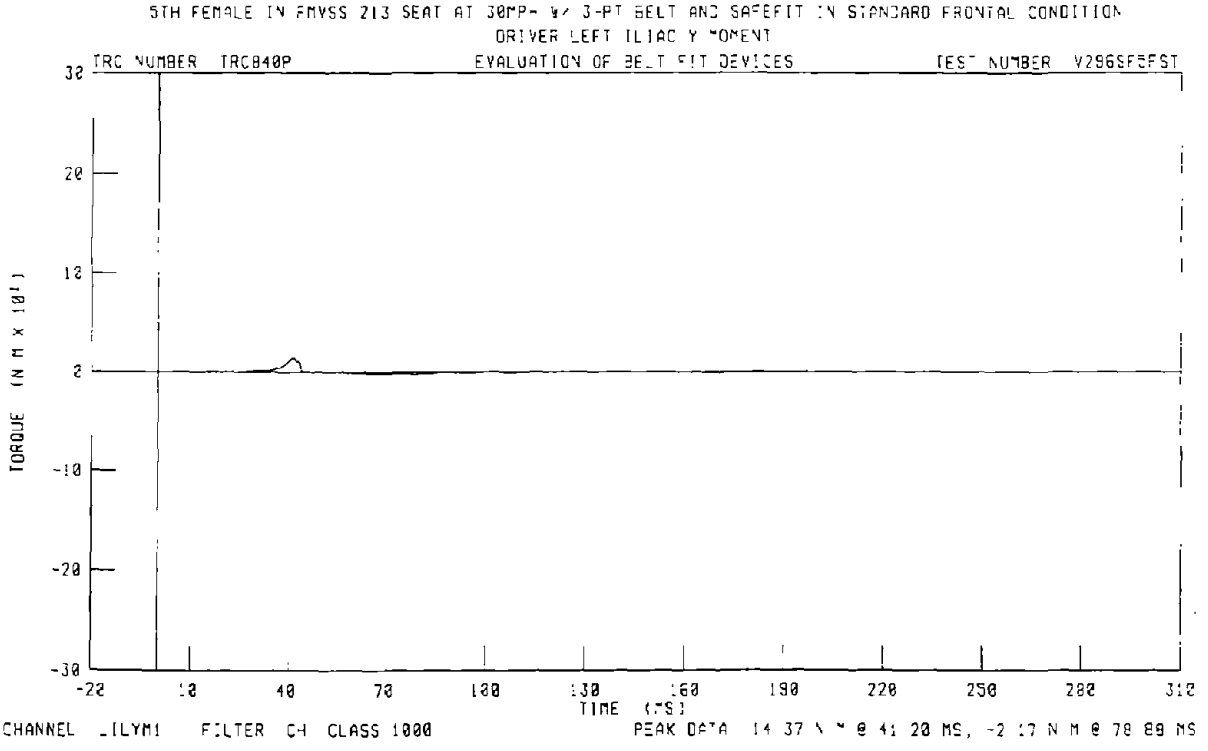

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FST
FORCE (N X 10²)
90
70
50
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LILXF1
FILTER: CH CLASS 1000
PEAK DATA 4603 00 N @ 50 72 MS, -166 74 N @ 79 92 MS

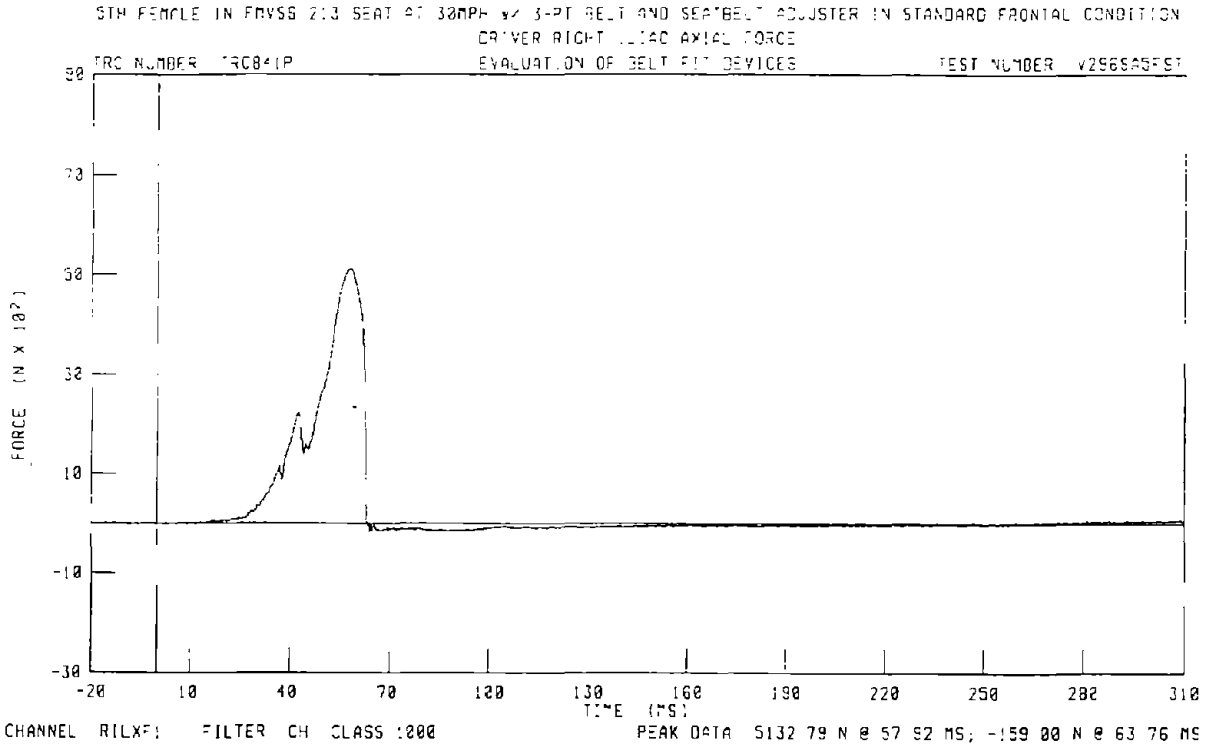

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC839P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296C55FST
TORQUE (N M X 10¹)
30
20
10
0
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LILYM1
FILTER CH CLASS 1000
PEAK DATA 74 26 N M @ 50 80 MS, -0 29 N M @ 21 20 MS

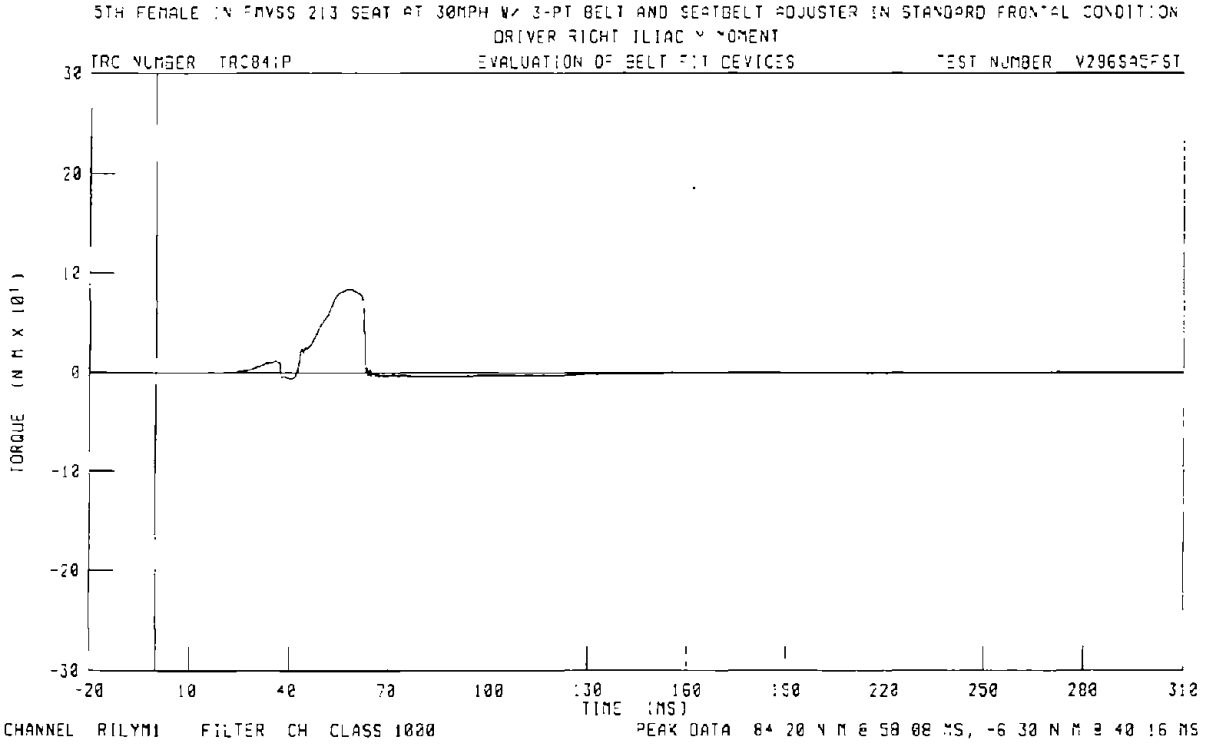

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF5FST
FORCE (N X 10²)
90
70
50
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 3418 42 N @ 53 20 MS, -171 59 N @ 59 35 MS

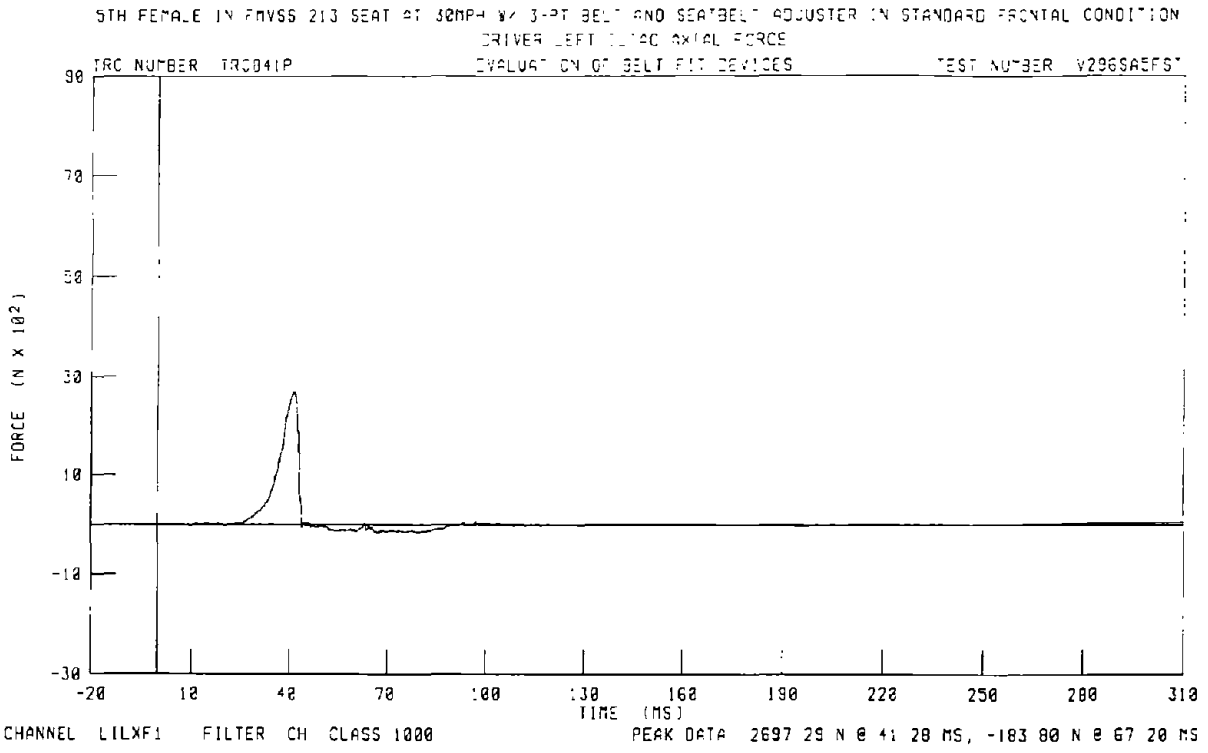

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SF5FST
TORQUE (N M X 10¹)
30
20
10
0
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 73 25 N M @ 53 26 MS, -3 72 N M @ 107 36 MS

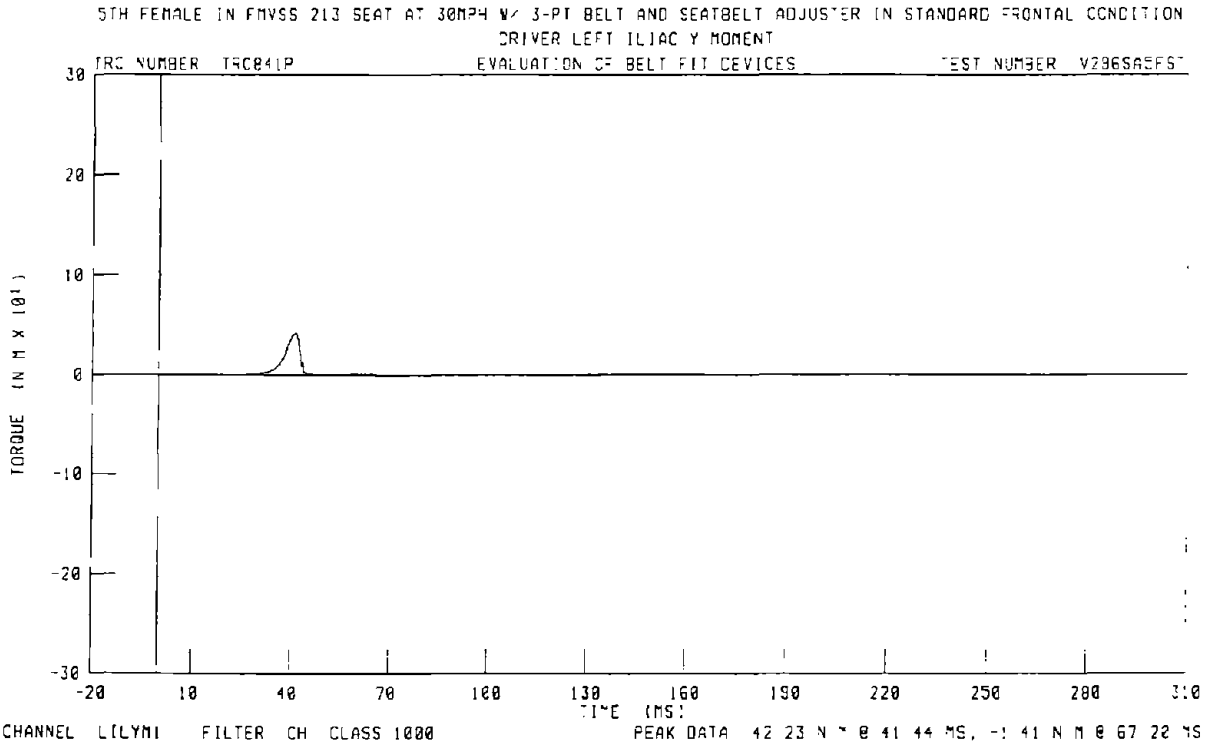

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SFEFST
FORCE (N X 10²)
TIME (MS)
CHANNEL LILXF1 FILTER CH CLASS 1000
PEAK DATA SEI 50 N @ 41 04 MS, -205 73 N @ 77 60 MS

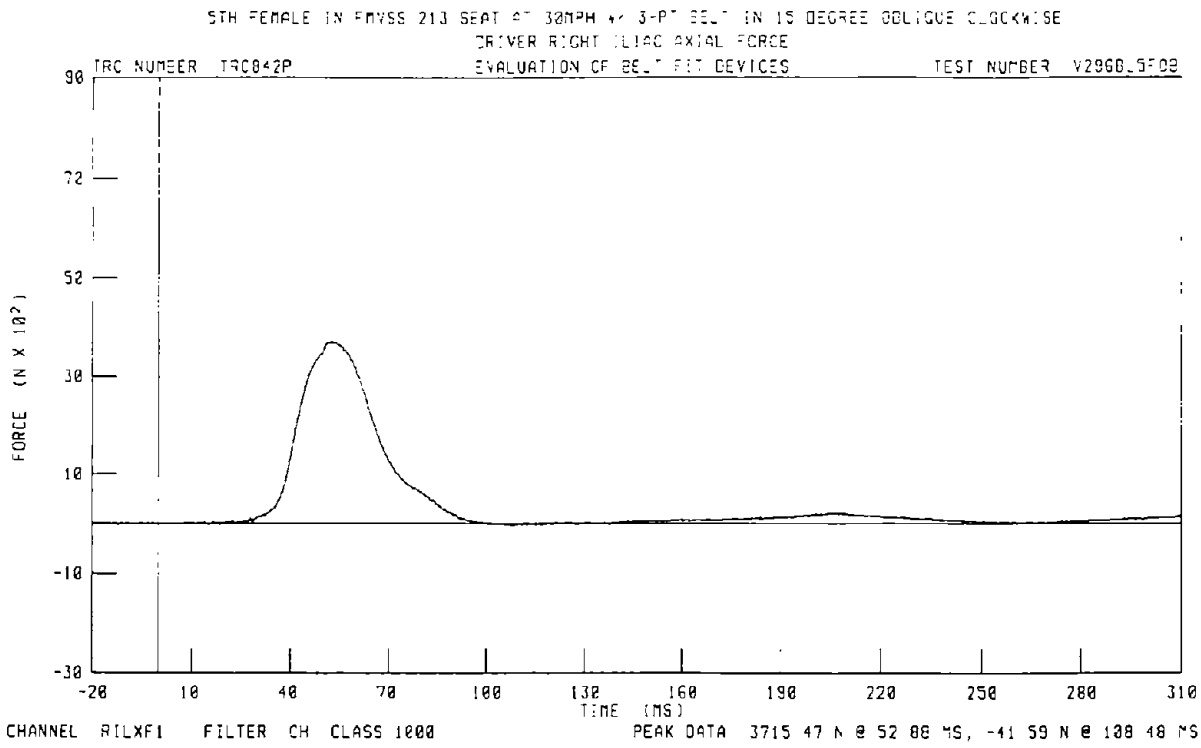

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC840P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SFEFST
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL LILYM1 FILTER CH CLASS 1000
PEAK DATA 14 37 N M @ 41 20 MS, -2 17 N M @ 78 89 MS

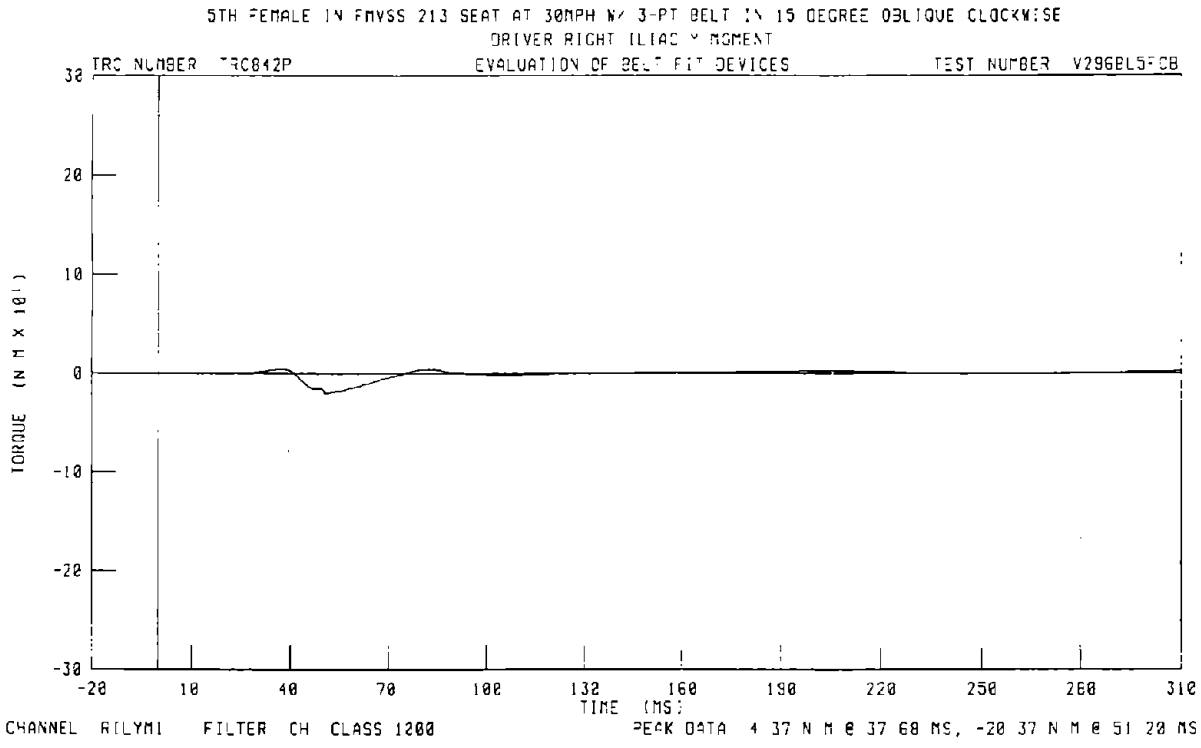

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC84IP
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5FST
FORCE (N X 10²)
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 5132.79 N @ 57.52 MS; -159.00 N @ 63.76 MS

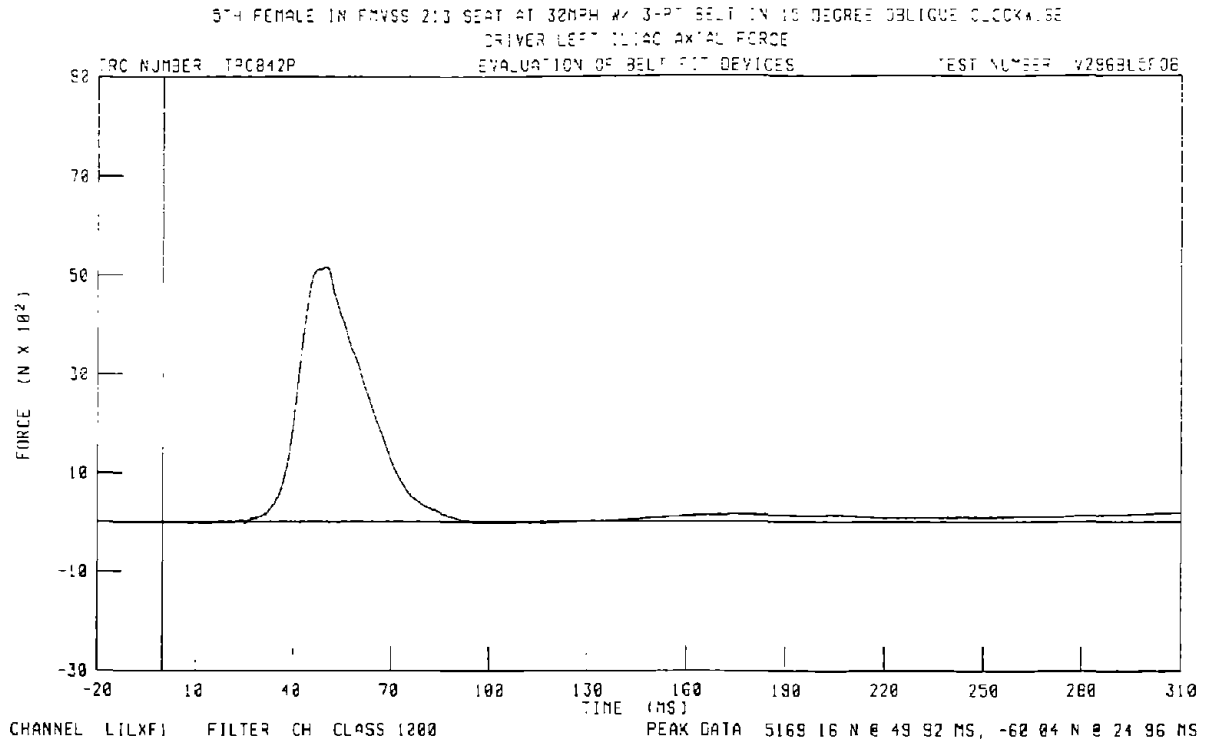

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC84IP
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5FST
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 84.20 N M @ 58.08 MS, -6.30 N M @ 40.16 MS

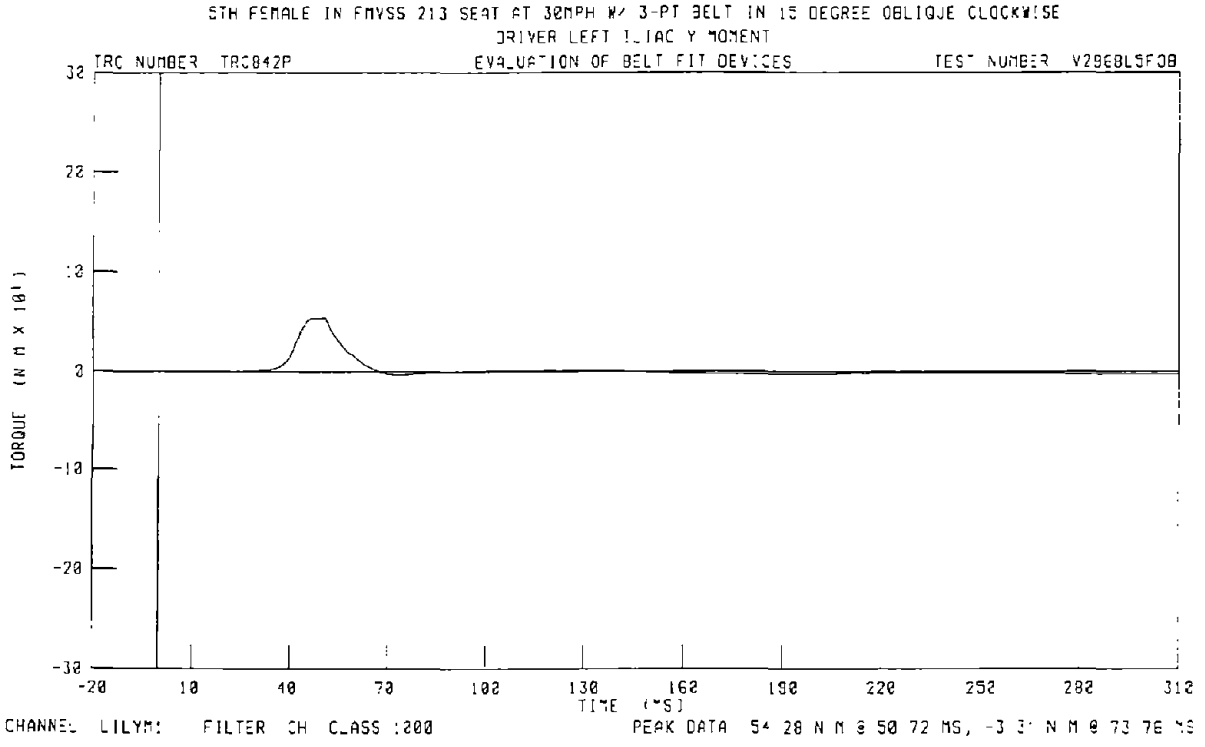

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC041P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SAEFST
FORCE (N X 10²)
90
70
50
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LILXF1 FILTER CH CLASS 1000
PEAK DATA 2697.29 N @ 41.28 MS, -183.80 N @ 67.20 MS

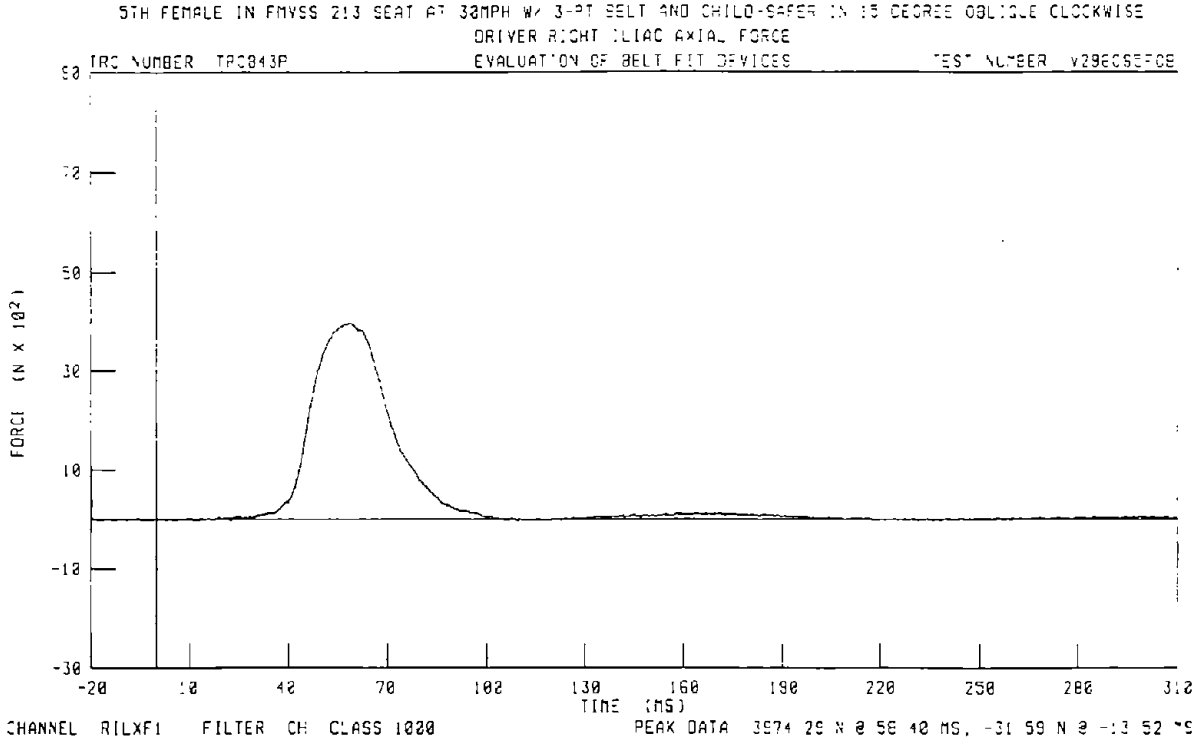

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN STANDARD FRONTAL CONDITION
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC041P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SAEFST
TORQUE (N M X 10¹)
30
20
10
0
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LILYM1 FILTER CH CLASS 1000
PEAK DATA 42.23 N M @ 41.44 MS, -1.41 N M @ 67.22 MS

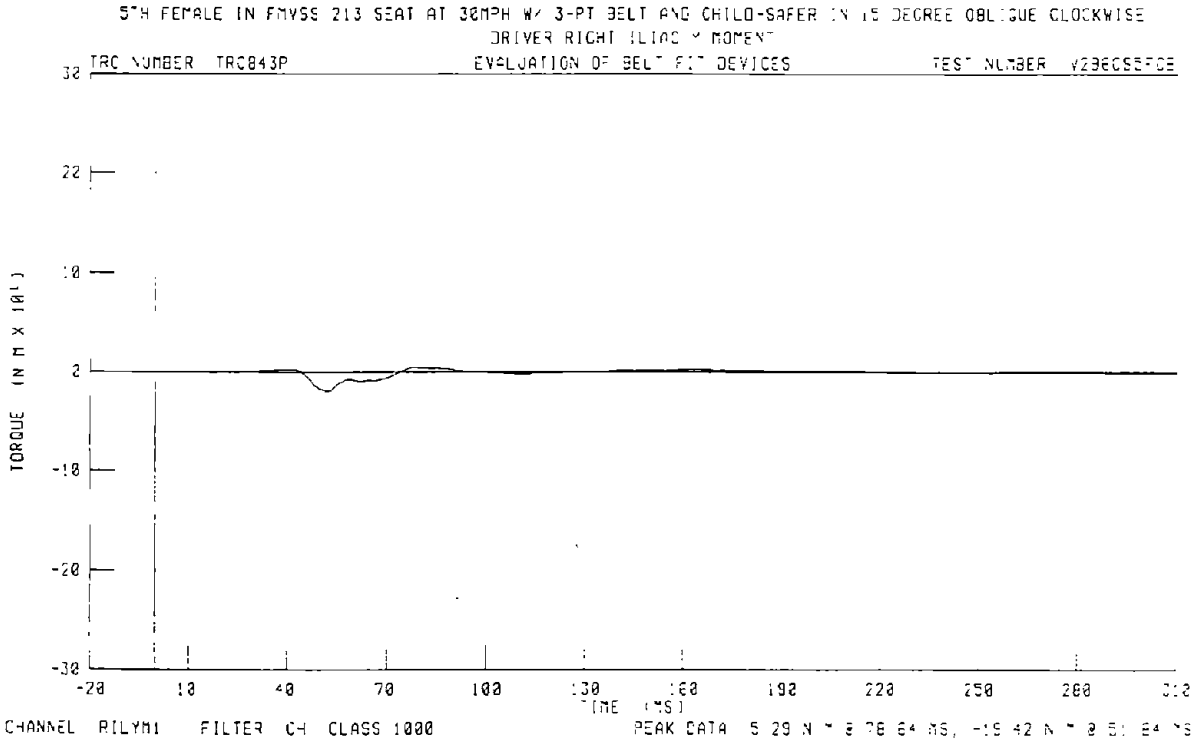

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296D_5F08
FORCE (N X 10²)
90
72
52
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL R1LXF1 FILTER CH CLASS 1000
PEAK DATA 3715 47 N @ 52 88 MS, -41 59 N @ 108 48 MS

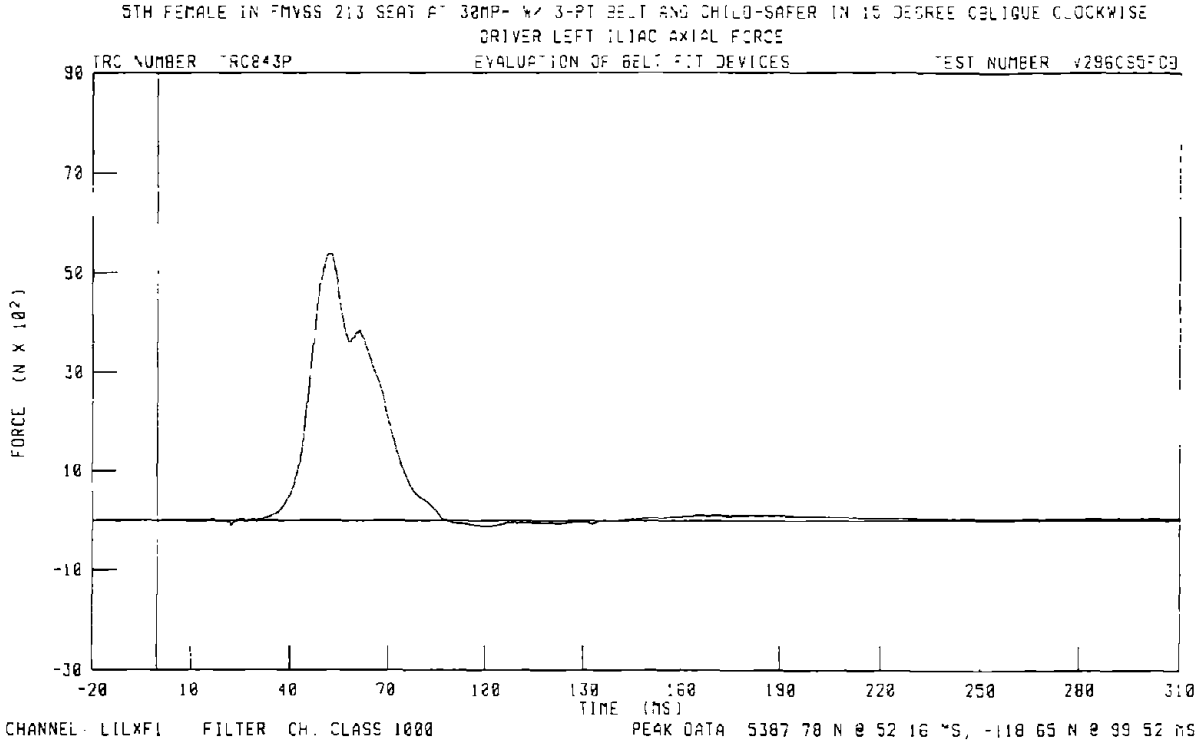

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296BL5F08
TORQUE (N M X 10¹)
30
20
10
0
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL R1LYM1 FILTER CH CLASS 1200
PEAK DATA 4 37 N M @ 37 68 MS, -20 37 N M @ 51 20 MS

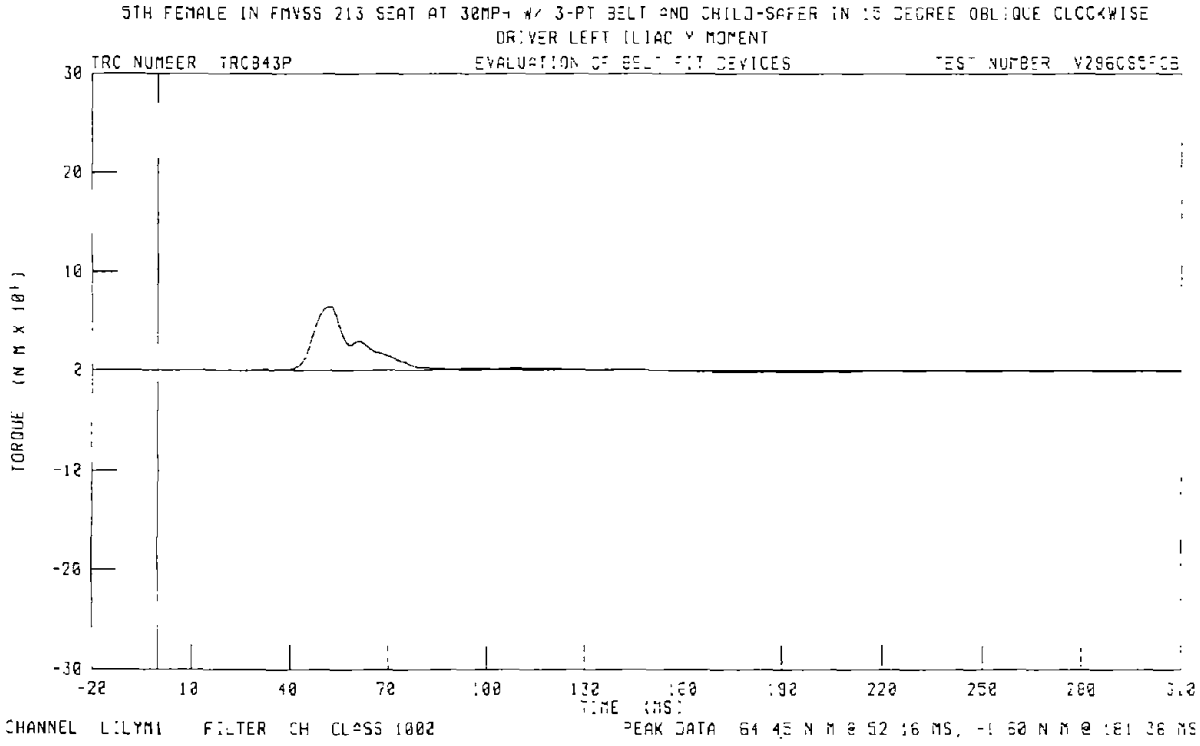

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968L5F08
FORCE (N X 10²)
TIME (MS)
CHANNEL LILXF1 FILTER CH CLASS 1200
PEAK DATA 5169 16 N @ 49 92 MS, -60 04 N @ 24 96 MS

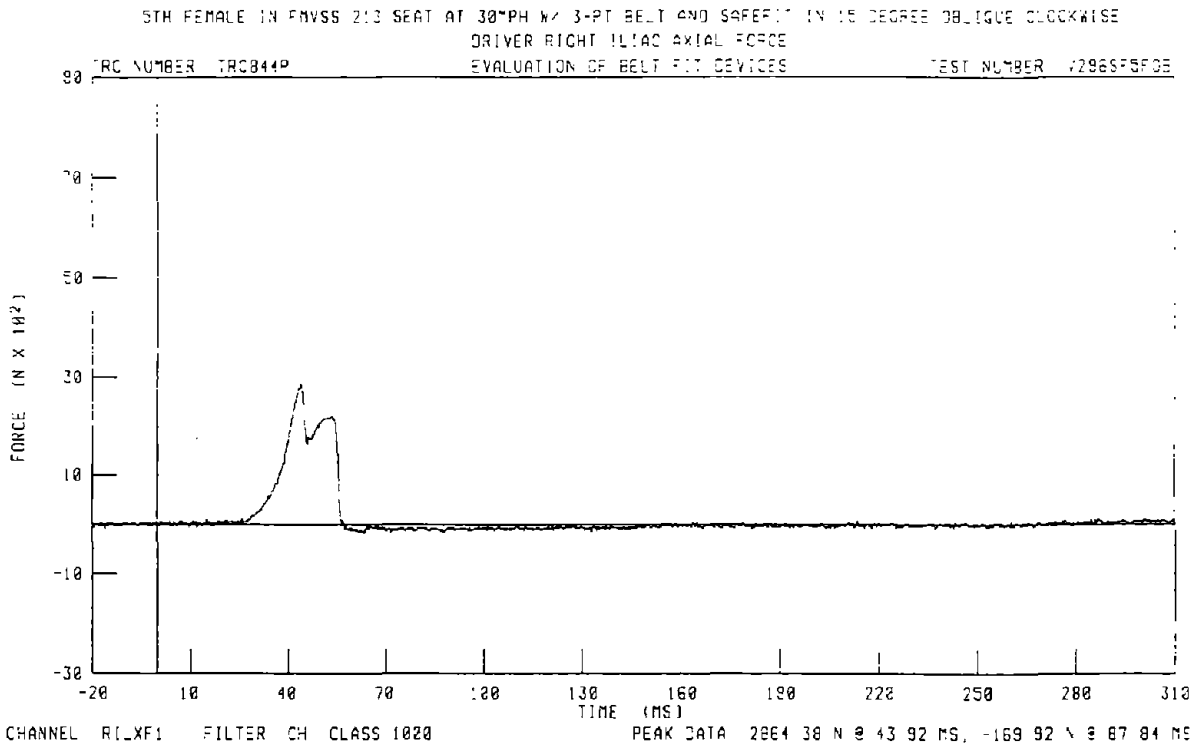

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC842P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968L5F08
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL LILYM1 FILTER CH CLASS 1200
PEAK DATA 54 28 N M @ 50 72 MS, -3 31 N M @ 73 76 MS

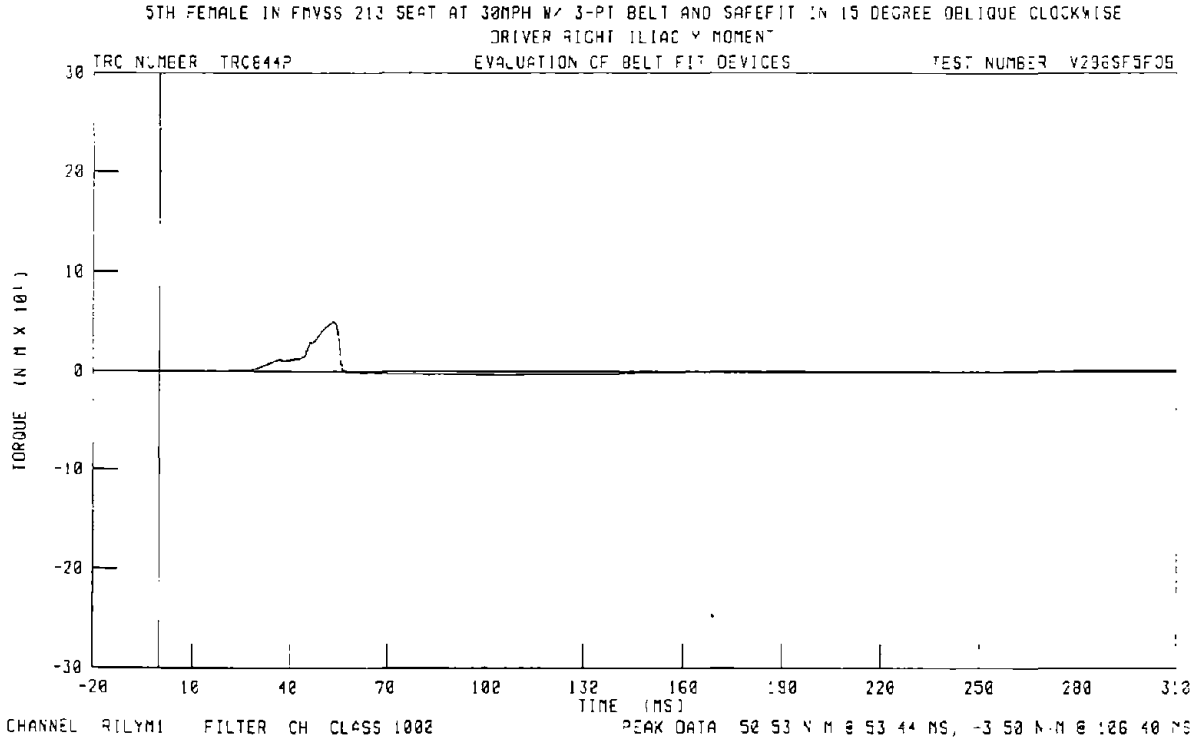

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V29E05EFDE
FORCE (N X 10²)
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 3974.29 N @ 58.40 MS, -31.59 N @ -13.52 MS

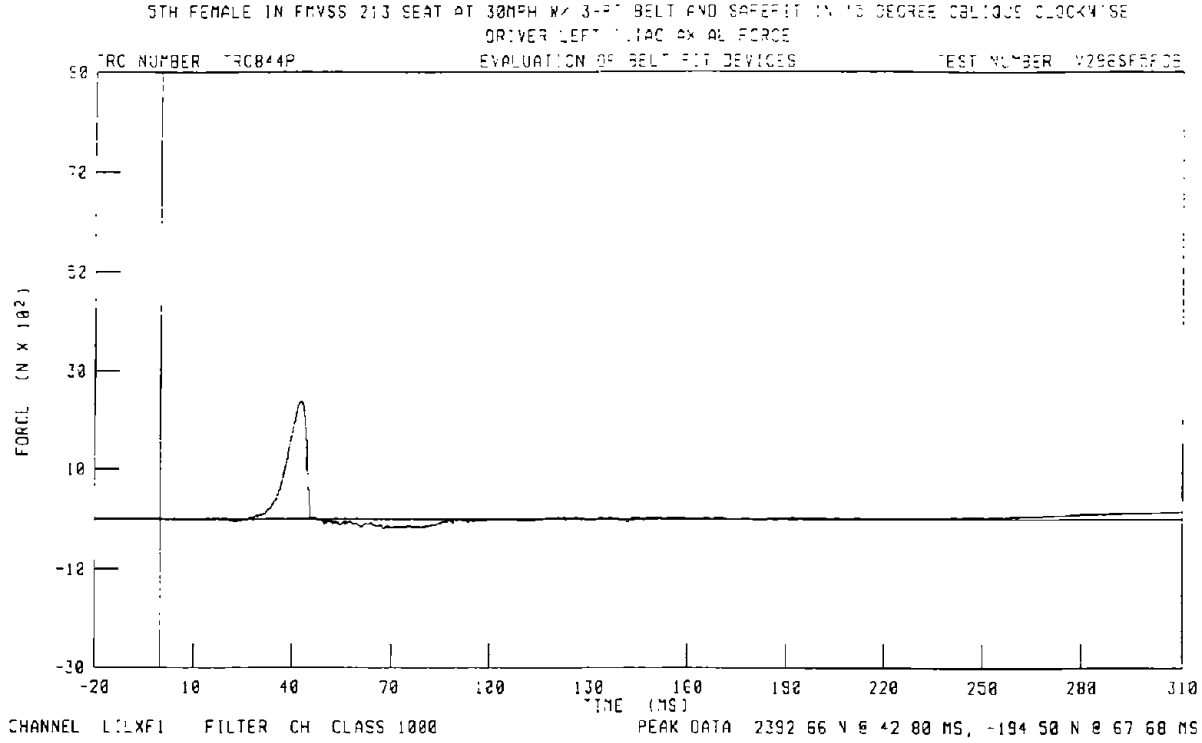

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V29E05EFDE
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 5.29 N M @ 78.64 MS, -19.42 N M @ 51.84 MS

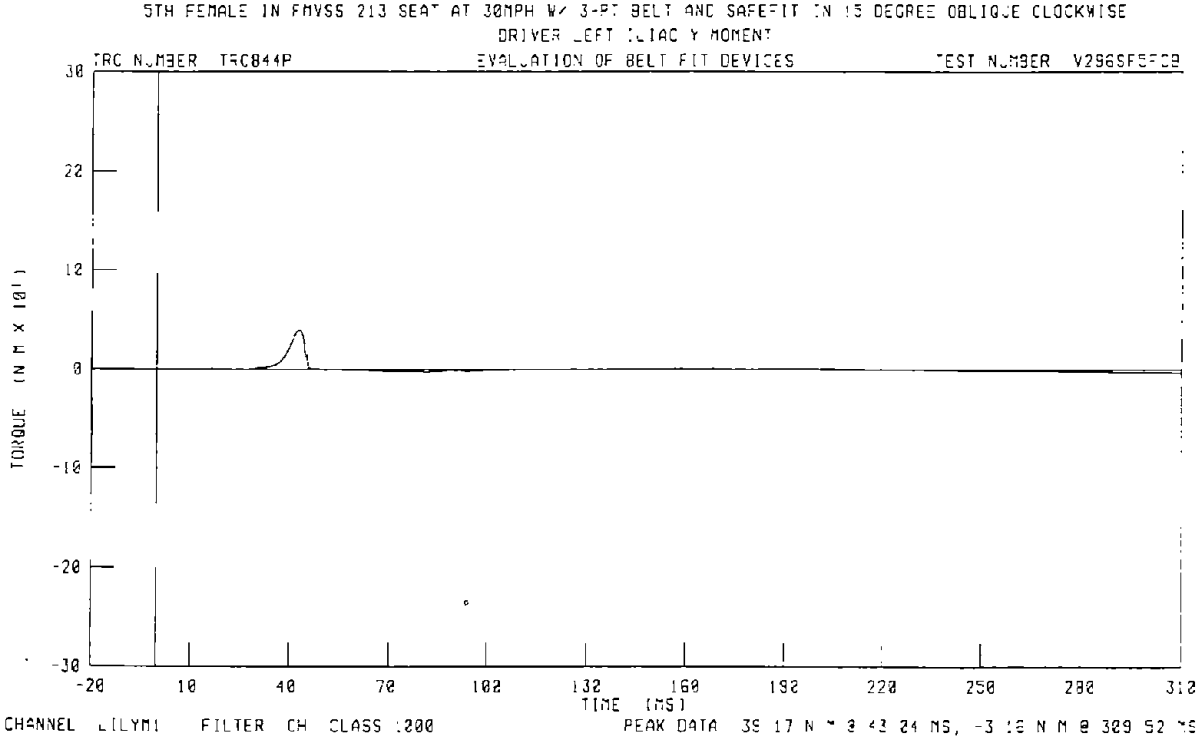

5TH FEMALE IN FMVSS 213 SEAT AT 30MP- W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2860S5FC0
FORCE (N X 10²)
TIME (MS)
CHANNEL LILXF1 FILTER CH. CLASS 1000
PEAK DATA 5387 78 N @ 52 16 MS, -118 65 N @ 99 52 MS

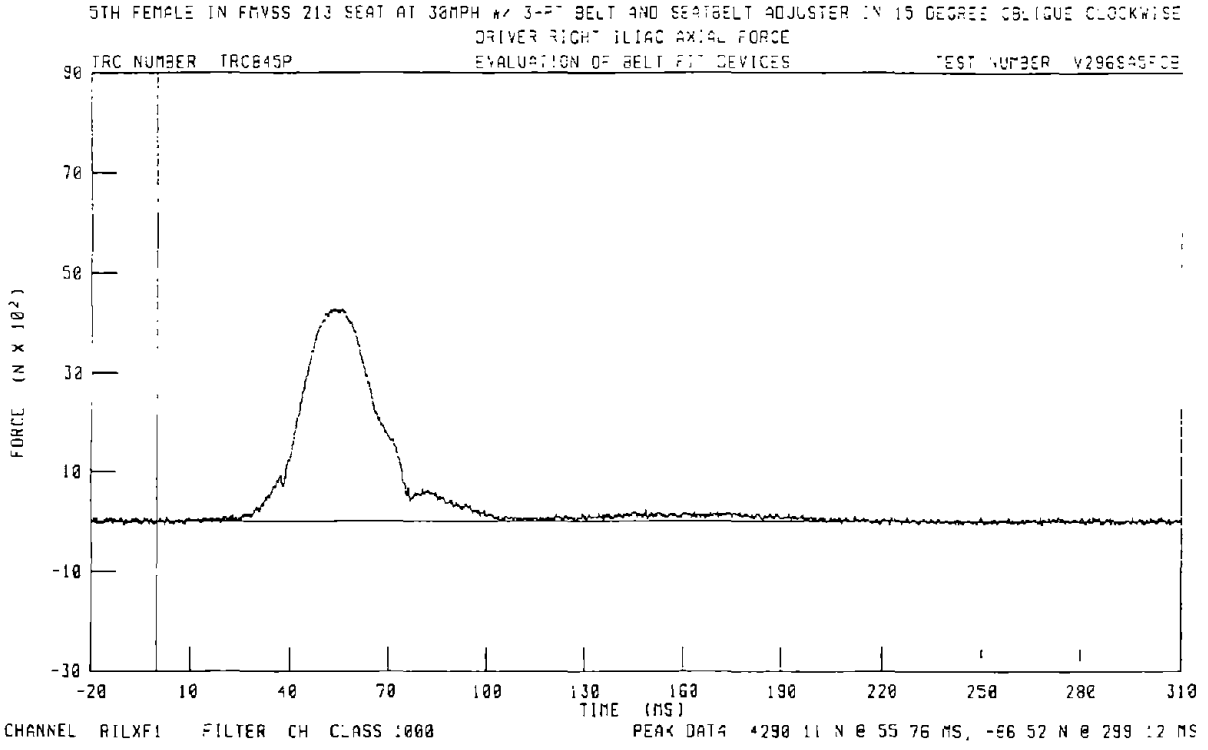

5TH FEMALE IN FMVSS 213 SEAT AT 30MP+ W/ 3-PT BELT AND CHILD-SAFER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC843P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2860S5FC0
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL LILYM1 FILTER CH CLASS 1002
PEAK DATA 64 45 N M @ 52 16 MS, -1 60 N M @ 181 26 MS

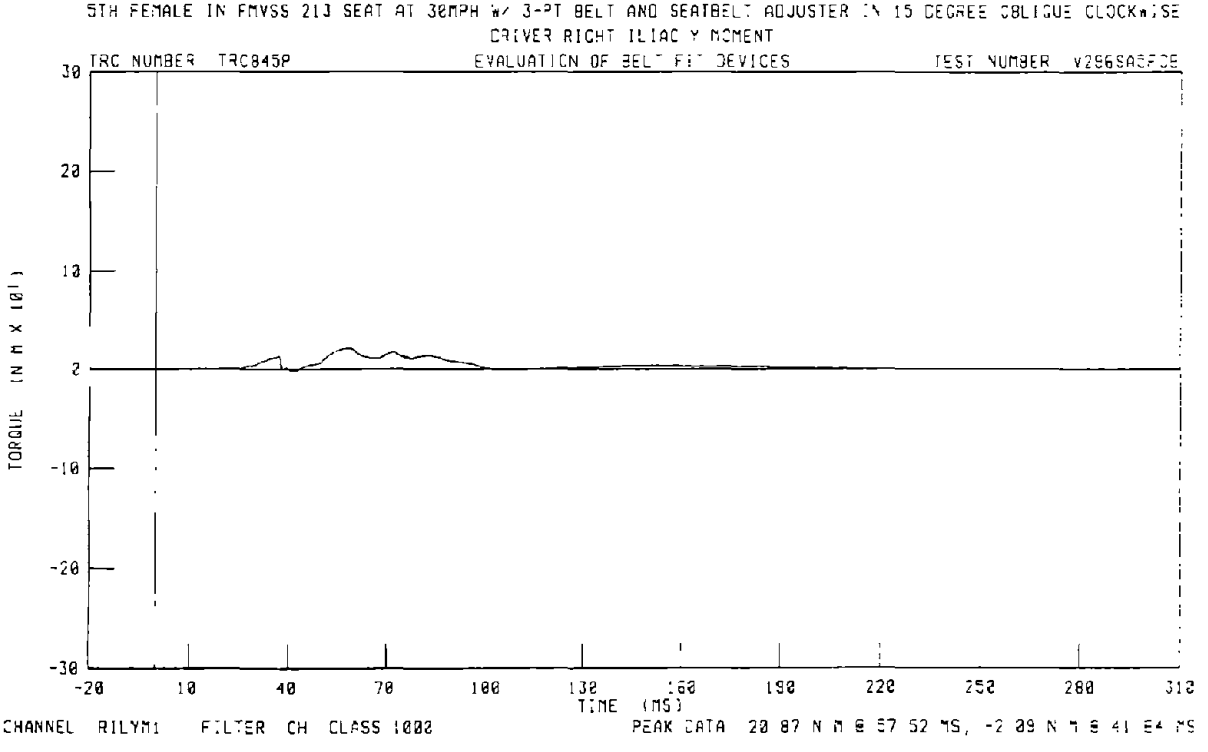

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V236SF5F05
FORCE (N X 10²)
90
70
50
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL R(_XF1 FILTER CH CLASS 1000
PEAK DATA 2864.38 N @ 43.92 MS, -169.92 N @ 87.84 MS

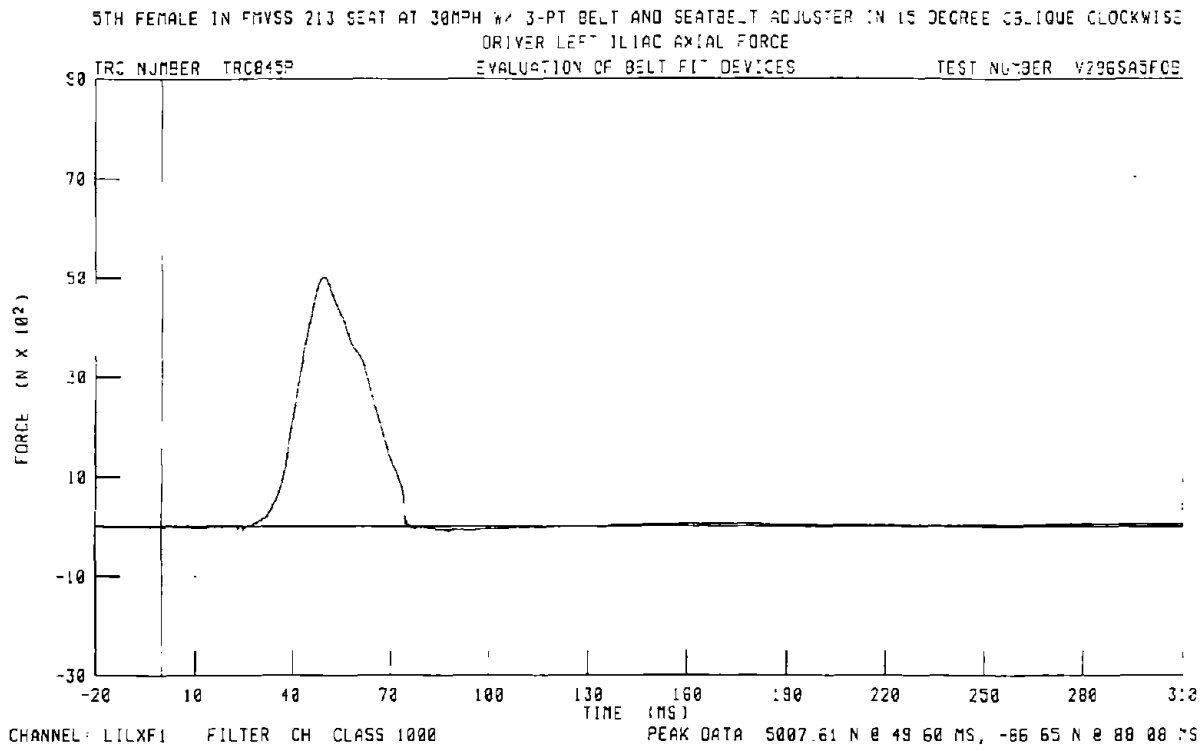

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V236SF5F05
TORQUE (N M X 10¹)
30
20
10
0
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 50.53 N M @ 53.44 MS, -3.50 N-M @ 126.40 MS

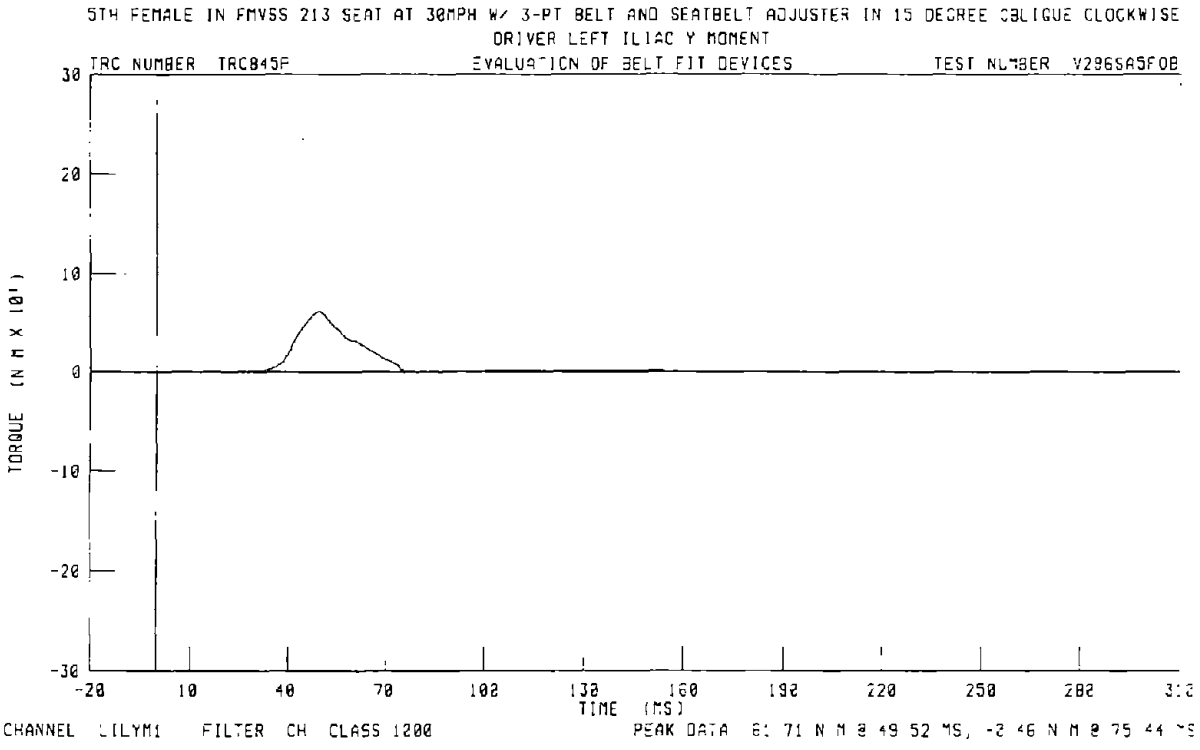

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT TIBIAC AX AL FORCE
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SFEC8
FORCE (N X 10²)
TIME (MS)
CHANNEL L1LXF1 FILTER CH CLASS 1000
PEAK DATA 2392 66 N @ 42 80 MS, -194 50 N @ 67 68 MS

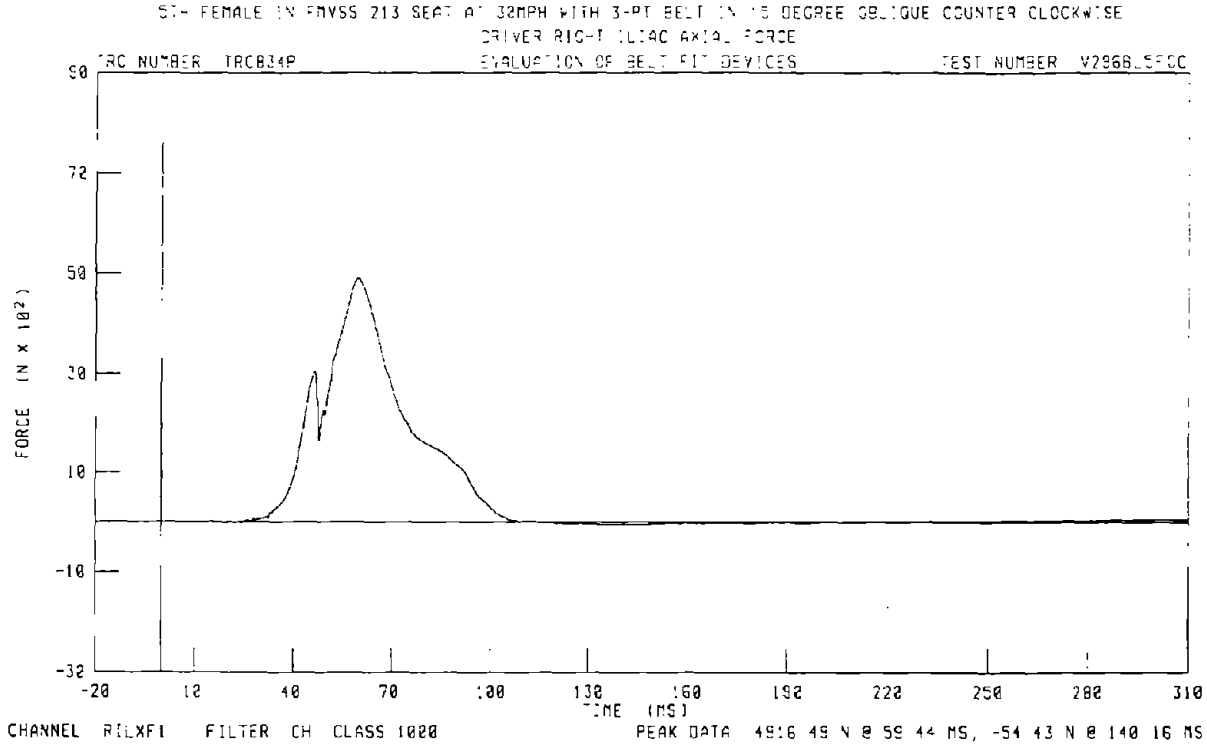

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT TIBIAC Y MOMENT
TRC NUMBER TRC844P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SFEC8
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL L1LYM1 FILTER CH CLASS 1000
PEAK DATA 39 17 N M @ 43 24 MS, -3 18 N M @ 309 52 MS

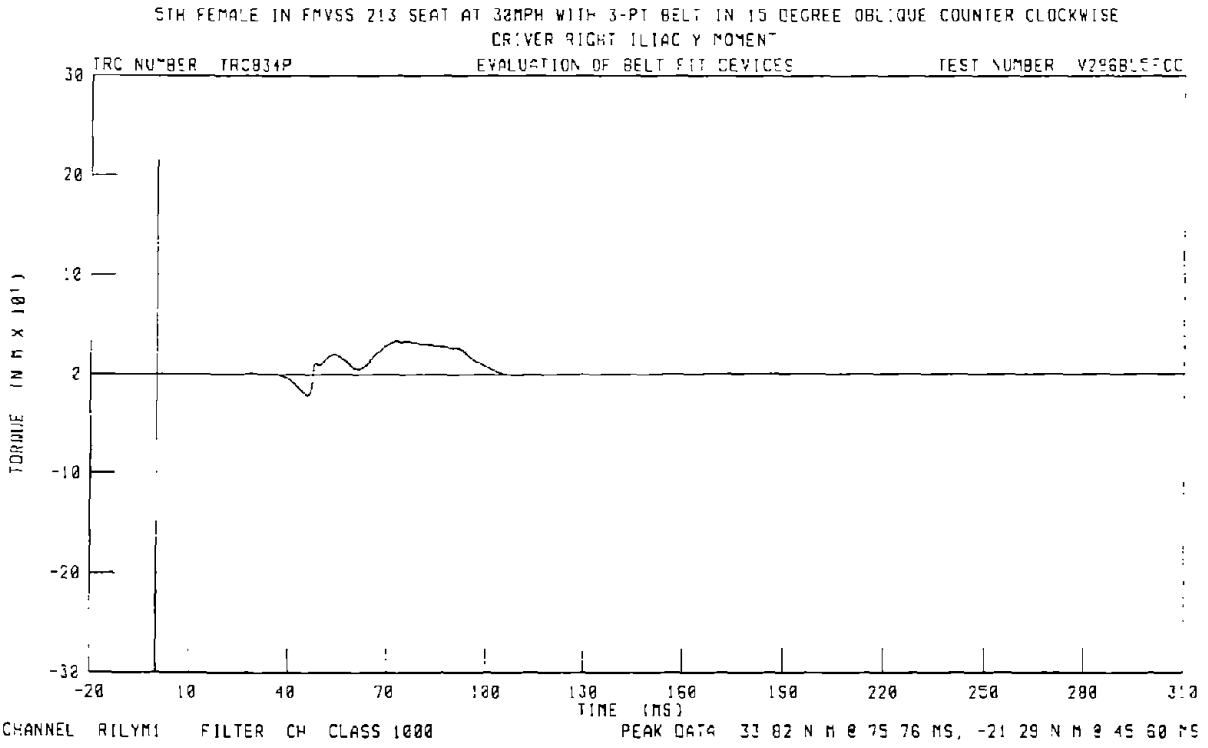

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH w/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5FCE
FORCE (N X 10²)
90
70
50
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 4290 11 N @ 55 76 MS, -86 52 N @ 299 12 MS

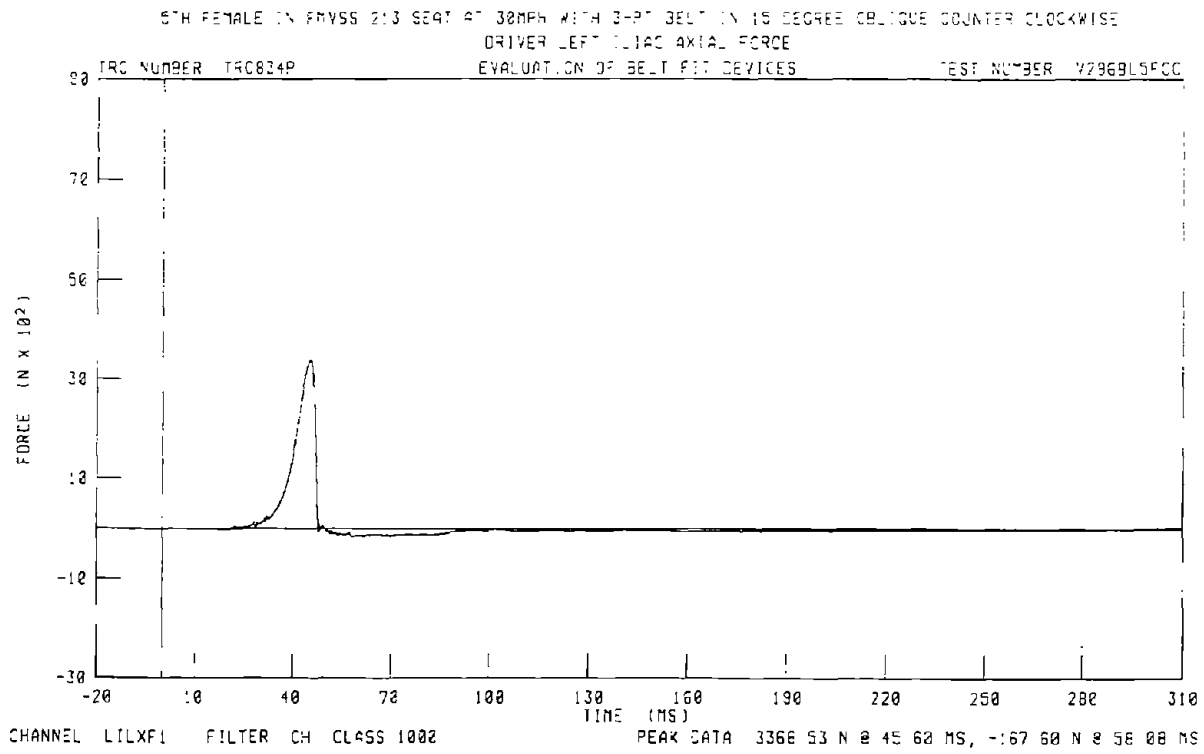

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH w/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5FCE
TORQUE (N M X 10¹)
30
20
10
2
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 20 87 N M @ 57 52 MS, -2 09 N M @ 41 64 MS

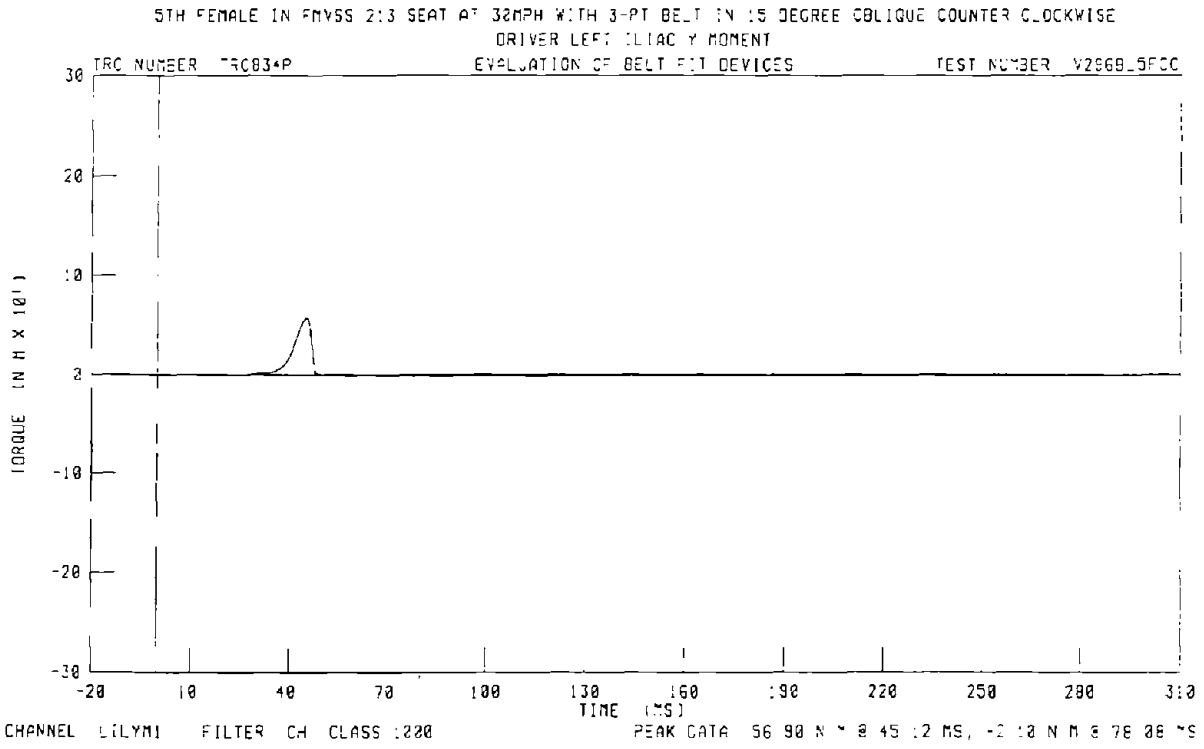

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5F08
FORCE (N X 10²)
TIME (MS)
CHANNEL: LILXF1 FILTER CH CLASS 1000
PEAK DATA 5007.61 N @ 49 60 MS, -86 65 N @ 88 88 MS

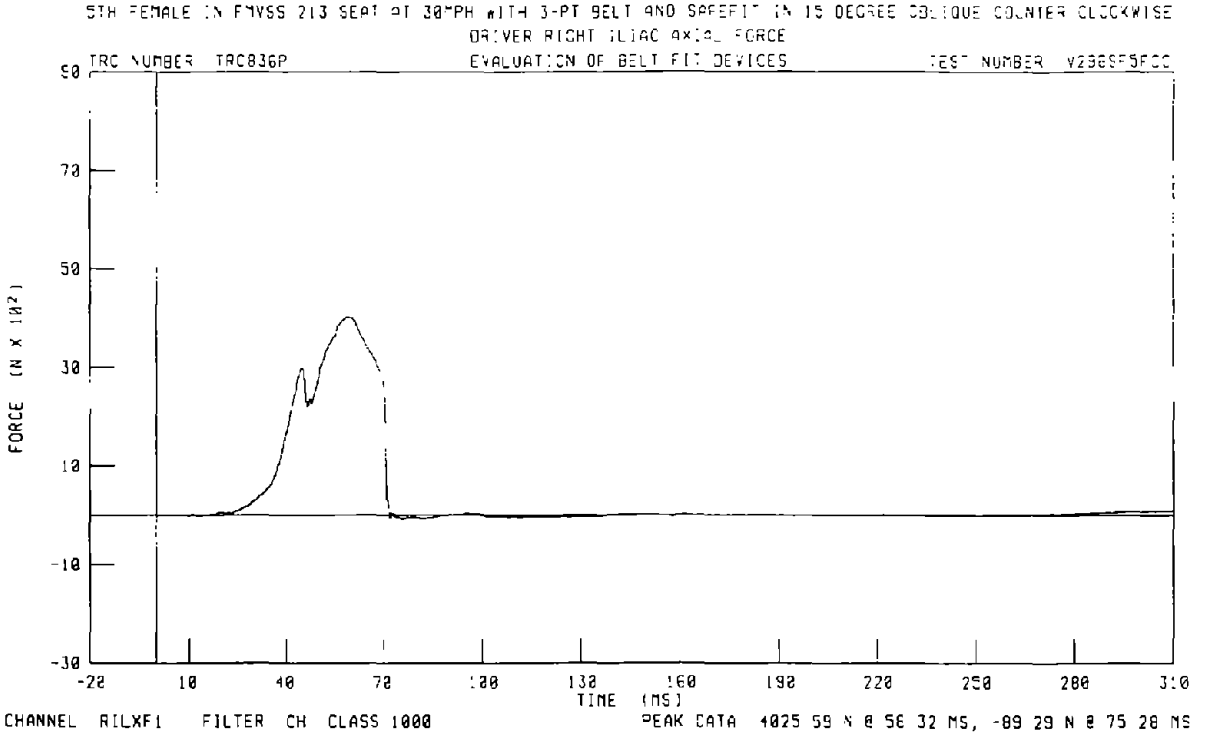

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH W/ 3-PT BELT AND SEATBELT ADJUSTER IN 15 DEGREE OBLIQUE CLOCKWISE
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC845P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V296SA5F08
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL LILYM1 FILTER CH CLASS 1200
PEAK DATA 61 71 N M @ 49 52 MS, -2 46 N M @ 75 44 MS

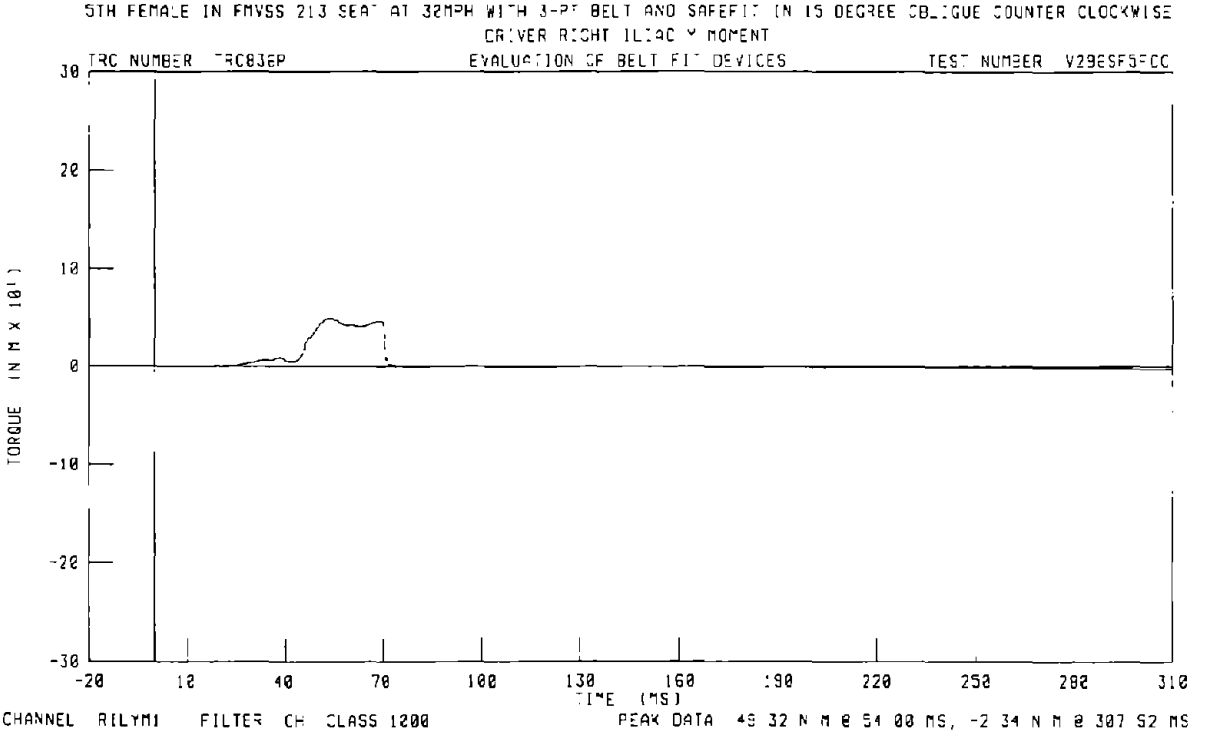

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968LSFDC
FORCE (N X 10²)
90
72
50
30
10
-10
-32
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 4916 49 N @ 59 44 MS, -54 43 N @ 140 16 MS

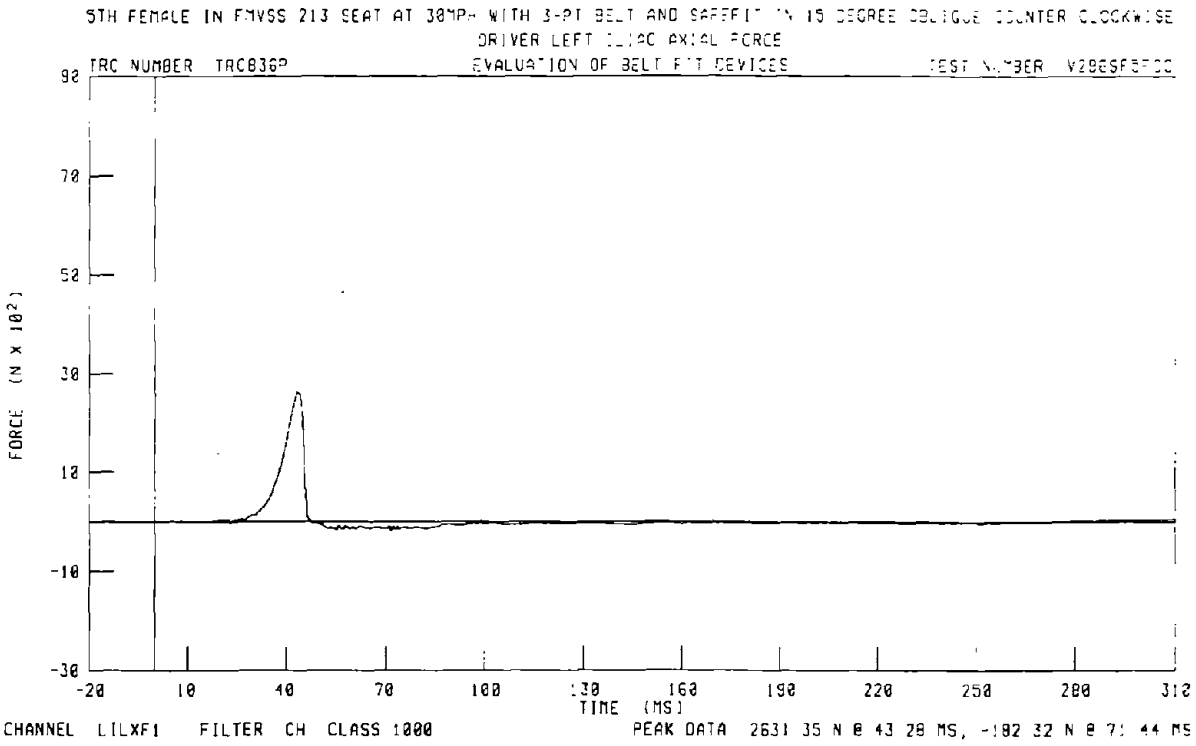

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2968LSFDC
TORQUE (N M X 10¹)
30
20
10
2
-10
-20
-32
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1000
PEAK DATA 33 82 N M @ 75 76 MS, -21 29 N M @ 45 60 MS

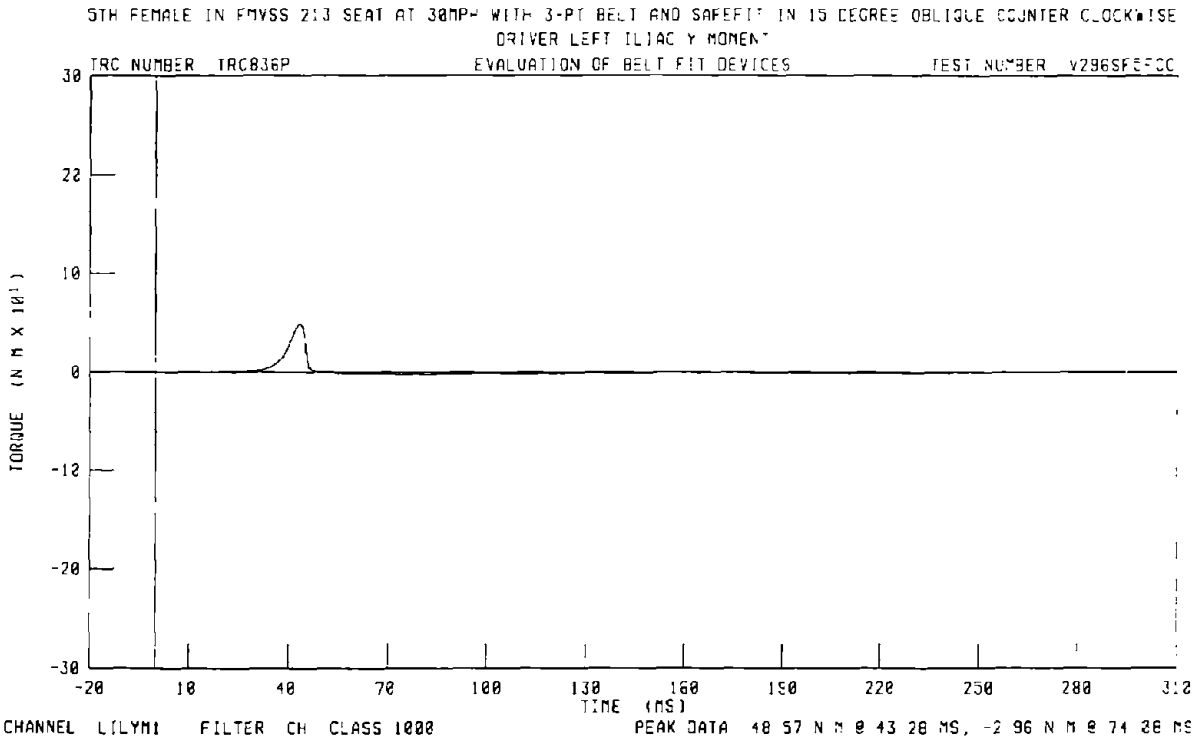

5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2969L5FCC
FORCE (N X 10²)
80
70
60
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LILXF1 FILTER CH CLASS 1000
PEAK DATA 3366 53 N @ 45 60 MS, -167 60 N @ 58 00 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC834P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V2969L5FCC
TORQUE (N M X 10¹)
30
20
10
0
-10
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
310
TIME (MS)
CHANNEL LILYM1 FILTER CH CLASS 1000
PEAK DATA 56 90 N M @ 45 12 MS, -2 10 N M @ 78 08 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER RIGHT ILIAC AXIAL FORCE
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298SF5FCC
FORCE (N X 10²)
TIME (MS)
CHANNEL RILXF1 FILTER CH CLASS 1000
PEAK DATA 4025 59 N @ 56 32 MS, -89 29 N @ 75 28 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER RIGHT ILIAC Y MOMENT
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V298SF5FCC
TORQUE (N M X 10¹)
TIME (MS)
CHANNEL RILYM1 FILTER CH CLASS 1200
PEAK DATA 49 32 N M @ 54 00 MS, -2 34 N M @ 307 52 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LEFT ILIAC AXIAL FORCE
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V286SFEDC
FORCE (N X 10²)
90
70
50
30
10
-10
-30
-20
10
40
70
100
130
160
190
220
250
280
312
TIME (MS)
CHANNEL LILXFI FILTER CH CLASS 1000
PEAK DATA 2631 35 N @ 43 28 MS, -182 32 N @ 71 44 MS


5TH FEMALE IN FMVSS 213 SEAT AT 30MPH WITH 3-PT BELT AND SAFEFIT IN 15 DEGREE OBLIQUE COUNTER CLOCKWISE
DRIVER LEFT ILIAC Y MOMENT
TRC NUMBER TRC836P
EVALUATION OF BELT FIT DEVICES
TEST NUMBER V286SFEDC
TORQUE (N M X 10¹)
30
22
10
0
-12
-20
-30
-20
10
40
70
100
130
160
190
220
250
280
312
TIME (MS)
CHANNEL LILYMI FILTER CH CLASS 1000
PEAK DATA 48 57 N M @ 43 28 MS, -2 96 N M @ 74 38 MS

Appendix G

Timed Kinematic Sequences for

3 Year Old, 6 Year Old and 5th Percentile Female Dummies

With and Without Belt Fit Devices

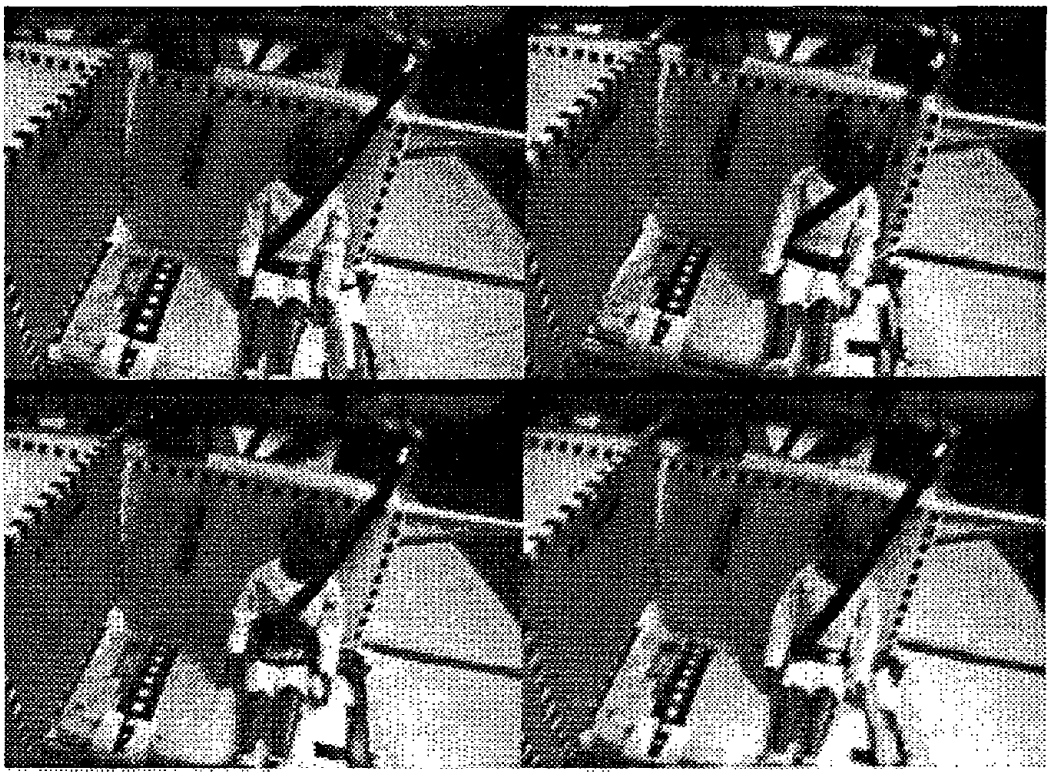
BL

CS

t=0 ms

SF

SA



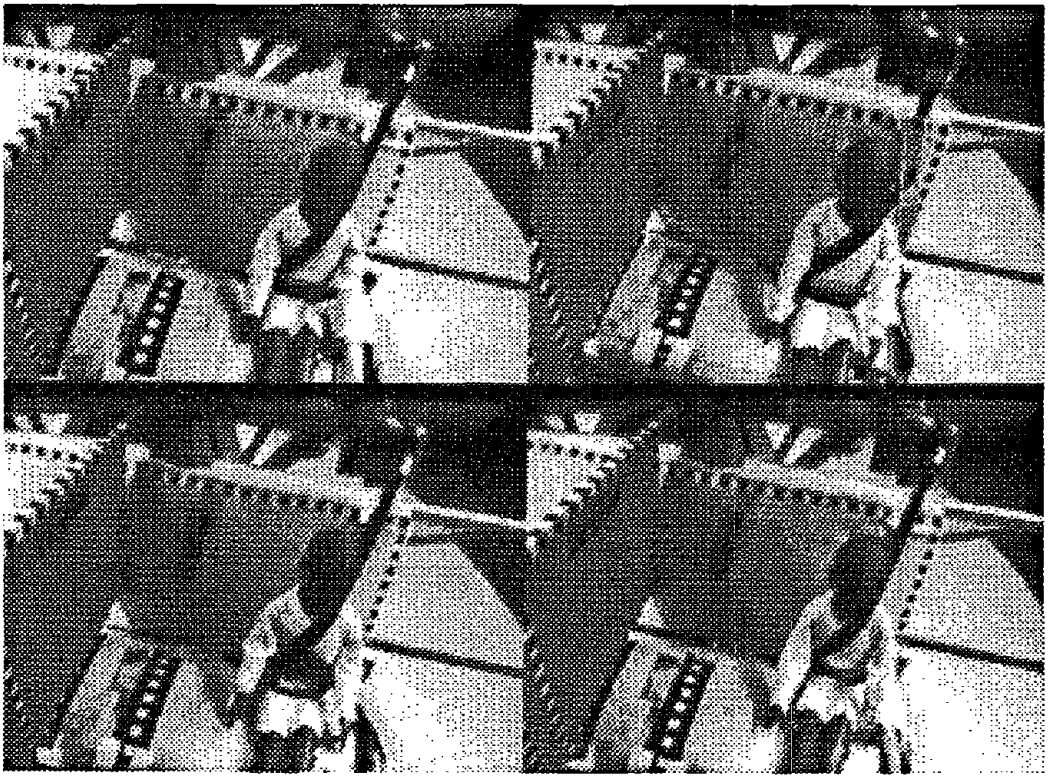
BL

CS

t=40 ms

SF

SA



Kinematic Comparison of 3 Year Old in Clockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

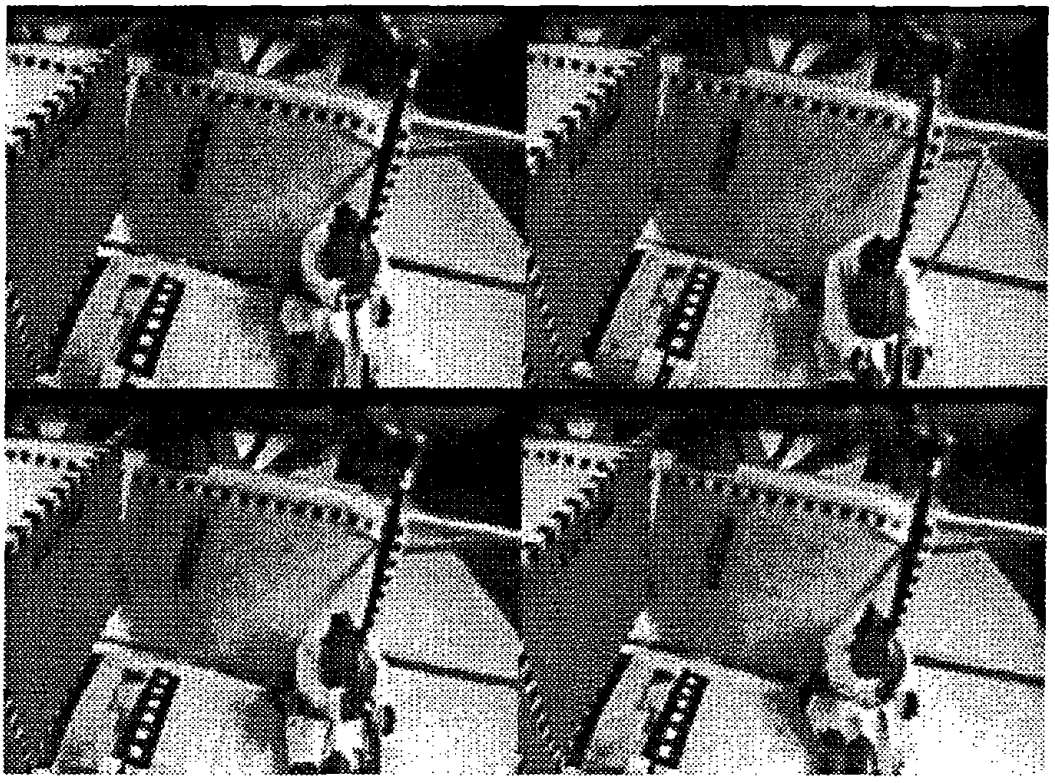
BL

CS

t=80 ms

SF

SA



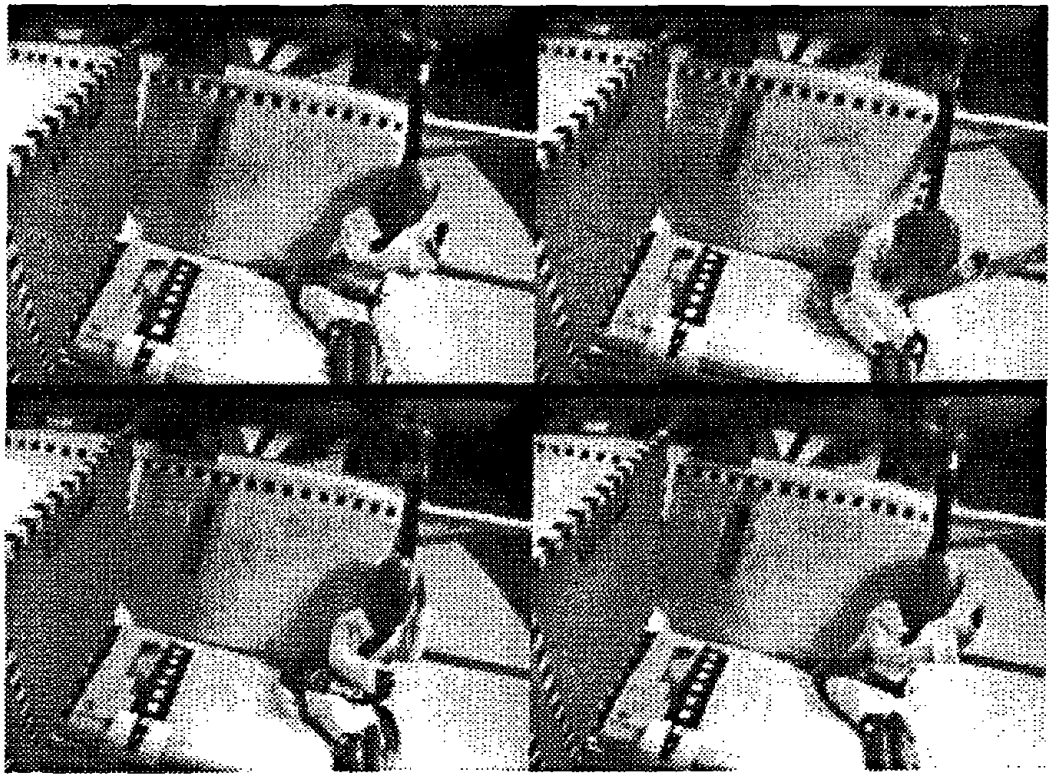
BL

CS

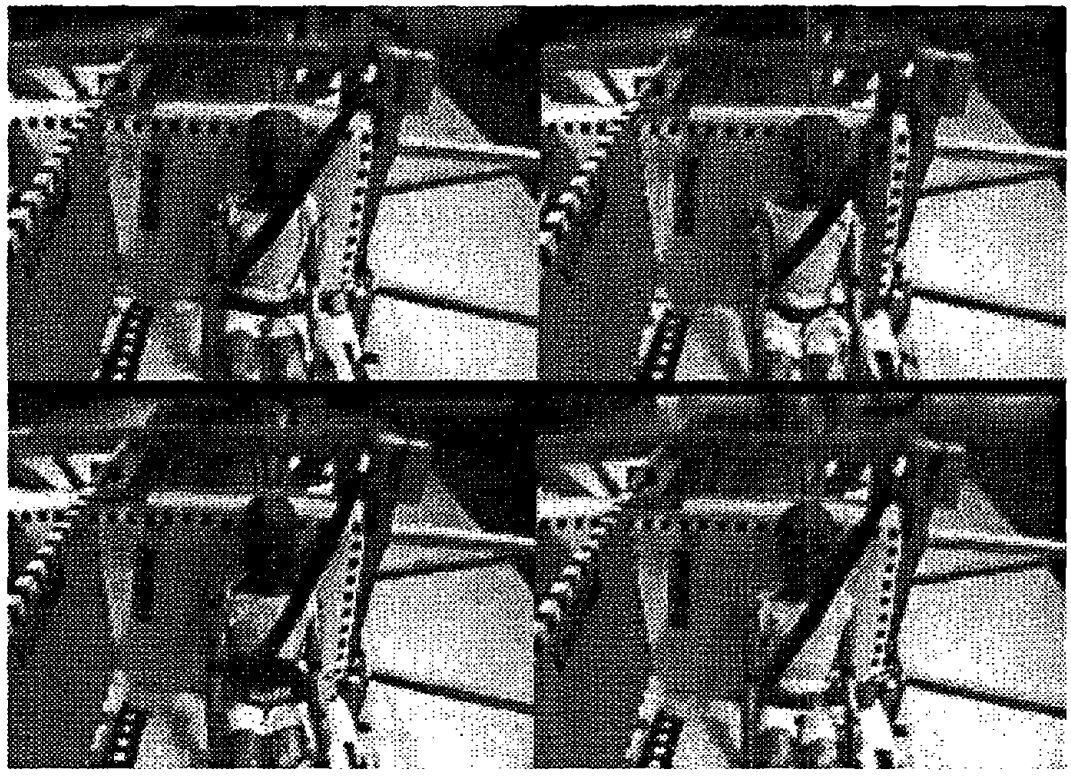
t=120 ms

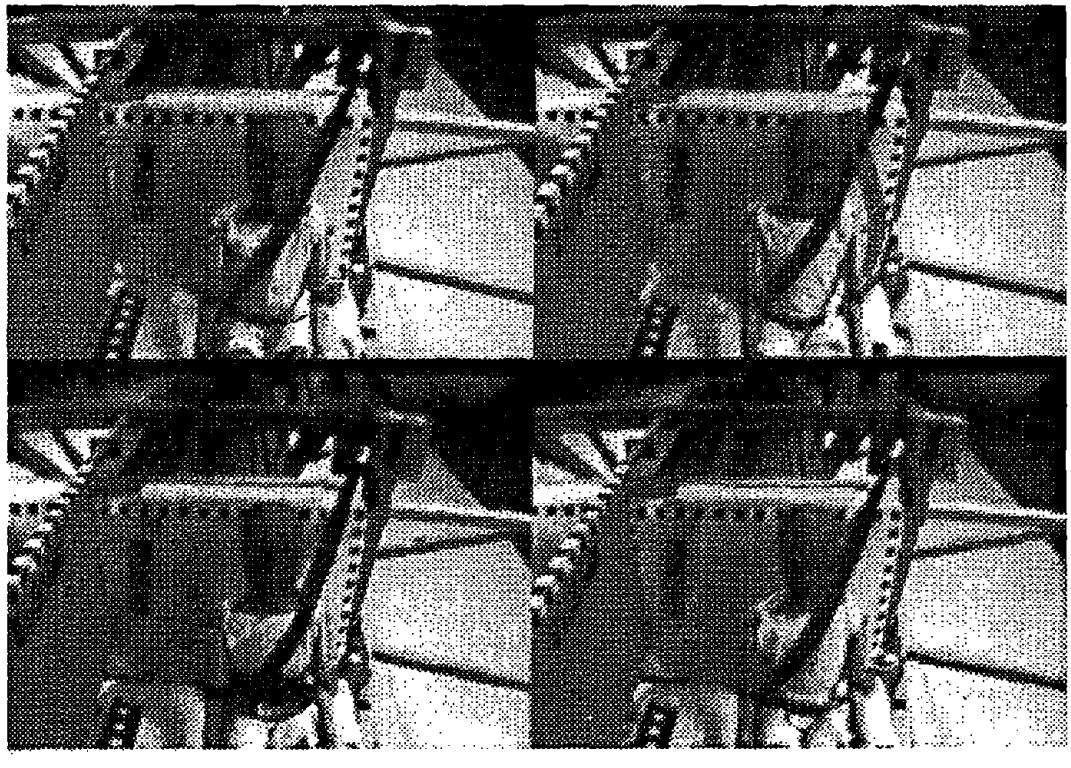
SF

SA



Kinematic Comparison of 3 Year Old in Clockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA) - Cont'd





Kinematic Comparison of 6 Year Old in Standard Frontal Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

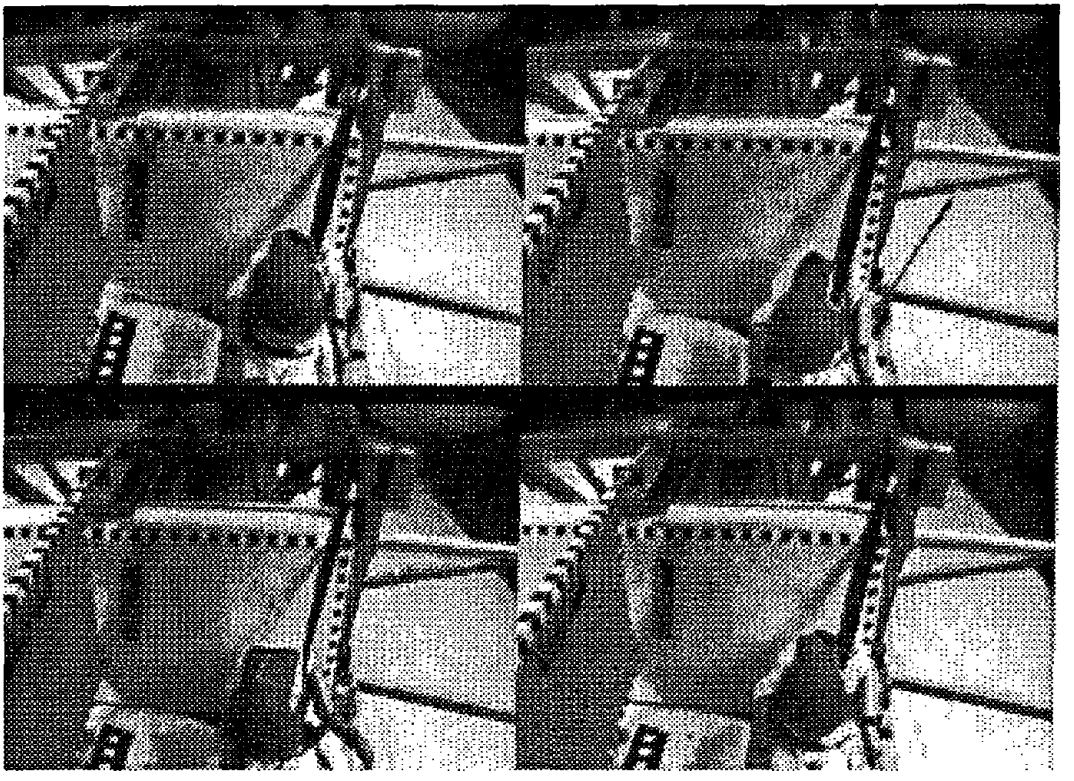
BL

CS

t=0 ms

SF

SA



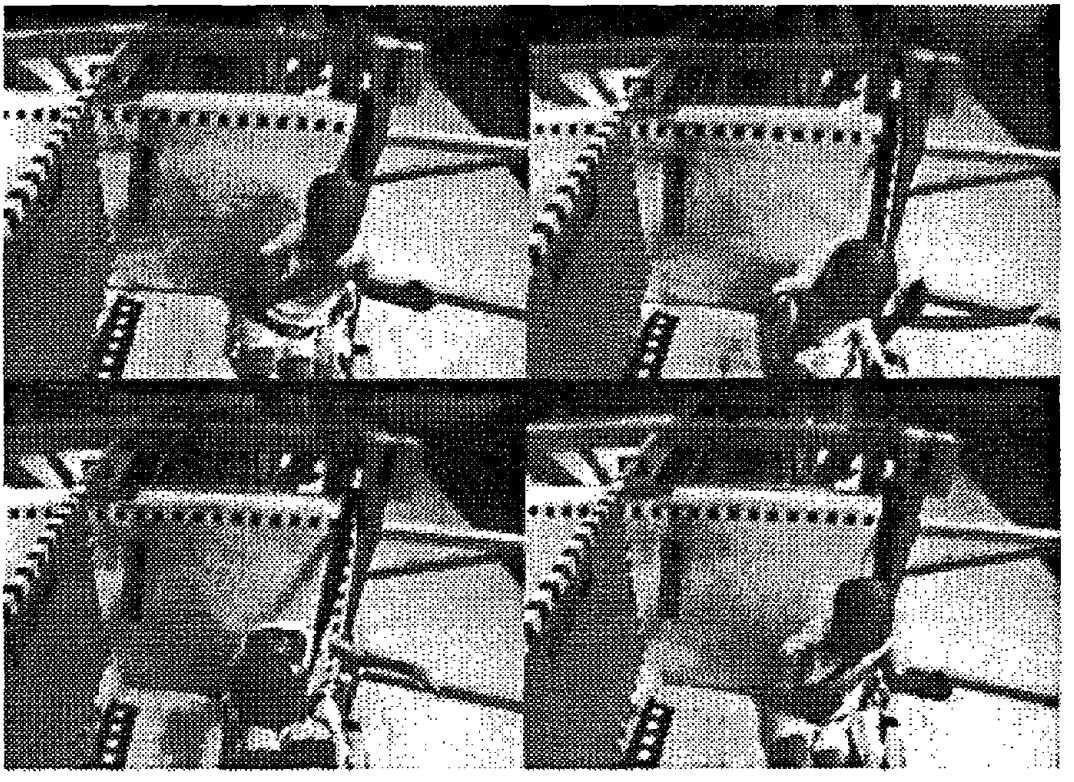
BL

CS

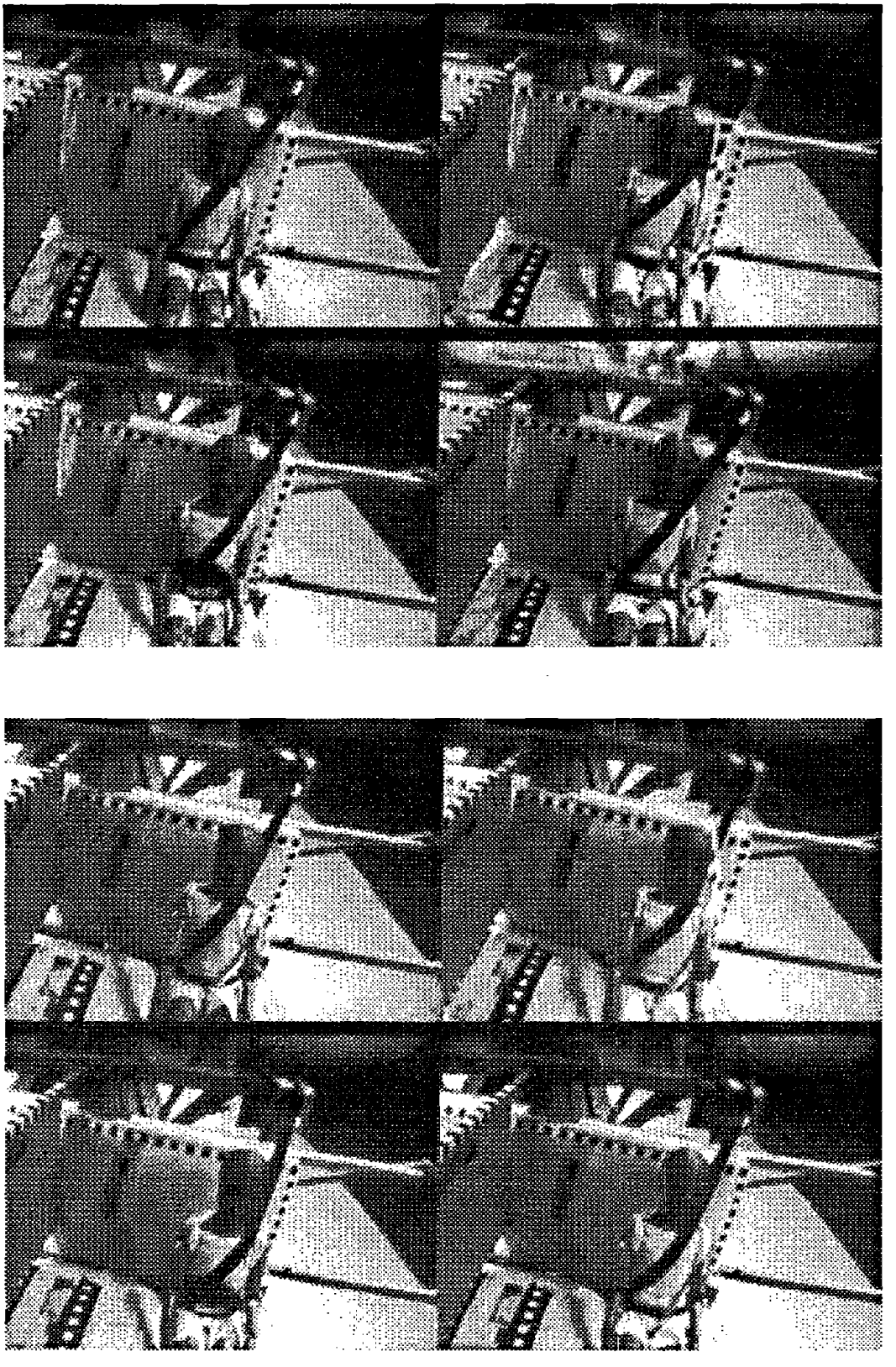
t=40 ms

SF

SA



Kinematic Comparison of 6 Year Old in Standard Frontal Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA) - Cont'd



Kinematic Comparison of 6 Year Old in Clockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

BL CS

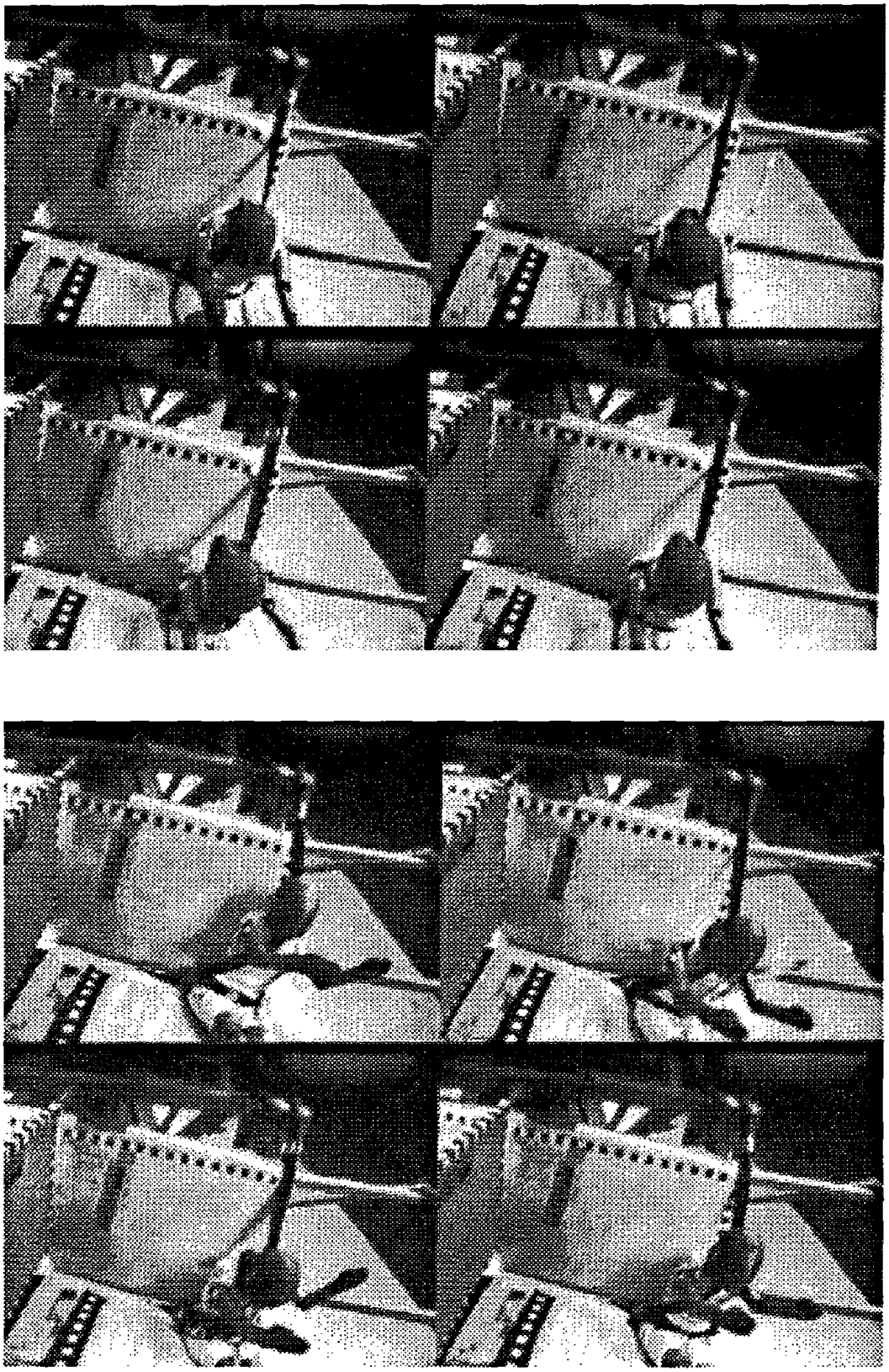
t=80 ms

SF SA

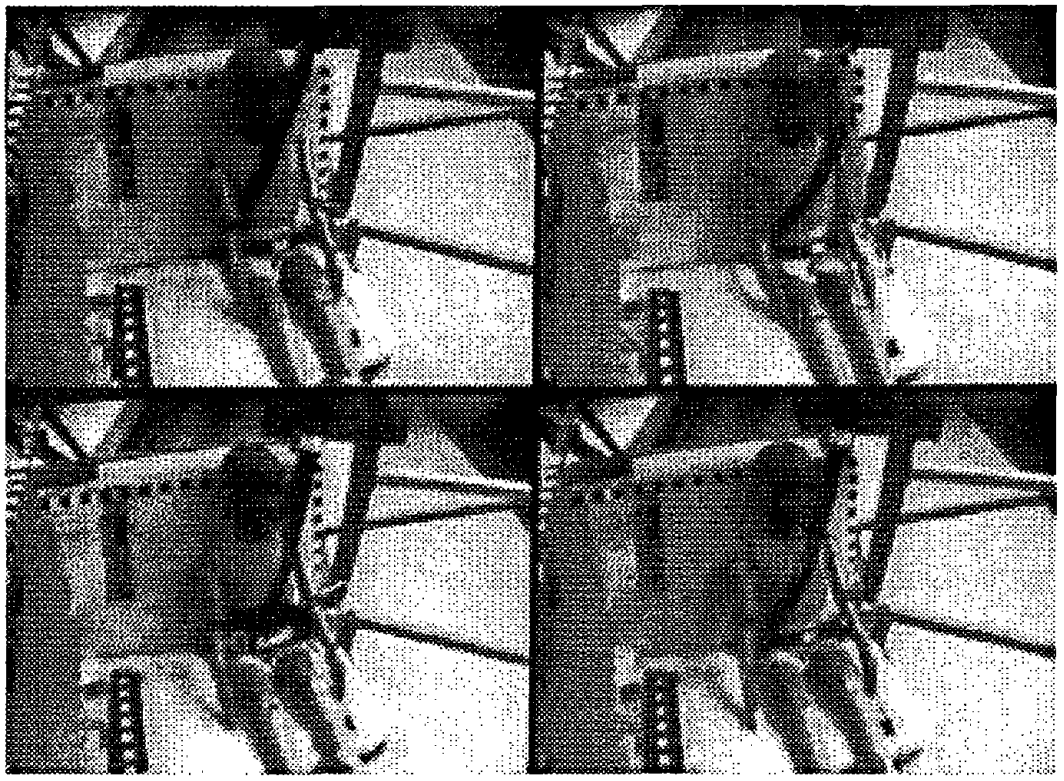
BL CS

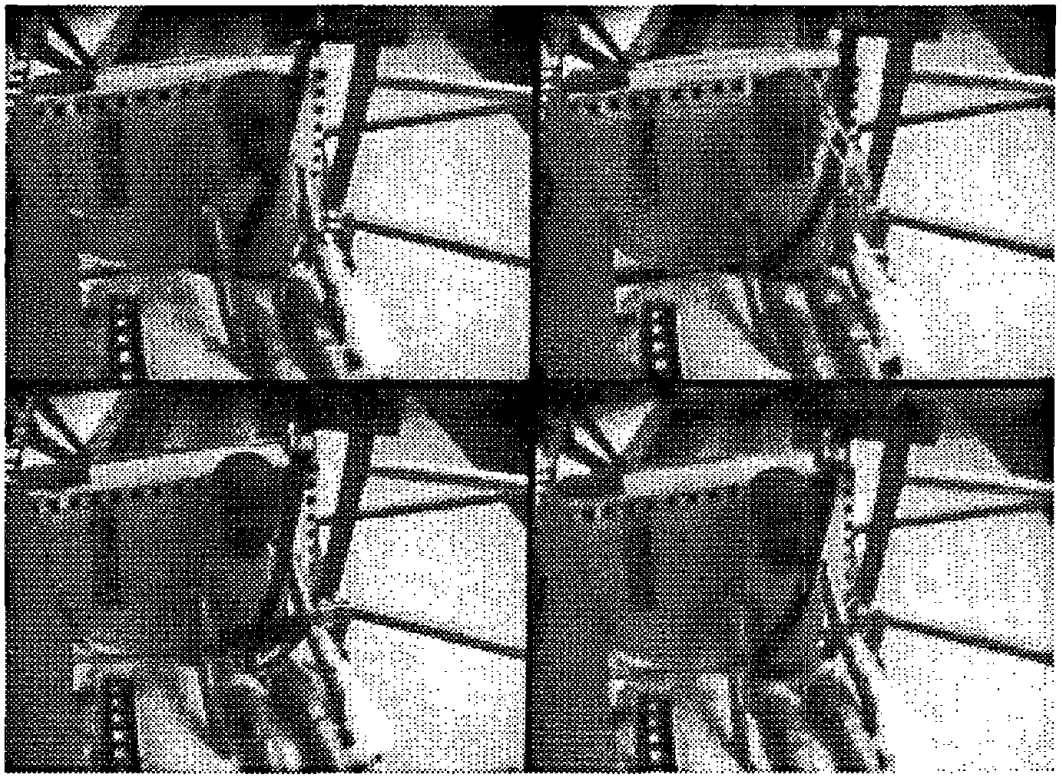
t=120 ms

SF SA

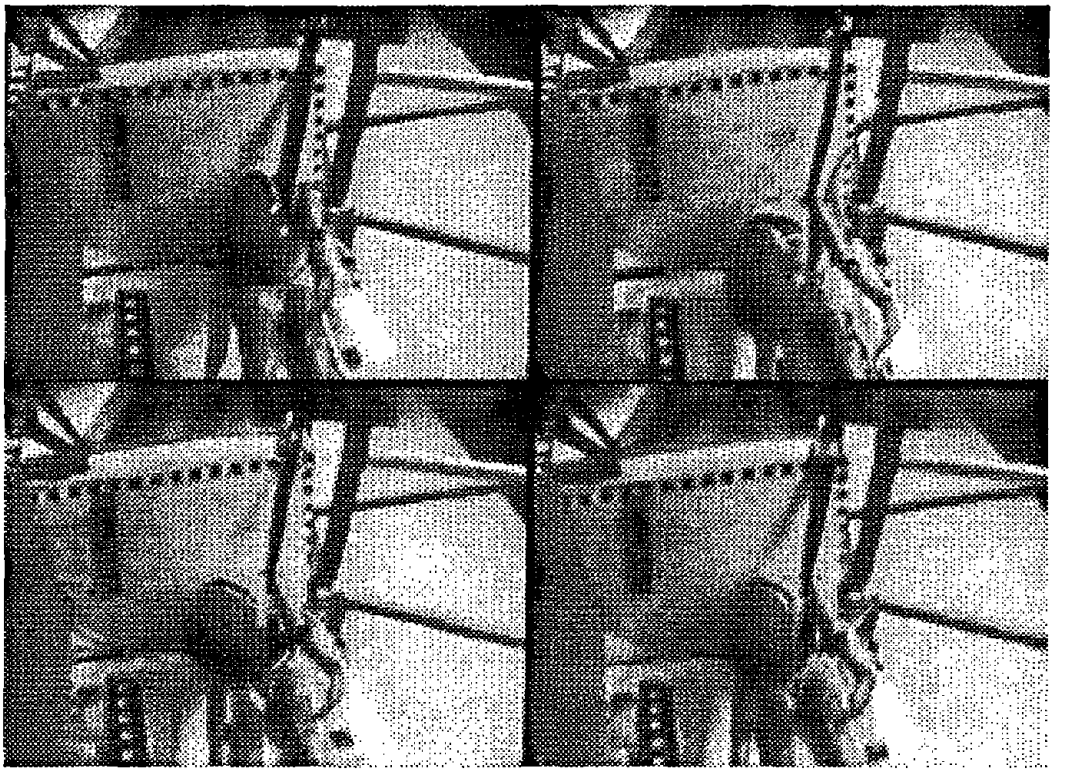


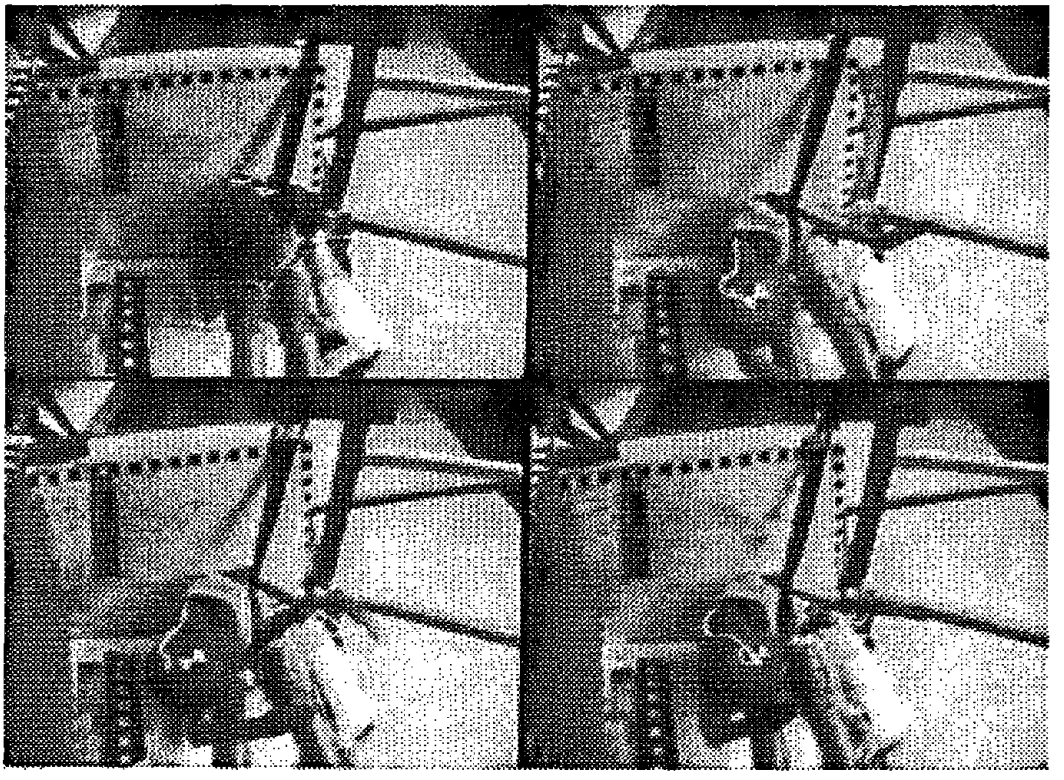
Kinematic Comparison of 6 Year Old in Clockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA) - Cont'd



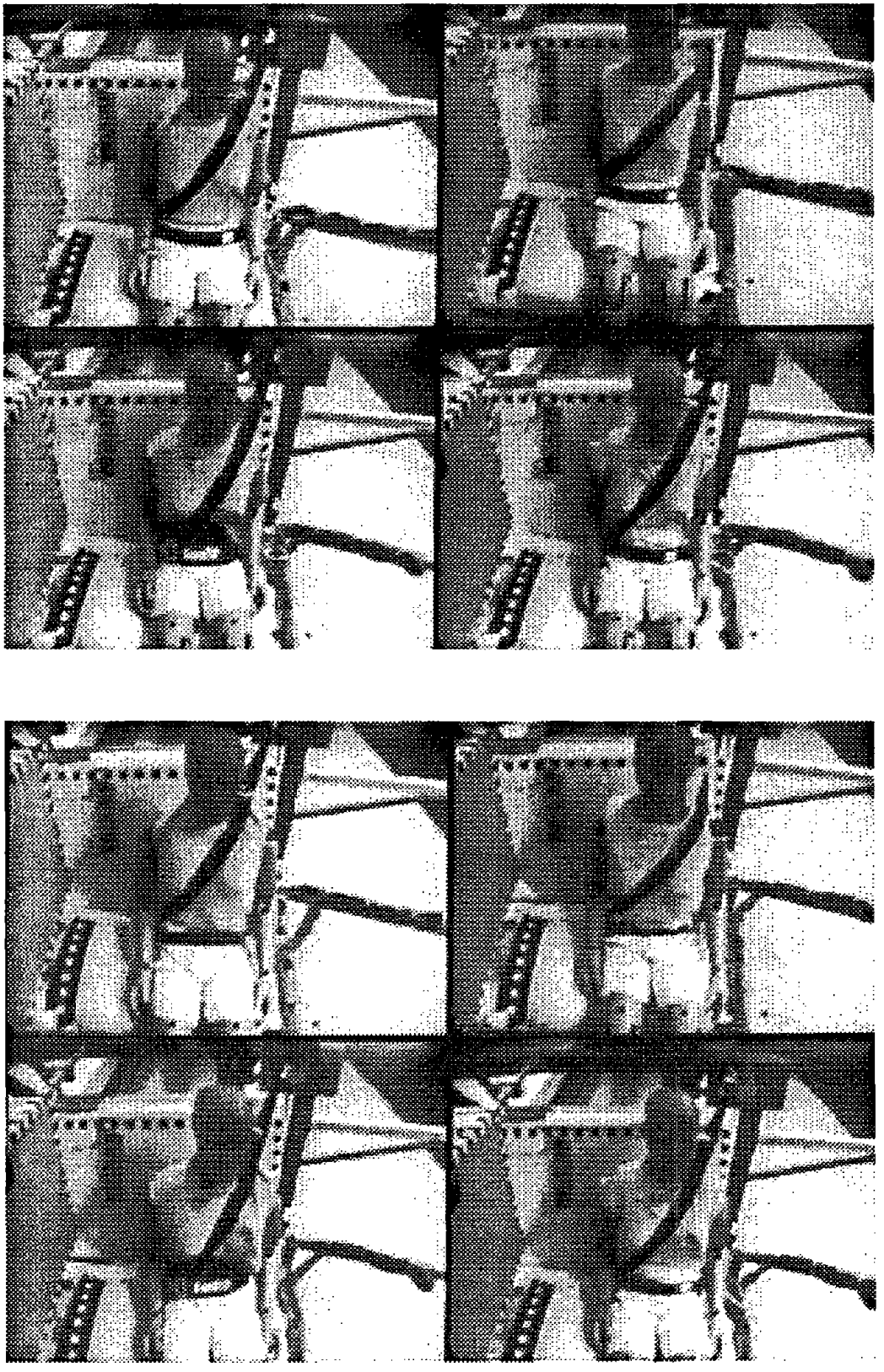


Kinematic Comparison of 6 Year Old in Counterclockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)





Kinematic Comparison of 6 Year Old in Counterclockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA) - Cont'd



Kinematic Comparison of 5th Percentile Female in Standard Frontal Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

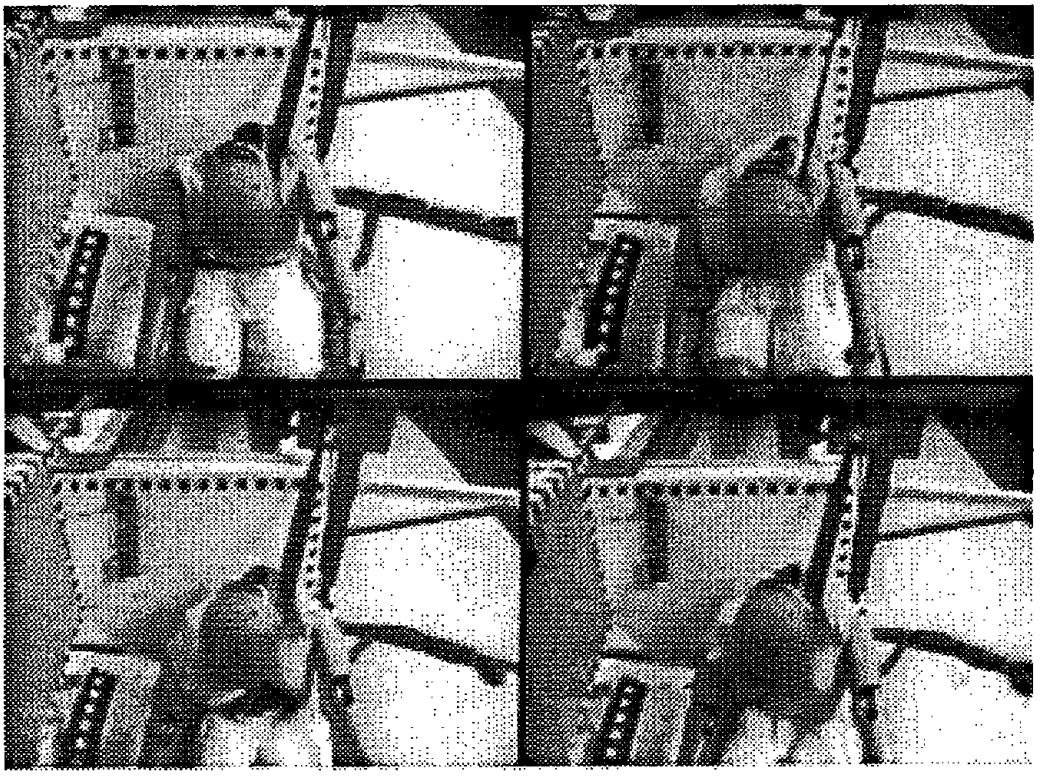
BL

CS

t=80 ms

SF

SA



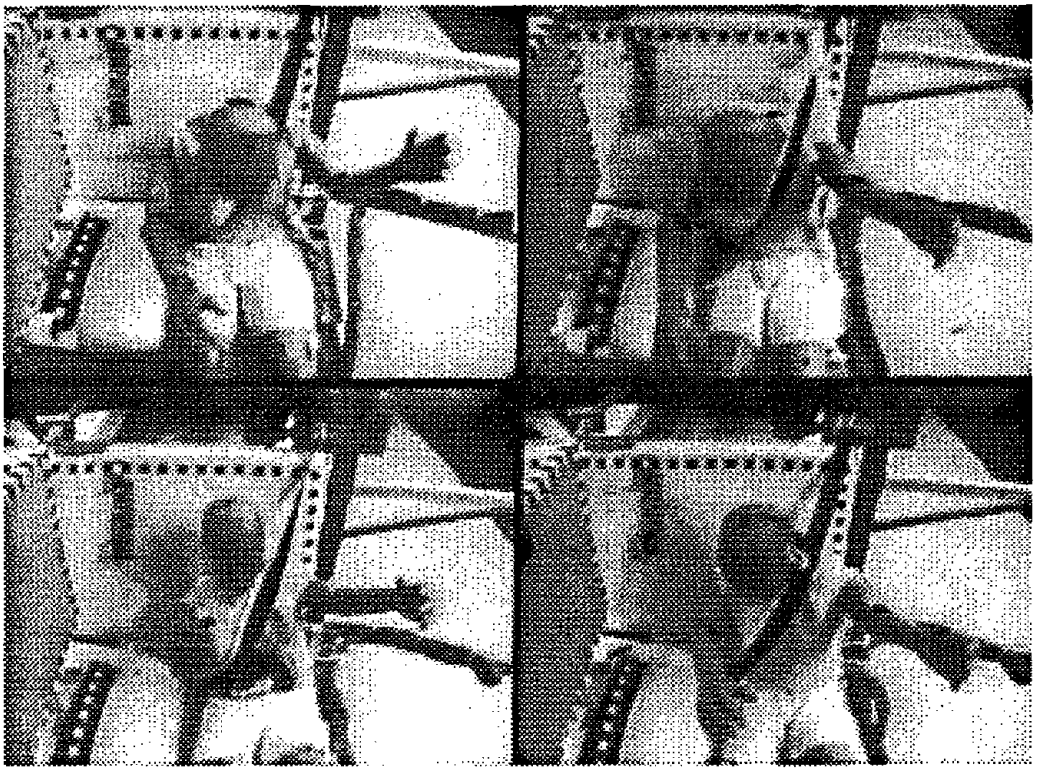
BL

CS

t=120 ms

SF

SA



Kinematic Comparison of 5th Percentile Female in Standard Frontal Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA) - Cont'd

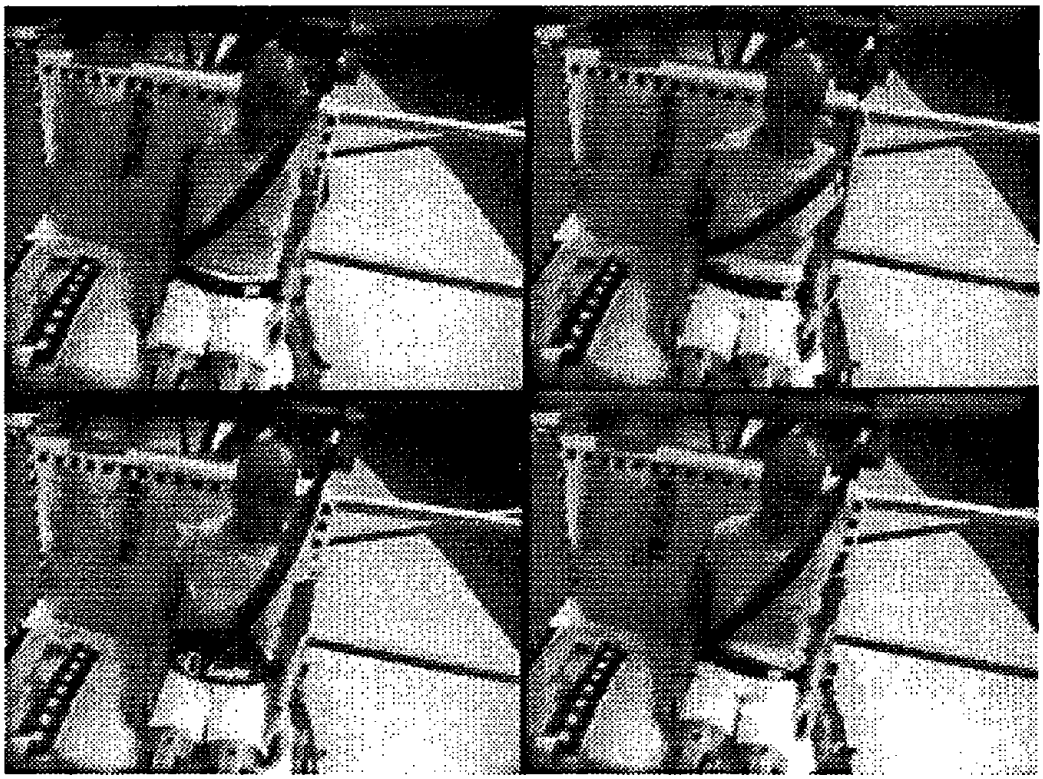
BL

CS

t=0 ms

SF

SA



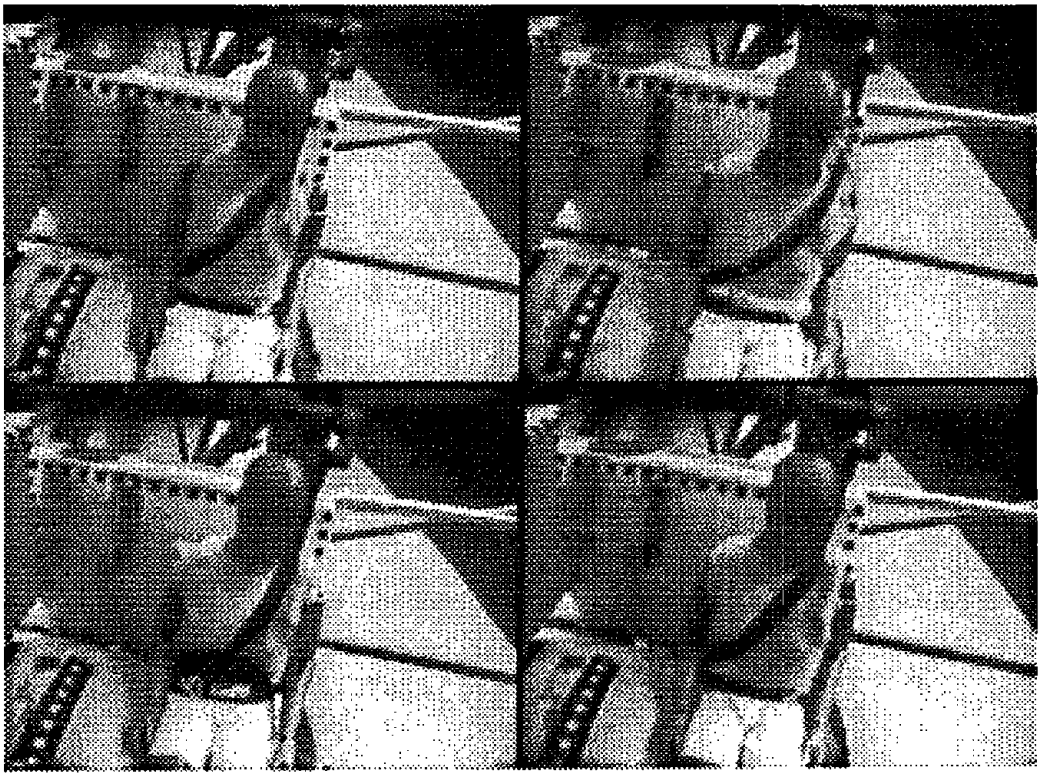
BL

CS

t=40 ms

SF

SA



Kinematic Comparison of 5th Percentile Female in Clockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

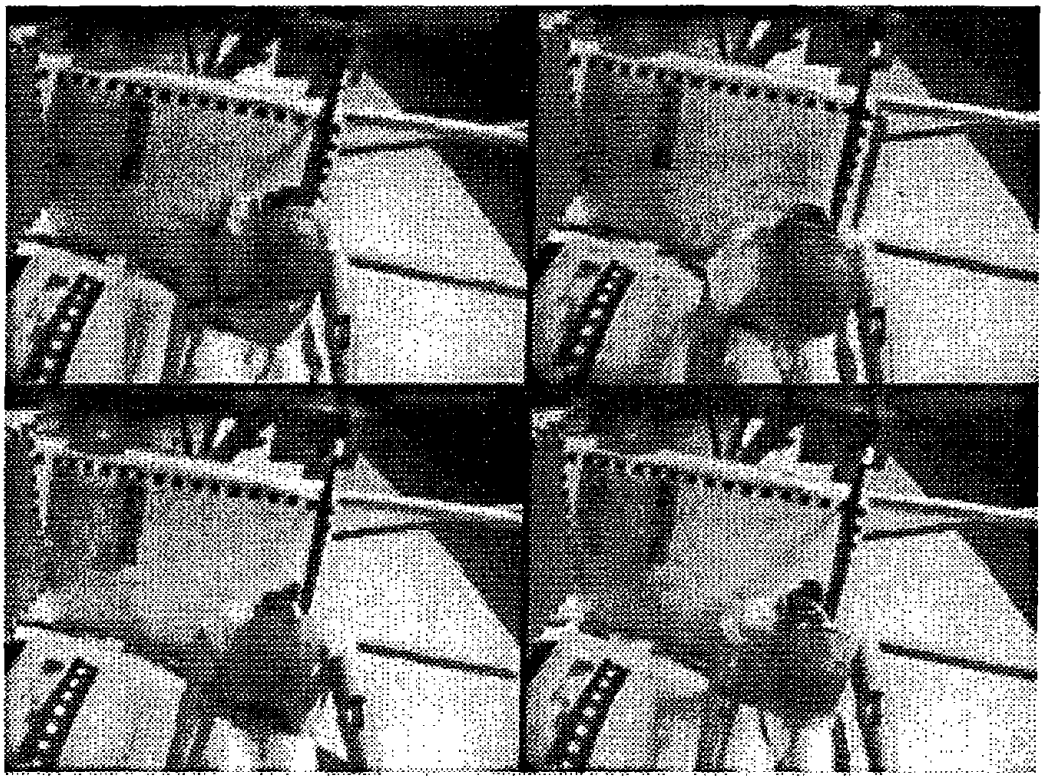
BL

CS

t=80 ms

SF

SA



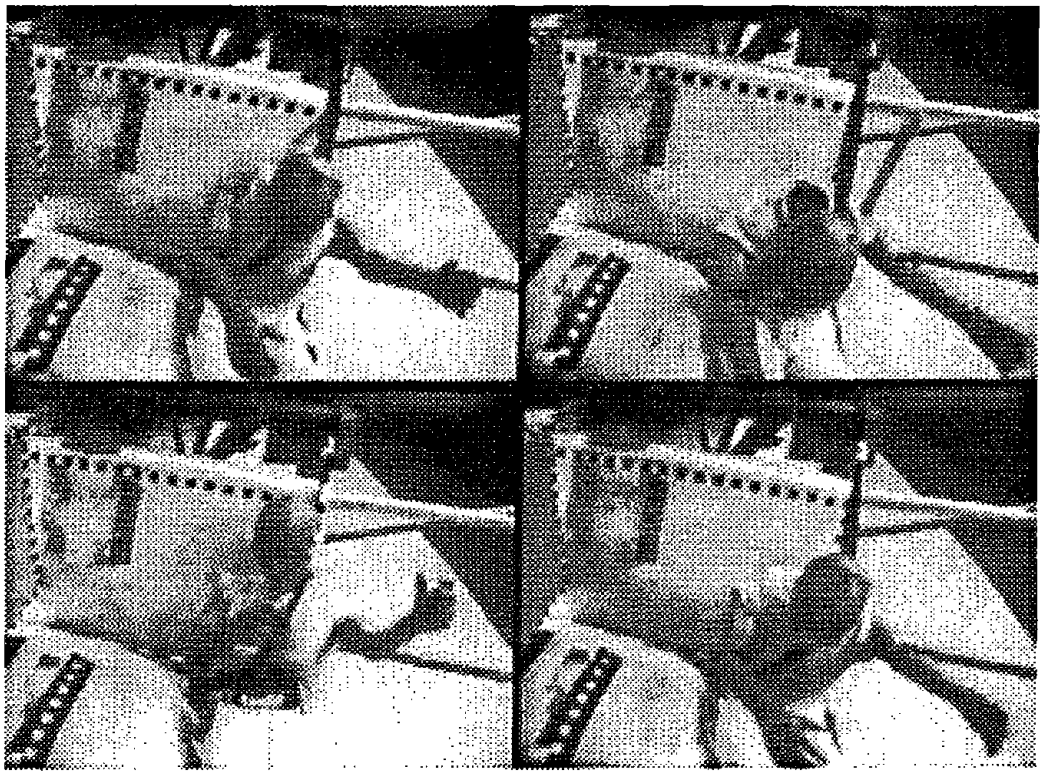
BL

CS

t=120 ms

SF

SA



Kinematic Comparison of 5th Percentile Female in Clockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA) - Cont'd

BL CS

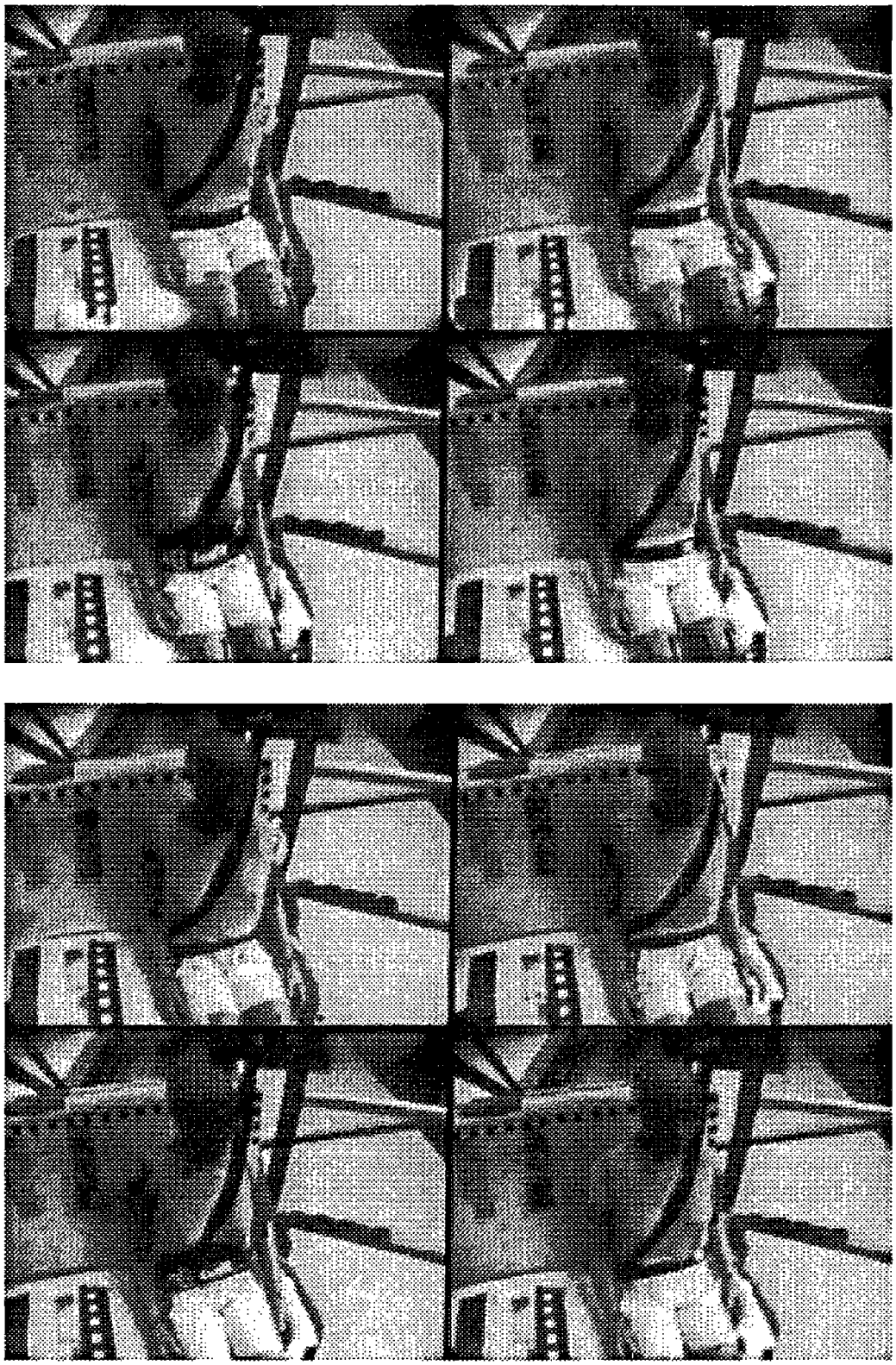
t=0 ms

SF SA

BL CS

t=40 ms

SF SA



Kinematic Comparison of 5th Percentile Female in Counterclockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA)

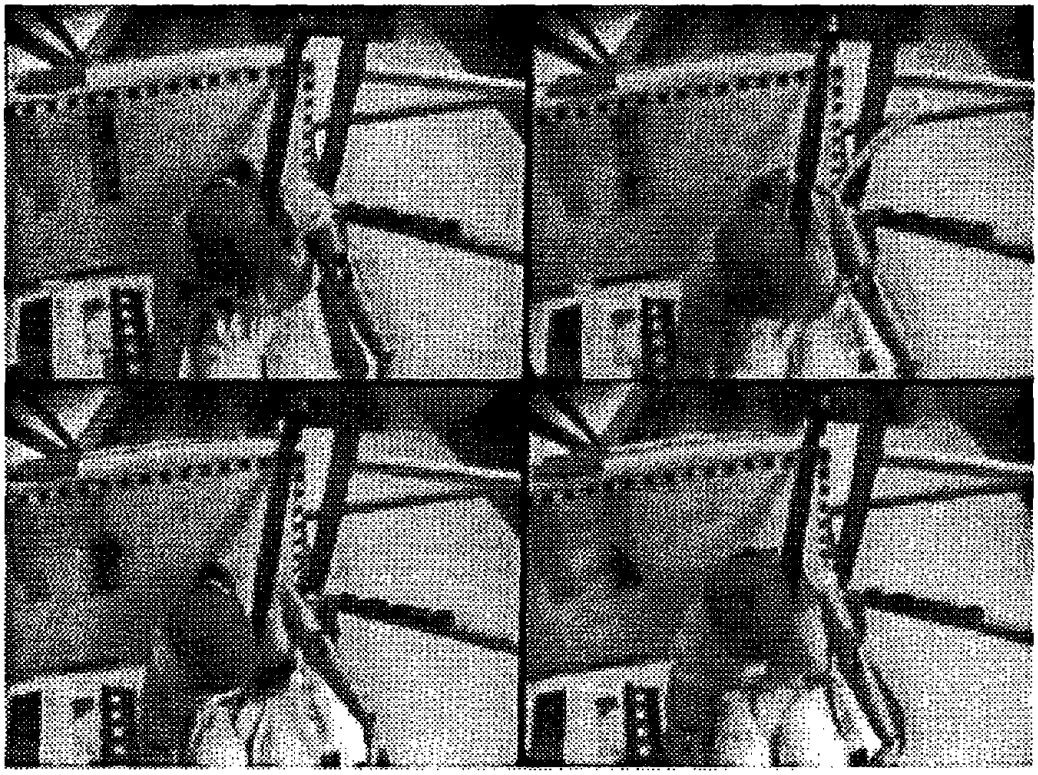
BL

CS

t=80 ms

SF

SA



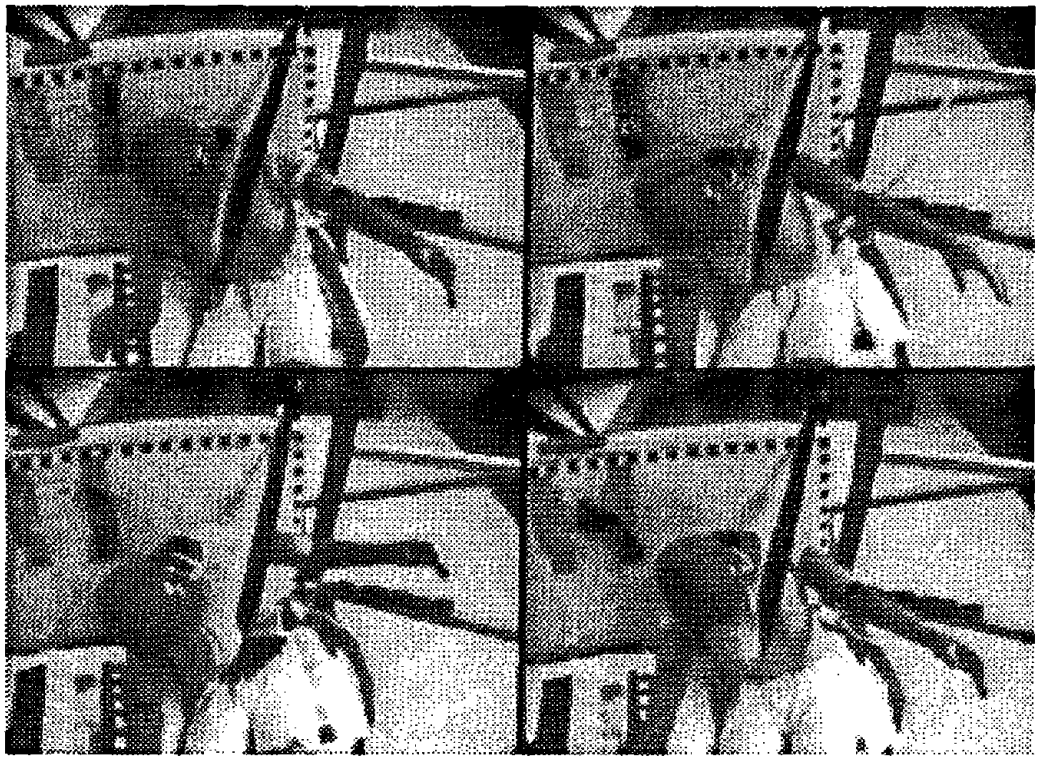
BL

CS

t=120 ms

SF

SA



Kinematic Comparison of 5th Percentile Female in Counterclockwise Oblique Orientation - Baseline (BL), Child-Safer™ (CS), SafeFit™ (SF), and Seatbelt Adjuster™ (SA) - Cont'd