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CHILD RESTRAINT LATERAL IMPACT TESTS

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16. Abstract

The Biomechanics Department of the Highway Safety Research Institute of The University of Michigan has performed a series of six 20 mph 60° lateral impact tests with various child restraints. The purpose of the tests was to provide a brief overview of the state-of-the-art in lateral protection of child restraints which have been developed through dynamic testing.

The method used to obtain the data consisted of performing simulation tests on the HSRI Impact Sled Facility. The test set-up utilized the DOT standard vehicle seat as the vehicle seat test base with Type I venicle belts with no retractors or reels. Two test dummies were used; an Alderson VIP-3C child dummy and a six-month old infant dummy. Both dummies were run in each of the six tests resulting in twelve individual tests of child restraints.

The results of the tests are reported in terms of dummy target motion with time, ancnorage belt loads versus time, sequence camera coverage and a brief narrative evaluation of the performance of each system.

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SECTION 1. INTRODUCTION

The Biomechanics Department of the Highway Safety Research Institute of The University of Michigan has performed a series of six 20 mph 60° lateral impact tests with various child restraints. The purpose of the tests was to provide a brief overview of the state-of-the-art in lateral protection capabilities of child restraints which have been developed through dynamic testing.

The objectives of the test program were to:

1. Determine the ability of various existing child restraints to prevent child head contact with vehicle interior lateral surfaces in 60° lateral (that is, 60° from straight ahead) impact simulations at 20 mph speeds.
2. Furnish data for use in developing Federal Motor Vehicle Safety Standard No. 213, Child Restraint Systems.

The method used to obtain the data consisted of performing impact simulation tests on the HSRI Impact Sled Facility. The test set-up utilized the DOT standard vehicle seat as the vehicle seat test base with Type I venicle belts with no retractors or reels. Two test dummies were used; an Alderson VIP-3C child dummy and a six-month old infant dummy. Both dummies were run in each of the six tests resulting in twelve individual tests of child restraints. The details of the test configurations and test conditions are described in Section 2, Test Methods.

The results of the tests are reported in terms of dummy target motion with time, anchorage belt loads versus time, sequence camera coverage and a brief narrative evaluation of the performance of each system. The results are detailed in Section 3 Test Results.

SECTION 2. TEST METHODS

2.1 Sled Facility All tests were performed on the HSRI Impact Sled Facility. The facility is a deceleration sled which uses the rebound principle to obtain the desired sled deceleration pulse and velocity change. The sled pulses used in the tests were nominally a 20 mph velocity change with an average deceleration of 16 G. This pulse falls approximately in the middle of the bounds shown in Figure 1. The individual sled pulses for each test are given with the belt load traces found in Section 3.

2.2 Test Base A DOT standard vehicle seat as specified in a set of drawings filed in Docket No. 74-9 was used as the vehicle seat test base. The specific seat was obtained from Wright-Patterson Air Force Base (WPAFB) and was originally constructed at HSRI as part of NHTSA Contract No. DOT-HS-4-00865. The seat was mounted to the HSRI sled frame with the seat facing at 60° to the sled direction of motion. Anchorage was provided behind the seat to simulate the center rear seat belt mounting of a typical sedan -- for attachment of top straps when supplied with the child restraint. Type I vehicle lap belts with no retractors or reels were used as the vehicle lap belts. Standard Ford seat belts were used and were replaced after each run.

The foam seating cushions were supplied with the seat by WPAFB and were changed after each run as were the seat back deflector rods.

2.3 Test Dummies

The test dummies used in the study were:

1. An Alderson VIP-3C child dummy.

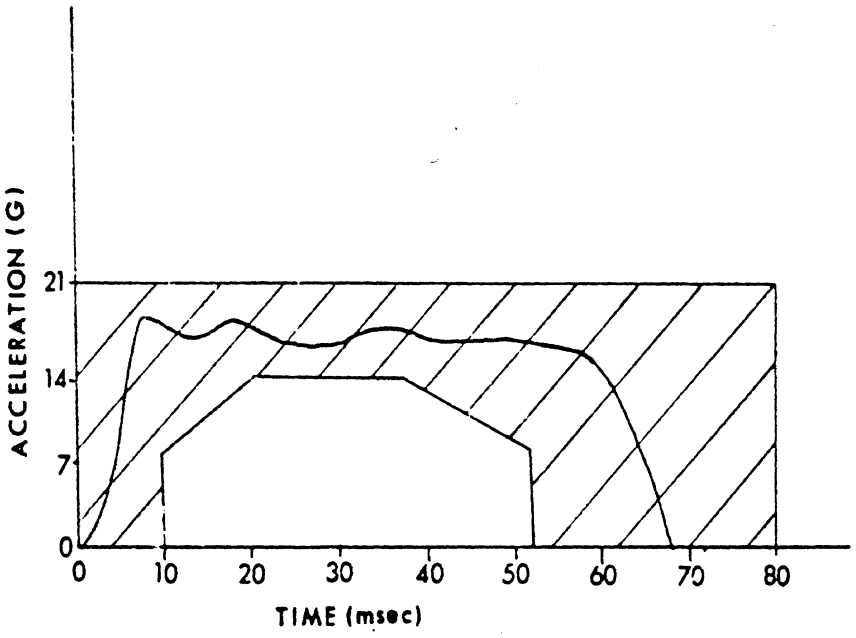


FIG.1 TYPICAL TEST SLED PULSE

2. A six-month-old infant dummy as specified in 49 CFR Part 573, Docket No. 74-9, Notice 2 (39FR18287-8), May 24, 1974.

The dummies were supplied to HSRI by NHTSA.

2.4 Child Restraints

The child restraint systems scheduled for testing were the following:

1. GM Child Love Seat
2. GM Infant Love Seat
3. Ford Tot-Guard
4. Kantwet Care Seat Model 985 (2)
5. Swingomatic Child Seat (2)
6. Hedstrom Child Seat
7. Peterson Model 75 Infant Restraint
8. Peterson Model 74 Child Restraint
9. Bunny Bear Sweetheart II Seat
10. Bobby-Mac Deluxe Car Seat

With the exception of the Hedstrom seat, which was not available anywhere in the southeast Michigan area, the above seats were purchased through retail outlets. The resulting gap in the test matrix due to the unavailability of the Hedstrom seat was filled by a second GM Child Love Seat test, as a check on an unusual seat failure during its first test.

The restraint systems were tested in pairs, one child and one infant, in each of the six sled runs.

2.5 Test Instrumentation

The instrumentation for each test involved the following:

1. A Graph-Chek sequence camera coverage of the event;
2. Photosonics 1000 fps color movie film coverage consisting of:
   a. A side view normal to the direction of sled motion (see Fig. 2)
   b. A side view normal to the standard bench seat (see Fig. 2)
   c. An overhead view
3. Sled mounted accelerometer for sled deceleration pulse measurement
4. Four GSE anchorage belt load cells
5. Sled velocity determination by discrete magnetic proximity probes

The load cells were applied to the anchorage belts in the most appropriate manner for the pair of restraint systems in each sled run (for example, in the case of a child seat with a top strap and car lap belt anchorage, three load cells were applied while only one load cell was used on the car lap belt of the second restraint in that test.)

2.6 Test Procedures

The restraint systems were placed on the bench seat in pairs with the two positions being designated position A and position B. In all cases position A was the left side (or driver's side) position and was nearest the front of the sled. The B position was usually the right side (or passenger's side) except in the case of the Ford Tot-Guard test when it was the center position. The pairing of the seats produced the following test matrix:

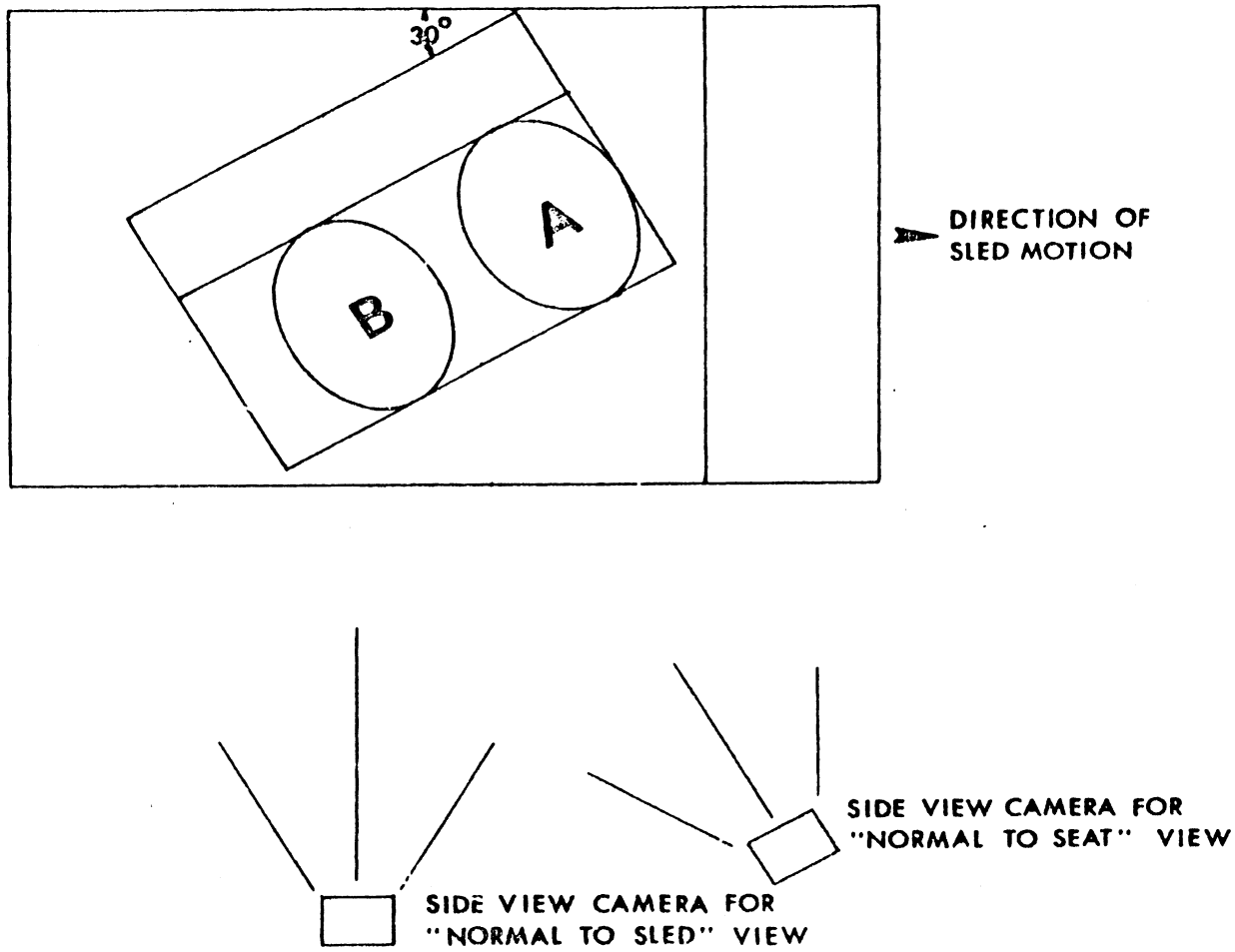


FIG. 2 PLAN VIEW OF TEST CAMERA COVERAGE

Test No.	Restraint System	Dummy
917 A	GM Child Love Seat	3 yr. old
3	Bobby Mac Deluxe Seat	6 mo. old
918 A	Kantwet Model 985	3 yr. old
B	Kantwet Model 985	6 mo. old
919 A	GM Child Love Seat	3 yr. old
B	Bunny Bear Sweetheart II	6 mo. old
920 A	GM Infant Love Seat	6 mo. old
B	Ford Tot-Guard	3 yr. old
921 A	Peterson Model 74 Child Seat	3 yr. old
B	Peterson Model 75 Infant Seat	6 mo. old
922 A	Swingomatic Child Seat	3 yr. old
B	Swingomatic Child Seat	6 mo. old

2.6.1 Dummy Set-Up Procedures

The 3 yr. old dummy set-up procedure was as follows:

1. Suspend the clothed dummy from an eye bolt placed in the head bolt receptacle.

2. Place the dummy in a seated configuration on the edge of a work table with arms and legs horizontal and with the head and back against a vertical surface.

3. Secure the dummy to the vertical surface by two inch wide cloth tape placed horizontally across the nipple area of the chest and horizontally across the abdominal area as low as possible without contacting the thighs.

4. With the arms horizontal, set the shoulder joints at 1 G so as to barely restrain the weight of the limb.

5. Set the elbow joints at 1 G so as to barely restrain the weight of the forearm with the upper arms vertically downward and the forearms

horizontal.

6. Place the dummy on its back on the table with the legs and pelvis extending over the edge of the table. With the leg horizontal, set the hip joints at 1 G so as to barely restrain the weight of the legs.

7. Place the dummy in a seated configuration on the edge of the table, and with the legs horizontal, adjust the knee joints at 1G so as to barely restrain the weight of the lower leg.

8. Set the ankle joint at 1G so as to barely restrain the weight of the foot when it is extended horizontally.

The 6 month old dummy set-up procedure was as follows:

1. Place the dummy in a supine position on a flat horizontal surface then position the left hand on the center of the torso and the right hand under the rear of both feet and bend the dummy until the legs contact the upper torso and the toes touch the head, then slowly release the legs.

2.6.2 Test Set-Up Procedure

A new child restraint system was installed in each of the two test positions on the standard vehicle seat. The restraints were anchored with new, untested Type I belt assemblies and with additional belts, when supplied by the manufacturer. The dummy was installed in most restraints with the centerline of the dummy centered in the seating position and midway between the vehicle seat lap belt anchorage points. The only exception was the Bunny Bear Sweetheart II seat which is a lateral facing infant seat.

The child dummy was placed in the restraint system and fastened in according to the instructions furnished with the system and positioned in accordance with the following procedure:

1. Seat the dummy on the seating surface while holding the torso upright until the dummy is seated.

2. Extend the arms of the dummy in a vertical direction and the legs in an anterior-posterior direction. The dummy's foot is to be perpendicular to the lower leg.

3. Push the dummy, first at the crotch and then at the upper thorax, with a distributed force of 40 lbs. against the seatback and release. (The 40 lbs. force was applied manually by adding a T-handle to a GSE adult dummy femur axial load cell with a four inch square block of balsa wood on the other end for load distribution.)

4. Rotate the arms and legs down parallel to the midsagittal plane until each segment contacts the first available surface or until the limb joint runs out of motion capability. (Care was taken so that the dummy arms did not inhibit dummy head excursion in the impact direction.)

The infant dummy was placed in the restraint system and fastened in according to the manufacturer's instructions furnished with the system, and positioned in accordance with the following procedure:

1. Place the dummy in the restraint with its midsagittal plane parallel to the longitudinal centerline of the restraint and with the restraint centered in the seating position midway between the vehicle seat lap belt anchorages.

2. Insure that the back of the dummy contacts the contour of the back or the bottom of the device, or both. Tape the head of the dummy to the child restraint seat back with a single thickness of one half inch wide paper masking tape. The tape is placed in the midsagittal plane from the forehead to the top of the restraint. A one-eighth inch diameter circular hole is punched through the tape near the dummy head

by means of a paper punch.

3. Swing the limbs from vertical position parallel to the mid-sagittal plane, until they contact the first available surface which supports them. The arms must not be confined by belts or shield-type restraints.

Following placement and positioning of the dummies, all the restraint belts on the child restraint were adjusted to fit snugly while still providing for a controlled amount of slack in the belts in the following manner. At each of four locations on the dummy (both shoulders and on each side of the pelvis above the legs) a one half inch diameter hard plastic rod two inches in length was placed under the belts prior to tightening. The belts were then tightened as snugly as could reasonably be achieved given the particular belt adjustment system and seat configuration and then the four rods were removed.

In all cases, with the exception of the Kantwet Child Care Seat which requires installation of the car lap belt prior to placing the dummy in the seat, the car lap belts and auxiliary seat anchorage belts were tightened to at least 12 and no greater than 15 lbs as measured by the GSE belt load cells installed on those anchorages. In the case of the Kantwet child seat, this tension was adjusted prior to placing the dummy in the seat.

2.7 Data Analysis

The data produced in the tests consisted of sled velocity and deceleration, restraint anchorage belt loads, and photographic records of the motions of the test dummies and restraints. The sled velocities were calculated from the discrete magnetic probe data and are listed with the test summaries in Section 3 as are the average sled decelerations. The sled deceleration and the anchorage belt loads as functions of time were replayed from magnetic tape records onto a four channel Brush strip chart recorder with filtering equivalent to SAE Channel Class 60. The strip chart records for each run are presented with the test summaries in Section 3.

The photometric analysis of the 1000 fps movie coverage was performed on a Vanguard film analyzer. The analysis was performed on the two side views ("normal to the sled" and "normal to the seat"). The target that was followed was the dummy head in those cases where it was visible. In many of the tests with the infant restraints, the dummy head was not visible. In those cases, the forward upper corner of the restraint was followed as this was the point on the restraint closest to the dummy head during the major motions of the tests. An exception to this was the Bunny Bear seat in which the uppermost center point of the seat was followed. The target which was followed is noted on the reduced motion graphs which are presented in Section 3. The method of analysis was to obtain the intersection of the horizontal and vertical lines which were tangent to the target. Thus, the coordinates are not those of any particular point on the dummy or seat but represent the bounding planes of the dummy-restraint system as it translates and rotates during the test. Due to the necessity of placing the camera for the view normal

to the seat well up above ground level and looking down at an angle from horizontal, the vertical coordinates obtained in the analysis of the view normal to the seat are not comparable to those obtained from the view normal to the sled. The reduced coordinates are relative to the centerline target of the dummy head at time equal zero of the sled pulse.

TABLE 1. TEST DATA SUMMARY - PEAK VALUES

TEST NUMBER AND POSITION		RESTRAINT	MAX. HEAD EXCURSIONS See Figure 2 "NORMAL TO SEAT," in.	"NORMAL TO SLED," in.	MAX. ANCHORAGE LOADS RT. LAP lbs	LT. LAP lbs	TOP STRAP lbs
A-917	A	GM Child Love Seat	28.5	27.9	405	260	335
	B	Bobby-Mac Infant Seat	24.6	19.4	400	-	-
A-918	A	Kantwet Child Care Seat	27.0	26.1	790	295	-
	B	Kantwet Infant Care Seat	18.7	18.4	575	245	-
A-919	A	GM Child Love Seat	15.1	13.5	405	220	485
	B	Bunny Bear Infant Seat	12.5	20.1	295	-	-
A-920	A	GM Infant Love Seat	21.4	21.7	330	190	-
	B	Ford Tot-Guard	30.1	29.3	615	310	-
A-921	A	Peterson 74 Child Seat	26.8	22.0	510	370	-
	B	Peterson 75 Infant Seat	19.3	18.3	450	185	-
A-922	A	Swingomatic Child Seat	20.6	18.3	450	-	445
	B	Swingomatic Child Seat (Infant Dummy)	20.3	20.7	510	-	60

SECTION 3. TEST RESULTS

This section presents the analyzed test results and summary commentary on the performance of each restraint system tested. The format consists of a description of the test set-up, a discussion of any difficulties or unusual features of the test followed by an assessment of the system performance. Accompanying the commentary are test set-up photographs, Graph Chek sequence photograph, target excursion plots, sled pulse and belt load traces and post-test photographs. These packages are grouped in order of test number. In addition, a listing of tabular target excursion values and time values are included in Appendix A for each test.

With the exceptions of the system failures in tests A-917-A and A-919-B the restraint systems performed as intended. One factor of the test configuration which led to some problems was the lack of an interior surface for the restraints in position A to interact with. This configuration did allow many of the restraint systems to roll over the edge of the bench seat and rotate laterally. However, the presence of a door surface at that point would have limited excursions of the systems while producing impacts to the test dummy -- an even more difficult problem in assessing system performance. It would appear that the most reasonable approach is to assess system performance with the restraint in the far side outboard or center position in side impact. In this manner, the effect of the edge of the bench seat and the lack of an interior surface are minimized. In the analysis of the data in the present tests the potential interaction of the restraint system and dummy with an interior surface were evaluated by assessing the configuration of the system and dummy at that point during the test

when interaction with the interior side structure would have occurred -- approximately 13 inches from the centerline of the A position.

3.1 Test Number A-917

Restraint Systems: A - GM Child Love Seat

B - Bobby Mac Deluxe Car Seat

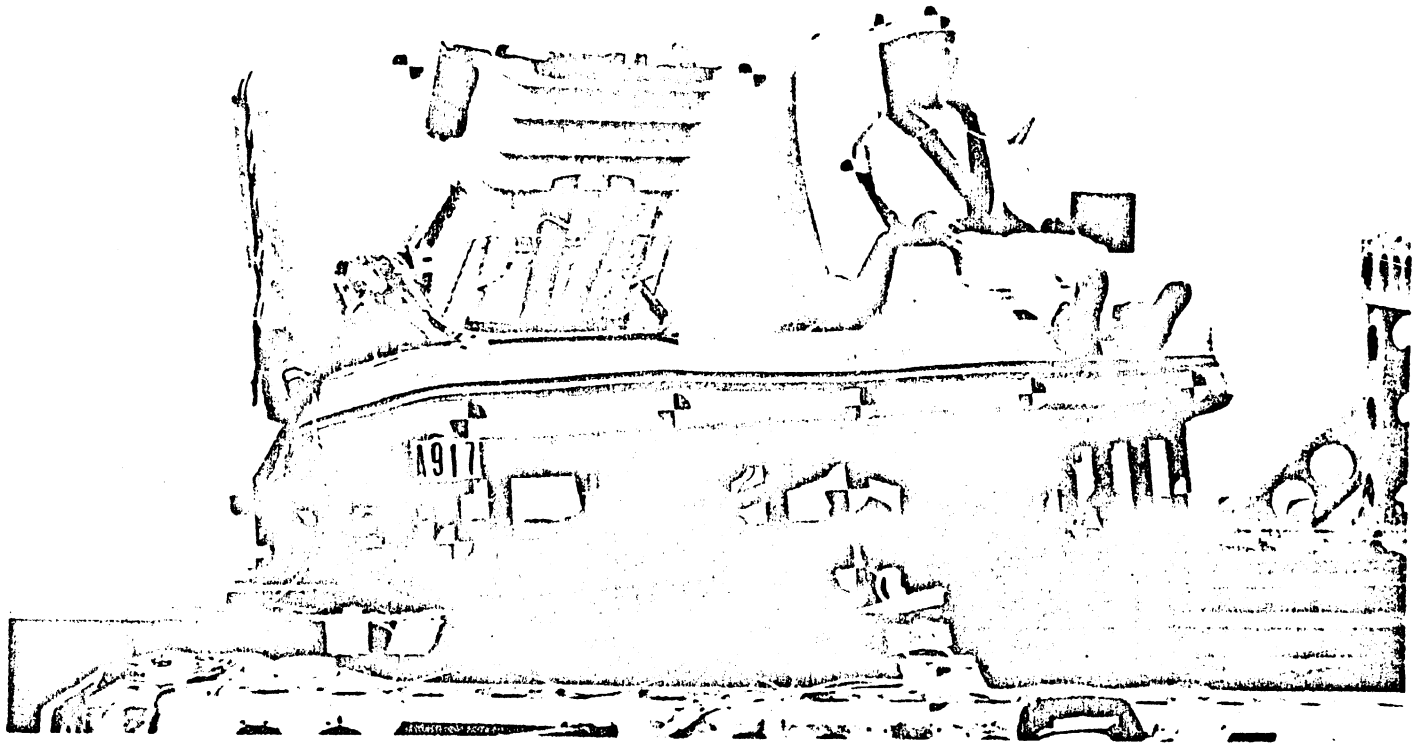
Sled Pulse: 20.7 mph - 16 G average

Seat Position A: A GM Child Love Seat was installed in this position with belt load cells on both left and right portions of the car lap belt and on the top strap. During the test, the top strap pulled out through the back of the restraint at approximately 320 lbs without fracturing the restraint structure and leaving only small deformed areas on either side of the belt slot as shown in the post-test photograph. No abnormalities in the top strap or its S-shaped anchor plate were noted after the test. The apparent cause of this failure was that at the time of manufacture the seat padding was fastened in place while the top strap was not completely pulled tight with its S-shaped anchor plate against the seat shell. The seat was installed on the sled and the dummy placed in position prior to tightening the anchorage straps to 12-15 lbs according to the test procedure outlined in Section 2.b.2. The pre-test photographs show that the dummy head was placed in a normal manner and thus no bulge in the padding due to the out-of-place plate was evident. It is possible that the stitched strap end that holds the S-plate could impede the sliding of the strap through the shell and thus, in combination with the dummy pressing against the padded back surface, it was possible to sustain both a static top strap load during test set-up and subsequent dynamic loading during the initial phase to the sled test. The short length of slack top strap between the seat back belt slot and the S-plate was pulled through the slot

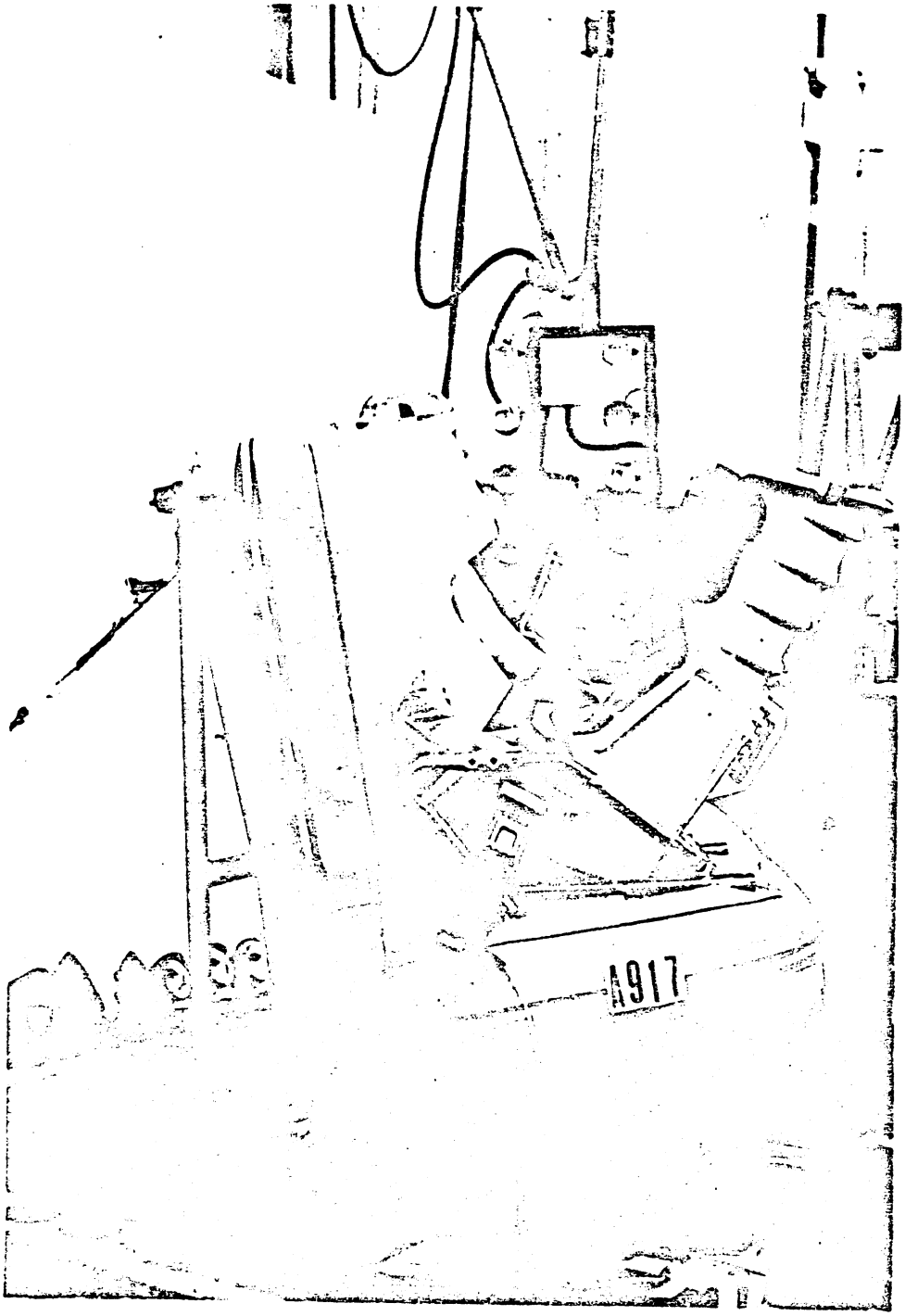
under dynamic loading and allowed the S-plate to rotate into a position perpendicular to the shell surface and be pulled through the slot with very little deformation of the shell material.

No Graph-Chek sequence photograph was obtained for this test due to a malfunction which was corrected for the remaining tests. Analysis of the test movie snow that without the top strap the seat's performance was severely degraded and allowed the seat to rotate off the bench seat by sliding along the car lap belt and resulting in large horizontal head excursions as shown in the excursion graphs. It appeared that if an interior door surface were placed at the edge of the bench seat, the dummy head would have possibly contacted it in this test. Due to the unusual pull-out failure of the top strap, the test was not representative of the true performance of this seat and a second test (A-919) was run with a new seat.

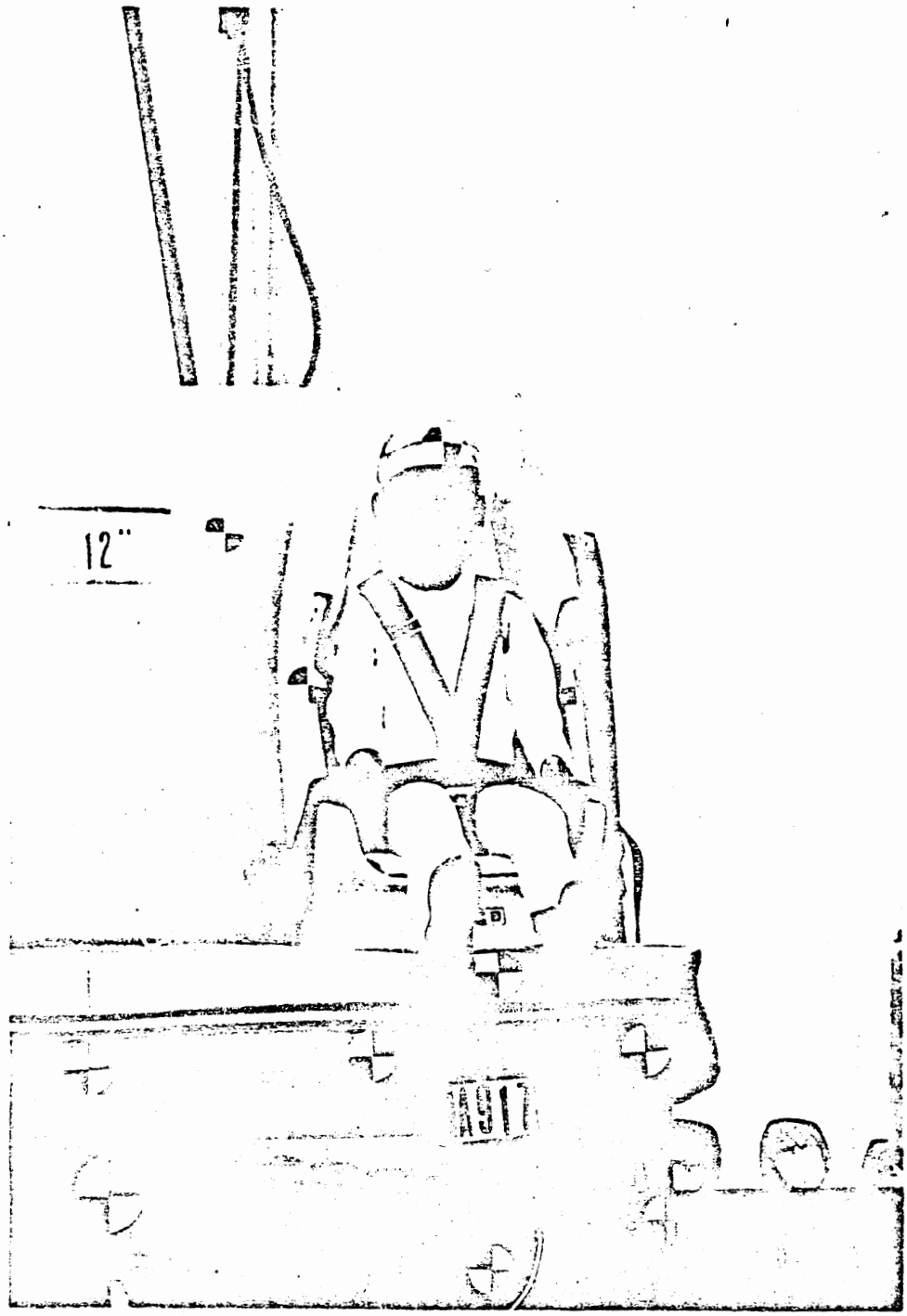
Seat Position B: A Bobby-Mac Deluxe Car seat was installed in this position with a belt load cell on the right portion of the car lap belt. The seat controlled the motion of the infant dummy and provided protection for the dummy head from contact with potential interior door surfaces. The dummy did not show any tendency to slip out of the harness of the seat.



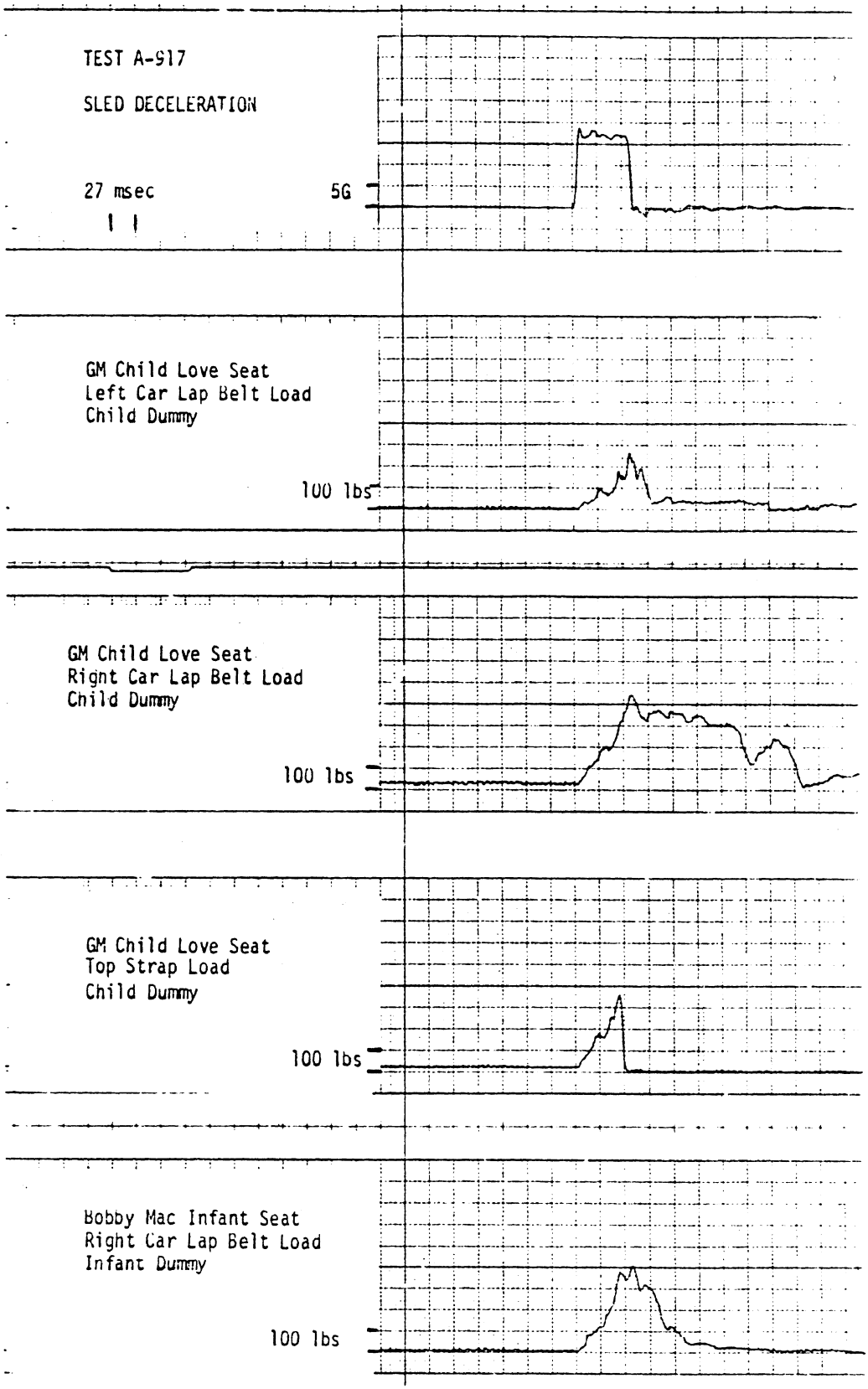
Test A-917 Over-all Test Set-Up

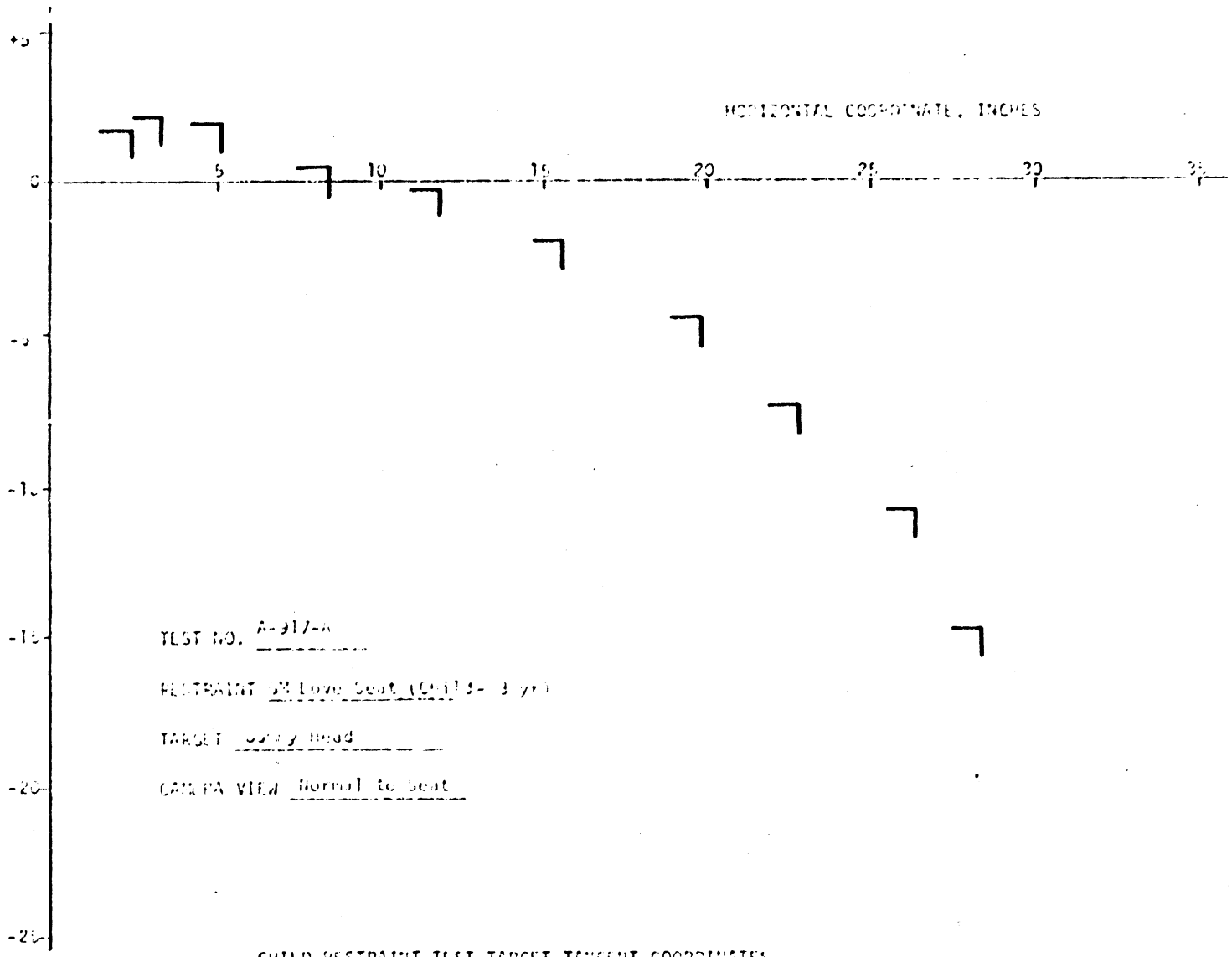


Bobby-Mac Deluxe Car Seat Test Set-Up

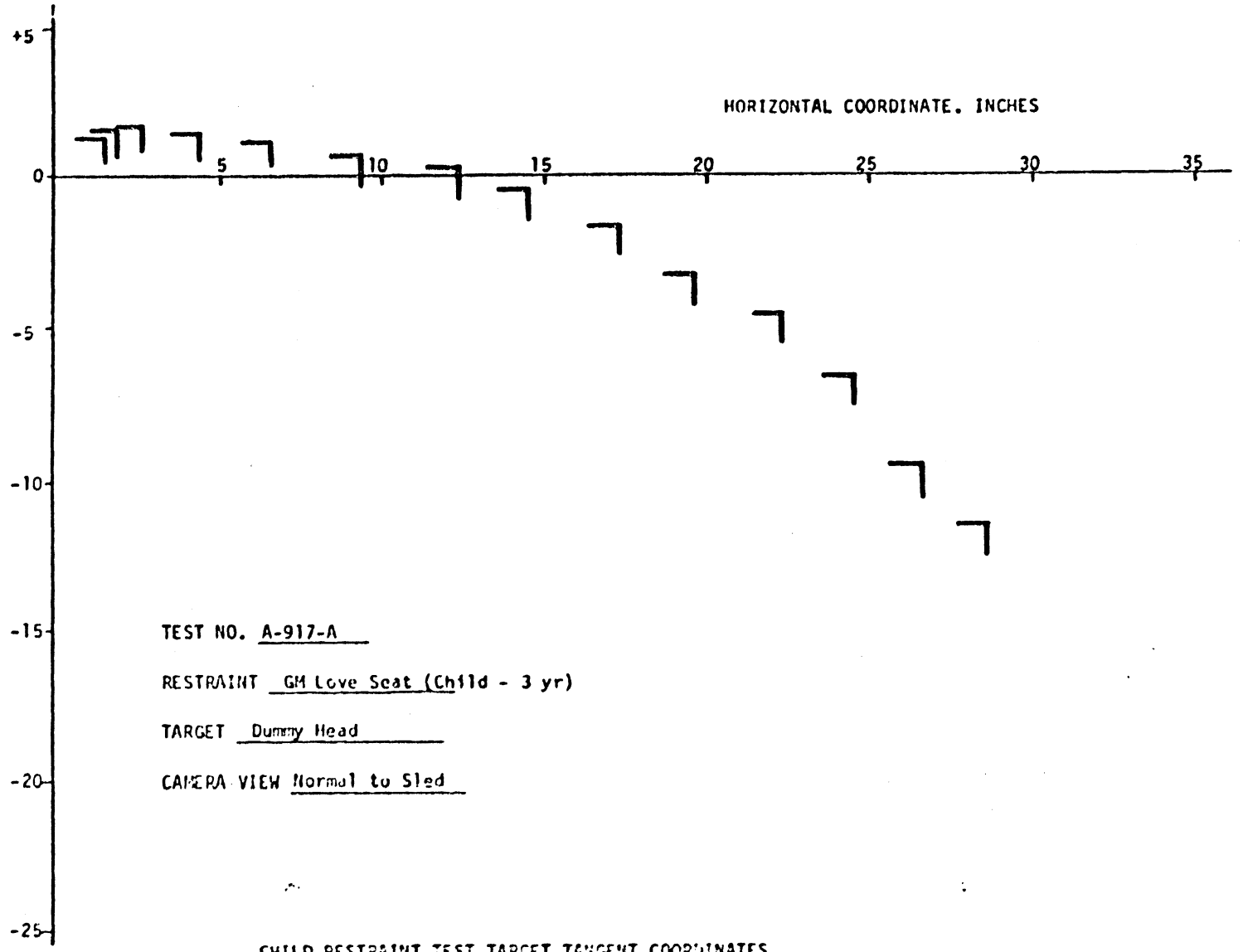


GI Child Love Seat Test Set-Up

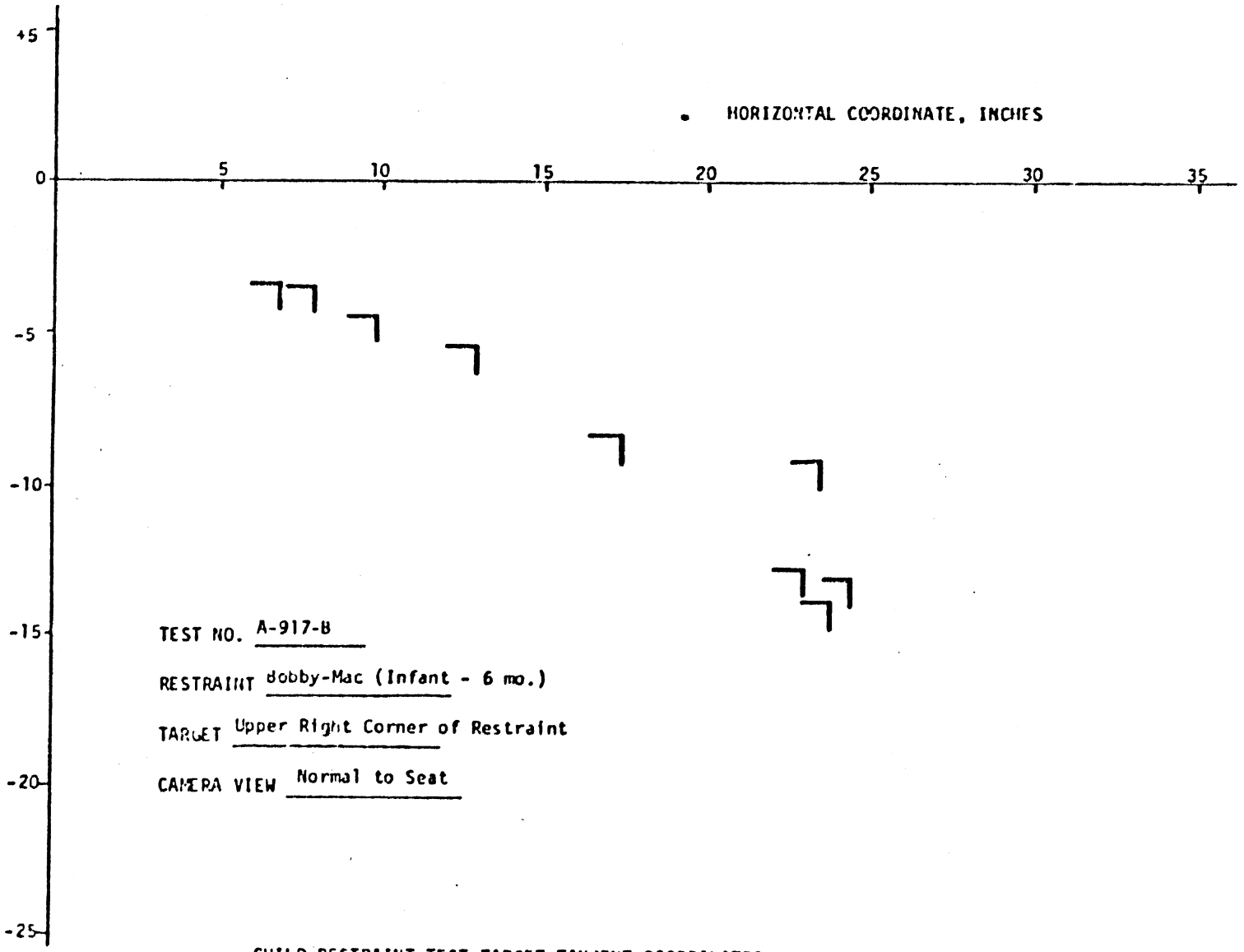

TEST A-917
SLED DECELERATION
27 msec
5G
GM Child Love Seat
Left Car Lap Belt Load
Child Dummy
100 lbs
GM Child Love Seat
Right Car Lap Belt Load
Child Dummy
100 lbs
GM Child Love Seat
Top Strap Load
Child Dummy
100 lbs
Bobby Mac Infant Seat
Right Car Lap Belt Load
Infant Dummy
100 lbs



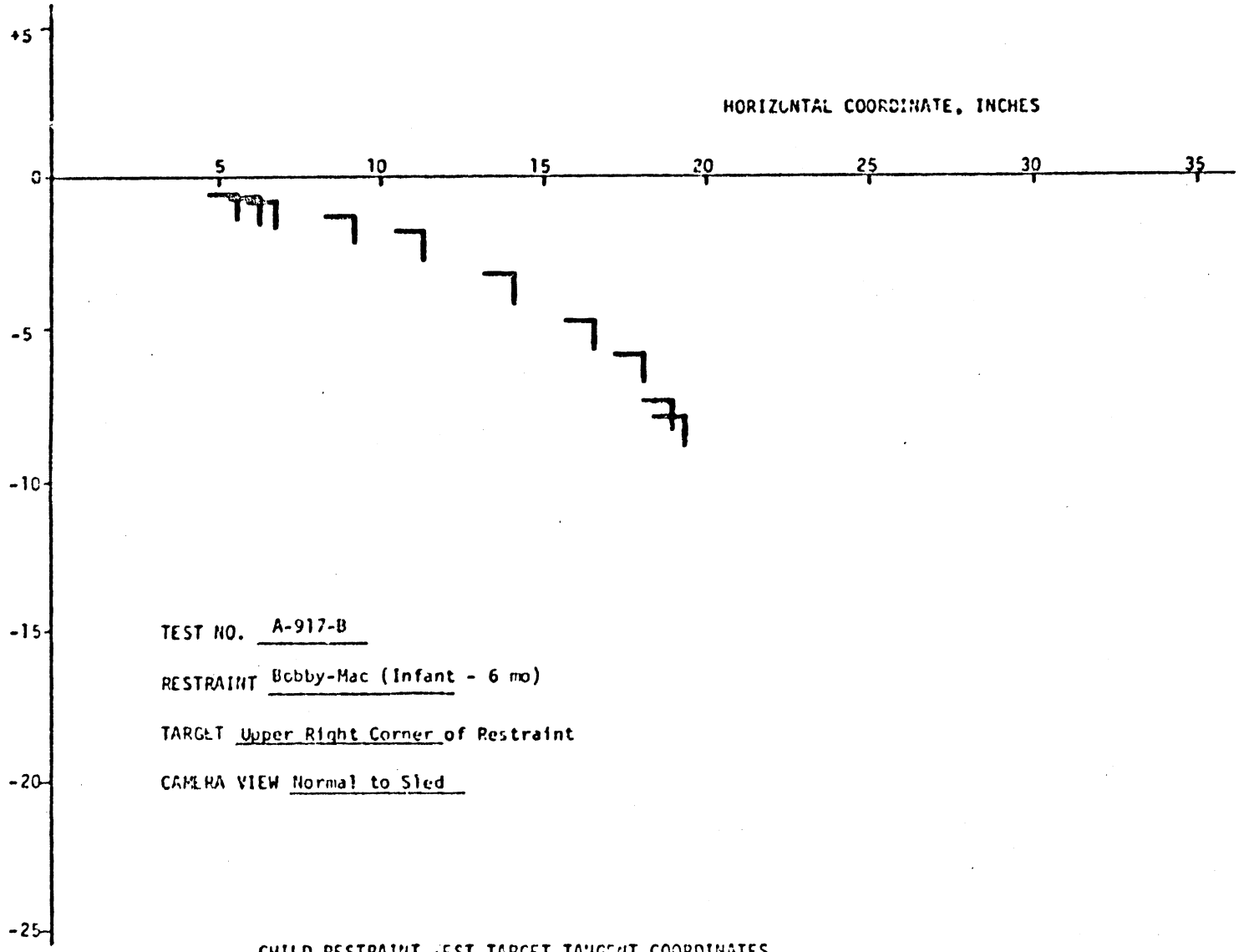
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES

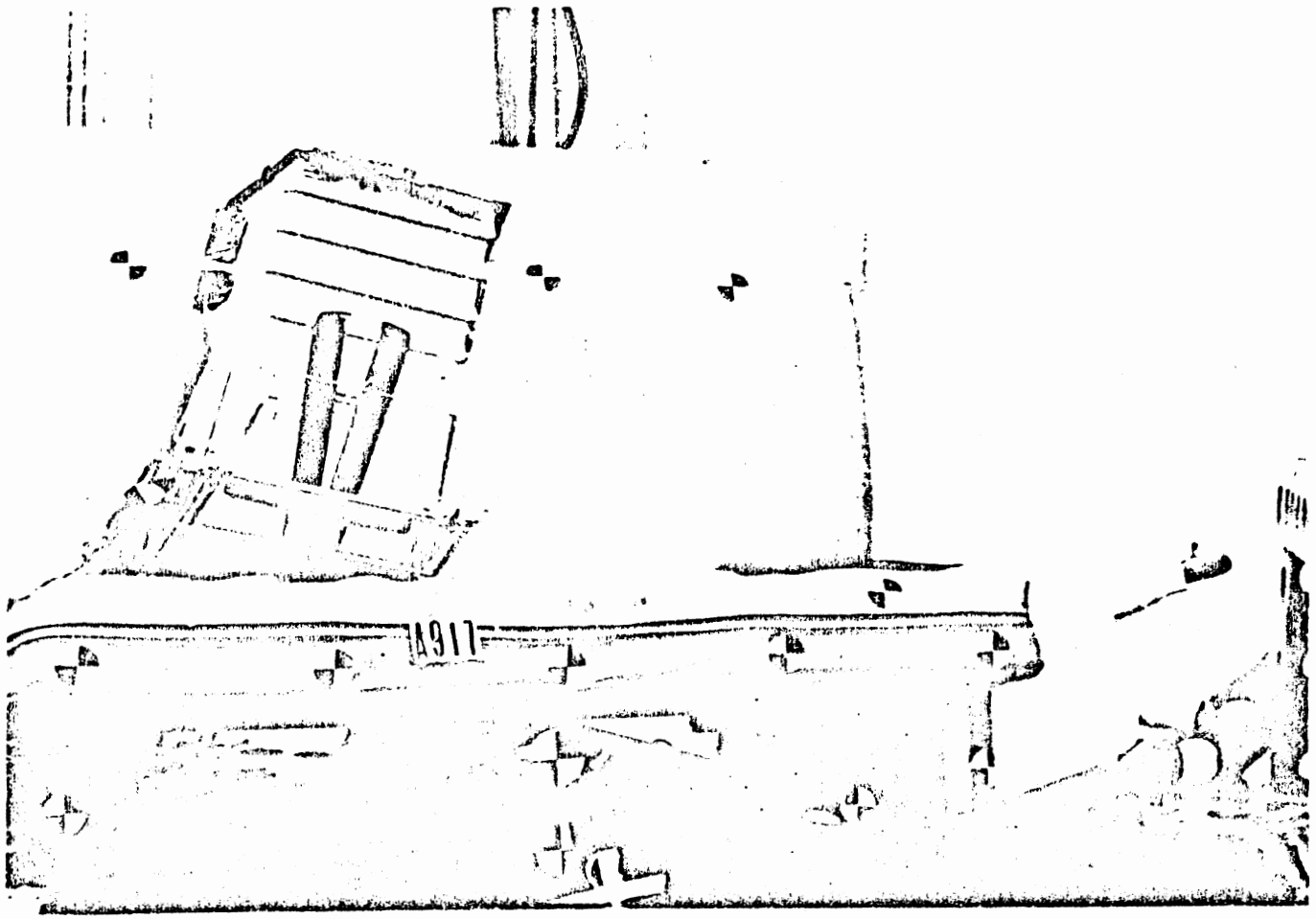


CHILD RESTRAINT TEST TARGET TANGENT COORDINATES

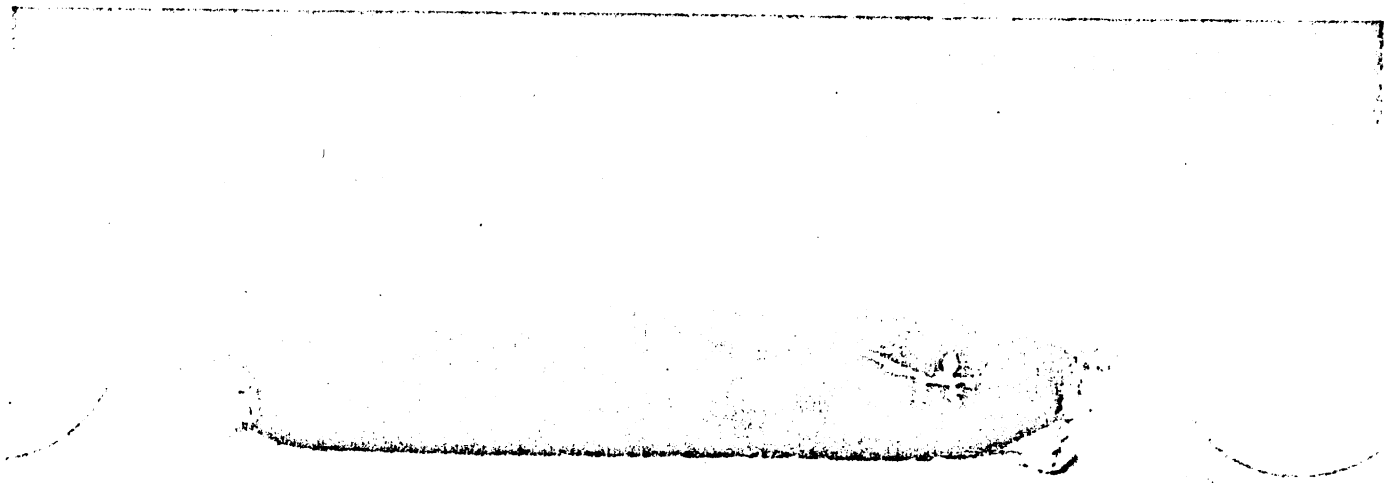


CHILD RESTRAINT TEST TARGET TANGENT COORDINATES

of Little Love Boat Test Test Configuration



Test A-917 Over-all Post Test Configuration



A917

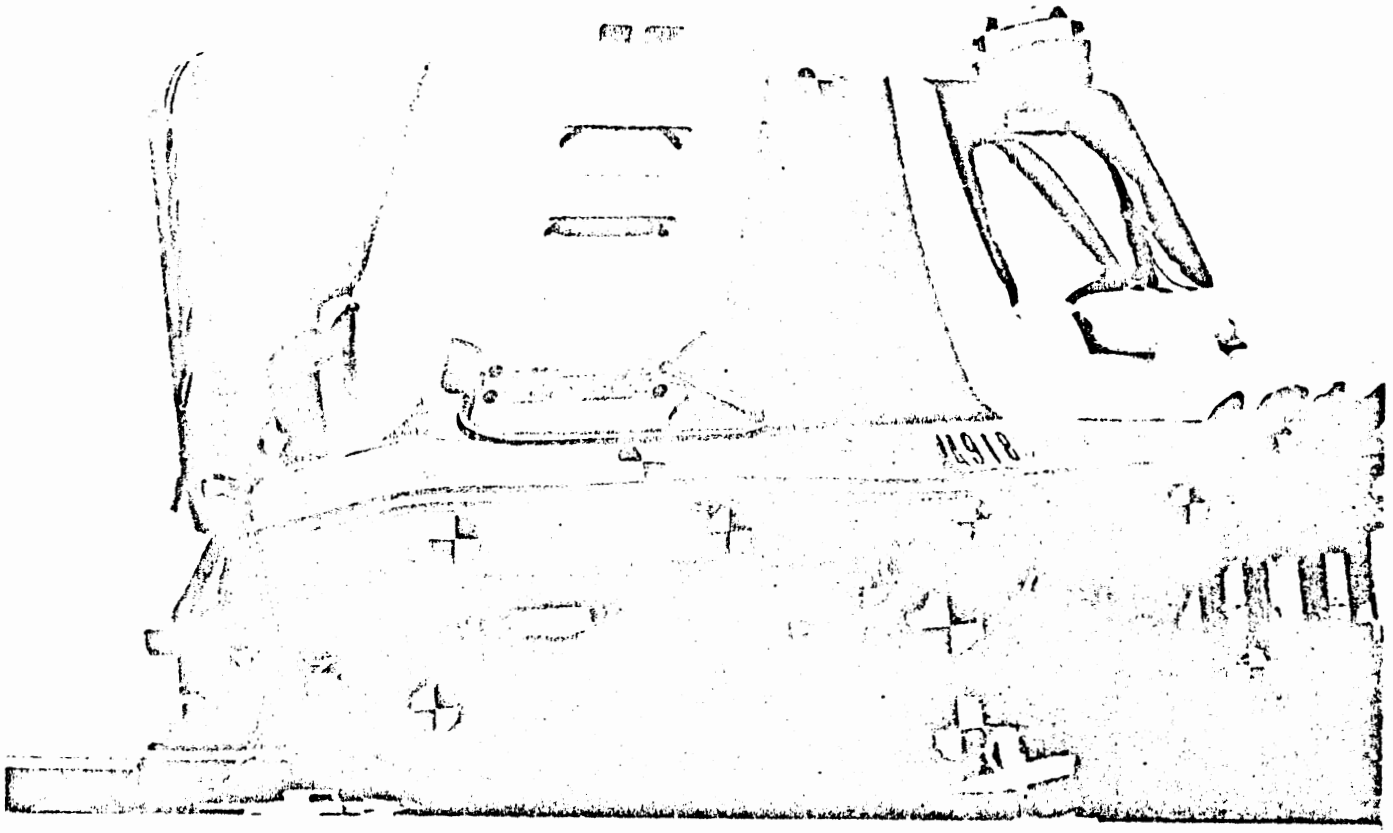
Post Test GI Child Love Seat Back Strap Slot

3.2 Test Number A-918

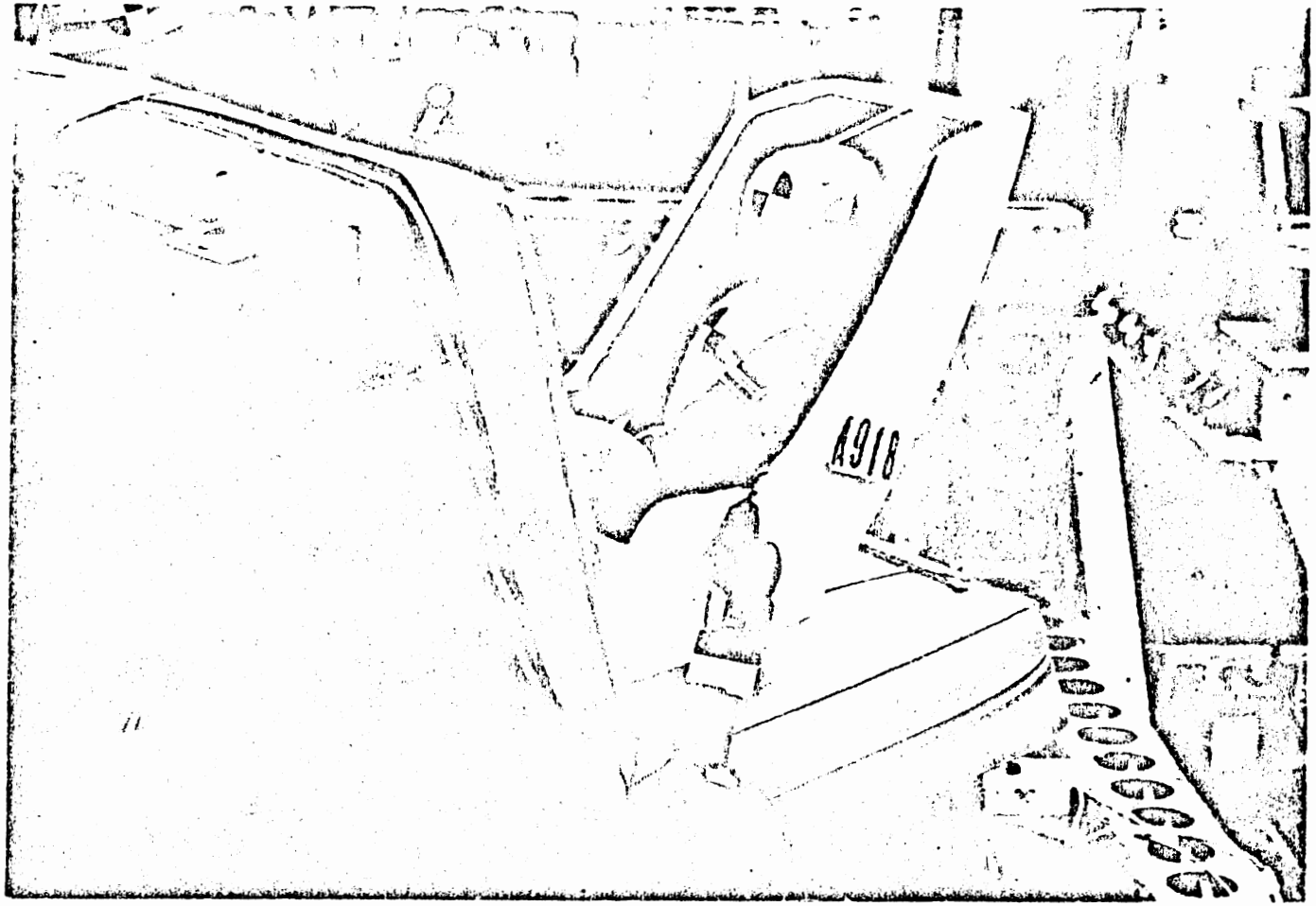
Restraint Systems	A - Kantwet Care Seat (Child Mode)
	B - Kantwet Care Seat (Infant Mode)
Sled Pulse:	20.0 mph - 16.2 G average

Seat Position A: A Kantwet Care Seat was installed in this position in a forward facing child restraint mode. Belt load cells were placed on both sides of the car lap belt; no top strap is used with this system. During the test, the restraint system slipped laterally along the car lap belt and rotated off the bench seat. The motion of the dummy was such that it is most likely that the head would strike potential interior surfaces of the door. The dummy showed no tendency to slip out of the restraint harness.

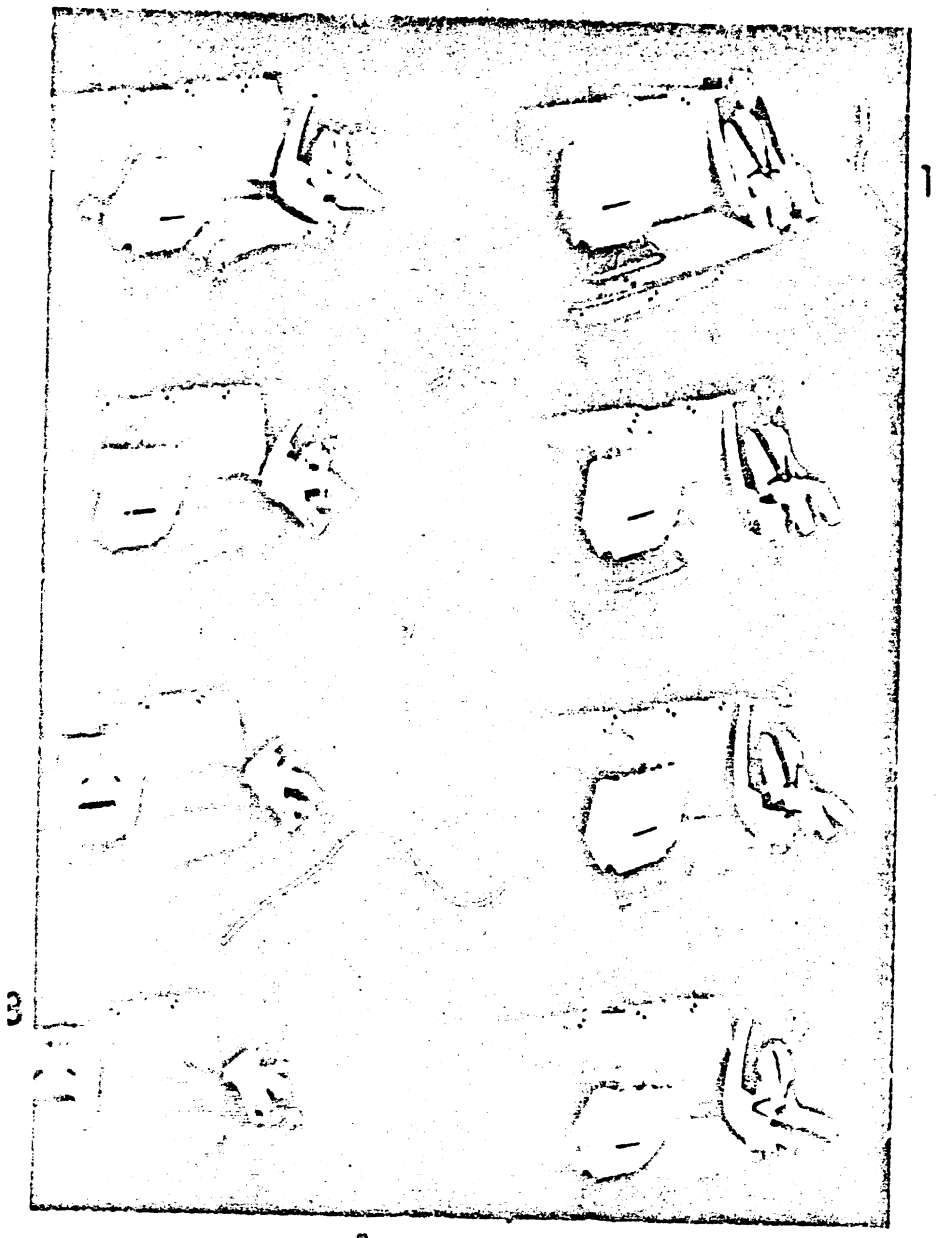
Seat Position B: A Kantwet Care Seat was installed in this position in a rearward facing infant restraint mode. Belt load cells were placed on both sides of the car lap belt. The restraint controlled the motion of the dummy and provided protection for the dummy head from contact with potential interior door surfaces. The dummy slipped the left shoulder partially out of the restraint harness (as shown in the post-test photograph).



Test A-918 Over-all Test Set-Up

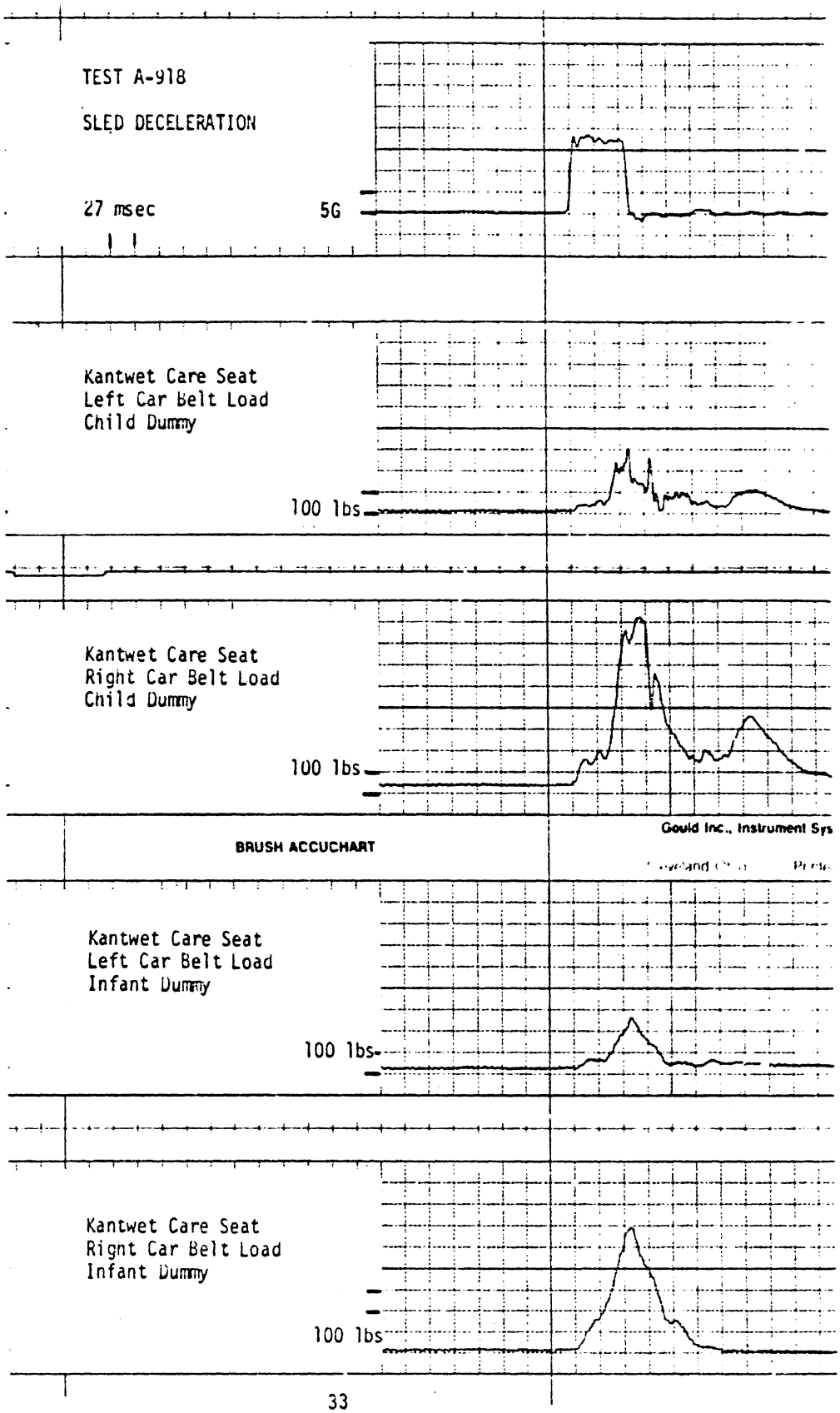


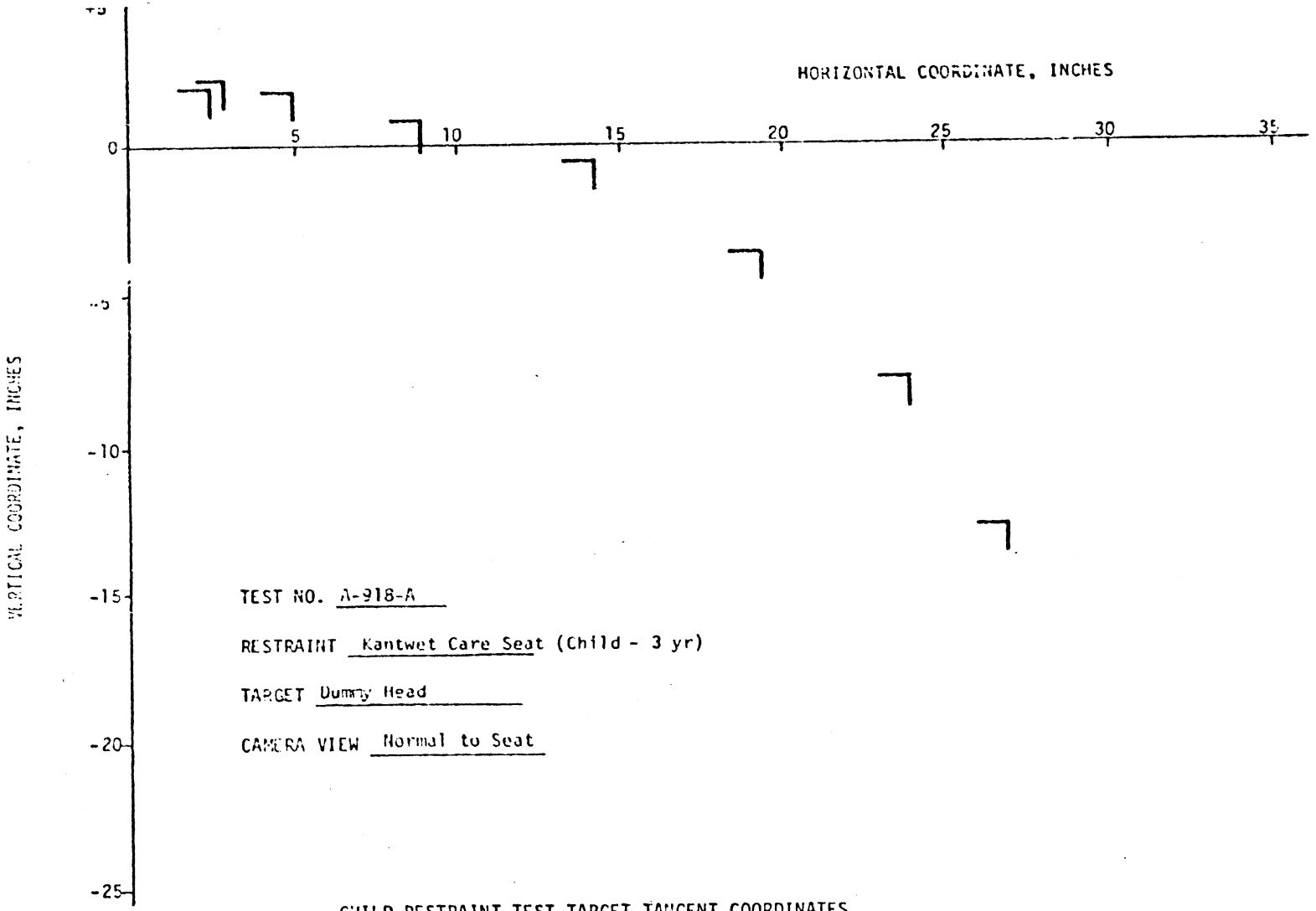
Kantwet Care Seat (Infant) Test Set-Up



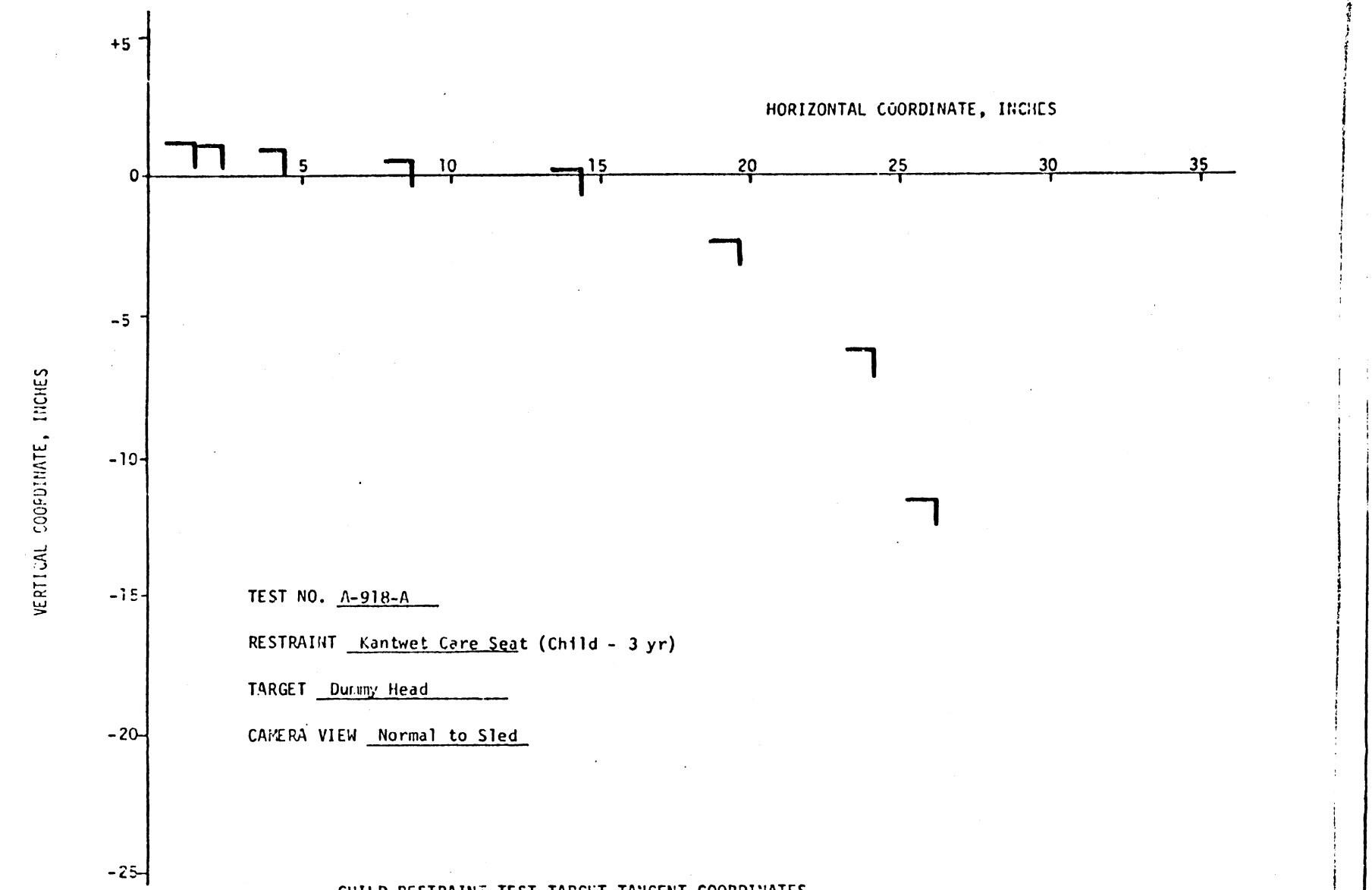
A 918

Grain-check for Test A-918

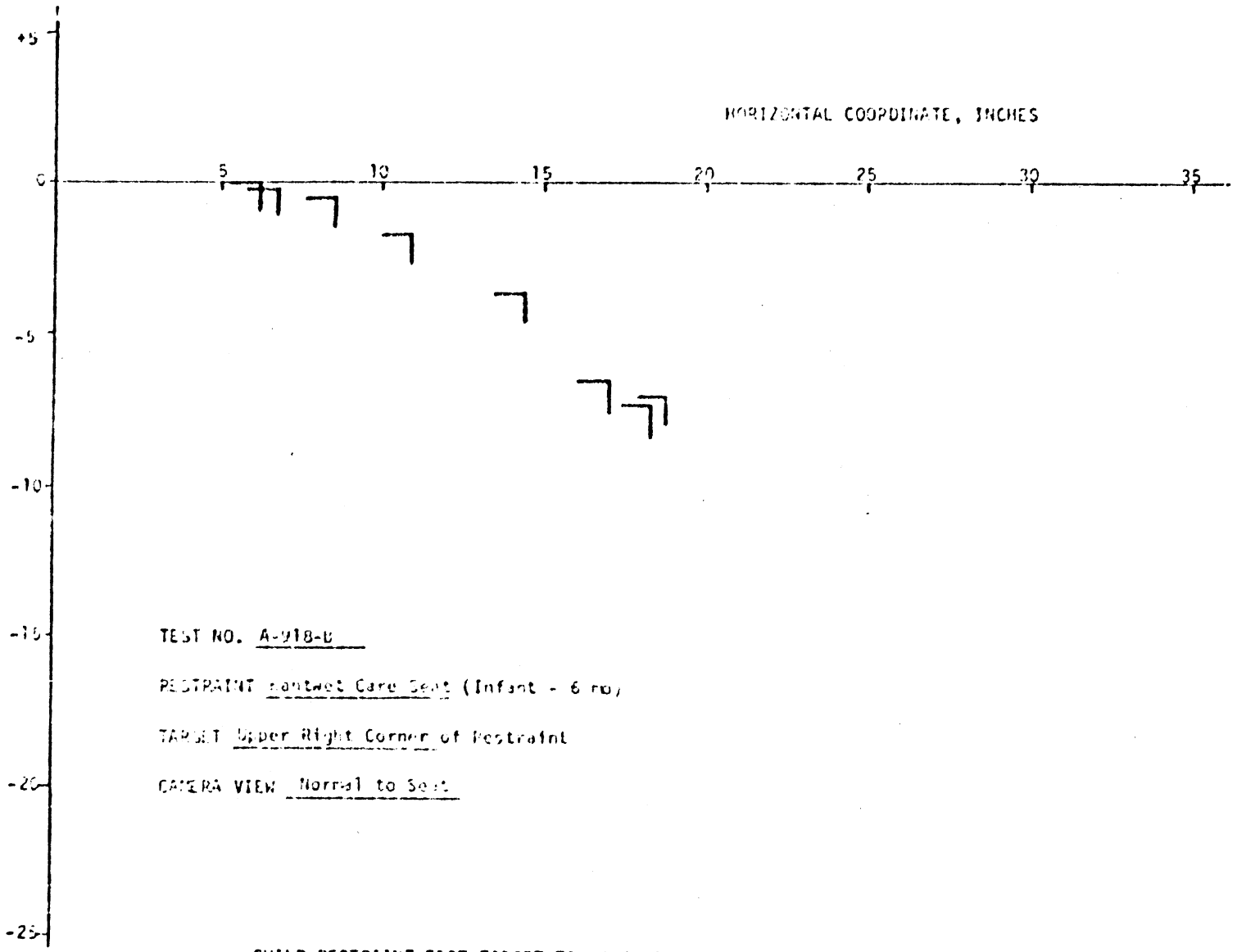

TEST A-918
SLED DECELERATION
27 msec
5G
Kantwet Care Seat
Left Car Belt Load
Child Dummy
100 lbs
Kantwet Care Seat
Right Car Belt Load
Child Dummy
100 lbs
Gould Inc., Instrument Sys
BRUSH ACCUCHART
Kantwet Care Seat
Left Car Belt Load
Infant Dummy
100 lbs
Kantwet Care Seat
Right Car Belt Load
Infant Dummy
100 lbs



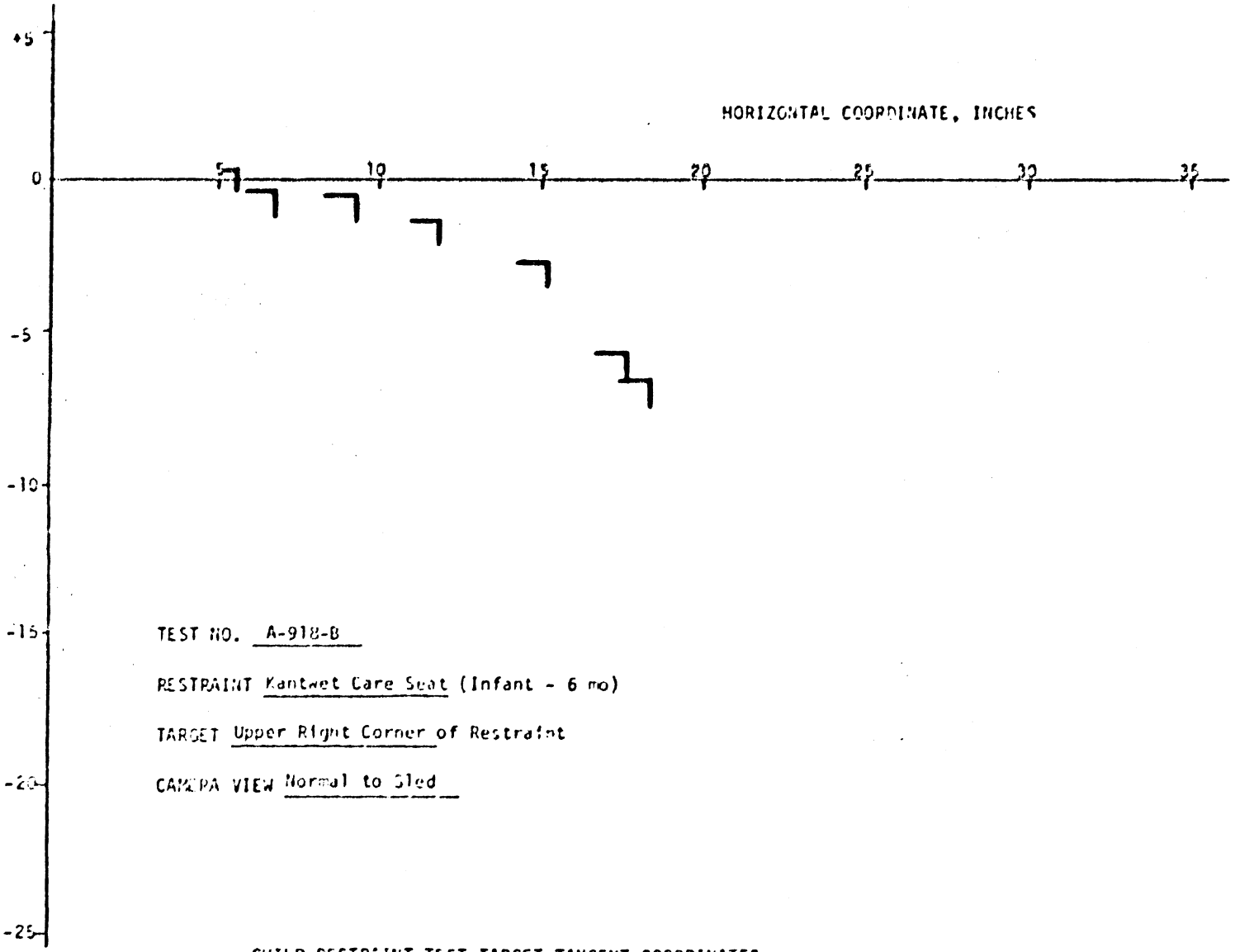
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



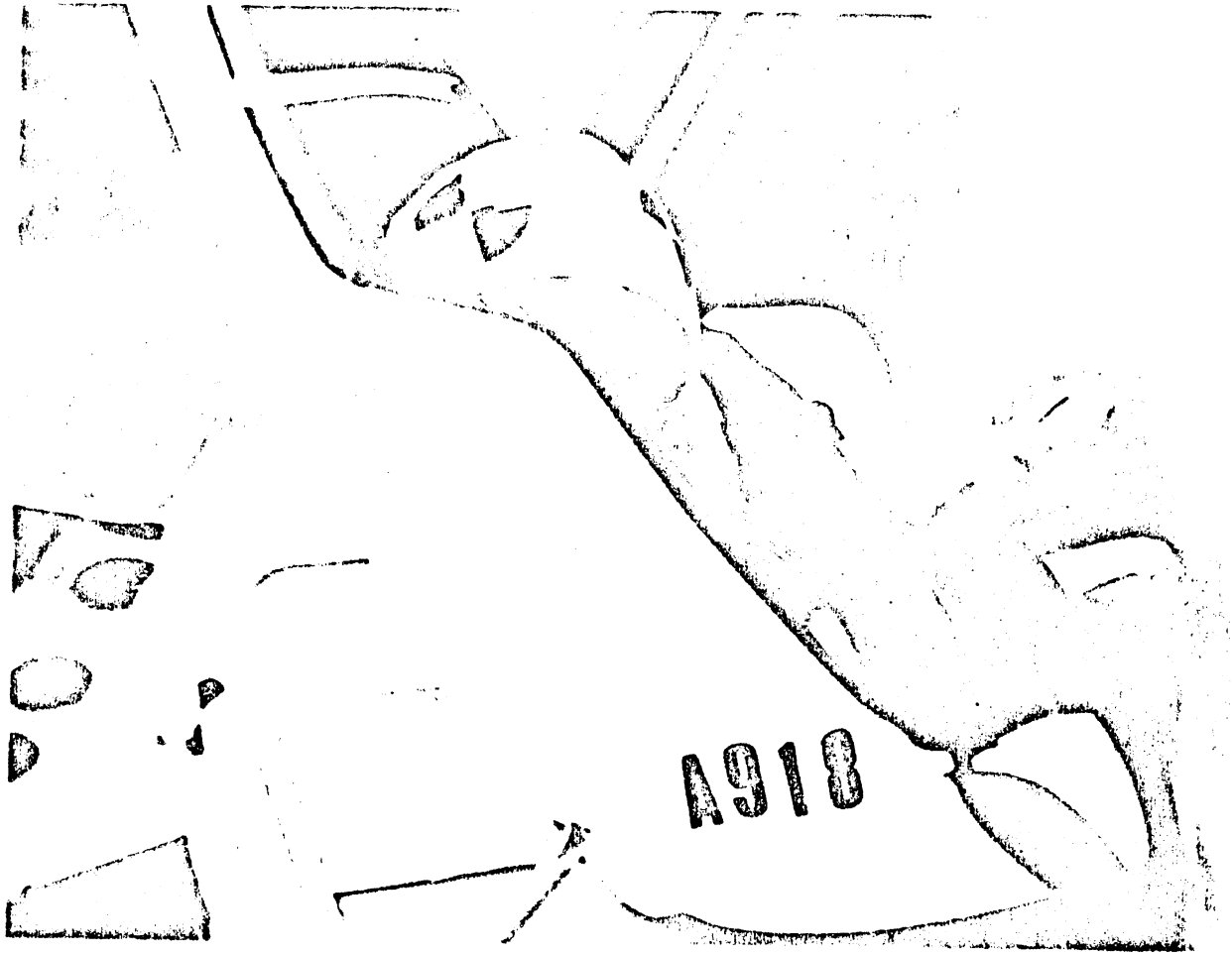
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



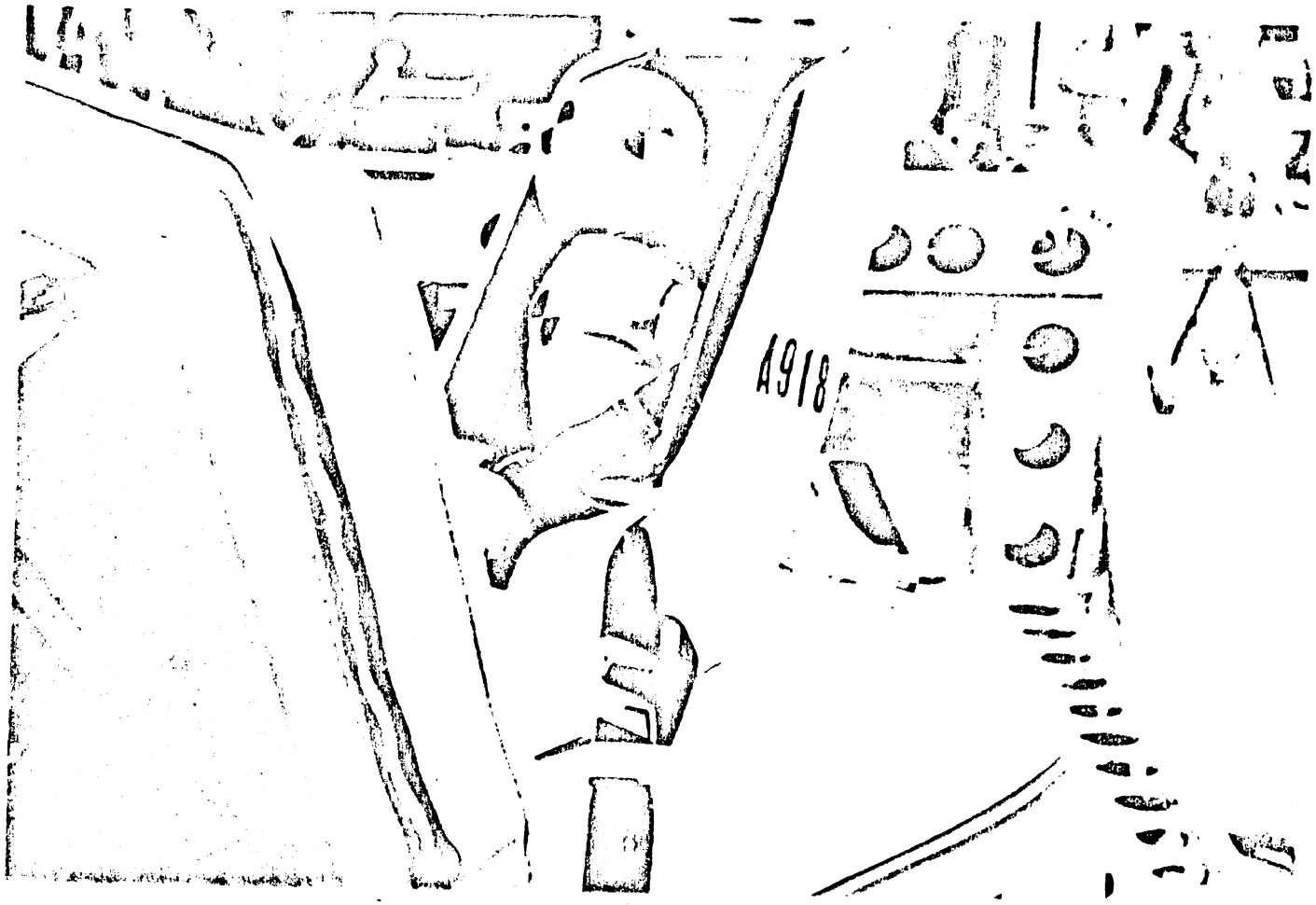
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES

Post Test Kantwet Care Seat (Child)

Post Test Restraint Care Seat (Child)



Post Test Kantwet Care Seat (Infant)


A918

3.3 Test Number A-919

Restraint Systems: A - GM Child Love Seat

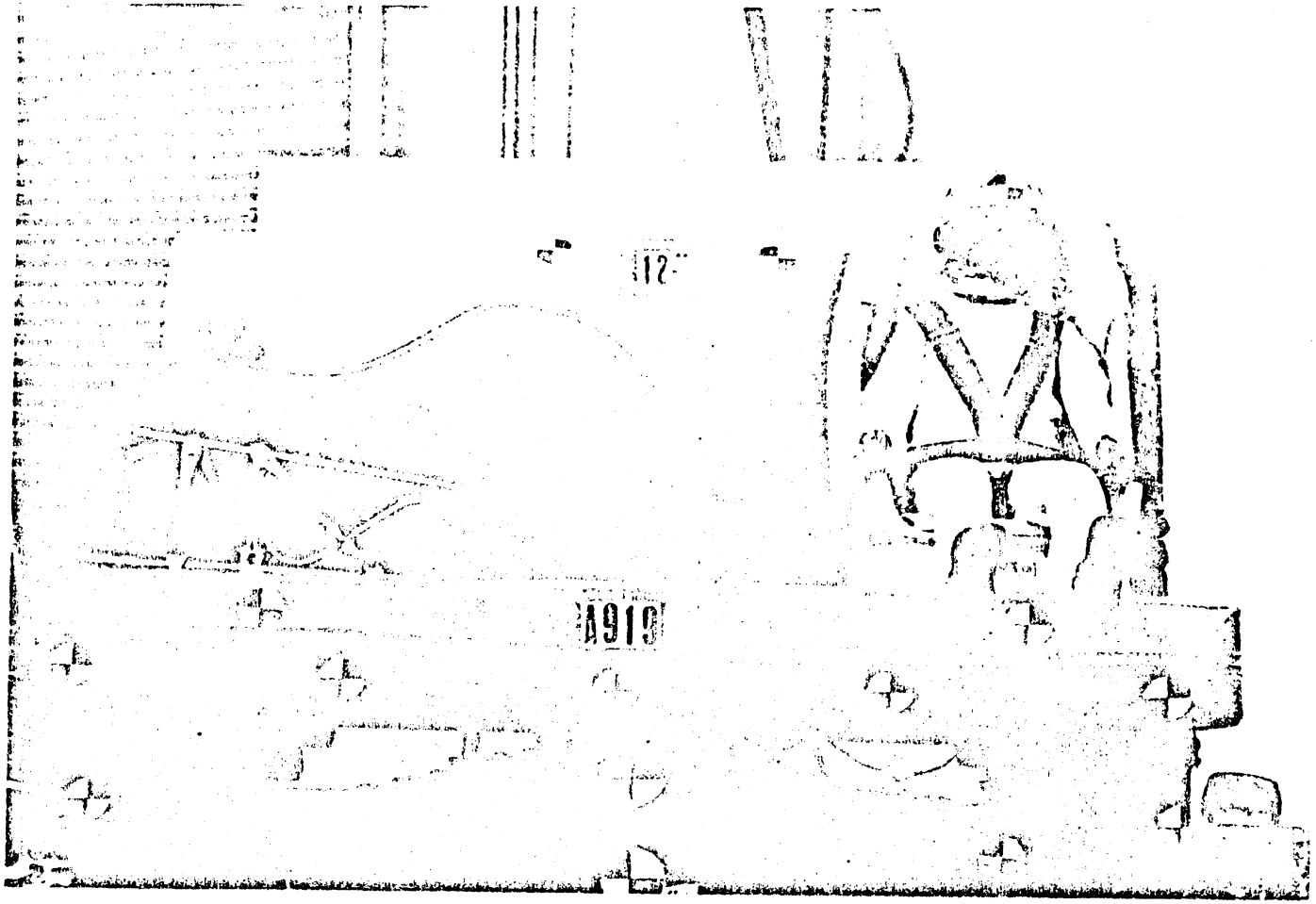
B - Bunny Bear Sweetheart II Seat

Sled Pulse: 20.1 mph - 16.2 G average

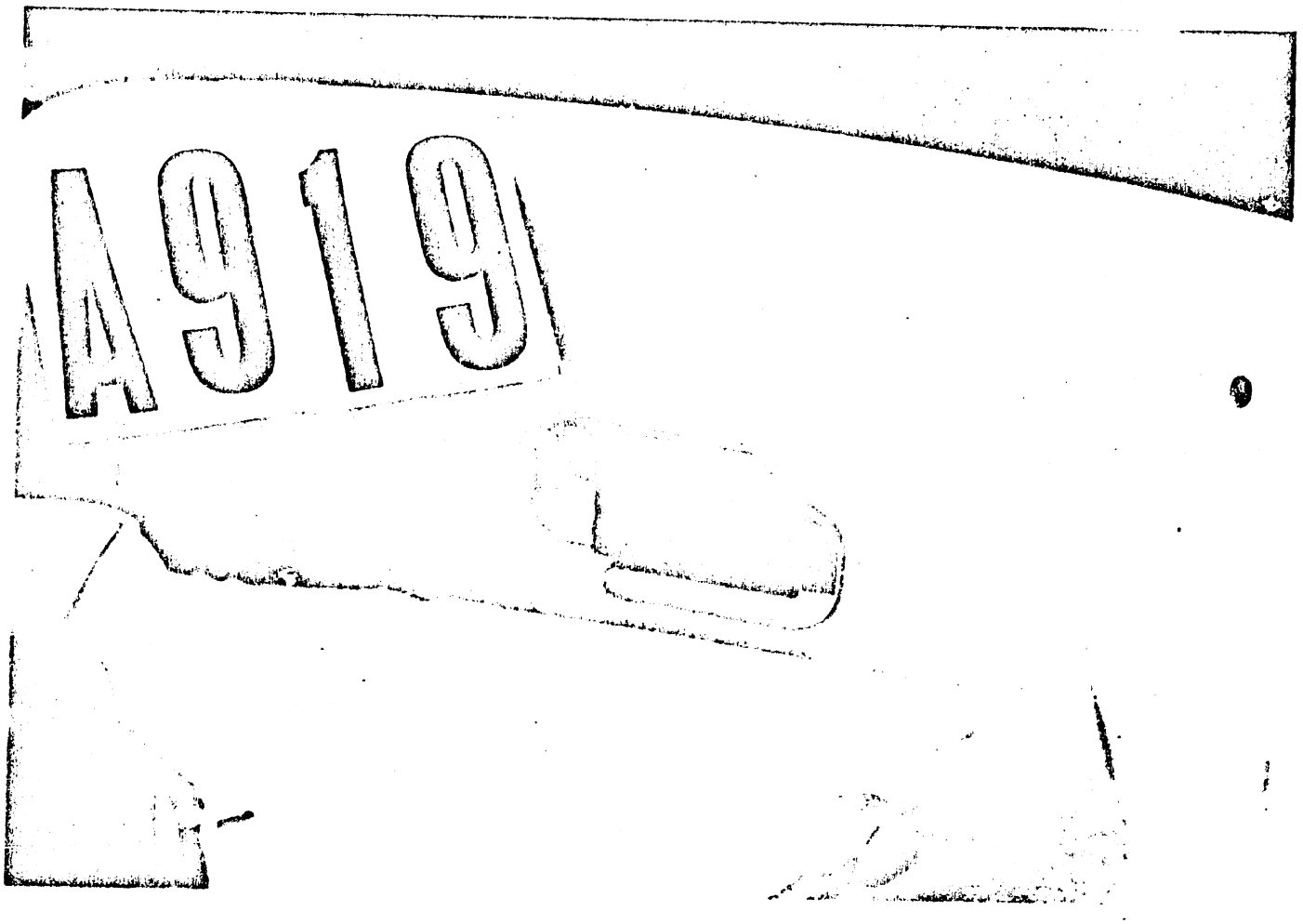
Seat Position A: A GM Child Love Seat was installed in this position with belt load cells on both left and right portions of the car lap belt and on the top strap. Special care was taken to ascertain that the top strap anchor plate was in place correctly (as shown in the pre-test photograph) in order to insure that the failure in test A-917 would not recur. During the test, the dummy motion was well-controlled and it appeared likely that the side of the restraint shell would prevent direct head interaction with a potential interior door surface. The seat did rotate partially off the bench seat due to a lack of door structure but did not tip off the seat as in the previous two tests in the A position. The restraint harness did not tend to slip off the dummy.

Seat Position B: A Bunny Bear Sweetheart II Infant Seat was installed in this position in a lateral mode. The seat was faced such that the dummy head was pointed toward the driver's side of the bench seat in order that it was oriented for the equivalent of a near-side impact. This orientation was equivalent to placing the seat in the left rear position in a car. The car lap belt was installed around the tubular framework of the seat as indicated in the manufacturer's instructions. A single belt load cell was installed on the right side of the car lap belt. Because of the unusual configuration of the system, the photo-metric target chosen for analysis was a portion of the masking tape

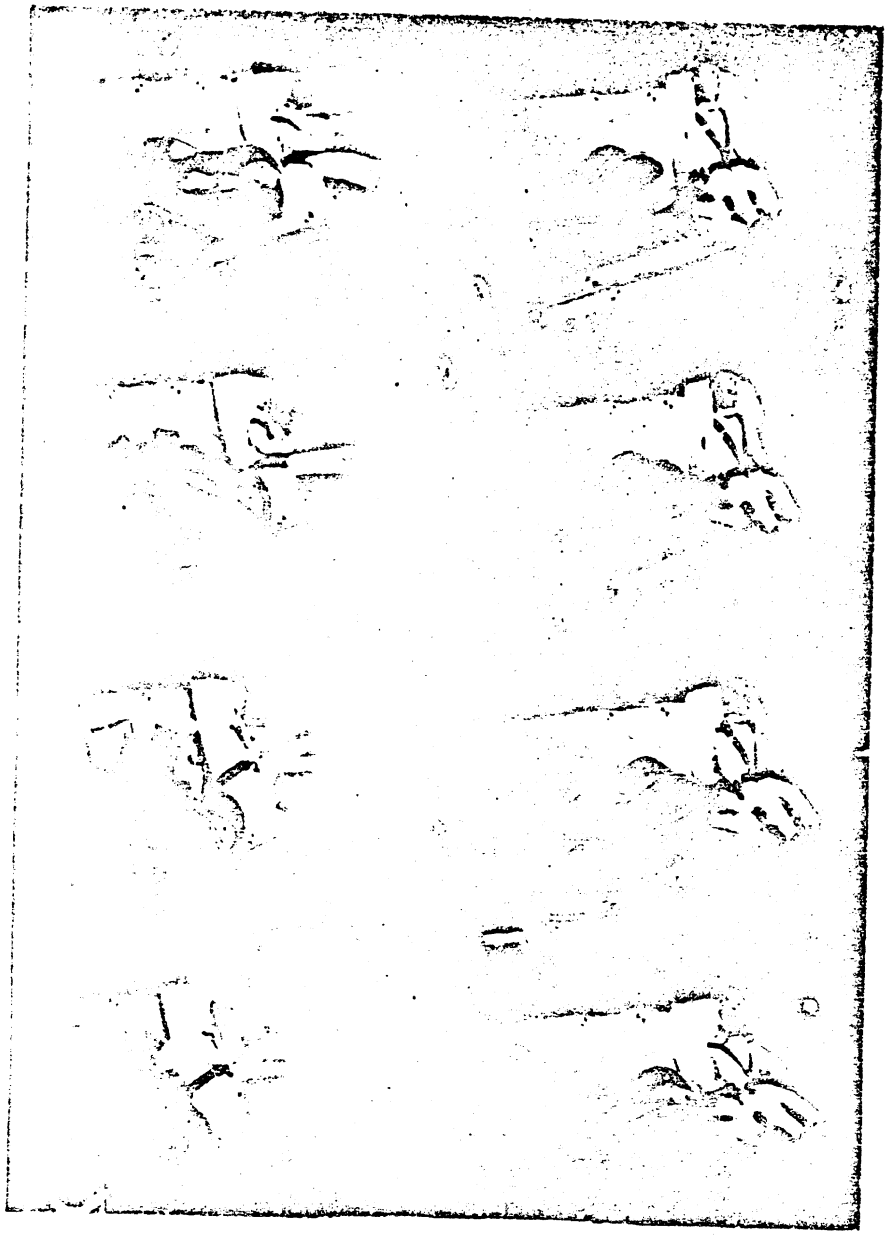
used for dummy head positioning. The portion used was that which appeared at the top edge on the centerline of the restraint. During the test, the tubular frame of the restraint system slipped out from under the car lap belt on the right side and the restraint proceeded to rotate 90° about a horizontal axis ending up with the dummy still restrained by the seat harness but head down in the center of the bench seat. The dummy remained within the confines of the restraint shell but the large uncontrolled motion of the total system could result in serious interaction with interior structures.



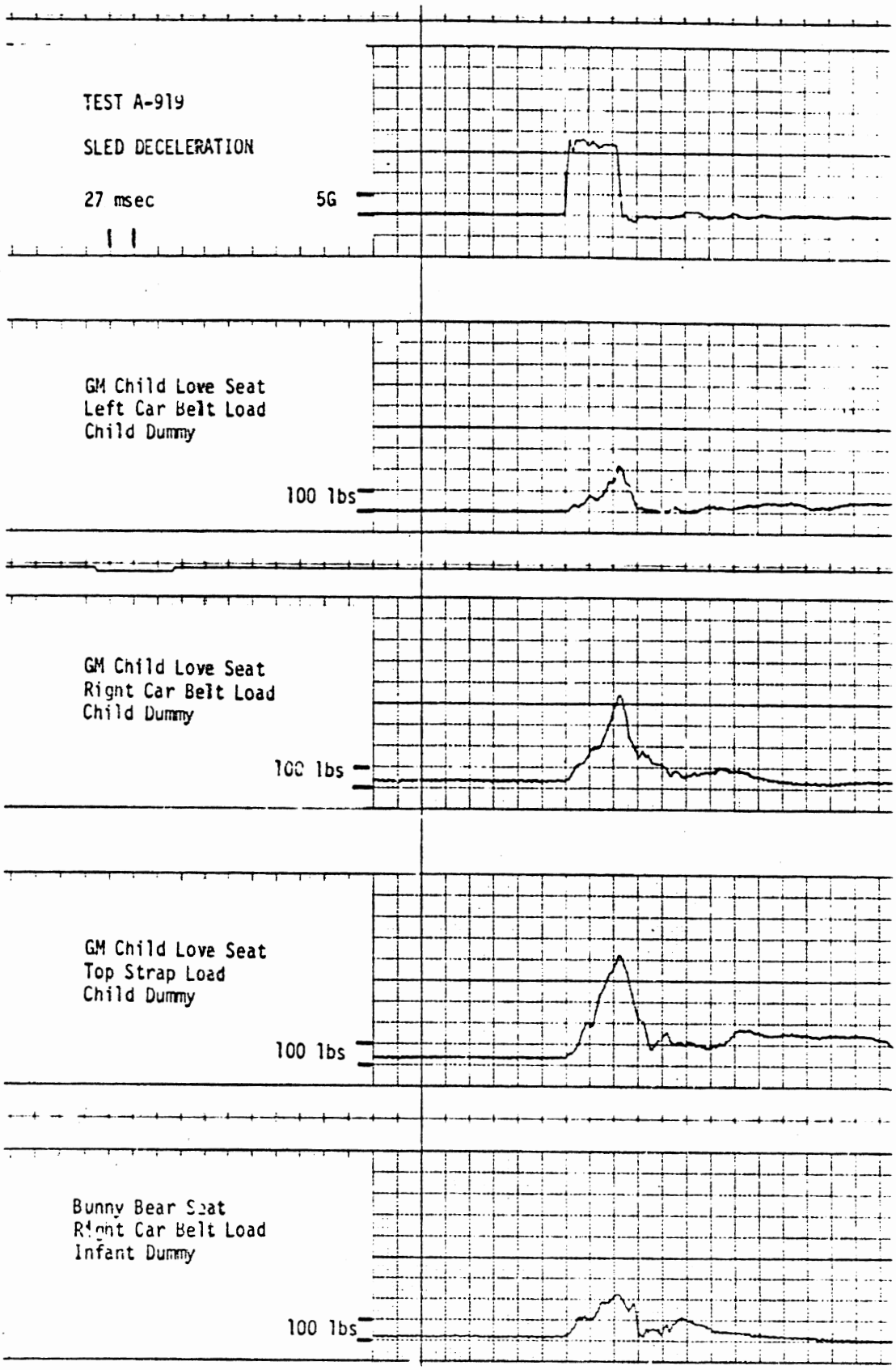
Test A-919 Over-all Test Set-Up

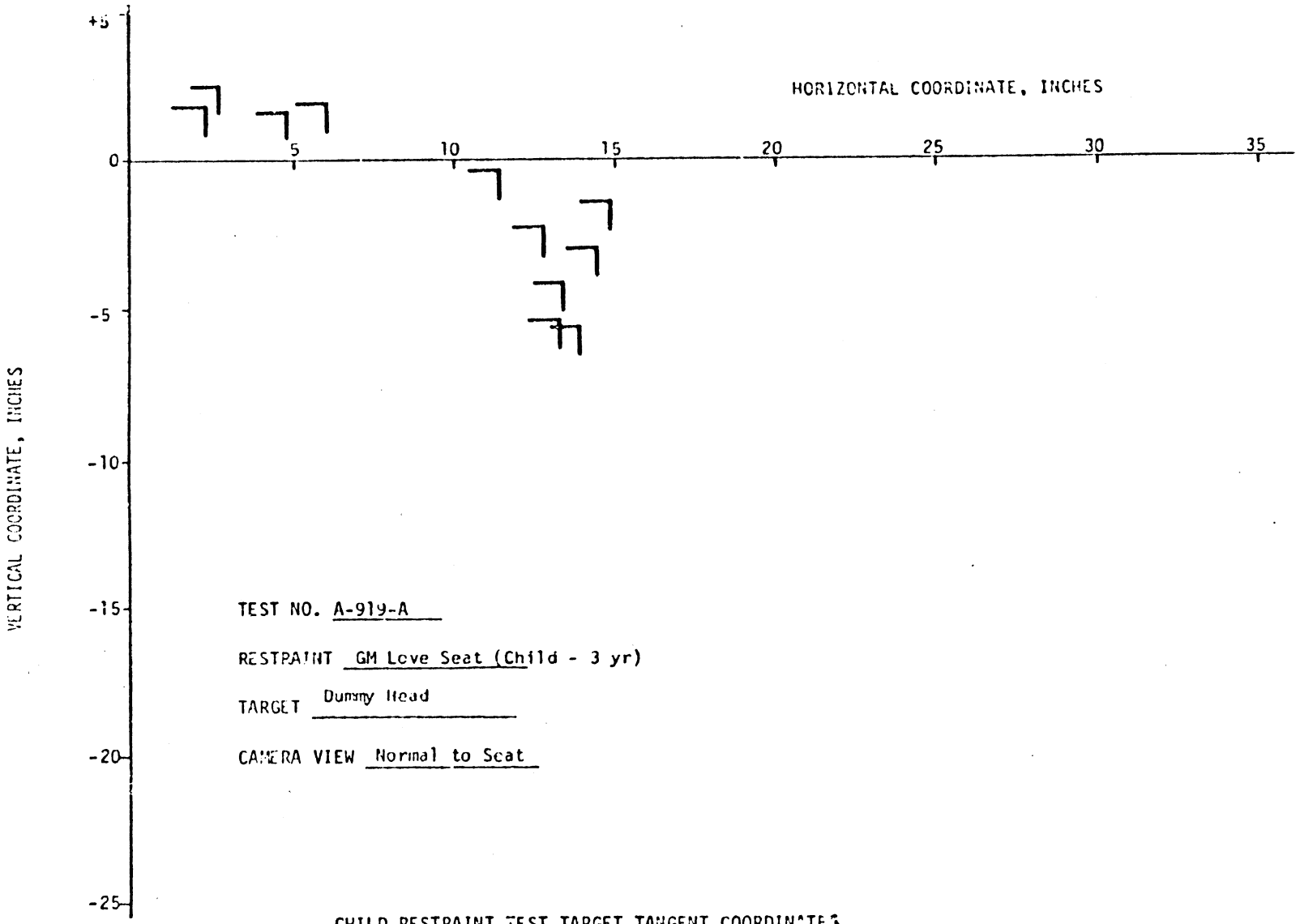


Pre-Test Gi Child Love Seat Back Strap Slot Configuration

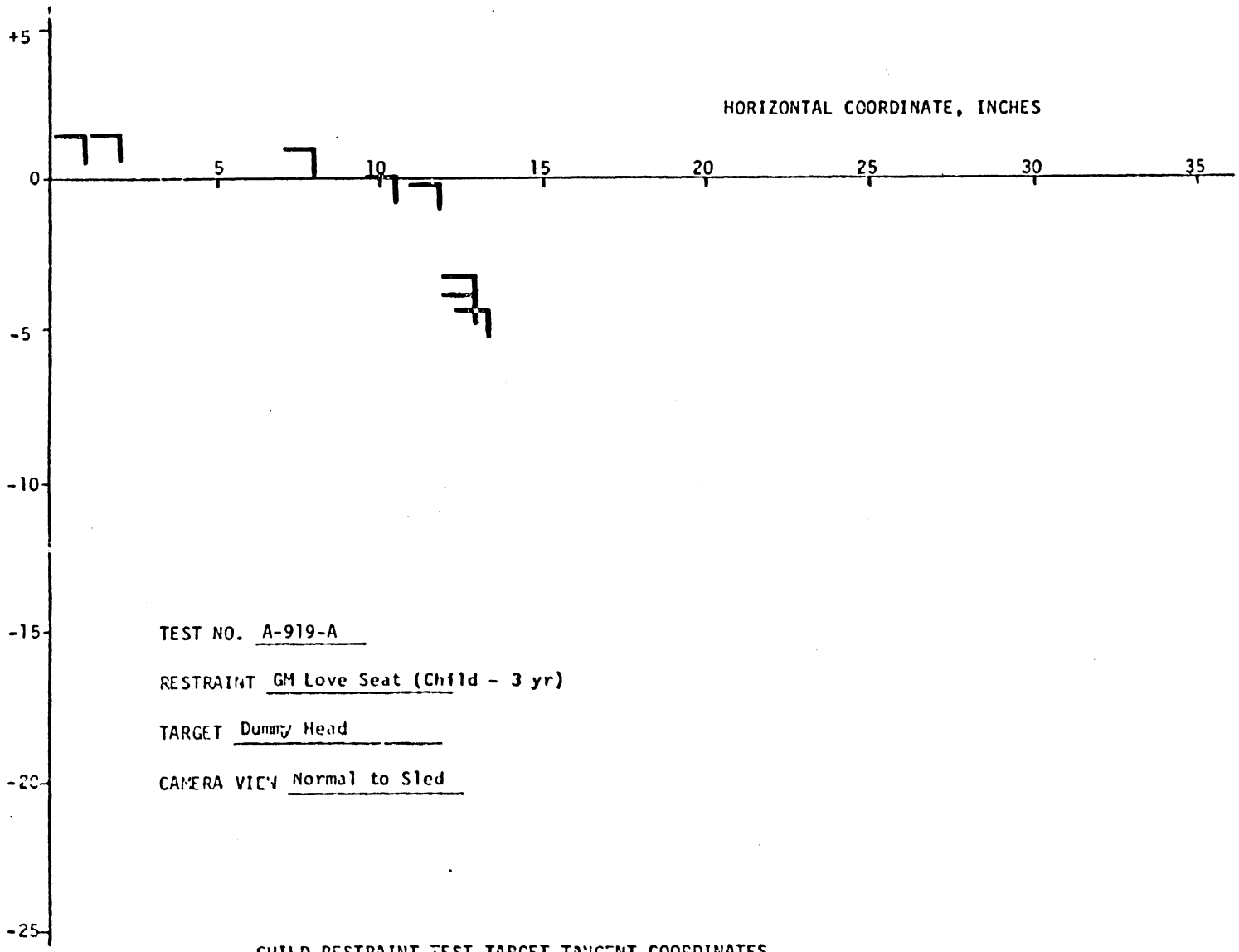


Graph-Check for Test A-919

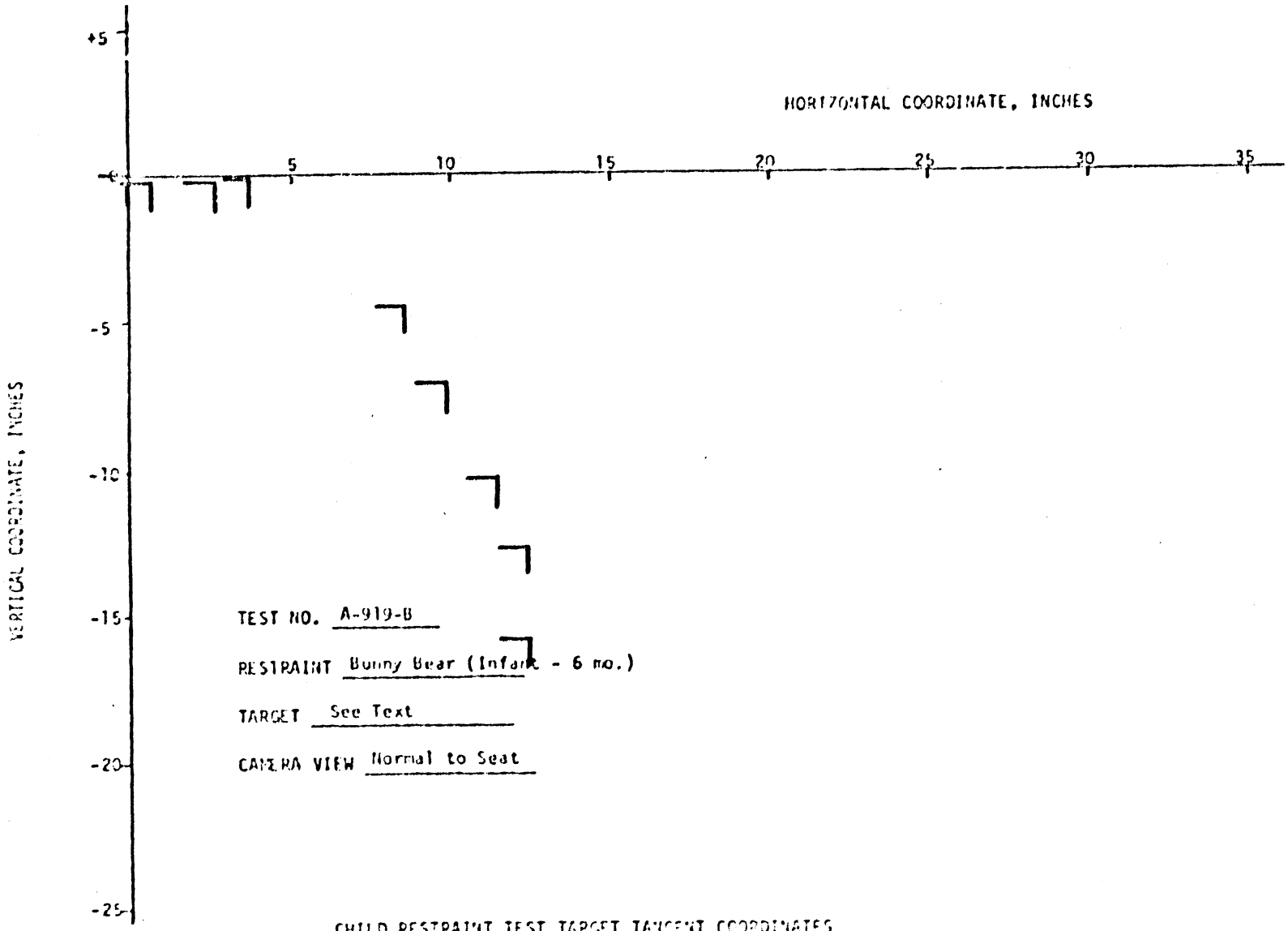

TEST A-919
SLED DECELERATION
27 msec
5G
GM Child Love Seat
Left Car Belt Load
Child Dummy
100 lbs
GM Child Love Seat
Right Car Belt Load
Child Dummy
100 lbs
GM Child Love Seat
Top Strap Load
Child Dummy
100 lbs
Bunny Bear Seat
Right Car Belt Load
Infant Dummy
100 lbs



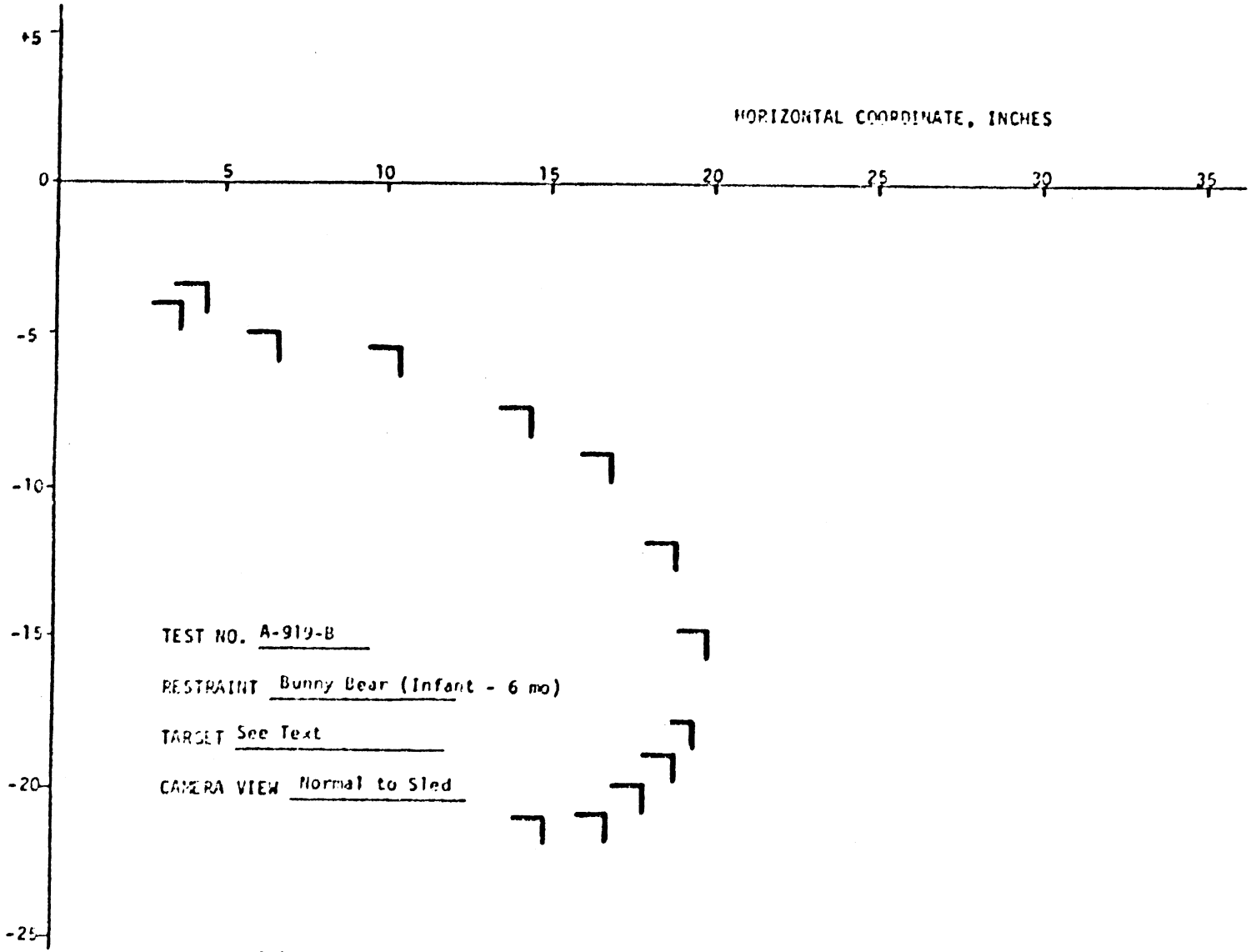
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



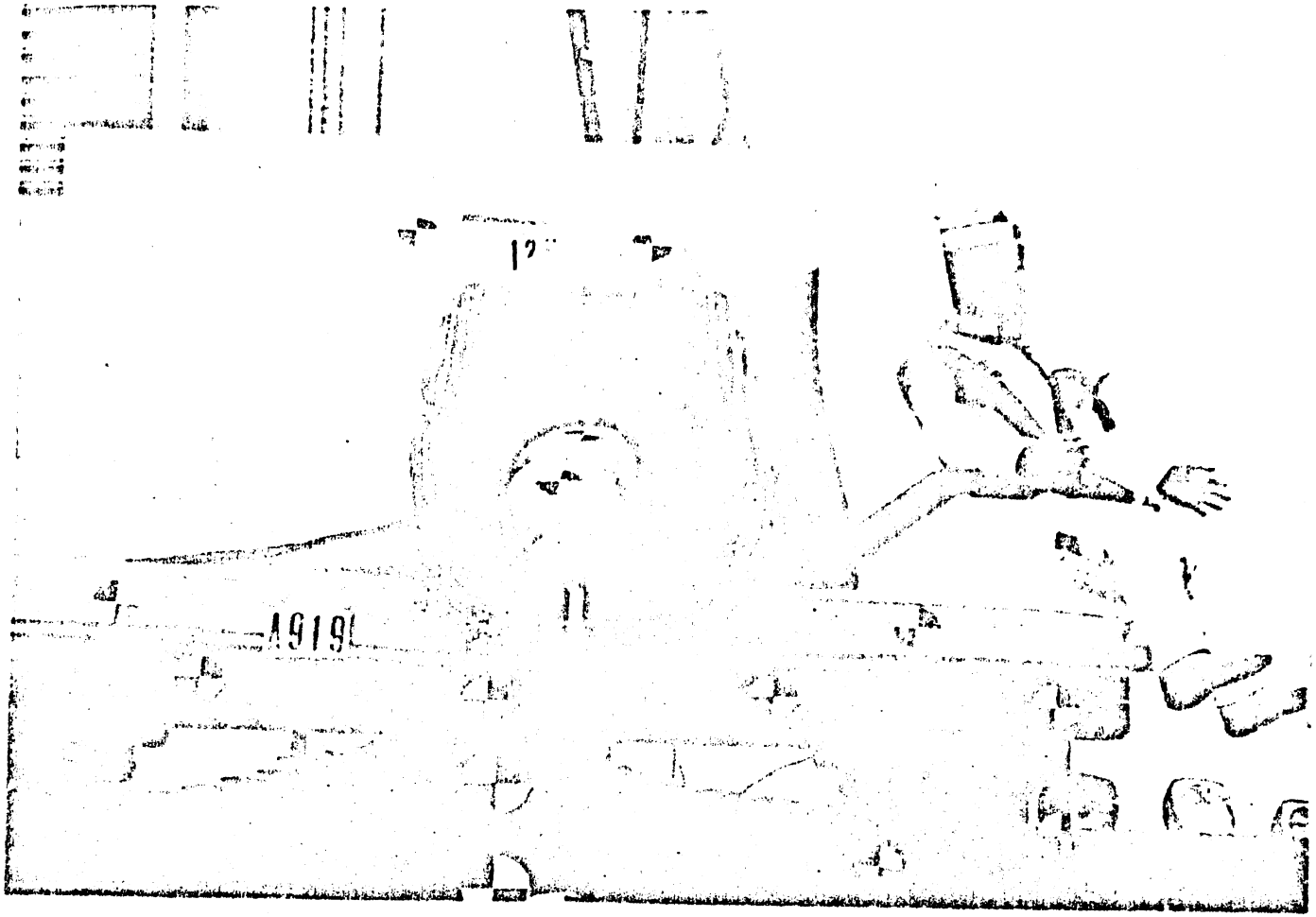
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



Test A-919 Over-all Post Test Configuration

3.4 Test Number A-920

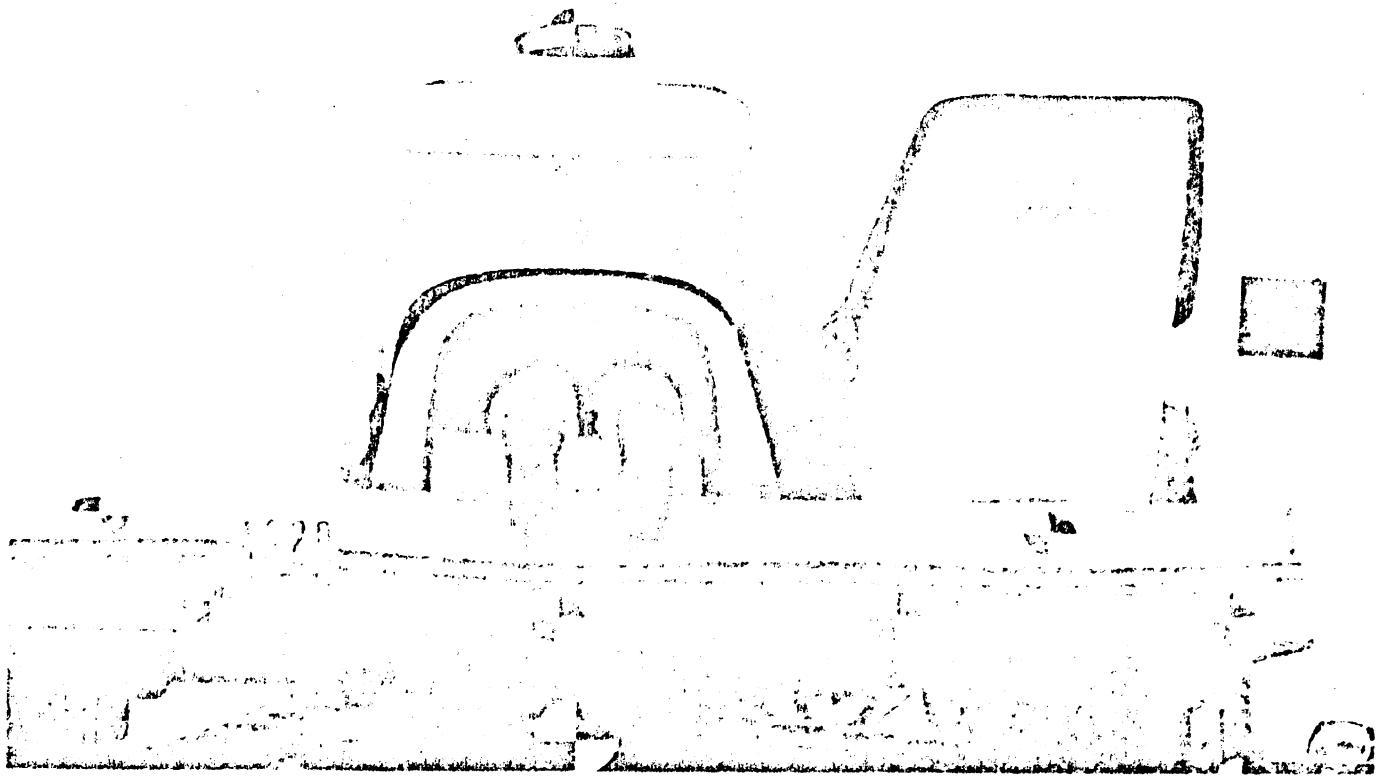
Restraint System: A - GM Infant Love Seat

B - Ford Tot Guard

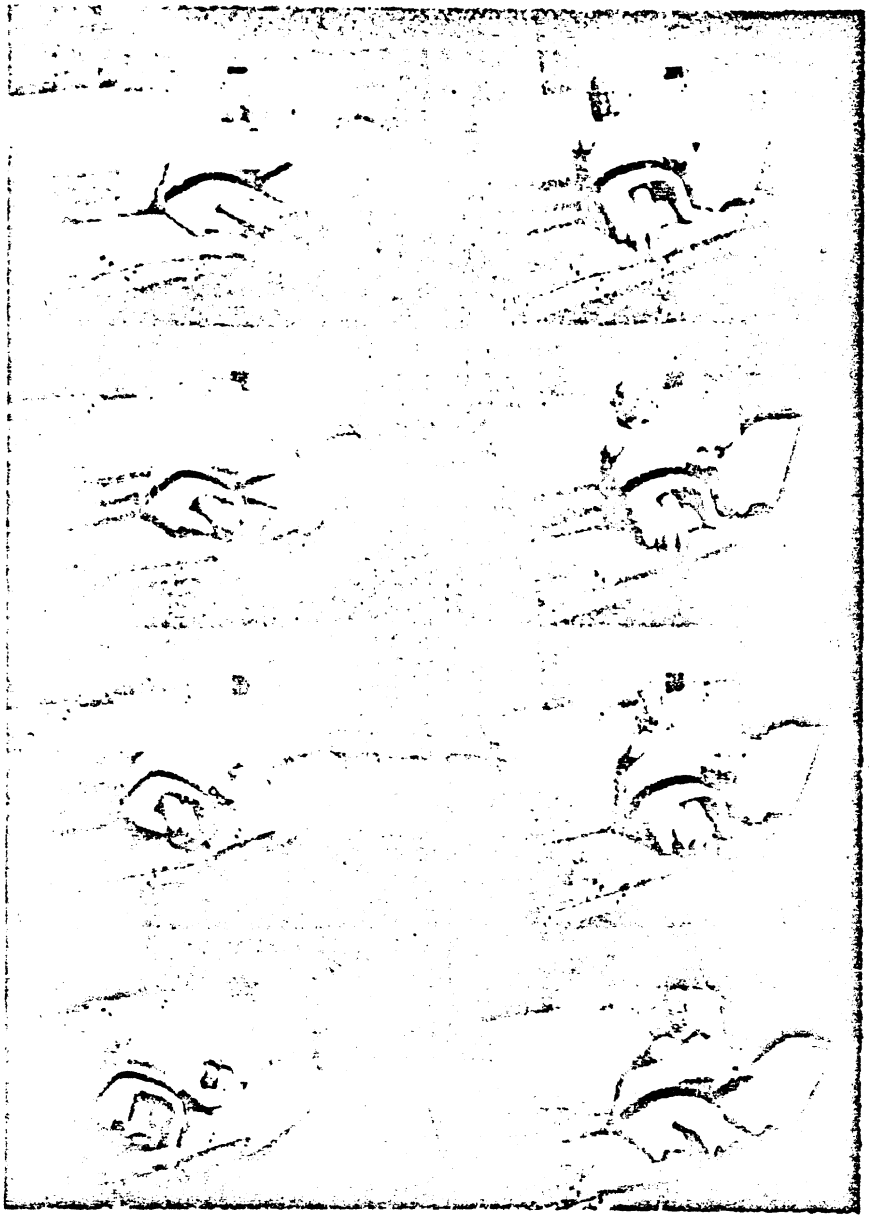
Sled Pulse: 20.3 mph - 16.5 G average

Seat Position A: A GM Infant Love Seat was installed in this position with belt load cells on both portions of the car lap belt. The restraint controlled the motion of the dummy but did rotate off the side of the bench seat. The dummy head was protected from impact with potential interior door surfaces but the harness did allow the dummy to slip out. The inner shell of the seat deformed and separated from the outer shell on the outboard side as shown in the post-test photograph.

Seat Position B: A Ford Tot-Guard child restraint was placed in the center position of the bench seat with belt load cells on each side of the car lap belt. During the test the motion of the dummy was not well-controlled and the dummy came close to ejecting from the restraint. The dummy head impacted the GM Infant Love Seat late in the sequence when the infant seat had fallen off of the bench seat. This indicates that even in the center position the child dummy would strike potential interior surfaces of a venicle door.

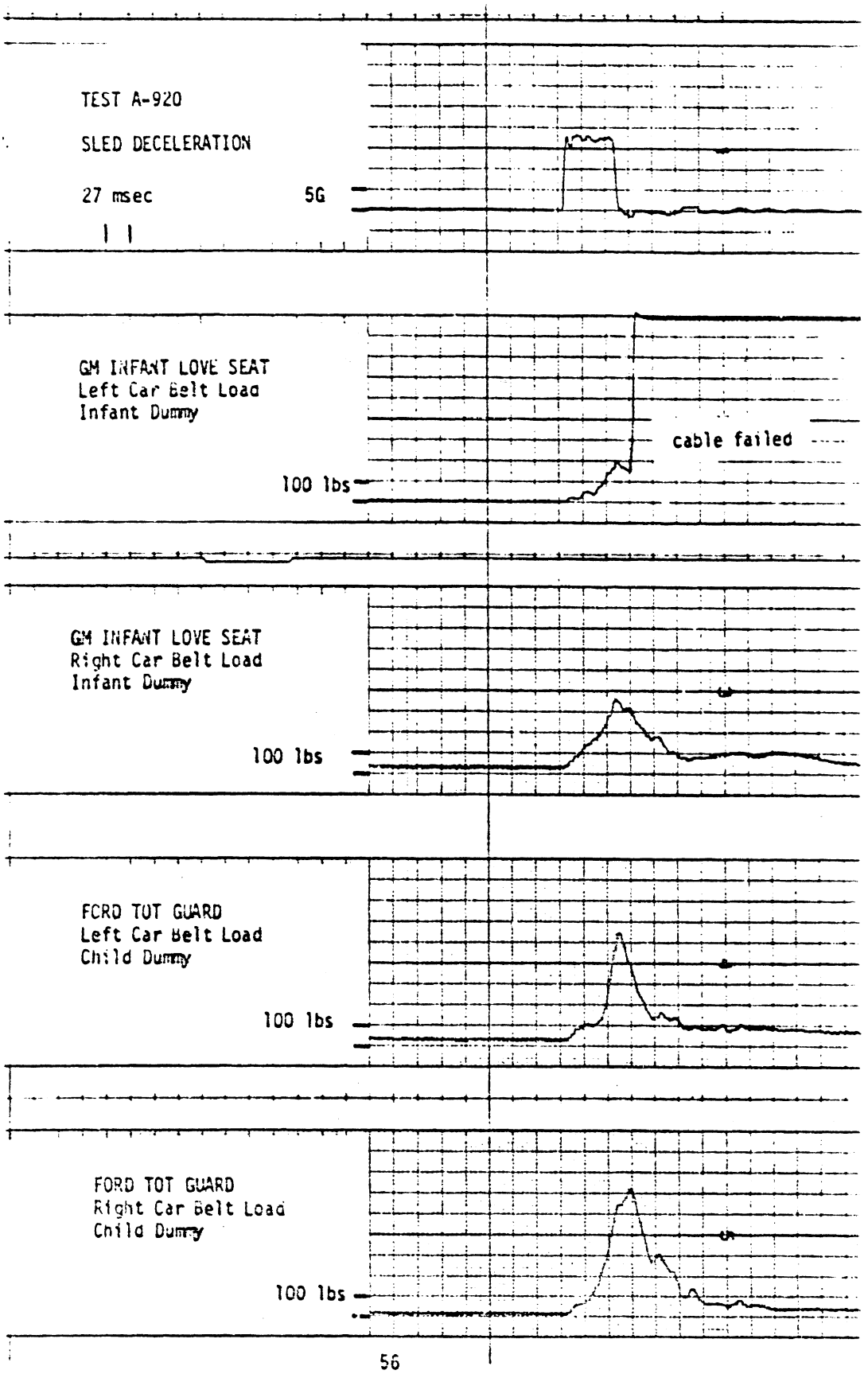


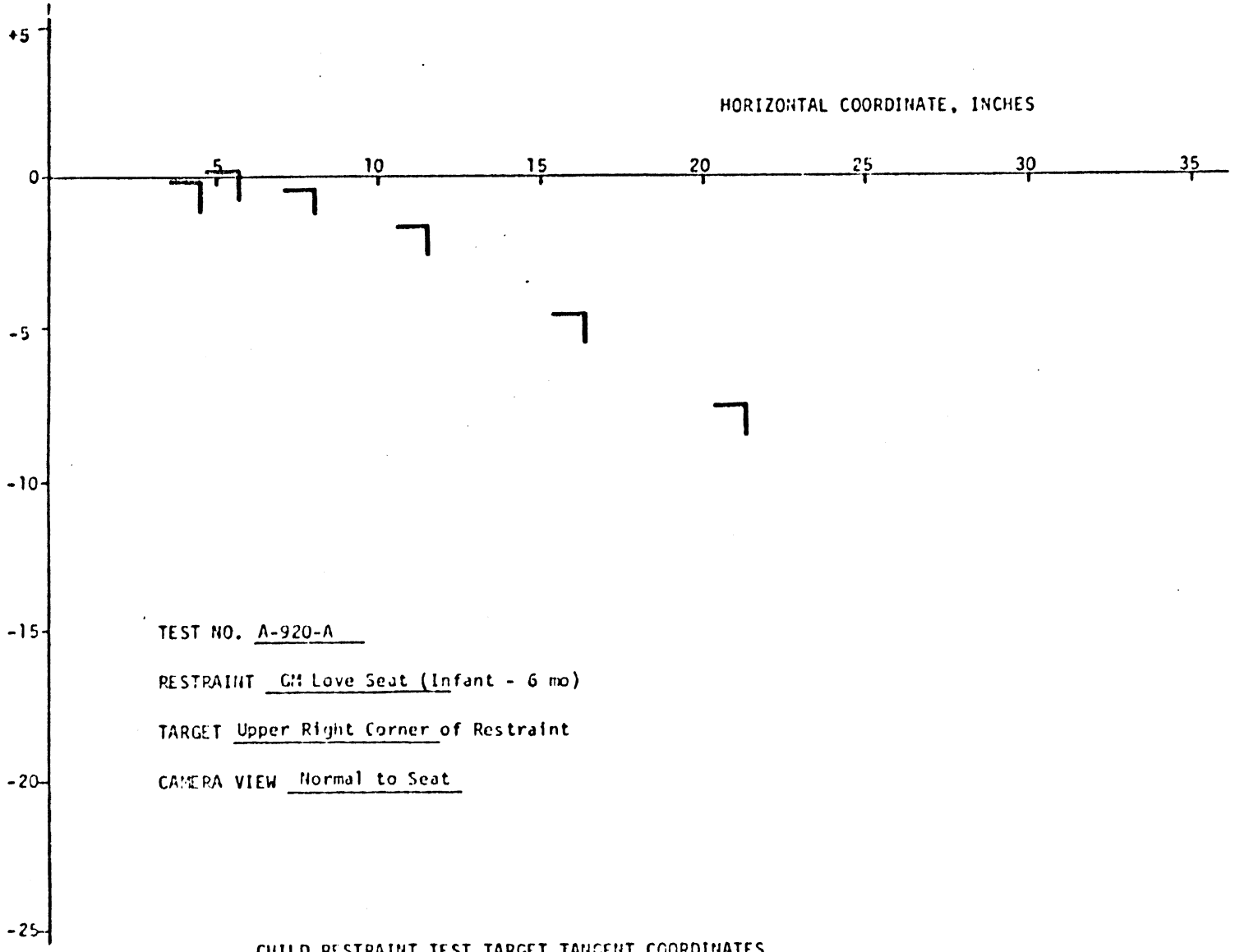
Test A-920 Over-all Test Set-Up



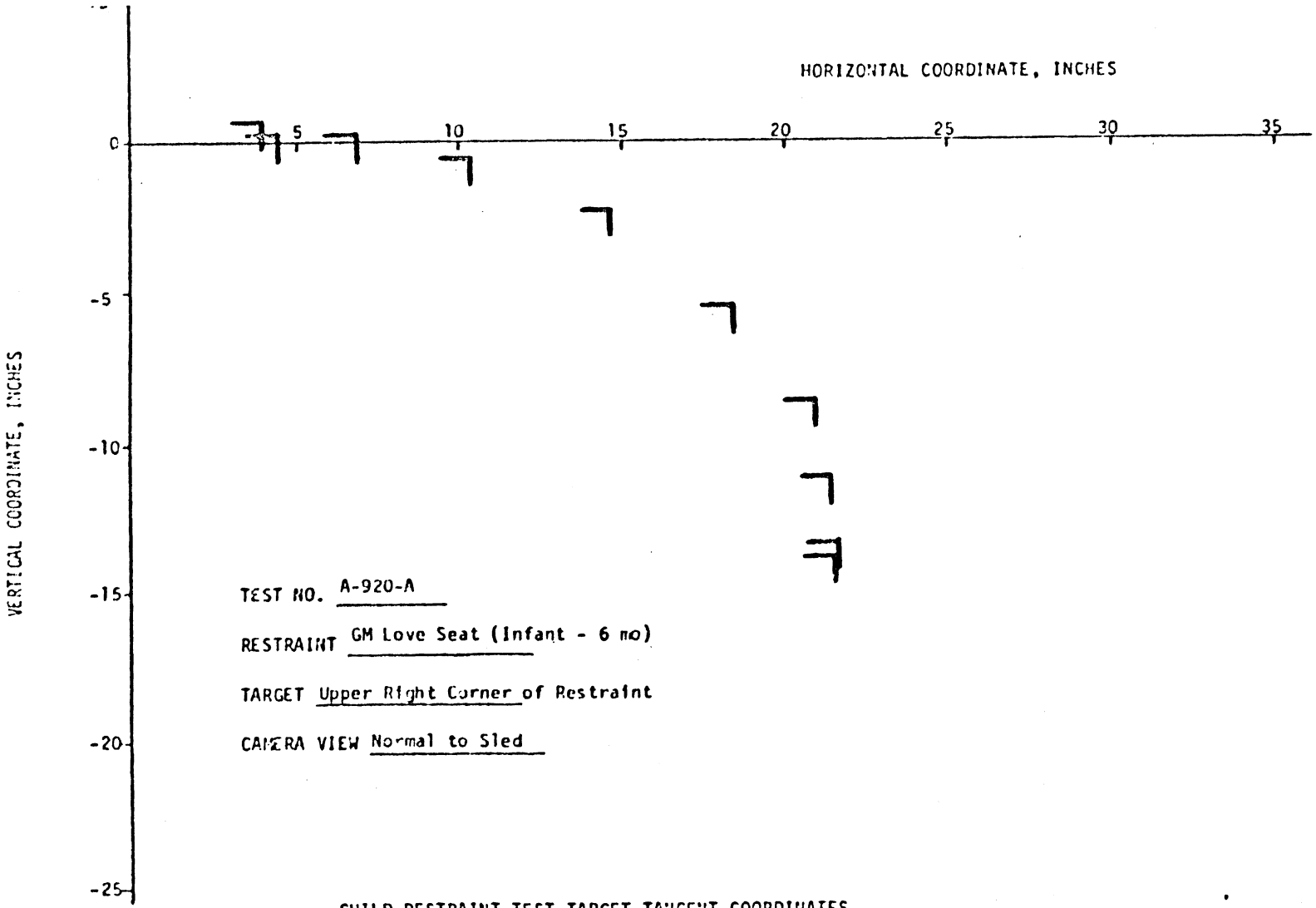
8

A 920

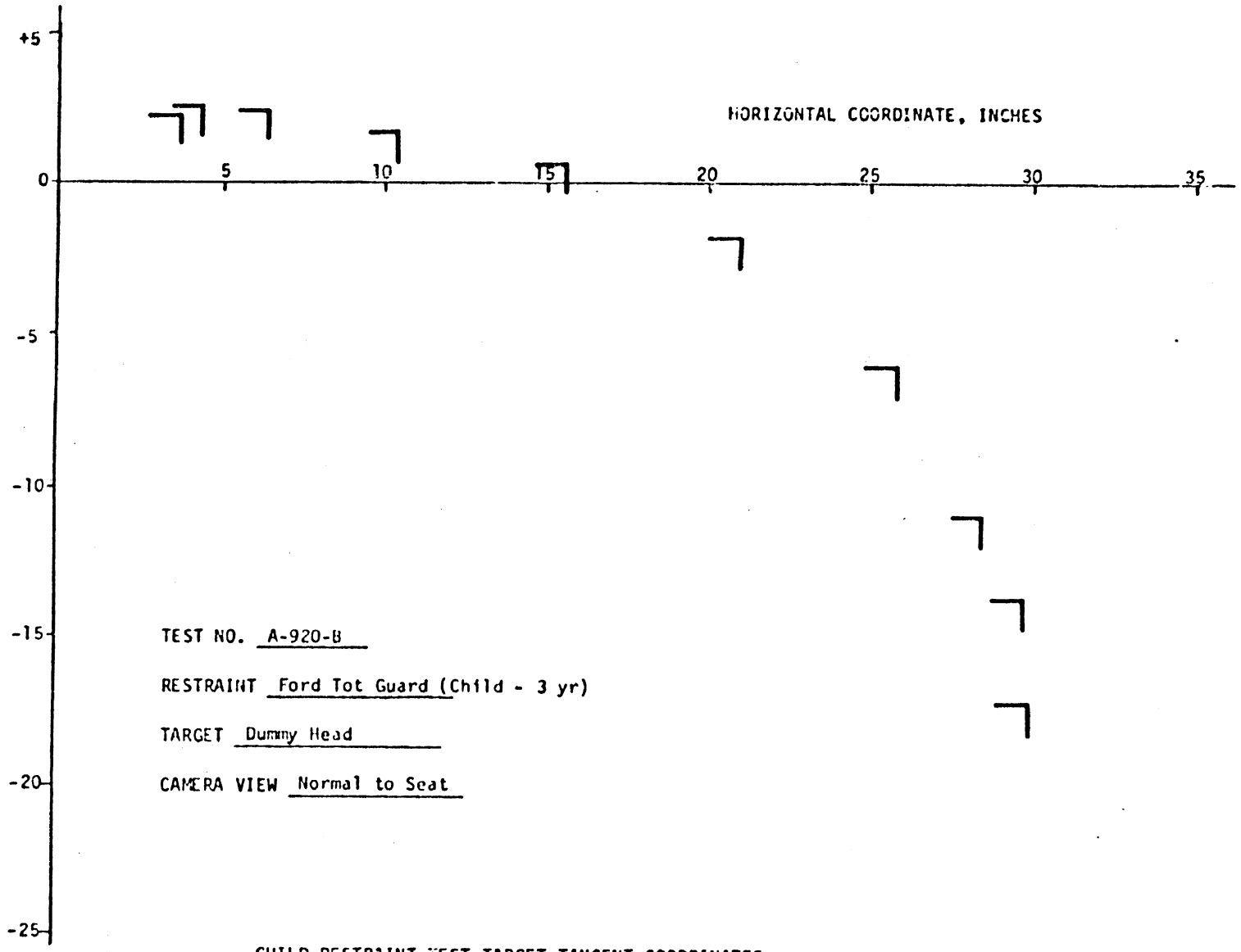

TEST A-920
SLED DECELERATION
27 msec
5G
GM INFANT LOVE SEAT
Left Car Belt Load
Infant Dummy
cable failed
100 lbs
GM INFANT LOVE SEAT
Right Car Belt Load
Infant Dummy
100 lbs
FORD TOT GUARD
Left Car Belt Load
Child Dummy
100 lbs
FORD TOT GUARD
Right Car Belt Load
Child Dummy
100 lbs



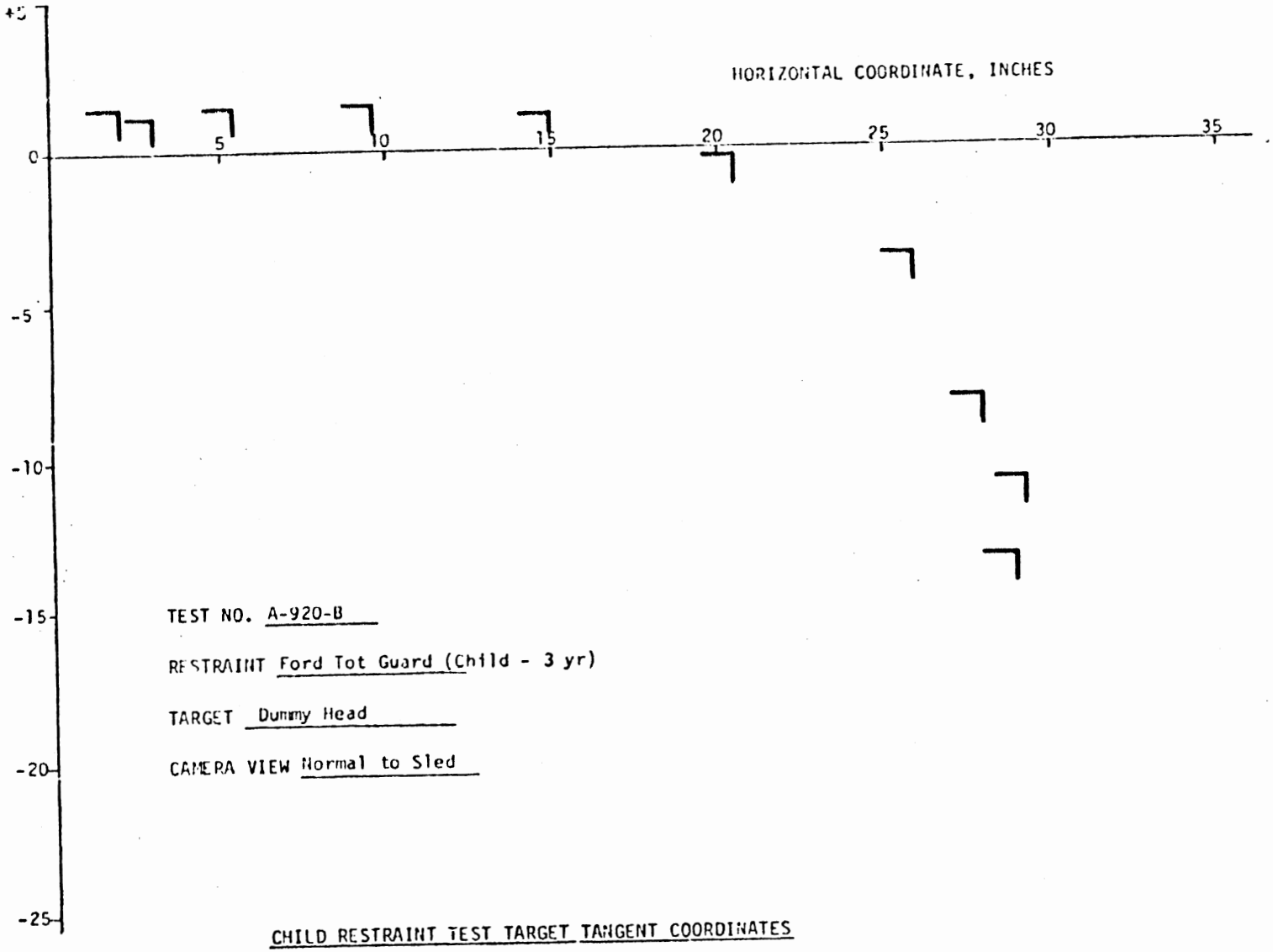
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



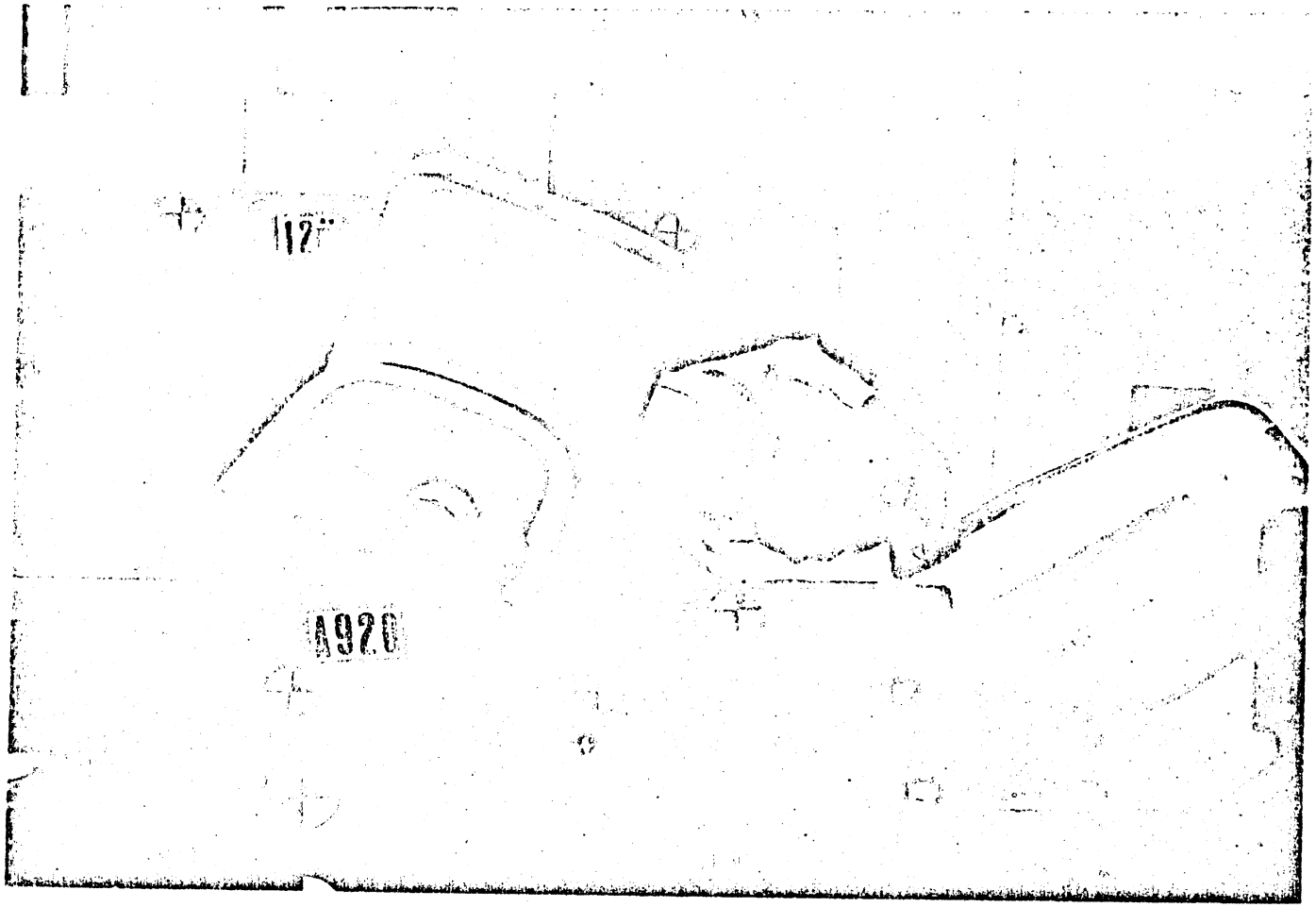
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



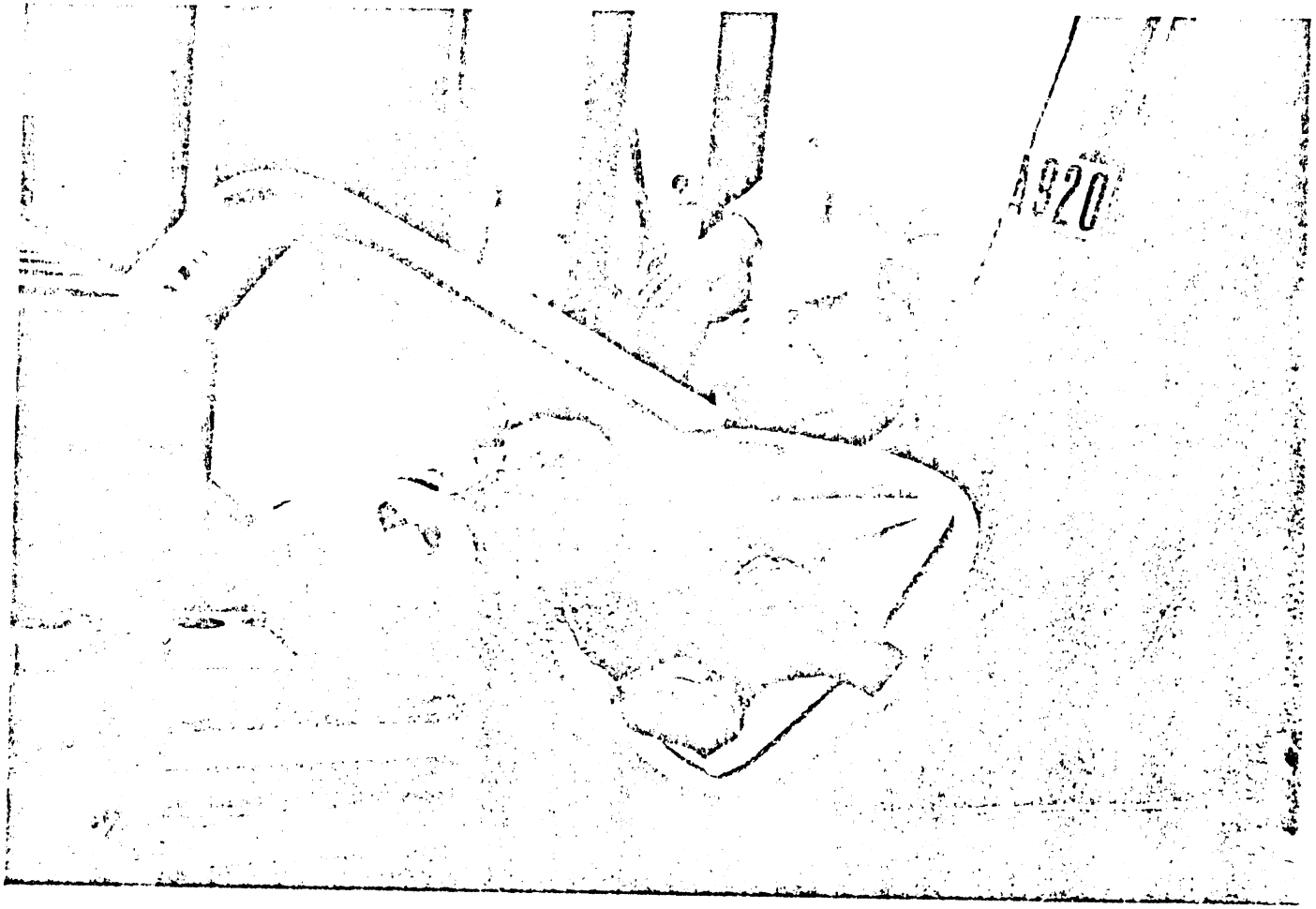
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



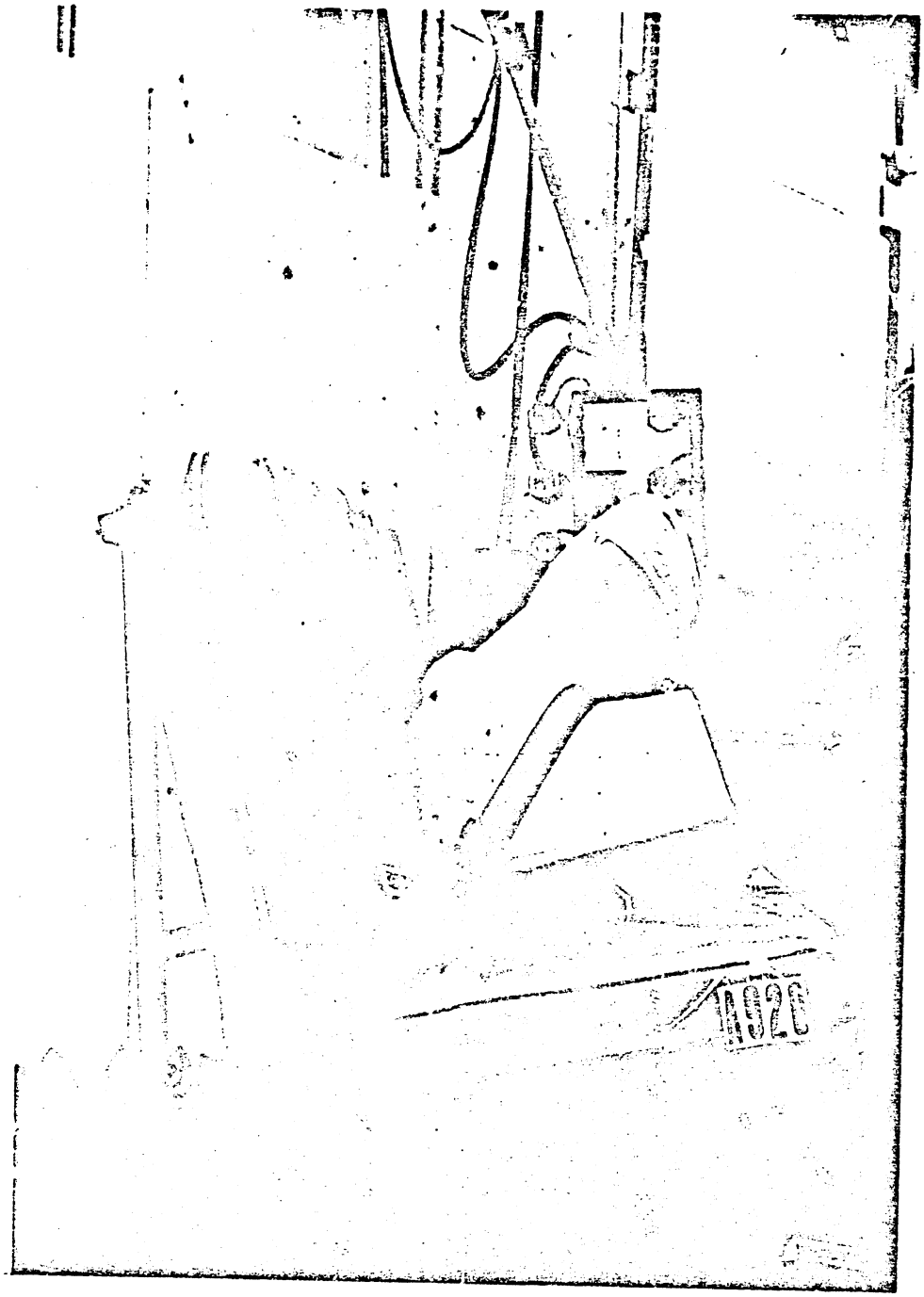
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



Test A-920 Over-all Post Test Configuration



Post Test Gli Infant Carrier



Post Test Ford Tot-Guard

3.5 Test Number A-921

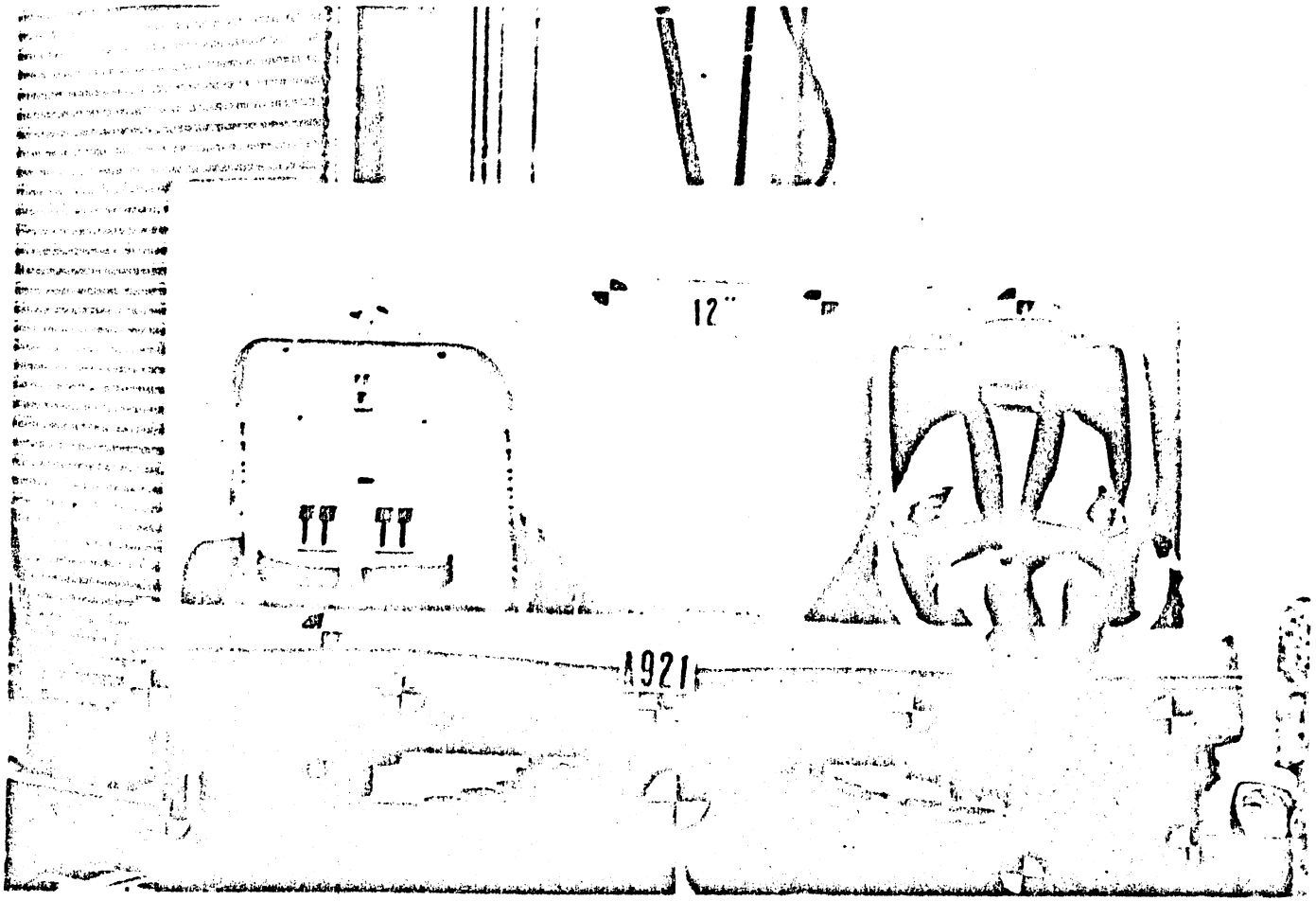
Restraint Systems: A - Peterson Model 74 Child Restraint

B - Peterson Model 75 Infant Restraint

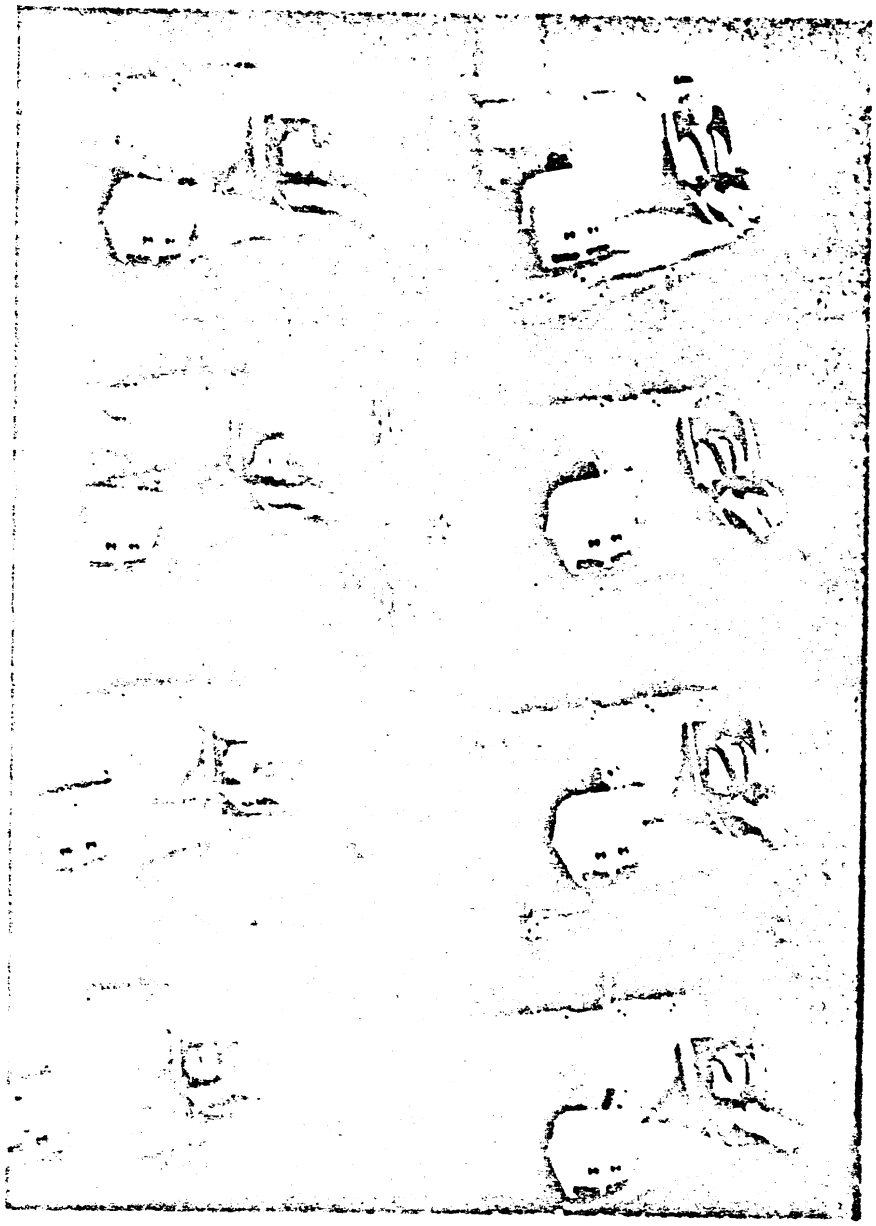
Sled Pulse: 20.3 mph - 16.3 G average

Seat Position A: A Peterson Model 74 Child Restraint was installed in this position using the side impact strap supplied with the seat in addition to the car lap belt for anchorage. Belt load cells were used on both sides of the car lap belt. During the test, the dummy motions were controlled and the restraint stayed on the bench seat although it did slide laterally. The harness showed no tendency to slip off the dummy but the head did rotate forward such that interaction with potential interior door surfaces would possibly occur.

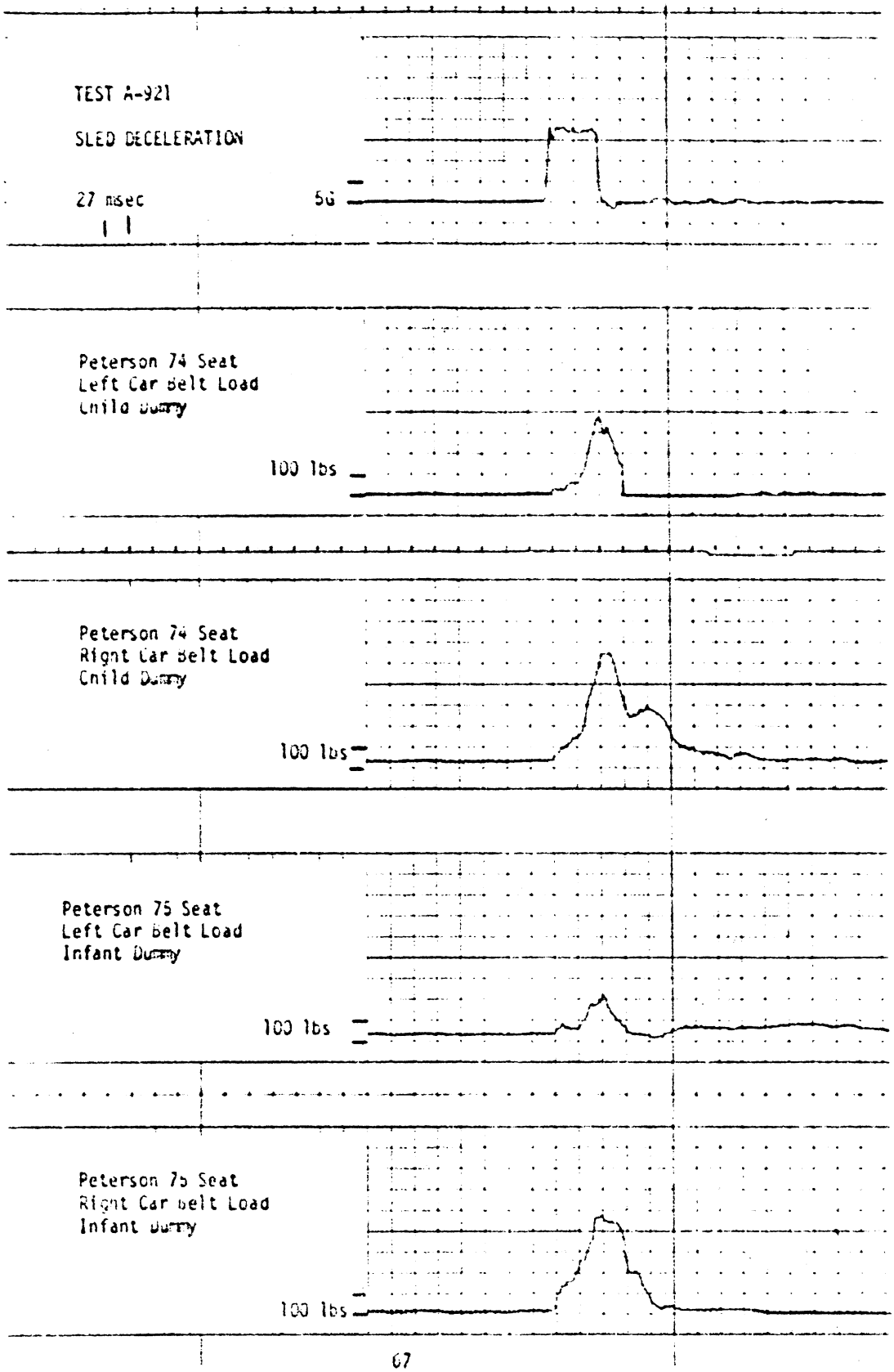
Seat Position B: A Peterson Model 75 Infant Restraint was installed in this position with belt load cells on both sides of the car lap belt. This seat was the only rear-facing infant restraint in which portions of the dummy head were visible for photometric analysis. During the test the dummy motions were well controlled and the dummy was held tightly by the harness. However, the head did lean over the side of the restraint shell and would have allowed head interaction with potential interior door surfaces.

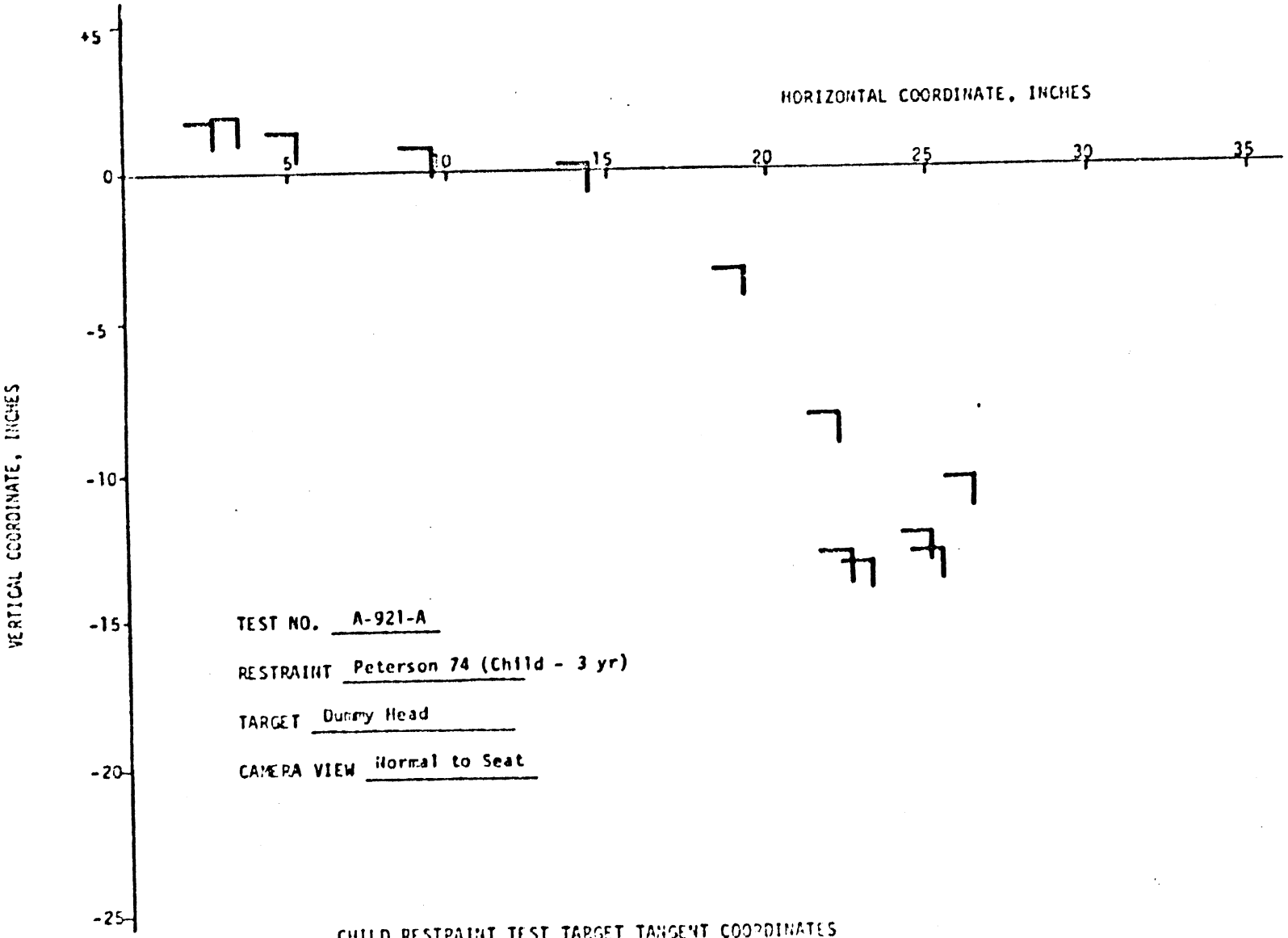


Test A-921 Over-all Test Set-Up

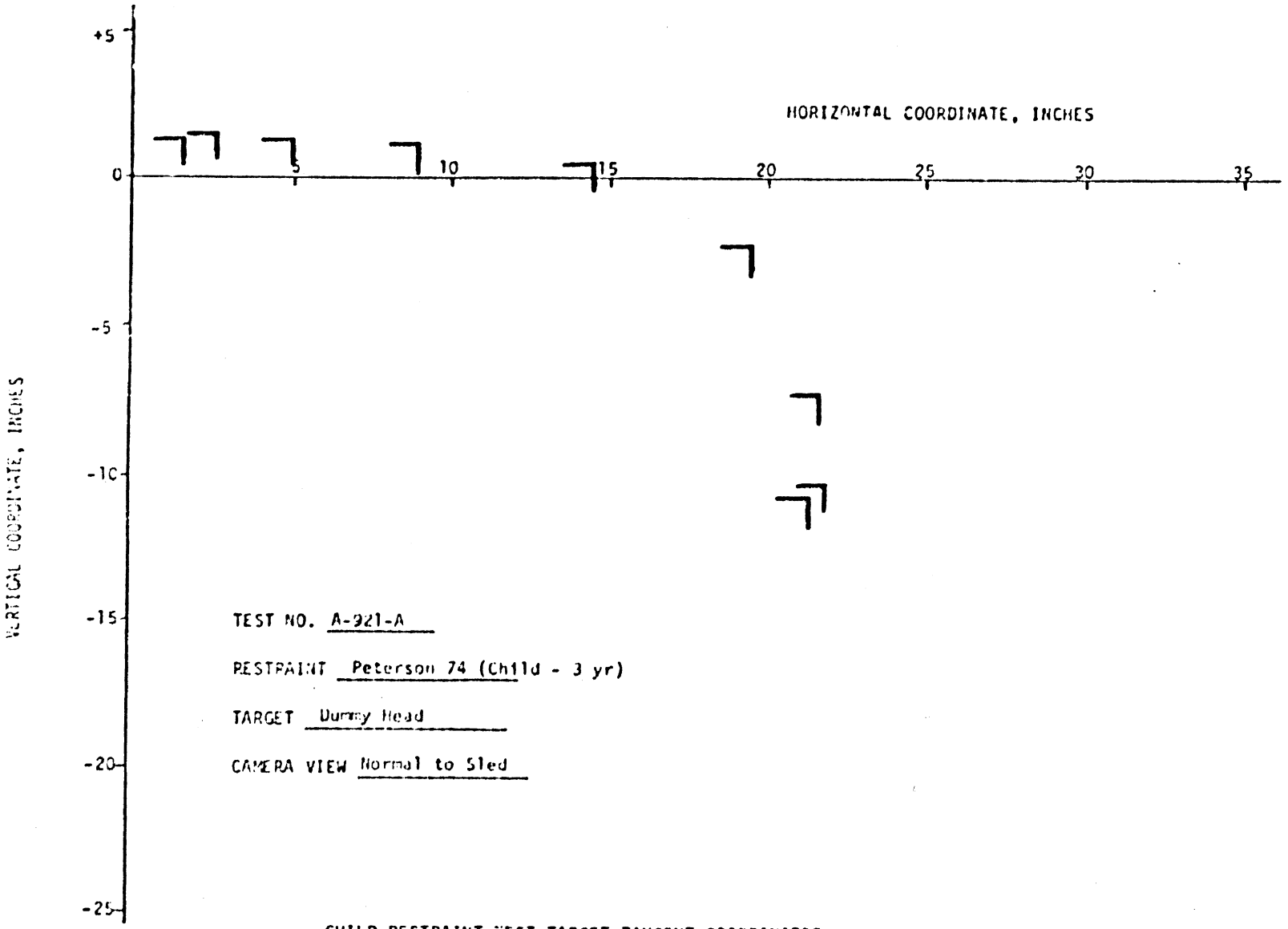


A 921

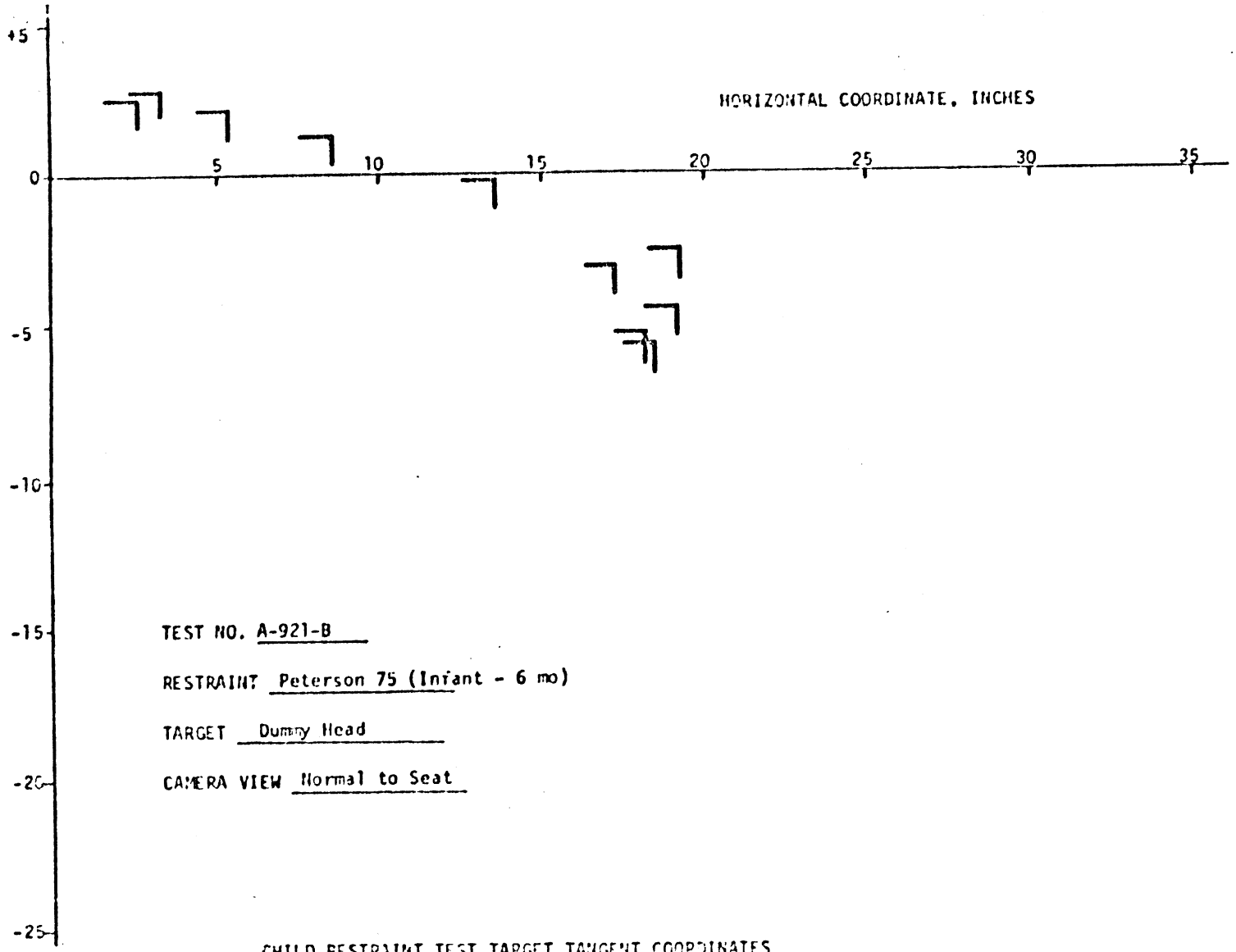

TEST A-921
SLED DECELERATION
27 msec
50
Peterson 74 Seat
Left Car Belt Load
Child Dummy
100 lbs
Peterson 74 Seat
Right Car Belt Load
Child Dummy
100 lbs
Peterson 75 Seat
Left Car Belt Load
Infant Dummy
100 lbs
Peterson 75 Seat
Right Car Belt Load
Infant Dummy
100 lbs



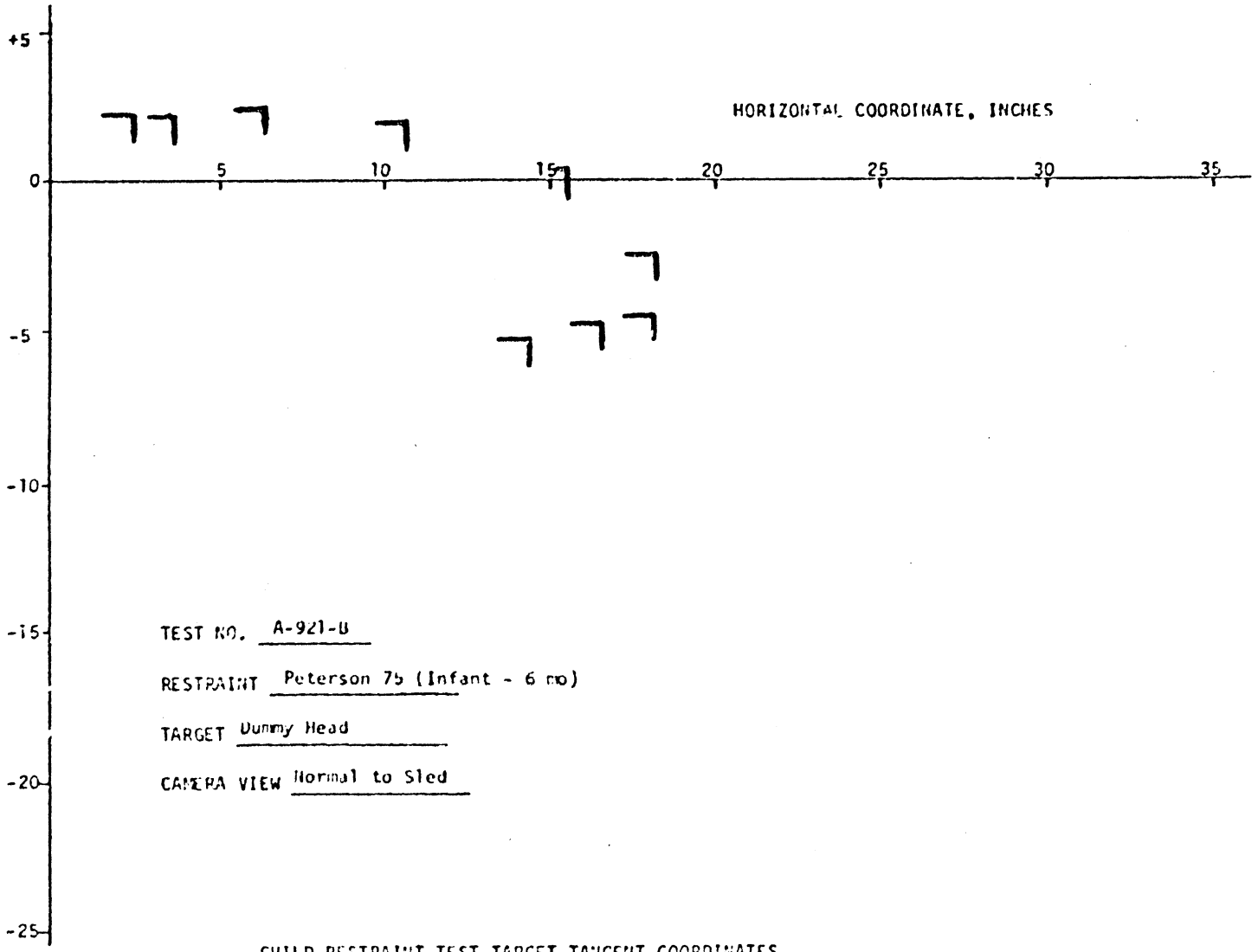
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



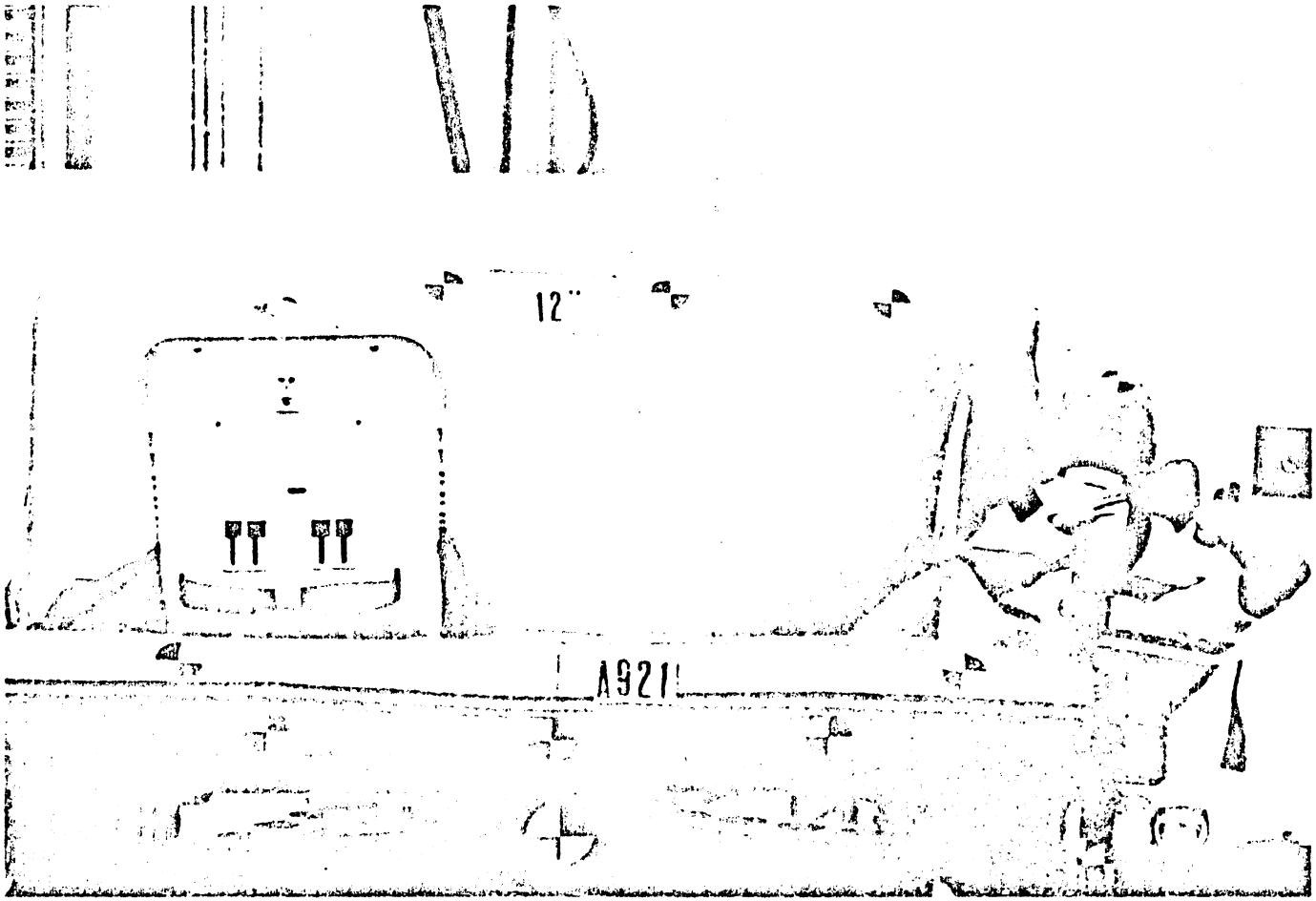
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



Test A-921 Overall-Post Test Configuration

3.6 Test Number A-922

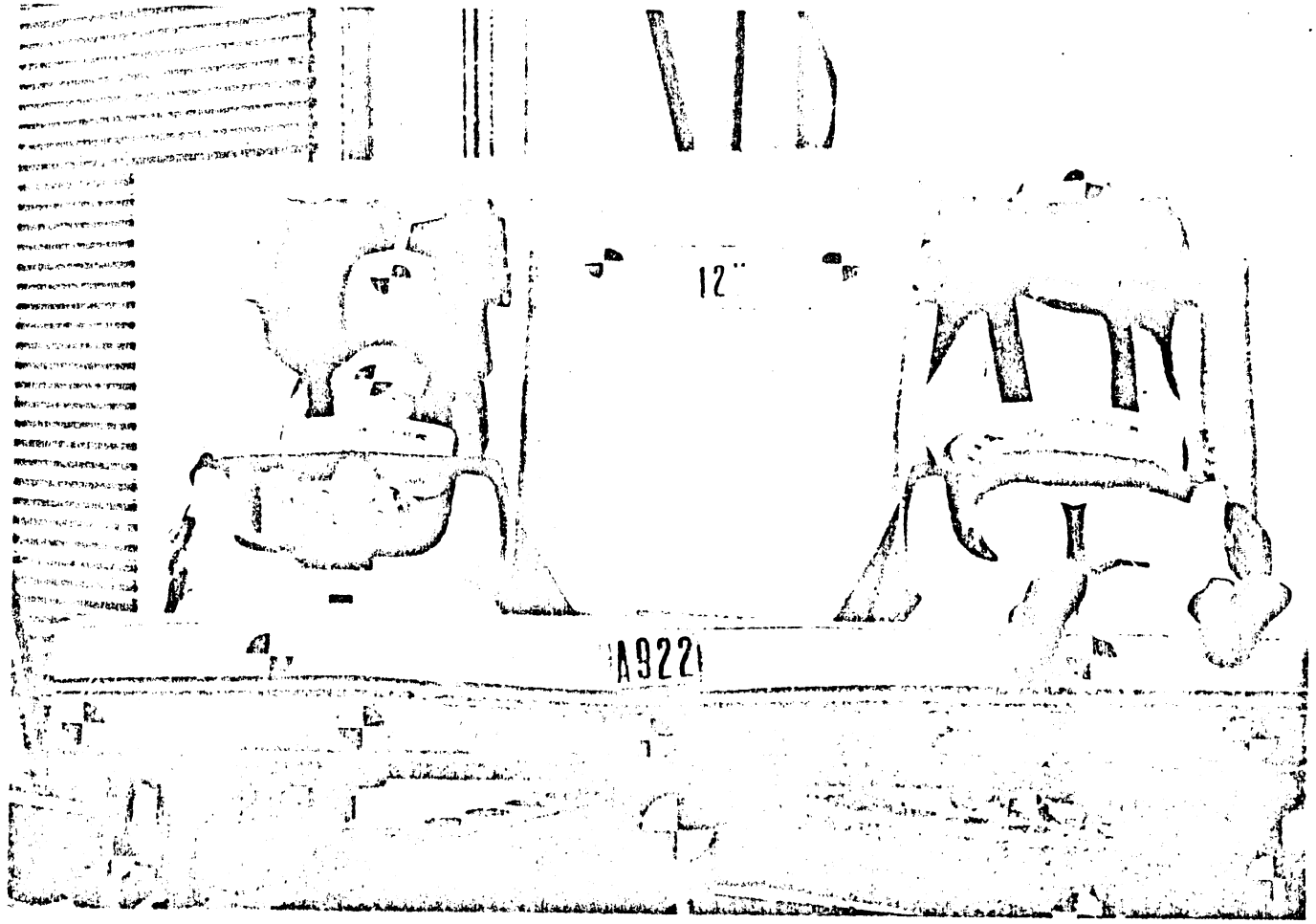
Restraint Systems: A - Swingomatic Child Seat

B - Swingomatic Child Seat with Infant Dummy

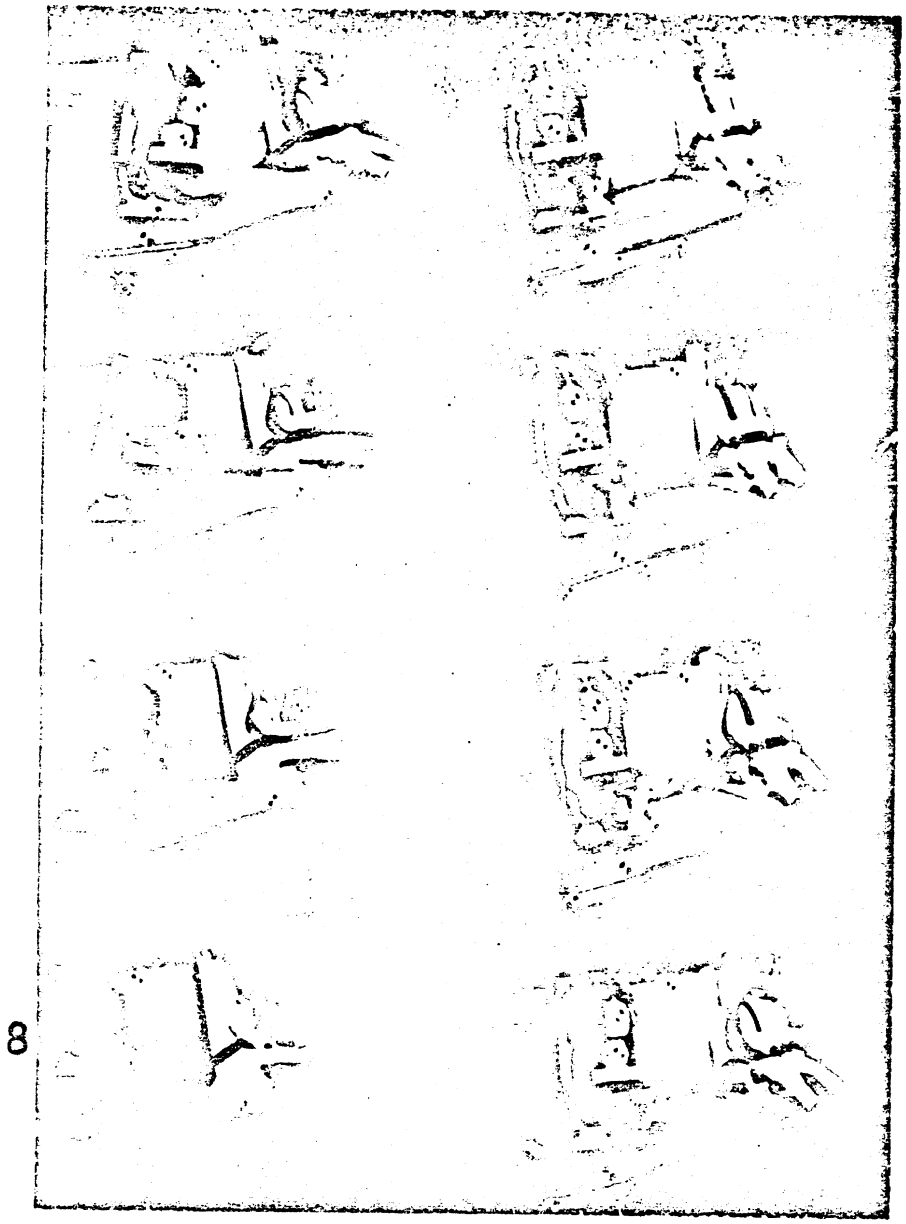
Sled Pulse 20.3 mpn - 16.3 G average

Seat Position A: A Swingomatic Child seat was installed in this position and anchored with the car lap belt and a manufacturer supplied top strap. Belt load cells were installed on the right side of the car lap belt and on the top strap. During the test the dummy motions were controlled. The unique harness system of this seat (shoulder straps and crotch strap but with a load distribution surface in place of the usual lap belt portion of a five point harness) did allow larger forward head excursions due to the dummy torso flexing downward. This motion was such that it is likely that the dummy head would interact with potential interior door surfaces. The harness system retained the dummy without slipping. The seat did rotate partially off the bench seat.

Seat Position B: Even though the system was not designed or intended for use with infants, a Swingomatic Child Seat was installed in this position in its normal forward-facing mode but with the infant dummy installed in it. Load cells were used on the right side of the car lap belt and the top strap. During the test the restraint controlled the dummy motions, however the harness system slipped off the shoulders of the dummy and allowed forward and lateral head excursions which would have resulted in dummy head interaction with potential interior door surfaces.

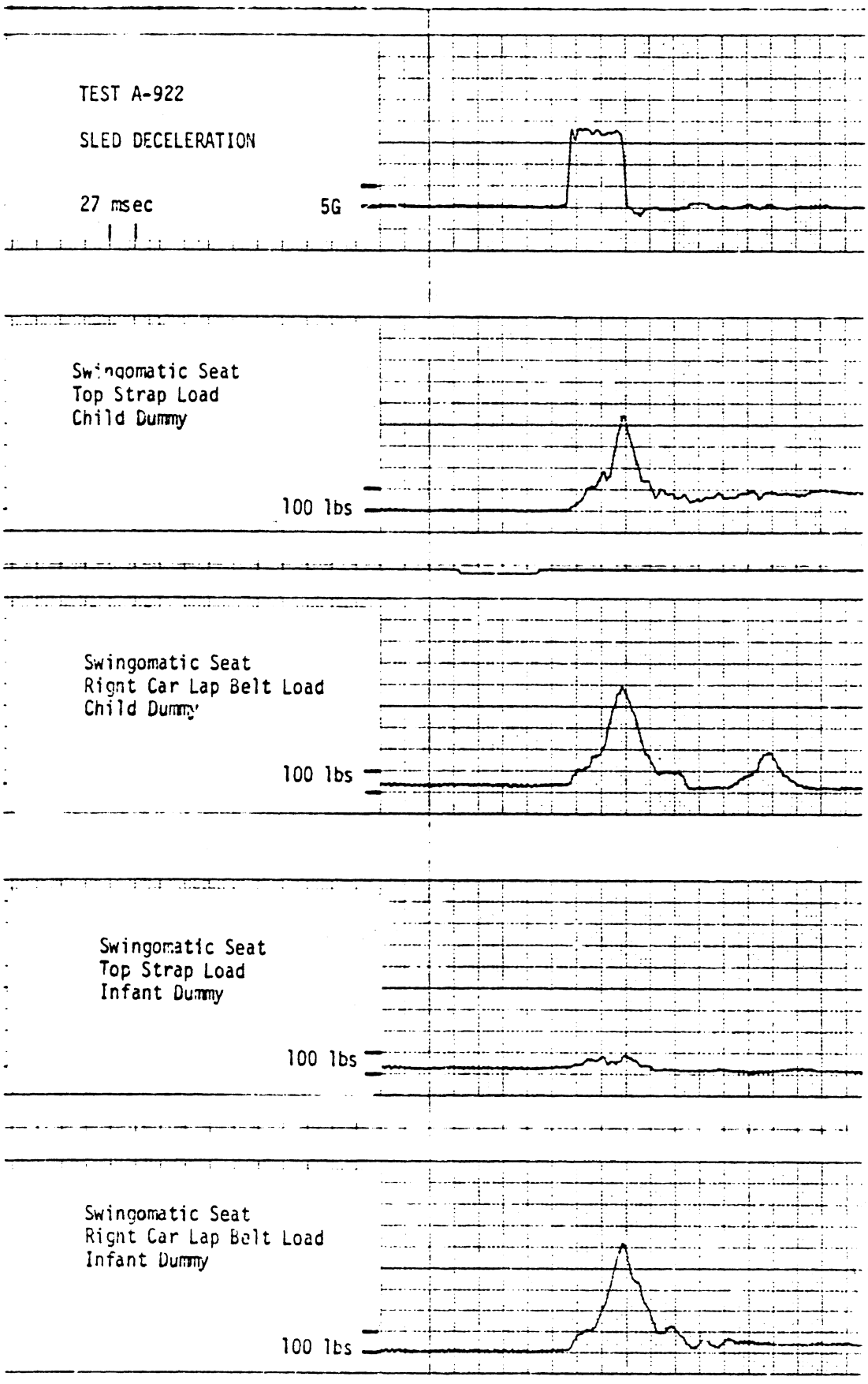


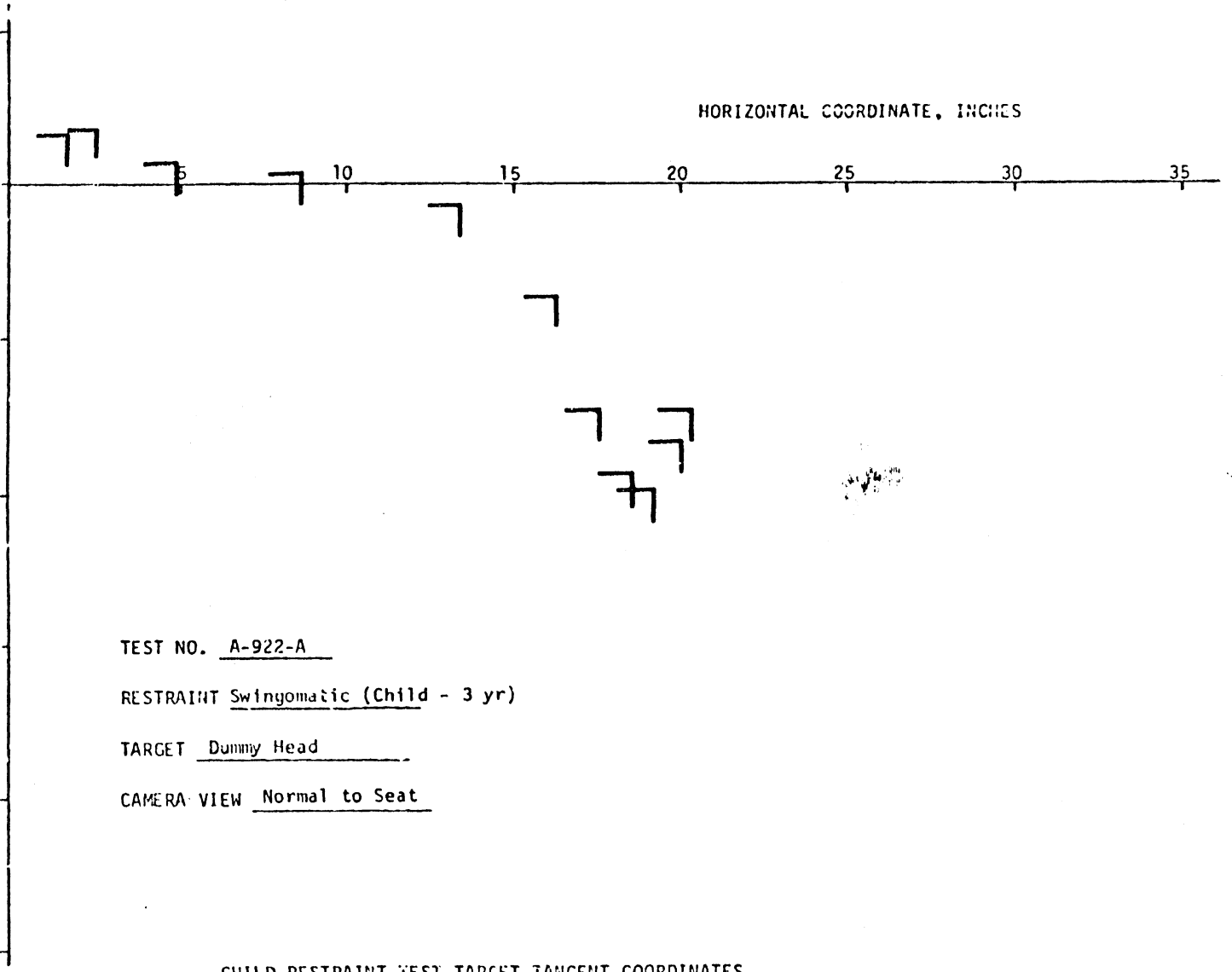
Test A-922 Over-all Test Set-Up



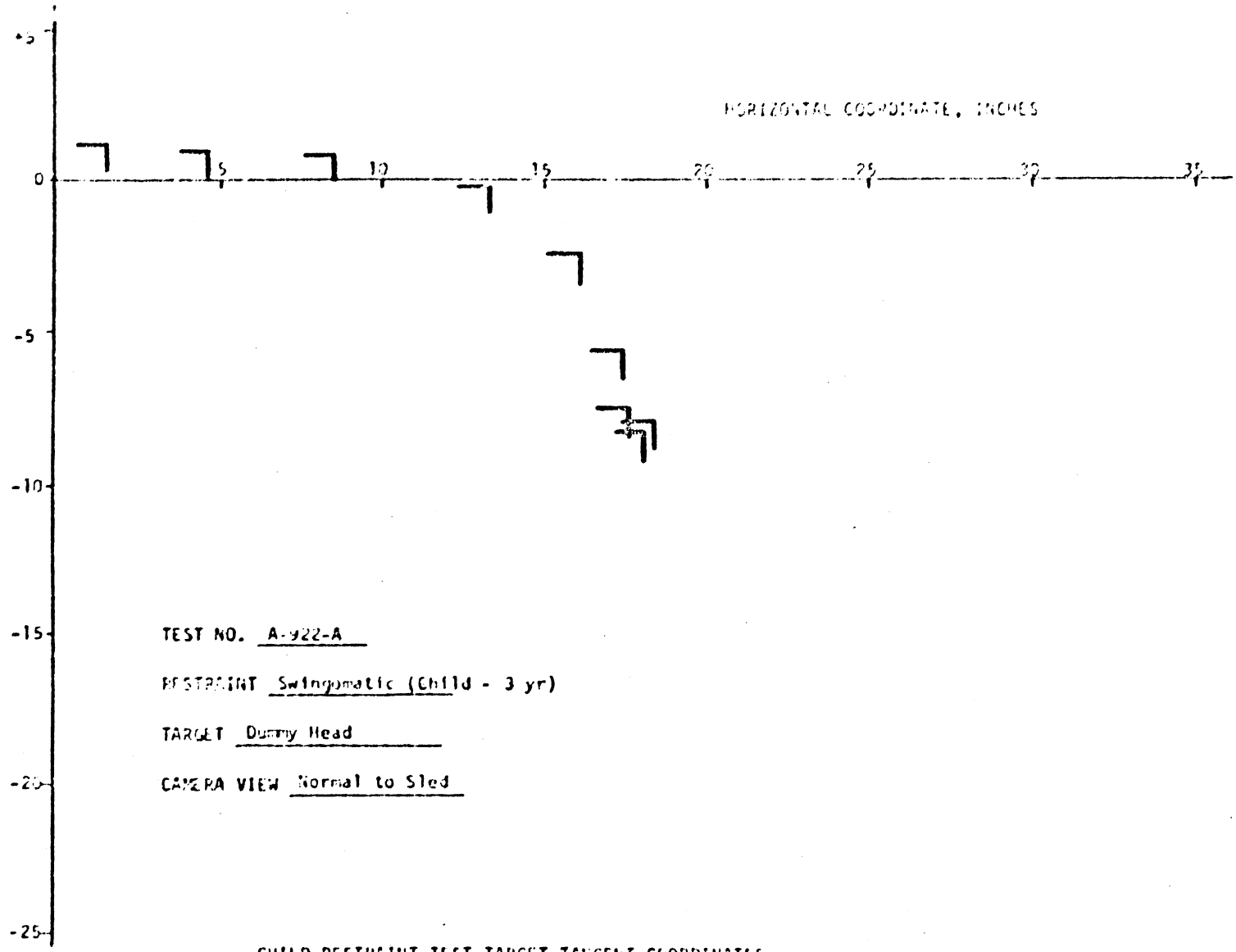
A 922

Graph-Liner for Test A-922

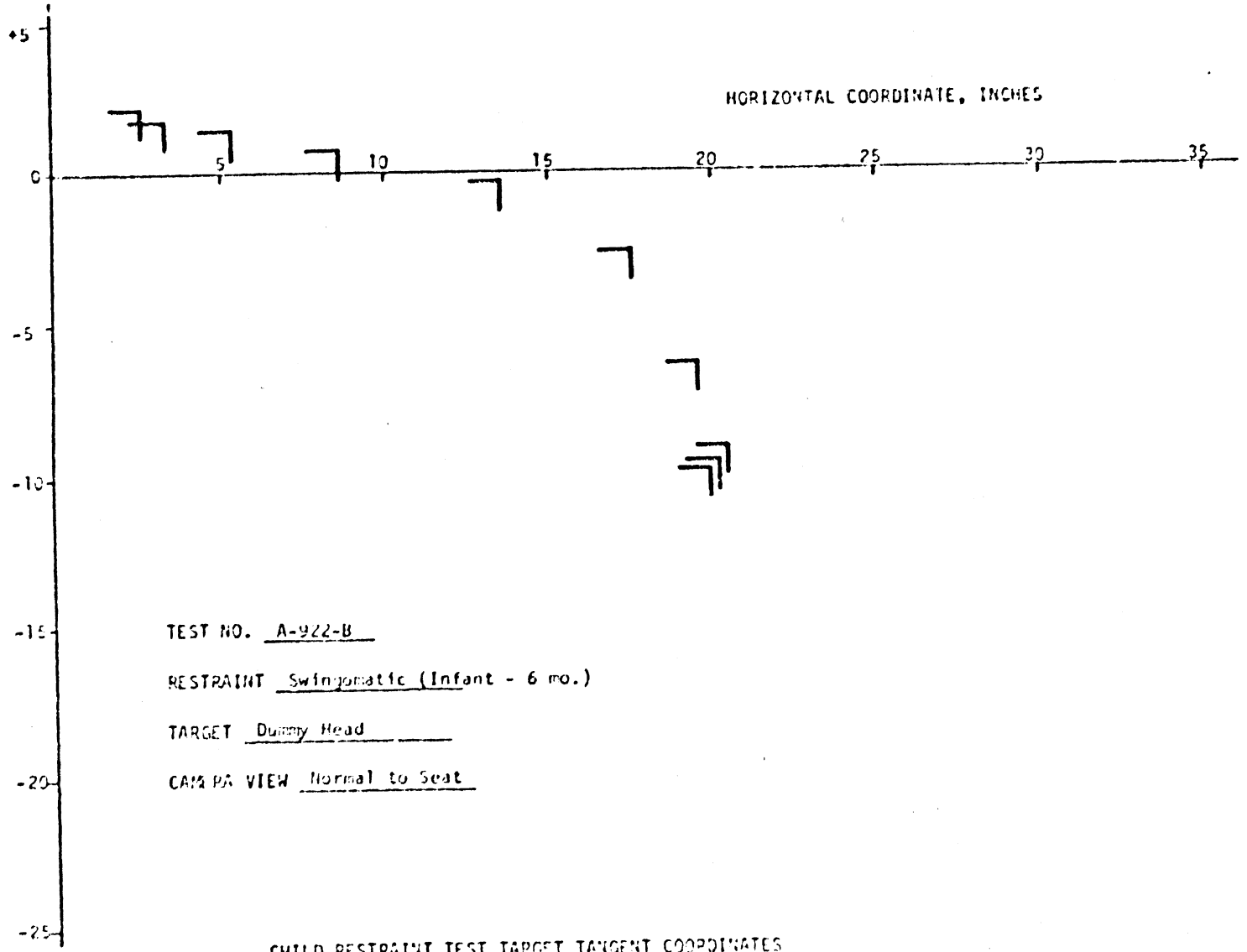

TEST A-922
SLED DECELERATION
27 msec
5G
Swingomatic Seat
Top Strap Load
Child Dummy
100 lbs
Swingomatic Seat
Right Car Lap Belt Load
Child Dummy
100 lbs
Swingomatic Seat
Top Strap Load
Infant Dummy
100 lbs
Swingomatic Seat
Right Car Lap Belt Load
Infant Dummy
100 lbs



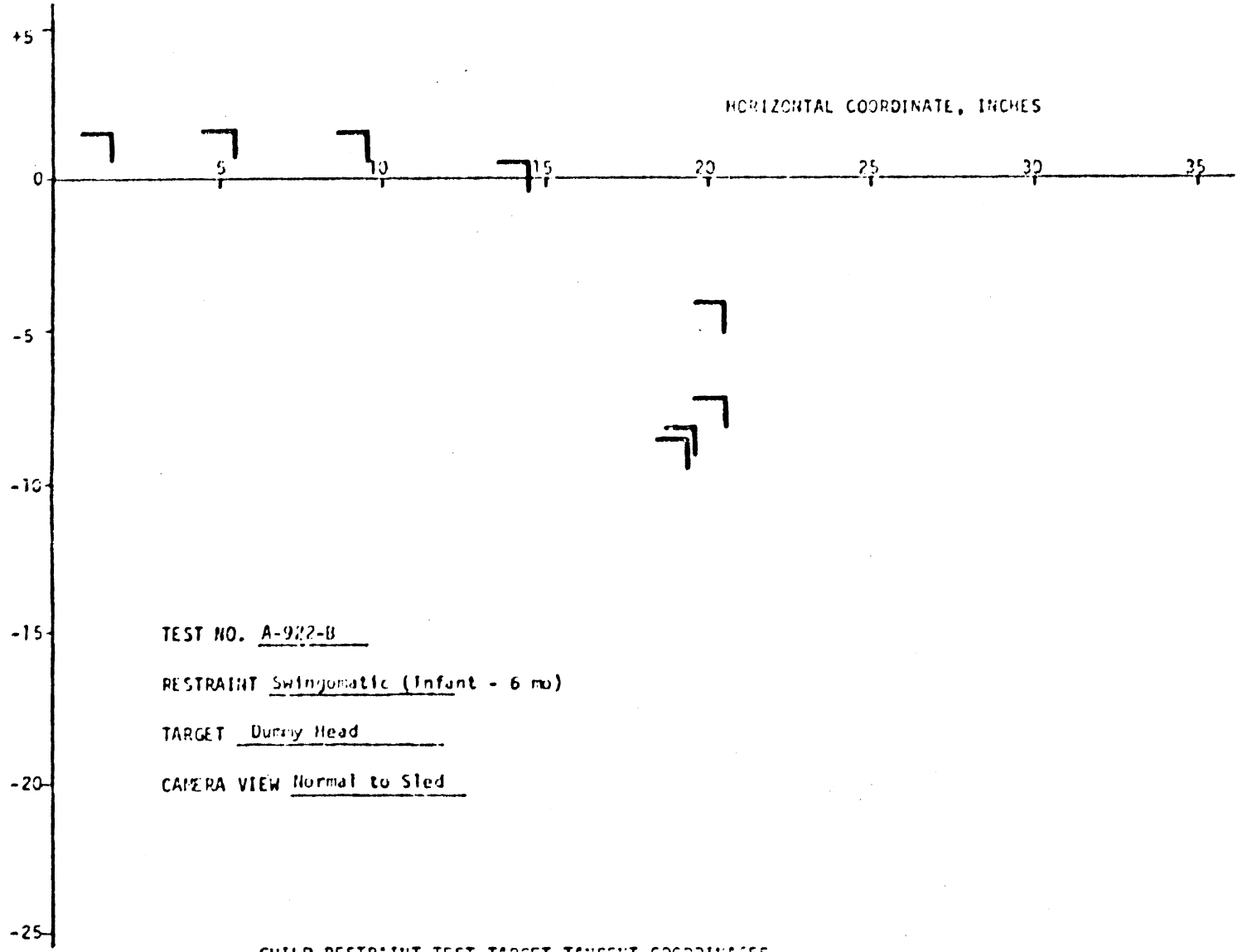
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



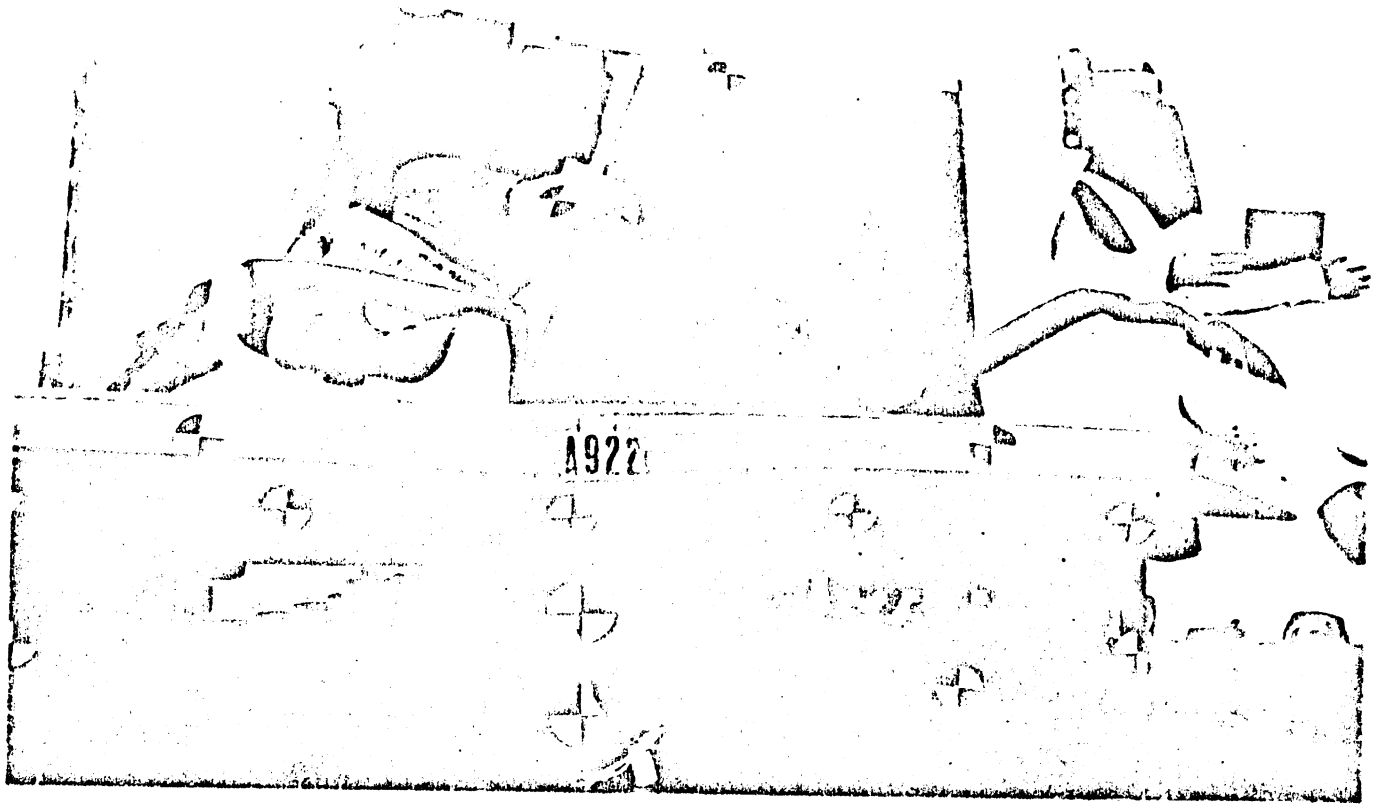
CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



CHILD RESTRAINT TEST TARGET TANGENT COORDINATES



Test A-922 Over-all Post Test Configuration

APPENDIX A. TARGET EXCURSION TABLES

This appendix lists the tabular results of the photometric analysis of the tests performed in this program. The tables are equivalent to the graphical presentations in the main body of the report except that time is included in the tables. Excursions measured normal to the seat and excursions measured normal to the sled are tabulated as indicated.

TEST NUMBER A-917

Target Tangent Coordinates - Normal to Seat

A. GM Child Love Seat

Time msec	Horiz. Coord. in.	Vert. Coord. in.
0	2.4	1.8
16	3.2	2.1
31	5.3	2.0
47	8.6	0.6
63	12.2	-0.4
78	15.7	-2.1
94	19.1	-4.8
109	22.9	-7.5
125	26.6	-11.3
141	28.5	-15.1

B. Bobby-Mac Infant Seat

Horiz. Coord. in.	Vert. Coord. in.
7.3	-3.7
8.1	-3.7
10.1	-4.4
13.6	-6.4
17.8	-8.6
23.9	-9.3
23.4	-13.3
24.4	-14.1
24.6	-13.4
24.0	-11.6

Target Tangent Coordinates - Normal to Sled

Time msec	Horiz. Coord. in.	Vert. Coord. in.	Horiz. Coord. in.	Vert. Coord. in.
0	1.5	1.4	5.7	-0.6
11	1.8	1.6	6.4	-0.7
22	2.9	1.6	6.9	-0.9
32	4.5	1.5	9.3	-1.2
43	6.7	1.2	11.4	-1.9
54	9.4	0.8	14.1	-3.2
65	12.3	0.3	16.6	-5.0
76	14.8	-0.5	18.2	-5.9
86	17.4	-1.8	19.2	-7.5
97	19.8	-3.2	19.4	-7.9
108	22.1	-4.6	19.3	-7.8
119	24.7	-6.9	19.1	-7.8
130	26.8	-9.6	18.8	-6.8
141	27.9	-11.8	18.1	-5.8

TEST NUMBER A-918

Target Tangent Coordinates - Normal to Seat

A. Kantwet Child Care Seat

Time msec	Horiz. Coord. in.	Vert. Coord. in.
0	2.5	2.1
16	2.9	2.2
32	5.1	1.8
48	8.9	0.9
64	14.3	-0.4
80	19.4	-3.8
96	23.9	-8.1
112	27.0	-13.2

B. Kantwet Infant Care Seat

Horiz. Coord. in.	Vert. Coord. in.
6.4	-0.0
6.7	-0.1
8.7	-0.4
11.1	-1.8
14.4	-3.8
17.3	-6.8
18.4	-7.5
18.7	-7.2

Target Tangent Coordinates - Normal to Sled

A. Kantwet Child Care Seat

Time msec	Horiz. Coord. in.	Vert. Coord. in.
0	1.4	1.4
17	2.2	1.1
33	4.5	1.0
50	8.9	0.7
67	14.3	0.1
83	19.8	-2.4
100	24.1	-6.3
116	26.1	-11.6
156	25.9	-24.8
172	25.5	-28.8
189	25.2	-29.6

B. Kantwet Infant Care Seat

Horiz. Coord. in.	Vert. Coord. in.
5.7	0.2
7.0	-0.1
9.1	-0.4
12.0	-1.1
15.1	-2.9
17.8	-5.7
18.4	-6.8
17.7	-6.2
-	-
-	-
-	-

TEST NUMBER A-919

Target Tangent Coordinates - Normal to Seat

A. GM Child Love Seat

Time msec	Horiz. Coord. in.	Vert. Coord. in.
0	2.2	2.0
15	2.9	2.7
30	5.0	1.8
45	6.0	1.9
60	11.5	-0.4
75	12.9	-2.3
90	13.4	-4.2
105	13.4	-5.5
120	14.0	-5.6
135	14.6	-3.2
150	15.1	-1.5

B. Bunny Bear (Infant)

Horiz. Coord. in.	Vert. Coord. in.
0.0	0.0
0.7	-0.1
2.7	-0.2
3.8	-0.1
8.7	-4.7
10.0	-7.1
11.5	-10.5
12.5	-14.0
12.5	-16.1
11.1	-14.9
9.7	-15.1

Target Tangent Coordinates - Normal to Sled

A. GM Child Love Seat

Time msec	Horiz. Coord. in.	Vert. Coord. in.
0	1.2	1.5
17	2.2	1.5
50	7.9	1.1
66	10.7	-0.1
83	12.4	-0.2
99	13.0	-3.2
116	13.1	-4.0
132	13.4	-4.3
149	13.5	-3.6
166	13.2	-3.0
182	13.0	-2.1
199	13.2	

B. Bunny Bear (Infant)

Horiz. Coord. in.	Vert. Coord. in.
3.8	-4.0
4.6	-3.4
10.8	-5.7
14.3	-7.6
16.9	-9.0
19.2	-12.2
20.1	-15.3
19.7	-18.0
19.2	-19.1
18.0	-20.0
17.1	-21.1
15.8	-21.2

TEST NUMBER A-920

Target Tangent Coordinates - Normal to Seat

A. GM Infant Love Seat

B. Ford Tot Guard

Time msec	Horiz. Coord. in.	Vert. Coord. in.	Horiz. Coord. in.	Vert. Coord. in.
0	4.6	0.0	3.8	2.2
16	5.7	0.0	4.3	2.5
31	8.0	-0.3	6.4	2.5
47	11.8	-2.0	10.5	1.9
62	16.5	-4.7	15.0	0.8
78	21.4	-7.9	21.1	-1.9
93	-	-	26.0	-6.1
109	-	-	28.9	-11.1
124	-	-	30.0	-14.0
140	-	-	30.1	-17.3

Target Tangent Coordinates - Normal to Sled

A. GM Infant Love Seat

B. Ford Tot Guard

Time msec	Horiz. Coord. in.	Vert. Coord. in.	Horiz. Coord. in.	Vert. Coord. in.
0	3.9	0.7	1.9	1.6
17	4.4	0.4	2.8	1.3
34	7.0	0.3	5.2	1.5
50	10.6	-0.6	9.7	1.6
67	14.9	-2.3	15.0	1.3
84	18.6	-5.5	20.7	-0.3
101	21.2	-8.8	26.3	-3.4
117	21.6	-11.3	28.8	-8.4
134	21.7	-13.6	29.3	-11.3
151	21.7	-14.0	29.1	-13.6

TEST NO. A-921

Target Tangent Coordinates - Normal to Seat

A. Peterson 74 (Child)			B. Peterson 75 (Infant)	
Time msec	Horiz. Coord. in.	Vert. Coord. in.	Horiz. Coord. in.	Vert. Coord. in.
0	2.9	1.9	2.7	2.7
16	3.5	2.0	3.3	2.9
31	5.4	1.4	5.5	2.1
47	9.6	1.0	8.8	1.3
62	14.6	0.1	13.8	-0.1
77	19.4	-3.4	17.4	-3.1
93	22.2	-8.3	18.4	-5.5
108	22.8	-13.0	18.5	-5.9
124	23.2	-13.4	17.6	-4.7
149	25.7	-13.1	19.3	-4.4
165	25.3	-12.4	18.3	-3.5
180	26.8	-10.5	19.3	-2.5
196	25.6	-8.5	17.6	-0.8
211	23.5	-7.1	15.5	0.5
227	20.6	-6.0	14.1	1.9
242	16.9	-5.0	12.3	3.9

Target Tangent Coordinates - Normal to Sled

A. Peterson 74 (Child)

Time msec	Horiz. Coord. in.	Vert. Coord. in.	Horiz. Coord. in.	Vert. Coord. in.
0	1.5	1.4	2.3	2.1
17	2.6	1.5	3.6	2.1
34	5.1	1.3	6.3	2.4
51	9.2	1.3	10.8	1.9
68	14.6	0.3	15.6	0.3
84	19.5	-2.3	18.3	-2.8
101	21.8	-7.5	18.3	-4.7
118	22.0	-10.7	16.7	-4.9
135	21.5	-10.9	14.5	-5.3
152	20.1	-9.7	-	-
169	18.3	-7.9	-	-
186	16.0	-5.8	-	-
191	12.7	-4.7	-	-
208	10.2	-4.7	-	-

TEST NO. A-922

Target Tangent Coordinates - Normal to Sled

A. Swingomatic (Child)			B. Swingomatic (Infant)	
Time msec	Horiz. Coord. in.	Vert. Coord. in.	Horiz. Coord. in.	Vert. Coord. in.
0	1.9	1.7	2.6	2.1
18	2.5	1.8	3.1	2.0
35	5.0	0.9	5.4	1.5
53	8.9	0.2	9.0	1.0
71	13.5	-0.9	13.9	-0.3
88	16.4	-3.7	17.8	-2.6
106	17.8	-7.5	19.7	-6.4
124	18.7	-9.7	20.5	-9.2
141	19.1	-10.1	20.2	-9.8
159	19.7	-9.7	20.0	-10.0
176	20.3	-8.8	20.3	-9.6
194	20.6	-7.7	20.3	-9.5
212	20.2	-6.2	19.8	-8.9
229	20.1	-5.5	19.3	-8.1
247	20.2	-5.3	18.6	-6.9
265	19.9	-5.5	18.0	-6.1
282	19.4	-6.4	17.5	-5.7
300	18.8	-6.5	17.0	-5.0
318	18.3	-6.7	17.1	-4.7
335	18.2	-6.5	17.2	-4.7

Target Tangent Coordinates - Normal to Sled

A. Swingomatic (Child)			B. Swingomatic (Infant)	
Time msec	Horiz. Coord. in.	Vert. Coord. in.	Horiz. Coord. in.	Vert. Coord. in.
0	1.5	1.2	1.8	1.7
32	4.8	1.0	5.5	1.7
47	8.6	1.0	9.8	1.5
63	13.1	-0.1	14.7	0.7
79	16.1	-2.4		
95	17.5	-5.9	20.6	-4.2
111	17.9	-7.8	20.7	-7.4
126	18.3	-8.1	19.9	-8.7
142	18.1	-8.2	19.6	-8.9
158	17.7	-7.5	20.2	-8.2
174	16.8	-6.7	20.3	-7.3
189	15.9	-5.8	20.4	-6.1
205	15.6	-5.1	20.0	-5.0
221	16.1	-4.8	19.5	-3.7
237	16.4	-5.1	18.9	-2.9
253	16.6	-5.3	18.6	-2.1

END

DATE

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