Final Report

EVALUATION OF CHILD RESTRAINT DEVICES

Prepared for:
Consumers Union of U.S., Inc.
Auto Test Division
367 Boston Post Road
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April 28, 1972

by

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PART I. INTRODUCTION

On April 1, 1971, the United States Department of Transportation adopted a static load-bearing requirement (U.S. Government Standard No. 571.213) for child seats. It requires that a child seat be able to sustain a transverse static load of 1000 pounds applied to a dummy torso at an angle between 5° and 15° above the horizontal, with a maximum torso deflection of 12 inches.

Recent investigation indicates that a static deflection test is an inadequate measure of the safety of a restraint system (D. H. Robbins, et al. (1)). This new evidence indicates that dynamic loading patterns are substantially different from the static load specified in Standard No. 571.213.

The Highway Safety Research Institute at The University of Michigan proposed and carried out a nationwide market survey followed by rigorous dynamic testing and evaluation of 18 different child restraint devices. The devices tested were selected from the large number of devices available in such a way as to test the widest possible variety of restraint device designs, and to test those which showed promise in earlier dynamic tests.

PART II. STATE OF THE ART AND MARKET SURVEY

The most general discussion of the protection of children in an automobile crash can be found in a study by Siegel, et al. (2) in which they discuss the frequency of various types of injuries, and child anthropometry as it relates to seating design. Based on a survey of accident cases, they recommend the use of lap belts for children over three to four years of age.

The excellent presentations of Burdi, et al. (3) and King (4) on child safety restraints are more anthropologically and medically oriented than that of Siegel. D. H. Robbins, et al., Burdi, and King, place great importance on head motions, particularly the snapping which can occur because of the lack of strength in children's neck muscles. They also warn against any head contact with the interior of a vehicle. They believe using an adult lap belt is dangerous because a child's iliac crest is not sufficiently developed to act as a belt anchor location. Caution is advised in applying restraint loads to the chest due to its highly compressible nature and due to the vulnerability of the internal organs to nonpenetrating injuries. Finally, distribution of restraint loads over wide areas of the body is recommended as an important design criterion.

Other studies by Aldman (5) suggest rear-facing children's seats, while Van Kirk (6) suggests a restraint net to obtain a gentle ride. Papers by Head and Grenier (7), Feles (8), and Appoldt (9) all discuss the performance of child seats.

Robbins and his co-workers found that, in addition to the above criteria, the devices should: (1) possess structural integrity, (2) avoid dynamic interaction with the adult seat, and (3) attach securely to the vehicle.

A retail market survey was conducted to determine what restraint devices for infants and children were available. Fifteen manufacturers and distributors of child restraint devices were contacted by telephone to determine which of their devices had the largest sales, and which they would recommend as their best. The devices tested and studied were available between February 14, 1972 and February 25, 1972, and all met Government Standard No. 517.213.

With this information, 18 test devices were selected on the basis of consumer popularity. More than one model from a manufacturer was tested when one of the child seats was found to differ substantially in design from the rest of that manufacturer's line. Descriptions and comments on the test devices are shown in Table I.

PART III. TEST PROGRAM

The basic objective of the test program is to obtain an experimentally-determined estimate of the protection potential offered to the child by the 18 devices to be tested in the study.

In order to achieve this, it was necessary to:

1. Develop a performance criterion for evaluating the various devices.

2. Select an occupant for use in the test program.

3. Construct a test environment, including an adult seat capable of being oriented so that impacts from various directions could be studied.

4. Select instrumentation and data-handling procedures to determine forces and motions experienced by the occupant in the test in order to provide data for performance evaluations.

5. Select a test matrix.

6. Conduct the test program and gather data.

PERFORMANCE CRITERION

The purpose of this research is to provide an objective measure of the protection from serious injury afforded a child occupant by these restraint systems.

Accordingly, we have developed a formula to express quantitatively the likelihood of injury to an occupant and the severity of any injury. We shall refer to this factor as Total Injury Index (TII). A high TII indicates that the restraint system affords limited protection from injury; conversely, a low TII indicates a safer restraint system (i.e., one in which injury is less likely, and the injuries are less serious).

Head Excursion Factor (HEF)

Injury to the vehicle occupants in a crash can arise from three basic causes. First, and probably most critical, is the possibility of the child being thrown on impact against the dashboard, windshield, door pillars, or windows, etc.

Since the head is the region most susceptible to this kind of injury, the best measure of danger is head excursion. Head excursion is the maximum displacement of the head from its initial (pre-impact) position in the direction of the impact. This measurement was made from high-speed film records of the tests. The HEF's were computed according to the formulae:

For front impacts:

$$HEF = (E_{max} - 19 \text{ inches})^2$$

where:

E_{max} is the Maximum Head Excursion.

If E_{max} - 19 inches is greater than, or equal to, five inches, the dummy's head has left the safety zone and the restraint system has failed the test and is given an HEF of 25.

For side impacts:

$$HEF = (E_{max} - 12 \text{ inches})^2$$

If E_{max} - 12 inches is greater than, or equal to, two inches, the seat has failed and is given an HEF of 4. (See Figure 1)

Acceleration Factor (AF)

The second factor which can cause injury to occupants of a restraint system in a crash is excessively high acceleration. The areas of the body most susceptible to serious injury due to acceleration are the head and the chest.

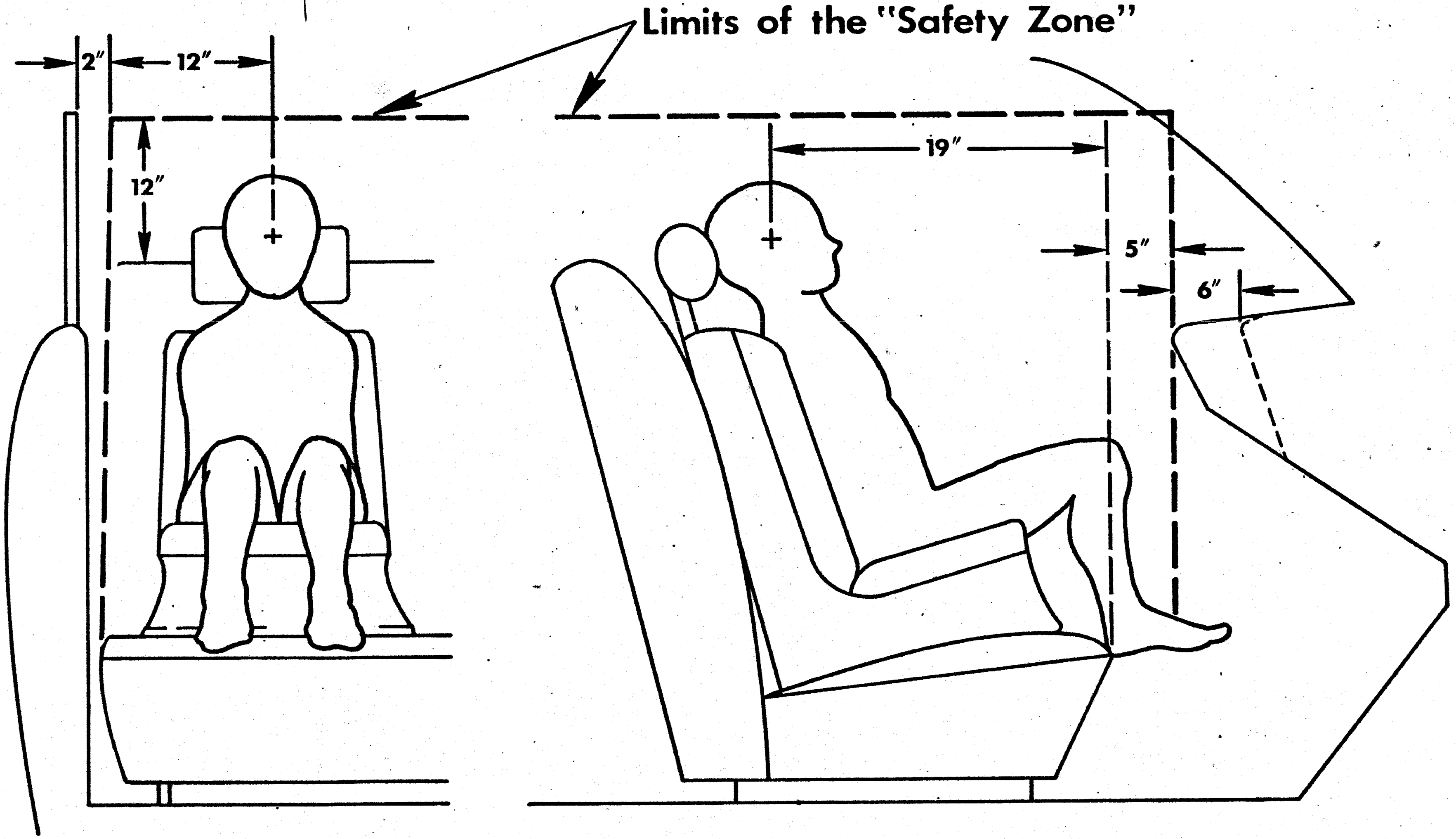

FIGURE 1. SAFETY ZONE -- IF THE CHILD'S HEAD LEAVES THE ZONE OUTLINED ABOVE, THE SEAT HAS FAILED THE TEST.

The Acceleration Factors (AF) are computed by application of the following formulae:

For front impacts:

$$AF = \frac{A_h}{21\ G's} + \frac{A_c}{21\ G's}$$

For side impacts:

$$AF = \frac{A_h}{15\ G's} + \frac{A_c}{15\ G's}$$

where:

A_h is the resultant head acceleration

A_c is the resultant chest acceleration

Twenty-one G's and 15 G's are the nominal sled pulse peaks for front and side or rear impacts, respectively. If the head accelerations (A_h) exceed the maximum survivable accelerations according to the Maximum Strain Criterion for triangular pulses (Stalnaker, et al., 10, 11), the restraint system has failed the test, and is given the cut-off score of 7.2 for forward and 6.4 for side impact.

The maximum survivable accelerations for adult humans according to the MSC are:

$(A_h)_{max}$ = 92 G's (for anterior-posterior (A-P) head acceleration)

$(A_h)_{max}$ = 54 G's (for left-right (L-R) head acceleration)

The maximum allowable chest acceleration (A_c) used by the U.S. Government in Standard No. 208 is 60 G's (for both A-P and L-R accelerations).

Load Distribution Factor (LDF)

The third cause of injury to a child in a restraint system is stress to vital organs during impact due to improper load distribution. The location of the restraining (load bearing) surfaces is especially critical in children because some skeletal regions are not fully developed, and ossification is not complete. In particular, the iliac crest has not developed and therefore doesn't provide as good a load bearing structure for a child as for an adult. Therefore, the lap belt has a strong tendency to ride-up off the pelvis and into the abdominal region, which is very dangerous.

In order to compute the Load Distribution Factor (LDF), we first divide the seats into two groups, according to whether or not the adult lap belt bears upon the child.

Group 1

If the adult lap belt bears upon the child's midsection, then the total transverse dynamic load must be borne at the child's midsection. (See Figure 2) Therefore, the load on the child is the sum of the loads on the adult seat belts.

$$LDF = \left(\frac{F_r + F_l}{A_e}\right) \times LF$$

where:

LF = Load Factor (See Group 2)

F_r = Maximum force on right adult lap belt

F_l = Maximum force on left adult lap belt

A_e = Effective load bearing area (See Group 2)

Group 2

In those seats where the adult lap belt does not bear upon the child's midsection (See Figure 3) the LDF is computed by application of the formula:

$$LDF = \left(\frac{D_w \times A_s}{A_e}\right) \times LF$$

where:

D_w = Weight of the dummy (31 pounds for all except the GM Infant Carrier, for which the weight of the dummy is 15 pounds)

A_e = Effective area of the restraint system, i.e., the load bearing area

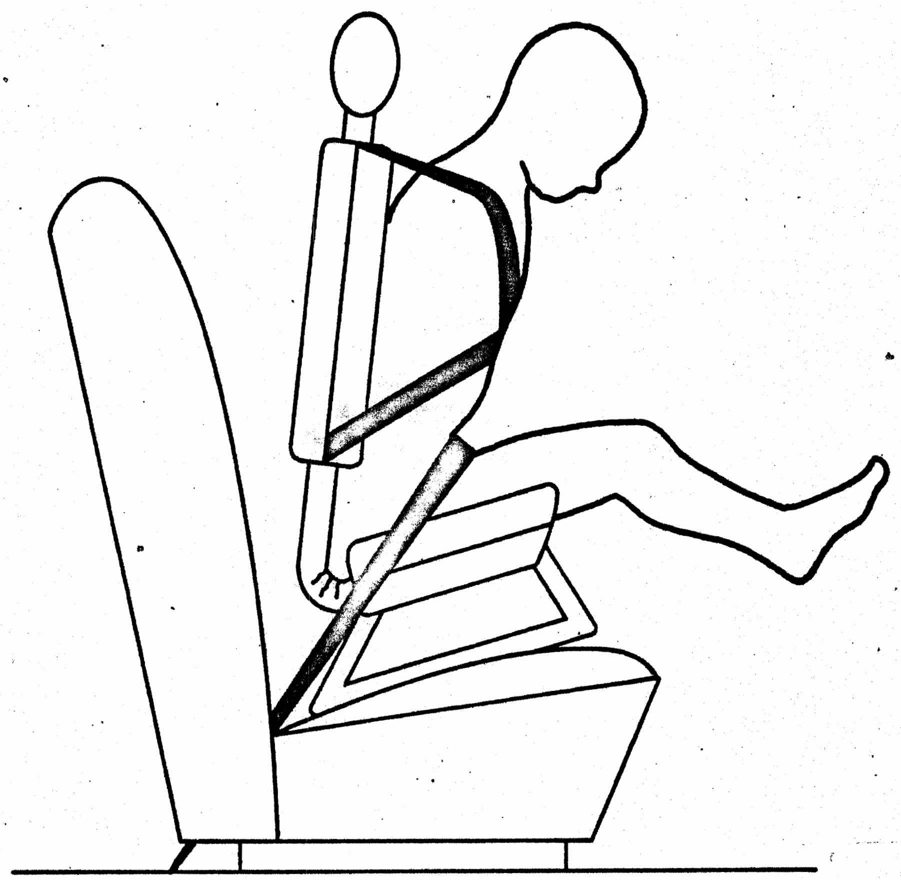

FIGURE 2. LAP BELT LOADS UPON CHILD.

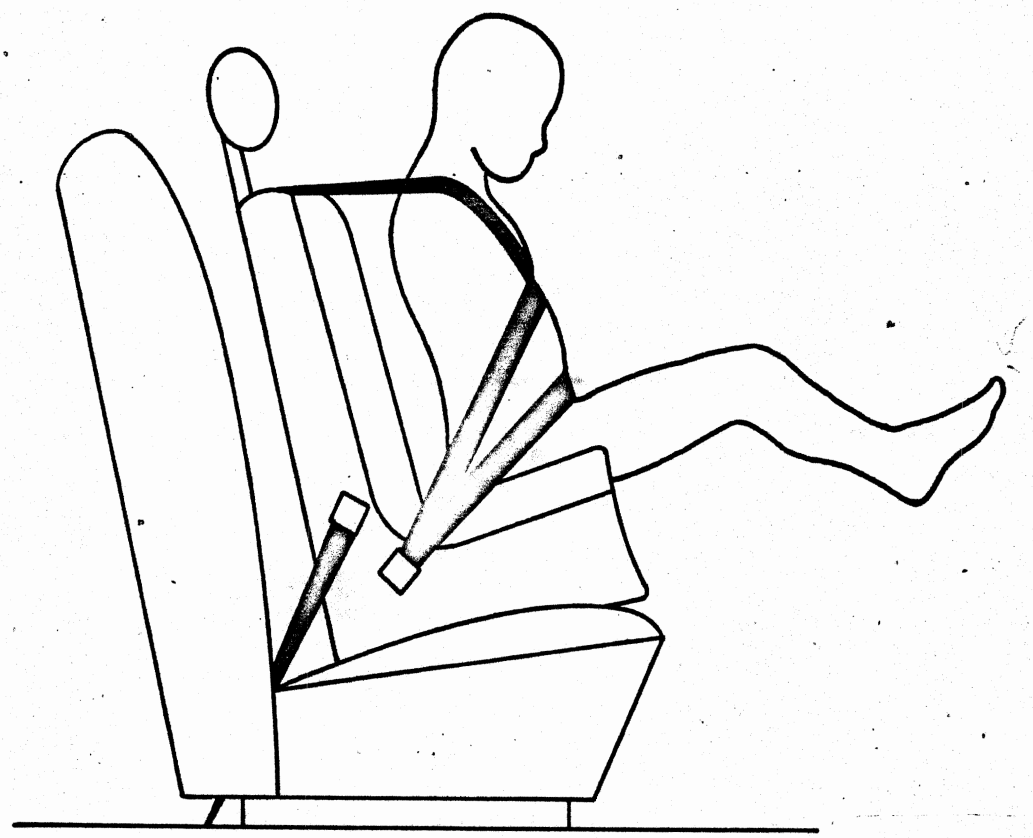

FIGURE 3. LAP BELT DOES NOT LOAD UPON CHILD.

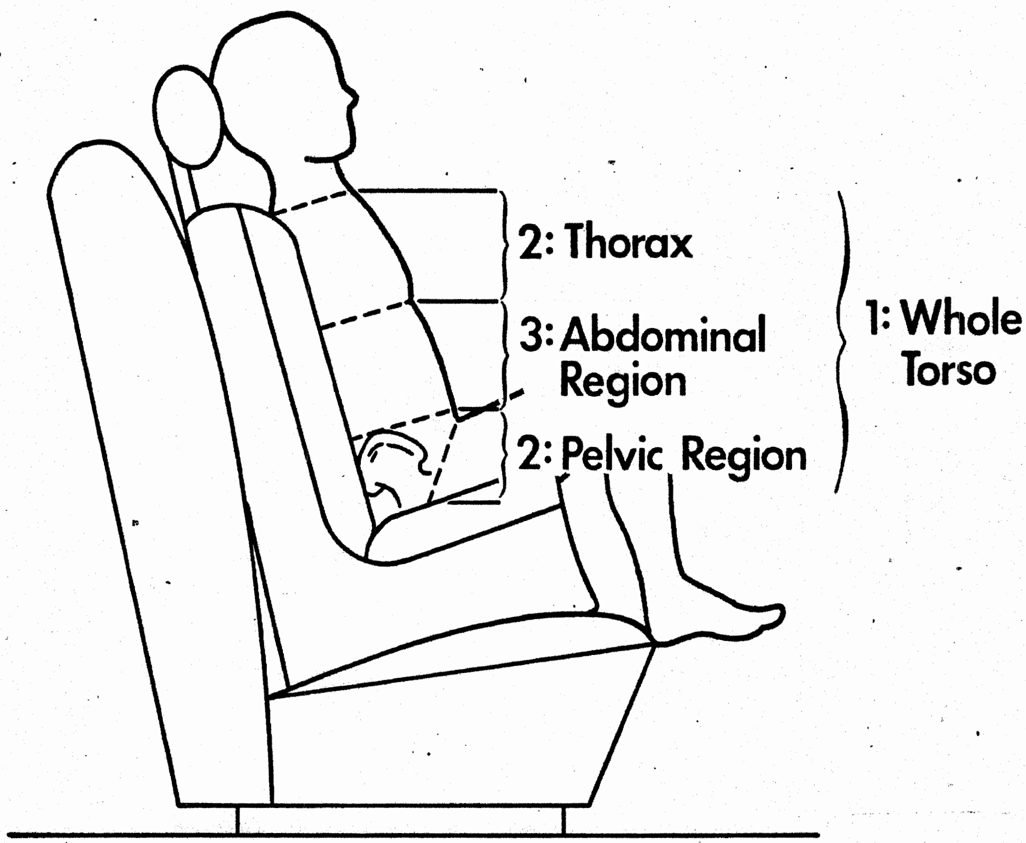

FIGURE 4. LOAD FACTOR.

TABLE I. DEVICES SELECTED FOR CONSUMER UNION STUDY

Manufacturer	Seat Name	Description	Comments
Thayer Inc. 205 School St. Garner, Mass.	Bobby-Mac 3 in 1 Baby Chair	Molded plastic shell with clip on double diagonal chest harness, also a belly strap. Gives side support to hips.	Has three uses: car seat, high chair, infant carrier.
Bunny Bear Inc. Nursery Lane Everest, Mass.	Model 61 E-Z Fit	Tubular steel pedestal fold-up seat with hook-under seat mounting. Foam padded shell with head rest and arm rests. Suspender-type shoulder straps. Seat and child restrained by adult lap belt.	Same as in Fall 1972 J. C. Penney's catalog, item no. A343 0782.
Century Products Inc. 2150 114th Street Cleveland, Ohio	Century Car Seat	Tubular frame fold-up pedestal with padded head restraint and arm rests, hook-under seat mounting. Chest strap. Seat and child restrained by lap belt.	Manufacturer's choice for consumers, best seller, and most expensive. Available in some Penney's stores as 1971 stock no. 6193.
General Motors Corp. GM Building Detroit, Mi	Infant Carrier	Molded plastic shell. Occupant rests in a semi-reclining position rearward facing. Shoulder straps.	Easy to use, and can be used to carry the baby outside the car. For infants less than 20 pounds only.
Ford Motor Company c/o American Road Dearborn, Mi	Tot Guard	Molded plastic shell encapsulating child. Padded face guard.	The quantity and type of material used in the body shield padding has been changed in the last two years. Very easy to use.
Hamill Mfg. Co. (Division of Firestone) 6116 Van Dyke Washington, Mi	Protecta Tot	Molded seat with padded sides, and a padded face and body shield supported by a tubular frame in front of child. The child and seat restrained by adult lap belt.	Sold at Montgomery Wards stores, item no. 6104.
International Mfg. 2512 Washington Roxeury, Mass.	Teddy Tot 6200	Molded plastic shell, padded seat and head rest, with hook-under seat mounting. Suspender-type shoulder harness. Adult lap belt restrains child and seat.	Same as Sears catalog item no. 1P85285C, manufacturer's choice for consumers.
International Mfg. 2500 Washington Roxeury, Mass.	Teddy Tot 6600	Tubular pedestal with molded plastic shell. Padded seat with arm rests and head rest. Hook-under seat mounting. Suspender-type shoulder harness. Child and seat restrained by adult lap belt.	Same as Sears catalog item no. 1P85271L or 1P85272L
Jamy Inc. 1 Jamy Lane Box 1499 Kingston, Pa	Model 5405	Tubular pedestal with padded arm rests and head rest. Suspender-type shoulder straps. Child and seat restrained by adult lap belt.	Manufacturer's best seller.
Jamy, Inc. 1 Jamy Lane Box 1499 Kingston, Pa	Model 5500	Molded plastic pedestal-type; padded seat, back, and head rest. Suspender-type shoulder belts, lap belt, and crotch belt.	Most expensive and manufacturer's choice for consumers.

TABLE I. DEVICES SELECTED FOR CONSUMER UNION STUDY (Continued)

Manufacturer	Seat Name	Description	Comments
Kantwet Baby Products 501 Young Street Piqua, Ohio	Snoozer 872	Tubular frame, fold-up pedestal with hook-under seat mounting, upright or reclining. Single diagonal chest strap and belly belt. Head restraint, arm rest, and seat back padded. Adult lap belt restrains seat and child.	Same as J. C. Penney's catalog item no. A343 3703. No instructions on arm rest were found when the box was opened. Best seller, most expensive and manufacturer's choice for consumer.
Peterson Baby Products 6904 Tujunga N. Hollywood, Ca 91201	Model 63	Tubular fold-up steel pedestal frame-type, which hooks under back of adult seat. Padded seat, arm rests and head rest. Double diagonal harness. Seat and child restrained by adult lap belt.	Same as Spiegal catalog item no. Z34W932. Manufacturer's choice for consumers and best seller.
Peterson Baby Products 6904 Tujunga N. Hollywood, Ca 91201	Model 61	Fold-up pedestal type seat with hook-under seat mounting. Padded arm rests and forward head restraint. Padded head restraint and seat back. Adult lap belt restrains seat and child.	The instructions with this seat were for the Model 63 and did not apply to this model. Had to call manufacturer.
Trimble Products Southern Pines, N.C. 28387	Model 875	Tubular pedestal-type seat with padding on seat, head rest, and arm rests. Suspender and belly straps.	Same as Montgomery Wards catalog item no. 66B6102A. Manufacturer's choice for consumers and best seller.
Sears, Roebuck and Co. Chicago, Ill. 60607	Harness	Small size harness with vest, crotch strap, and shoulder strap, strap over seat back anchors to floor bracket.	Very hard to adjust properly with heavy clothing on child. Available in two sizes.
Strolee of California 19077 S. Reves Avenue Compton, Ca 90221	590 Car Seat	Tubular pedestal fold-up type; padded seat, back, head rest, and arm rests, hook-under seat mounting. Suspender and belly straps.	Same as Montgomery Wards catalog item no. 66B6101M. Manufacturer's choice for consumers, best seller and most expensive.
Klippan of N. America 9 S. Passaic Avenue Chattam, N.J. 04928	Safety Seat for Children	Molded plastic shell with heavy padding. Integral suspender-type shoulder straps with belly strap. Padded head restraint rear and sides. Padded hip-leg side restraints.	The instructions were for forward-facing only.
Sears, Roebuck and Co. Chicago, Ill. 60607	Adult Lap Belt	2" wide lap belt with buckle.	There is no significant difference between this lap belt and others available on the market.

For those seats which used the adult lap belt around the child, A_e is the area of the lap belt that bears on the child.

For those devices which did not collapse, and in which the adult lap belt did not bear upon the child, A_e is simply the area of the restraining surfaces bearing on the child.

For those devices in which the seat back collapsed, and in which the adult lap belt did not bear upon the child, A_e was determined to be one-half the total area of all the restraining straps.

A_s = Maximum height of sled acceleration pulse.

LF = Load Factor (See Figure 4). The LF is a weighting function to account for the different load bearing capabilities of different areas of the body. A restraint system bearing upon the whole torso is good, and its LF is 1. A system bearing upon the thorax and/or pelvis receives an LF of 2. A system bearing upon the abdomen is poor and its LF is 3.

If the restraining belts bear upon areas where there is no suitable skeletal structure to bear the load, penetration occurs and damage to internal organs may result. Consequently, those regions best able to bear loads without injury have low load factors.

For both groups, if the LDF exceeds that of the case below, then it is considered to have failed the test.

Failure (for forward impacts):

Minimum restraining belt area = 15 in^2

Restraining belt bears on the most susceptible region (abdomen), LF=3

$$\text{Maximum LDF} = \left[\frac{31 \text{ lbs} \times 21 \text{ G's}}{15 \text{ in}^2}\right] \times 3 = 130$$

Failure (for side impacts):

Minimum restraining belt area = 12 in^2

Restraining belt bears on the most susceptible region (side of abdomen), LF=3

$$\text{Maximum LDF} = \left[\frac{31 \text{ lbs} \times 15 \text{ G's}}{12 \text{ in}^2}\right] \times 3 = 116.3$$

The Total Injury Index is made up of these three parts, weighted in order to make their magnitudes comparable. It is very important, however, to note that a seat must perform reasonably well according to all three indices in order to be considered safe. For example, a seat with good load distribution factors and acceleration factors (i.e., low values), but which allows the child's head to go through the windshield, is clearly not safe.

Each of the three performance factors (LDF, HEF, AF) is weighted so that their respective cut-off cases each contributed 33 1/3 points. Therefore, a seat which fails all three measures of safety receives a score of 100.

SELECTION OF OCCUPANT

The 3-year-size Sierra Engineering anthropometric dummy was used for all tests, except the G.M. Infant Carrier test. The Sierra 3-year is 38 inches high and weighs 37.5 pounds. The weights of the various body components are distributed nearly correctly, thus giving a fair duplication of body kinematics. (See Figure 5)

In order to test the G.M. Infant Carrier, a doll with the approximate dimensions of an average three-month-old baby was disassembled. The two legs, torso, two arms, and head were weighted with lead shot to simulate the body segment weights for a baby of this size. The doll was then reassembled. The length of the doll was 16 inches and it weighed 15 pounds. This technique has been used by General Motors in developing their Infant Carrier (See Figure 6).

FIGURE 5. SIERRA 3-YEAR ANTHROPOMETRIC DUMMY

FIGURE 6. WEIGHTED DOLL

SELECTION OF TEST ENVIRONMENT

The test configurations consisted of a Ford bench seat mounted on a test rig which exactly duplicated the seat mounting, lap belt attachment points, and floor and toe board locations in a full-size 1971 Ford vehicle. The entire assembly was capable of being rotated as a unit and thus the geometry of the simulated vehicle remains constant for front, side, and rear impacts.

SELECTION OF INSTRUMENTATION AND DATA-HANDLING PROCEDURES

The 3-year dummy was instrumented with triaxial accelerometer packs in the head and in the chest. The individual accelerometers were Setra Model Number 111. A Statham strain-gage accelerometer was used to sense sled deceleration. Belt loads were recorded using Lebow seat-belt force transducers if an adult lap belt was used with the child seat. Timing signals and impact velocity were also recorded using a Honeywell 1612 light-beam oscillograph.

High-speed motion pictures were also taken for each test. A Photosonics 16-mm camera was located directly to the side of the impact area, and another directly overhead. The filming rate used was 1000 frames per second. These motion pictures were supplemented by slides taken before and after each test. Also, a Graph-chek sequence camera was used in the test program to provide an instantaneous evaluation of the test as a sequence of eight frames on a 3 x 5-in. Polaroid sheet.

TEST MATRIX

The test matrix for this program was designed to include forward impact, side impact, and rear impact. Each of the restraint devices was mounted on the bench seat in accordance with the manufacturer's instructions (Table II), securing the dummy in the device with the appropriate emergency restraints. All of the test devices were tested in the frontal impact direction at 30 mph and 21 G's. The devices which performed satisfactorily were then retested,

TABLE II. SUMMARY OF MANUFACTURER SPECIFICATIONS

Manufacturer's Name and Model No.	Test Number	Age of Child (years)	Standing Height of Child (inches)	Weight of Child (pounds)	For Use in Forward Facing Seats Only	Used With Adult Lap Belt Across Child's Lap	Does Not Use Adult Seat Belt	Use Only With Non-Folding Seats or Seats With a Latch	Not For Use in Trucks or Buses	Use on Both Front and Rear Facing Seats	Only For Children Capable of Sitting Upright	Use in Light Trucks	Restrictions on Use
Ford Tot Guard	518 535 536 541	1-5	<48*										
Peterson Model 63	519		26-40.5	17-37	✓	✓		✓	✓				
Peterson Model 61	520		26-40.5	17-37	✓	✓		✓	✓				
Klippan Safety Seat	521		<42	14-44	✓			✓	✓	✓	✓		
Strolee Model 590	522		29.5-48	18-50				✓			✓	✓	In front seat, use in center of seat only, in rear seat, can be used anywhere.
Trimble Model 875	523		<40	15-50	✓			✓			✓	✓	Belt must attach 4 inches aft of child seat back.
Kantwet Model 872	524		25-43	15-45	✓			✓			✓	✓	
Jamy Model 5500	525		<42	15-50	✓			✓			✓	✓	
Jamy Model 5405	526		<42	15-50	✓	✓		✓			✓	✓	For seats with head restraint height >22 inches.
Teddy Tot Model 6200	527		<35	15-35	✓	✓		✓			✓	✓	Belt must attach 4 inches aft of child seat back.
Teddy Tot Model 6600	548		<40	15-42	✓	✓		✓	✓		✓		Child's head must be below top of the seat.
Firestone Protecta-Tot	529		<33	15-28	✓	✓		✓					Clearance of 17.9 inches between top of lap seat back and Protecta-Tot.
Century Model 4845	530		<43	15-45	✓	✓		✓			✓	✓	Belt must attach 4 inches aft of child seat back. Cannot be used in cars with shoulder belt permanently attached to the lap belt.
Bunny Bear Model 61	531		24-40	15-40	✓	✓		✓			✓		
Sears Harness (Small)	532 537 540			>50 or 40-70 **			✓						
General Motors Infant Carrier	533 534 538 539 543 544			<20				✓					Infant faces rearward.
Thayer Bobby Mac	546		<40	7-35	✓			✓	✓				Auto seat belt must have belt loop length above the auto seat cushion of at least 40" so it can loop around and secure Bobby Mac. When used for youngsters ≤30" in height, it must be used on auto seat where seat back height or combined seat back and head restraint is at least 22" above cushion.

*Child's standing height should be <48 inches and his sitting height should be 19-25 inches.
**Two sizes of Sears harnesses are available; small for children less than 50 pounds and large for children weighing 40-75 pounds.

with new restraints where necessary, in the rear direction at 20 mph and 15 G's. Those devices which performed satisfactorily in the rear impact were then retested for side impact performance, at 20 mph and 15 G's. Any device which performed satisfactorily in all three modes was then retested in the front, rear, and side impact modes for repeatability.

DATA GATHERED IN TEST PROGRAM

The data from all tests are summarized in Table III. All acceleration and force data are given as peak values. The head and chest accelerations are given as "A-P" referring to the anterior-posterior direction, "S-I" to the superior-inferior direction, and "L-R" to the left-right direction.

The complete set of data gathered in this study is included as Appendix A to this report.

TABLE III. CHILD RESTRAINT TEST SUMMARIES

Manufacturer and Model	Test No.	Direction	SLED		HEAD					CHEST				BELT LOAD		Maximum Head Excursion Inches
			Velocity MPH	ACCN G's	AP G's	SI G's	LR G's	RES G's	SEVERITY INDEX	AP G's	SI G's	LR G's	RES G's	Rt. Lbs.	Lt. Lbs.	
Ford Tot Guard	518	Front	30.00	21.0	75	64	8.7	85	1140	49	19	15	53	NA	NA	23.75
	535	Front	30.10	20.5	80	65	10	93	1200	51	25	15	54	NA	NA	23.33
	536	Back	20.40	13.6	34	15	2.5	36	128	40	27	2.5	43	NA	NA	1.21
	541	Side	20.00	14.5	7*	46	20*	48*	350*	11	16	25	27	NA	NA	27.43
Peterson: Model 63	519	Front	29.70	20	152	105	15	166	>2000	50	21	15	50	500	880	30.37
Model 61	520	Front	29.15	20.5	91	93	38	112	>2000	40	33	11	42	520	1200	28.25
Klippan Safety Seat	521	Front	30.05	22.0	35	64	39	68	780	46	21	10	48	NA	NA	21.55
Strolee Model 590	522	Front	29.50	21.0	61	70	26	85	1160	42	19	10	43	NA	NA	31.02
Trimble Model 875	523	Front	29.70	21.0	43	67	21	71	960	25	35	11	39	NA	NA	34.78
Kantwet Model 872	524	Front	29.72	20.8	44	63	45	71	1155	28	21	15	32	560	770	27.38
Jamy: Model 5500	525	Front	29.50	20.5	97	77	30	120	1500	27	16	6	29	NA	NA	31.81
Model 5405	526	Front	29.25	21.5	108	82	30	134	>2000	38	23	14	39	525	775	25.23
Teddy Tot: Model 6200	527	Front	30.20	22.5	198	85	148	250	>2000	33	17	13	39	525	810	26.53
Model 6600	548	Front	20.40	21.0	72	105	35	112	>2000	40	22	10	43	1225	1000	30.20
Firestone Protecta-Tot	529	Front	29.50	22.0	45	120	18.0	124	>2000	53	18	8	54	575	930	30.08
Century Model 4845	530	Front	29.90	21.5	210	125	100	270	>2000	52	29	11	53	500	800	32.17
Bunny Bear Model 61	531	Front	29.20	20.5	175	188	32	245	>2000	52	34	14	55	550	1050	31.97
Sears Harness (small)	532	Front	29.50	20.5	56	75	25	82	1400	45	20	9	46	NA	NA	22.52
	537	Back	20.05	13.5	23*	10*	5*	25*	120*	49	24	3	50	NA	NA	4.61
	540	Side	19.80	14.5	20	40	13	42	230	13	16	17	21	NA	NA	25.74
General Motors: Infant Carrier	533	Front	30.10	20.5	-	-	-	-	-	-	-	-	-	NA	NA	NA
	534	Front	30.10	21.0	-	-	-	-	-	-	-	-	-	NA	NA	NA
	538	Back	19.80	14.0	-	-	-	-	-	-	-	-	-	NA	NA	NA
	539	Back	20.00	14.0	-	-	-	-	-	-	-	-	-	NA	NA	NA
	543	Side	19.40	13.5	-	-	-	-	-	-	-	-	-	NA	NA	NA
	544	Side	19.70	14.5	-	-	-	-	-	-	-	-	-	NA	NA	NA
Thayer Bobby Mac	546	Front	30.20	21.0	56	69	6.3	72	1000	37	11	6	37	NA	NA	26.36
Seat Belt only	549	Front	30.00	20.0	118	116	38	144	>2000	25	28	10	35	440	380	23.01

*Data has been adjusted to remove experimental artifact.

NA = Not applicable.

TABLE IV. RANKING OF CHILD RESTRAINT SYSTEM FOR FORWARD 30 MPH IMPACTS

Manufacturer and Model	Load Distribution Factor (LDF)	Weighted Load Distribution Factor (WLDF)	Acceleration Factor (AF)	Weighted Acceleration Factor (WAF)	Head Excursion Factor (HEF)	Weighted Head Excursion Factor (WHEF)	Total Injury Index
Front Impact (30 mph)							
G.M. Infant Carrier	6.70	3.44	4.00	19.000	0	0	20.7
Ford Tot Guard	6.50	1.66	6.70	31.900	23.7	32.2	65.8
Sears Harness (Small)	24.00	6.14	6.10	29.000	12.4	16.9	52.0
Klippan Safety Seat	139.00	33.30	5.50	26.200	6.5	8.8	68.3
Thayer Bobby-Mac	102.00	26.10	5.20	24.800	54.2	33.3	84.2
Strolee Model 590	122.00	31.20	6.10	29.000	144.0	33.3	93.5
Trimble Model 875	102.00	26.10	5.30	25.200	250.0	33.3	84.6
Jamy Model 5500	98.00	25.10	7.20	33.300	164.0	33.3	91.7
Kantwet Model 872	266.00	33.30	4.90	23.300	340.0	33.3	89.9
Seat Belt Only	112.00	28.70	7.20	33.300	16.2	22.0	84.0
Peterson Model 63	184.00	33.30	7.20	33.300	129.0	33.3	100.0
Peterson Model 61	229.00	33.30	7.20	33.300	86.0	33.3	100.0
Jamy Model 5405	173.00	33.30	7.20	33.300	39.0	33.3	100.0
Teddy Tot Model 6200	178.00	33.30	7.20	33.300	57.0	33.3	100.0
Firestone Protecta Tot	301.00	33.30	7.20	33.300	122.0	33.3	100.0
Century Model 4845	173.00	33.30	7.20	33.300	174.0	33.3	100.0
Teddy Tot Model 6600	296.00	33.30	7.20	33.300	126.0	33.3	100.0
Bunny Bear Model 61	213.00	33.30	7.20	33.300	171.0	33.3	100.0
Rear Impact (20 mph)							
G.M. Infant Carrier	11.25	5.56	4.00	17.800	0	0	23.4
Ford Tot Guard				Very Gentle Ride Down			
Sears Harness (Small)				Very Gentle Ride Down			
Side Impact (20 mph)							
G.M. Infant Carrier	5.11	2.53	4.00	17.800	0	0	20.4
Ford Tot Guard	28.50	8.16	5.00	22.321	238.0	33.3	65.8
Sears Harness (Small)	77.50	22.20	4.20	18.800	189.0	33.3	74.2

*Low score is safe, high score is unsafe.
A seat must have all of its scores below 33.3 to pass.

PART IV. QUALITATIVE EVALUATION

A qualitative evaluation of the restraint systems was made on the basis of all available data (quantitative data, film record, lab notes, etc.). The results are given below (Table IV).

EXCELLENT

General Motors Infant Carrier - The Infant Carrier's performance was the best overall. It's biggest drawback is that it can be used only for infants of less than 20 pounds. This is the only seat which passed all the safety criteria for front, side, and rear impacts.

GOOD

Ford Tot Guard - The Tot Guard's performance was excellent in front and rear collisions, but poor in side collisions. This seat was the easiest to use by far, with no straps to tighten and no buckles to buckle. For a child heavier than 20 pounds, this is the best seat.

Sears Harness (Small) - Sold by Sears as the freedom harness, this device lets the child sit, stand and lie down. Its dynamic performance was excellent. Its biggest handicap is that it may take up to one hour to install and could require five minutes to put the harness on every time it's used. This device failed the side impact test because of excessive head excursion.

BORDERLINE

Klippan - The quantitative data indicates that this is a superior seat; however, the anthropometric dummy suffered severe distortion of the lumbar vertebrae. This device would be greatly improved by adding a crotch strap to inhibit the harness from sliding up into the abdominal region, which would, in turn, reduce distortion of the occupant.

Thayer Bobby-Mac - Failed only head excursion.

NOT ACCEPTABLE

The seats below have all definitely failed the test.

Strolee Model 590 - Dummy's head hit the dash hard.

Trimble Model 875 - The seat collapsed, crushing the dummy. Dummy's head impacted the dash very hard.

Jamy 5500 - Seat base broke. Dummy's head struck dash hard. This seat would be greatly improved with use of the adult shoulder harness to support the seat back.

Kantwet Model 872 - Shoulder belt slipped down around upper abdomen. Dummy bent badly at mid-thoracic.

All of the seats below use the adult lap belt around the child's abdomen.

Adult Lap Belt Only - For comparison purposes.

Peterson Model 63 - Lap belt bears on child resulting in severe distortion of sacral spine region. This seat collapsed completely on impact.

Peterson Model 61 - Lap belt bears on child resulting in considerable distortion of sacral spine region. This seat collapsed on impact.

Jamy 5405 - Lap belt goes around the child. Severe spinal distortion and abdominal penetration. The seat collapsed and folded up, wedging the dummy out of the seat.

Teddy Tot 6200 - Lap belt goes around the child. Severe distortion of spine in lumbar sacral region. Abdominal penetration evident. The seat shattered, with the upper part of the seat breaking completely off.

Firestone Protecta Tot - Adult lap belt bears on the child. This seat holds the lap belt up off the pelvis, resulting in severe penetration of abdomen and severe lumbar-sacral distortion.

Century Car Seat - Lap belt bears on child. This seat is very flimsy, it totally collapsed on impact. Back of child seat hit dummy's head, speeding it up as it went into the dash.

Teddy Tot 6600 - Lap belt bears on child. Very poor restraint location, resulted in spinal distortion. Severe penetration by lap belt.

Bunny Bear Model 61 - Lap belt bears on child. The seat belt pulled the dummy's sacrum through the rear of the seat. Folded the dummy over and jammed his back. This seat has good structural strength, but needs to have a different belt arrangement, one without the adult belt around the child.

Table V is a recommended ordering of the child restraint systems according to their overall safety.

TABLE V. THE QUANTITATIVE RESULTS OF THE CHILD RESTRAINT SYSTEMS TESTED

EXCELLENT	General Motors Infant Carrier
GOOD	Ford Tot Guard Sears Child Harness
BORDERLINE	Klippan Safety Seat Thayer Bobby-Mac
NOT ACCEPTABLE	Strolee Model 590 Trimble Model 875 Jamy 5500 Kantwet Model 872 Adult Lap Belt Only Peterson Model 63 Peterson Model 61 Jamy 5405 Teddy Tot 6200 Firestone Protecta Tot Century Car Seat Teddy Tot 6600 Bunny Bear Model 61

LIST OF REFERENCES

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2. Siegel, A. W., Nahum, A. M. and Appleby, M. R., "Injuries to Children in Automobile Collisions," Proc. Twelfth Stapp Car Crash Conference, 1-46, 1968.

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4. King, B. G., Paul, E. C. and Spitznagel, C. R., "Children's Automobile Safety Restraints, Characteristics and Body Measurements," SAE Paper No. 690467, 1969.

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10. Stalnaker, R. L., et al., "Door Crashworthiness Criteria," Final Report, NTIS Release No. PB-203-721, 1971.

11. Stalnaker, R. L., McElhaney, J. H. and Roberts, V. L., "MSC Tolerance Curves for Human Head Impacts," ASME Paper No. 71-WA/BHF-10, 1971.

APPENDIX A

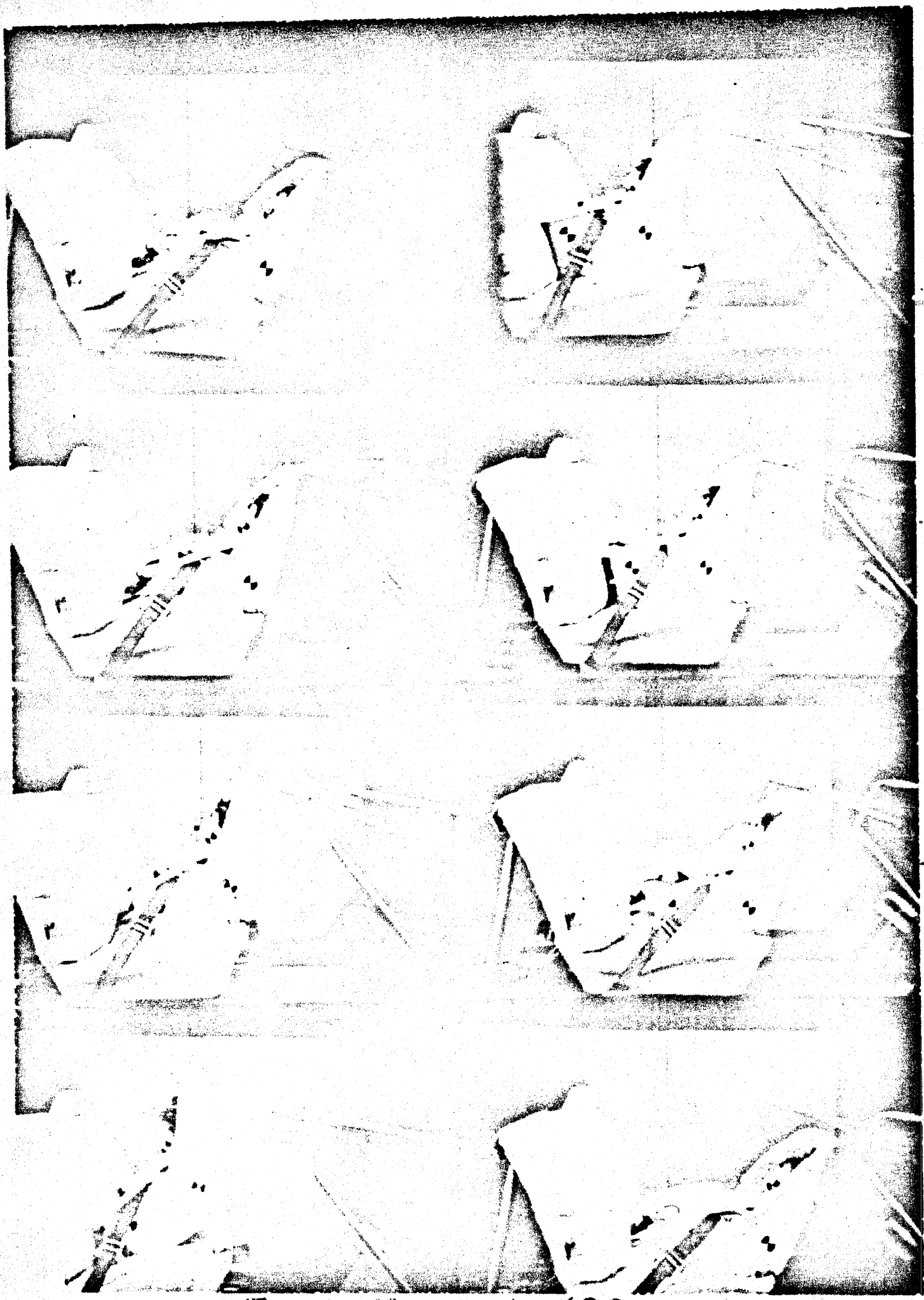
HSRI SUMMARY DATA SHEET

Test Number:	A-533
Test Date:	February 23, 1972
Restraint Description:	General Motors Infant Carrier
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the rear of the simulated vehicle.

Test Observation:

The doll received a very gentle ride. The rebound caused the Carrier to rotate around the adult seat belt forming a protective shield over the doll. The Carrier cracked on each side where the belt crossed through the Carrier.

1



8

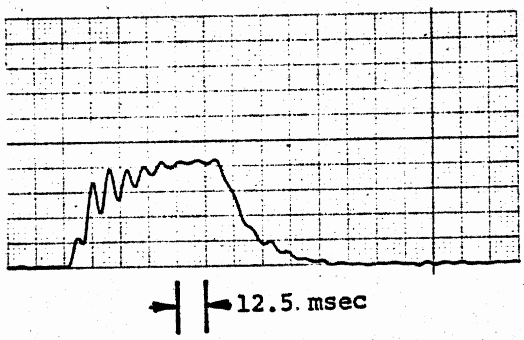
Test No.; A-533

FIGURE A-1. GRAPHCHEK SEQUENCE CAMERA

SUMMARY DATA HEAD ACCELERATIONS

Test Number A533 Test Type GM INFANT CARRIER
Dummy 6 MONTHS - DOLL FRONT - 30 MPH
Sled Velocity 44.2 ft/sec

Sled Pulse
5 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
50.0 g's/division
Filtered
Class 1000

Superior-Inferior
Head Acceleration
50.0 g's/division
Filtered
Class 1000

NOTE: The 15 lb. doll used for the General Motors Infant Carrier was not instrumented with accelerometers, therefore no acceleration data is given for the doll.

Left-Right
Head Acceleration
50.0 g's/division
Filtered
Class 1000

Resultant Head
Acceleration
50 g's/division
Filtered
Class 1000

Severity Index
200 sec/div.

HSRI SUMMARY DATA SHEET

Test Number:	A-534
Test Date:	February 23, 1972
Restraint Description:	General Motors Infant Carrier
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the rear of the simulated vehicle.

Test Observation:

The doll received a very gentle ride. The rebound was as in Run A-533. The Carrier did not break because a simulated dash was put on the sled to limit the forward motion of the Carrier.

FIGURE A-2. GRAPHCHEK SEQUENCE CAMERA

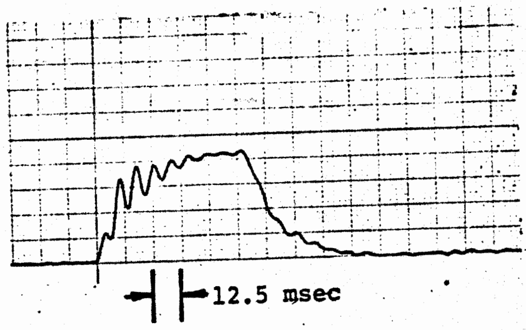
SUMMARY DATA HEAD ACCELERATIONS

Test Number A534 Test Type GM INFANT CARRIER

Dummy 6 MONTHS – DOLL FRONT – 30 MPH

Sled Velocity 44.2 ft/sec

Sled Pulse
5 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

NOTE: The 15 lb. doll used for the General Motors Infant Carrier was not instrumented with accelerometers, therefore no acceleration data is given for the doll.

Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Resultant Head
Acceleration
5 g's/division
Filtered
Class 1000

Severity Index
20 sec/div.

HSRI SUMMARY DATA SHEET

Test Number:	A-538
Test Date:	February 25, 1972
Restraint Description:	General Motors Infant Carrier
Dummy:	3-Year
Sled Velocity:	20 mph
Sled G-Level:	15
Impact Direction:	Back
Dummy Attitude:	Sitting, facing toward the rear of the simulated vehicle.

Test Observation:

The doll received a fairly gentle ride. There was a tendency for the doll to submarine under the adult seat belt.

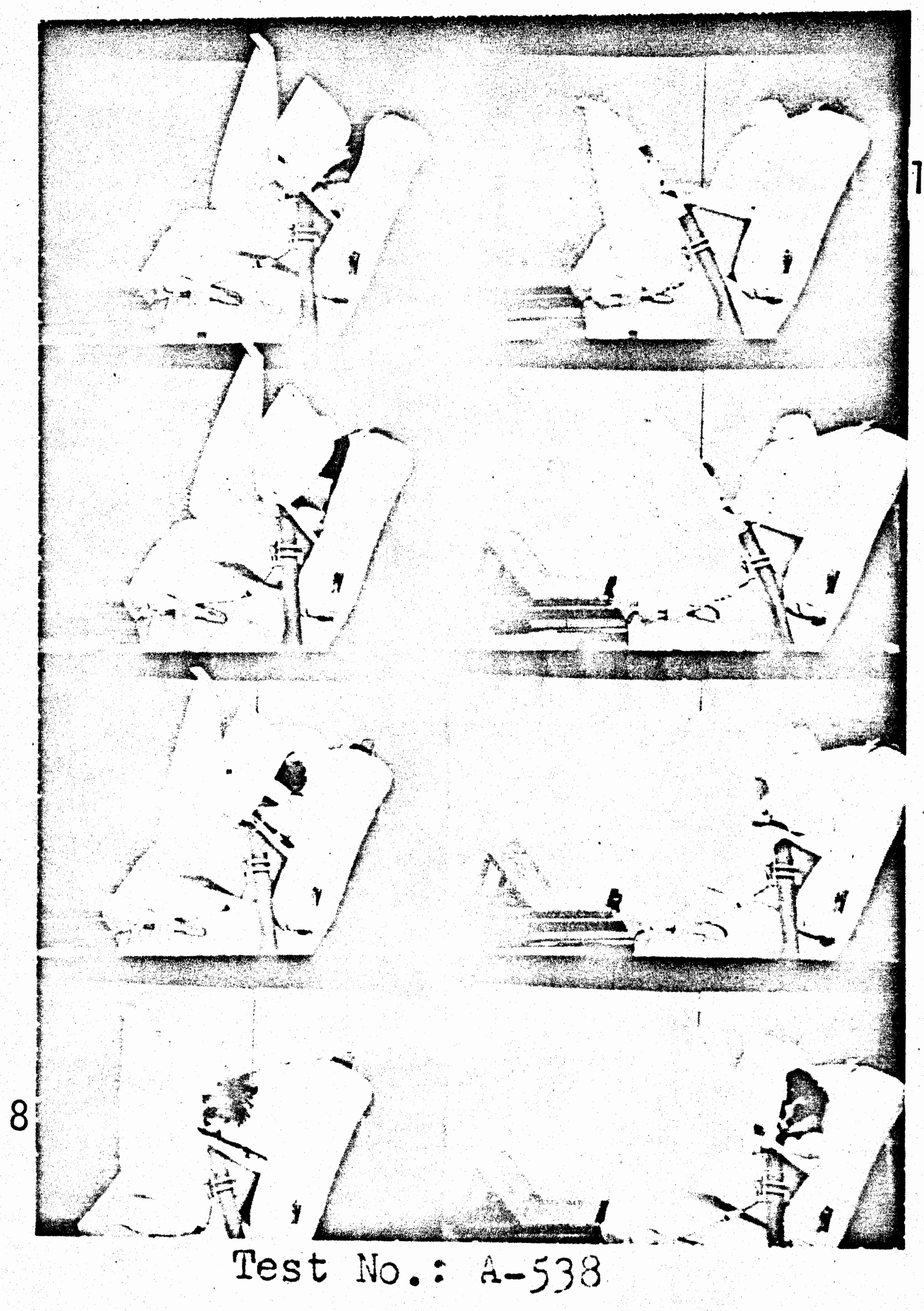


FIGURE A-3. GRAPHCHEK SEQUENCE CAMERA

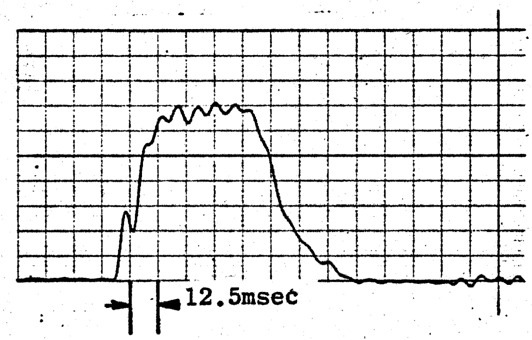
SUMMARY DATA HEAD ACCELERATIONS

Test Number A 538 Test Type GM INFANT CARRIER

Dummy DOLL - 6 MONTHS BACK - 20 MPH

Sled Velocity 29.16 ft/sec

Sled Pulse
2 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

NOTE: The 15 lb. doll used for the General Motors Infant Carrier was not instrumented with accelerometers, therefore no acceleration data is given for the doll.

Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000

Severity Index
50 $g^{2.5}$ sec/div.

HSRI SUMMARY DATA SHEET

Test Number:	A-539
Test Date:	February 25, 1972
Restraint Description:	General Motors Infant Carrier
Dummy:	3-Year
Sled Velocity:	20 mph
Sled G-Level:	15
Impact Direction:	Back
Dummy Attitude:	Sitting, facing toward the rear of the simulated vehicle.

Test Observation:

The doll received a fairly gentle ride. There was a tendency for the doll to submarine under the adult seat belt.

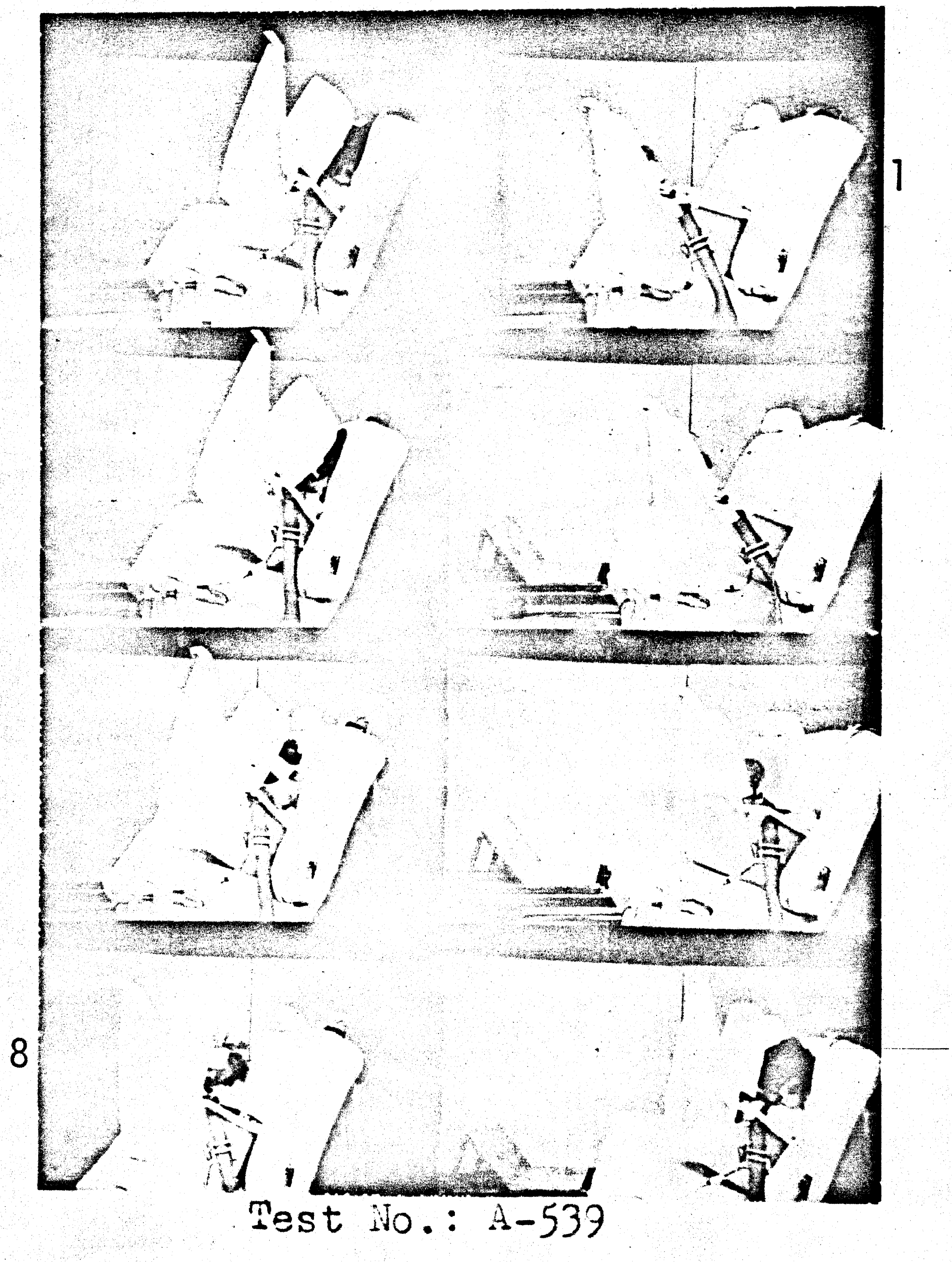


FIGURE A-4. GRAPHCHEK SEQUENCE CAMERA

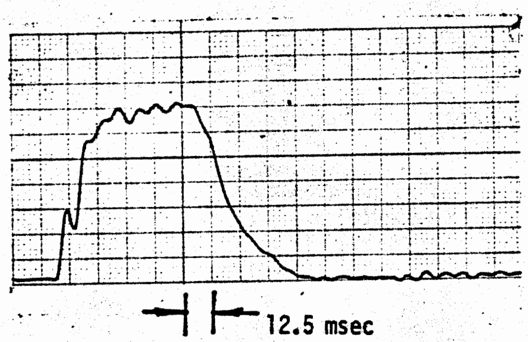
SUMMARY DATA HEAD ACCELERATIONS

Test Number A539 Test Type GM INFANT CARRIER

Dummy 6 MONTHS - DOLL BACK - 20 MPH

Sled Velocity 29.28 ft/sec

Sled Pulse
2 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

NOTE: The 15 lb. doll used for the General Motors Infant Carrier was not instrumented with accelerometers, therefore no acceleration data is given for the doll.

Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000

Severity Index
100 $g^{2.5}$ sec/div.

HSRI SUMMARY DATA SHEET

Test Number:	A-543
Test Date:	February 28, 1972
Restraint Description:	General Motors Infant Carrier
Dummy:	3-Year
Sled Velocity:	20 mph
Sled G-Level:	15
Impact Direction:	Side
Dummy Attitude:	Sitting, facing toward the rear of the simulated vehicle.

Test Observation:

The doll received a fairly gentle ride. No damage was observed to the doll or Carrier.

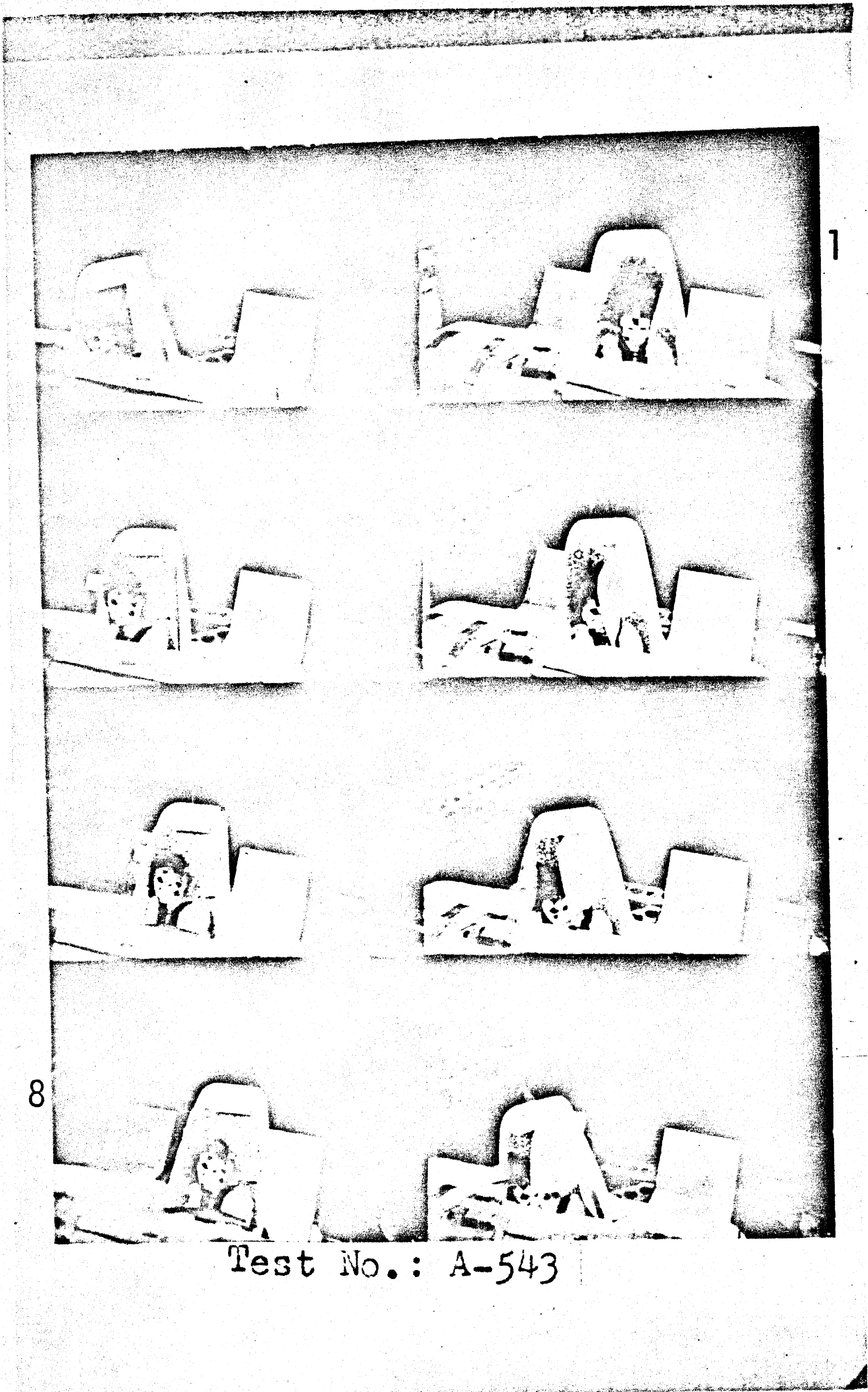


FIGURE A-5. GRAPHCHEK SEQUENCE CAMERA

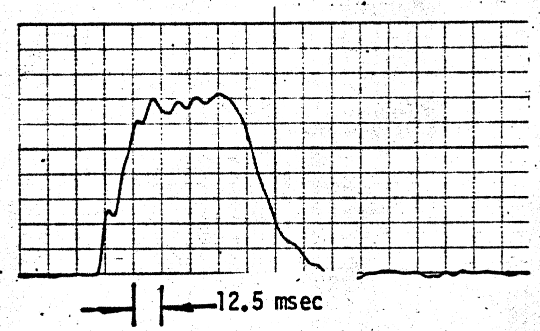
SUMMARY DATA HEAD ACCELERATIONS

Test Number A 543 Test Type GM INFANT CARRIER

Dummy DOLL - 6 MONTHS SIDE - 20 MPH

Sled Velocity 28.41 ft/sec

Sled Pulse
2 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

NOTE: The 15 lb. doll used for the General Motors Infant Carrier was not instrumented with accelerometers, therefore no acceleration data is given for the doll.

Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000

Severity Index
50 $g^{2.5}$ sec/div.

HSRI SUMMARY DATA SHEET

Test Number:	A-544
Test Date:	February 29, 1972
Restraint Description:	General Motors Infant Carrier
Dummy:	3-Year
Sled Velocity:	20 mph
Sled G-Level:	15
Impact Direction:	Side
Dummy Attitude:	Sitting, facing toward the rear of the simulated vehicle.

Test Observation:

The doll received a fairly gentle ride. No damage was observed to the doll or Carrier.

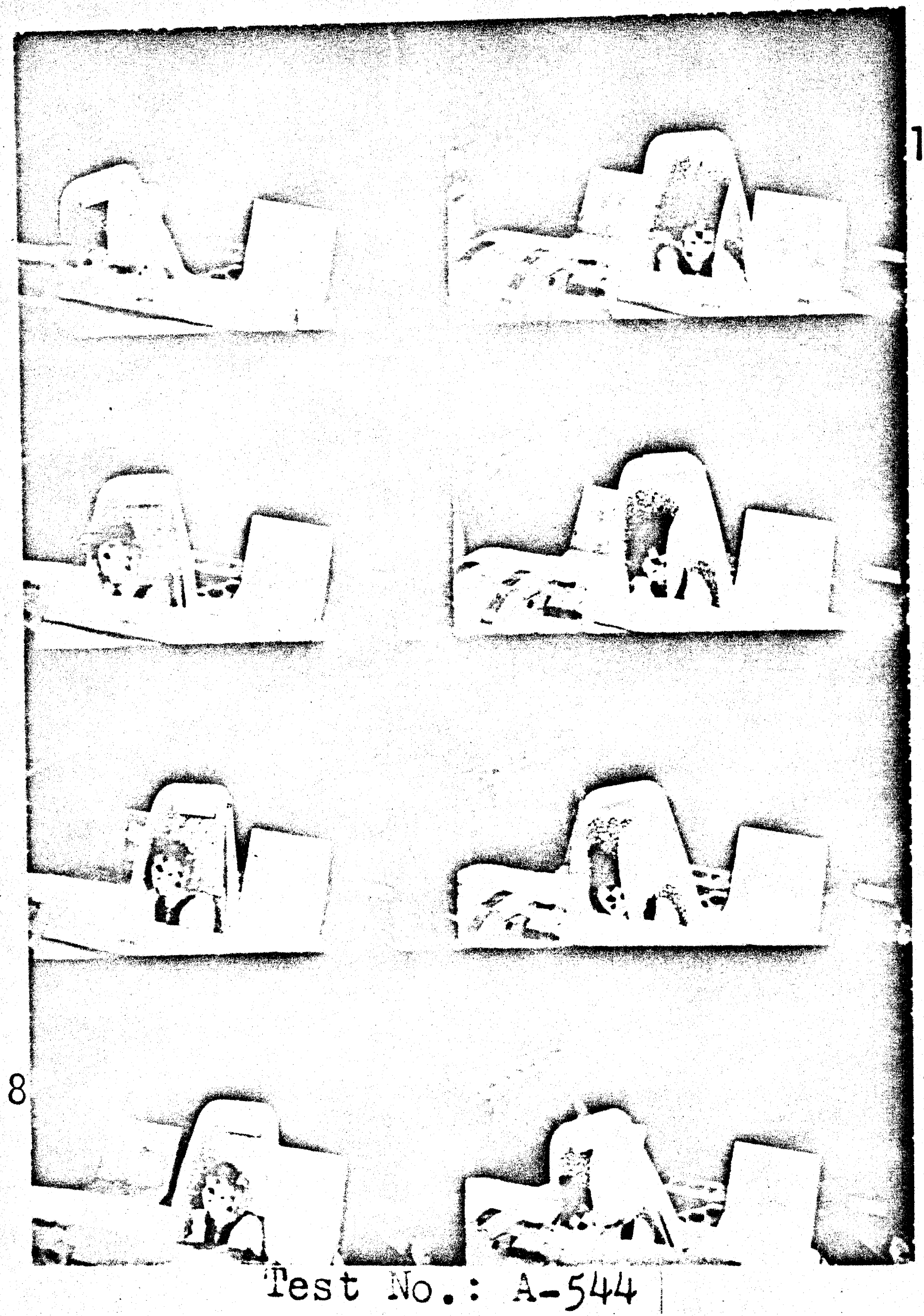


FIGURE A-6. GRAPHCHEK SEQUENCE CAMERA

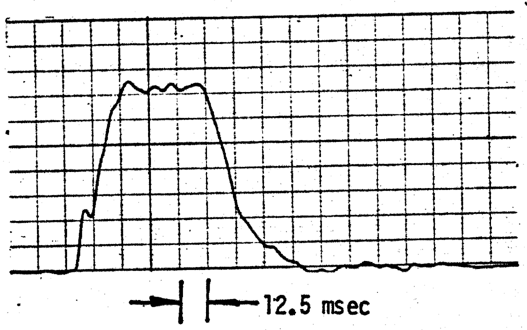
SUMMARY DATA HEAD ACCELERATIONS

Test Number A 544 Test Type G.M. INFANT CARRIER

Dummy DOLL - 6 MONTHS SIDE - 20 MPH

Sled Velocity 28.87 ft/sec

Sled Pulse
2 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

NOTE: The 15 lb. doll used for the General Motors Infant Carrier was not instrumented with accelerometers, therefore no acceleration data is given for the doll.

Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000

Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000

Severity Index
200 $g^{2.5}$ sec/div.

HSRI SUMMARY DATA SHEET

Test Number:	A-518
Test Date:	February 18, 1972
Restraint Description:	Ford Tot Guard
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The motions experienced by the dummy were minimal. The seat cracked on the sides due to the loading of the face and chest shield. Head and chest G loadings were high.

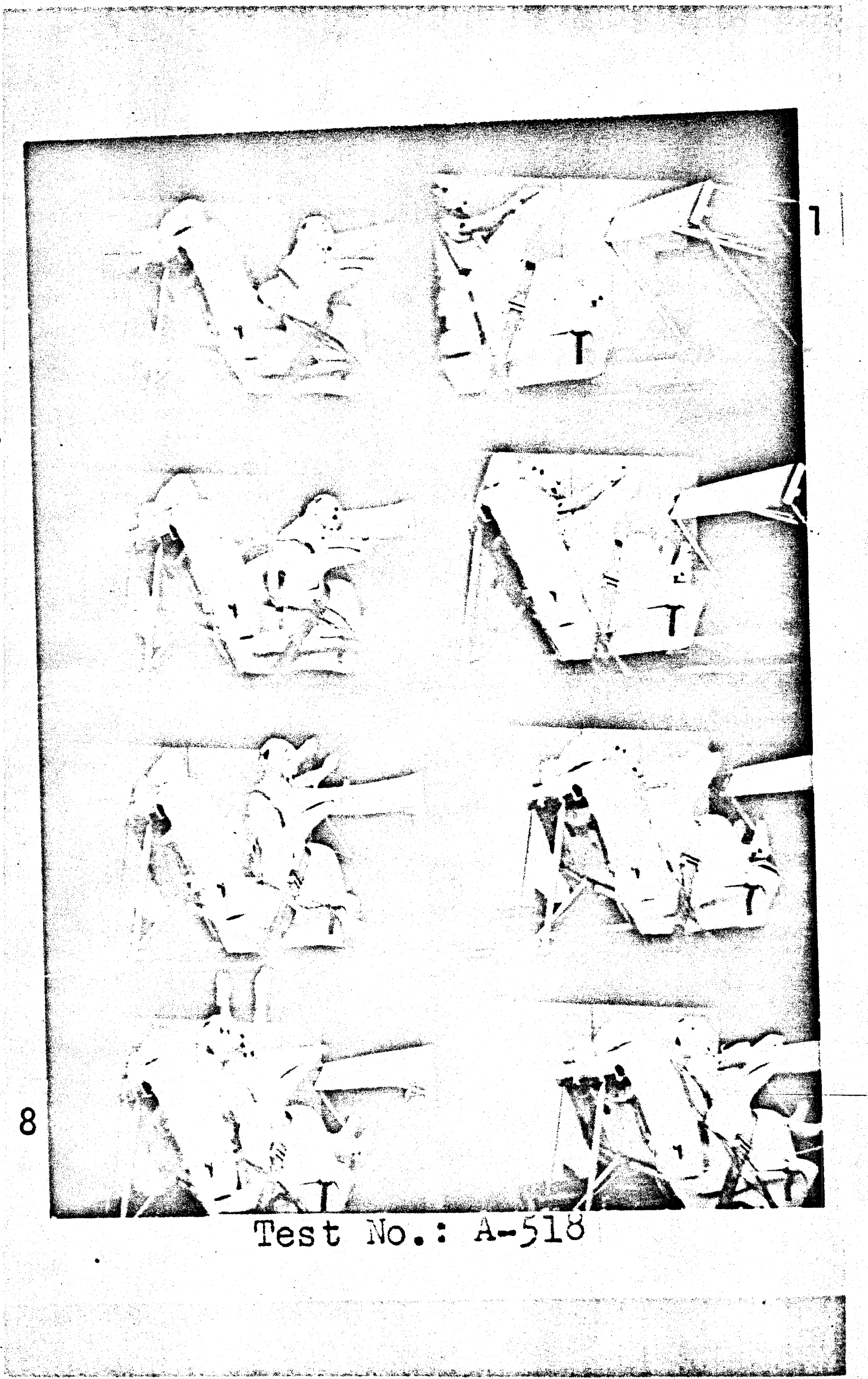


FIGURE A-7 GRAPHCHEK SEQUENCE CAMERA

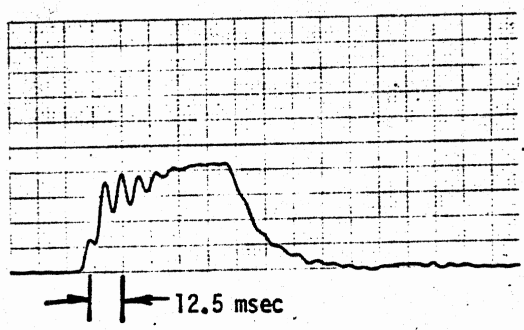
SUMMARY DATA HEAD ACCELERATIONS

Test Number A 518 Test Type FORD TOT GAURD

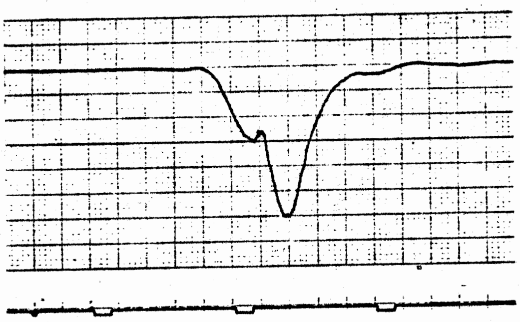
Dummy 3 YEARS OLD FRONT — 30.0 mph

Sled Velocity 44.0 ft/sec

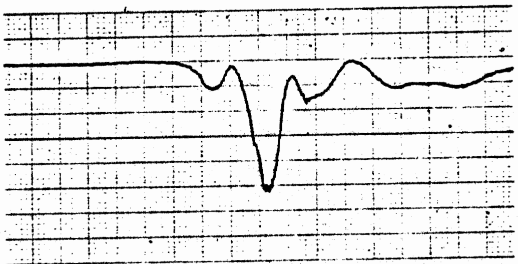
Sled Pulse
5 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



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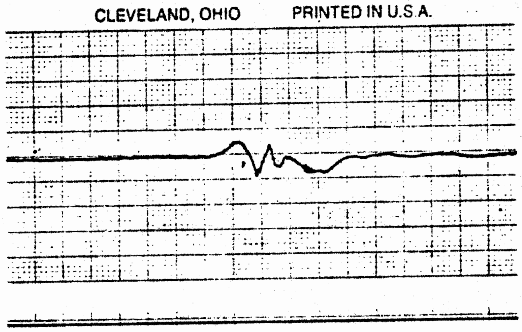
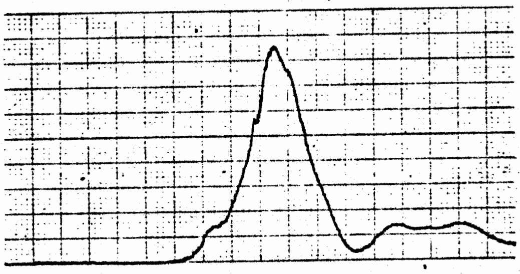
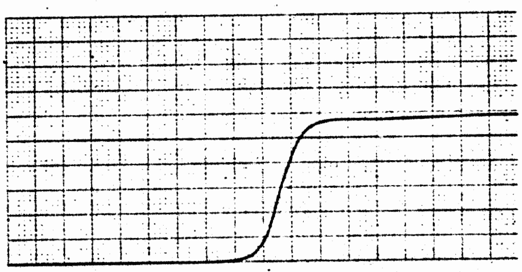
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.

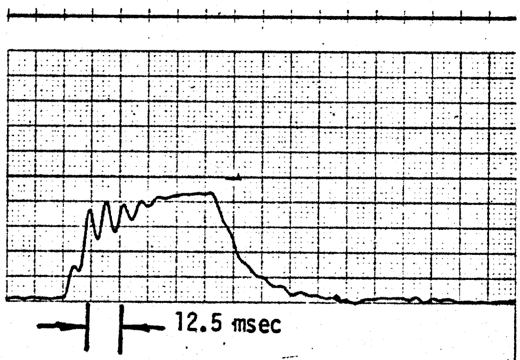


SUMMARY DATA CHEST ACCELERATIONS

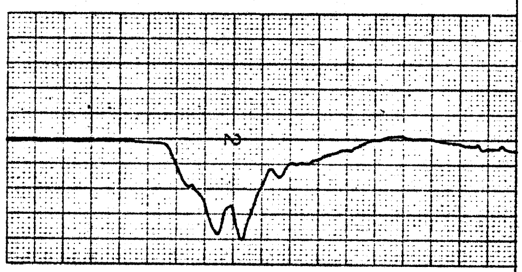
Test Number A518
Dummy 3 YEARS OLD
Sled Velocity 44.0 ft/sec

Test Type FORD TOT GAURD
FRONT - 30 MPH

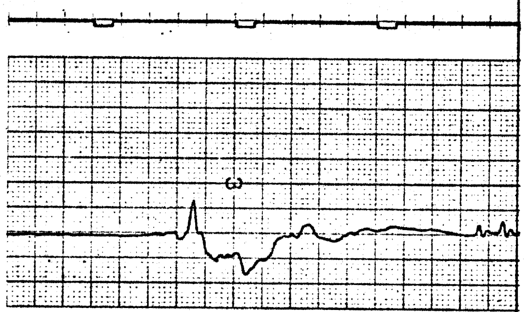
Sled Pulse
5 g's/division
Filtered
Class 60



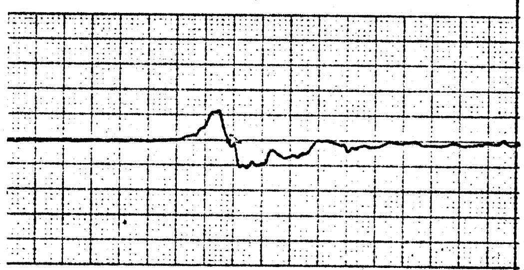
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



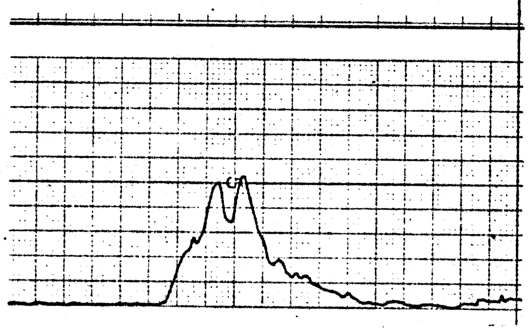
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-535
Test Date:	February 23, 1972
Restraint Description:	Ford Tot Guard
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The motions experienced by the dummy were minimal. The padding on the face and chest shield was pushed off by the impact. Approximately 90° of whiplash was experienced by the dummy on rebound due to the removal of the head rest. The head and chest G loadings were high.

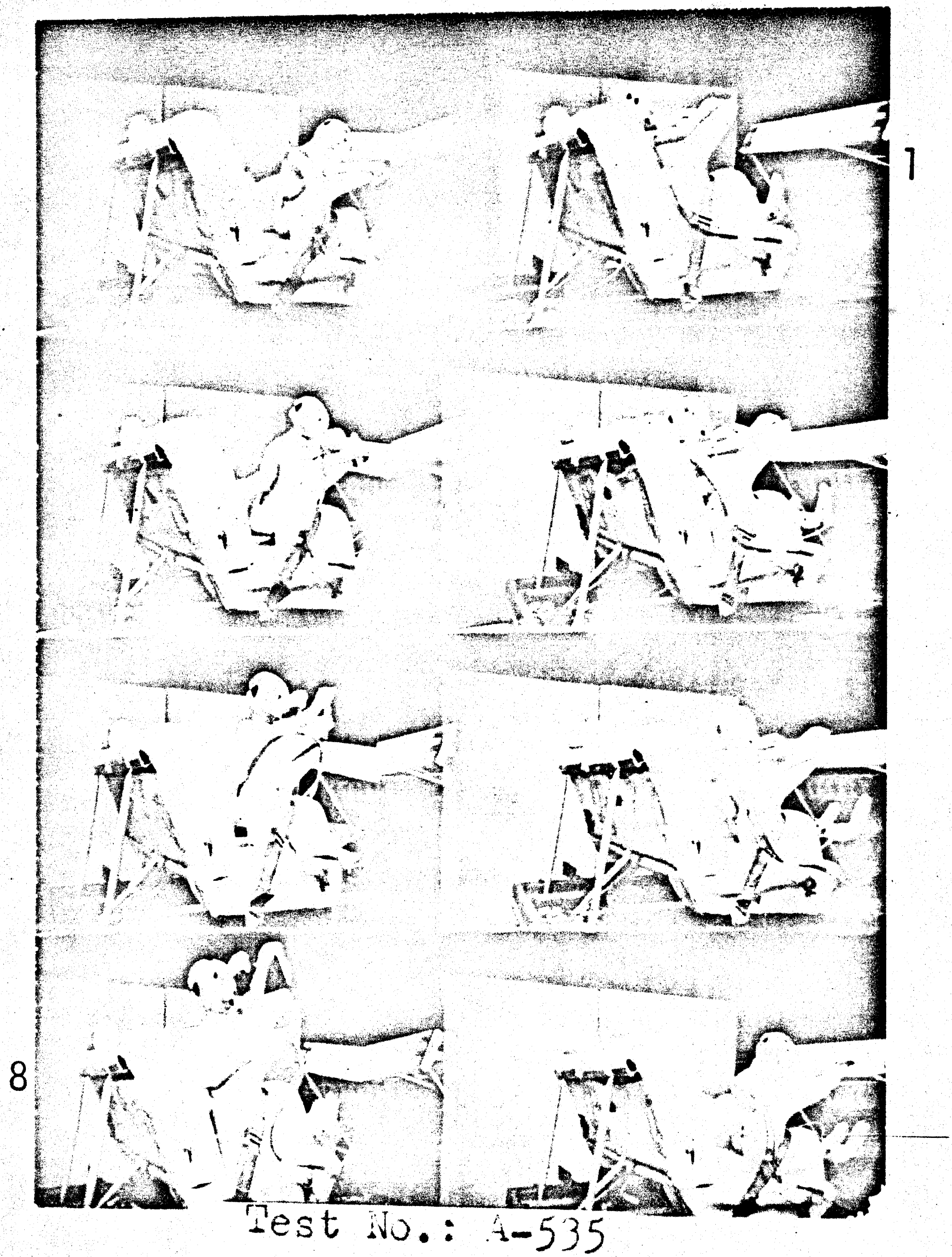


FIGURE A-8. GRAPHCHEK SEQUENCE CAMERA

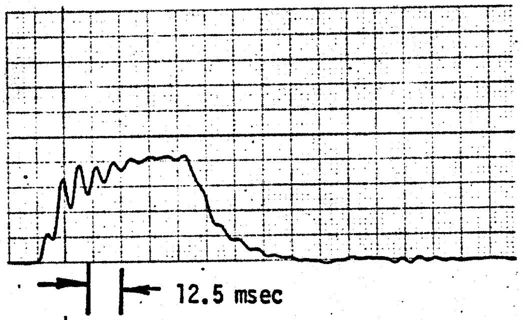
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-535 Test Type FORD TOT GAURD

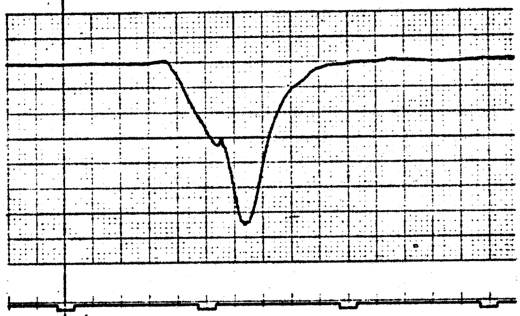
Dummy 3 YEARS OLD FRONT - 30 MPH

Sled Velocity 44.1 ft/sec

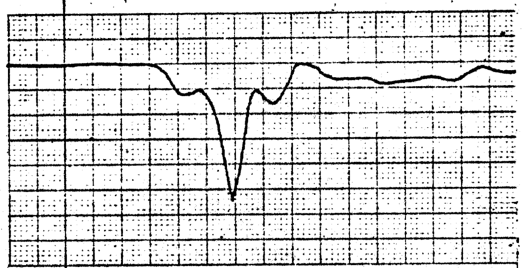
Sled Pulse
5 g's/division
Filtered
Class 60



Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



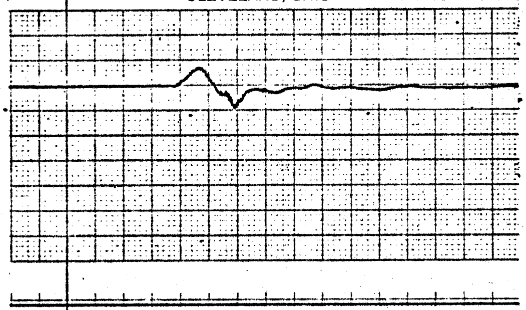
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



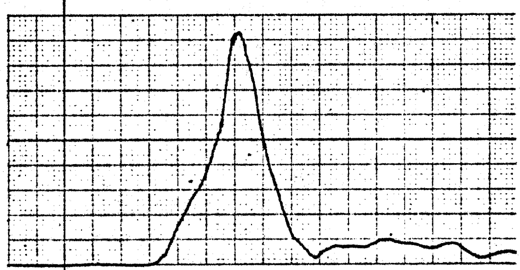
BRUSH INSTRUMENTS DIVISION, GOULD

CLEVELAND, OHIO PRINTED IN U.S.A.

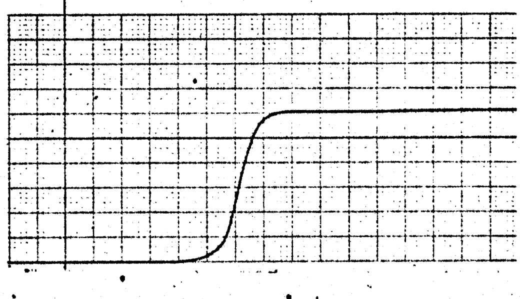
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.

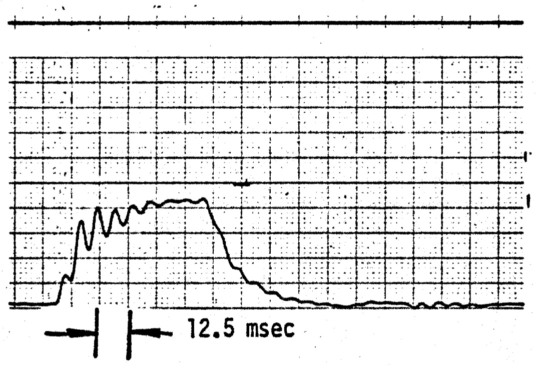


SUMMARY DATA CHEST ACCELERATIONS

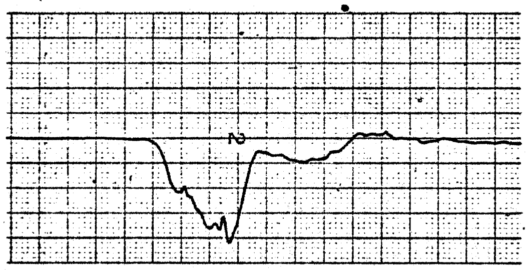
Test Number A535
Dummy 3 YEARSOLD
Sled Velocity 44.1 ft/sec

Test Type FORD TOT GAURD
FRONT - 30 MPH

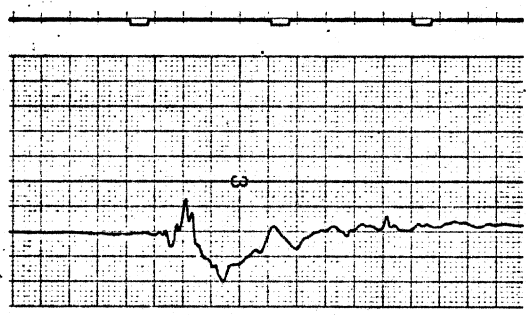
Sled Pulse
5 g's/division
Filtered
Class 60



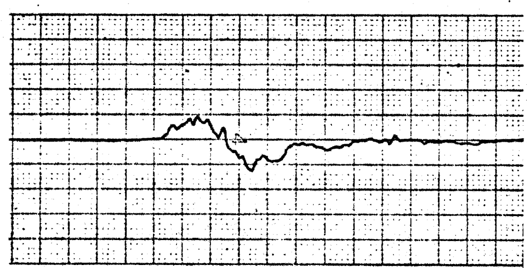
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



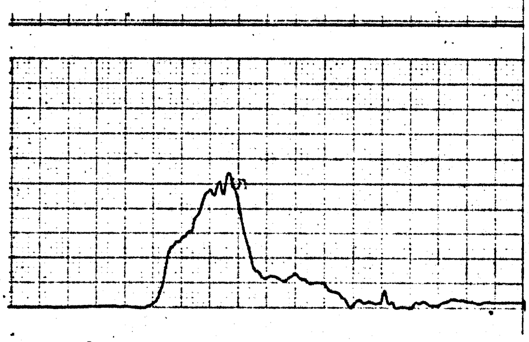
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-536
Test Date:	February 24, 1972
Restraint Description:	Ford Tot Guard
Dummy:	3-Year
Sled Velocity:	20 mph
Sled G-Level:	15
Impact Direction:	Back
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Neither the G loadings nor the excursion of the dummy were severe. However the face and chest shield pivoted upward and slapped the dummy's face.

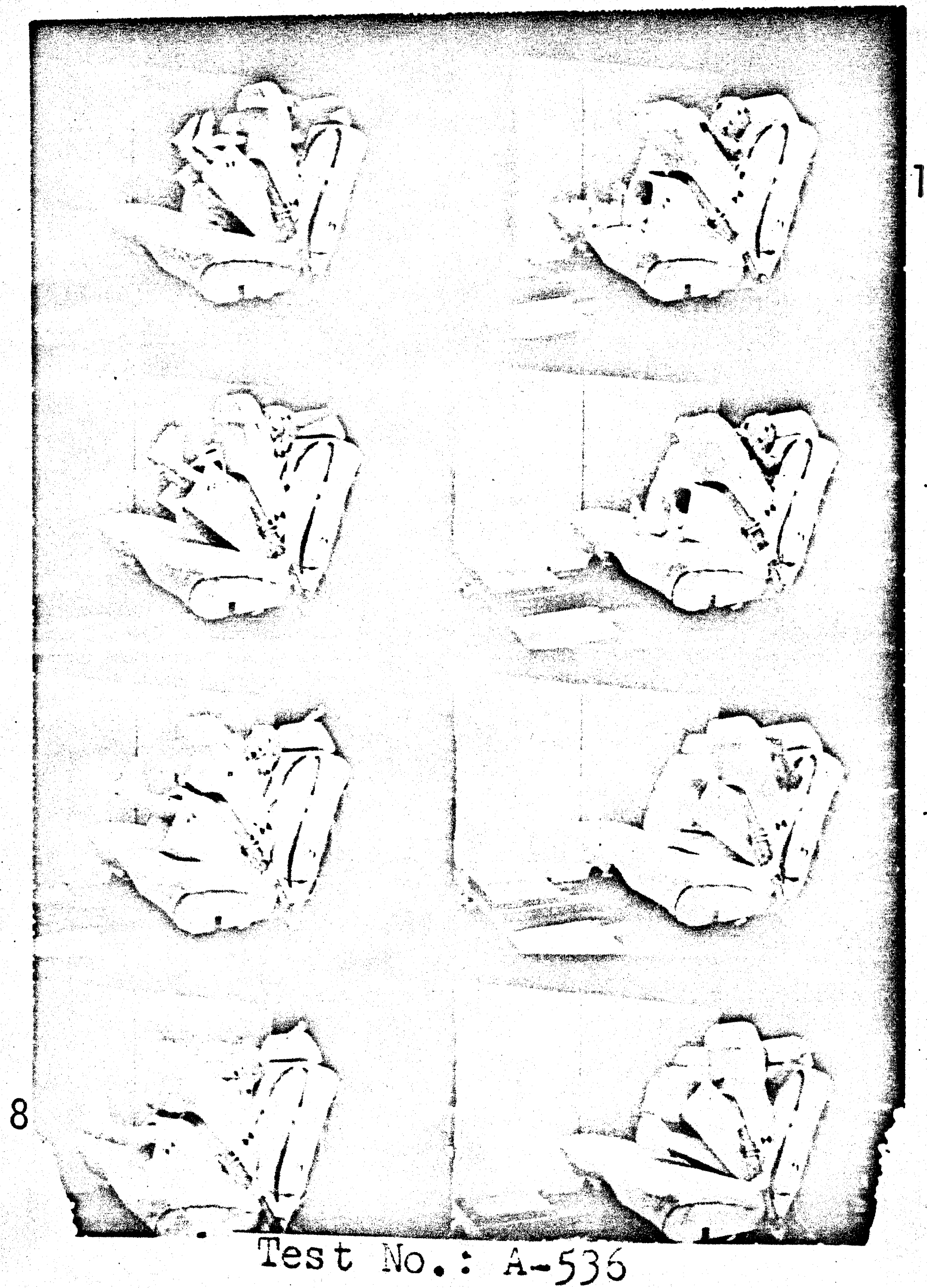


FIGURE A-9. GRAPHCHEK SEQUENCE CAMERA

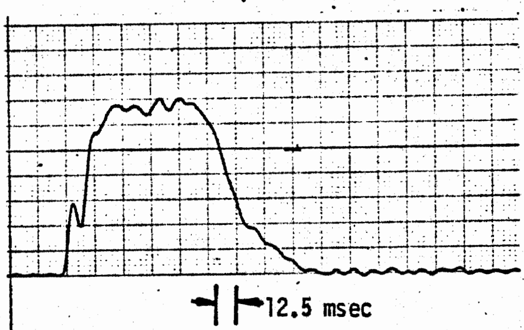
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-536 Test Type FORD TOT GAURD

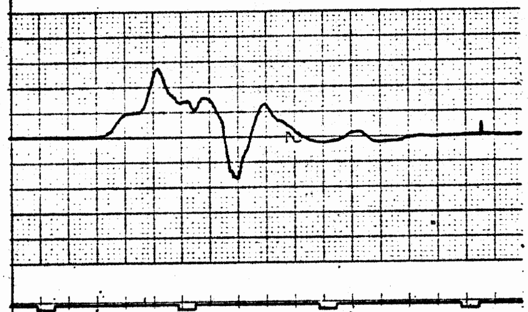
Dummy 3 YEARS OLD BACK - 20 MPH

Sled Velocity 29.9 ft/sec

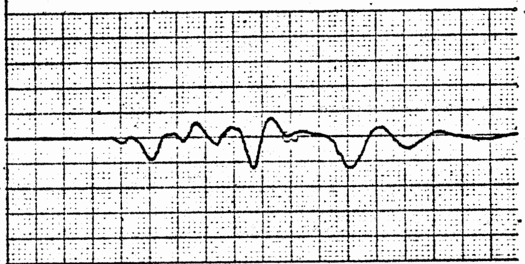
Sled Pulse
2 g's/division
Filtered
Class 60



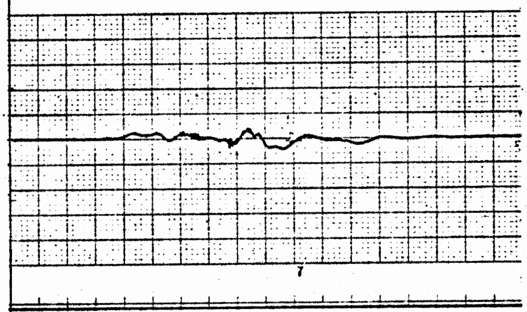
Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



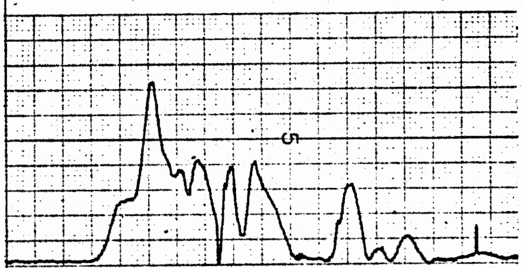
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



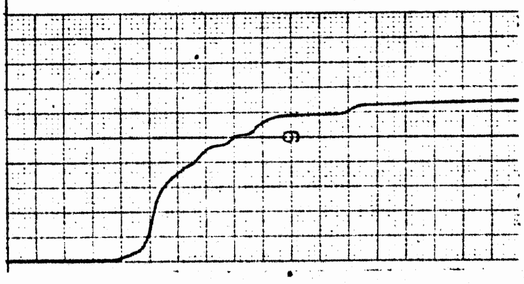
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
5 g's/division
Filtered
Class 1000



Severity Index
20 $g^{2.5}$ sec/div.

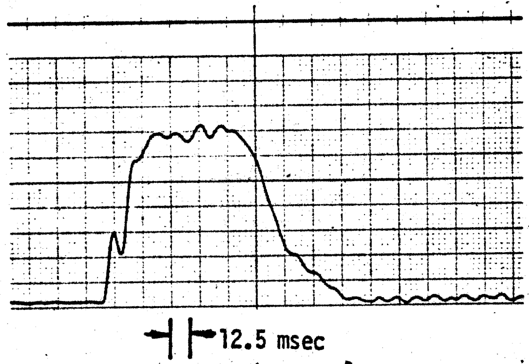


SUMMARY DATA CHEST ACCELERATIONS

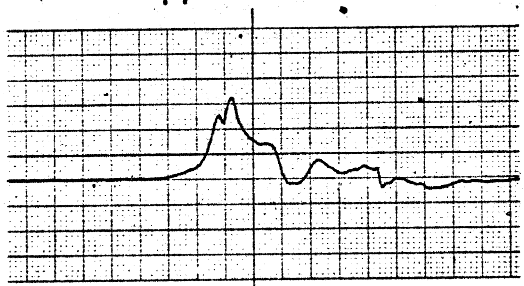
Test Number A536
Dummy 3 YEARS OLD
Sled Velocity 29.9 ft/sec

Test Type FORD TOT GAURD
BACK - 20 MPH

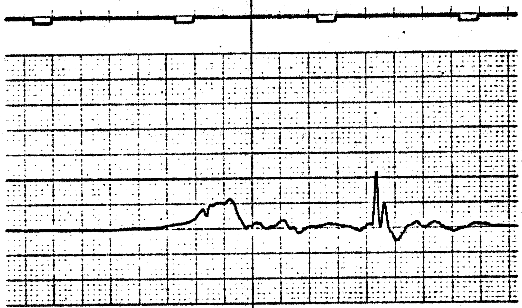
Sled Pulse
2 g's/division
Filtered
Class 60



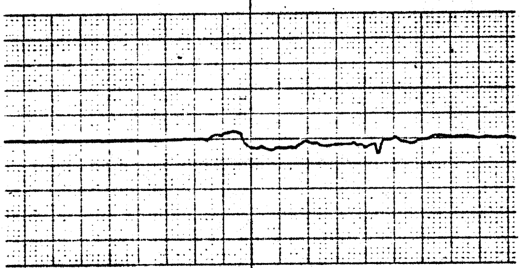
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



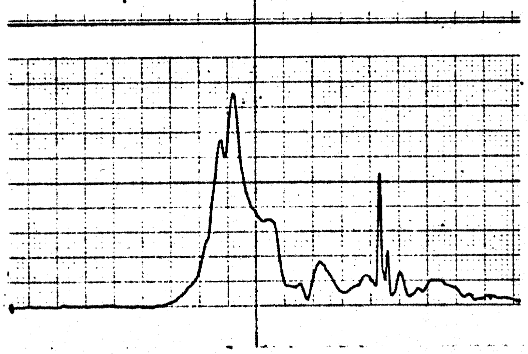
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number: A-541

Test Date: February 28, 1972

Restraint Description: Ford Tot Guard

Dummy: 3-Year

Sled Velocity: 20 mph

Sled G-Level: 15

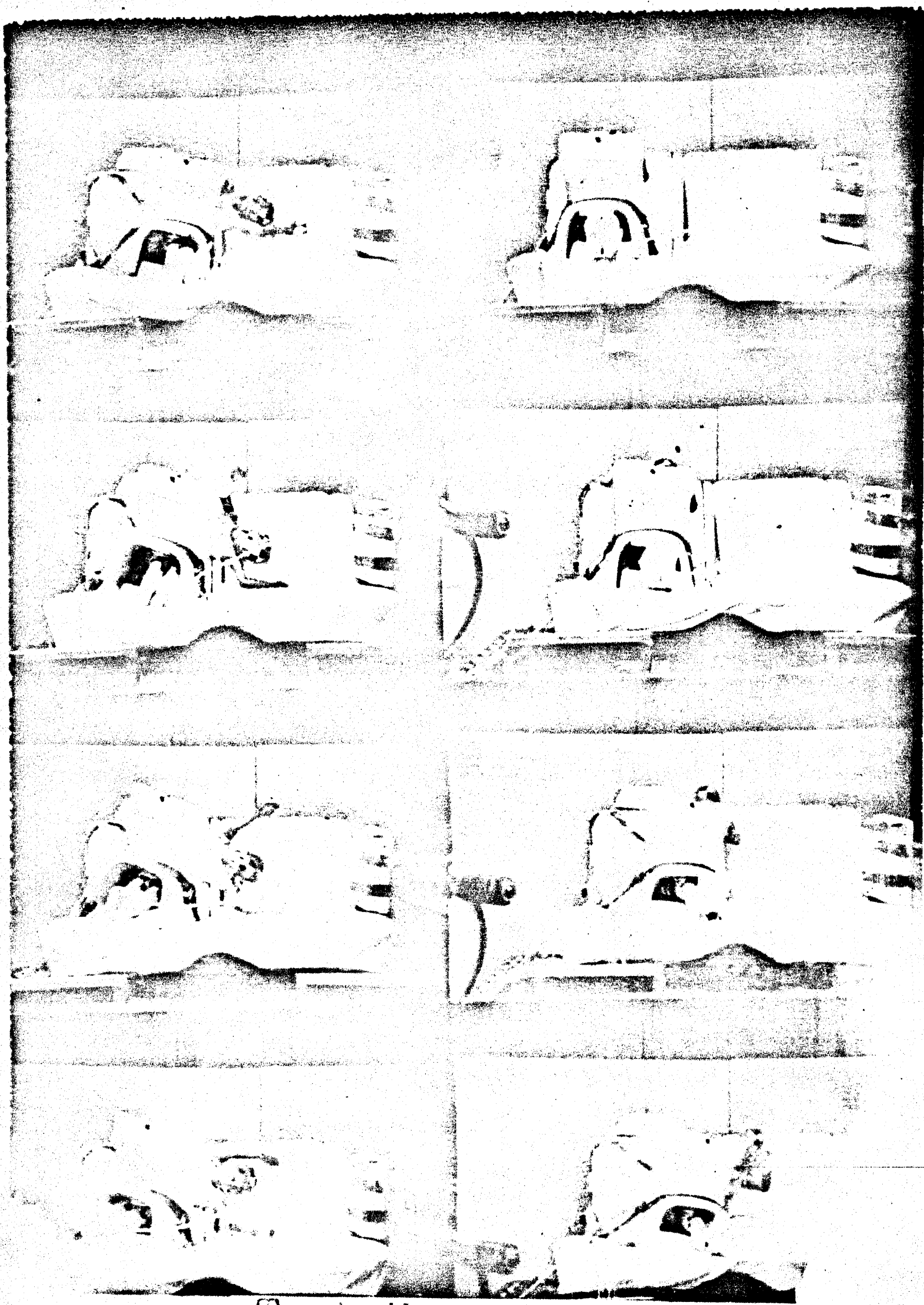
Impact Direction: Side

Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The dummy torso and head bent sideways over the low support structure at the side of the Tot Guard. Contact with the vehicle interior side structure is likely. The dummy's arm hit the side of his head giving a right-left acceleration spike.

1



8

Test No.: A-541

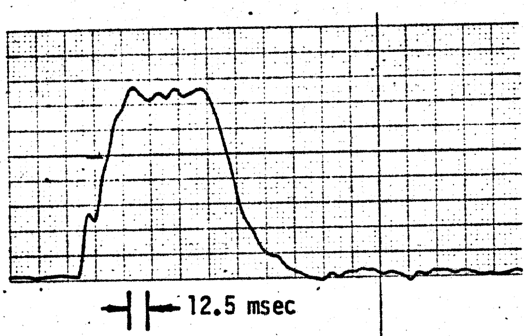
FIGURE A-10. GRAPHCHEK SEQUENCE CAMERA

SUMMARY DATA HEAD ACCELERATIONS

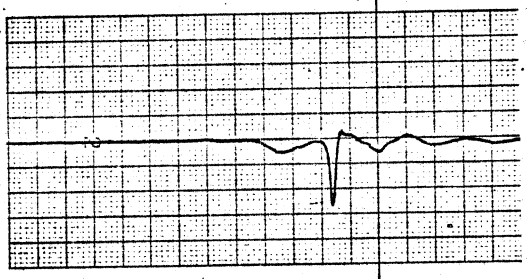
Test Number A 541 Test Type FORD TOT GAURD

Dummy 3 YEARS OLD SIDE - 20 MPH

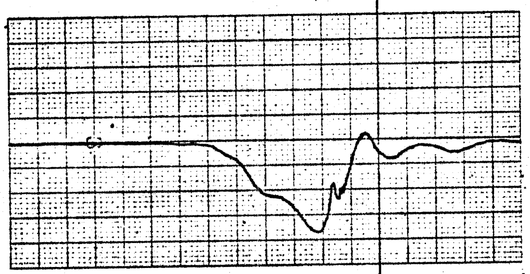
Sled Velocity 2926 ft/sec



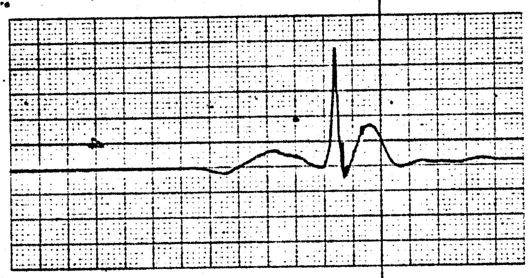
Sled Pulse
2 g's/division
Filtered
Class 60



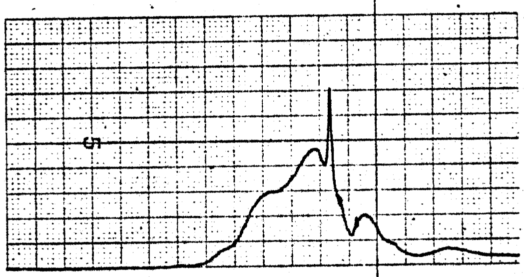
Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



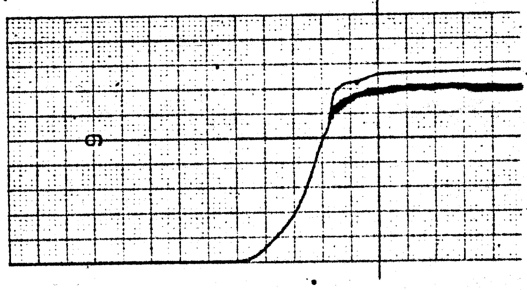
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000



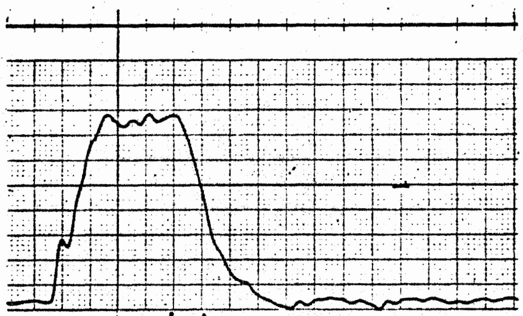
Severity Index
50 $g^{2.5}$ sec/div.

SUMMARY DATA CHEST ACCELERATIONS

Test Number A541
Dummy 3 YEAR OLD
Sled Velocity 29.26 ft/sec

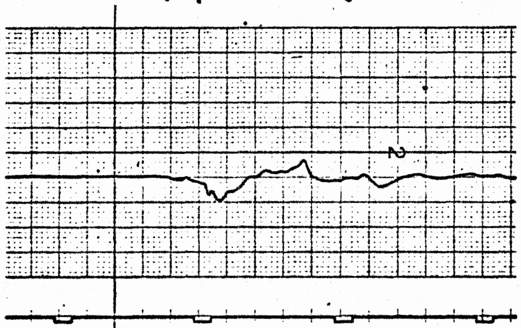
Test Type FORD TOT GAURD
SIDE - 20 MPH

Sled Pulse
2 g's/division
Filtered
Class 60

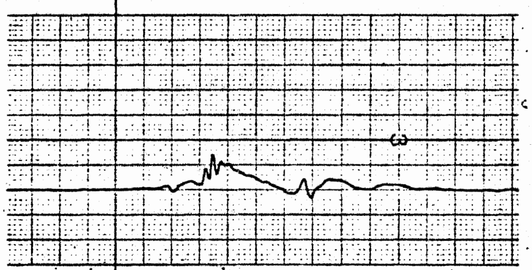


12.5 msec

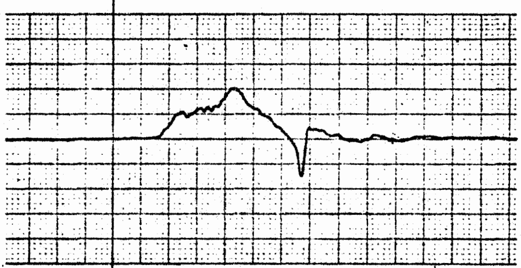
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



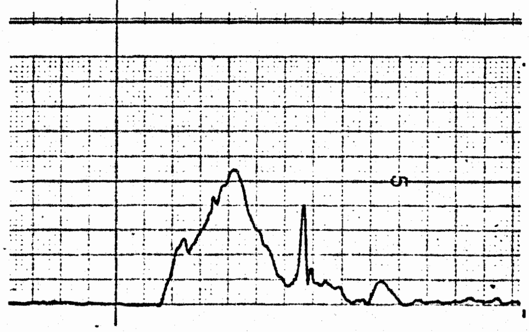
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-532
Test Date:	February 23, 1972
Restraint Description:	Sears Harness (Small)
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The dummy motion was minimal. No damage was observed to the restraint system. Head accelerations were high. The rebound due to the elastic energy, was observed to be very large.

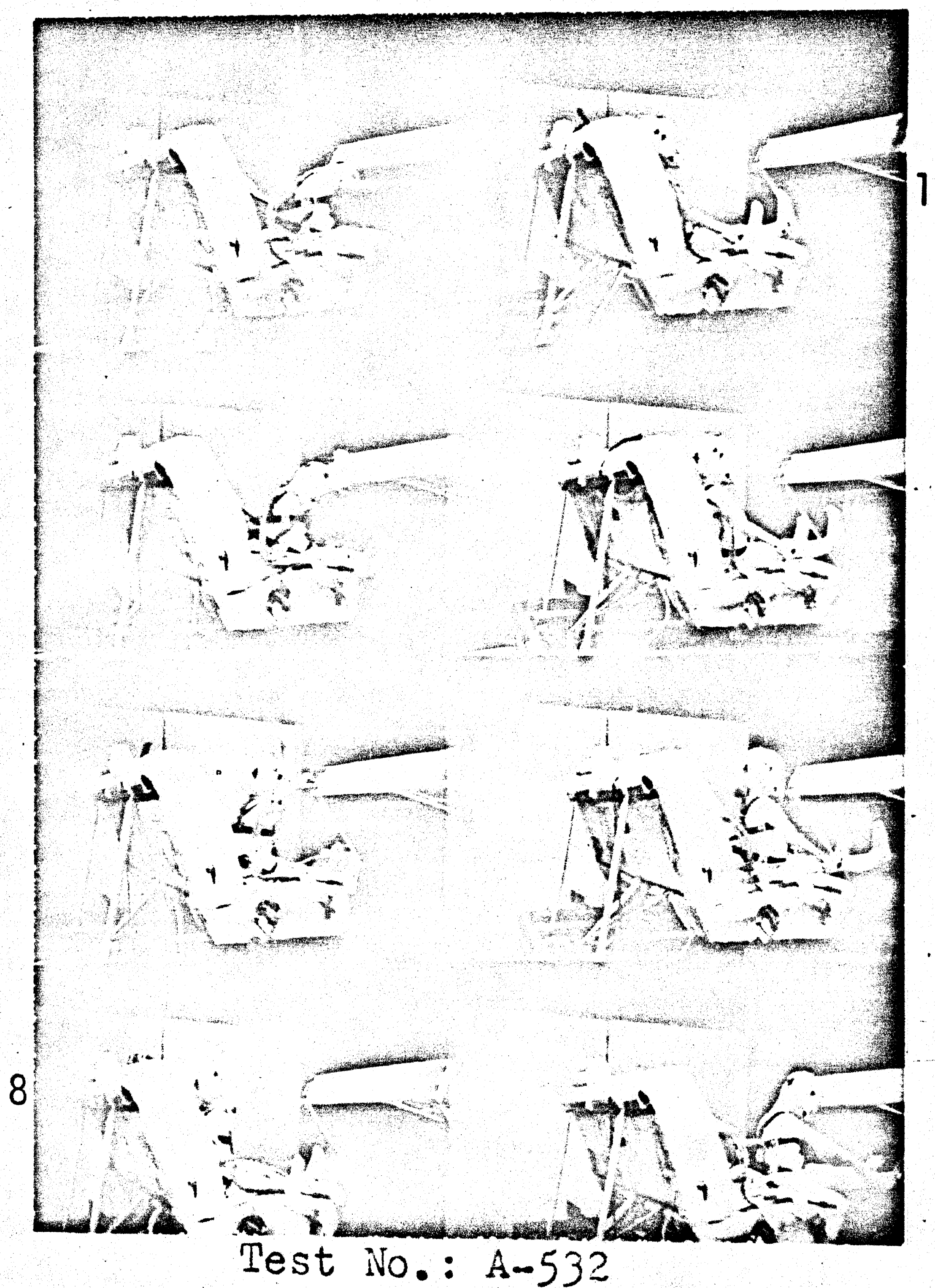


FIGURE A-11. GRAPHCHEK SEQUENCE CAMERA

SUMMARY DATA HEAD ACCELERATIONS

Test Number A - 532 Test Type SEARS HARNESS FRONT - 30 MPH

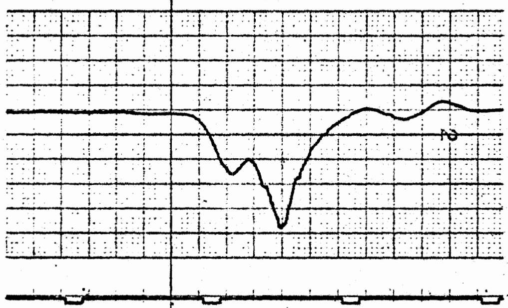
Dummy 3 YEARS OLD

Sled Velocity 43.3 ft/sec

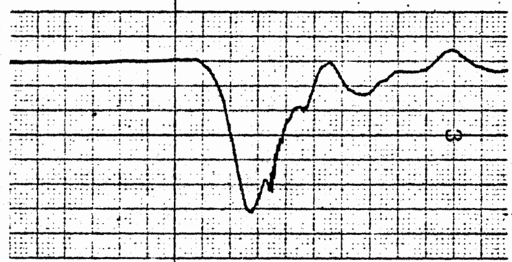
Sled Pulse
5 g's/division
Filtered
Class 60

12.5 msec

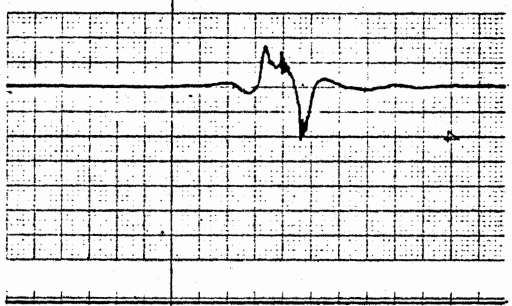
Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

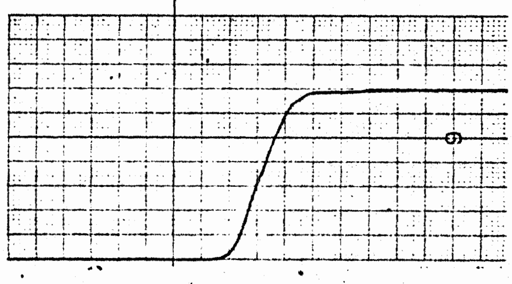


Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000

Severity Index
200 $g^{2.5}$ sec/div.

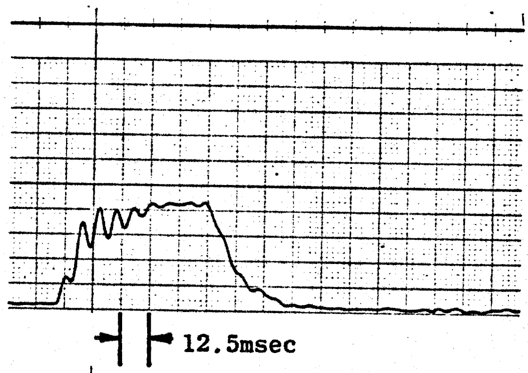


SUMMARY DATA CHEST ACCELERATIONS

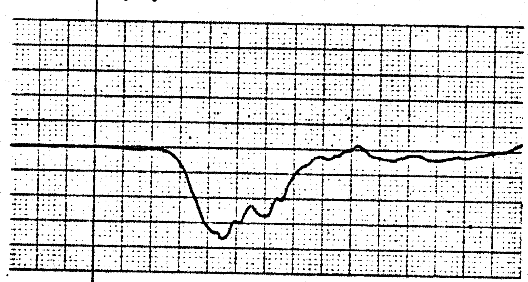
Test Number A532
Dummy 3 YEARS OLD
Sled Velocity 43.3 ft/sec

Test Type SEARS HARNESS
FRONT - 30 MPH

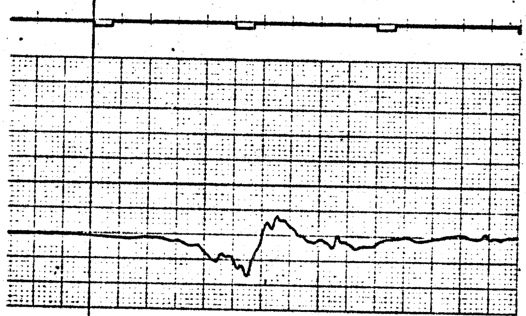
Sled Pulse
5 g's/division
Filtered
Class 60



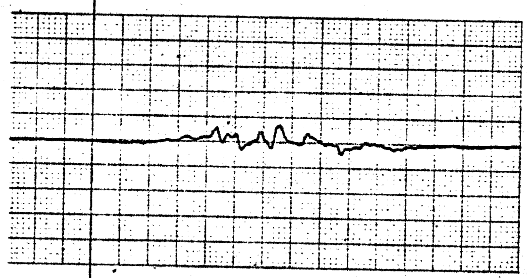
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



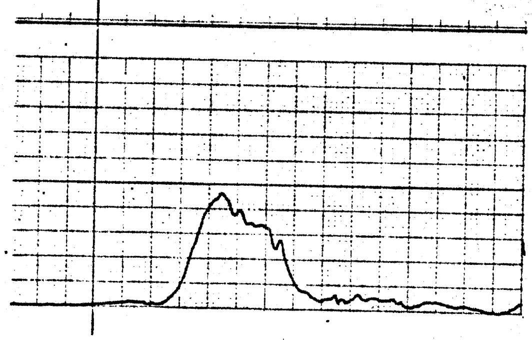
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600

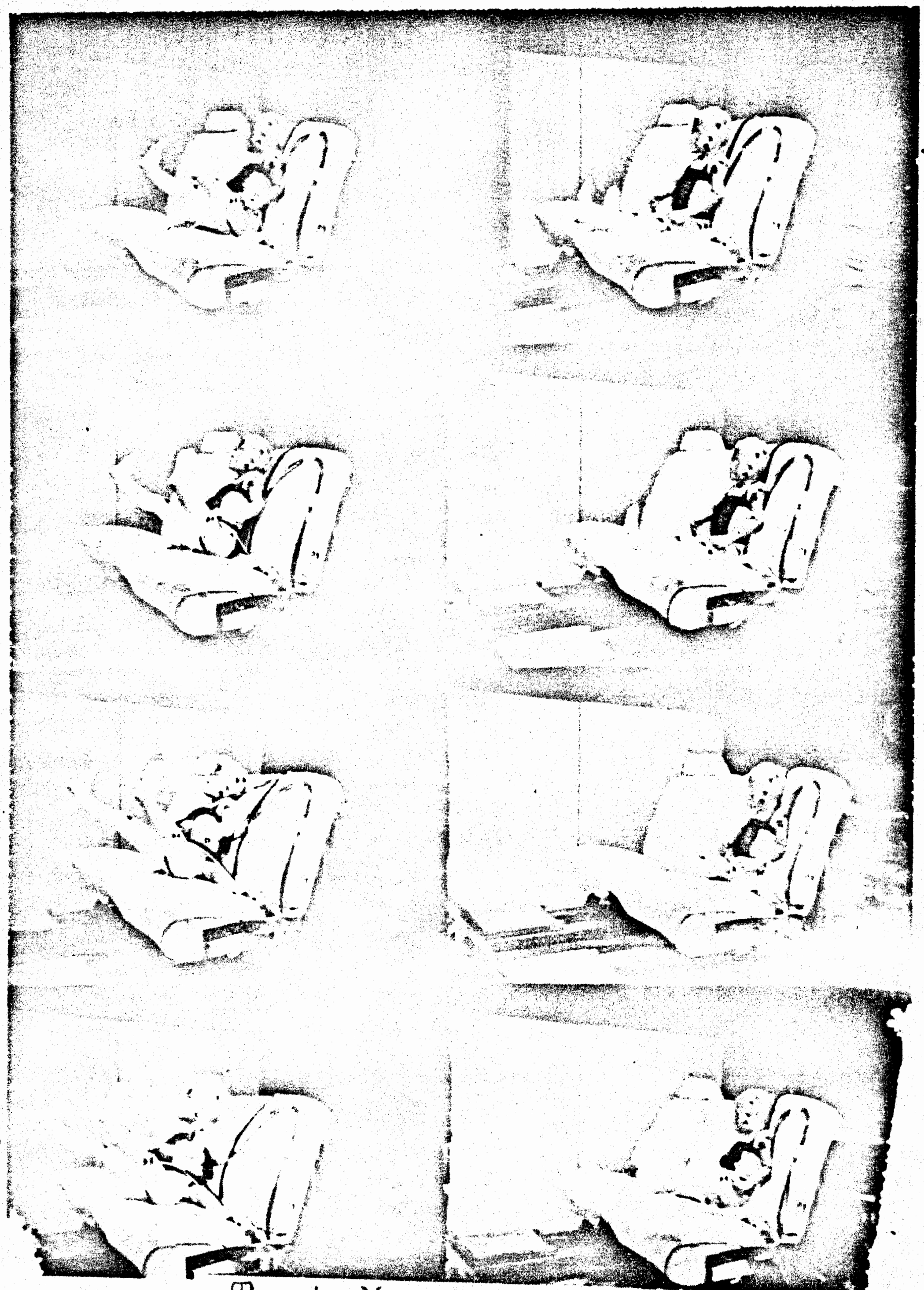


HSRI SUMMARY DATA SHEET

Test Number:	A-537
Test Date:	February 24, 1972
Restraint Description:	Sears Harness (Small)
Dummy:	3-Year
Sled Velocity:	20 mph
Sled G-Level:	15
Impact Direction:	Back
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Dummy's head struck a support used to reinforce the adult seat belt. Aside from this, no gross loadings of motions were observed.



Test No.: A-537

FIGURE A-12. GRAPHCHEK SEQUENCE CAMERA

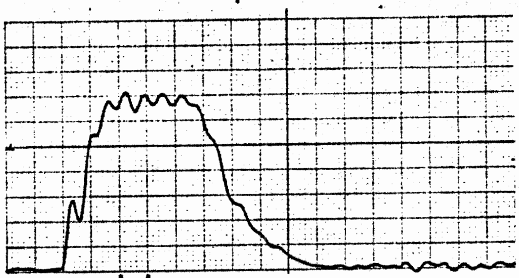
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-537 Test Type SEARS HARNESS BACK - 20 MPH

Dummy 3 YEARS OLD

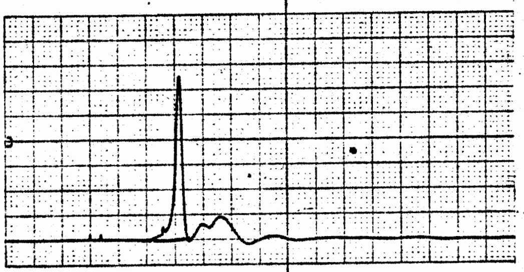
Sled Velocity 29.42 ft/sec

Sled Pulse
2 g's/division
Filtered
Class 60

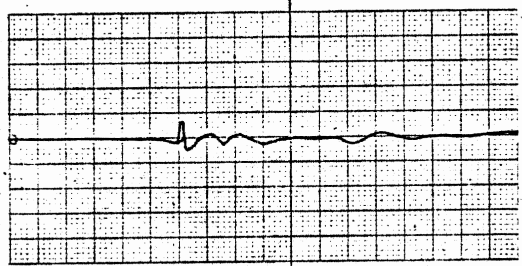


12.5 msec

Anterior-Posterior
Head Acceleration
25 g's/division
Filtered
Class 1000



Superior-Inferior
Head Acceleration
25 g's/division
Filtered
Class 1000



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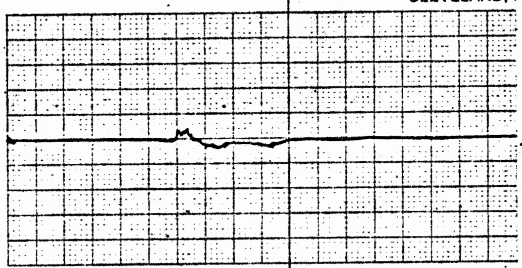
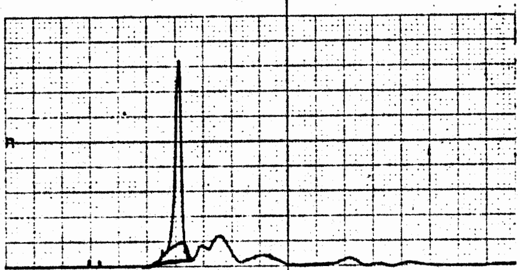
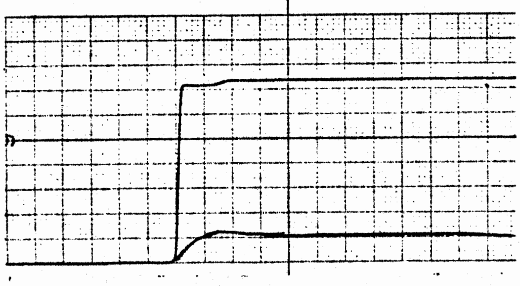
Left-Right
Head Acceleration
25 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
100 $g^{2.5}$ sec/div.

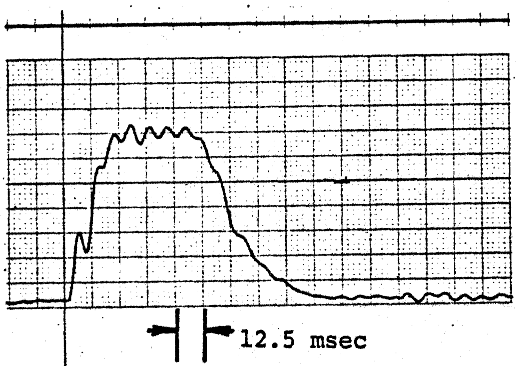


SUMMARY DATA CHEST ACCELERATIONS

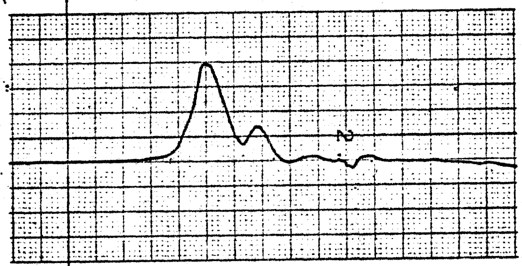
Test Number A537
Dummy 3 YEARS OLD
Sled Velocity 29.42 ft/sec

Test Type SEARS HARNESS BACK — 20 MPH

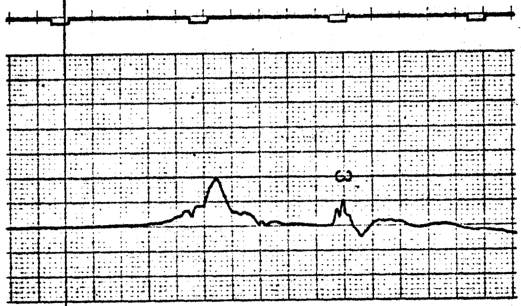
Sled Pulse
2 g's/division
Filtered
Class 60



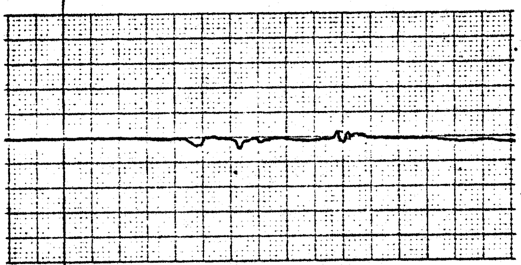
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



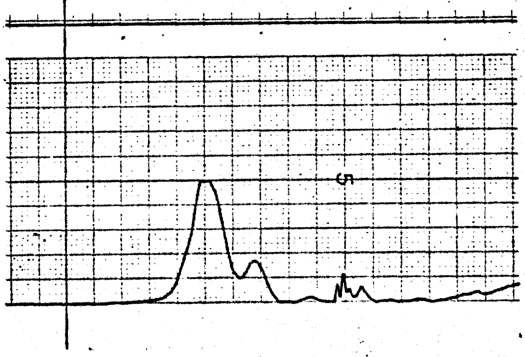
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-540
Test Date:	February 28, 1972
Restraint Description:	Sears Harness (Small)
Dummy:	3-Year
Sled Velocity:	20 mph
Sled G-Level:	15
Impact Direction:	Side
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The dummy received a very gentle ride. The excursion was such that the likelihood of contact with the car side structure is great. Head and chest accelerations were low.

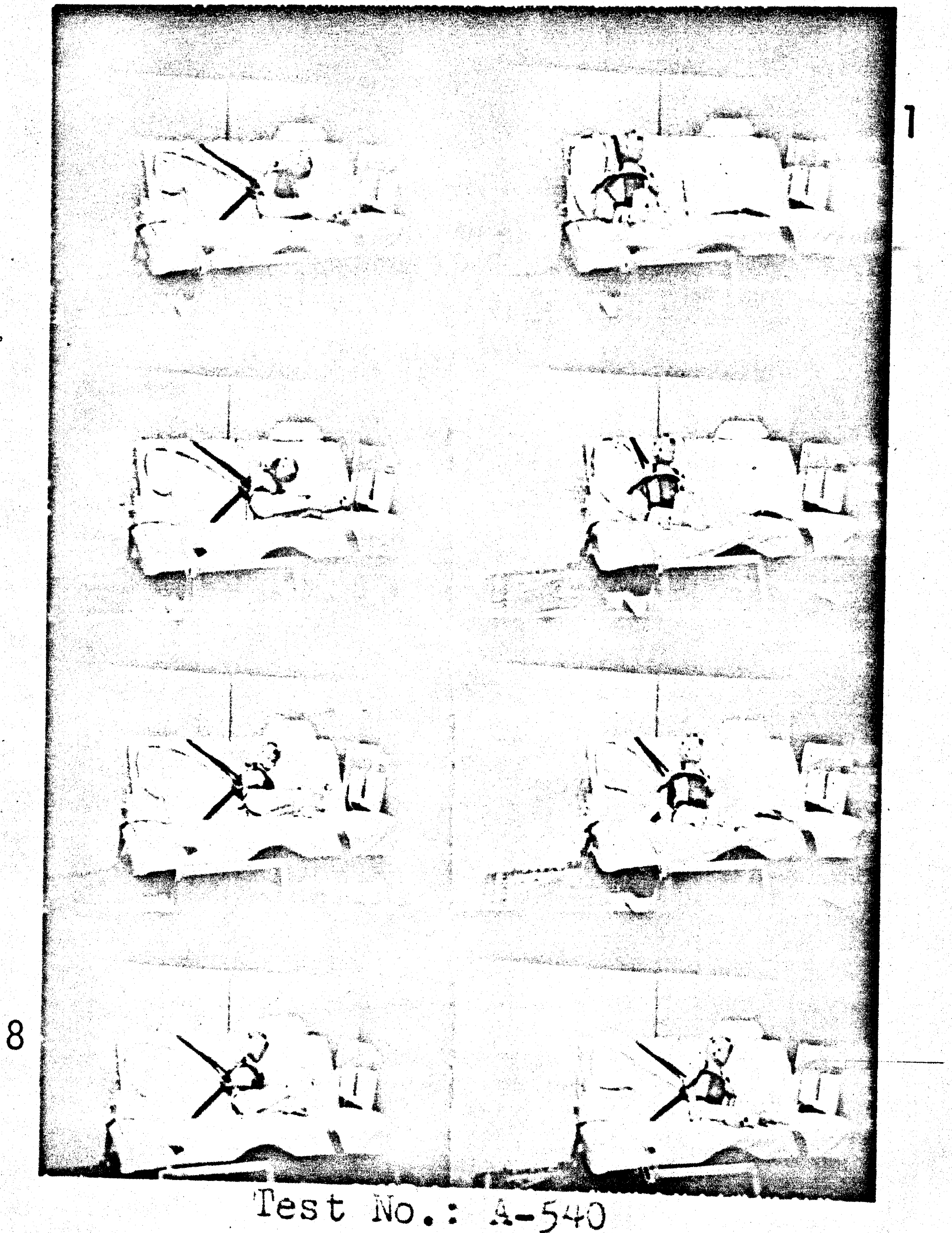


FIGURE A-13. GRAPHCHEK SEQUENCE CAMERA

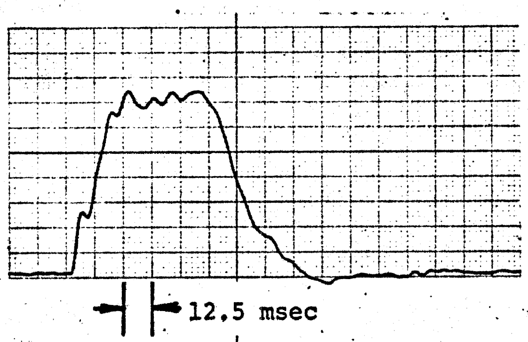
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-540 Test Type SEARS HARNESS-

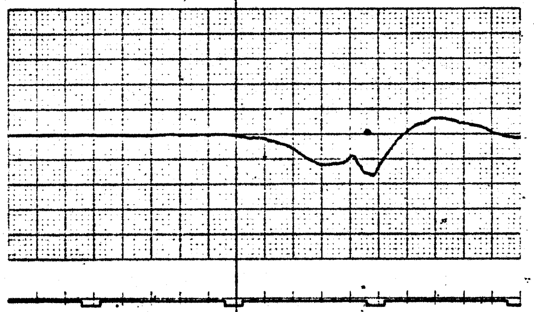
Dummy 3 YEARS OLD SIDE - 20MPH

Sled Velocity 29.17 ft/sec

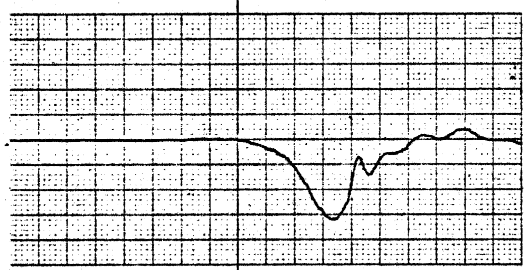
Sled Pulse
2 g's/division
Filtered
Class 60



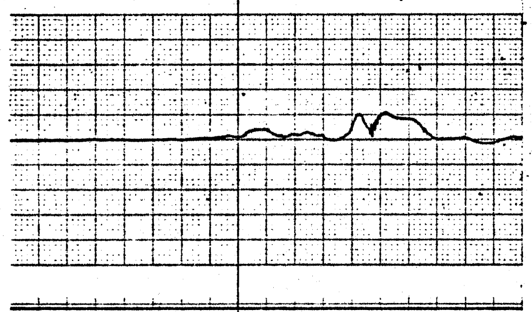
Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



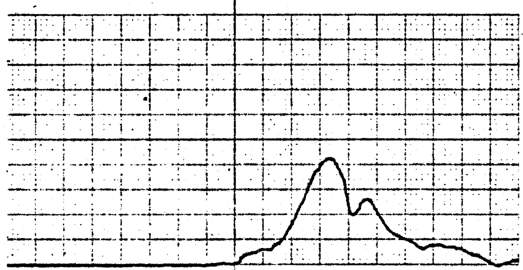
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



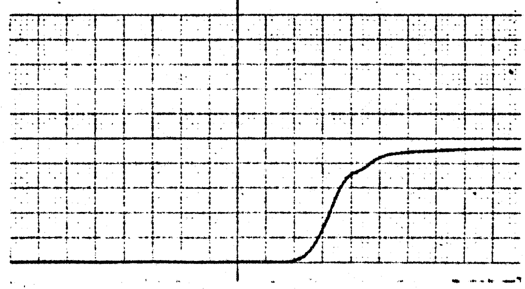
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000



Severity Index
50 $g^{2.5}$ sec/div.

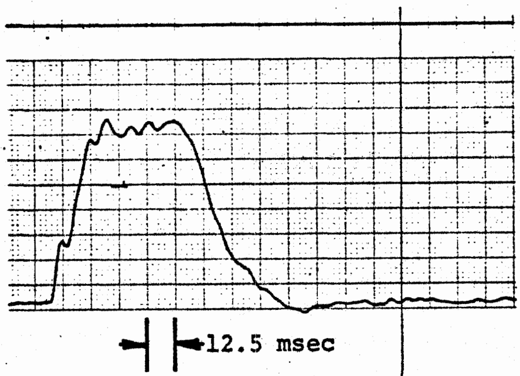


SUMMARY DATA CHEST ACCELERATIONS

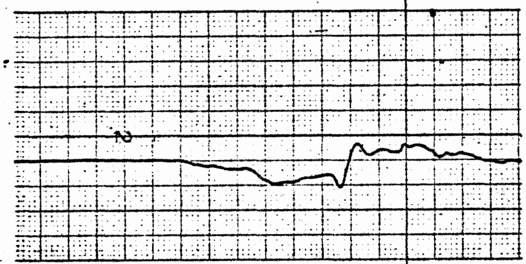
Test Number A590
Dummy 3 YEARS OLD
Sled Velocity 29.17 ft/sec

Test Type SEARS HARNESS
SIDE - 20 MPH

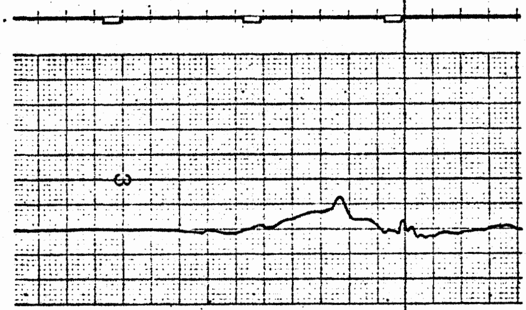
Sled Pulse
2 g's/division
Filtered
Class 60



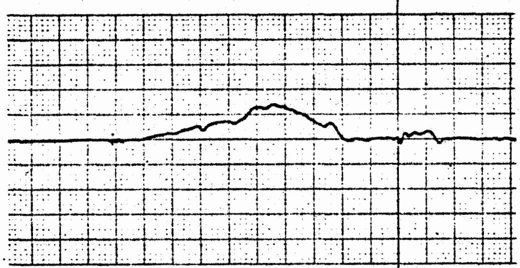
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



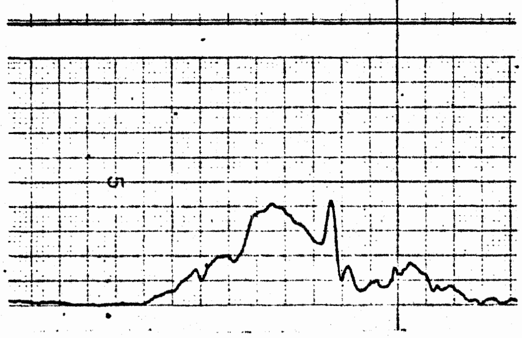
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600

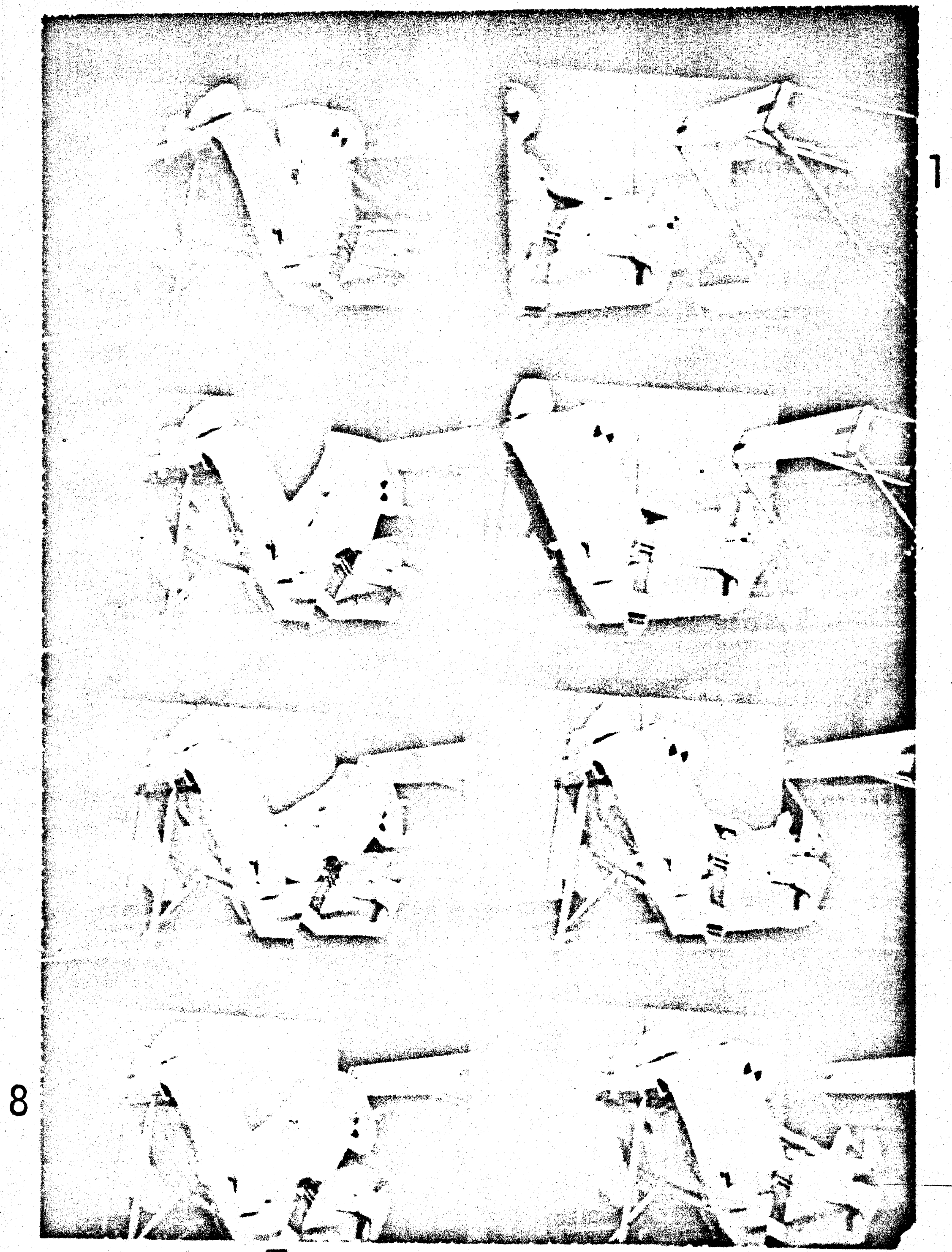


HSRI SUMMARY DATA SHEET

Test Number:	A-521
Test Date:	February 21, 1972
Restraint Description:	Klippan Safety Seat
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The dummy motion was minimal. The fiberglass shell was fractured on each side where the adult seat belt crosses the child seat. The dummy appeared to submarine under the child harness and contacted the adult seat belt causing the back of the dummy to be jammed. Head and chest acceleration were low.



Test No.: A-521

FIGURE A-14. GRAPHCHEK SEQUENCE CAMERA

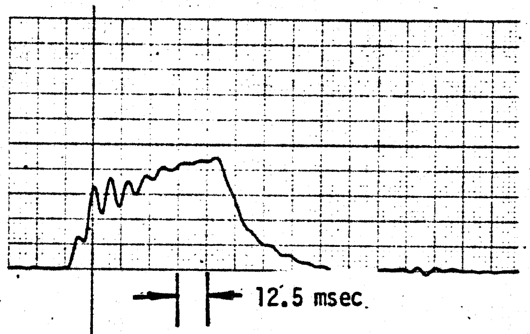
SUMMARY DATA HEAD ACCELERATIONS

Test Number A 521 | Test Type KLIPPAN

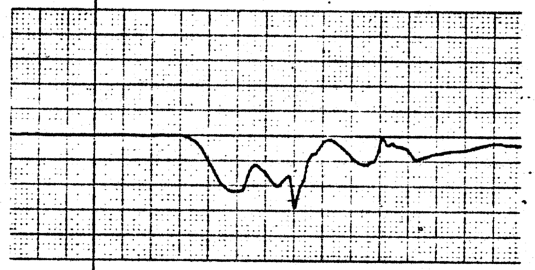
Dummy 3 YEARS OLD | FRONT – 30 MPH

Sled Velocity 44.06 ft/sec

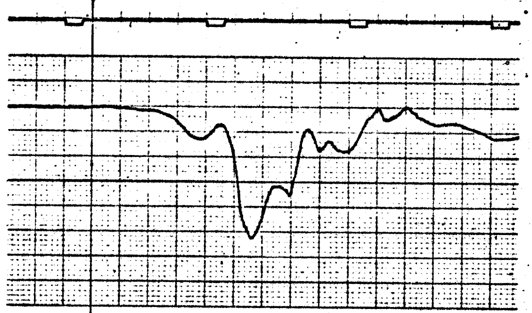
Sled Pulse
5 g's/division
Filtered
Class 60



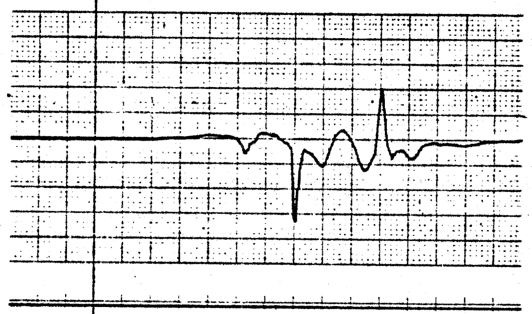
Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



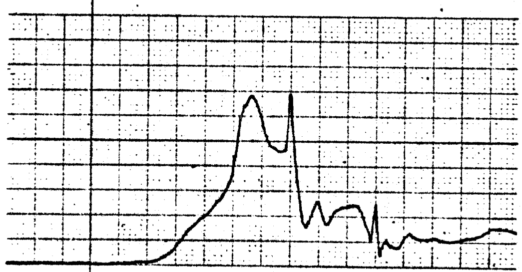
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



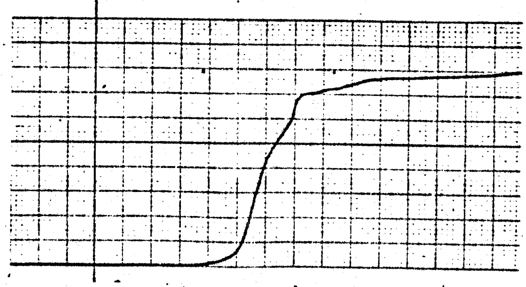
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000



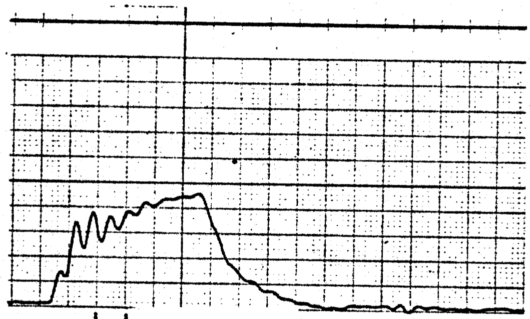
Severity Index
100 $g^{2.5}$ sec/div.



SUMMARY DATA CHEST ACCELERATIONS

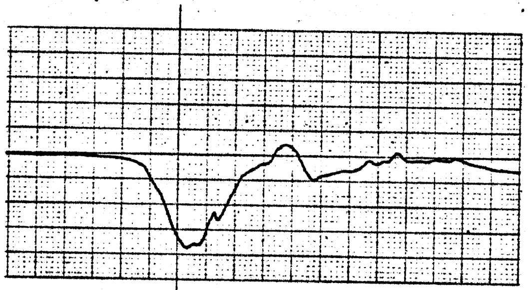
Test Number A521 Test Type KLIPPAN
Dummy 3 YEARS OLD FRONT - 30 MPH
Sled Velocity 44.06 ft/sec

Sled Pulse
5 g's/division
Filtered
Class 60

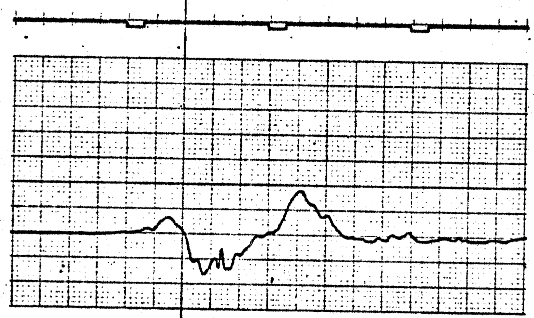


12.5 msec

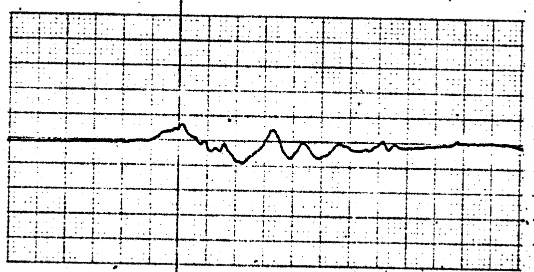
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



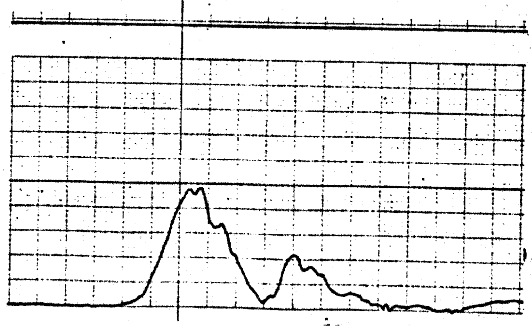
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-546
Test Date:	29 February 1972
Restraint Description:	Thayer Bobby-Mac
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The motions experienced by the dummy were minimal. The seat failed where the adult lap belt is secured allowing the dummy to go into the adult belt very hard. Head accelerations were high.

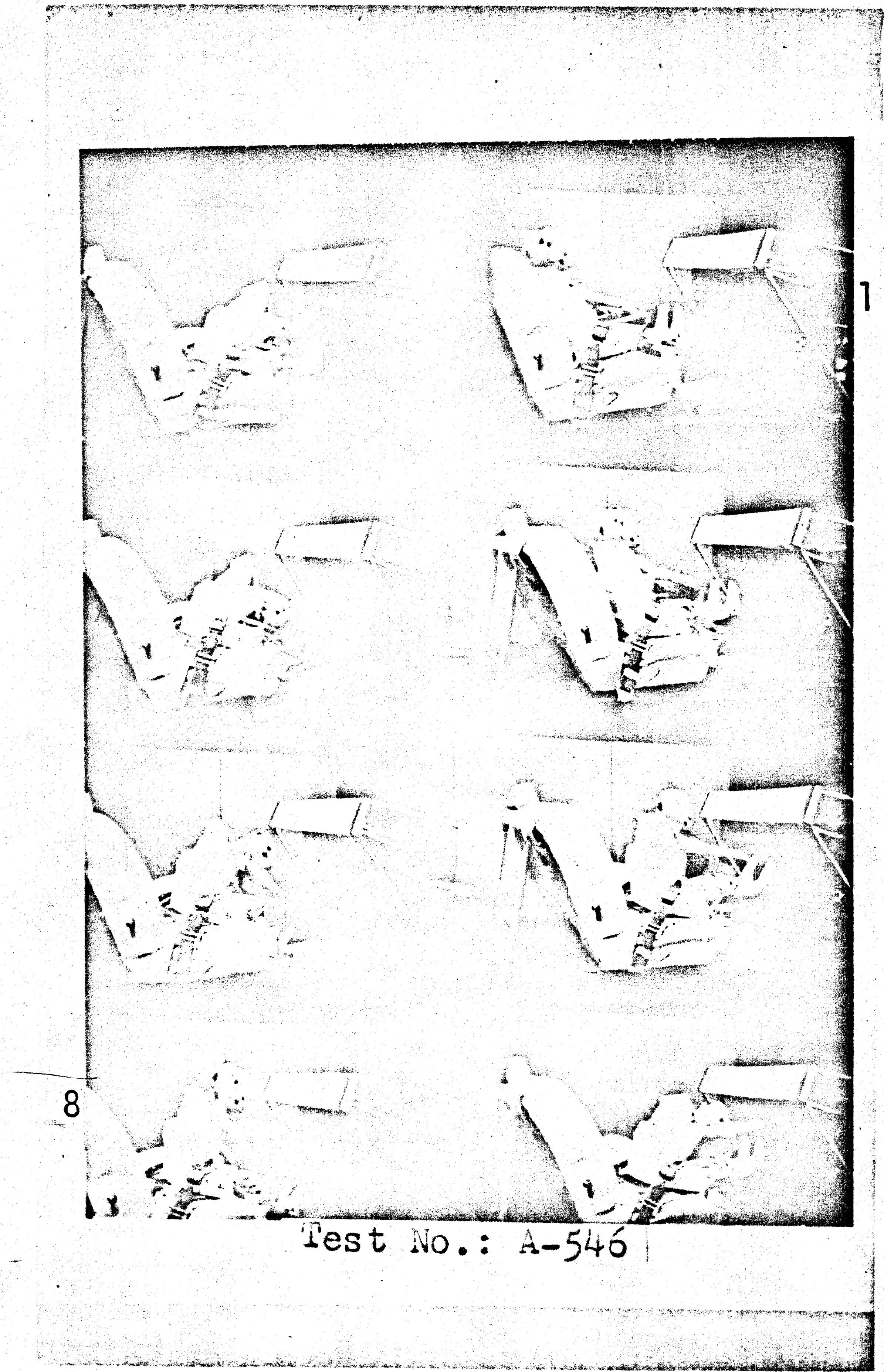


FIGURE A-15. GRAPHCHEK SEQUENCE CAMERA

SUMMARY DATA HEAD ACCELERATIONS

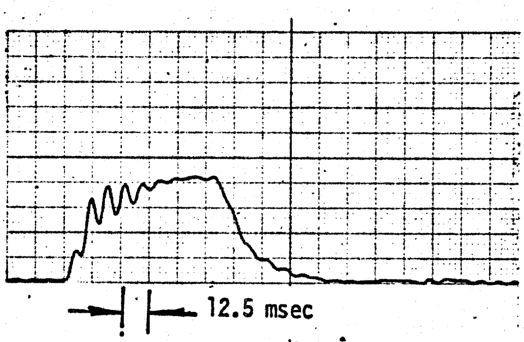
Test Number A- 546

Dummy 3 YEARS OLD

Sled Velocity 44.3 ft/sec

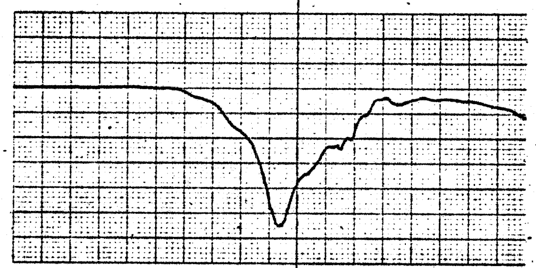
Test Type THAYER'S BOBBY MAC FRONT - 30 MPH

Sled Pulse
5 g's/division
Filtered
Class 60

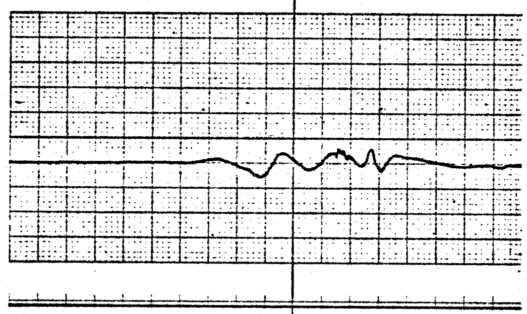


Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

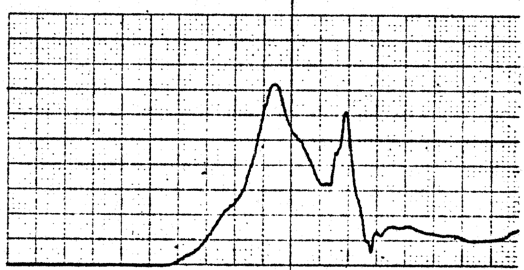
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



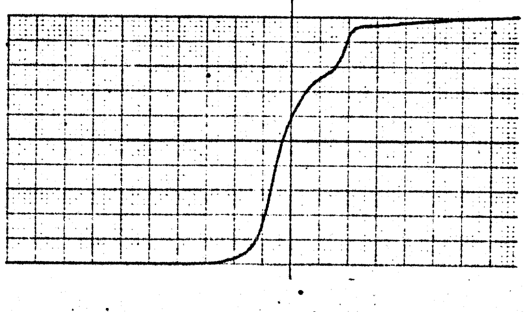
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000



Severity Index
100 $g^{2.5}$ sec/div.



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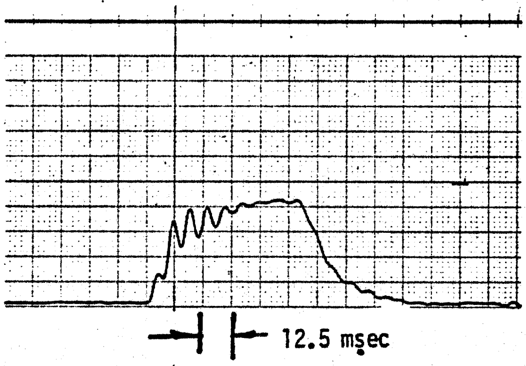
SUMMARY DATA CHEST ACCELERATIONS

Test Number A546 Test Type THAYER'S BOBBY MAC

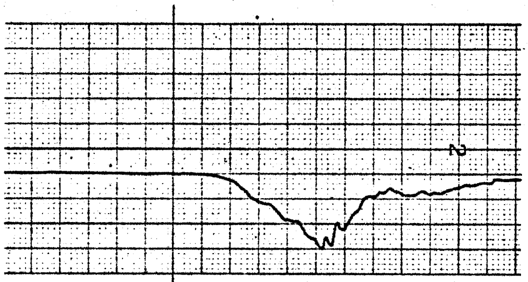
Dummy 3 YEARS OLD FRONT - 30 MPH

Sled Velocity 44.3 ft/sec

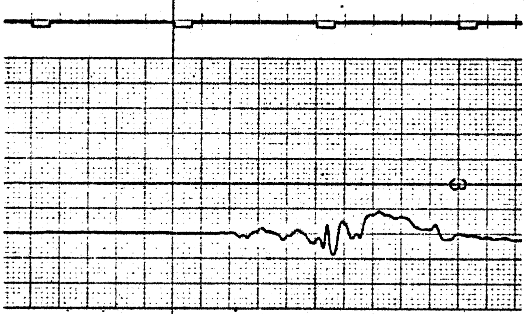
Sled Pulse
5 g's/division
Filtered
Class 60



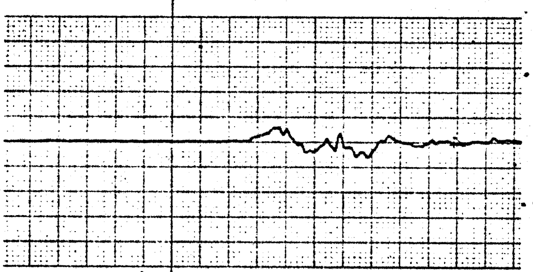
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



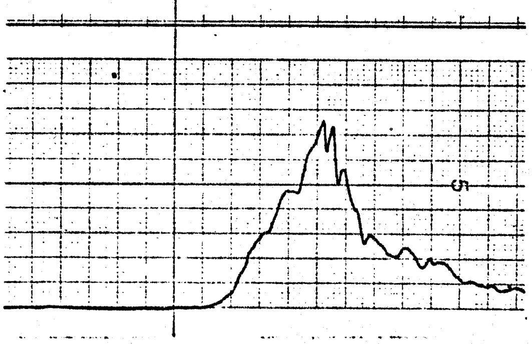
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-522
Test Date:	February 21, 1972
Restraint Description:	Strolee Model 590
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

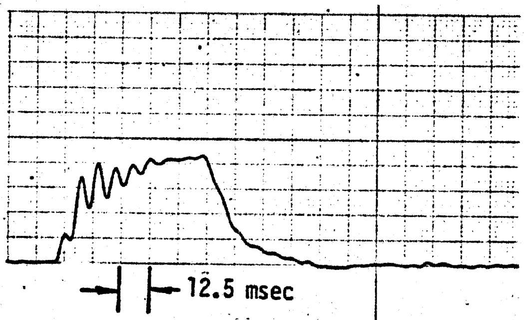
The seat structure collapsed allowing the dummy to move forward and contact the simulated dash board. The seat bent and then held the dummy in a bent over position so that the harness buckle was buried in the abdomen, and could not be unbuckled. The head and chest G loads were high.

FIGURE A-16. GRAPHCHEK SEQUENCE CAMERA

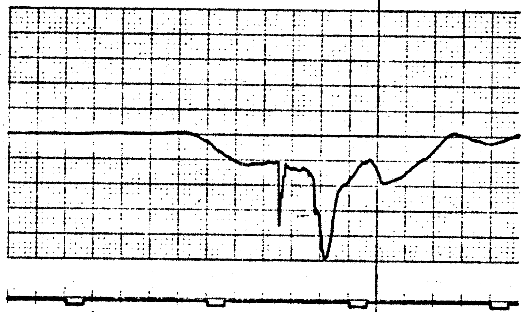
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-522 Test Type STROLEE MODEL 590
Dummy 3 YEARS OLD FRONT - 30 MPH
Sled Velocity 43.25 ft/sec

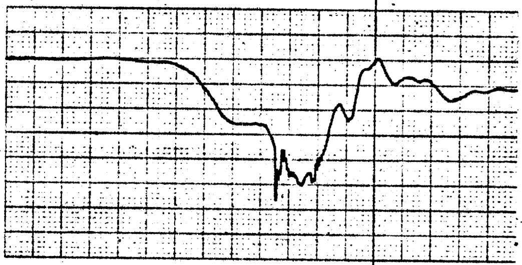
Sled Pulse
5 g's/division
Filtered
Class 60



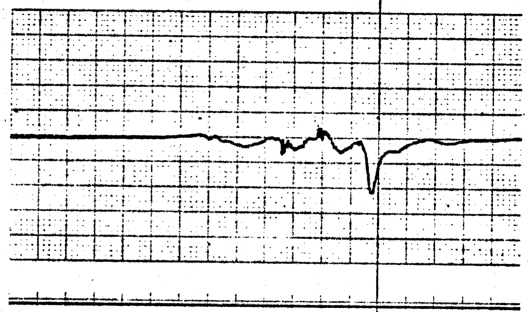
Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



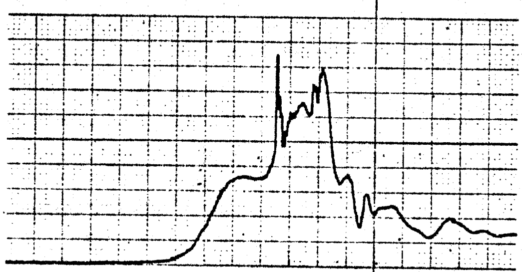
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



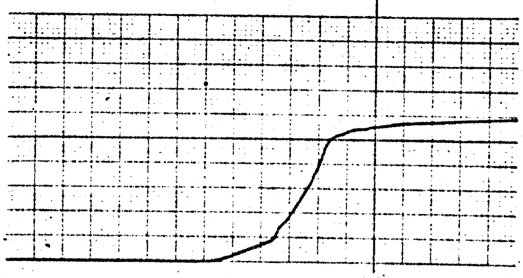
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000



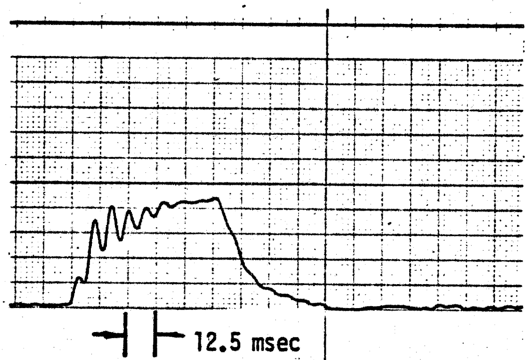
Severity Index
200 $g^{2.5}$ sec/div.



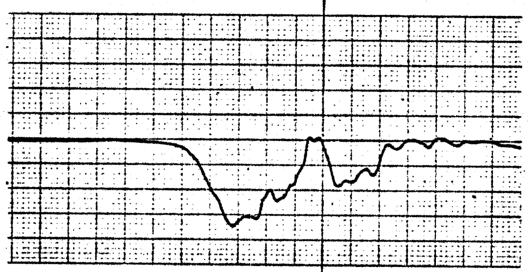
SUMMARY DATA CHEST ACCELERATIONS

Test Number A522 | Test Type STROLEE MODEL 590
Dummy 3 YEARS OLD | FRONT – 30 MPH
Sled Velocity 43.25 ft/sec

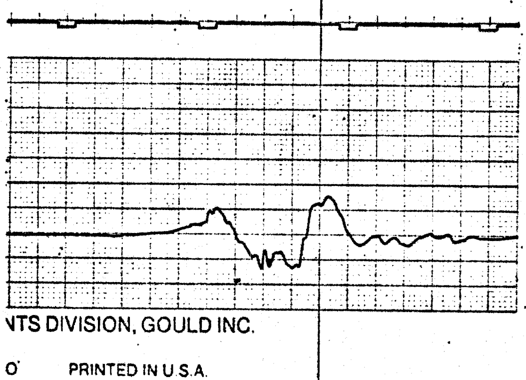
Sled Pulse
5 g's/division
Filtered
Class 60



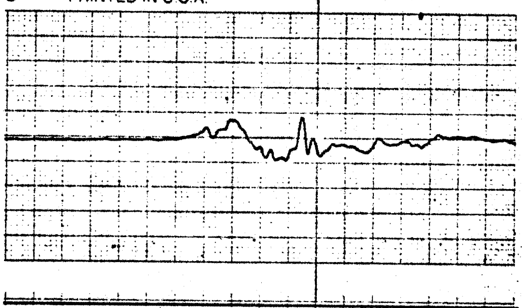
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



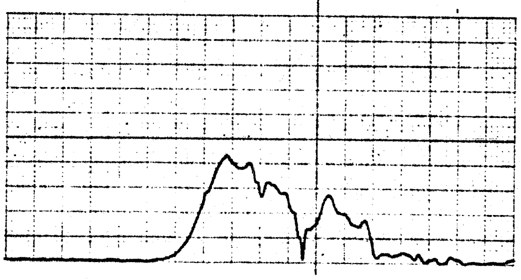
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-523
Test Date:	February 21, 1972
Restraint Description:	Trimble Model 875
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Semi-reclining, facing toward the front of the simulated vehicle.

Test Observation:

The seat structure collapsed allowing the dummy to move forward and contact the simulated dash board. The collapse of the seat back wedged the dummy forward out of the seat causing the lap and torso belt on the dummy to be pulled very tight. The head and chest accelerations were low.

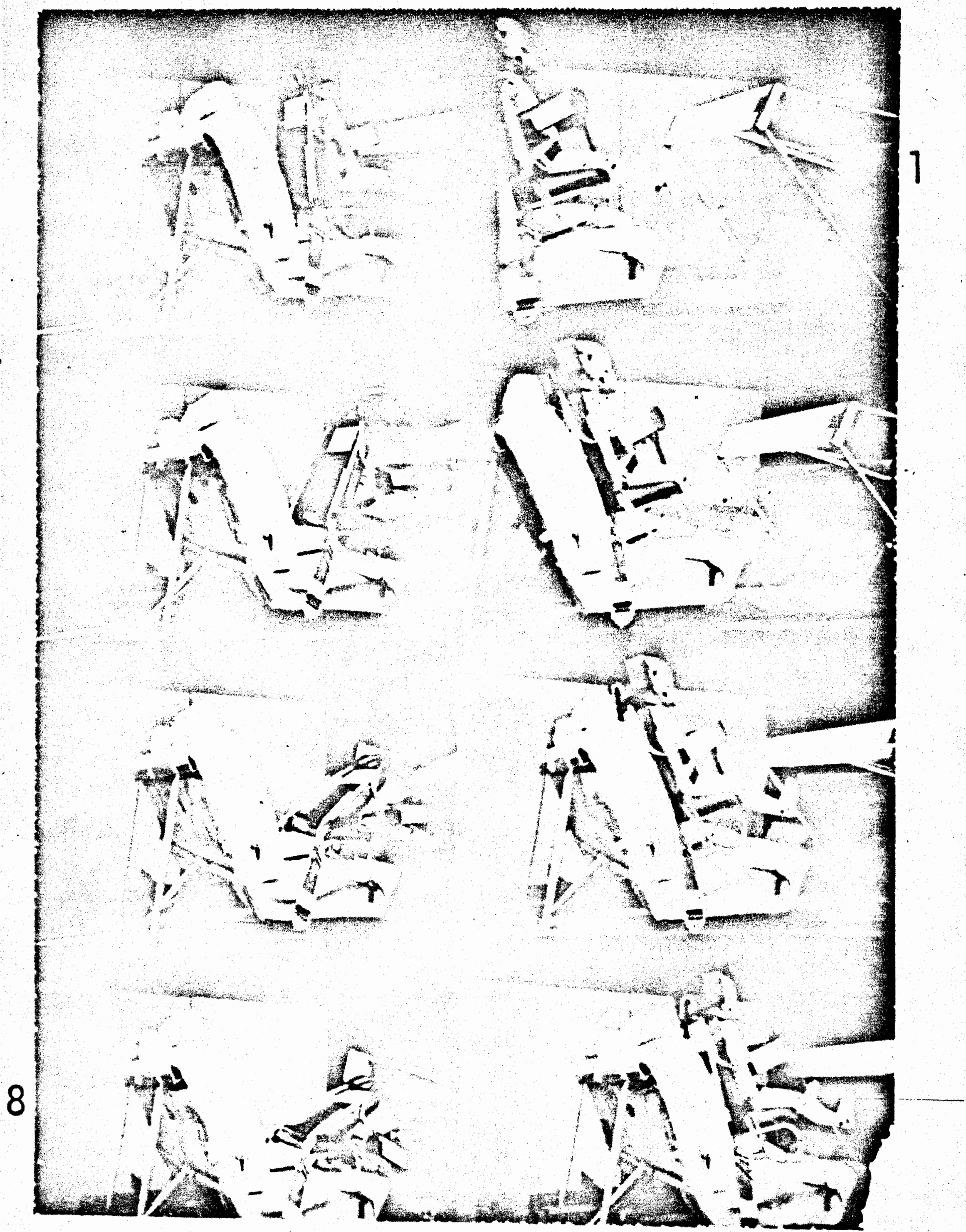


FIGURE A-17. GRAPHCHEK SEQUENCE CAMERA

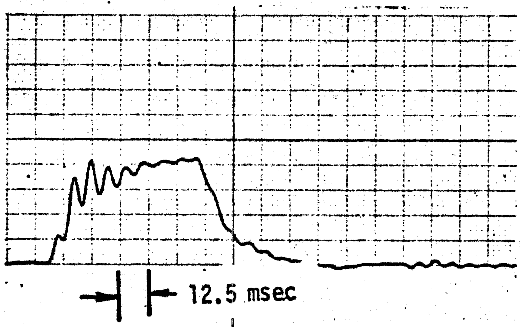
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-523　　Test Type TRIMBLE MODEL 875

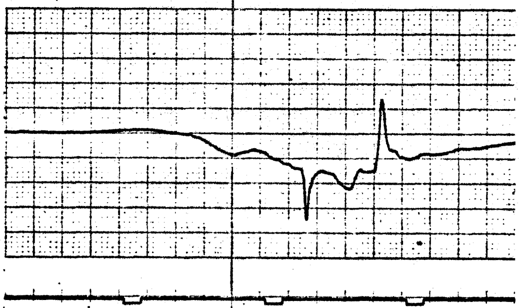
Dummy 3 YEARS OLD　　FRONT - 30 MPH

Sled Velocity 43.54 ft/sec

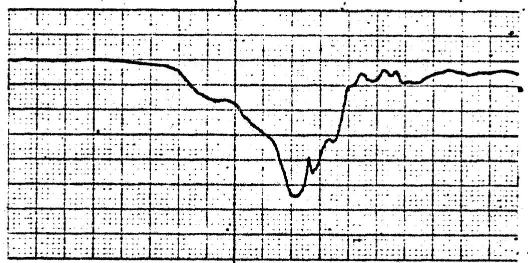
Sled Pulse
5 g's/division
Filtered
Class 60



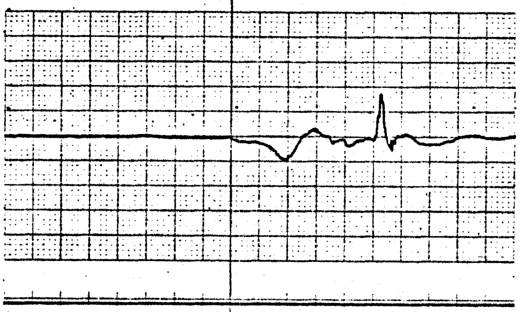
Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

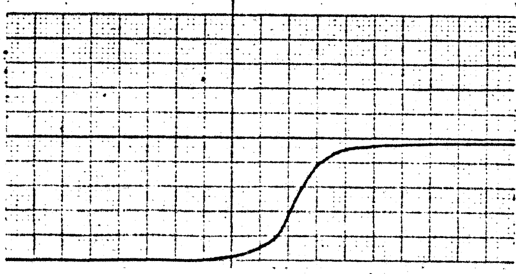


Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
10 g's/division
Filtered
Class 1000

Severity Index
200 $g^{2.5}$ sec/div.

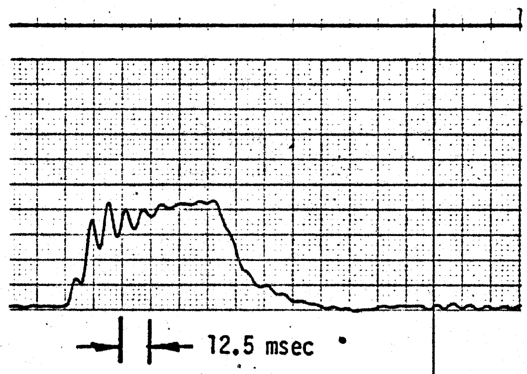


SUMMARY DATA CHEST ACCELERATIONS

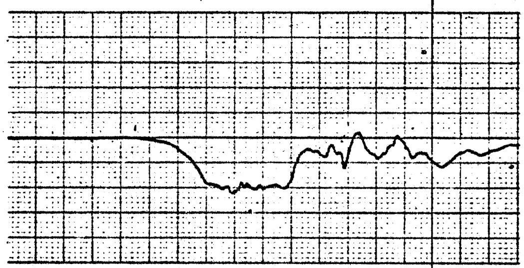
Test Number A523
Dummy 3 YEARS OLD
Sled Velocity 43.54 ft/sec

Test Type TRIMBLE MODEL 875
FRONT — 30 MPH

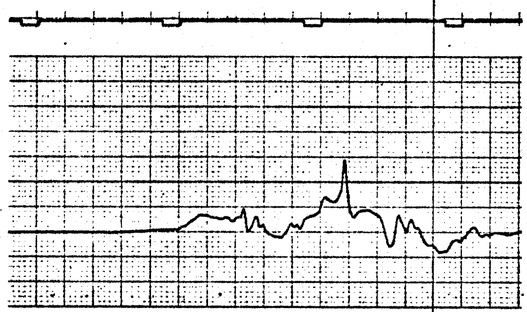
Sled Pulse
5 g's/division
Filtered
Class 60



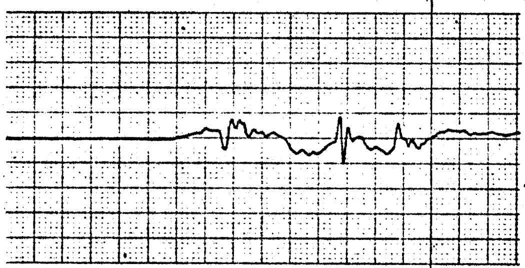
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



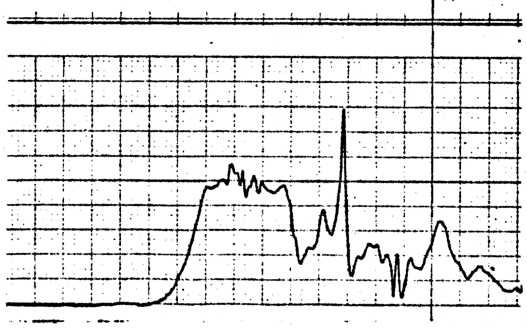
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-525
Test Date:	February 22, 1972
Restraint Description:	Jamy Model 5500
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The seat back bent forward allowing the dummy to move forward and contact the simulated dash board. The dummy's back was bent so much that the back links jammed. The base of the seat broke. The lap belt was pulled very tight around the dummy's mid-section. Head accelerations were high.

FIGURE A-18. GRAPHCHEK SEQUENCE CAMERA

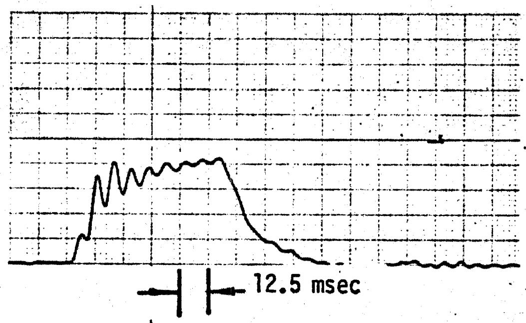
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-525 Test Type JAMY MODEL 5500

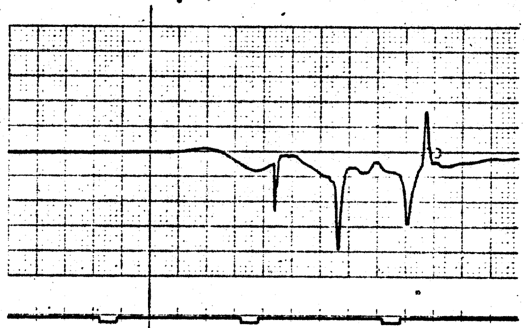
Dummy 3 YEARS OLD FRONT - 30 MPH

Sled Velocity 43.3 ft/sec

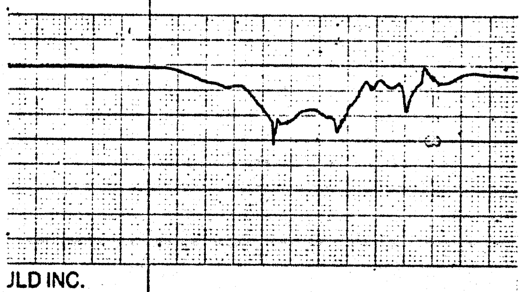
Sled Pulse
5 g's/division
Filtered
Class 60



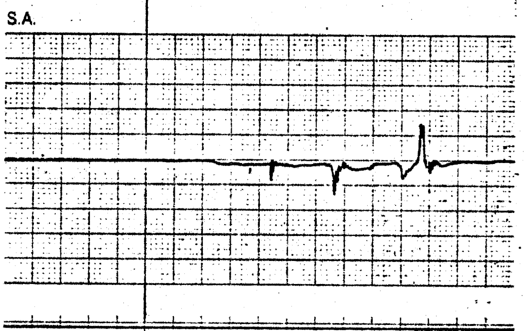
Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



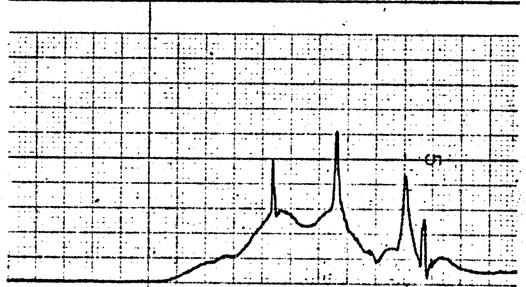
Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



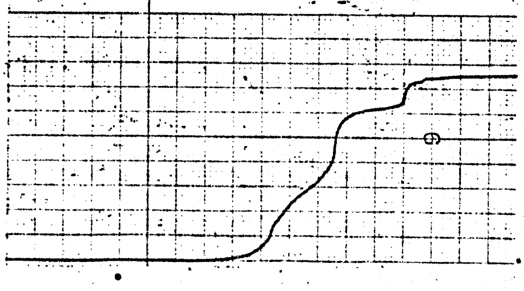
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.

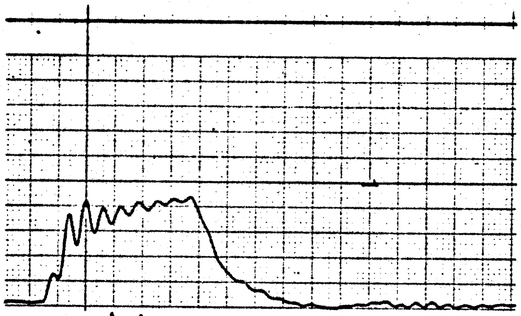


SUMMARY DATA CHEST ACCELERATIONS

Test Number A525
Dummy 3 YEARS OLD
Sled Velocity 43.3 ft/sec

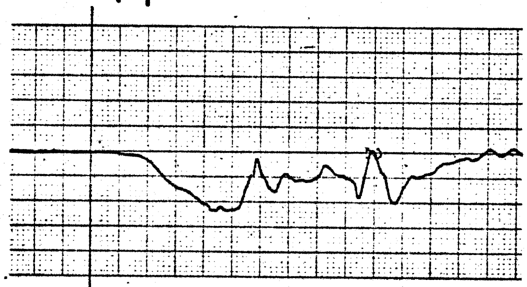
Test Type JAMY MODEL 5500
FRONT - 30 MPH

Sled Pulse
5 g's/division
Filtered
Class 60

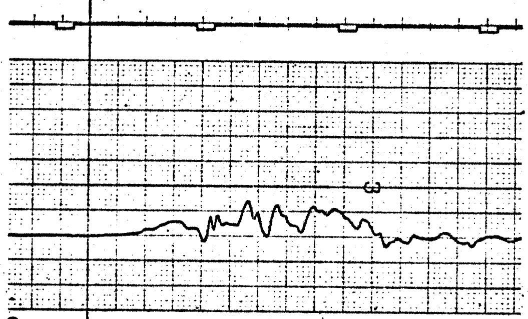


12.5 msec

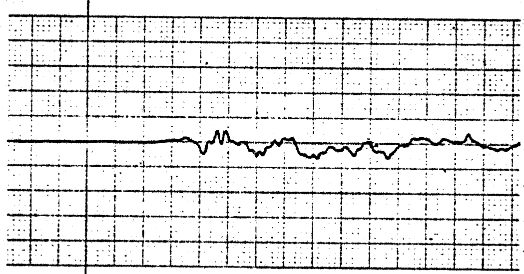
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



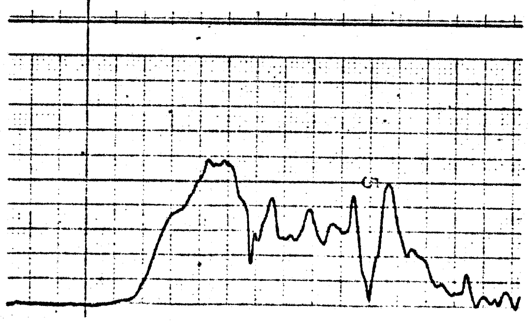
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-524
Test Date:	February 23, 1972
Restraint Description:	Kantwet Model 872
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Reclining, facing toward the front of the simulated vehicle.

Test Observation:

The child seat rotated forward and down until the child seat bottomed on the car seat. The dummy moved forward far enough to contact the simulated dash board. The torso belt slipped down and off the dummy's chest allowing the dummy to bend over the adult lap belt. The adult belt loads were very high, as was the head acceleration.

NOTE: The tape record of this test was lost. The data used in evaluation and computation was obtained from the oscillograph record.

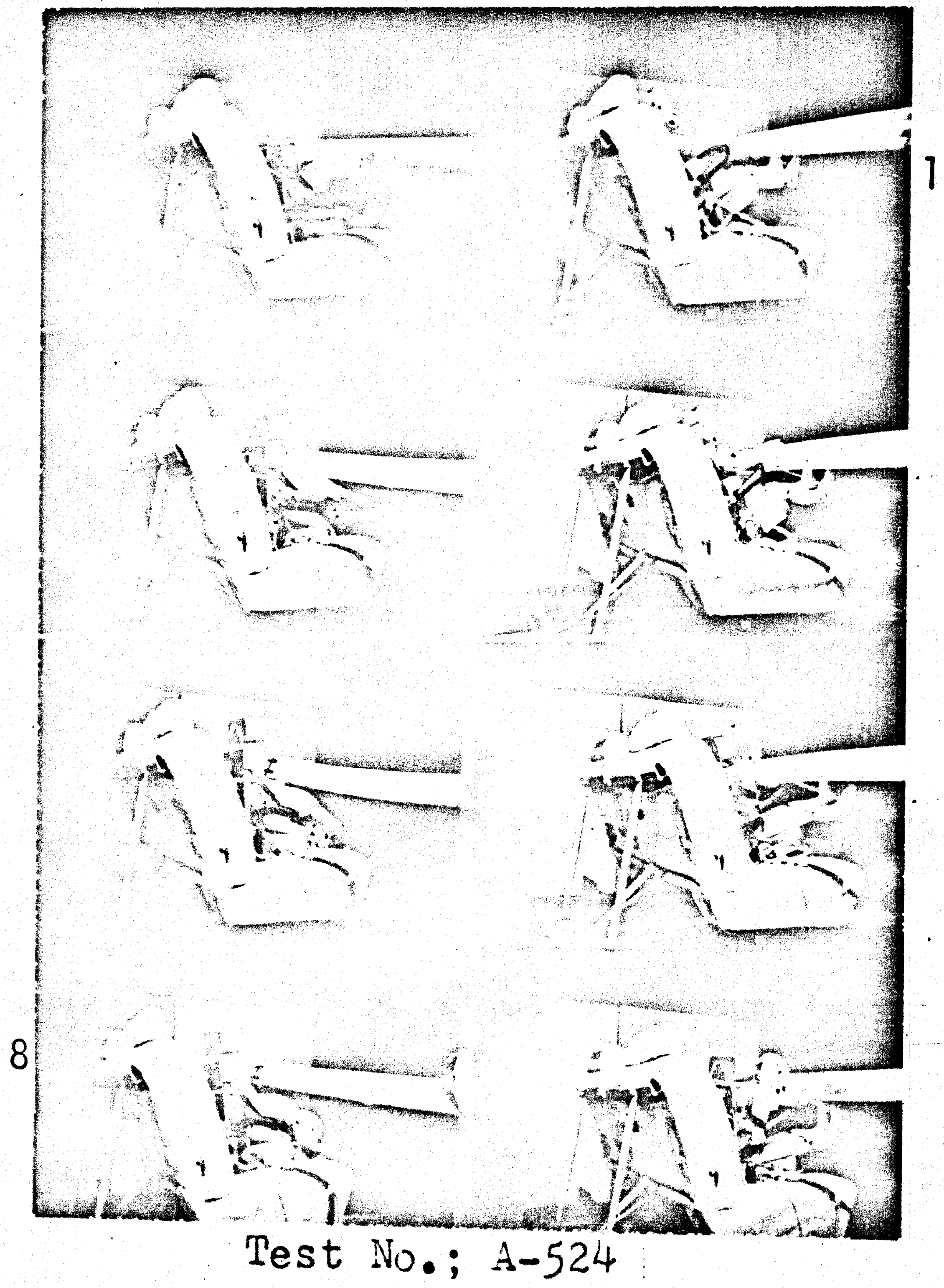


FIGURE A-19. GRAPHCHEK SEQUENCE CAMERA

HSRI SUMMARY DATA SHEET

Test Number:	A-549
Test Date:	March 2, 1972
Restraint Description:	Seat Belt Only
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The motions experienced by the dummy were minimal. Head and chest G loadings were very high. The dummy's head hit the sled floor.

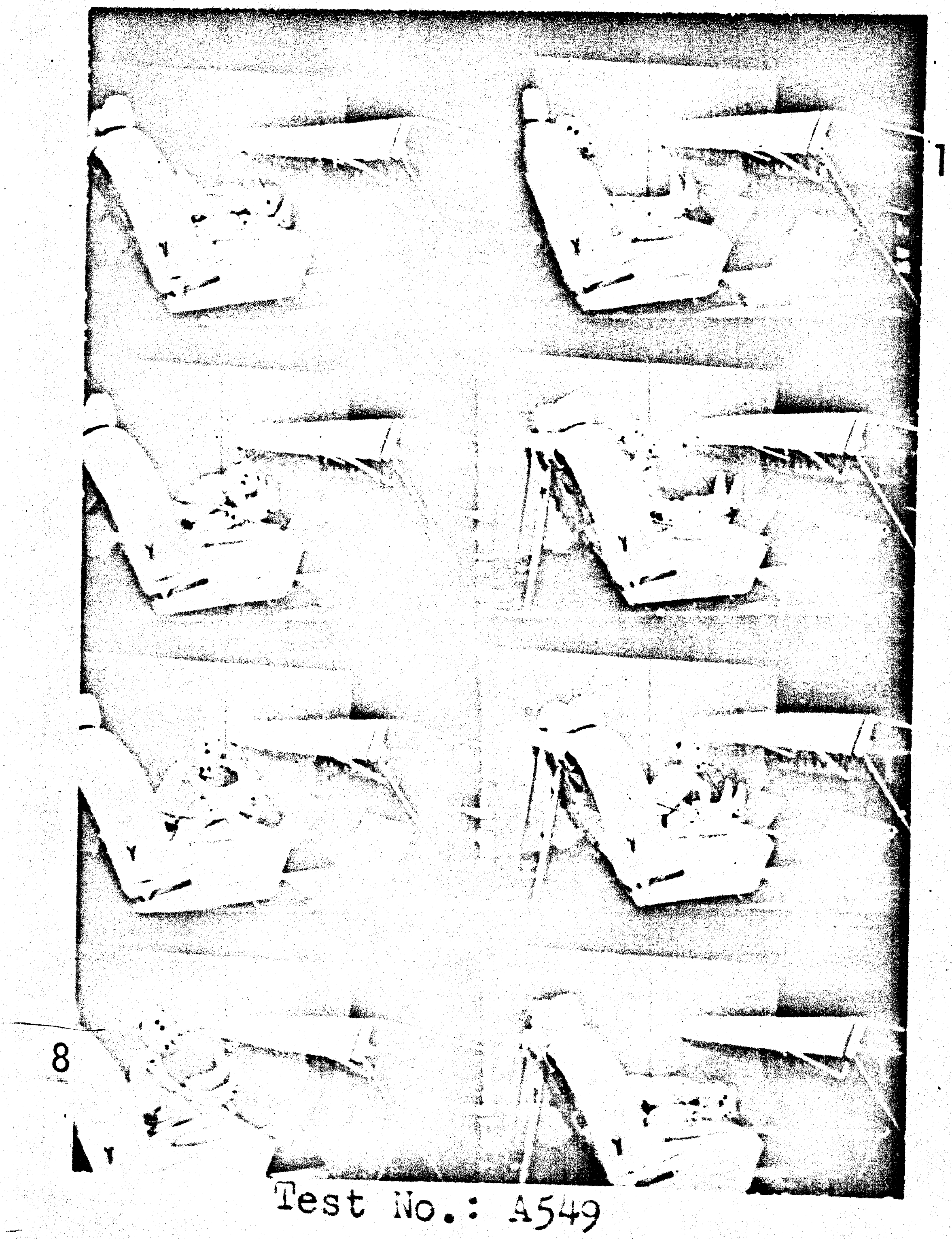


FIGURE A-20. GRAPHCHEK SEQUENCE CAMERA

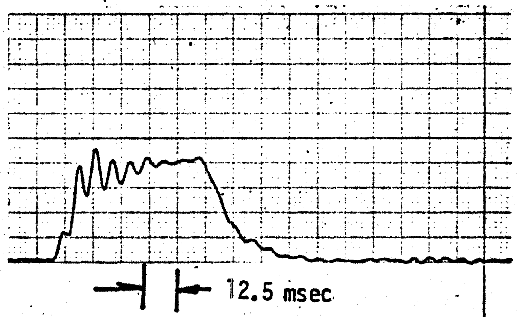
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-549　　Test Type ADULT SEAT BELT

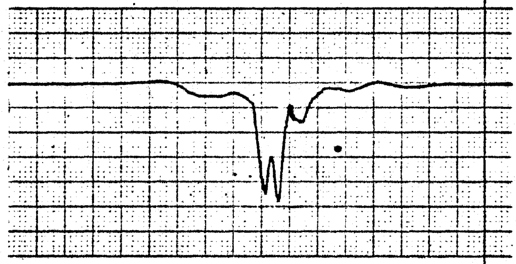
Dummy 3 YEARS OLD　　FRONT - 30 MPH

Sled Velocity 44.01 ft/sec

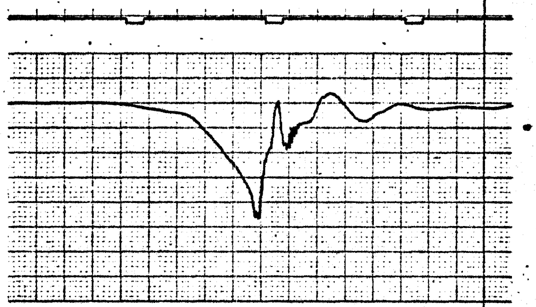
Sled Pulse
5 g's/division
Filtered
Class 60



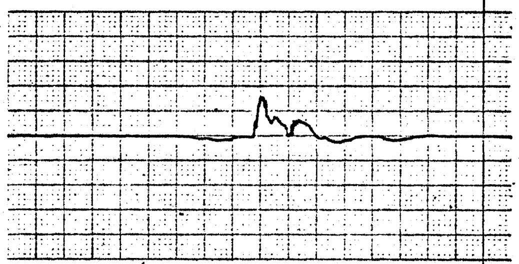
Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



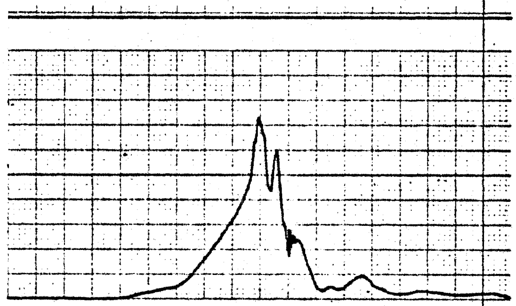
Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



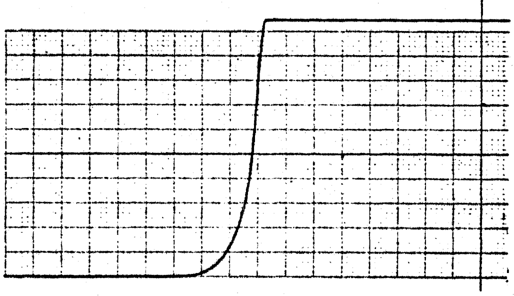
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.

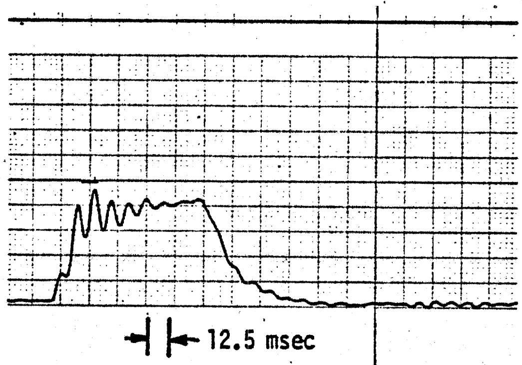


SUMMARY DATA CHEST ACCELERATIONS

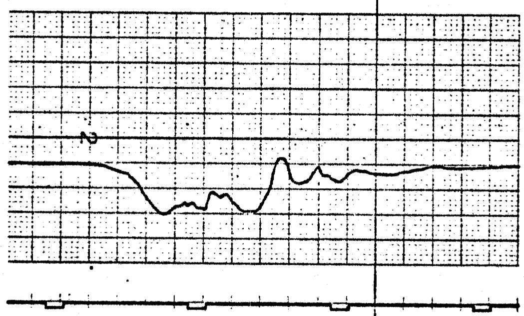
Test Number A549
Dummy 3 YEARS OLD
Sled Velocity 44.01 ft/sec

Test Type ADULT SEAT BELT
FRONT – 30 MPH

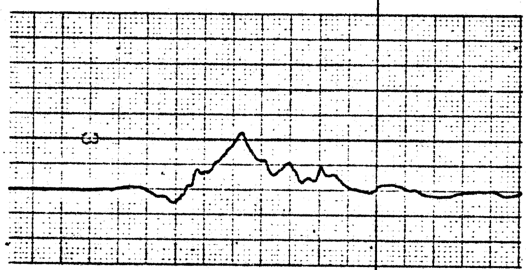
Sled Pulse
5 g's/division
Filtered
Class 60



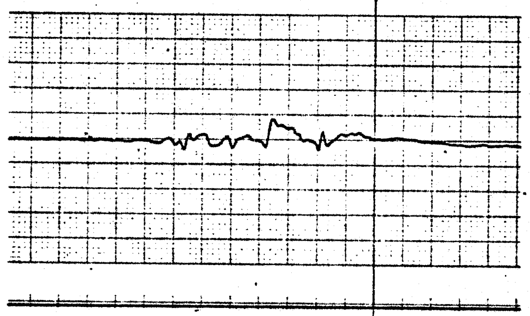
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



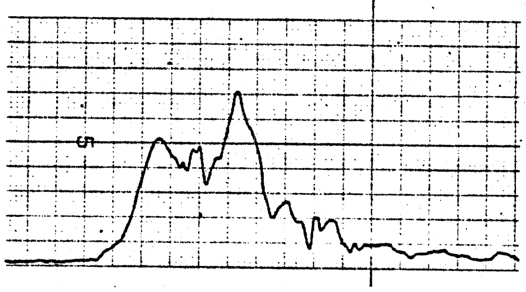
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number: A-519

Test Date: February 18, 1972

Restraint Description: Peterson Model 63

Dummy: 3-Year

Sled Velocity: 30 mph

Sled G-Level: 21

Impact Direction: Front

Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The seat structure collapsed allowing the dummy to move forward and contact the simulated dash board. The dummy then carried through the dash and struck the floor pan. The adult belt loads on the dummy were very high. Head and chest accelerations were very high.

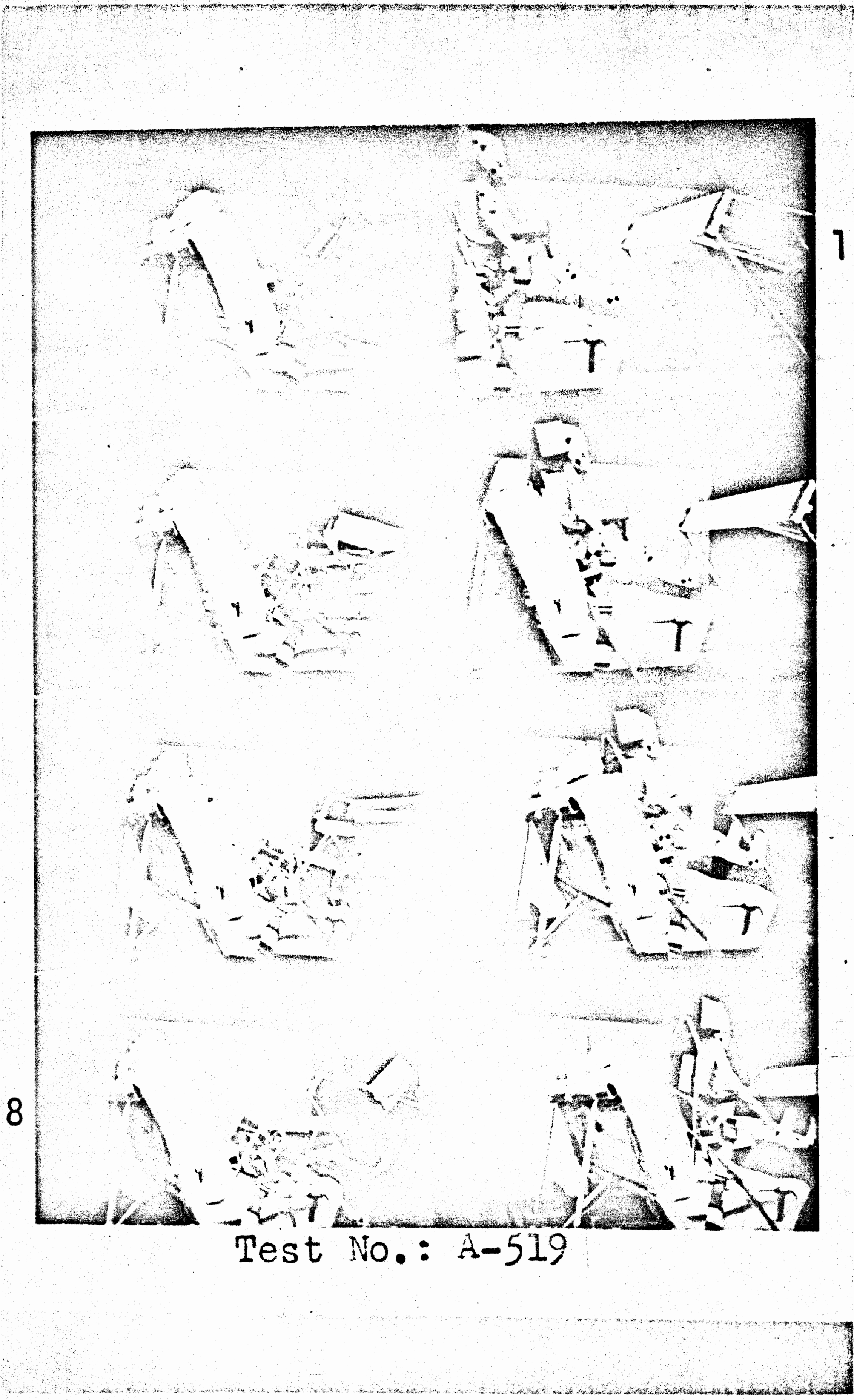


FIGURE A-21. GRAPHCHEK SEQUENCE CAMERA

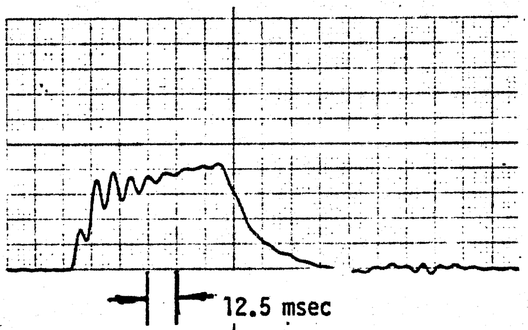
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-519 Test Type PETERSON MODEL 63

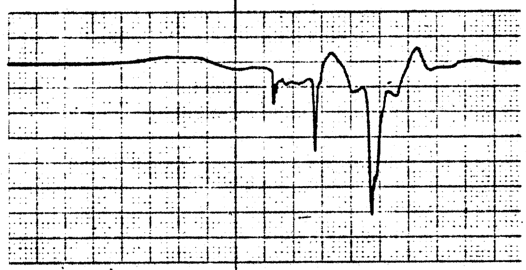
Dummy 3 YEAR OLD FRONT – 30 MPH

Sled Velocity 43.5 ft/sec

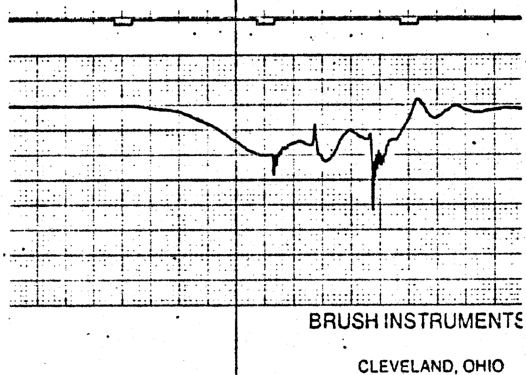
Sled Pulse
5 g's/division
Filtered
Class 60



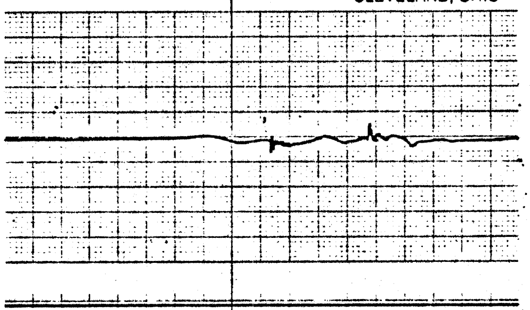
Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



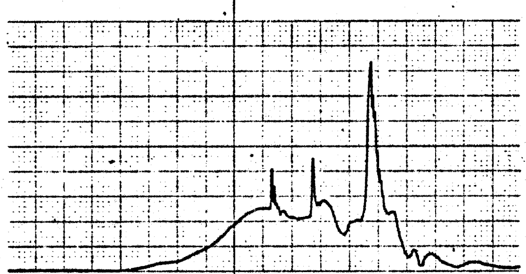
Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



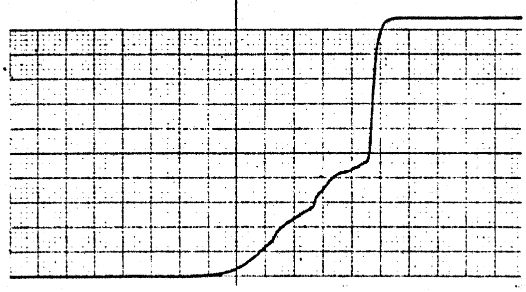
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.



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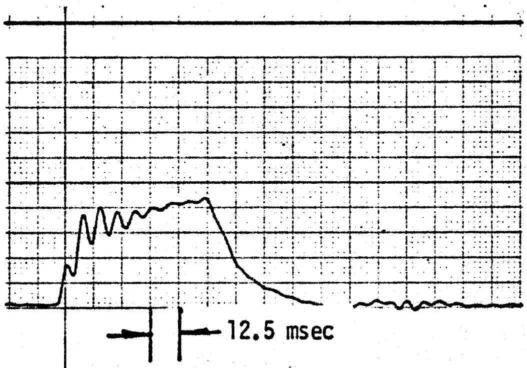
SUMMARY DATA CHEST ACCELERATIONS

Test Number A 59 Test Type PETERSON MODEL 63

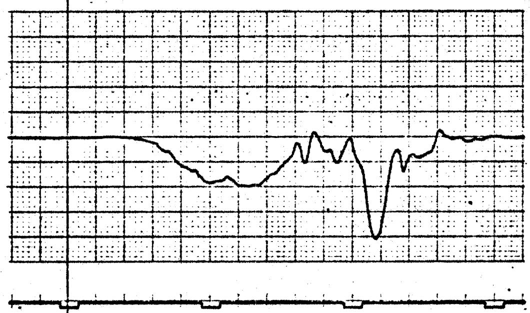
Dummy 3 YEARS OLD FRONT — 30 MPH

Sled Velocity 43.5 ft/sec

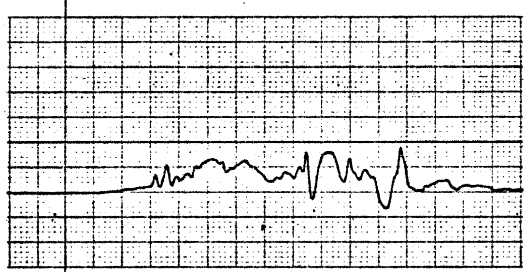
Sled Pulse
5 g's/division
Filtered
Class 60



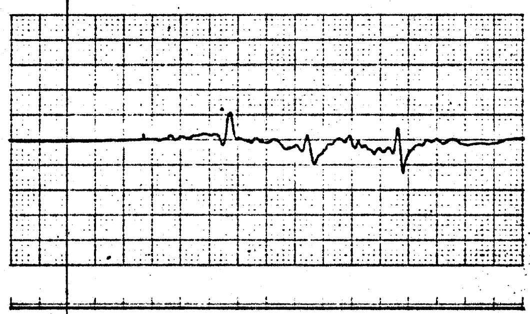
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



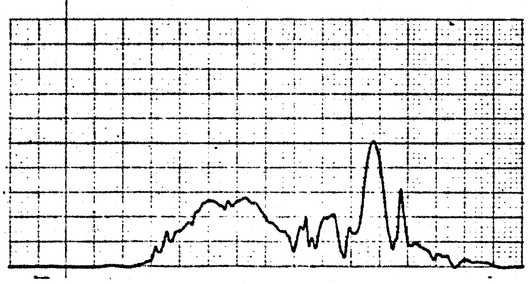
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-520
Test Date:	February 18, 1972
Restraint Description:	Peterson Model 61
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The seat structure collapsed allowing the dummy to move forward and contact the simulated dash board. The dummy then carried through the dash and struck the floor pan. The adult belt loads on the dummy were very high. Head and chest acceleration were very high.

1

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Test No.: A-520

FIGURE A-22. GRAPHCHEK SEQUENCE CAMERA

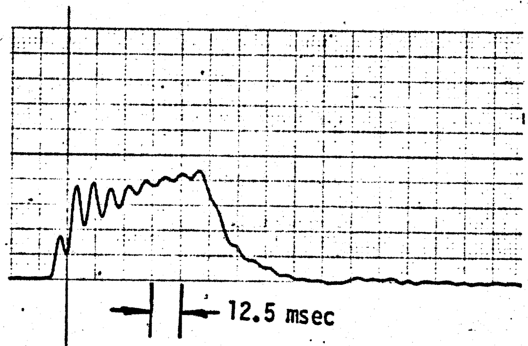
SUMMARY DATA HEAD ACCELERATIONS

Test Number A 520 Test Type PETERSON MODEL 61

Dummy 3 YEARS OLD FRONT - 30 MPH

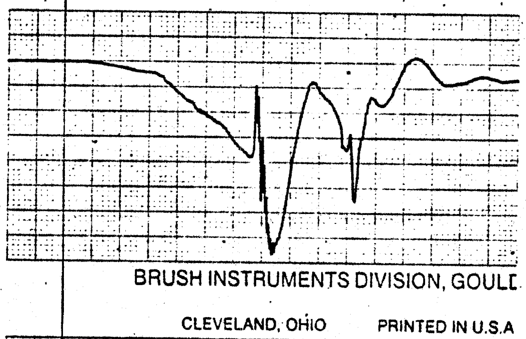
Sled Velocity 42.71 ft/sec

Sled Pulse
5 g's/division
Filtered
Class 60

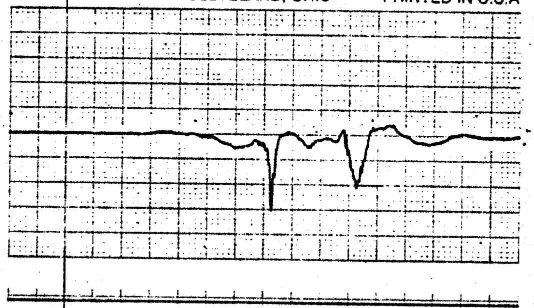


Anterior-Posterior
Head Acceleration
12.5 g's/division
Filtered
Class 1000

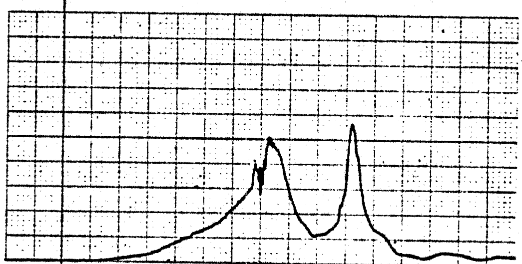
Superior-Inferior
Head Acceleration
12.5 g's/division
Filtered
Class 1000



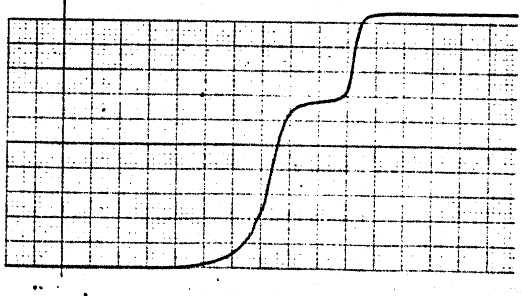
Left-Right
Head Acceleration
12.5 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.

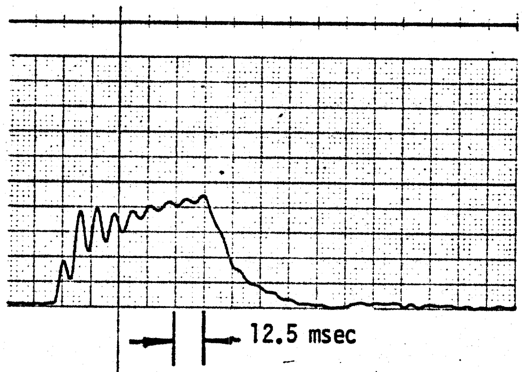


SUMMARY DATA CHEST ACCELERATIONS

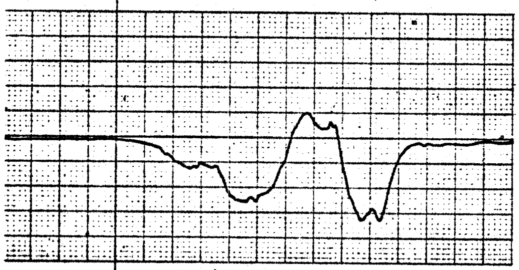
Test Number A520
Dummy 3 YEARS OLD
Sled Velocity 42.71 ft/sec

Test Type PETERSON MODEL 61
FRONT - 30 MPH

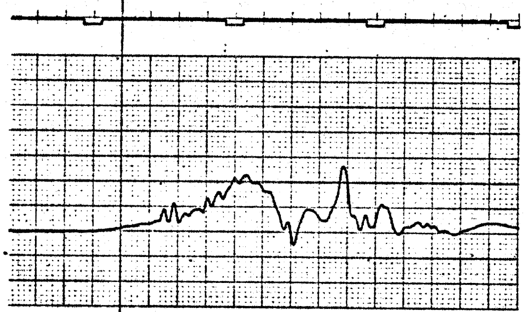
Sled Pulse
5 g's/division
Filtered
Class 60



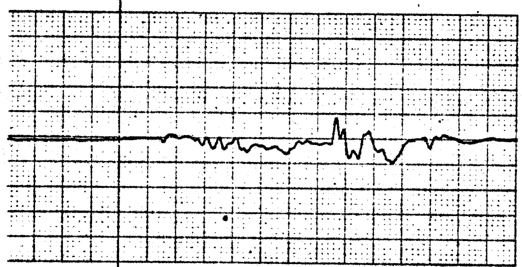
Anterior-Posterior Chest Acceleration
12.5 g's/division
Filtered
Class 600



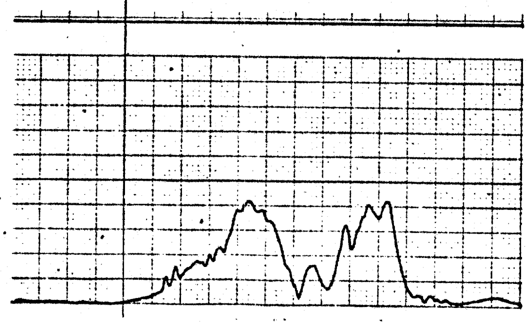
Superior-Inferior Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest Acceleration
10 g's/division
Filtered
Class 600



HSRI SUMMARY DATA SHEET

Test Number:	A-526
Test Date:	February 22, 1972
Restraint Description:	Jamy Model 5405
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The seat back collapsed allowing the dummy to move forward and contact the simulated dash board. The adult belt loads were very high. Head accelerations were very high.

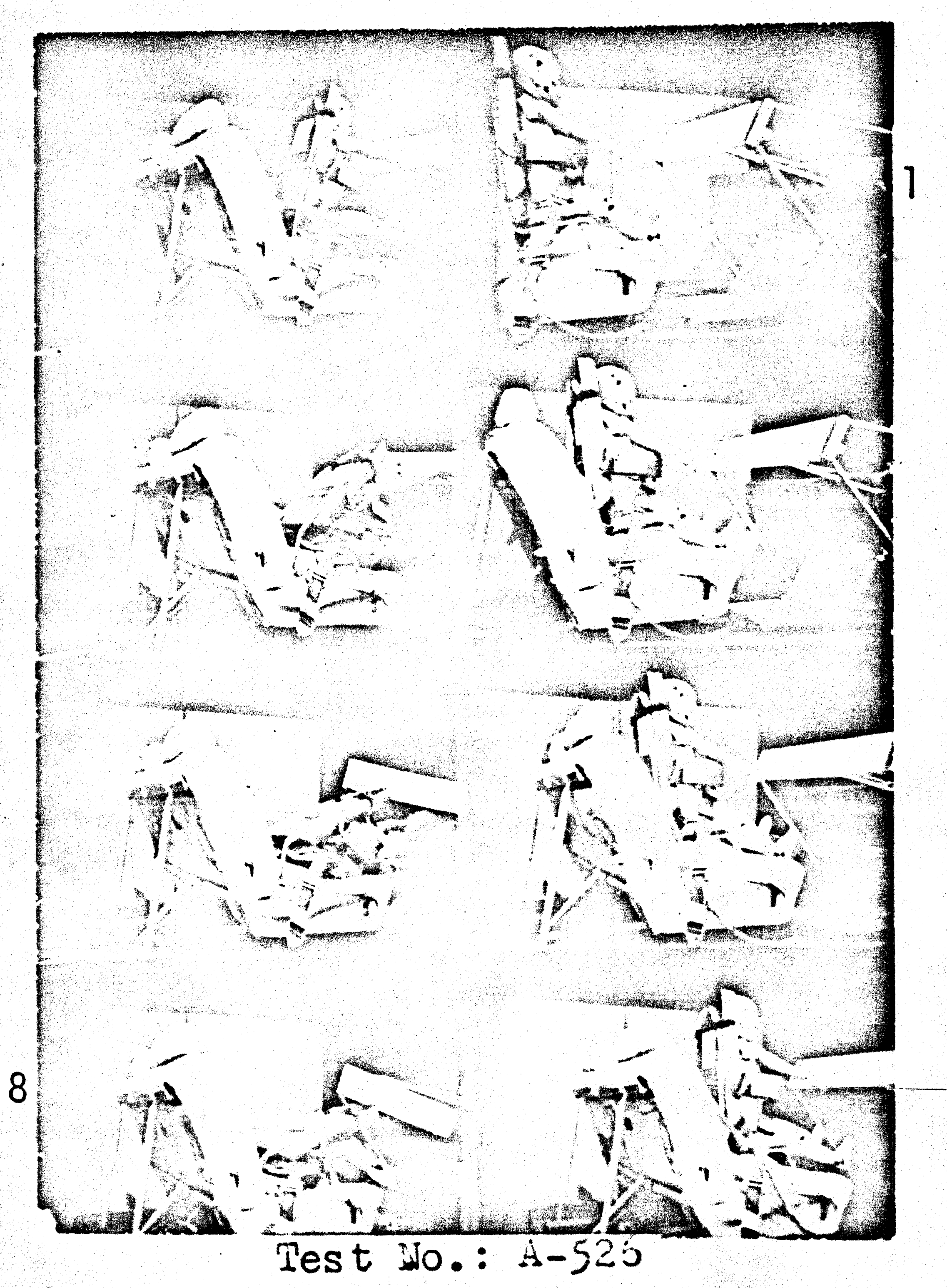


FIGURE A-23. GRAPHCHEK SEQUENCE CAMERA

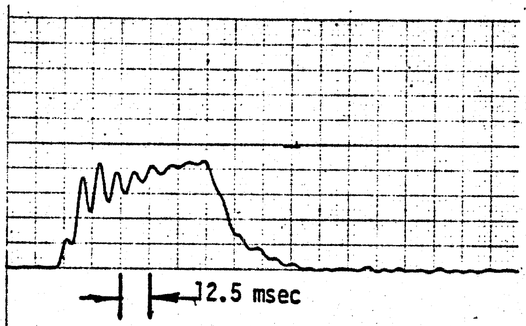
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-526 Test Type JAMY MODEL 540S

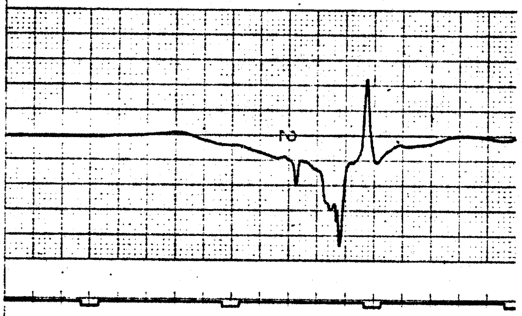
Dummy 3 YEARS OLD FRONT - 30 MPH

Sled Velocity 42.94 ft/sec

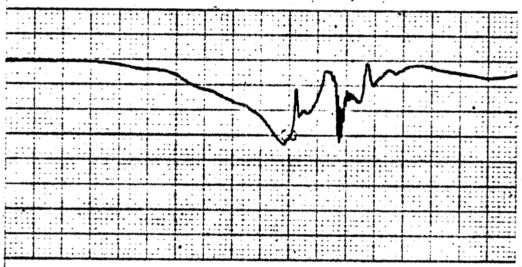
Sled Pulse
5 g's/division
Filtered
Class 60



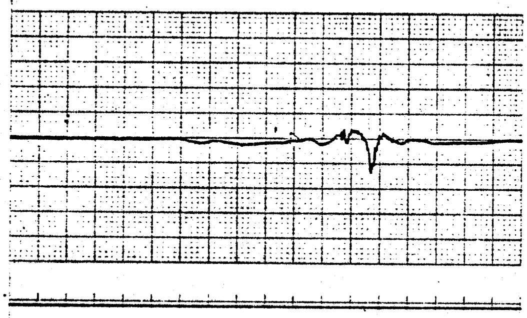
Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



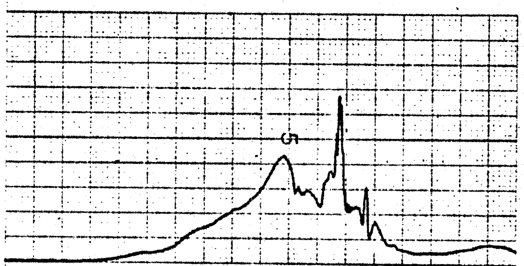
Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



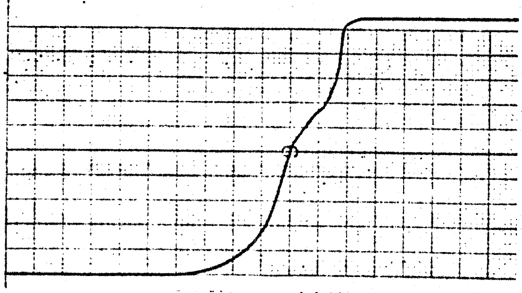
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.

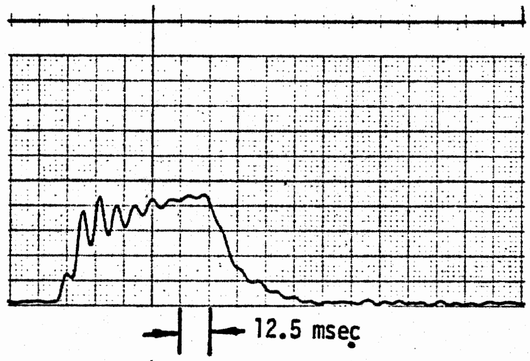


SUMMARY DATA CHEST ACCELERATIONS

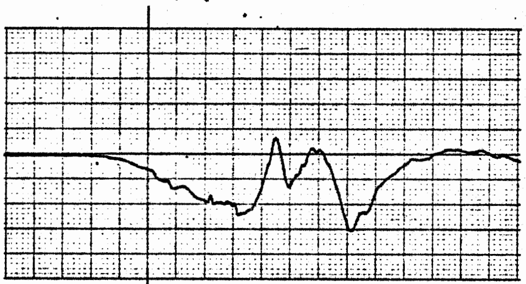
Test Number A526
Dummy 3 YEARS OLD
Sled Velocity 42.94 ft/sec

Test Type JAMY MODEL 5405
FRONT - 30 MPH

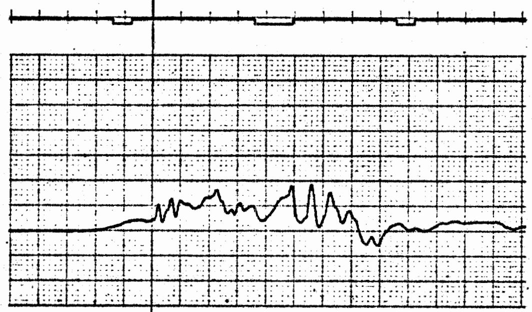
Sled Pulse
5 g's/division
Filtered
Class 60



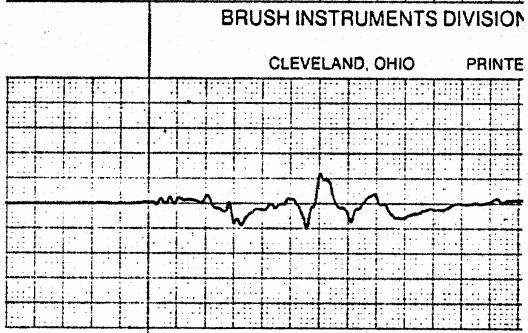
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



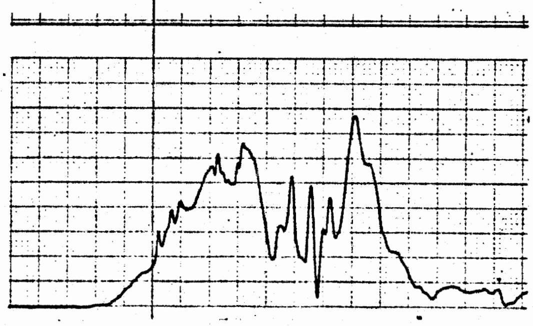
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600

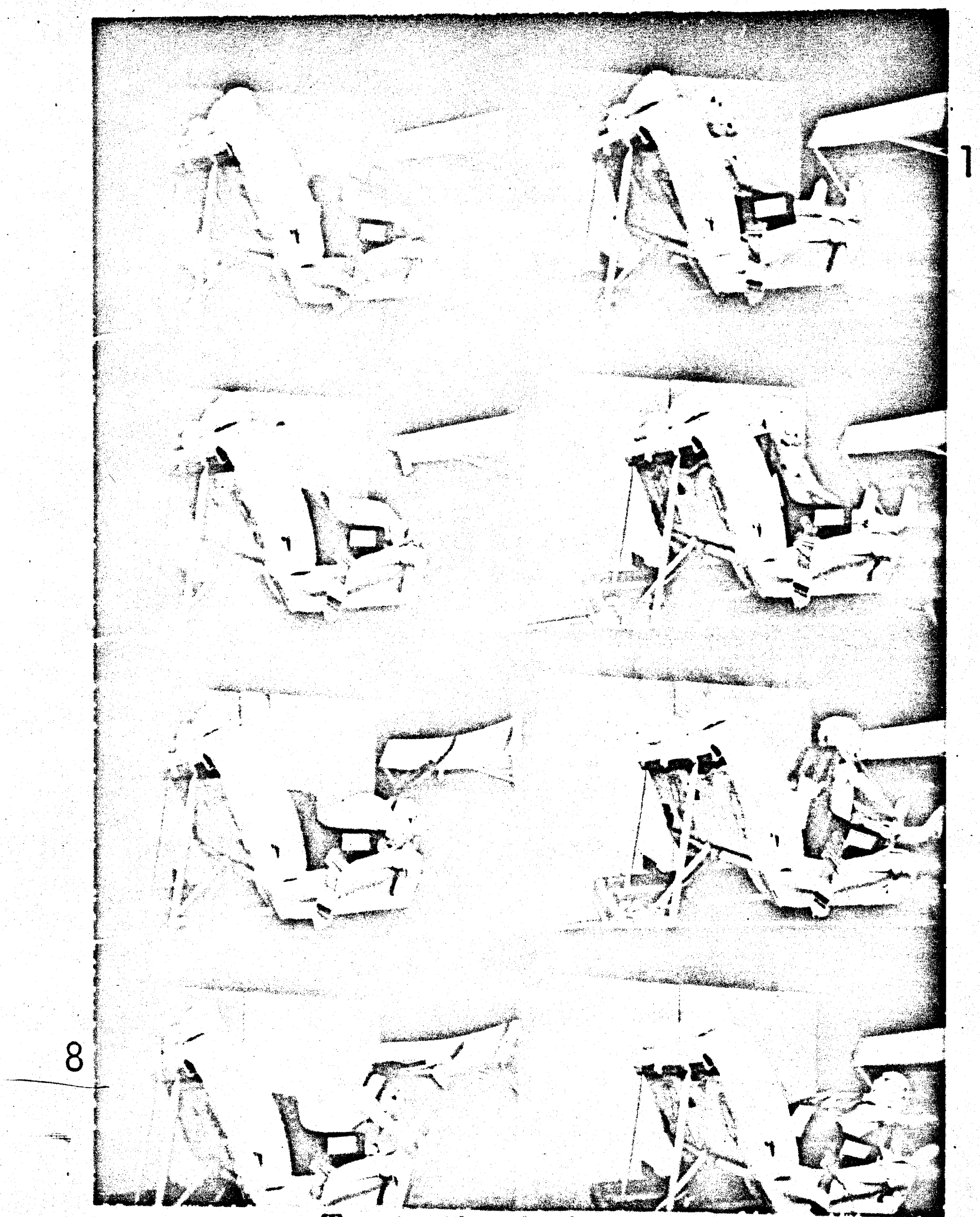


HSRI SUMMARY DATA SHEET

Test Number:	A-527
Test Date:	February 22, 1972
Restraint Description:	Teddy Tot Model 6200
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The dummy motion was not great enough to contact the simulated dash board. The plastic seat back broke due to the loading of the upper torso restraint system. The adult belt loads were very high as well as the head acceleration. The head struck the front edge of the adult seat.



Test No.: A-527

FIGURE A-24. GRAPHCHEK SEQUENCE CAMERA

SUMMARY DATA HEAD ACCELERATIONS

Test Number A-527

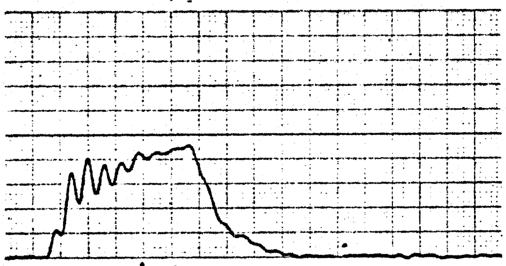
Test Type TEDDY TOT 6200

Dummy 3 YEARS OLD

FRONT 30 MPH

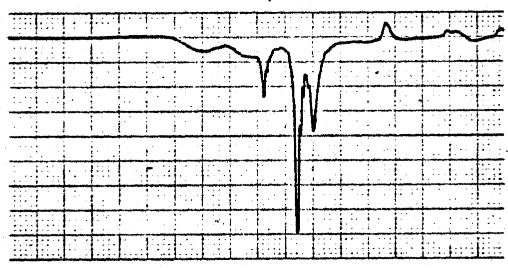
Sled Velocity 44.46 ft/sec

Sled Pulse
5 g's/division
Filtered
Class 60

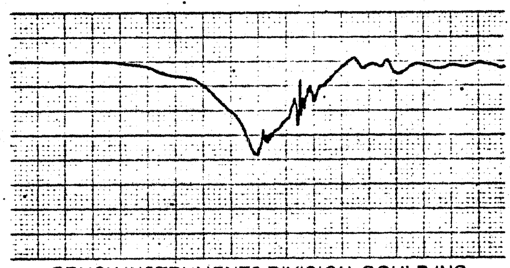


12.5 msec

Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



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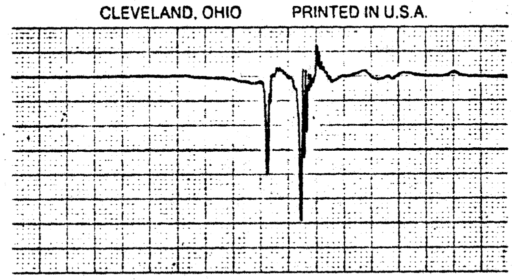
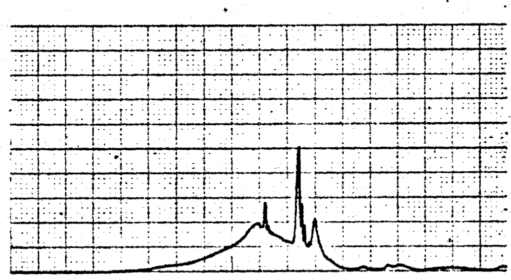
CLEVELAND, OHIO PRINTED IN U.S.A.

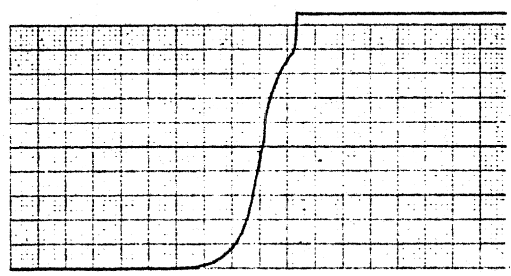
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
50 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.

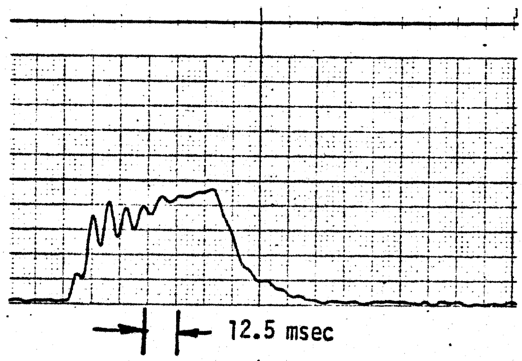


SUMMARY DATA CHEST ACCELERATIONS

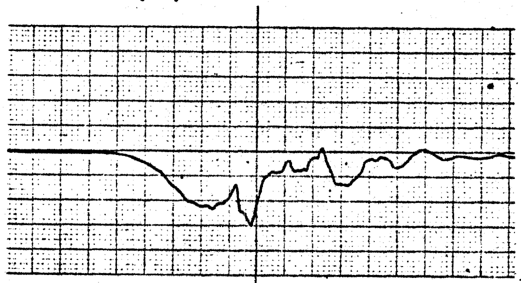
Test Number A527
Dummy 3 YEARS OLD
Sled Velocity 44.46 ft/sec

Test Type TEDDY TOT 6200
FRONT – 30 MPH

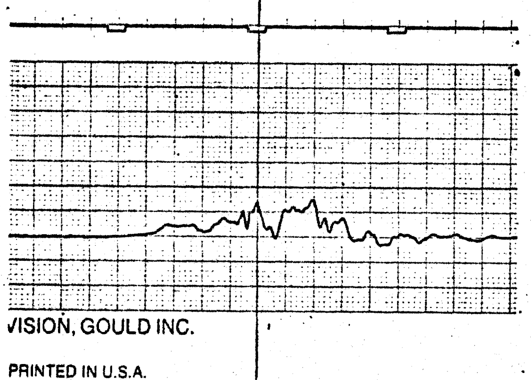
Sled Pulse
5 g's/division
Filtered
Class 60



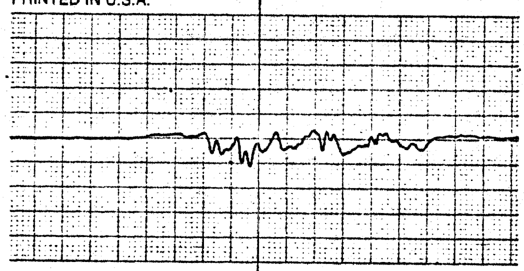
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



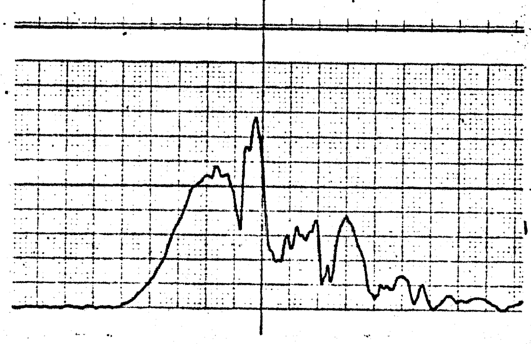
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
5 g's/division
Filtered
Class 600



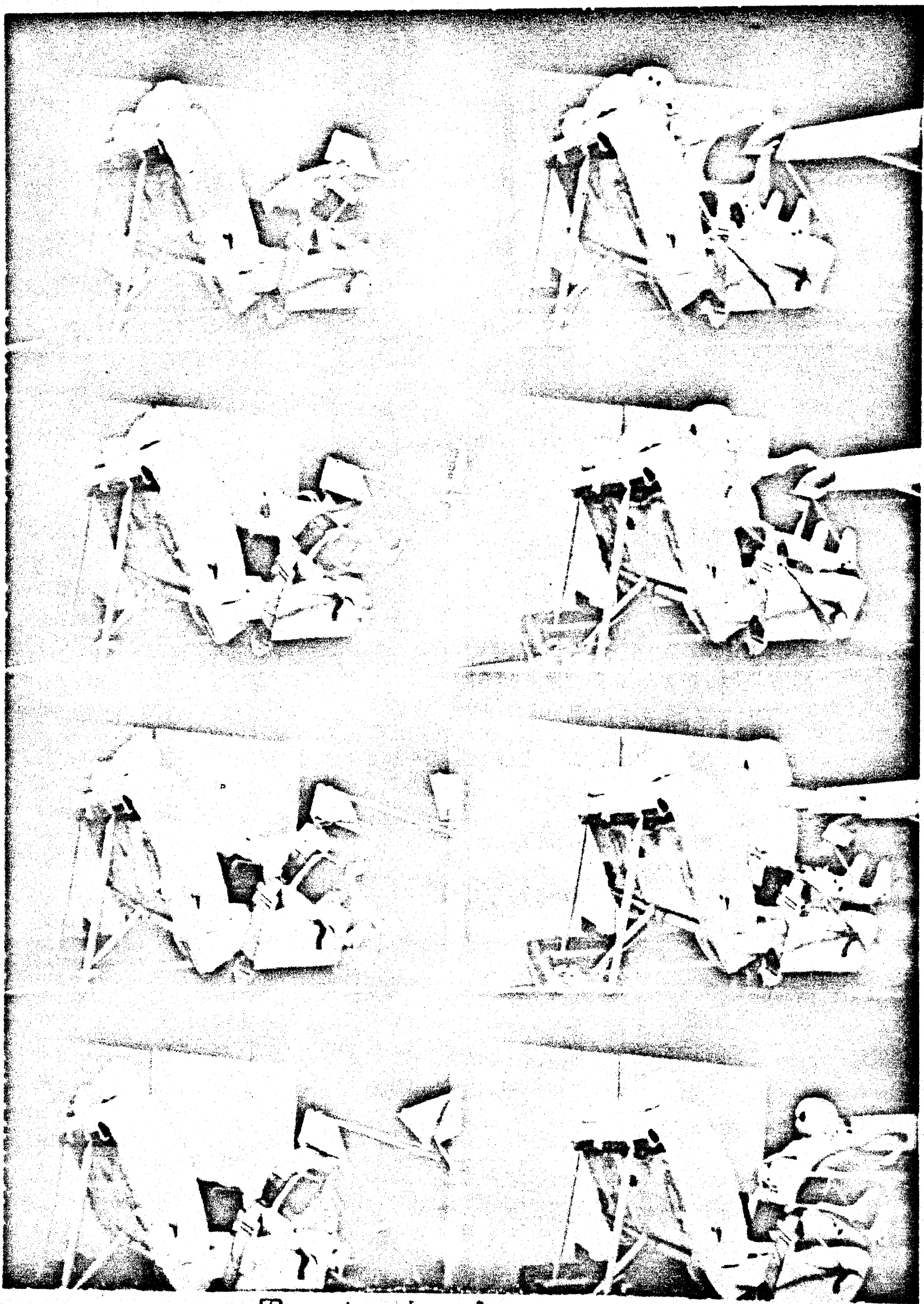
HSRI SUMMARY DATA SHEET

Test Number:	A-529
Test Date:	February 22, 1972
Restraint Description:	Firestone Protecta Tot
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The body shield collapsed allowing the dummy to move forward enough to make contact with the simulated dash board. The adult belt loads were very high, as well as the head and chest acceleration.

1



8

Test No. A-529

FIGURE A-25. GRAPHCHEK SEQUENCE CAMERA

SUMMARY DATA HEAD ACCELERATIONS

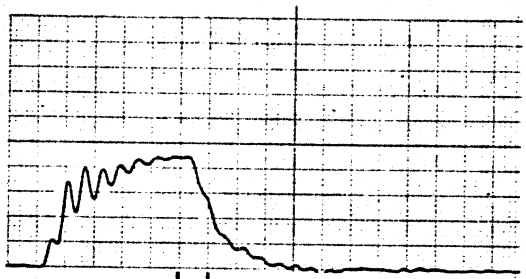
Test Number A - 529

Dummy 3 YEARS OLD

Sled Velocity 43.34 ft/sec

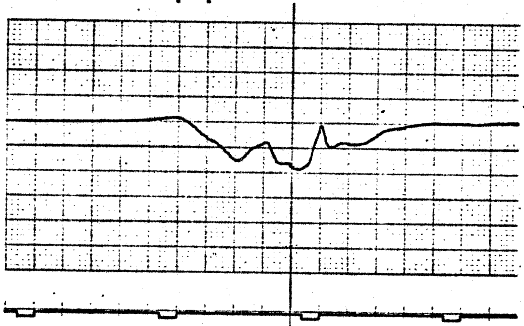
Test Type FIRESTONE PROTECTA-TOT FRONT - 30 MPH

Sled Pulse
5 g's/division
Filtered
Class 60

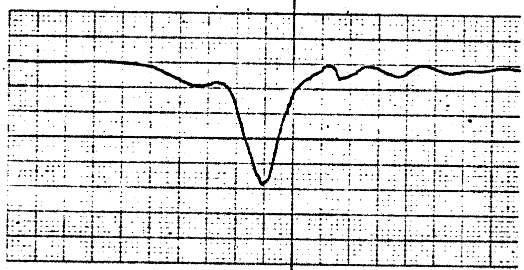


12.5 msec

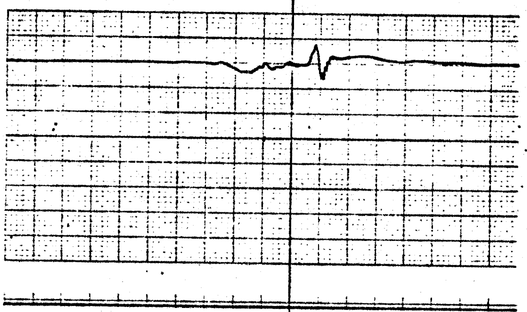
Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



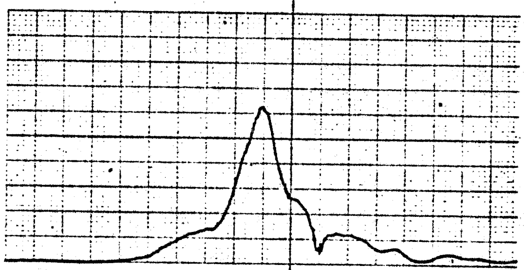
Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



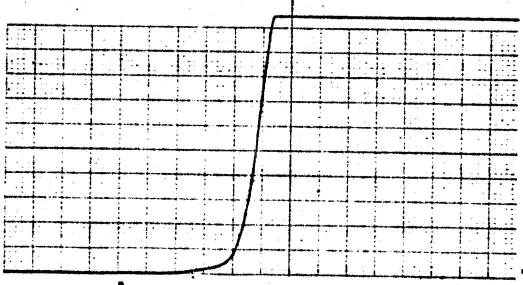
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.



SUMMARY DATA CHEST ACCELERATIONS

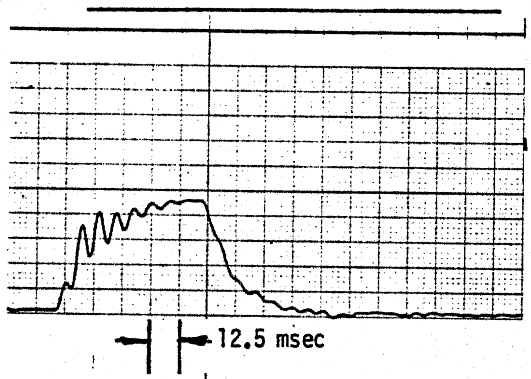
Test Number A529

Dummy 3 YEARS OLD

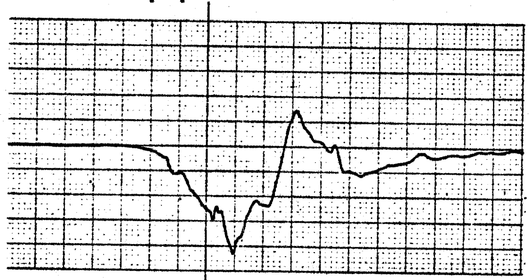
Sled Velocity 43.34 ft/sec

Test Type FIRESTONE PROTECTA-TOT FRONT — 30 MPH

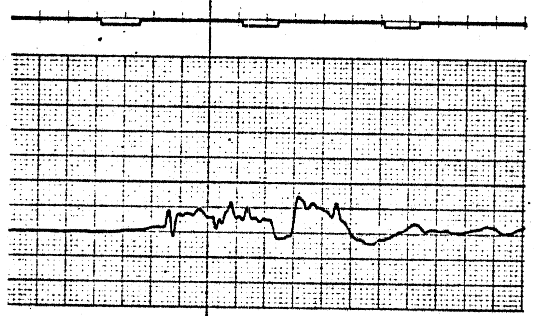
Sled Pulse
5 g's/division
Filtered
Class 60



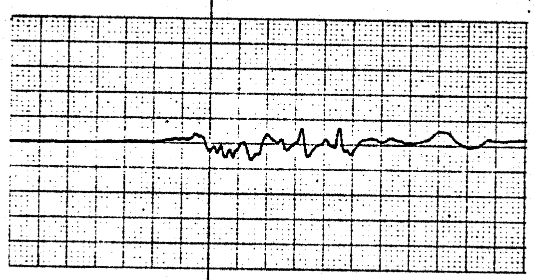
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



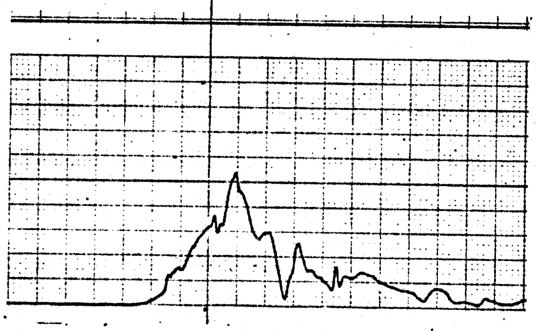
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600



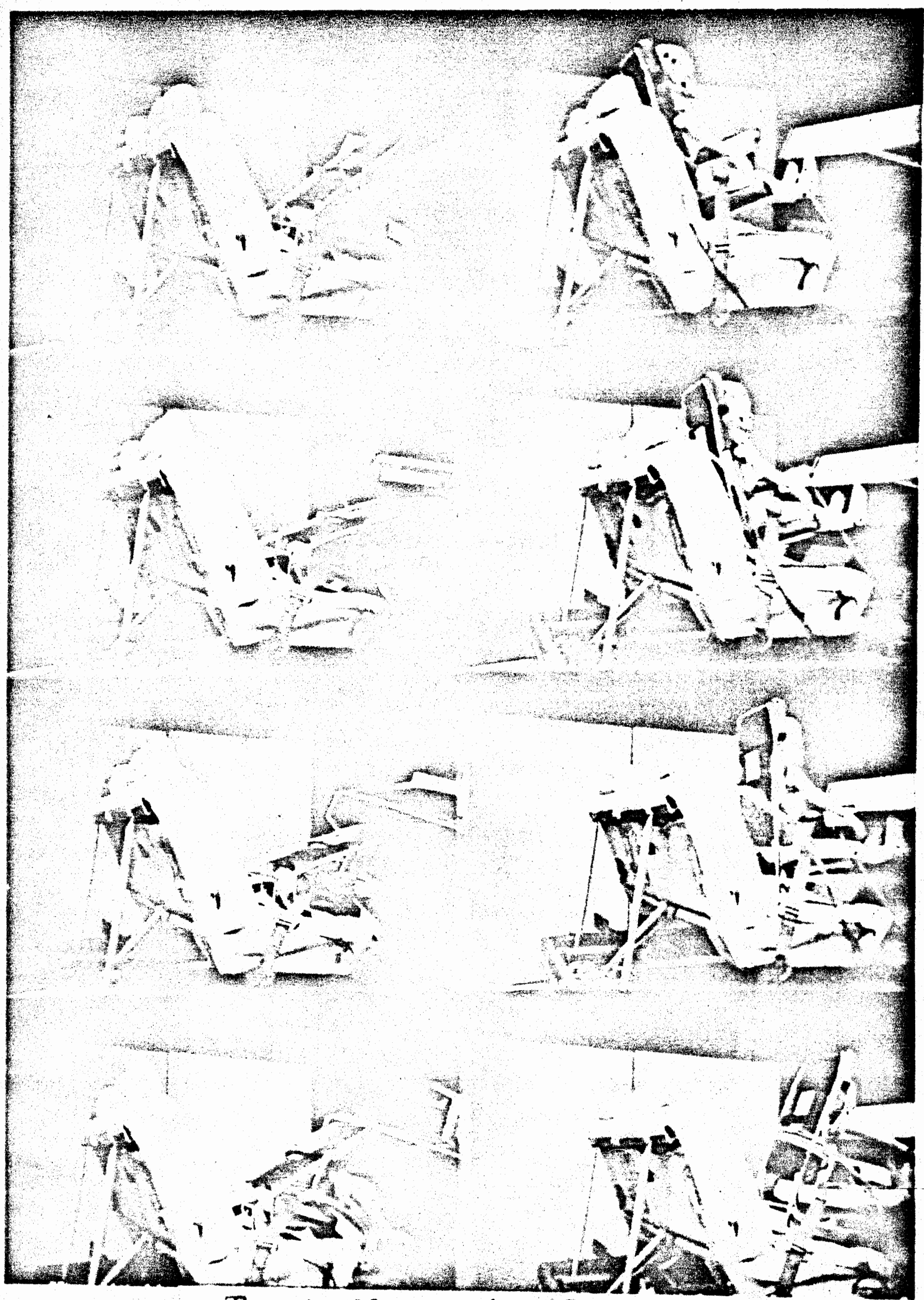
HSRI SUMMARY DATA SHEET

Test Number:	A-530
Test Date:	February 22, 1972
Restraint Description:	Century Model 4845
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The seat structure collapsed allowing the dummy to move forward and contact the simulated dash board. The adult belt loads were very high as well as the head and chest acceleration. The head struck the base of the adult seat.

1



8

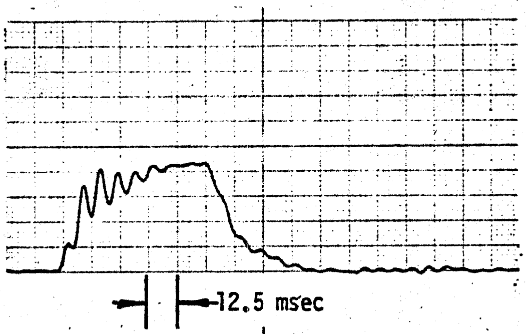
Test No. :A-530

FIGURE A-26. GRAPHCHEK SEQUENCE CAMERA

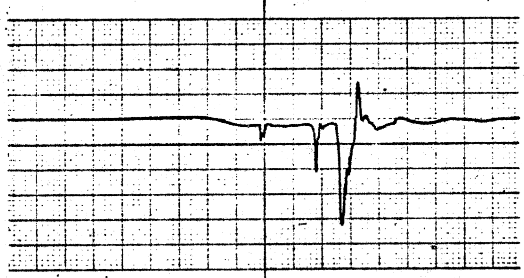
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-530 Test Type CENTURY 4845
Dummy 3 YEARS OLD FRONT - 30 MPH
Sled Velocity 43.92 ft/sec

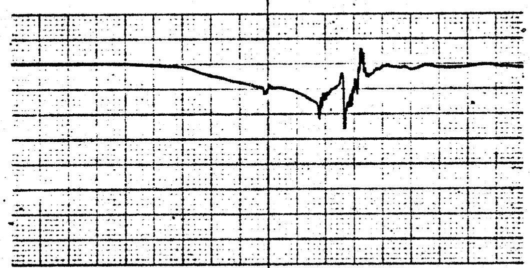
Sled Pulse
5 g's/division
Filtered
Class 60



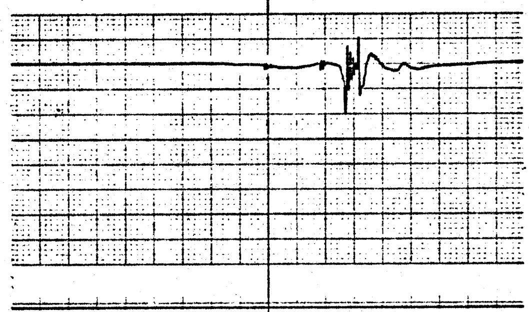
Anterior-Posterior
Head Acceleration
50 g's/division
Filtered
Class 1000



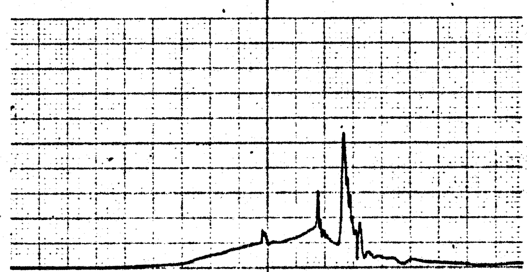
Superior-Inferior
Head Acceleration
50 g's/division
Filtered
Class 1000



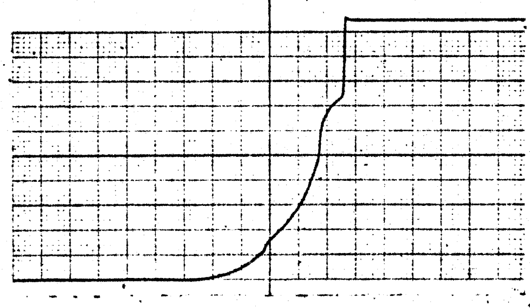
Left-Right
Head Acceleration
50 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
50 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.



SUMMARY DATA CHEST ACCELERATIONS

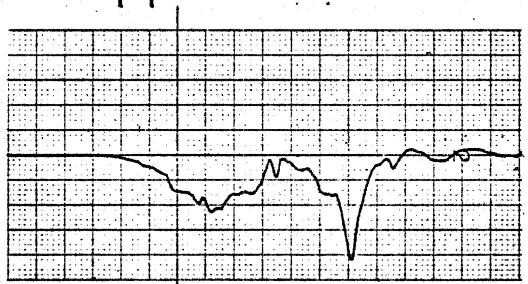
Test Number A530
Dummy 3 YEARS OLD
Sled Velocity 43.92 ft/sec

Test Type CENTURY 4845
FRONT - 30 MPH

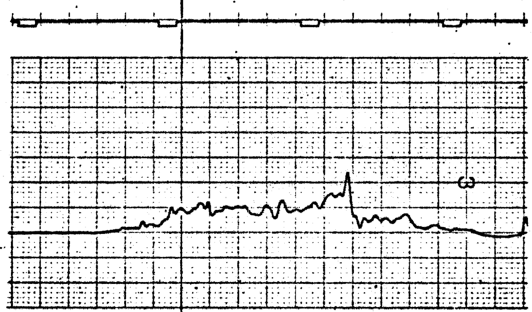
Sled Pulse
5 g's/division
Filtered
Class 60

12.5 msec

Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600

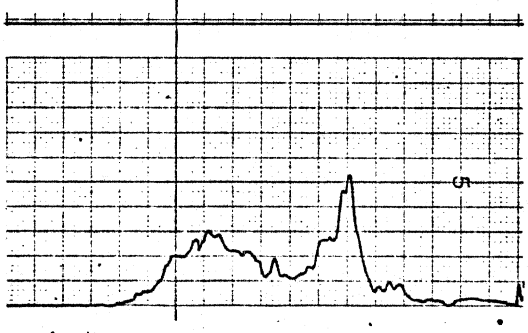


Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600

Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600

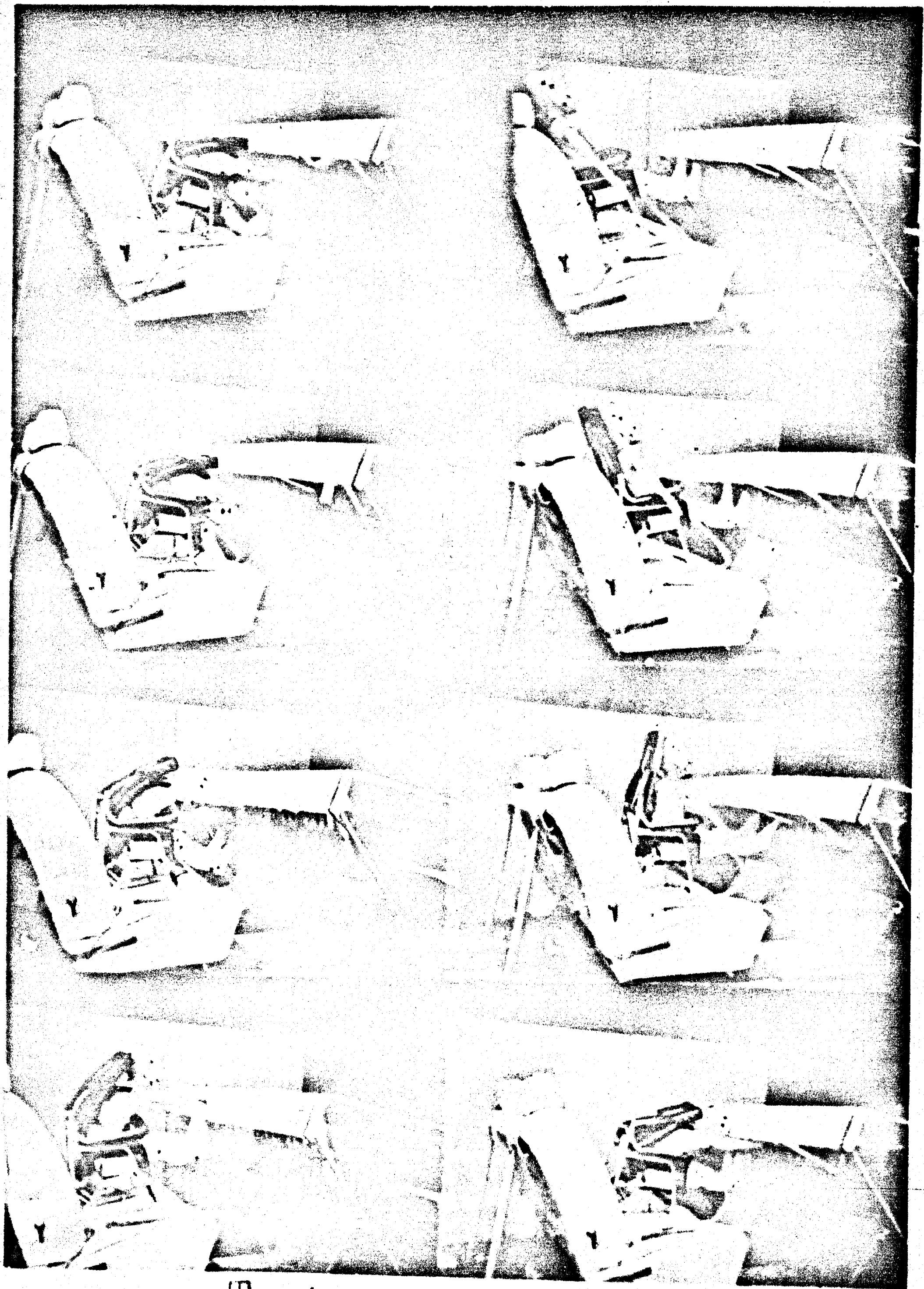


HSRI SUMMARY DATA SHEET

Test Number:	A-548
Test Date:	March 2, 1972
Restraint Description:	Teddy Tot Model 6600
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The seat back collapsed allowing the dummy to move forward and contact the simulated dash board. The adult belt loads were very high, as were the head accelerations.


1

8

Test No.: A-548

FIGURE A-27. GRAPHCHEK SEQUENCE CAMERA

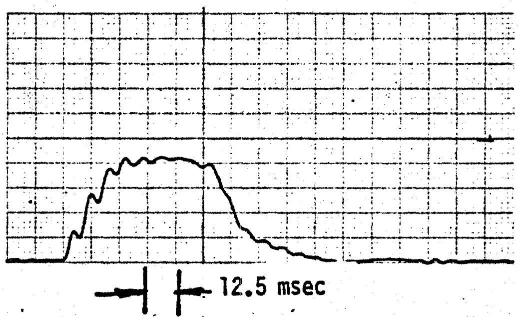
SUMMARY DATA HEAD ACCELERATIONS

Test Number A-548 — Test Type TEDDY TOT 6600

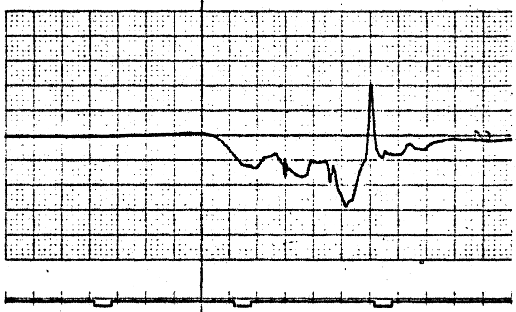
Dummy 3 YEARS OLD — FRONT - 30 MPH

Sled Velocity 43.22 ft/sec

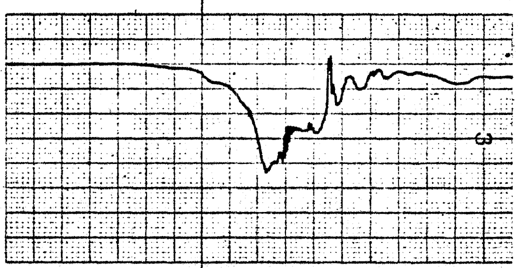
Sled Pulse
5 g's/division
Filtered
Class 60



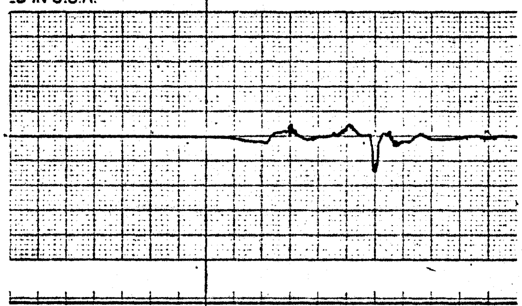
Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



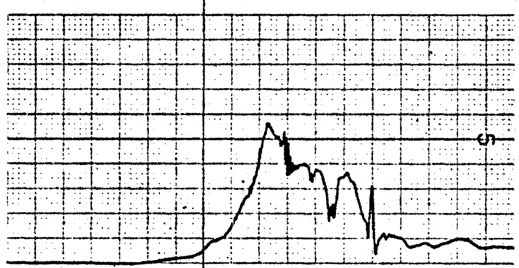
Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



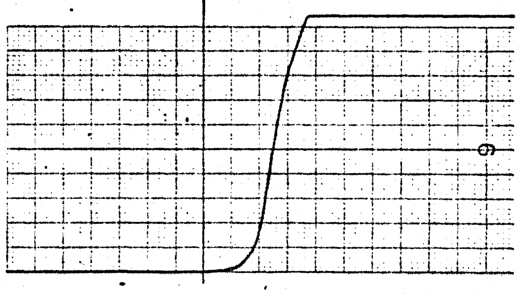
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
20 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.



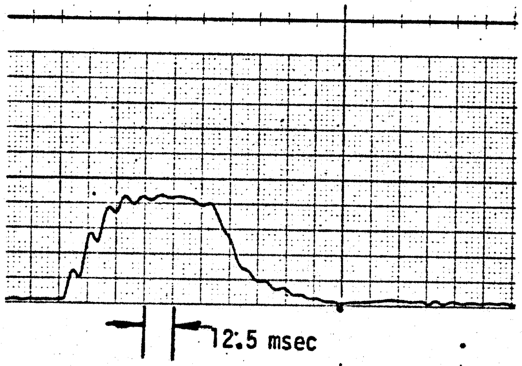
[48]

SUMMARY DATA CHEST ACCELERATIONS

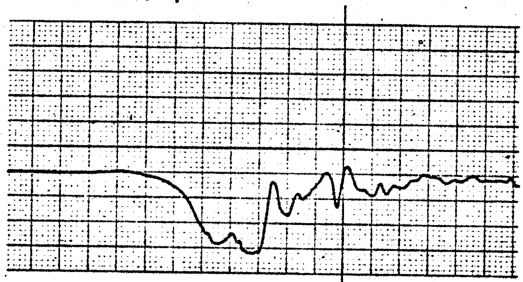
Test Number A548
Dummy 3 YEARS OLD
Sled Velocity 43.22 ft/sec

Test Type TEDDY TOT 6600
FRONT - 30 MPH

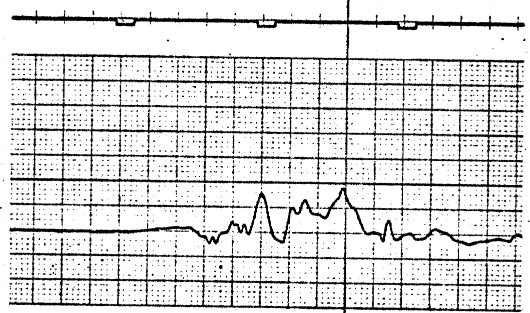
Sled Pulse
5 g's/division
Filtered
Class 60



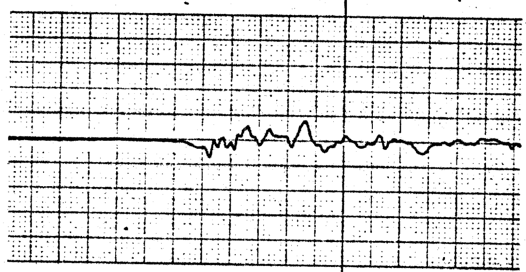
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



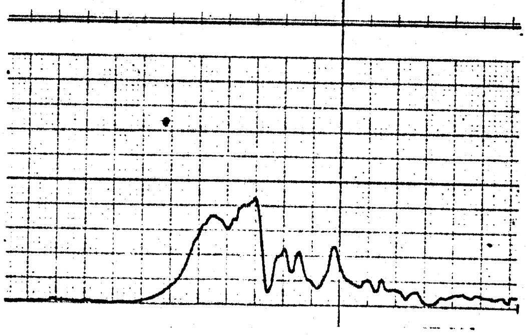
Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600

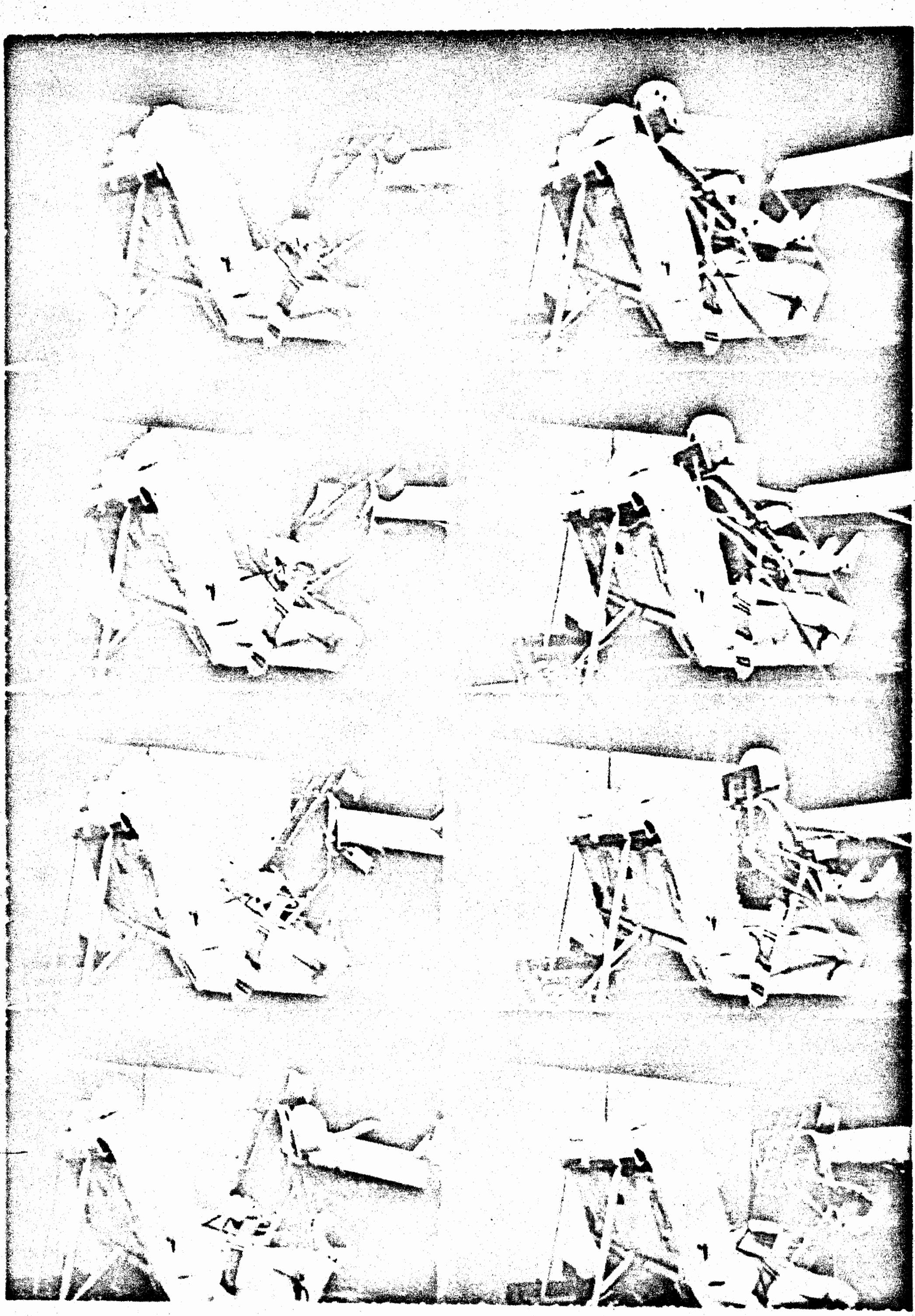


HSRI SUMMARY DATA SHEET

Test Number:	A-531
Test Date:	February 23, 1972
Restraint Description:	Bunny Bear Model 61
Dummy:	3-Year
Sled Velocity:	30 mph
Sled G-Level:	21
Impact Direction:	Front
Dummy Attitude:	Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The seat moved forward and then rotated over the front edge of the adult seat. The dummy was then allowed to contact the simulated dash board. Because of the angle at which the adult seat belt goes over the dummy's hips, the belt loads were very large. The head and chest loads were very large also.



Test No.: A-531

FIGURE A-28. GRAPHCHEK SEQUENCE CAMERA

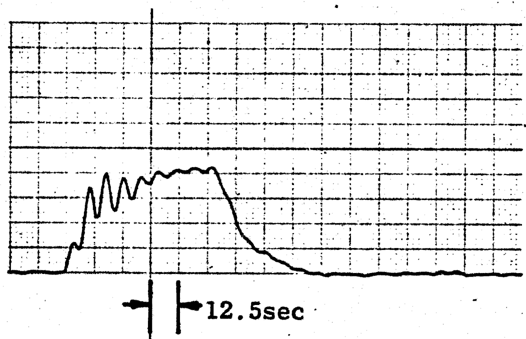
SUMMARY DATA HEAD ACCELERATIONS

Test Number A- 531 Test Type BUNNY BEAR 61

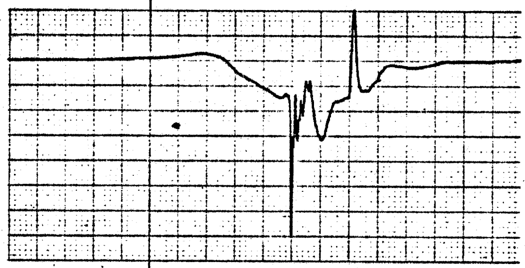
Dummy 3 YEARS OLD FRONT - 30 MPH

Sled Velocity 42.9 ft/sec

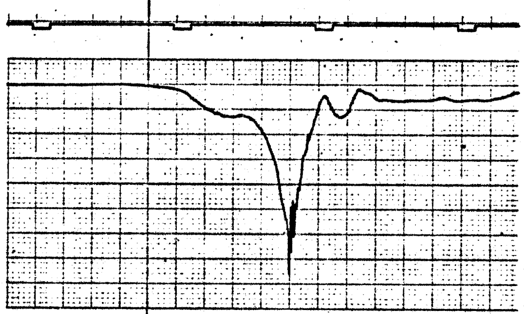
Sled Pulse
5 g's/division
Filtered
Class 60



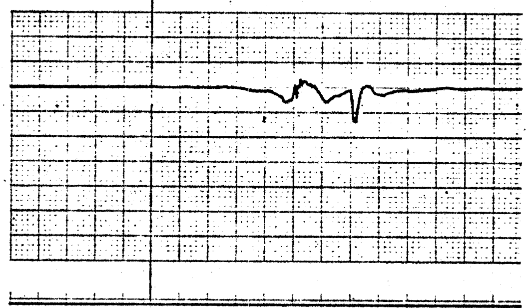
Anterior-Posterior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



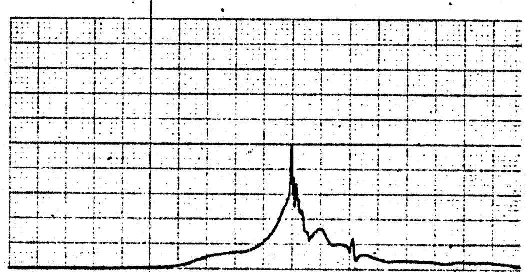
Superior-Inferior
Head Acceleration
25.0 g's/division
Filtered
Class 1000



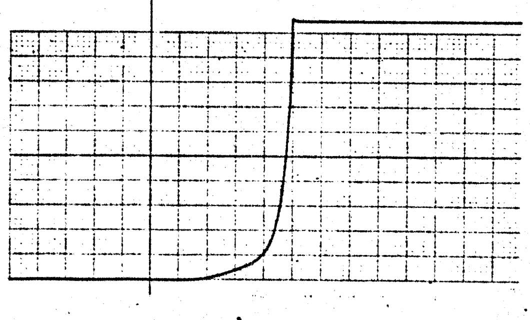
Left-Right
Head Acceleration
25.0 g's/division
Filtered
Class 1000



Resultant Head
Acceleration
50 g's/division
Filtered
Class 1000



Severity Index
200 $g^{2.5}$ sec/div.



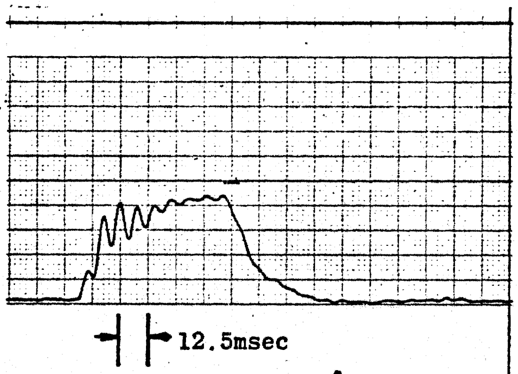
(31)

SUMMARY DATA CHEST ACCELERATIONS

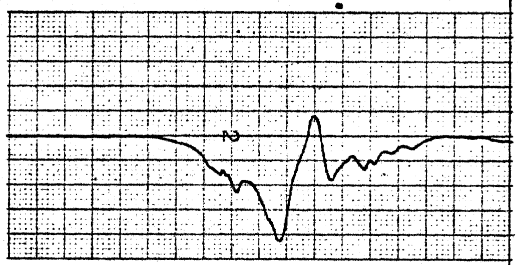
Test Number A531
Dummy 3 YEARS OLD
Sled Velocity 42.9 ft/sec

Test Type BUNNY BEAR 61
FRONT - 30 MPH

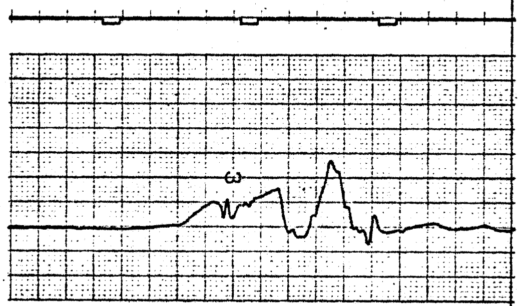
Sled Pulse
5 g's/division
Filtered
Class 60



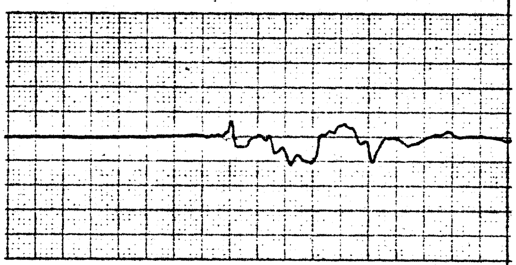
Anterior-Posterior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Superior-Inferior
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Left-Right
Chest Acceleration
12.5 g's/division
Filtered
Class 600



Resultant Chest
Acceleration
10 g's/division
Filtered
Class 600