Final Report

DYNAMIC PERFORMANCE OF CHILD RESTRAINT SYSTEMS

Prepared for:
Consumers Union of U S., Inc.
Auto Test Division
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by

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Approximately 1,000 children per year under the age of four are killed in automotive accidents (1) with an even greater number injured. Last year in the City of Detroit alone (2) over 70% of all children injured in traffic accidents of all forms including pedestrians, bicycles and mini-bike operators were passengers in motor vehicles at the time of their injury. Many of these deaths and injuries could have been prevented had the children been wearing a proper restraint system.

The research regarding effective child protection has been underway since the 1950's. Myo et al (3) reported the accident experience of child passengers in auto accidents studied in the ACIR program in 1959. In 1962, Dye (4) reported his experiences in the evaluation of a large series of then available child restraint devices and documented a number of criteria which should be applied in the evaluation of potential child seats or restraints systems. Subsequent to the Dye paper, Aldman (5) reported in 1966 on the development of a rearward facing child seat for use in Swedish automobiles, and Appoldt (6) discussed dynamic tests of child restraint devices manufactured by Rose Manufacturing Company. In addition, Siegel (7) and his coworkers in 1968 related the design of several types of child seats to the types and frequency of injury patterns as found in accident investigations. Based upon accident cases, Siegel recommended the use of lap belts for children over four years of age but recommended special devices for younger children.

Burdie (8) and his coworkers have discussed the injury of children with...
They suggested that the child's braincase is relatively weaker than that of adults and therefore recommended that head impact tolerances for children be reduced accordingly. This paper by Burdie, as well as other works on the same subject, points out the danger of a lap belt only restraint used in conjunction with the child due to the lack of development of the iliac crest on the child's pelvis. Because the child's pelvis is incompletely developed relative to the adult pelvis, the iliac crest does not provide the foundation for total body support as is generally given by the larger, more developed bone structure found in the adult. Burdie also suggested that restraint loads be distributed widely over the chest because of the extreme flexibility of the child's thorax and hence the vulnerability of the internal thoracic organs to nonpenetrating compression injuries.

King (9) in 1969 developed a reasonably thorough presentation of child anthropometry which included a set of design criteria. King suggested that for children under 50 pounds a stable support platform be provided for any child restraint device. He noted that extreme motion is undesirable due to the danger of contact with interior vehicle structures, and developed requirements for the distribution of load over wide areas of the body. He pointed out the importance of the location of the child's center of gravity as it would affect the dynamic design of a restraint system. For children weighing more than 50 pounds, it was suggested that a stiff booster cushion coupled with a stable mounting platform and an adult lap belt should provide an acceptable restraint system.
other restraint system developed with the automotive industry, the Ford Tot Guard, was discussed and the basis for its design given in the paper by Head (11) in 1970. Both the General Motors Infant Carrier and the Ford Tot Guard reflect improvements which are possible in child restraints if a carefully conceived program is used to develop and dynamically test the child seating device.

The child seating standard which currently exists had the effect of removing the "hook over" and "hook under" seats from the marketplace and, in some instances, raising the performance of the seating systems to a 15 to 20 mph frontal barrier equivalent crash. Unfortunately in almost every instance, the intent of the standard, injury reduction at 30 mph was not achieved.
PART II. 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 9 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. 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 dash board, windshield, door pillars, or windows, etc.

The second factor which can cause injury to occupants of a restraint
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, in an accident there is a strong tendency for the lap belt to
ride up off the pelvis and into the abdominal region, which can be very danger-
ous.

SELECTION OF OCCUPANT

The 3-year size Sierra Engineering anthropometric dummy was used for all
tests. The Sierra 3 year is 37.5 inches high and weighs 31 pounds. The
weights of the various body components are distributed nearly correctly, thus
giving a fair duplication of body kinematics (See Figure 1).

SELECTION OF TEST ENVIRONMENT

The test configurations consisted of a 1973 General Motors bench seat
mounted on a test rig which exactly duplicated the seat mounting, lap belt
attachment points, simulated dash and floor and toe board locations in a 1973
Chevrolet Impala. 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, thorax and pelvis. The instrumentation used were Sierra Model
"4033", "8370", and "5970" accelerometers to sense g's. The
outputs of these signals are converted to g's via a computer program and
are used in the analysis of the impact..."
High speed motion pictures were 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

A retail market-survey was conducted to determine which restraint devices for children would offer the most protection in a crash environment. The devices tested and studied were available between August 6, 1973 and August 29, 1973, and all met government Standard No. 517.213.

With this information, nine test devices were selected on the basis of their potential effectiveness. Descriptions and comments on the test devices are shown in Table I.

All seat restraint systems were installed according to the manufacturer's instructions. In addition, the General Motors Love Seat and the Sears Harness were tested in modes of installation not recommended by the manufacturer. This was done in anticipation of possible incorrect installation by the user.

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 dolly in the device with the appropriate restraints. All of the restraint devices were tested in the frontal impact direction at 30 mph or 40s. Those critical which did not withstand 40s were then retested,
<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>SEAT NAME</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Motors Corp.</td>
<td>Love Seat</td>
<td>Molded plastic seat with padding. Side support along entire upper torso. Belly, crotch, and suspender strap with one universal buckle. Retained by a 6x lap belt and top belt over car seat attached to rear seat belt.</td>
<td>Top anchor belt over car seat. Can adjust with change in position of front seat.</td>
</tr>
<tr>
<td>Mian Industries, Inc.</td>
<td>Child Car Seat</td>
<td>U-shaped vinyl and cloth &quot;bean bag&quot; (styrofoam beans) for face protection. Plastic seat riser with pad. Bag and seat riser restrained by adult lap belt.</td>
<td>Adult lap belt must be buckled to retain bag in place.</td>
</tr>
<tr>
<td>Alvin Baby Products</td>
<td>Recliner</td>
<td>Tubular fold-up pedestal. Padded seat and chest guard bar. Suspending type child shoulder harness and crotch belt. Child seat restrained by adult lap belt and top strap over car seat anchor to floor.</td>
<td>Top anchor belt over car seat. Can adjust with change in position of front seat.</td>
</tr>
<tr>
<td>MANUFACTURER</td>
<td>SEAT NAME</td>
<td>DESCRIPTION</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Kantwet Baby Products</td>
<td>Infanseat Harness</td>
<td>Suspender, waist, and crotch straps. One universal buckle. Anchor strap around car seat back and</td>
<td>Same as above. (Kantwet Fitz-All Deluxe Recliner)</td>
</tr>
<tr>
<td>501 Young Street</td>
<td>Model 275</td>
<td>anchored to floor.</td>
<td></td>
</tr>
<tr>
<td>Piqua, Ohio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sears, Roebuck, and Co.</td>
<td>Harness #6401</td>
<td>Small Harness size with vest, crotch, and shoulder straps. Anchor strap encircles car seat back.</td>
<td>Very hard to adjust properly with heavy clothing on child. Available in two sizes: (small) #6401 and (large) #6402.</td>
</tr>
<tr>
<td>Chicago, Ill. 60607</td>
<td>Part No. 504082</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of Child (years)</td>
<td>Standing Height of Child (inches)</td>
<td>Weight of Child (pounds)</td>
<td>Use on Both Front and Rear Facing Seats</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------</td>
<td>--------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>1-5</td>
<td>30-45</td>
<td>21-50</td>
<td>v</td>
</tr>
<tr>
<td>6-9</td>
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<td>v</td>
</tr>
<tr>
<td>11-14</td>
<td>72</td>
<td>69</td>
<td>v</td>
</tr>
<tr>
<td>15-17</td>
<td>72</td>
<td>70</td>
<td>v</td>
</tr>
<tr>
<td>18-20</td>
<td>72</td>
<td>70</td>
<td>v</td>
</tr>
<tr>
<td>21-24</td>
<td>72</td>
<td>70</td>
<td>v</td>
</tr>
<tr>
<td>25+</td>
<td>72</td>
<td>70</td>
<td>v</td>
</tr>
</tbody>
</table>

*座带安全带，不推荐用于儿童年龄为1岁以下的儿童。*
**TABLE II SUMMARY OF MANUFACTURER SPECIFICATIONS (continued)**

| MANUFACTURER'S NAME AND MODEL NUMBER | TEST NUMBER | AGE OF CHILD (YEARS) | STANDING HEIGHT OF CHILD (INCHES) | WEIGHT OF CHILD (POUNDS) | FOR USE IN FORWARD FACED SEAT ONLY | USED WITH ADULT LATCHED CHILD'S LAP | DOES NOT USE ADULT SEAT BELT | USED ONLY WITH NON-FOLDING SEATS OR SEATS WITH LATCH | NOT FOR USE IN TRUCKS OR BUSES | USE ON BOTH FRONT AND REAR SEATS | ONLY FOR CHILDREN NOT CAPABLE OF SITTING UPRIGHT | RESTRICTIONS ON USE |
|-------------------------------------|-------------|---------------------|-----------------------------------|-------------------------|----------------------------------|----------------------------------|---------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|---------------------------------|-------------------|
| COLLIPOWER-KEYWORTH                | 697         | 40                  | 7-35                              |                         | ✓                                |                                  |                                 |                               | ✓                              |                                |                                | (1) For Children ≥ 30" high, seat back/headrest must be at least 22" above cushion. |
|                                      | 798         | 40                  | 7-35                              |                         |                                  |                                  |                                 |                                |                                |                                |                                | (2) Infants ≤ 15 lbs., must use rear facing position only. |
|                                      | 714         | 40                  | 7-35                              |                         |                                  |                                  |                                 |                                |                                |                                |                                | |
| IVE IN MODEL 1-165                  | 698         | 39                  | 15-35                             |                         | ✓                                |                                  |                                 |                               | ✓                              |                                |                                | (1) Car seat back must be at least 19" above the child's headrest and at least 10" below the top of the child's headrest, or the seat must be placed on the seat saver. |
|                                      | 799         | 39                  | 25-35                             |                         |                                  |                                  |                                 |                                |                                |                                |                                | |
| CAVIET HULL 4 SEAT                  | 701         | 25-43               | < 40                              |                         |                                 |                                  |                                 |                                |                                |                                |                                | |
| CAVIET HULL 775 INFANTSEAT HAVING   | 711         | 43                  | < 53                              |                         |                                 |                                  |                                 |                                |                                |                                |                                | |
| SEARS HANNESS                       | 702         | 40-70               | < 50                              |                         |                                  |                                  |                                 |                                | ✓                              |                                |                                | |

a  Seating Height should be 19-25 inches
b  Shoulder and lap belts must be separable
c  Adult lap belt holds only seat in place
d  Adult belt loop length above cushion must be at least 43" so it can loop around
using another child seat where necessary, in the side direction at 20 mph and 16 G's. Those devices which performed satisfactorily in the side impact were then tested for rear impact performance, at 20 mph and 16 G's.

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>
<thead>
<tr>
<th>Manufacturer and Model</th>
<th>Test. No.</th>
<th>Direction</th>
<th>SLED</th>
<th>HEAD ACCELERATION</th>
<th>CHEST ACCELERATION</th>
<th>Maximum Head Excursion (inches)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>VEL. MPH</td>
<td>ACCL G's</td>
<td>AP G's</td>
<td>LR G's</td>
<td>SI G's</td>
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<td>PETRERSON, 67B</td>
<td>690</td>
<td>FRONT</td>
<td>27.2</td>
<td>21</td>
<td>220</td>
<td>34</td>
<td>78</td>
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<td>FORD, TOT GUARD</td>
<td>691</td>
<td>FRONT</td>
<td>26.1</td>
<td>21</td>
<td>67</td>
<td>10</td>
<td>38</td>
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<tr>
<td></td>
<td>705</td>
<td>SIDE</td>
<td>20.0</td>
<td>16</td>
<td>50</td>
<td>215</td>
<td>30</td>
</tr>
<tr>
<td>CHRYSLER, MOPAR</td>
<td>692</td>
<td>FRONT</td>
<td>30.0</td>
<td>21</td>
<td>16</td>
<td>15</td>
<td>35</td>
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<tr>
<td></td>
<td>706</td>
<td>SIDE</td>
<td>20.6</td>
<td>16</td>
<td>90</td>
<td>209</td>
<td>40</td>
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<tr>
<td>GENERAL MOTORS, LOVE SEAT</td>
<td>693</td>
<td>FRONT</td>
<td>30.0</td>
<td>21</td>
<td>65</td>
<td>11</td>
<td>66</td>
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<tr>
<td></td>
<td>707</td>
<td>SIDE</td>
<td>20.2</td>
<td>16</td>
<td>21</td>
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<td>9</td>
</tr>
<tr>
<td></td>
<td>712</td>
<td>BACK</td>
<td>19.3</td>
<td>16</td>
<td>26</td>
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<td>13</td>
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<td>694</td>
<td>FRONT</td>
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<td>10</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>696</td>
<td>FRONT</td>
<td>30.0</td>
<td>21</td>
<td>55</td>
<td>35</td>
<td>63</td>
</tr>
<tr>
<td>COLLIER-KEYWORTH BOBBY-MAC</td>
<td>697</td>
<td>FRONT</td>
<td>29.5</td>
<td>21</td>
<td>83</td>
<td>10</td>
<td>56</td>
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<tr>
<td></td>
<td>708</td>
<td>SIDE</td>
<td>19.9</td>
<td>16</td>
<td>50</td>
<td>205</td>
<td>52</td>
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<tr>
<td></td>
<td>714</td>
<td>BACK</td>
<td>20.2</td>
<td>16</td>
<td>43</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>IPVIN, I-165</td>
<td>698</td>
<td>FRONT</td>
<td>29.8</td>
<td>21</td>
<td>230</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>KANTWET, 784</td>
<td>699</td>
<td>FRONT</td>
<td>29.8</td>
<td>21</td>
<td>48</td>
<td>8</td>
<td>46</td>
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<tr>
<td></td>
<td>709</td>
<td>SIDE</td>
<td>20.5</td>
<td>16</td>
<td>66</td>
<td>120</td>
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</tr>
<tr>
<td></td>
<td>715</td>
<td>BACK</td>
<td>20.2</td>
<td>16</td>
<td>38</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>KANTWET INFAN-SEAT HARNESS</td>
<td>701</td>
<td>FRONT</td>
<td>30.2</td>
<td>21</td>
<td>35</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>711</td>
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<td>20.0</td>
<td>16</td>
<td>75</td>
<td>29</td>
<td>85</td>
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<tr>
<td>SEARS HARNESS</td>
<td>702</td>
<td>FRONT</td>
<td>30.2</td>
<td>21</td>
<td>52</td>
<td>6</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>710</td>
<td>SIDE</td>
<td>13.9</td>
<td>16</td>
<td>185</td>
<td>225</td>
<td>6c</td>
</tr>
<tr>
<td></td>
<td>703</td>
<td>FRONT</td>
<td>30.2</td>
<td>21</td>
<td>265</td>
<td>30</td>
<td>70</td>
</tr>
</tbody>
</table>

* Restraint device installation not in accordance with manufacturer's recommendations.
PART III RESULTS

HEAD EXCURSION

Most serious injuries and fatalities in automobile accidents are due to head injuries resulting from impact of the occupant's head with the interior of the vehicle. Therefore, head excursion is the most important indicator of the protection afforded by the restraint device.

The devices tested for this study were ranked largely according to the amount of head excursion allowed. The Canadian Government is considering a proposed standard which requires that maximum head excursion be limited to less than 24 inches in a front impact at 30 mph.

The GM Love Seat, Kantwet Infanseat Harness, Kantwet Model 784, and Bobby-Mac all met this standard. The Ford Tot-Guard and the Sears Harness failed the proposed standard, but prevented the dummy's head from coming into contact with the simulated dash. The Irvin I-165 and Peterson Model 67B failed the standard and allowed the dummy's head to impact the simulated dash.

In the side impact tests, only the GM Love Seat prevented the dummy's head from impacting the door. Acceleration records and high speed movies indicated that the Kantwet Infanseat and Model 784 restrained the dummy partially so that its head impacted the door with minimal force. The Ford Tot-Guard, Mopar Seat, Bobby-Mac Seat and Sears Harness all allowed the dummy's head to impact the door with considerable velocity. The Peterson Model 67B and the Irvin I-165 were not tested in a side impact because they also clearly failed the front impact.
is too high. Each seat uses a pair of shoulder harnesses to limit excursion of the head and torso.

The Ford Tot Guard and Nopar seat employ the same type of load bearing surface. Both have semi-rigid encasing shells that bear upon the child's chest and abdomen in a front impact. The loads are very well distributed in front impacts. Neither provides protection for the head and torso in a side impact.

The Sears Harness distributed loads fairly well. The Irvin seat and the Peterson Model 61 used the adult lap belt around the child. As a result, these two seats offer little or no protection over that supplied by the adult lap belt alone.

ACCELERATION

Accident investigations show that little if any head injury occurs if there is no head-to-vehicle contact. Therefore, performance criteria based on head acceleration are inadequate and inappropriate for evaluating the life-saving potential of a restraint system in frontal impacts without head-to-vehicle contact. In the frontal test the G.M. Love Seat, Kantwet Seat and Harness, and the Sears Harness all fit into this category of injury assessment. That is, no head contact, therefore no life-threatening injury potential.

The Bobby-Mac, Ford Tot Guard, and Chrysler Nopar seat all have front body shields which were contacted by the dummy's head in the front impact. Head accelerations for the Bobby-Mac and the Tot-Guard are high but not so high as to make the seat unsafe. Head accelerations for the Nopar are higher than expected due to the stiffness of the shield.
The Peterson and the Irvin seats both allowed the dummy's head to contact the simulated dash. The resulting head accelerations were high enough in these tests to be considered life threatening.

The G.M. Love Seat gave total side protection with the dummy's head contacting only the side of the child seat. Head accelerations were very low. The Kantweit seat and harness allowed the dummy's head to impact the side door, but the force of impact was very light and no serious injury would be expected.

The Bobby-Mac, Ford Tot Guard, Chrysler Mopar, and the Sears Harness all allowed the dummy's head to impact the door in the side impact test. The head accelerations were all high enough to be considered dangerous to life.

In all tests, chest accelerations were low enough to be considered no threat to life except for the Peterson front impact and the Mopar side impact.
PART IV CONCLUSIONS

All seats evaluated in this study must be installed and used according to their directions. In addition, it is recommended that they be installed in the middle section of the rear seat, wherever possible.

The GM Love Seat, both the Kantwet seat and harness, and the Sears harness require a back strap. When any of these seats are installed in the front seat the strap passes through the rear passenger compartment where it can be a nuisance. Without these straps, the protection afforded by these seats is greatly reduced.

The test configuration employed in the side impacts for this study represents the most severe conditions which may result from a real automobile side collision. The child restraint system was installed on a bench seat nearest the point of impact. If the restraint system had been installed in the middle of the seat, or on the side opposite the impact site, the test results would have indicated less severe consequences.

The restraint systems for all 1974 American made autos incorporate a single buckle which is hard fastened to both the lap belt and the shoulder strap. This configuration may seriously reduce the safety effectiveness of those seats which require that the seat belt be passed through an enclosure (i.e. the Chrysler Mopar, Kantwet Model 784 seats). Preliminary examination revealed that the above described seat belt configuration may cause the seats to rotate out of position in an impact. This would be particularly dangerous for the Mopar seat, as it has no belts to restrain the child, and the child may be ejected from the seat.

One additional important limitation upon the performance of all the restraint devices tested was the adult car seat. These seats deformed
considerably in all tests. Head excursion in the rear impacts, and to a lesser extent in the front impacts was due in part to deflection of the adult car seat back. This deflection allowed the child restraint system to travel further than it would have, had the seat back been rigid.
A qualitative evaluation of the restraint systems was made on the basis of all available (quantitative data, film record, lab notes, etc.)

EXCELLENT

General Motors Love Seat - Provided good protection in all impact directions. Proper installation of this seat is critical (See Text). Head and chest accelerations were low. Can be used in all '74 cars.

GOOD

Kantwet Harness - Provided good protection in front and rear impacts, only fair in side impact. This harness system is excellent. Accelerations were very low for both head and chest. Can be used in all '74 cars.

Kantwet Child Seat - The harness system employed by this seat is identical to the Kantwet harness, and its performance is similar. Head and chest acceleration were very low. Can be used in all '74 cars.

Bobby-Mac - Good general performance. Head and chest accelerations were low. Stiff face shield on this seat may cause facial injuries. Can be used in all '74 cars.

POOR

Tot-Guard - The Tot Guard's performance was excellent in front and rear collisions, but poor in side collisions. This seat was by far the easiest to use, with no straps to tighten and no buckles to fasten. Can be used in all '74 cars.

Mopar - Fair protection in front and rear impacts, poor protection in side impacts. G loads high. This seat is easy to use, and can be used in all '74 cars.
Sears Harness - Its dynamic performance is fair, but this device may take up to one hour and could require five minutes to put the harness on every time it's used. Can be used in all '74 cars.

NOT ACCEPTABLE

Irvin I-165 - This seat provides little or no real protection. Dummy's head impacted dash at high velocity, resulting in extremely high accelerations. Can be used in all '74 cars.

Peterson - Head and chest accelerations were very high. The structure of the seat collapsed allowing the dummy to move forward and impact the dash. Can be used in all '74 cars.

Table IV is a recommended ordering of child restraint systems according to their overall safety.
**TABLE IV. THE QUANTITATIVE RESULTS OF THE CHILD RESTRAINT SYSTEMS TESTED**

<table>
<thead>
<tr>
<th>EXCELLENT</th>
<th>General Motors Love Seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD</td>
<td>Kantwet Harness Model 275</td>
</tr>
<tr>
<td></td>
<td>Kantwet Seat Model 784</td>
</tr>
<tr>
<td></td>
<td>Bobby-Mac</td>
</tr>
<tr>
<td>PCOR</td>
<td>Ford Tot-Guard</td>
</tr>
<tr>
<td></td>
<td>Chrysler Monar Seat</td>
</tr>
<tr>
<td></td>
<td>Sears Harness</td>
</tr>
<tr>
<td>* NOT ACCEPTABLE</td>
<td>Peterson Model 678</td>
</tr>
<tr>
<td></td>
<td>Irvin Child Seat Model I-165</td>
</tr>
</tbody>
</table>

* The rating *Not Acceptable* implies that the child restraint system being tested did not successfully meet the performance criterion I used to evaluate the effectiveness of the restraint system. That doesn't mean these restraint systems have no protective ability at all. They all did meet the requirements of Federal Motor Vehicle Safety Standard 213.
PART VI REFERENCES


HSRI SUMMARY DATA SHEET

Test Number: A-690
Test Date: August 23, 1973
Restraint Descriptions: Peterson Model 67B

Dummy: 3-Year
Sled Velocity: 27.2 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

The structure of the child seat collapsed, allowing the dummy to move forward and contact the simulated dash. The dummy then carried through the dash. Head and chest accelerations were very high.
FIGURE A-1  SET UP FOR PETERSON 67B, FRONT IMPACT
Test no.: A-690

FIGURE A-2 GRAPHCHEK SEQUENCE CAMERA
<table>
<thead>
<tr>
<th>Test No.</th>
<th>2-628</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy</td>
<td>3-Year</td>
</tr>
<tr>
<td>Sled Velocity</td>
<td>39.9 ft/sec</td>
</tr>
<tr>
<td>Sled Pulse</td>
<td>2 g/s/division Filtered Class 60</td>
</tr>
<tr>
<td>Anterior-Posterior Head Acceleration</td>
<td>5 g/s/division Filtered Class 1000</td>
</tr>
<tr>
<td>Superior-Inferior Head Acceleration</td>
<td>5 g/s/division Filtered Class 1000</td>
</tr>
<tr>
<td>Left-Right Head Acceleration</td>
<td>5 g/s/division Filtered Class 1000</td>
</tr>
<tr>
<td>Resultant Head Acceleration</td>
<td>10 g/s/division Filtered Class 1000</td>
</tr>
<tr>
<td>Severity Index</td>
<td>40 sec/div</td>
</tr>
</tbody>
</table>

Head Acceleration Data

Seat Type: Peterson Model 67B
Impact Type: Front
TEST NO. A-690
DURTY 3-Year
SLED VELOCITY 39.9 ft/sec

SEAT TYPE Peterson Model 67B
IMPACT TYPE Front

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Resultant Chest
Acceleration
2.0 g's/division
Filtered
Class 1000

CHEST ACCELERATION DATA
HSRI SUMMARY DATA SHEET

Test Number: A-691
Test Date: August 23, 1973
Restraint Descriptions: Ford Tot Guard

Dummy: 3-Year
Sled Velocity: 26.1 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Good load distribution over chest and head. Head and chest g loads were moderate. Dummy rebounded into adult seat back and headrest, resulting in flexion of the neck. No damage to seat.
FIGURE A-3 SET UP FOR FORD TOT GUARD, FRONT IMPACT
Test No.: A-697

FIGURE A-4 GRAPHCHEK SEQUENCE CAMERA
TEST NO. A-691

SEAT TYPE Ford Tot Guard

DUMMY 2-Year

IMPACT TYPE Front

SLED VELOCITY 38.3 ft/sec

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity index
40 sec/div
CHEST ACCELERATION DATA

TEST NO. A-691
SEAT TYPE Ford Tot Guard
DUTY 3-Year
IMPACT TYPE Front
SLED VELOCITY 38.3 ft/sec

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Resultant Chest
Acceleration
1.0 g's/division
Filtered
Class 1000
Test Number: A-705
Test Date: August 28, 1973
Restraint Descriptions: Ford Tot Guard

Dummy: 3-Year
Sled Velocity: 20.0 mph
Sled g-Level: 16
Impact Direction: Side
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Seat provides little or no protection in side impacts. Head and chest g-s were very high. Head impacted door.
Test No.: A-705

FIGURE A-6  GRAPHCHERK SEQUENCE CAMERA
HEAD ACCELERATION DATA

TEST NO. 6-303
DUMMY 3-year

SEAT TYPE Ford Tot Guard
IMPACT TYPE Side

SLED VELOCITY 29.3 ft/sec

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
40 sec/div
CHEST ACCELERATION DATA

TEST NO. A-705
DUMMY 3-Year
SLED VELOCITY 29.3 ft/sec

SEAT TYPE Ford Tot Guard
IMPACT TYPE Side

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Resultant Chest
Acceleration
2.0 g's/division
Filtered
Class 1000
HSRI SUMMARY DATA SHEET

Test Number: A-692
Test Date: August 23, 1973
Restraint Descriptions: Chrysler Kopar

Dummy: 3-year
Sled Velocity: 30.0 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:
G's in head and chest were high due to rigidity of face shield. Dummy tends to submerge.
FIGURE A-7 SET UP FOR CHRYSLER MOPAR, FRONT IMPACT
HEAD ACCELERATION DATA

TEST NO. A-692
DUMMY 3-Year
SEAT TYPE Chrysler Mopar
IMPACT TYPE Front

SLED VELOCITY 44.0 ft/sec

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
40 sec/div

VISION, GOERING
POINT 1, 3
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value 1</th>
<th>Value 2</th>
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</thead>
<tbody>
<tr>
<td>TEST NO.</td>
<td>A-692</td>
<td></td>
</tr>
<tr>
<td>SEAT TYPE</td>
<td>Chrysler Mopar</td>
<td></td>
</tr>
<tr>
<td>SLED VELOCITY</td>
<td>44 ft/sec</td>
<td></td>
</tr>
<tr>
<td>SLED PULSE</td>
<td>2.0 g/s/division</td>
<td></td>
</tr>
<tr>
<td>Anterior-Posterior Chest Acceleration</td>
<td>1.0 g/s/division</td>
<td></td>
</tr>
<tr>
<td>Superior-Inferior Chest Acceleration</td>
<td>1.0 g/s/division</td>
<td></td>
</tr>
<tr>
<td>Left-Right Chest Acceleration</td>
<td>1.0 g/s/division</td>
<td></td>
</tr>
<tr>
<td>Resultant Chest Acceleration</td>
<td>1.0 g/s/division</td>
<td></td>
</tr>
</tbody>
</table>
HSRI SUMMARY DATA SHEET

Test Number: A-706
Test Date: August 28, 1973
Restraint Descriptions: Chrysler Mopar

Dummy: 3-Year
Sled Velocity: 20.0 mph
Sled G-Level: 16
Impact Direction: Side
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Seat provides little or no protection in side impacts. Head and chest g's were very high. Head impacted door.
FIGURE A-10  
GRAPHIC CHECK SEQUENCE  
CAMERA  

Test No.: A-706
HEAD ACCELERATION DATA

TEST NO. A-706

DUddy 3-Year

SLED VELOCITY 29.3 ft/sec

SEAT TYPE Chrysler Hophar

IMPACT TYPE Side

SLED Pulse
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
40 sec/div
TEST NO. A-706

DUMMY 3-Year

SEAT TYPE Chrysler Mopar

IMPACT TYPE Side

SLED VELOCITY 29.3 ft/sec

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
5.0 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
5.0 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
5.0 g's/division
Filtered
Class 1000

Resultant Chest
Acceleration
4.0 g's/division
Filtered
Class 1000
HSRI SUMMARY DATA SHEET

Test Number: A-693
Test Date: August 23, 1973
Restraint Descriptions: G.M. Love Seat

Dummy: 3-Year
Sled Velocity: 30.0 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Good load distribution, minimum head excursion. Possible overflexion of the neck, also possible abdominal contact with adult lap belt if harness is loose.
FIGURE A-11 SET UP FOR GENERAL MOTORS LOVE SEAT, FRONT IMPACT
Test No.; A-693

FIGURE A-12  GRAPHCHEK SEQUENCE CAMERA
HEAD ACCELERATION DATA

TEST NO. A-693

DUMMY 3-Year

SLED VELOCITY 44 ft/sec

SEAT TYPE G.M. Love Seat

IMPACT TYPE Front

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
40 sec/div
TEST NO. A-693
DUTY 3-Year
SLED VELOCITY 44 ft/sec

SEAT TYPE G.M. Love Seat
IMPACT TYPE Front

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Resultant Chest Acceleration
1.00 g's/division
Filtered
Class 1000
Test Number: A-707
Test Date: August 28, 1973
Restraint Descriptions: G.M. Love Seat

Dummy: 3-year
Sled Velocity: 20.2 mph
Sled G-Level: 16
Impact Direction: Side
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

G-loads very low. No contact of head and torso with vehicle interior. Lower extremeties contacted door.
Test No.: A-707

FIGURE A-14  GRAPHCHEK SEQUENCE CAMERA
TEST NO. A-707
DUMMY 3-Year
SLED VELOCITY 29.6 ft/sec

SEAT TYPE G.M. Love Seat
IMPACT TYPE Side

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
10 sec/div
TEST NO. A-707
DUMMY 3-Year
SLED VELOCITY 29.6 ft/sec

SEAT TYPE G.M. Love Seat
IMPACT TYPE Side

SLED PULSE
2.0 g/s/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g/s/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g/s/division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g/s/division
Filtered
Class 1000

Resultant Chest Acceleration
1.0 g/s/division
Class 1000
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<tr>
<th>Test Number:</th>
<th>A-712</th>
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<tbody>
<tr>
<td>Test Date:</td>
<td>August 30, 1973</td>
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<tr>
<td>Restraint Descriptions:</td>
<td>G.M. Love Seat</td>
</tr>
<tr>
<td>Dummy:</td>
<td>3-Year</td>
</tr>
<tr>
<td>Sled Velocity:</td>
<td>19.3 mph</td>
</tr>
<tr>
<td>Sled G-Level:</td>
<td>16</td>
</tr>
<tr>
<td>Impact Direction:</td>
<td>Rear</td>
</tr>
<tr>
<td>Dummy Attitude:</td>
<td>Sitting, facing toward the front of the simulated vehicle.</td>
</tr>
</tbody>
</table>

**Test Observation:**

>Gentle ride, g loads very low, head well supported.
FIGURE A-15 SET UP FOR GENERAL MOTORS LOVE SEAT, BACK IMPACT
FIGURE A-16 GRAPHCHEK SEQUENCE CAMERA

Test No. A-712
DUCKY  5-Year
SLED VELOCITY  79.3 ft/sec

SLED PULSE
2 g/s/division
Filtered
Class 60

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

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

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

Resistant Head
Acceleration
1 g/s/division
Filtered
Class 1000

SEAT TYPE: G.M. Love Seat
IMPACT TYPE: Rear


circle-clip
TEST NO. ... A-71?    SEAT TYPE  G.M. Love Seat
......3-Year       IMPACT TYPE  Rear
SLED VELOCITY  28.3 ft/sec

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g's/division
Filtered
Class 1010

Superior-Inferior
Chest Acceleration
1.0 g's/division
Filtered
Class 1010

Left-right
Chest Acceleration
1.0 g's/division
Filtered
Class 1010
HEAT SURVEY DATA SHEET

Test Number: A-554
Test Date: August 24, 1973
Restraint Description: G.M. Lap Belt without back strap

Vehicle:

Sidelash: 30.0 mph
Sidelash: 21
Impact Direction: Front
 Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Slow motion, resulting in large head excursions. Distinct possibility of suit and occupant rotating out of adult lap belt and becoming a free body.
FIGURE A-17 SET UP FOR GENERAL MOTORS LOVE SEAT WITHOUT REAR STRAP, FRONT IMPACT
Test No.; A-694

FIGURE A-18  GRAPHCHEK SEQUENCE CAMERA
SLED PULSE
2 g's/division
Filtered
Class 1000

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

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

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

Resultant Head
Acceleration
5 g's/division
Filtered
Class 1000
TEST NO. A-094

SEAT TYPE G.M. Love Seat
Run without back strap

DUMMY 3-Year

IMPACT TYPE Front

SLED VELOCITY 44 ft/sec

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Resultant Chest Acceleration
1.0 g's/division
Filtered
Class 1000
HSRI SUMMARY DATA SHEET

Test Number: A-695
Test Date: August 24, 1973
Restraint Descriptions: G.M. Love Seat with Adult Lap Belt in lowest position

Dummy: 3-Year
Sled Velocity: 30.0 mph
Sled C-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Distinct possibility of seat back failure at the point of connection with the top strap. The seat would then pivot out of the adult lap belt and become a free body.

Otherwise, the seat performance in this configuration is good.
FIGURE A-19  SET UP FOR GENERAL MOTORS LOVE SEAT WITH STRAP AROUND LOWER PORTION, FRONT IMPACT
Test No.; A-696

FIGURE A-20  GRAPHCHEK SEQUENCE CAMERA
HEAD ACCELERATION DATA

TEST NO. M-C05
DUMMY 3-Year
SLED VELOCITY 44.0 ft/sec

SEAT TYPE G.M. Love Seat
IMPACT TYPE Run with adult lap belt in lowest position - Front

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
40 sec/div

OJ SHINE
TEST NO. A-696

DUTY 3-Year

SLED VELOCITY 44 ft/sec

SEAT TYPE G.M. Love Seat

IMPACT TYPE Front - Run with adult lap belt in lowest position

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Resultant Chest
 Acceleration
1.0 g's/division
Filtered
Class 1000
Test Number: A-697
Test Date: August 24, 1973
Restraint Descriptions: Collier-Keyworth Bobby Mac

Dummy: 3-Year
Sled Velocity: 29.5 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Head excurs ion minimal, chest g loads moderate, good load distribution.
Facial injuries possible due to impact with stiff face shield.
HEAD ACCELERATION DATA

TEST NO. A-697

DUMMY 3-Year

SLED VELOCITY 43.3 ft

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
40 sec/div

SEAT TYPE Collier-Keyworth Bobby-Mac

IMPACT TYPE Front
<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>A-697</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRDY</td>
<td>3-Year</td>
</tr>
<tr>
<td>SLED VELOCITY</td>
<td>43.3 ft/sec</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEAT TYPE</th>
<th>Collier-Keyworth Bobby-Mac</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT TYPE</td>
<td>Front</td>
</tr>
</tbody>
</table>

**SLED PULSE**
- 2.0 g's/division
- Filtered
- Class 60

**Anterior-Posterior**
- Chest Acceleration 1.0 g's/division
- Filtered
- Class 1000

**Superior-Inferior**
- Chest Acceleration 1.0 g's/division
- Filtered
- Class 1000

**Left-Right**
- Chest Acceleration 1.0 g's/division
- Filtered
- Class 1000

**Resultant Chest Acceleration**
- 1.0 g's/division
- Filtered
- Class 1000
Test Number: A-708
Test Date: August 28, 1973
Restraint Descriptions: Collier-Keyworth Bobby-Mac

Dummy: 3-year
Sled Velocity: 19.9 mph
Sled G-Level: 16
Impact Direction: Side
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Some (limited) protection in side impact. Head impacted door.
FIGURE A-23  SET UP FOR COLLIER-KENTWORTH BOBBY-MAC, SIDE IMPACT
<table>
<thead>
<tr>
<th>Component</th>
<th>Measurement</th>
<th>Filtered Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLED PULSE</td>
<td>2 g's/division</td>
<td>60</td>
</tr>
<tr>
<td>Anterior-Posterior Head Acceleration</td>
<td>5 g's/division</td>
<td>1000</td>
</tr>
<tr>
<td>Superior-Inferior Head Acceleration</td>
<td>5 g's/division</td>
<td>1000</td>
</tr>
<tr>
<td>Left-Right Head Acceleration</td>
<td>5 g's/division</td>
<td>1000</td>
</tr>
<tr>
<td>Resultant Head Acceleration</td>
<td>10 g's/division</td>
<td>1000</td>
</tr>
<tr>
<td>Severity Index</td>
<td>40 sec/div</td>
<td></td>
</tr>
</tbody>
</table>
COLLIER-KEYWORTH

3-Year

SLIP VELOCITY: 29.2 ft/sec

Impact Type: Side

Anterior-Posterior
Chest Acceleration: 1.0 g's/division
Filtered
Class 1/0

Superior- Inferior
Chest Acceleration: 1.0 g's/division
Filtered
Class 10/0

Horizontal
Chest Acceleration: 1.0 g's/division
Filtered
Class 1/0
Test Number: 1174
Test Date: August 30, 1973

Dummy: 3-Year
Seat Velocity: 20.2 mph
Seat Belt Level: 16
Impact Direction: Rear
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:
Gentle ride
FIGURE A-25 SET UP FOR COLLIER-KENTWORTH BOBBY-MAC, BACK IMPACT
HEAD ACCELERATION DATA

TEST NO. A-714
DUMMY 3-Year
SLED VELOCITY 29.6 ft/sec

SEAT TYPE Collier-Keyworth
IMPACT TYPE Rear

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
10 sec/div
SLED VELOCITY 29.6 ft/sec
Test Number: A-608
Test Date: August 21, 1973

Duration: 3-sec.

cushion: 2.3 g

Sled G-level: 21

Impact Direction: Front

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

Test Observation:

Large head excursion (head impacted cushion at high velocity). Extensive
of neck was severe. Abdominal loading resulted from direct contact with
the adult lap belt. G levels extremely high.
FIGURE A-27 SET UP FOR IRVIN I-65, FRONT IMPACT
Test No.: A-698

FIGURE A-28  GRAPHCHEK SEQUENCE CAMERA
TEST NO. A-698

DUTY  3-Year

SLED VELOCITY  43.8 ft/sec

SLED PULSE
2.0 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
40.0 sec/div
TEST NO. A-698  
DATE 3-Year  
SLED VELOCITY 43.7 ft/sec  

SEAT TYPE Irvin Model I-165  
IMPACT TYPE Front  

SLED PULSE  
2.0 g's/division  
Filtered  
Class 60  

Anterior-Posterior  
Chest Acceleration  
2.5 g's/division  
Filtered  
Class 1000  

Superior-Inferior  
Chest Acceleration  
2.5 g's/division  
Filtered  
Class 1000  

Left-Right  
Chest Acceleration  
2.5 g's/division  
Filtered  
Class 1000  

Resultant Chest  
Acceleration  
1.0 g's/division  
Filtered  
Class 1000
HSRI SUMMARY DATA SHEET

Test Number: A-699
Test Date: August 27, 1973
Restraint Descriptions: Kantwet 784

Dummy: 3-Year
Sled Velocity: 29.8 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Body motions moderate. G levels very low. Overall body restraint good.
Test No.: A-699

FIGURE A-30  GRAPHCHEK SEQUENCE CAMERA
SLED VELOCITY: 43.7 ft

SLED PULSE
2 g's/division
Filtered
Class: 50

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

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

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

Resultant Head Acceleration
2.5 g's/division
Filtered
Class: 1000
TEST NO. A-699

SEAT TYPE Kantwet 784

IMPACT TYPE Front

SLED VELOCITY 43.7 ft/sec

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Superior-Inferior Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Left-Right Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Resultant Chest Acceleration
1.0 g's/division
Filtered
Class 1000
Test Duration: 30 sec

Test Date: August 21, 1973

Test Description: Various tests on a... to determine the effects of various... on the... of the... vehicle.

Test Conditions:

Positioning: Sitting, facing... of the... vehicle.

...were involved. No... were observed.
Test No.: A-709

FIGURE A-32  GRAPHCHECK SEQUENCE CAMERA
TEST NO. 2-793
DUMMY 3-year
SLED VELOCITY 30.1 ft/sec

SLED PULSE
2 g's/division
Filtered
Class 00

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

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

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

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

Impact Type Side
Seat Type Kantwet Model 784
TEST NO. A-709
DEPLOY 3-Year
SLED VELOCITY 30.1 ft/sec

SLED PULSE
2.0 g/s/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g/s/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g/s/division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g/s/division
Filtered
Class 1000

Resultant Chest
 Acceleration
1.0 g/s/division
Filtered
Class 1000

SEAT TYPE Kantbet Model 764
IMPACT TYPE Side
Test Number: A-715
Test Date: August 30, 1973
Restraint Descriptions: Kantwet Model 784

Dummy: 3-Year
Sled Velocity: 20.2 mph
Sled G-Level: 16
Impact Direction: Rear
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:
Gentle ride.
HEAD ACCELERATION DATA

TEST NO. 7-215
DUMMY 3-Year
SLED VELOCITY 29.6 ft

SEAT TYPE Kantwest Model 784
IMPACT TYPE Rear

SLED PULSE
2 g/s/division
Filtered
Class 60

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

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

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

Resultant Head Acceleration
1 g/s/division
Filtered
Class 1000

Severity Index
4 sec/div
TEST NO. A-715

SEAT TYPE Kantwe Model 784

DUMMY 3 Year

IMPACT TYPE Rear

SLED VELOCITY 29.6 ft/sec

SLED PULSE
2.0 g's/ division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
1.0 g's/ division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g's/ division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g's/ division
Filtered
Class 1000

Resultant Chest
Acceleration
1.0 g's/ division
Filtered
Class 1000
HSRI SUMMARY DATA SHEET

Test Number: A-701
Test Date: August 27, 1973
Restraint Descriptions: Kantwet Model 275 Inmanseat Harness

Dummy: 3-Year
Sled Velocity: 30.2 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Head excursion very low. G levels very low. Belts distribute load well. Possible overflexion of the neck.
FIGURE A-35  SET UP FOR KANTWET INFANSEAT HARNESS, FRONT IMPACT
Test No.: A-701

FIGURE A-36  GRAPHCHEK SEQUENCE CAMERA
TEST NO. 8-381

DUCKY 3-Year

SLED VELOCITY 44.3 ft/sec

SEAT TYPE Infant seat harness

IMPACT TYPE Front

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index
HSRI SUMMARY DATA SHEET

Test Number: A-711
Test Date: August 30, 1973
Restraint Descriptions: Kantwet Model 275 Infant Seat Harness

Dummy: 3-Year
Sled Velocity: 20.0 mph
Sled G-Level: 16
Impact Direction: Side
Dummy Attitude: Sitting, facing toward front of simulated vehicle.

Test Observation:

Restraint system slowed dummy considerably before head and shoulders contacted door. G levels moderate. Graph-check failed; no still photos.
HEAD ACCEL. TEST DATA

TEST NO. SHOP
BUNNY 3-Year
SLED VELOCITY 29.3 ft

SLED PULSE
2 g's/division
Filtered
Class 60

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

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

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

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

Severity Index (Note 2 g's/division)
<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>A-711</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>2-Year</td>
</tr>
<tr>
<td>SLED VELOCITY</td>
<td>29.3 ft/sec</td>
</tr>
</tbody>
</table>

**SEAT TYPE**  Kantwet Model 275
**IMPACT TYPE**  Side

**SLED PULSE**
2.0 g's/division
Filtered
Class 1E

**Anterior-Posterior**
Chest Acceleration
1.0 g's/division
Filtered
Class 1E00

**Superior-Inferior**
Chest Acceleration
1.0 g's/division
Filtered
Class 1E00

**Left-Right**
Chest Acceleration
1.0 g's/division
Filtered
Class 1E00

** Antarrior-Costal**
Chest Acceleration
1.0 g's/division
Filtered
Class 1E00
Test Number: A-702
Test Date: August 27, 1973
Restraint System: Seat Belts Only [401]

Belt:

Side Valance:

Side A:

Impact Direction: Front

Buddy Attitude: Sitting, facing forward. The front of the vehicle.

Test Observations:

Head – very high. May get occipital. Chest and abdominal loads are not well distributed with this harness.
Test No.: A-702

FIGURE A-39 GRAPHCHEK SEQUENCE CAMERA
TEST NO. ________________  
DUMMY _____________  
SLED VELOCITY 44.3 ft/sec  

SLED PULSE  
2 g's/division  
Filtered  
Class 50  

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

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

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

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

Severity 1.4
TEST ID: A-702

SEAT TYPE: Sports Harness Model 601

INHABITANT WEIGHT: 3-Year

SLED VELOCITY: 44.3 ft/sec

SLED PULSE
2.0 g's/division
Filtered
Class C

Anterior-Posterior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
1.0 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
1.0 g's/division
Filtered
Class 1000
HSRI SUMMARY DATA SHEET

Test Number: A-710
Test Date: August 29, 1973
Restraint Description: Sears harness model 6070

Dummy: 3-Year
Sled Velocity: 13.9 mph
Sled G Level: 16
Impact Direction: Side
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:
Little protection in side impact.
Test No.: A-710

FIGURE A-41 GRAPHCHEK SEQUENCE CAMERA
<table>
<thead>
<tr>
<th><strong>TEST NO.</strong></th>
<th>A-710</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DUMMY.</strong></td>
<td>3-Year</td>
</tr>
<tr>
<td><strong>SLED VELOCITY</strong></td>
<td>29.2 ft</td>
</tr>
<tr>
<td><strong>SLED PULSE</strong></td>
<td>2 g's/division</td>
</tr>
<tr>
<td></td>
<td>Filtered</td>
</tr>
<tr>
<td></td>
<td>Class 60</td>
</tr>
<tr>
<td><strong>Anterior-Posterior Head Acceleration</strong></td>
<td>10 g's/division</td>
</tr>
<tr>
<td></td>
<td>Filtered</td>
</tr>
<tr>
<td></td>
<td>Class 1000</td>
</tr>
<tr>
<td><strong>Superior-Inferior Head Acceleration</strong></td>
<td>10 g's/division</td>
</tr>
<tr>
<td></td>
<td>Filtered</td>
</tr>
<tr>
<td></td>
<td>Class 1000</td>
</tr>
<tr>
<td><strong>Left-Right Head Acceleration</strong></td>
<td>10 g's/division</td>
</tr>
<tr>
<td></td>
<td>Filtered</td>
</tr>
<tr>
<td></td>
<td>Class 1000</td>
</tr>
<tr>
<td><strong>Resultant Head Acceleration</strong></td>
<td>10 g's/division</td>
</tr>
<tr>
<td></td>
<td>Filtered</td>
</tr>
<tr>
<td></td>
<td>Class 1000</td>
</tr>
<tr>
<td><strong>Severity Index</strong></td>
<td>10 g's/division</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SEAT TYPE</strong></th>
<th>Sears Harness Model 6401</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IMPACT TYPE</strong></td>
<td>Side</td>
</tr>
</tbody>
</table>
TEST NO. A-710

SEAT TYPE Sears Harness Model 6401

DUTY 3-Year

IMPACT TYPE Side

SLED VELOCITY 29.2 ft/sec

SLED PULSE
2.0 g/s/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
2.5 g/s/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
2.5 g/s/division
Filtered
Class 1000

Left-Right
Chest Acceleration
2.5 g/s/division
Filtered
Class 1000

Resultant Chest
Acceleration
2.0 m/s/division
Filtered
Class 1000
HSRI SUMMARY DATA SHEET

Test Number: A-703
Test Date: August 27, 1973
Restraint Descriptions: Sears Harness Model 6401 with car seat belt

Puck: 3-Year
Sled Velocity: 30.2 mph
Sled G-Level: 21
Impact Direction: Front
Dummy Attitude: Sitting, facing toward the front of the simulated vehicle.

Test Observation:

Large head and whole body excursions. Dummy slid off adult seat, impacted dash and floor pan. Head and chest accelerations extremely high.
Test No.: A-703

FIGURE A-43 GRAPHCHEK SEQUENCE CAMERA
<table>
<thead>
<tr>
<th>Test No.</th>
<th>A-1203</th>
<th>Seat Type</th>
<th>Sears Harness Model 552 with car seat belt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy</td>
<td>3-Year</td>
<td>Impact Type</td>
<td>Front</td>
</tr>
<tr>
<td>Sled Velocity</td>
<td>44.3 ft/sec</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sled Pulse**
- 2 g's/division
- Filtered
- Class 60

**Anterior-Posterior**
- Head Acceleration 2.5 g's/division
- Filtered
- Class 1000

**Superior-Inferior**
- Head Acceleration 2.5 g's/division
- Filtered
- Class 1000

**Left-Right**
- Head Acceleration 2.5 g's/division
- Filtered
- Class 1000

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

Severity Index
- 40 sec/div
TEST NO.  A-703

SEAT TYPE  Sears Harness Model 6401

DUR/VI  3-Year

SLED VELOCITY  44.3 ft/sec

IMPACT TYPE  with car seat belt front

SLED PULSE
2.0 g's/division
Filtered
Class 60

Anterior-Posterior
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Superior-Inferior
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Left-Right
Chest Acceleration
2.5 g's/division
Filtered
Class 1000

Resultant Chest
Acceleration
1.0 g's/division
Filtered
Class 1000