UM-HSRI-BI-74-5

REPORT DOT-HS-4-00865

# FABRICATION OF A STANDARD BENCH VEHICLE SEAT

Prepared For:

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National Highway Traffic Safety Administration
Washington, D.C. 20591

Final Report for Period
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February 7, 1975

Jere Medlin
National Highway Traffic Safety Administration
U.S. Department of Transportation
Nassif Building 5320 K
7th and E Streets, S. W.
Washington, D.C. 20590

Dear Mr. Medlin:

This letter summarizes delivery of report, film and equipment for contract DOT-HS-4-00865, "Fabrication of Standard Bench Vehicle Seat." The delivery of the various parts of the text of the report was as follows:

1. One original and one copy of the main text of the Final Report, "Fabrication of a Standard Bench Vehicle Seat," which contains Appendix A, "Recycling Procedure for a Standard Seat," were delivered by Dr. John Melvin on January 23, 1975. Corrections to 3 figures and 2 tables were completed and sent to NHTSA on January 27, 1975.

2. Two sets of Appendix B, "Standard Seat Drawings, B, C, & D," (blueprints in a manila envelope) were delivered January 15, 1975. Two additional sets were delivered on January 23, 1975.

3. One copy of Appendix C, "Data from Fabrication of a Standard Bench Vehicle Seat," was sent to NHTSA on December 20, 1974. The original was submitted January 15, 1975, and two additional copies were delivered January 23, 1975.

4. One copy of Appendix D, "Belt Retractor Testing with Standard Vehicle Seat," was sent to NHTSA on December 12, 1975. The original was submitted January 15, 1975, and two additonal copies were delivered January 23, 1975.

Films and slides of each sled test were delivered to NHTSA as completed during the period September through November 1974.

The bench seat, which was developed for the project, along with 55 foam cushions and the child seats used in the sled testing were delivered by Republican Van Lines on 12-12-74. The shipment arrived at Hal Water's office in Maryland on 12-17-74.

Sincerely,

John W. Melvin, Ph.D.
Head, Biomechanics Department

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15. Supplementary Notes

16. Abstracts


This report discusses the development of a standard bench seat for the testing of child restraint systems based on the configuration and performance parameters of the 1974 Chevrolet Impala production bench seat. Both static and dynamic characteristics of the production seat were modeled into the frame deformation and foam stiffness of the standard seat, and impact sled tests were conducted on each using a representative sample of child restraint systems to provide direct comparison between the two seats.

The standard seat was shown to be a durable, repeatable test platform for child restraints that provided reasonable simulation of the production seat. Its economic breakeven point occurs when more than four new production bench seats are required for testing. Child restraint tests on the standard seat tend to give slightly lower head and chest peak resultant acceleration, HIC and Severity Index values and, in some cases larger head excursion values than comparable tests with the production seat.


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## 1.0 ABSTRACT

This report discusses the development of a standard bench seat for the testing of child restraint systems based on the configuration and performance parameters of the 1974 Chevrolet Impala production bench seat. Both static and dynamic characteristics of the production seat were modeled into the frame deformation and foam stiffness of the standard seat, and impact sled tests were conducted on each using a representative sample of child restraint systems to provide direct comparison between the two seats.

The standard seat was shown to be a durable, repeatable test platform for child restraints that provided reasonable simulation of the production seat. Its economic breakeven point occurs when more than four new production bench seats are required for testing. Child restraint tests on the standard seat tend to give slightly lower head and chest peak resultant acceleration, HIC and Severity Index values and in some cases larger head excursion values than comparable tests with the production seat.

## 2.0 INTRODUCTION

The purpose of this project was to develop for the Department of Transportation, a standard automobile seat bench for use as a dynamic test platform in impact tests of child restraint systems. A "standard" automobile seat bench for use in impact tests is defined as a platform which yields controlled and repeatable known interaction with a system being tested with it.

Impact sled testing of child restraint systems has traditionally utilized production automobile bench seat as the most logical test platform. However, unless the back is restrained, an automobile seat is usable only for a single test, since significant permanent deformation of the seatback structure occurs during impact. Although tethering the seatback permits the seat to be reused many times, any interaction between the deforming seatback and child restraint is then lost, possibly biasing the data. New automobile seats are also quite difficult to obtain in quantity, are expensive, and their mode of frame deformation varies from sample to sample. Used seats from salvage yards reduce the cost and availability problems, but introduce an unknown history which may involve prior accident and weathering effects.

These problems, plus the need for repeatable and comparable data, make a strong case for standardized platform for dynamic child restraint system testing. This platform or standard seat should simulate the response of a given production seat and have similar interaction with child restraints, be quickly recycled between tests, and be easily adaptable to simulate different seats so it may be updated when necessary.

This report describes the development and verification, of such a standard seat, and compares its dynamic performance with that of a 1974

Chevrolet Impala production bench seat, using various child restraint systems under identical test conditions.

This development was performed for The National Highway Traffic Safety Administration, Department of Transportation under Contract No. DOT-HS-4-00865.

# 3.0 DETERMINATION OF IMPALA BENCH SEAT PARAMETERS

Four new 1974 Chevrolet Impala production bench seats were obtained to determine the functional parameters that were to be incorporated into the standard seat. The following information on those seats was obtained:

1. The geometry of seatback deformation during impact, and the location of an effective "hinge point."

2. Static and dynamic load-deflection curves for both the seatback and seat cushion foam.

3. Physical dimensions of the production seat.

4. Static and dynamic load-deflection curves for the seatback frame in both forward and rearward directions.

Since many of the tests were destructive, the data collection process had to be cost-effective. The test sequence followed in this study is shown in Figure 1.

## 3.1 PHYSICAL DIMENSIONS

The four production seats were measured, and the results averaged to give a typical profile on which to base standard seat dimensions. Figure 2 shows the average dimensions obtained for the production seats.

## 3.2 STATIC PERFORMANCE CHARACTERISTICS

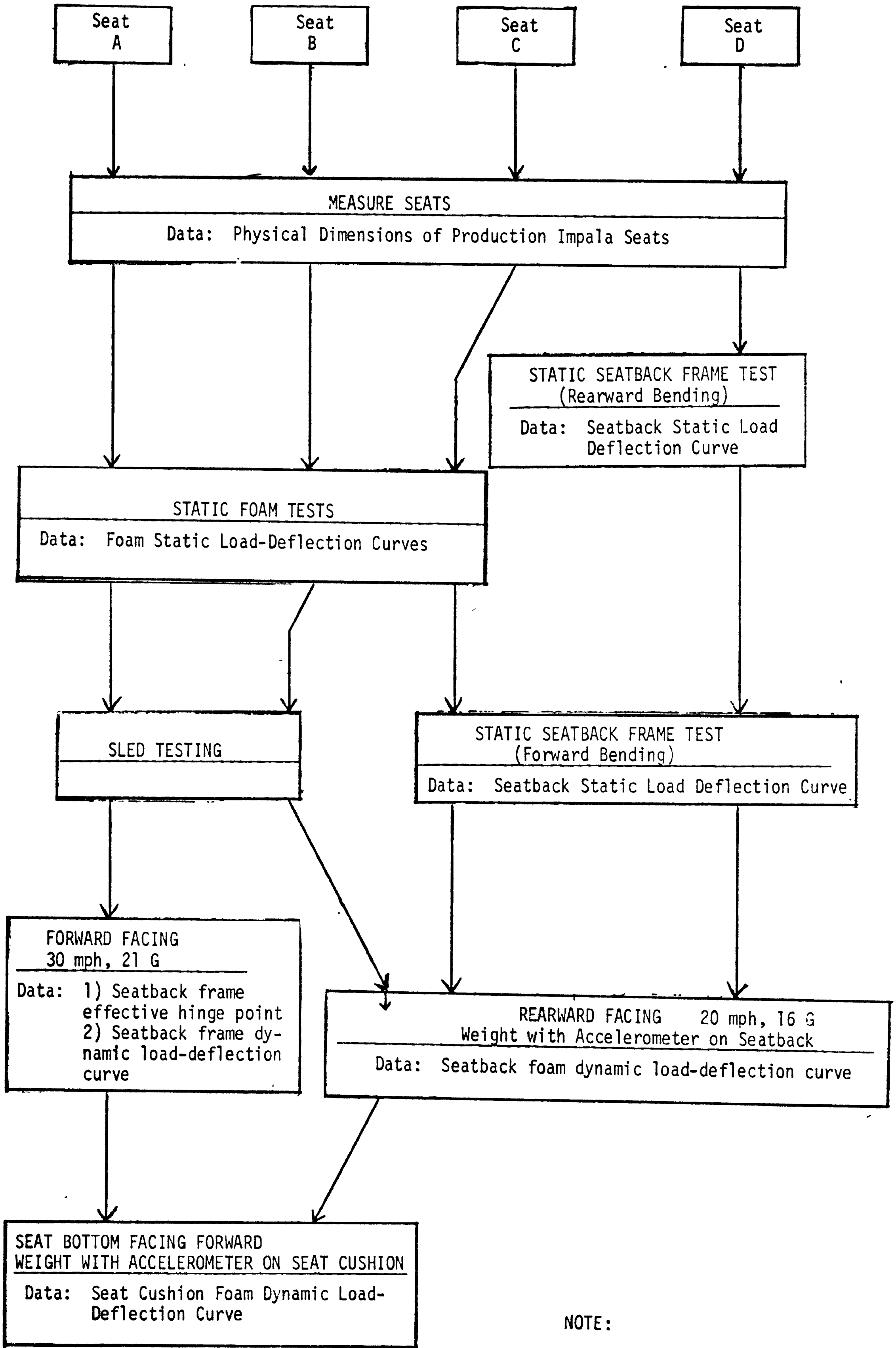
### 3.2.1 Foam Cushion Test

A simple load cell and extensometer setup was used to obtain the static load deflection curves of the seatback and seat cushion foam. The seat frame was braced so any deflection measured would be solely due to the foam. Figure 3 shows a photo of the test setup for this measurement.

### 3.2.2 Seatback Frame Bending Tests

The test setup shown in Figure 4 was used to determine the static load-deflection characteristics of the production seatback frames.

FIGURE 1 : TEST SEQUENCE AND RESULTING DATA




NOTE:

PRODUCTION 1974 IMPALA BENCH SEATS

-TEST SEQUENCE AND RESULTING DATA

FOUR NEW 1974 IMPALA BENCH SEATS

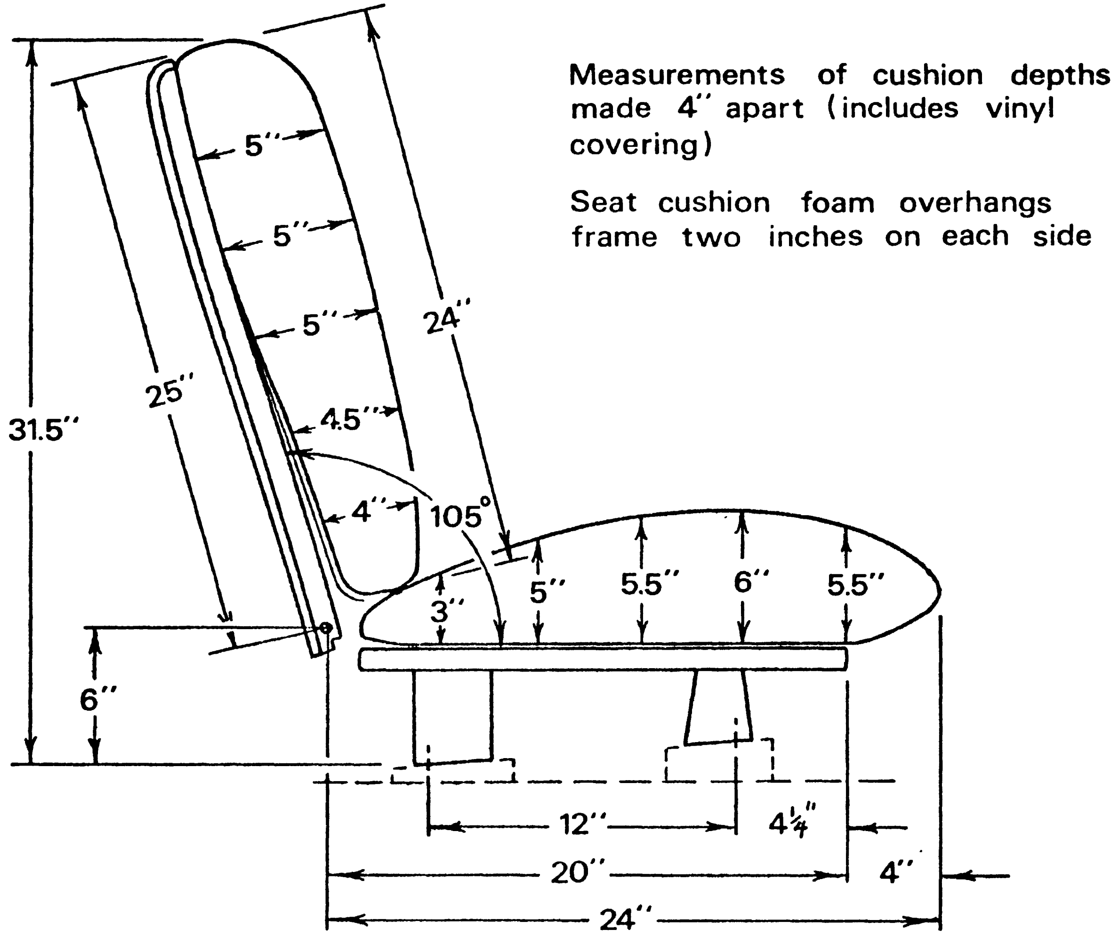



Figure 2. Chevrolet Impala Seat Physical Dimensions

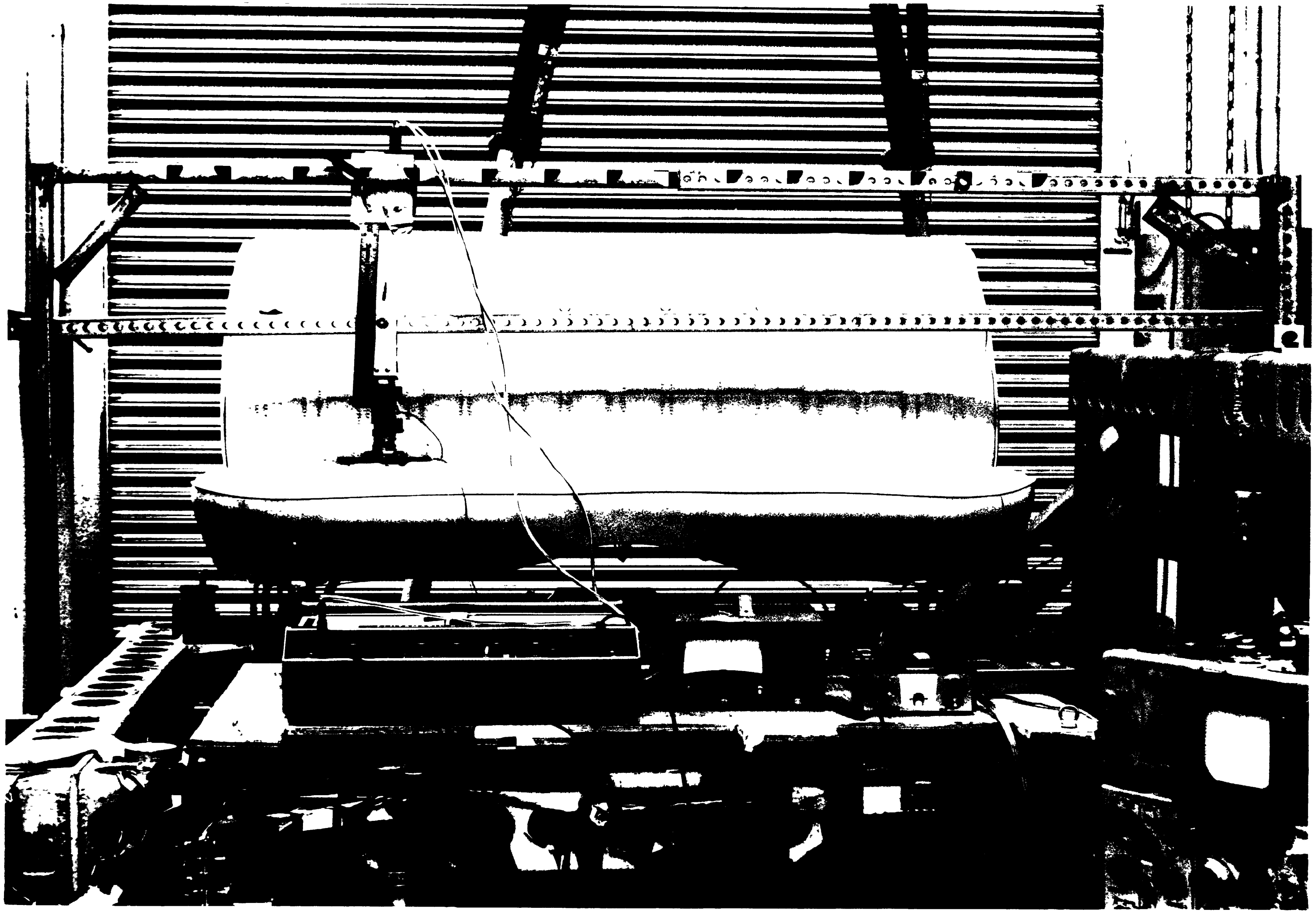


Figure 3. Setup for Static Load Deflection Measurements

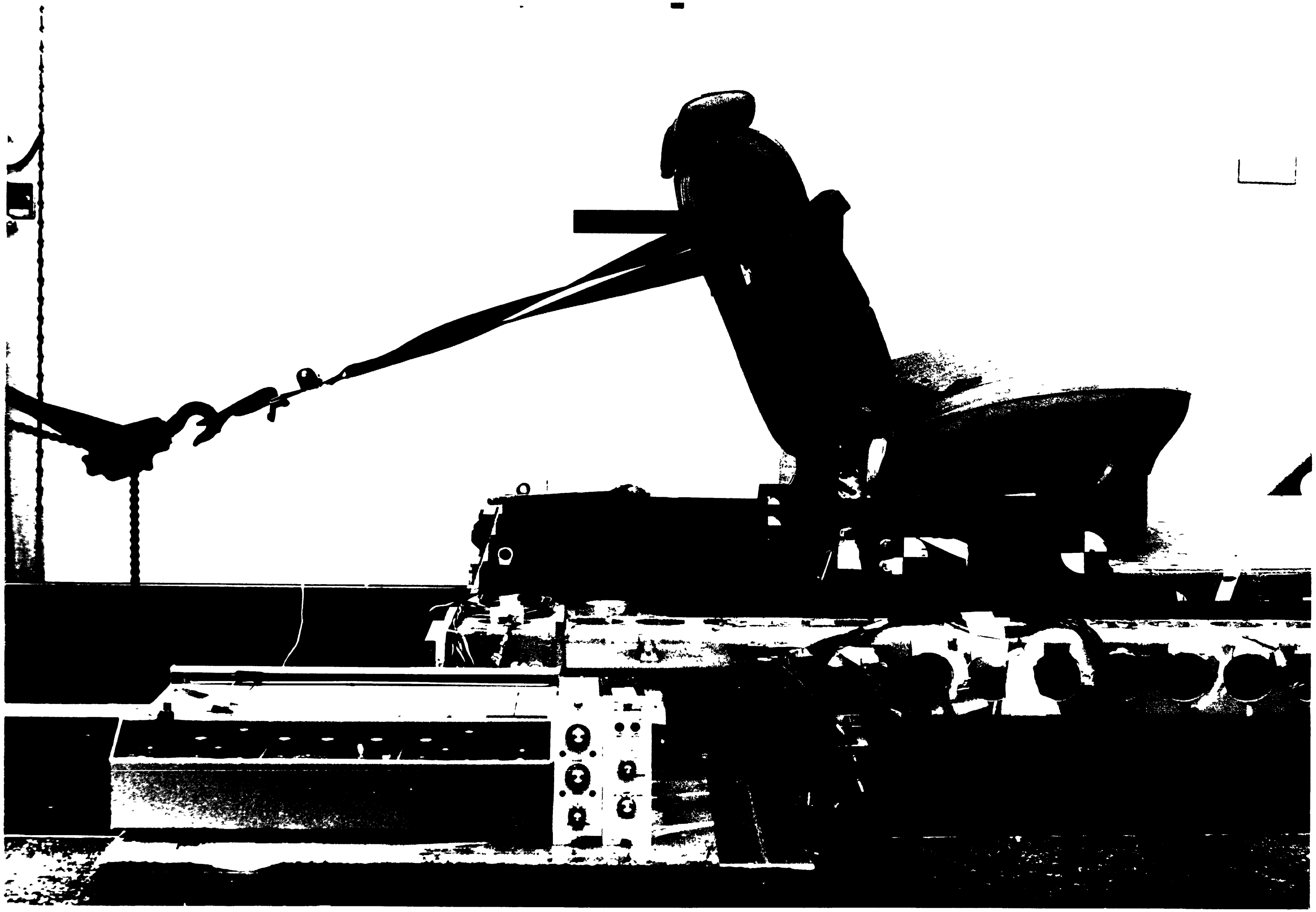


Figure 4. Setup for Static Seatback Frame Bending Tests

Obtaining this data required testing two production seats to destruction--one for forward and one for rearward deformation. A force plateau was reached in forward bending as a result of seat frame geometry. This plateau means seat deformation in an impact will show greater dependence on acceleration pulse duration in the forward direction than in the rearward direction.

### 3.3 DYNAMIC PERFORMANCE CHARACTERISTICS

The impact sled tests on the production seats yielded the following dynamic information:

1. Seatback frame deformation magnitude and geometry, with emphasis on identifying a "hinge point" that could easily be designed into the standard seat.
2. Seat foam dynamic load-deflection curves.
3. Performance characteristics of the Ford Tot Guard.

#### 3.3.1 Frame Dynamic Performance

Seatback frame dynamic deformation tests were conducted only in the forward direction because of the limitations imposed by the test sequence (Fig. 1). The seat frame was targeted (Fig. 5) and a 30-mph, 20 G sled-impact test was performed. The plotted results of movie analyses shown in Figure 6 display the movement of the targets on the seat frame with respect to a fixed reference point on the sled. The seat can be seen to have two hinge points--one at the base of the seatback and the other at approximately two-thirds of the height of the back.

#### 3.3.2 Foam Dynamic Performance

For the dynamic seat foam load-deflection characteristics, a 31.2 lb mass with an accelerometer at its center of gravity was suspended against the seat foam and sled tests were performed. Photos of this setup are shown in Figure 7 for seatback foam, and Figure 8 for seat-cushion foam.


Figure 5. Sled Setup for Production Seatback Dynamic Deflection Tests

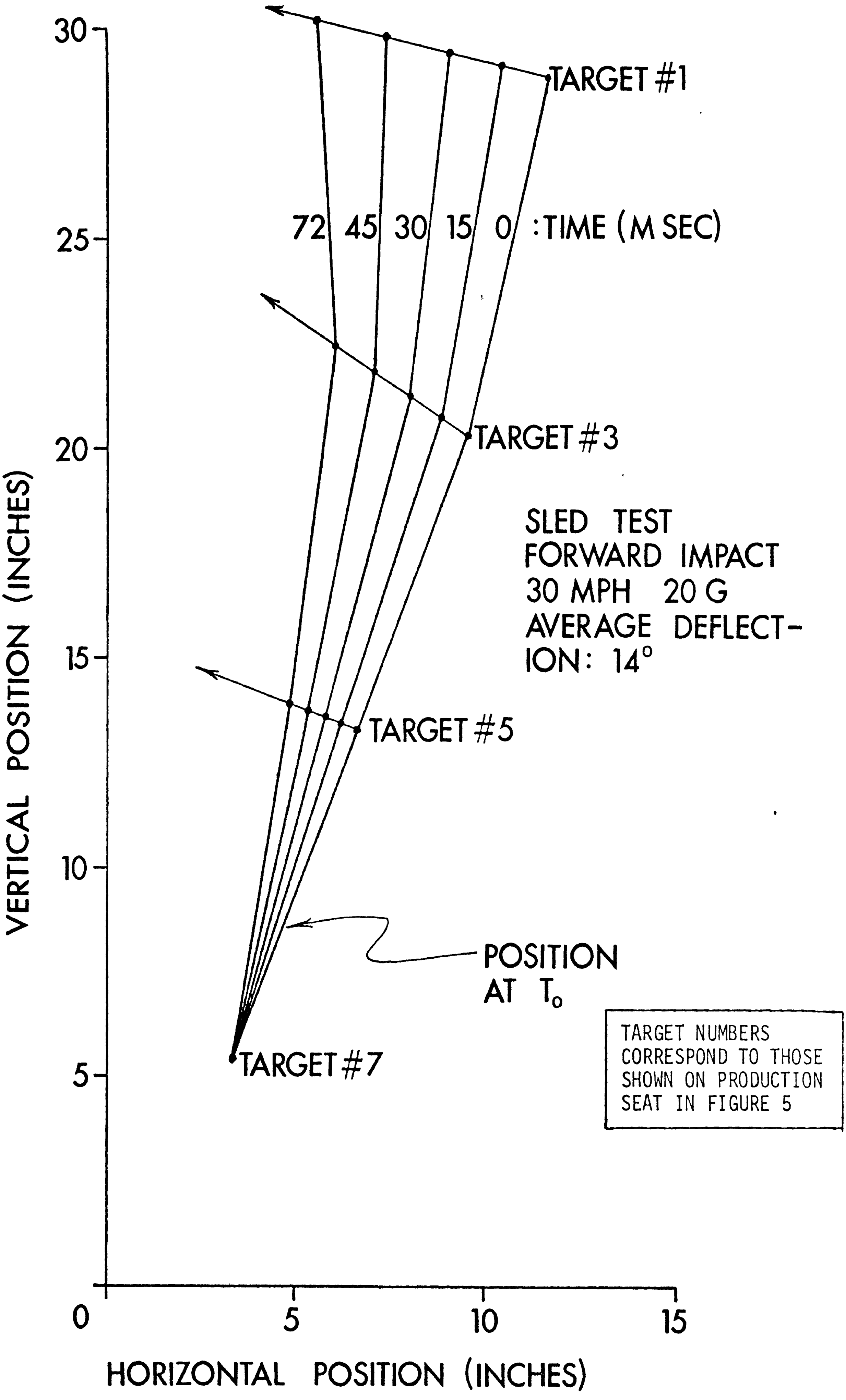



Figure 6. Production Seatback Target Motion During Impact

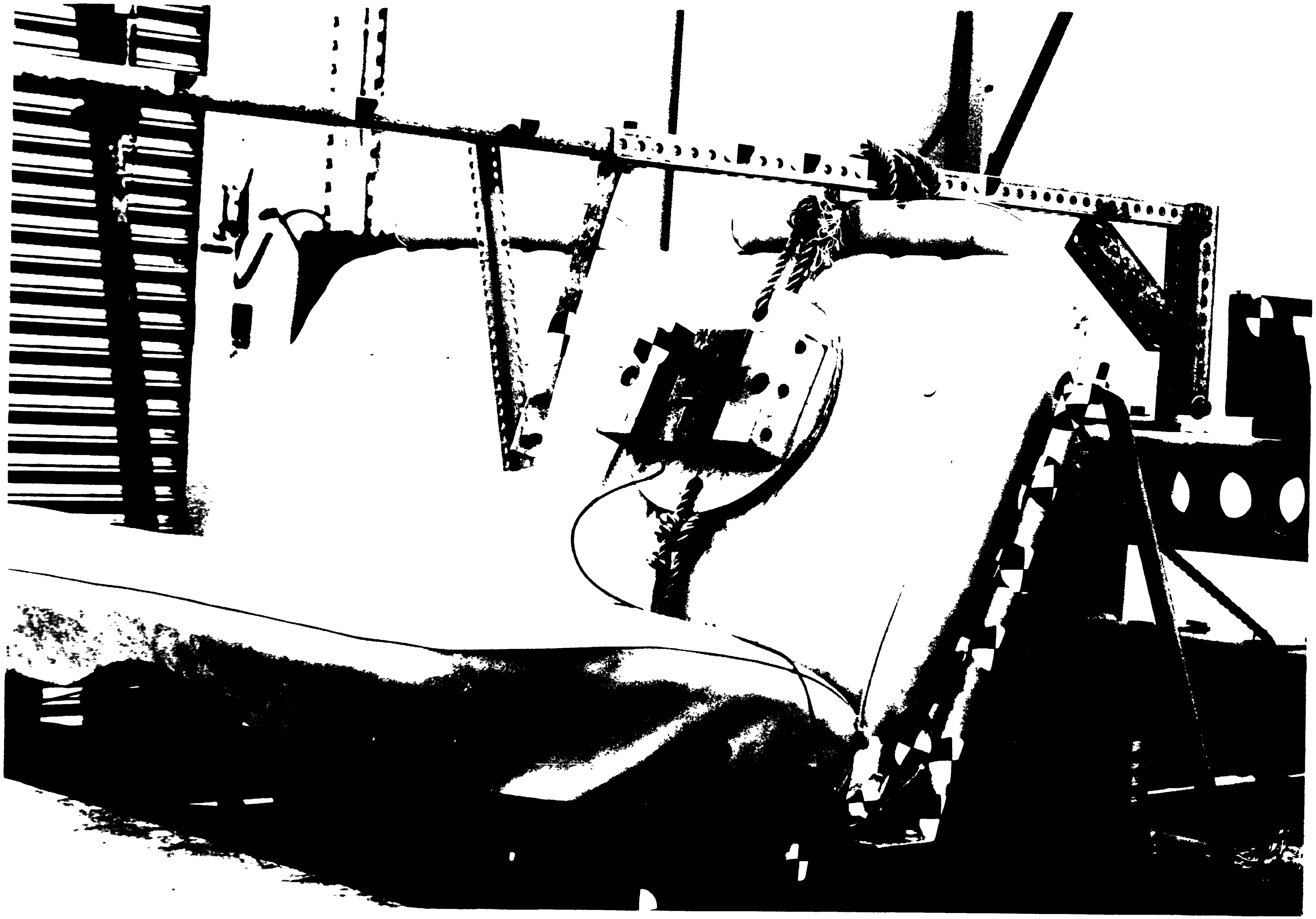


Figure 7. Setup for Seatback Foam Dynamic Load Deflection Tests


Figure 8. Setup for Seat Cushion Foam Dynamic Load Deflection Tests

### 3.3.3 Child Restraint System Performance

A Ford Tot-Guard child restraint system was selected to determine its interaction with a Chevrolet Impala production bench seat. The production seat was mounted on a sled buck in frontal impact position. Upholstery cover material was removed from the sides of the bench and seatback so that the foam padding and metal framework of the seat could be observed. Appropriate points on the foam and metal frame were targeted for subsequent motion and deformation analysis (Figure 9).

The Tot-Guard child restraint system was mounted on the prepared production seat with a 3-year old dummy. Several sled runs were conducted to observe and record foam padding and metal frame deformation interaction with the child restraint system load during impact.


Figure 9. Setup on Sled Production Seat With Tot Guard

## 4.0 STANDARD SEAT DESIGN

### 4.1 FUNCTIONAL REQUIREMENTS

The goal of developing a standard seat design which will simulate the major performance features of a production seat while maintaining the important testing related features of repeatability, durability, ease of use and cost effectiveness required that certain simplified functional characteristics be incorporated into the standard seat design. These functional characteristics are:

1. Rigid seat pan and seat back structures that are able to withstand the loads of dynamic sled testing without significant deformation.

2. Centralization of production seat cushion and seat pan deflection characteristics into the seat cushion foam characteristics of the standard seat.

3. Idealization of production seat back deflection characteristics as a rotation about a single hinge point.

4. Rigid lateral response of the seat structure to side loads.

5. Easily replaced, low cost deformable elements for control of both seat cushion response and seatback deformation response.

Rigid seat structures for both the seat pan base and the seat back were developed using welded tubular frame construction with 15 gauge wall one-inch square steel tubing. The seatback and the seat base were two separate structures with the seatback being joined to the base by means of a pillow block bearing on each side. The bearings served to define the axis of rotation of the seatback during loading. The resistance to seatback motion was achieved by means of bending two replaceable aluminum bars. The bars were loaded in three-point bending by an extension link from the seat back just below the bearing blocks. The bar diameter, effective lever arm of the seat back link, and the distance between bar support blocks were three easily modified variables that could be used to change the effective stiffness of the seatback, and thus match it to various production seats. A five-eights inch diameter bar of 6061-T651 aluminum rod was selected as the best combination size and mechanical properties that would produce equivalent response to the production seat. The foam cushion slabs for the seatback and for the seat cushion were inserted into heavy vinyl cloth zippered bags with plywood face panels in the bags to allow attachment to the seat frames by bolts.

The seat frame had six symmetrically located holes, shown in Figure 10 for fastening the seat to an impact sled or test fixture. Seatbelt attachment points were also incorporated on the base frame in the same position as the 1974 Chevrolet Impala with its seat in the midposition. On the outboard belt attachment points, the vertical threaded hole is intended for use with retractor type belts and the horizontal threaded hole is intended for use with Type 1 lap belts.

## 4.2 SELECTION OF CUSHION FOAMS

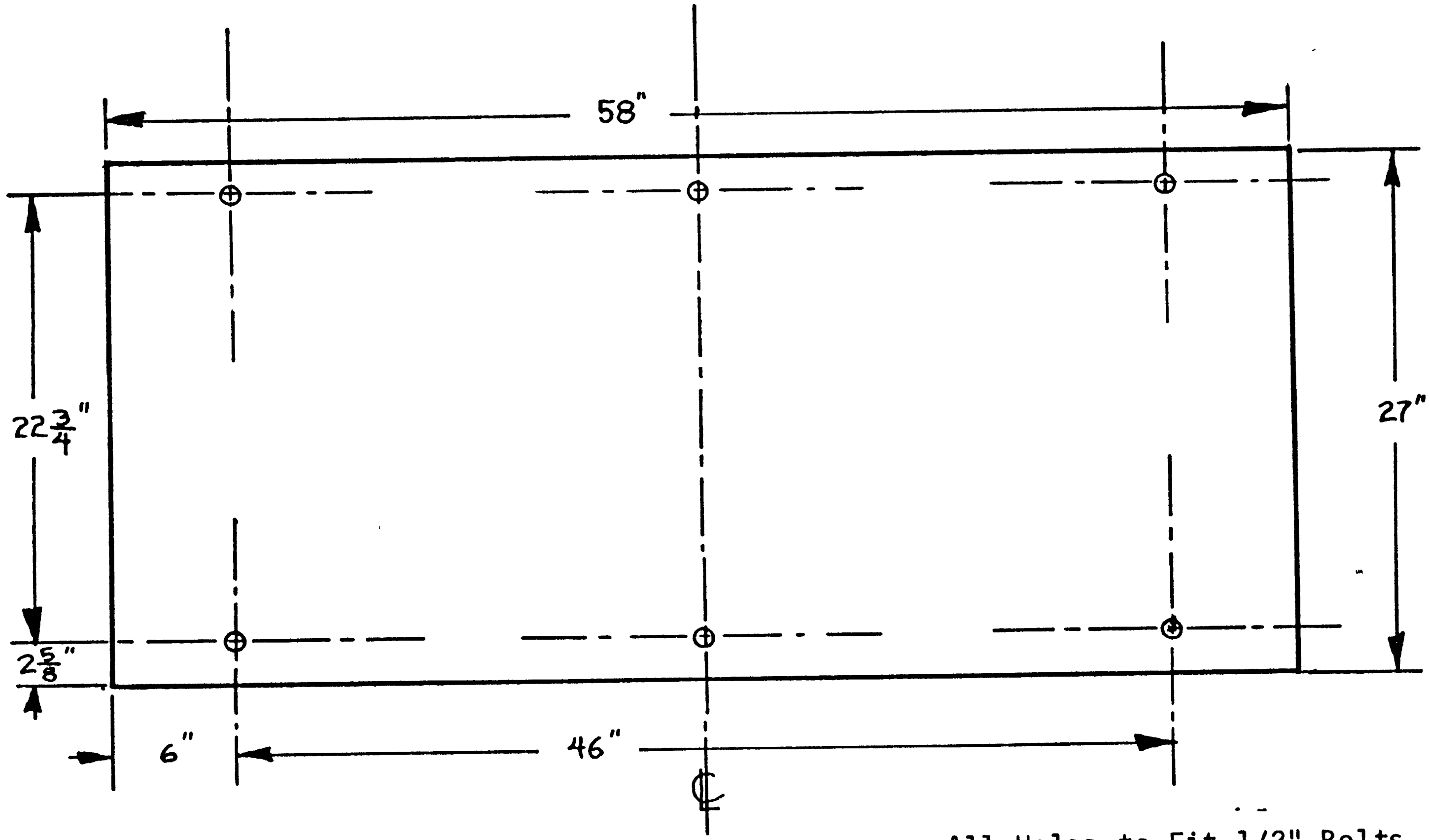
Foam pads for the standard seat were selected to meet the following criteria:

1. Static load deflection data to match the production seat foams as closely as possible.

2. Seatback and seat cushion foams to be the same material, if possible, to simplify specification and quality control considerations.

A number of foams were tested by the same procedure described in Section 3.2.1. On the basis of these tests, the specifications of the foam selected are shown in Table 1.

Comparison of static load -eflection curves for the production seat back foam selected foam is shown in Figure 11. Figure 12 shows a comparison of




All Holes to Fit 1/2" Bolts.

All Holes to be on Flat Level Mounting Surface.

Figure 10. Standard Seat Clearances and Mounting Hole Locations

TABLE I.

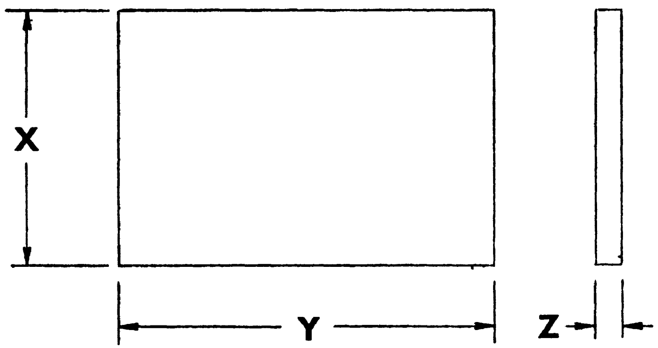
POLYURETHANE SEATING FOAM SPECIFICATIONS

| SPECIFICATION | | FOAM A | FOAM B |
|---|---|---|---|
| DESCRIPTION | | Extra Firm High Density Grade | Medium Soft Grade |
| DENSITY | | 2.70 .10 | 1.50 + .05 - .10 |
| INDENT LOAD - LBS. -4 THK @ 25% DEFLECTION * | | 45 - 55 | 21 - 27 |
| INDENT LOAD RATIO (65/25) - MIN. | | 2.0 | 1.9 |
| TENSILE - PSI - MIN. | | 12 | 12 |
| ELONGATION - % - MIN. | | 175 | 175 |
| TEAR RESISTANCE - LBS./IN. - MIN. | | 1.75 | 1.75 |
| COMPRESSION SET* | METHOD B - ORIGINAL 50% - MAX. | 15.0 | |
| | 22 HRS. @ 158° F - 90% MAX. | | 20.0 |
| HUMIDITY AGED 5 HRS. @ 250°F | 50% MAX. | 20.0 | 20.0 |
| | 90% MAX. | | 20.0 |

SAMPLE SOURCE: United Foam Corporation
Breman, Indiana

Foam A - Their Foam #2028
Foam B - Their Foam #2021

* As per ASTM Standard D 2405-68 (Method B)




| FOAM POSITION | FOAM TYPE | X | Y | Z |
|---|---|---|---|---|
| SEATBACK LOWER (AGAINST PLYWOOD BACKING) | A | 24 | 54 | 2 |
| SEATBACK UPPER | B | 24 | 54 | 4 |
| SEAT BASE LOWER (AGAINST PLYWOOD BACKING) | A | 20 | 54 | 2 |
| SEAT BASE UPPER | B | 20 | 54 | 4 |

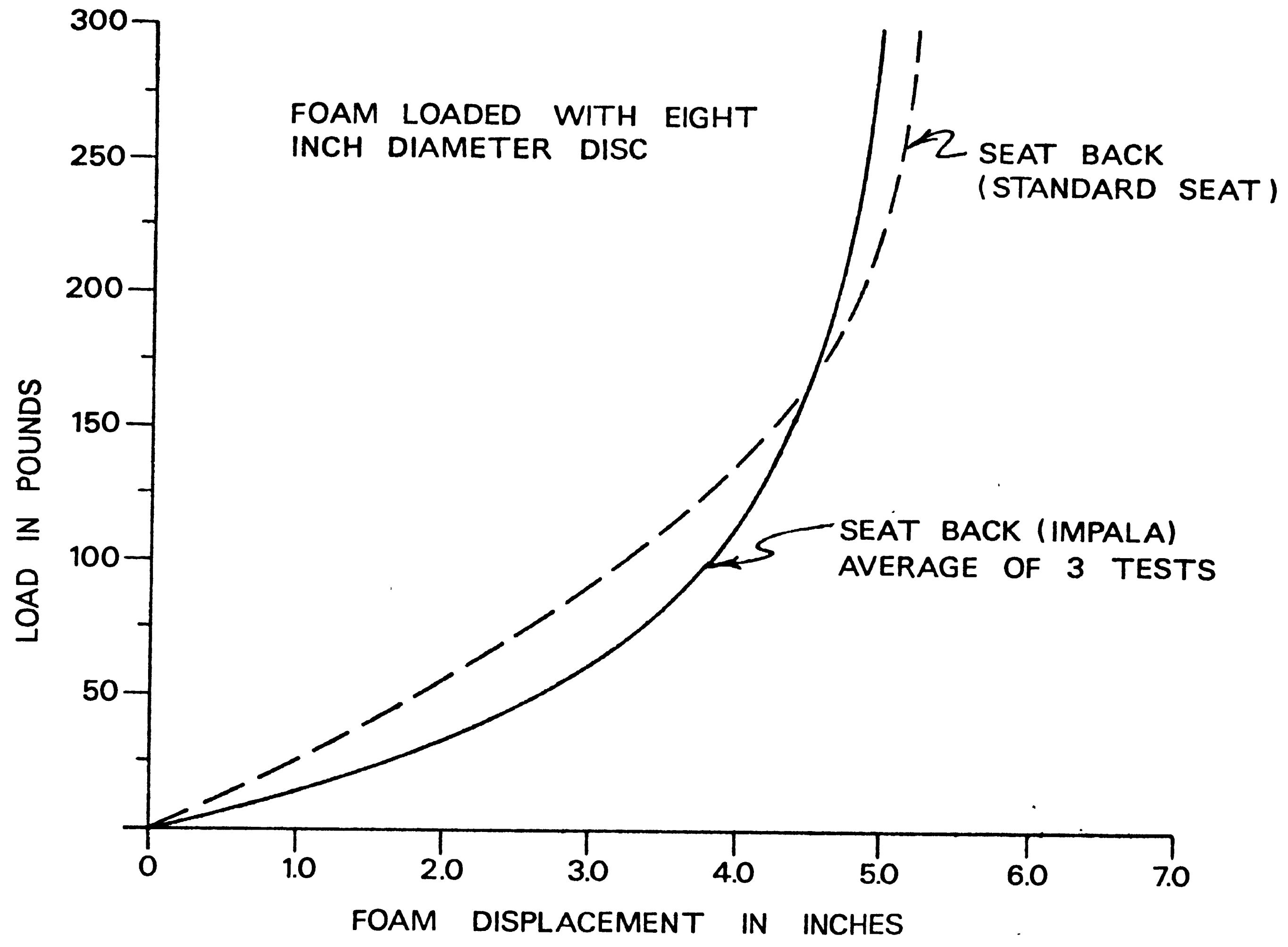



Figure 11. Seatback Foam Static Load-Deflection Curves

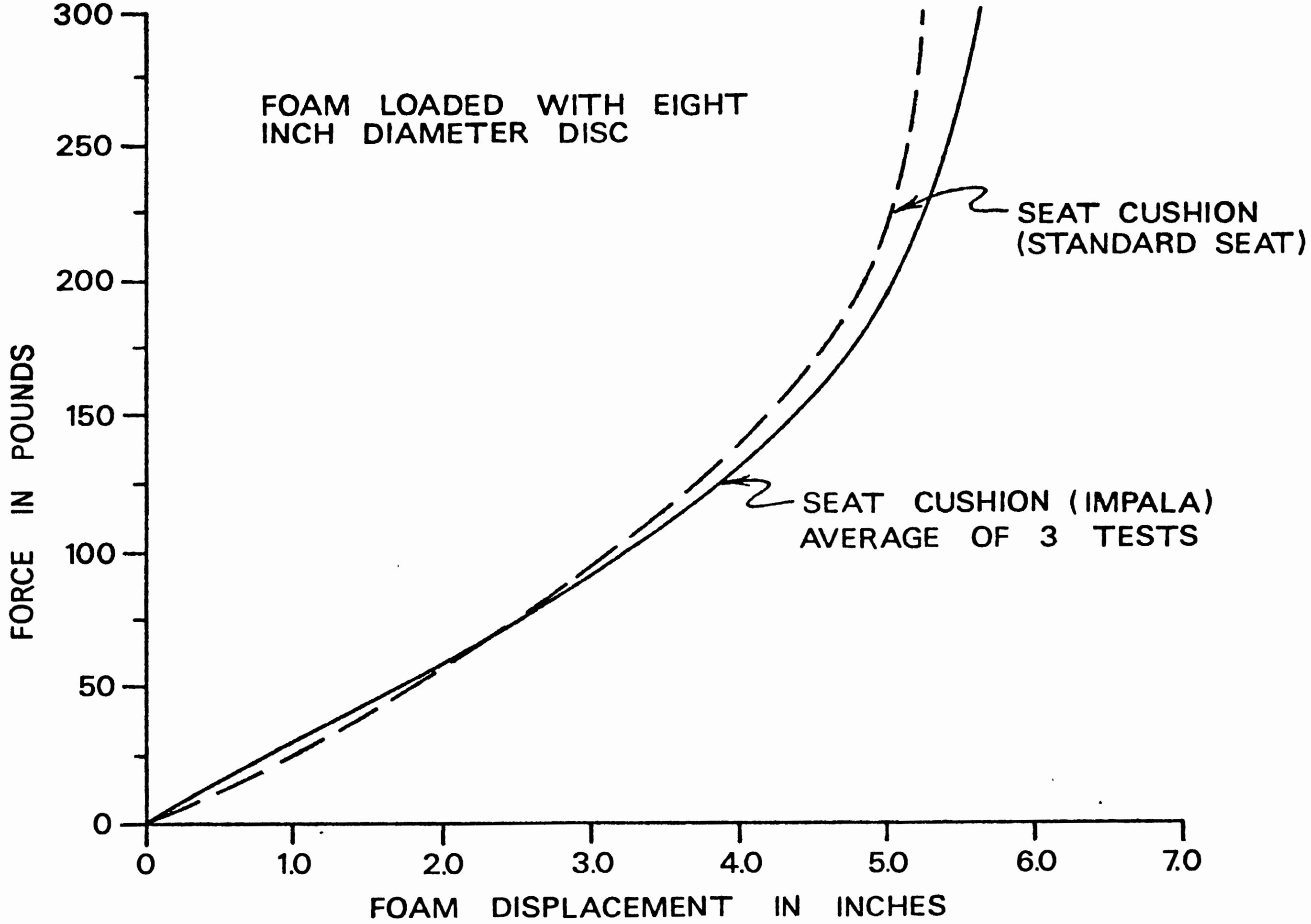



Figure 12. Seat Cushion Foam Static Load-Deflection Curves

static load deflection curves for the production seat cushion and the selected foam.

In order to simulate the series effect of the wire foam support springs in the production seat, composite foam samples were tested. From the test results, the following conclusions were reached:

1. Six inches appeared to be the optimal thickness for modeling both the Impala cushion and seatback.

2. A composite using four inches of a compliant foam #2021 over two inches of stiffer foam #2028 came closest to simultaneously meeting the requirements of both seatback and cushion.

If a child restraint system deflects more than five and one-half inches into the foam then the standard seat foam begins to bottom out. The wire support springs in the production seat prevent this condition. Under this condition (a relatively infrequent occurrence) the simulation of the production seat is not maintained by the standard seat.

## 4.3 SELECTION OF SEATBACK DEFLECTION CONTROL ELEMENT

A deformable bar was selected to provide the constraint that maintained the seatback in the correct initial position and allowed it to duplicate the kinematics of the production seatback frame during impact. The bar also met the following functional requirements:

1. Its material was readily available and inexpensive material.
2. It allowed the seatback the same degree of motion during impact as measured in the Impala seat.
3. It restrained the seatback in the deflected position for the rebound phase.
4. Because it was easily replaceable, it allowed quick recycling between tests.

5. It eliminated assembly errors by having only one possible installation configuration usable for both front and rear impacts.

The method of loading and supporting the control element also proved to be a significant factor in the performance of the standard seat. The configuration selected consisted of two 9.5-in. lengths of 5/8-in.-dia. aluminum bar, stock #6061-T651, supported at each end by pillow blocks which limited the loading on the bars to simple bending. Loading was applied to each bar at its midpoint by a short arm from the seatback frame extending below the hinge point. One arm was on each side of the seat, passing between each set of pillow blocks. The bar passes through a slot in the loading arm, thereby rigidly linking the seat position before, during, and after impact to the constraint of the deformable element. The leading and trailing faces of the slot were tapered inward to provide the tightest clearance at the midpoint. This facilitated removal of the bent aluminum bars after testing.

Figure 13 shows the pillow block assembly and deformable element mechanism before impact. The hinge assembly and deformable element mechanism after impact is shown in Figure 14. The deformable element, together with its mounting blocks, after impact, is shown in Figure 15.

The seatback frame load-deflection curves shown in Figures 16 and 17 compare the static stiffness curves obtained with the standard seat to the production seat. The load plateau in forward bending observed for the production seat was also reproduced by the standard seat by limiting loading on the deformable element to simple bending. The correct magnitude of load at the plateau was provided by adjusting the center-to-center distance between pivot blocks to the optimal value of 7.75 inches, with an effective

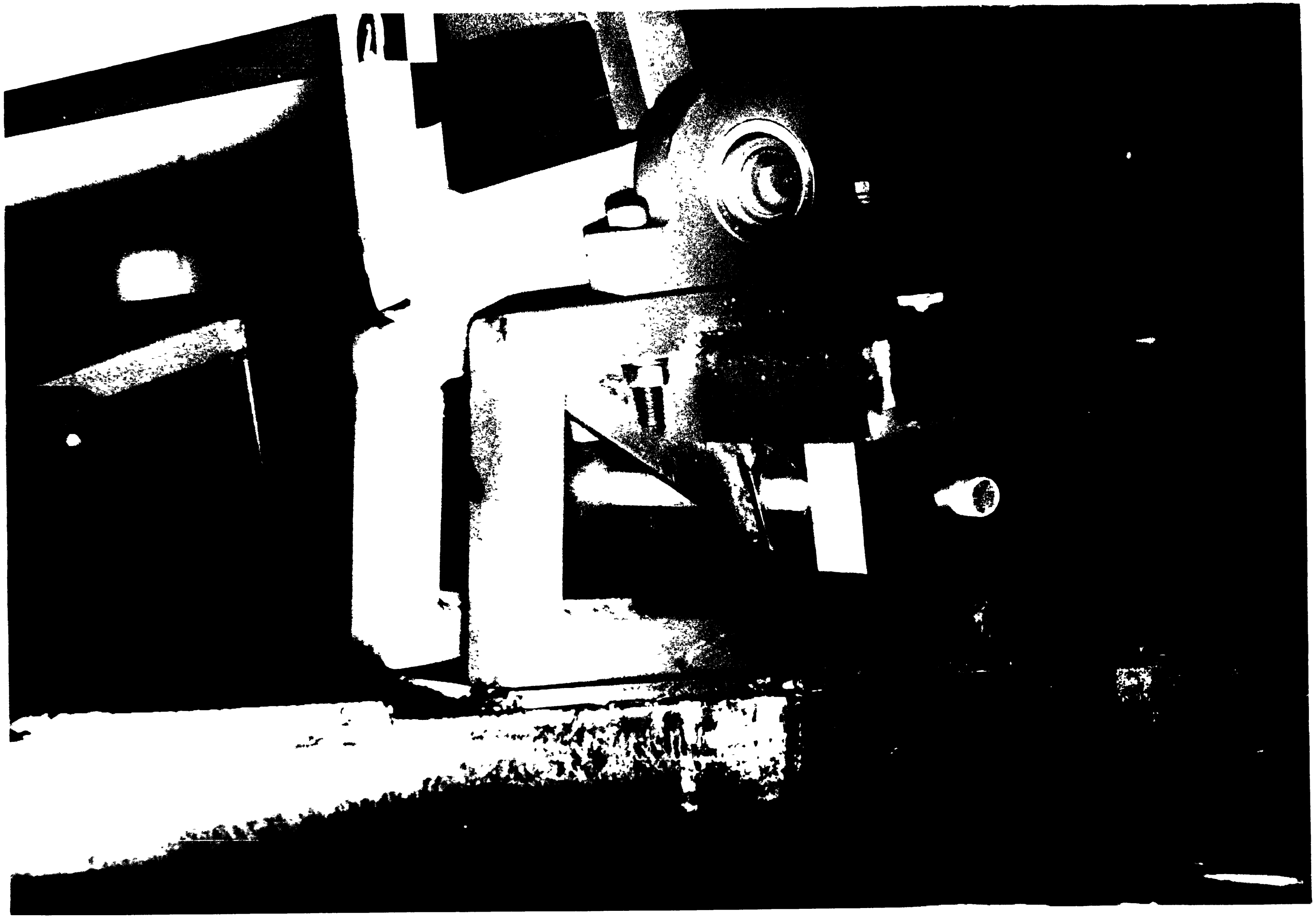


Figure 13. Detail of Installed Deformable Element Before Testing

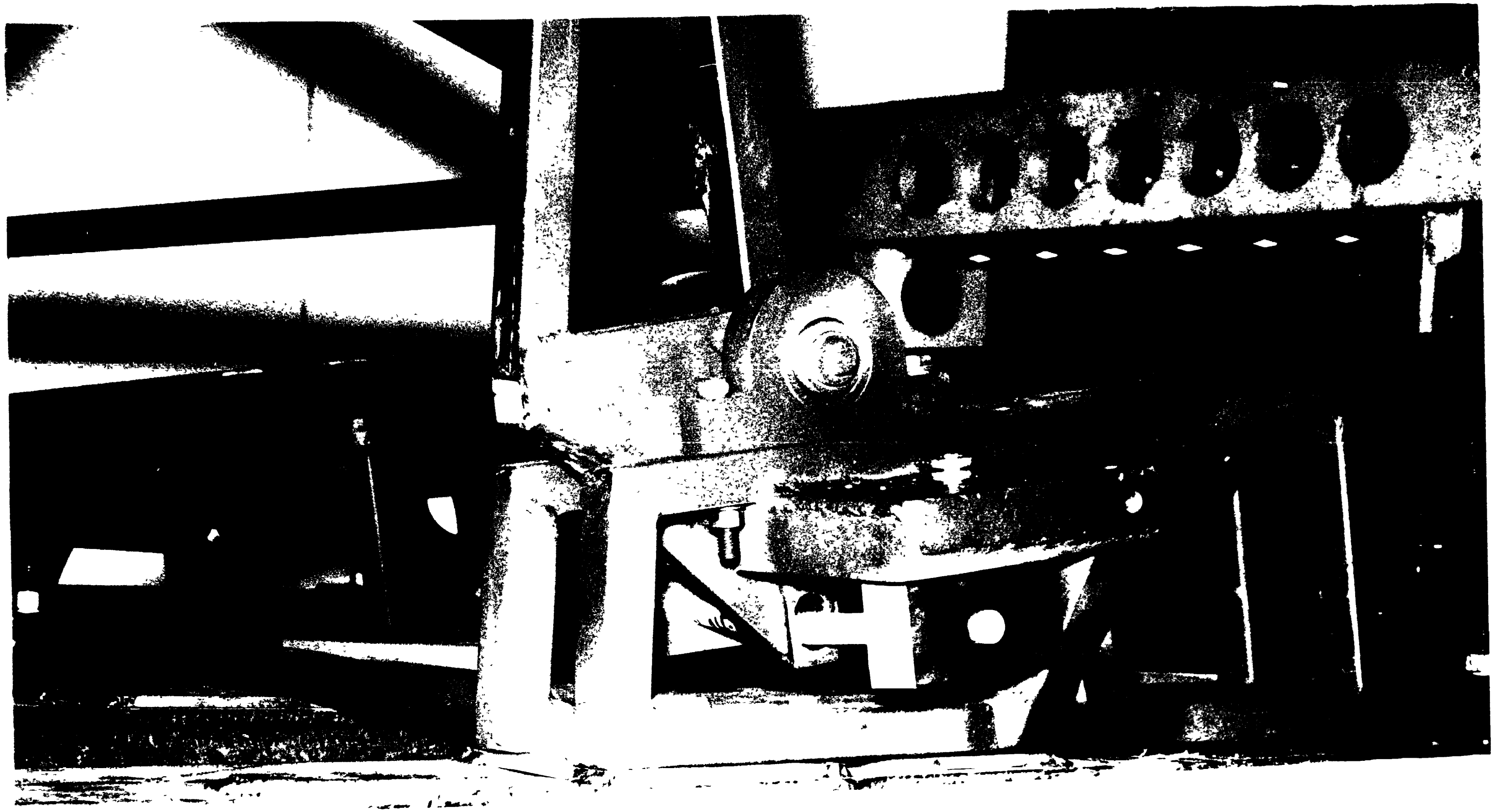


Figure 14. Detail of Installed Deformable Element After Testing

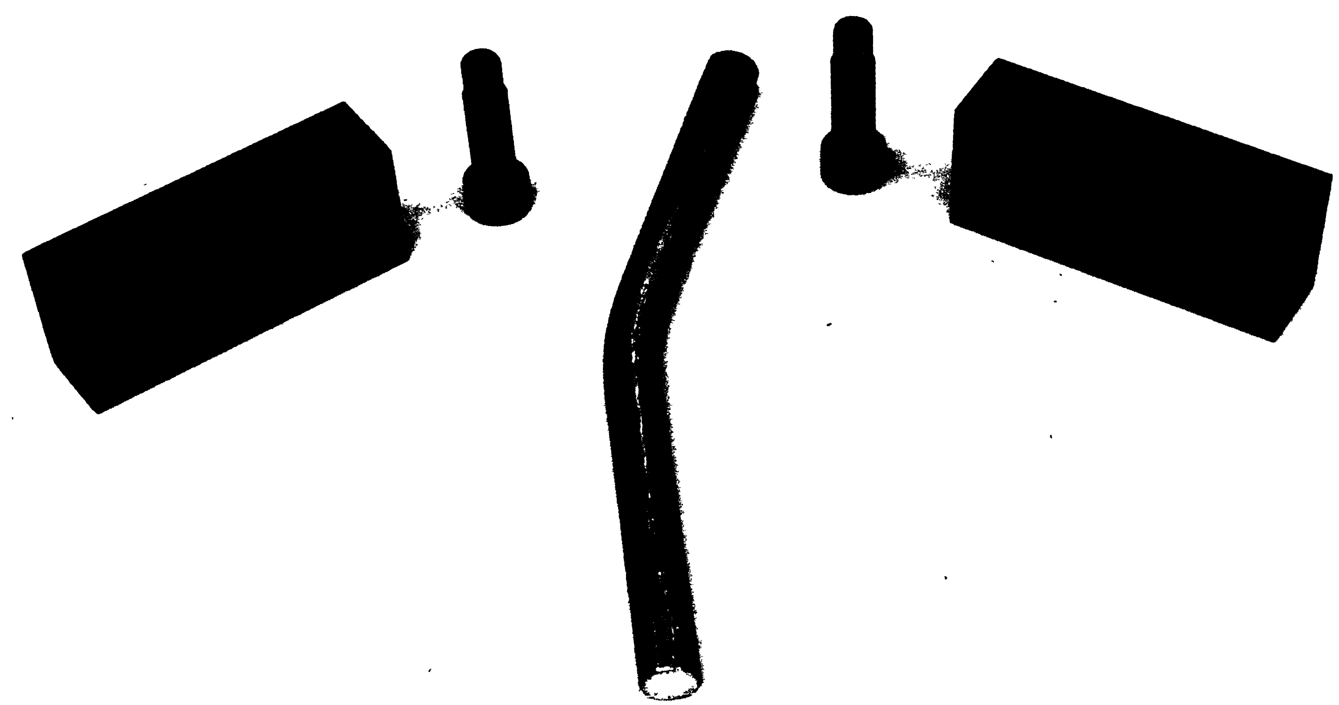


Figure 15. Used Deformable Element with Pivot Blocks

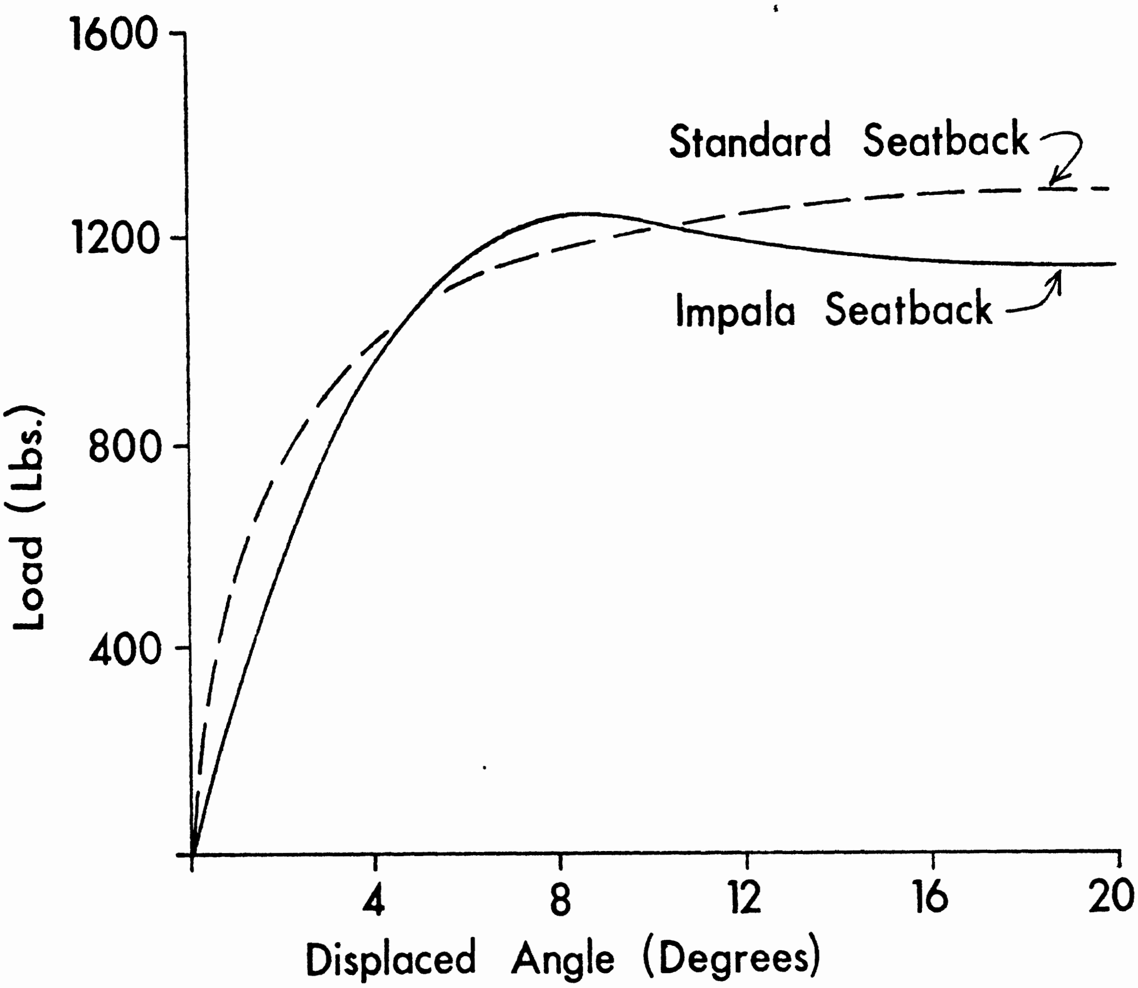



Figure 16. Seatback Static Load-Deflection Curves (Forward Bending)

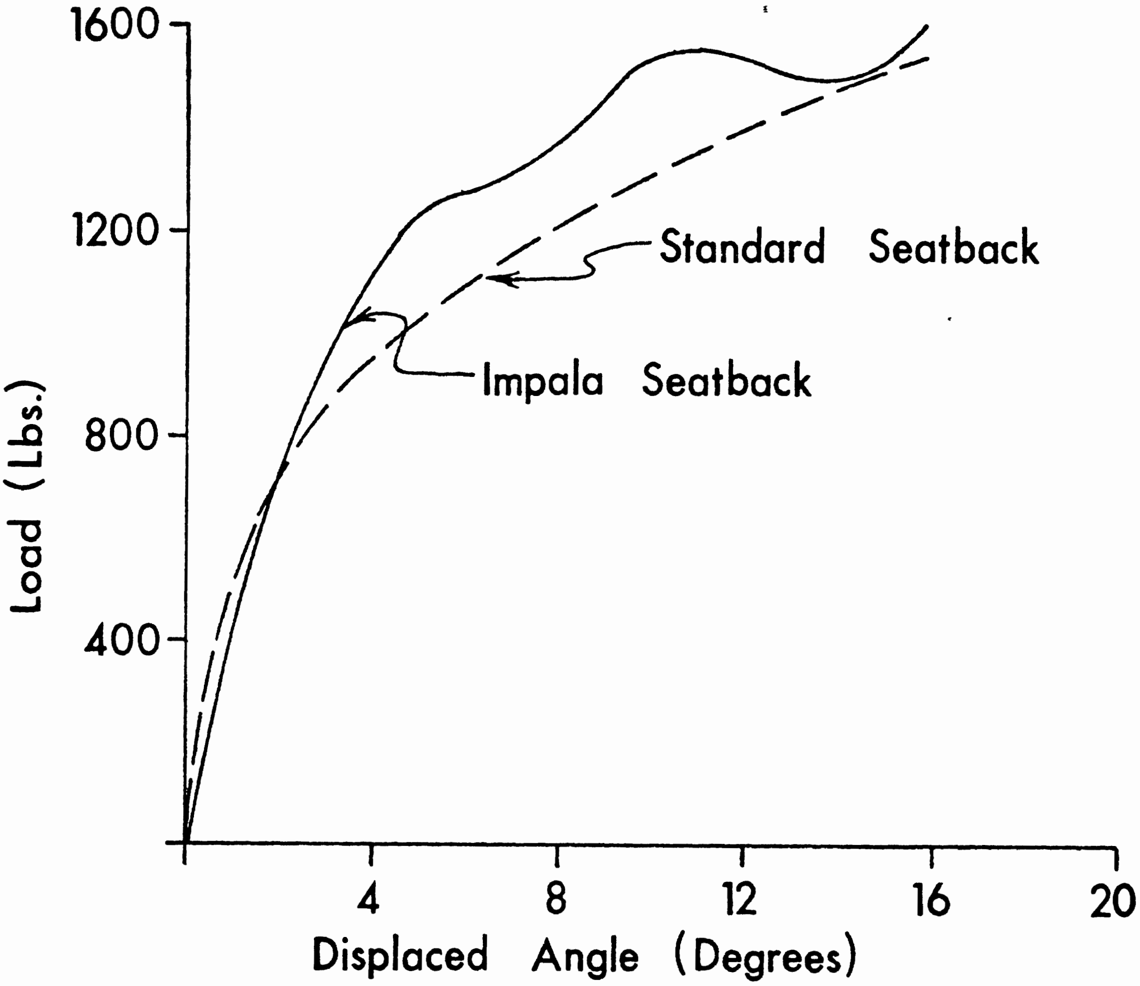



Figure 17. Seatback Static Load-Deflection Curves (Rearward Bending)

lever arm of 4.125 inches.

The general physical dimensions of the standard seat were patterned as closely as possible after those of the production Impala seat. Figure 18 is a dimensioned side view of the resulting standard seat design. (Figure 19).

## 4.4 DYNAMIC PERFORMANCE CHARACTERISTICS

Standard seat dynamic performance data were obtained from various impact sled tests, as follows:

1. seatback frame rotation magnitude and geometry;
2. seat foam dynamic load-deflection;
3. performance with the Ford Tot-Guard system.

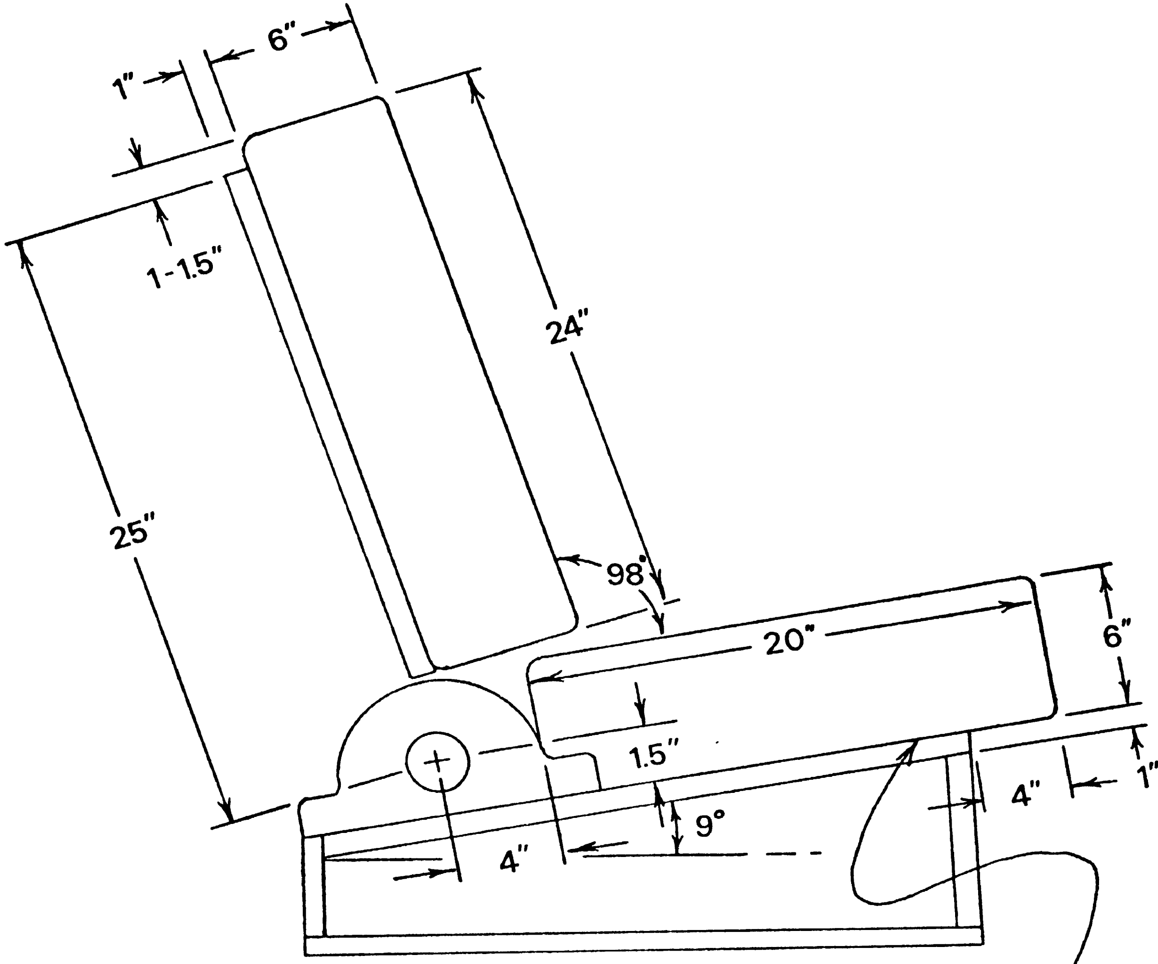
### 4.4.1 Frame Dynamic Performance

The standard seat was mounted on a sled buck and impacted in both frontal and rearward positions. Seatback frame rotation magnitude and geometry were obtained from high-speed motion picture analysis. Table 2 gives these data for the standard seat and the production seat.

### 4.4.2 Foam Dynamic Performance

Standard seat foam dynamic data were obtained for the seatback foam and the seat cushion foam from an accelerometer mounted at the center of gravity of a 31.2-lb. mass, placed against the foam, during impact on the impact sled.

Seatback foam dynamic load-deflection data for the production and standard seat, are presented in Figure 20. Seat cushion foam dynamic load-deflection data for the production and standard seats are shown in Figure 21. Note the pronounced rate sensitivity of the foam when compared to the static data in Figures 11 and 12.




Seat cushion foam overhangs frame two inches on each side to duplicate Impala seat edge characteristics

Figure 18. Standard Seat Dimensions, Side View

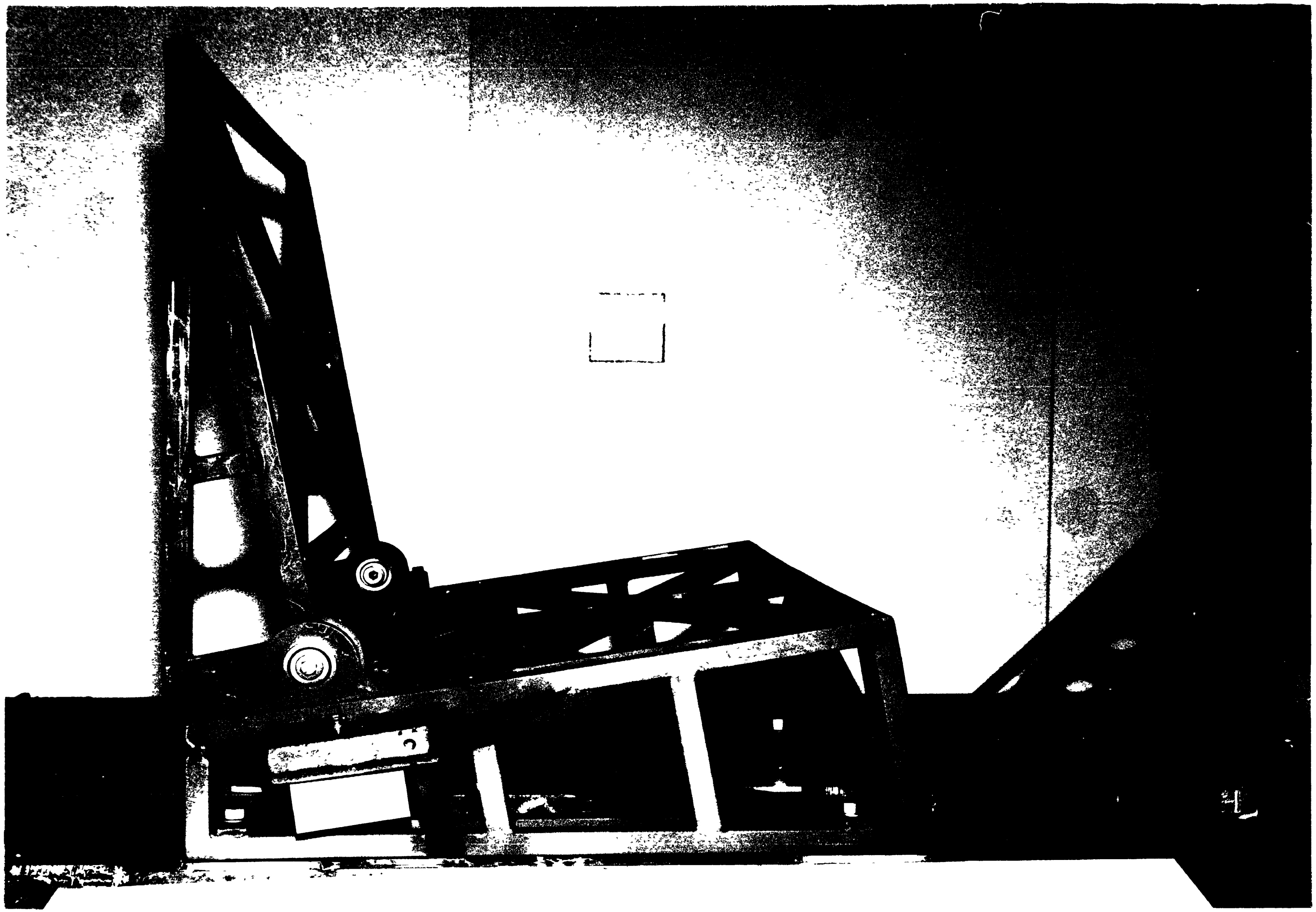
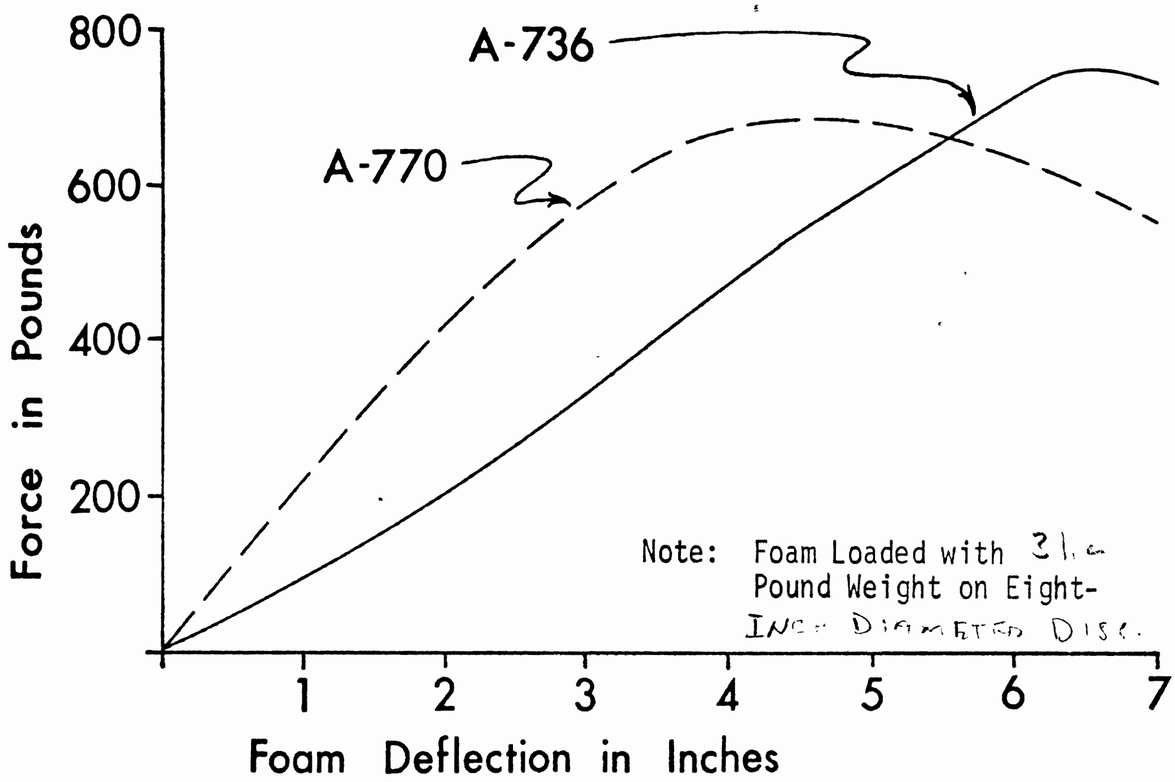


Figure 19. Standard Seat Frame Structure

TABLE II.

STANDARD SEAT DEVELOPMENTAL TESTS

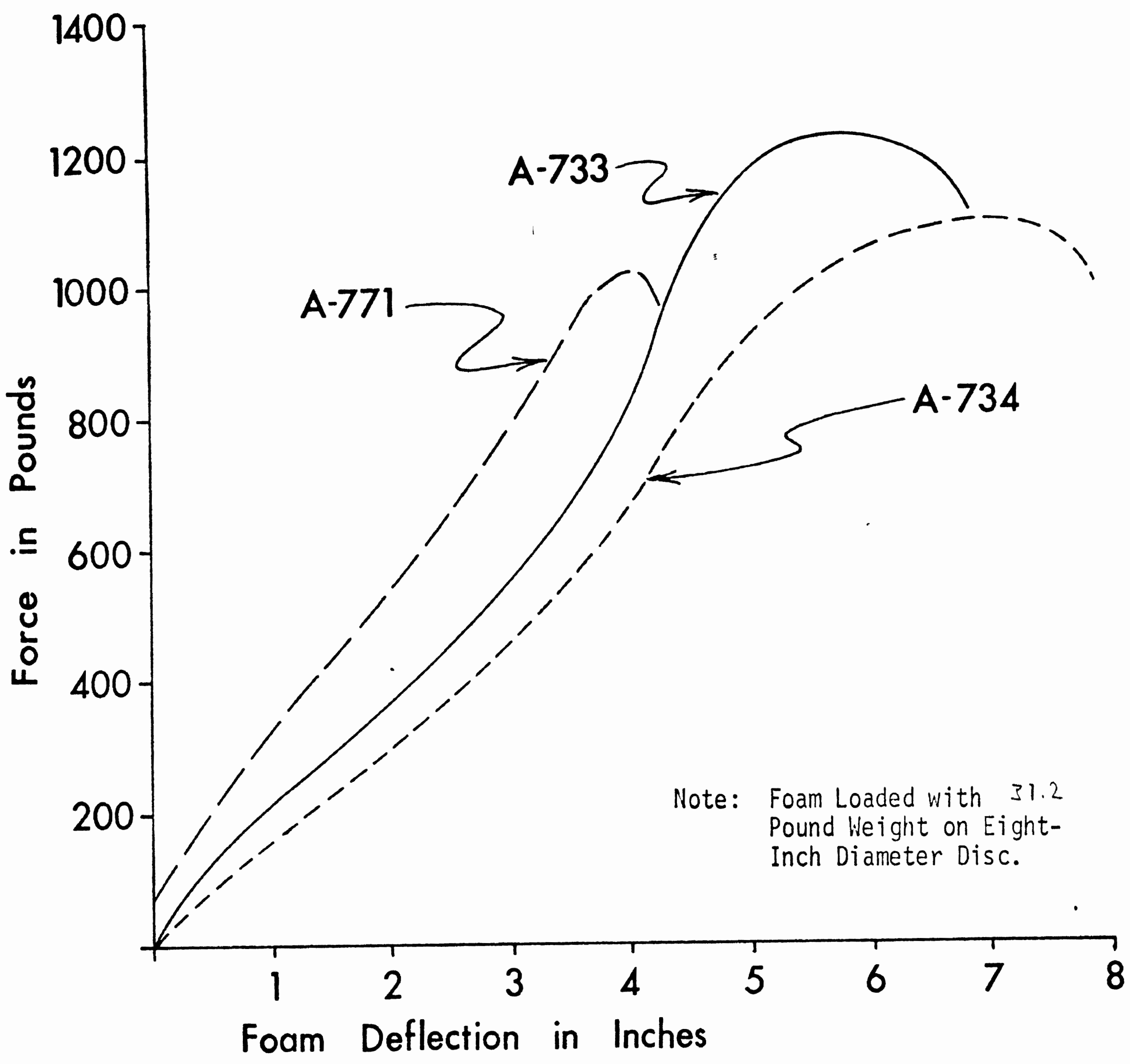
| TEST NO. | DIRECTION | SEAT TYPE | SLED AVE. VEL. (ft/sec) | SLED AVE. DECEL. (G's) | ANGLE SEATBACK DEFLECTION | COMMENTS |
|---|---|---|---|---|---|---|
| A-733 | - | Production | 26.48 | 16.0 | - | Dynamic seat cushion test (foam and frame) |
| A-734 | - | Production | 27.81 | 16.0 | - | Dynamic seat cushion test (foam and frame) |
| A-735 | Front | Production | 43.4 | 18.4 | Lost Data | Dynamic seat back test (foam and frame) |
| A-736 | Rear | Production | 29.6 | 16.0 | - | Dynamic seat back test (foam and frame) |
| A-743 | Front | Standard | 48.91 | 21.2 | 18.5° | Dynamic seat back deflection test |
| A-751 | Rear | Production | 30.22 | 16.0 | 5.0° | Dynamic seat back deflection test |
| A-755 | Front | Production | 45.91 | 21.0 | 14.0° | Dynamic seat back deflection test |
| A-758 | Front | Standard | 46.70 | 21.6 | 13.0° | Dynamic seat back deflection test |
| A-769 | Rear | Standard | 29.60 | 16.0 | 4.0° | Dynamic seat back deflection test |
| A-770 | - | Standard | 30.20 | 16.0 | - | Dynamic seat back test (foam and frame) |
| A-771 | - | Standard | 30.29 | 16.0 | - | Dynamic seat cushion test (foam and frame) |
| A-772 | Front | Standard | 44.37 | 20.8 | 29.0° | Dynamic tuning of seatback deflection (12# weight) |
| A-773 | Front | Standard | 41.71 | 21.6 | 16 .5° | Dynamic tuning of seatback deflection (6# weight) |




A-770: Standard Seat Seatback Dynamic Loading Slope = 181 #/in

A-736: Production Seat Seatback Dynamic Loading Slope = 122 #/in

Figure 20. SEATBACK DYNAMIC LOAD-DEFLECTION CURVES




A-771: Standard Seat Cushion Dynamic Loading Slope = 240 #/in

A-733: Production Seat Cushion Dynamic Loading Slope = 206 #/in

A-734: Production Seat Cushion Dynamic Loading Slope = 163 #/in

Figure 21. SEAT CUSHION DYNAMIC LOAD-DEFLECTION CURVES

### 4.4.3 Child Restraint System Performance

As in the case of the production seat, a Ford Tot-Guard child restraint system was selected to determine its interaction with the standard seat (Figure 22). Targeting and impact procedures were the same as for the production seat system interaction test. Test conditions and resulting system interaction data are given in Table 3, for both the production and the standard seat with the Ford Tot Guard in passenger position.

The head excursions for the two seats are essentially the same, with 25.0-in. for the production seat, and an average of 25.1-in for the standard seat. Peak resultant accelerations for both the head and chest are lower with the standard seat because of low anterior-posterior components. These lower accelerations are due to the generally softer child restraint interaction with the leading edge of the seat cushion frame as the seat cushion foam bottoms.

Seatback deflection angles are similar for the production seat and the standard seat, with averages of 15.1 deg. and 14.4 deg., respectively.

Test A-752 was anomalous because of dummy interaction with the Tot-Guard shield. The shield struck the dummy high on its chest on impact. This resulted in a significantly lower head excursion and a slight submarining condition. Test A-752 was not used in the seat performance comparison data.

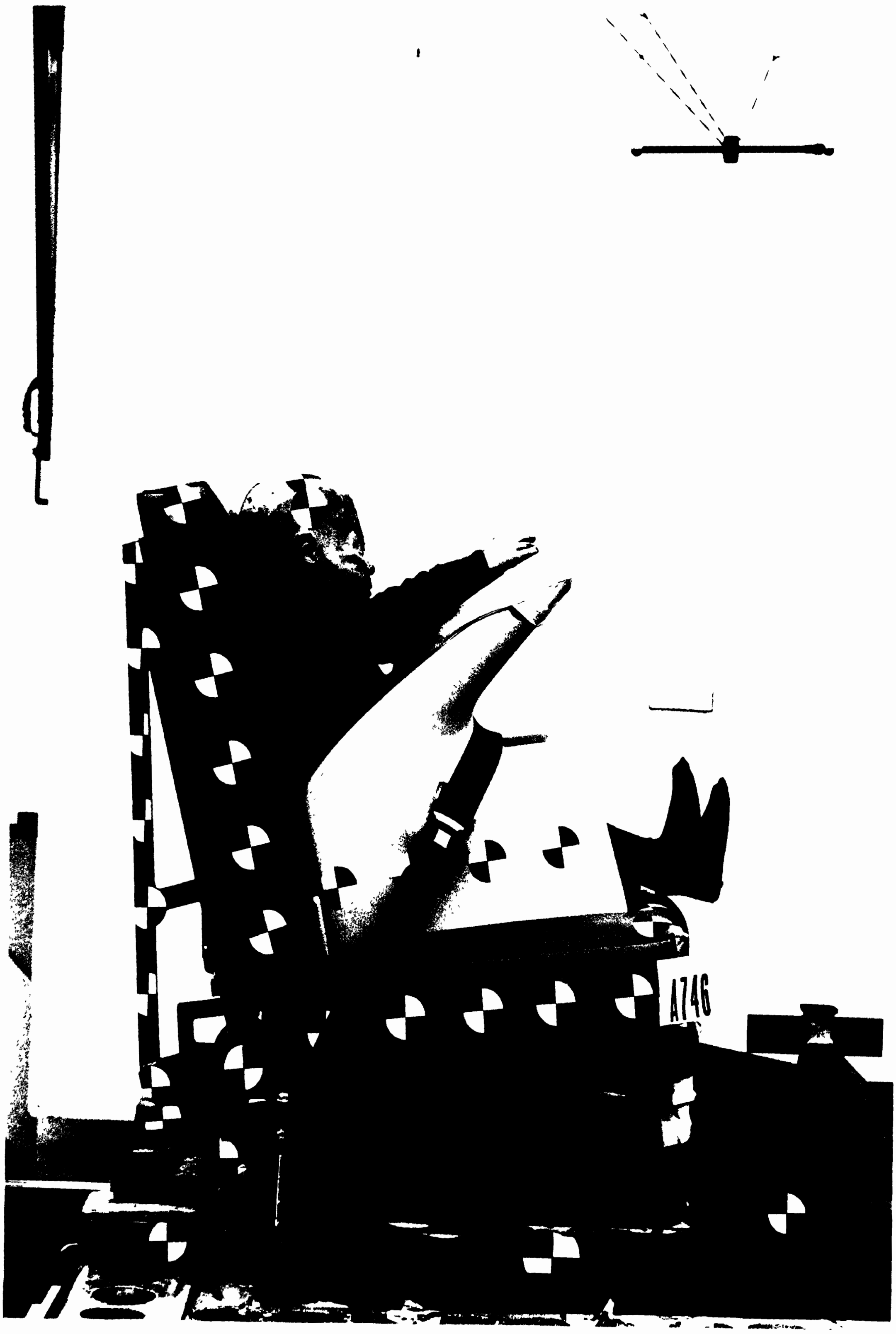



Figure 22. Standard Seat W/Tot-Guard Setup on Sled

TABLE III. CHILD RESTRAINT PERFORMANCE DATA

FRONTAL IMPACT 30 MPH 20 G's

FORD TOT GUARD IN PASSENGER POSITION

TYPE I LAP BELTS

| SEAT TYPE | | 1974 IMPALA | | STANDARD SEAT | | |
|---|---|---|---|---|---|---|
| TEST NO. | | A-721 | A-752 | A-744 | A-746 | A-759 |
| SLED | VEL. ft/sec | 44.02 | 42.87 | 46.19 | 46.07 | 44.31 |
| SLED | ACC. (G) | 20.5 | 20.4 | 20.8 | 20.0 | 21.0 |
| HEAD ACCELERATIONS | AP | 97 | 85 | - | - | 64 |
| HEAD ACCELERATIONS | SI | 50 | 47 | - | - | 42 |
| HEAD ACCELERATIONS | LR | 9 | 3 | - | - | 11 |
| HEAD ACCELERATIONS | PEAK RES. | 99 | 91.5 | - | - | 72 |
| HEAD ACCELERATIONS | SEV. INDEX | 1626.9 | 1456.5 | - | - | 1013.3 |
| HEAD ACCELERATIONS | HIC | 1271.9 | 1068.2 | - | - | 744.4 |
| CHEST ACCELERATIONS | AP | 59 | 44 | - | - | 38 |
| CHEST ACCELERATIONS | LR | 31 | 27 | - | - | 19 |
| CHEST ACCELERATIONS | SI | 12 | 8 | - | - | 11 |
| CHEST ACCELERATIONS | PEAK RES. | 60 | 45 | - | - | 43 |
| HEAD EXCURSION | HORIZONTAL (MRHE)** | 25.0 | 20.66* | 25.01 | 25.63 | 24.72 |
| SEAT BACK DEFLECTION ANGLE | | 15.5° | 14.7° | 16.8° | 15.5° | 11.0° |

* Dummy Contacted Shield High on Chest Resulting in Low Head Excursion.

** MRHE -- Maximum Relative Head Excursion

## 5.0 STANDARD U.S. PRODUCTION SEAT DYNAMIC PERFORMANCE COMPARISON USING VARIOUS CHILD RESTRAINT SYSTEMS

The final version of the standard seat is described in section 4.0 and in the detail drawings of Appendix B. This final version represents the third redesign of the seat, and it should be noted that it became available only at the conclusion of the developmental and performance tests, because the design depended on the data those tests produced. Because of scheduling and budgetary limitations, the sled test performance data reflected the performance of an intermediate design which differed from the final standard seat as follows:

1. The correct size of vinyl foam cover for the seatback was not available for performance sled tests. The cover allowed only four rather than six inches of foam to be installed, causing the seatback to be lighter and its foam to be less compliant. However, the seat cushion response was correct. The cushion response is the most significant factor in child restraint for frontal and side impacts.

2. The foam pads, vinyl covers and plywood inserts were redesigned in the final version to provide stronger attachment to the frame, and to eliminate sliding and bowing of the foam during impact, which was observed in the performance tests.

3. The deformable element mechanism which controls seatback motion was redesigned for the final version of the standard seat to provide closer conformance to the Impala seatback deflection characteristics, to improve ease of recycling, and to increase durability.

4. Weights were added to the top of the seatback frame on the final version to give a fine adjustment for dynamic seatback deflection.

## 5.1 PERFORMANCE TEST CONDITIONS

Performance tests using various child restraint systems were conducted on the standard seat and production seat. Seats under test were fastened securely to the frame of the HSRI Impact Sled with a mounting adapter fabricated from steel channels. The entire seat-adapter assembly was rotated to provide the desired direction of impact. The child restraints were fastened with Type I lap belts, and were used in conjunction with a Sierra 3-year old instrumented child dummy. Two Photosonics 1-B high-speed motion picture cameras operating at 1000 frames per second provided overhead and right side movie coverage. All tests utilized a qualifying trapezoidal sled pulse, as shown in Figure 23. To fall within the defined envelope of the qualifying trapezoidal pulse, frontal impacts were conducted at average velocity and deceleration values of 30 ±1 mph and averaged 21 G's respectively; rear impacts at 20 ±1 mph and averaged 16 G's, and side impacts at 20 ±1 mph and averaged 16 G's.

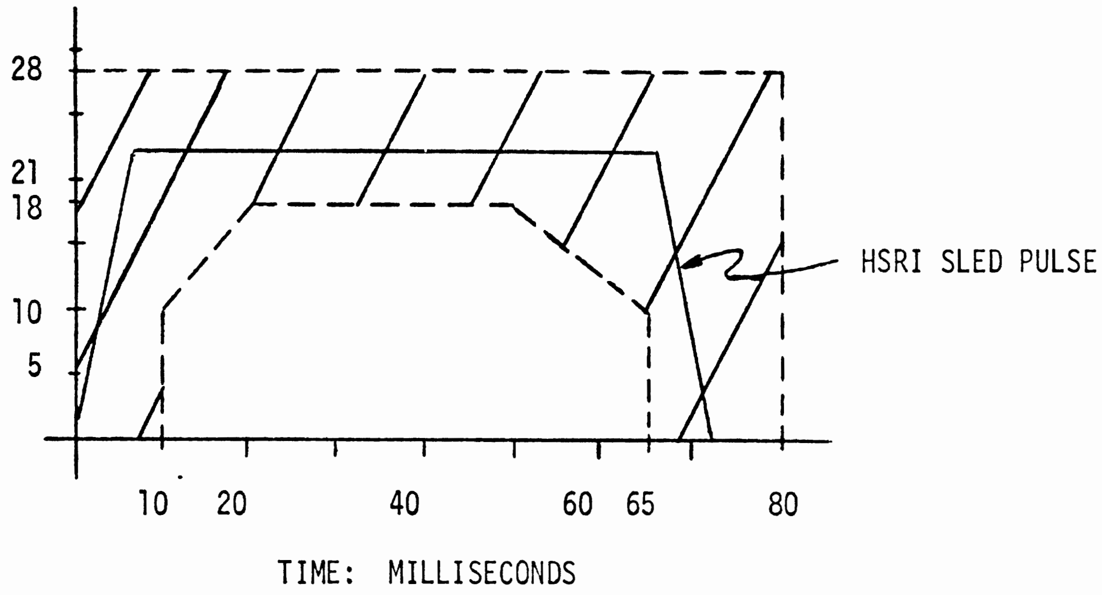
## 5.2 STANDARD SEAT PERFORMANCE VERIFICATION

Performance verification sled test data for the production and standard seats are tabulated in Tables 4 and 5. The following observations were made for the various impact directions.

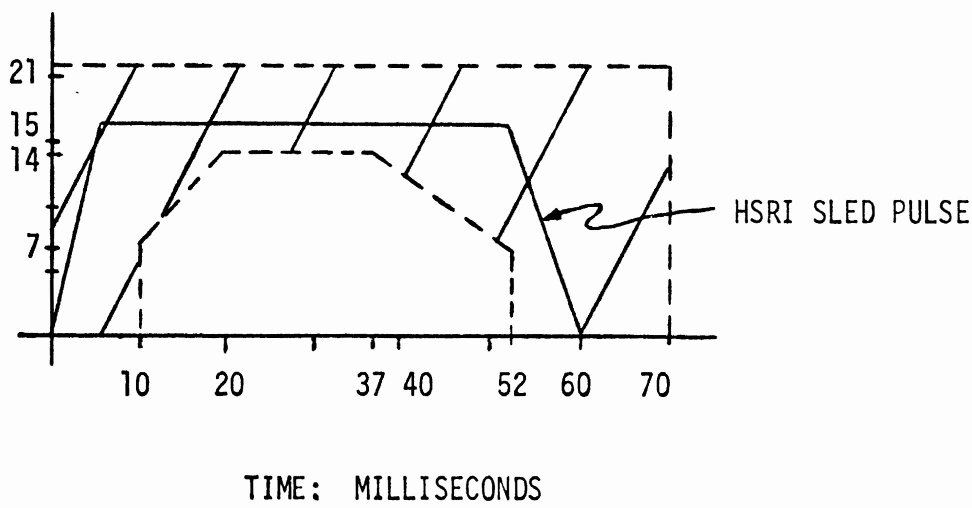
### 5.2.1. Frontal Impact

Comparison of data with the Strolee child restraint is questionable because this seat structure collapsed in both tests. However, this indicates that the standard seat would reproduce a child restraint failure in the same manner as the production seat. Tests with the Chrysler Mopar child restraint produced similar data on both the standard and production seats, with particularly good agreement on HIC and severity index values. Head excursion variation was less than two inches; a reasonable amount for this type

ACCELERATION ENVELOPE




23A: 30 MPH QUALIFYING TRAPEZOIDAL SLED PULSE




23B: 20 MPH QUALIFYING TRAPEZOIDAL SLED PULSE

FIGURE 23. Qualifying Acceleration Envelopes

TABLE IV. PERFORMANCE VERIFICATION ON DOT STANDARD SEAT

| [illegible] | SLED DATA: TEST NO. | SLED DATA: AVE VEL. (ft/sec) | SLED DATA: AVE DECEL. (G's) | HEAD ACCELERATION: PEAK AP (G's) | HEAD ACCELERATION: PEAK SI (G's) | HEAD ACCELERATION: PEAK LR (G's) | HEAD ACCELERATION: PEAK RES. (G's) | HEAD ACCELERATION: SEV. INDEX | HEAD ACCELERATION: HIC | CHEST ACCELERATION: PEAK AP (G's) | CHEST ACCELERATION: PEAK SI (G's) | CHEST ACCELERATION: PEAK LR (G's) | CHEST ACCELERATION: PEAK RES. (G's) | HEAD EXCURSIONS: HORIZ. MRHE (in) | HEAD EXCURSIONS: HORIZ. MAHE (in) | VERT. MAHE (in) | ANGLE SEATBACK DEFLECTION | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FRONTAL IMPACT** | | | | | | | | | | | | | | | | | | |
| [illegible] Guard | A-744 | 46.19 | 20.8 | - | - | - | - | - | - | - | - | - | - | 25.01 | - | - | 16.8° | Dummy Not Instrumented |
| [illegible] Guard | A-746 | 46.07 | 20.0 | - | - | - | - | - | - | - | - | - | - | 25.63 | - | - | 15.5° | Dummy Not Instrumented, [illegible] |
| [illegible] Guard | A-759 | 44.31 | 21.0 | 64 | 42 | 11 | 72 | 1013.3 | 744.4 | 38 | 11 | 19 | 43 | 24.72 | - | - | 11.0° | |
| [illegible] | A-763 | 43.81 | 21.2 | 28 | 46 | 2 | 47 | 377.1 | 269.4 | 33 | 6 | 8 | 34 | 32.47 | - | - | 10.0° | Seat Collapsed. |
| [illegible] | A-760 | 43.71 | 22.0 | 93 | 52 | 17 | 109 | 1524.3 | 1221. | 54 | 10 | 25 | 56 | 26.76 | - | - | 9.7° | |
| [illegible] Seat | A-761 | 42.81 | 20.6 | 62 | 57 | 26 | 79 | 1738.4 | 1022.4 | 33 | 11 | 20 | 37 | - | - | - | Data Lost | Lost Side Camera Functio[illegible] |
| [illegible] Seat | A-762 | 4[illegible].42 | 21.2 | 60 | 53 | 14 | 75 | 1090.4 | 946.4 | 35 | 5 | 24 | 38 | 20.26 | - | - | 7.0° | Low Seatback Angle from [illegible]se of [illegible] The-Back Strap |
| **SIDE IMPACT** | | | | | | | | | | | | | | | | | | |
| [illegible] Seat | A-764 | 29.43 | 16.0 | 11 | 6 | 22 | 28 | 62.6 | 46.3 | - | 18 | 8 | - | - | 18.55 | - | - | |
| [illegible] Seat | A-765 | 29.18 | 16.0 | 8 | 12.5 | 20 | 25 | 69.9 | 59.0 | - | 21 | 14 | - | - | 14.89 | - | - | |
| **REAR IMPACT** | | | | | | | | | | | | | | | | | | |
| [illegible] | A-767 | 29.6 | 16.0 | 36 | 13 | 6 | 37 | 162.2 | 133.3 | 24 | 2 | 12 | 26 | - | 7.79 | 0.60 | 13.0° | Center Position |
| [illegible] | A-768 | 29.7 | 16.0 | 36 | 14 | 4 | 37 | 158.5 | 136.1 | 26 | 3 | 10 | 27 | - | 8.73 | 1.41 | 12.0° | Center Position |

Unless Otherwise Stated, All Above Tests Conducted With 3 Year Old Sierra Child Dummy in the Passenger Position Restrained With Type I Lap Belts.

TABLE V. PERFORMANCE VERIFICATION ON 1974 IMPALA SEAT

| [illegible] | SLED DATA | | | HEAD ACCELERATION | | | | | | CHEST ACCELERATION | | | | HEAD EXCURSIONS | | | ANGLE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TEST NO. | AVE. VEL. (ft/sec) | AVE. DECEL (G's) | PEAK AP (G's) | PEAK SI (G's) | PEAK LR (G's) | PEAK RES. (G's) | SEV. INDEX | HIC | PEAK AP (G's) | PEAK SI (G's) | PEAK LR (G's) | PEAK RES. (G's) | HORIZ. MRHE (in) | HORIZ. MAHE (in) | VERT. MAHE (in) | SEATBACK DEFLECTION | COMMENTS |
| FRONTAL IMPACT | | | | | | | | | | | | | | | | | | |
| [illegible] Guard | A-751 | 44.02 | 20.5 | 97 | 50 | 9 | 99 | 1626.9 | 1271.9 | 59 | 12 | 31 | 60 | 25.0 | - | - | 15.5° | |
| [illegible] Guard | A-752 | 42.87 | 20.4 | 85 | 47 | 3 | 91.5 | 1456.5 | 1068.2 | 44 | 8 | 27 | 45 | 20.66 | - | - | 14.7° | |
| [illegible] | A-753 | 44.02 | 20.4 | 40 | 44 | 7 | 46 | 710.6 | 605.4 | 29 | 5 | 8 | 30 | 30.18 | - | - | 14.2° | Seat Collapsed |
| [illegible] | A-754 | 44.31 | 17.2 | 97 | 43 | 13 | 103 | 1497.3 | 1247.6 | 45 | 12.5 | 29 | 45 | 24.89 | - | - | 20.0° | Seatback weakened from past test[illegible] |
| [illegible] Seat | A-756 | 43.53 | 21.6 | 66 | 48 | 4 | 77 | 1158. | 932.8 | 36 | 5 | 21 | 41 | 17.22 | - | - | 9.0° | Low Seatback angle from use of [illegible]-the-back strap |
| SIDE IMPACT | | | | | | | | | | | | | | | | | | |
| [illegible] Seat | A-747 | 29.43 | 16.6 | 20 | 19 | 37 | 40.5 | 266.0 | 219.6 | 4 | 25 | 16 | 26 | - | 17.09 | - | - | |
| [illegible] | A-748 | 29.87 | 17.0 | 22 | 20 | 34 | 40 | 183.8 | 157.3 | 7 | 26 | 17 | 28 | - | 15.36 | - | - | |
| REAR IMPACT | | | | | | | | | | | | | | | | | | |
| [illegible] | A-749 | 30.01 | 17.2 | 34 | 23 | 5.5 | 32.5 | 169.2 | 149.8 | 29 | 3 | 15 | 30 | - | 7.70 | 3.81 | 8° | Center Position |
| [illegible] | A-750 | 30.33 | 16.8 | 24 | 17.5 | 3 | 26 | 92.9 | 79.1 | 25 | 5 | 15 | 29 | - | 10.84 | 5.68 | 6.5° | Center Position |

UNLESS OTHERWISE STATED, ALL ABOVE TESTS CONDUCTED WITH 3 YEAR OLD SIERRA CHILD DUMMY IN THE PASSENGER POSITION RESTRAINED WITH TYPE I LAP BELTS.

of restraint where initial dummy positioning is a large factor in head travel.

The GM Child Love Seat also showed close agreement on peak resultant accelerations, HIC and severity index values for both seats, although the head excursion was three inches further on the standard seat. The reduced seatback deflection from the use of an over-the-back strap was also comparable for both the Impala and standard seats.

5.2.2 Side Impacts

The GM Child Love Seat was used for side impact comparison tests. In this mode, the standard seat produced lower peak accelerations for the head and chest, and lower HIC and severity index values. The head excursion values were essentially identical, however, with an average of 16.2 inches for the Impala seat and 16.8 inches for the standard seat.

5.2.3 Rear Impacts

The Chrysler Mopar child restraint was used for rear impact comparisons. The accelerations, HIC and severity index can be seen to be similar for the production and standard seats. The horizontal head excursion values are also close with an average of 9.1 inches for the Impala seat and 8.3 inches for the standard seat. However, the vertical head excursion is much lower for the standard seat, indicating a smaller tendency for the dummy to ramp up the seatback during impact. This occurred in spite of a seatback deflection angle larger than that of the production seat, which should have increased the ramping tendency.

5.3 DYNAMIC PERFORMANCE OF TYPE III BELT SYSTEMS

An additional set of sled tests were conducted on the final version of the standard seat to investigate the interaction of type III belt systems with child restraint impact test data. The results of these tests are summarized in Appendix D. The data from these tests are presented in Tables D-1A and D-1B for additional comparisons between standard seat and production seat performance. It should be noted that these data are not directly comparable to the developmental and performance data previously discussed because of the following considerations: 1) additional interaction of shoulder belts and retractor mechanisms, 2) the slightly modified characteristics of the final standard seat, and 3) the various sled pulses used.

The first twelve tests listed in Tables D-1A and D-1B use the Ford Tot Guard child restraint and provide a good performance comparison between the production seat and the final version of the standard seat.

However, in test 805, the dummy contacted the restraint shield unusually low on the chest which gave an atypically large head excursion. This test was not included in the following tabulated summary of averaged data from these two tables.

TABLE 6 AVERAGED RESULTS OF FORD TOT GUARD TESTS REPORTED IN APPENDIX D

| SEAT TYPE | IMPACT DIRECTION | SLED PULSE | PEAK RESULTANTS HEAD | PEAK RESULTANTS CHEST | HIC | SEVERITY INDEX | HEAD EXCURSION |
|---|---|---|---|---|---|---|---|
| Standard | Front | Q- | 79 G | 49 G | 798 | 986 | 20.1 in |
| Production | | Trap | 75 G | 64 G | 755 | 1095 | 16.0 in |
| Standard | Front | C- | 70 G | 42 G | 565 | 697 | 18.2 in |
| Production | | Trap | 78 G | 43 G | 667 | 881 | 16.0 in |
| Standard | Front | Q-Half- | 59 G | 49 G | 484 | 552 | 20.5 in |
| Production | | sine | 76 G | 51 G | 644 | 859 | 16.3 in |
| Standard | Rear | Q- | 37 G | 24 G | 76 | 94 | - |
| Production | | Trap | 32 G | 28 G | 95 | 121 | - |

Several observations may be drawn from the summary of Type III belt tests:

1. Head excursion values appear to be independent of the type of sled pulse for both standard and production seats.

2. Head excursion values were an average of 3.5-in higher for the standard seat compared to the production seat. This additional head travel is due to child restraint interaction with the leading edge of the seat cushion frame during foam bottoming, indicating the standard seat is more compliant in this region.

3. The qualifying trapezoidal sled pulse generally results in higher HIC and severity index values than the compliance trapezoidal or the qualifying half-sine sled pulses for both the standard and production seats.

4. The standard seat tended to produce somewhat lower peak resultant acceleration, HIC and severity index values in both frontal and rear impacts than the production seat, due to higher head excursion values.

## 6.0 COST ANALYSIS

The materials and labor costs of building a standard seat are tabulated in Table 7. This cost of $1255 should be compared to the approximate cost of $300 for a new production automobile bench seat, or approximately $80 for a used seat from a salvage yard. The standard seat can then be seen as a distinct economic advantage if many child restraint tests are to be run. This is particularly true if untethered seatbacks are required, since the breakeven point is then four tests when using new production seats.

One item in the analysis that deserves comment is the high labor cost of machining the seatback bearing support blocks. The seat cost could be reduced by several hundred dollars if suitable commercial pillow blocks could be obtained, the problem again being the physical size limitations imposed by the tube frame, hinge point location, and bending bar requirements, plus the desirability of a spherical bearing for its impact load tolerance. Commercial pillow blocks are typically too wide and generally unavailable with spherical bearings.

TABLE 7. MATERIAL AND LABOR COSTS

| Material Requirements | Cost |
|---|---|
| 1" Square Steel Tubing (100 feet @ $.69 per foot) | $ 70.00 |
| Vinyl Covers (one set) | 100.00 |
| Deformable elements (one set) | 1.50 |
| Small Hardware | 5.00 |
| Plywood Backing | 15.00 |
| Foam Cushions (one set) | 10.00 |
| Steel Plate (Seat frame) | 15.00 |
| Spherco Uniball Bearings (seatback pivot - four required) | 55.00 |
| MATERIAL TOTAL | $ 271.50 |

| Labor Requirements | Cost (assumed $12/hour labor and overhead) |
|---|---|
| Fitting and welding of seat frame (Time Estimate: 50 hours) | $ 600.00 |
| Machining of Pivot Mechanism Components (Time Estimate: 32 hours) | 384.00 |
| LABOR TOTAL | $ 984.00 |

| | |
|---|---|
| COST OF ONE STANDARD SEAT: (Labor Plus Material) | $ 1,255.00 |
| COST TO RECYCLE STANDARD SEAT: (New Foam Cushions and Deformable Elements) | $ 11.50 |

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

The static and dynamic test results indicate that this standard seat as designed is a durable, repeatable test platform that closely simulates the static and dynamic impact characteristics of the 1974 Chevrolet Impala bench seat. Its economic breakeven point occurs when more than four new or approximately thirty-three used production bench seats are required, even when new foam cushions are installed for each standard seat test. Child restraint tests on the standard seat tend to give slightly lower head and chest peak resultant acceleration, HIC and severity index values than comparable tests on the production seat, and head excursion values for the Ford Tot-Guard were comparable with those obtained with the Impala seat using Type I belts. When tested with Type III belts, the Tot-Guard head excursion values averaged 3.5 inches greater with the standard seat.

The qualifying trapezoidal sled pulse produced generally higher HIC and severity index values than either the compliance trapezoidal or the qualifying half-sine pulse, although the peak resultant head and chest accelerations were not significantly higher for the qualifying trapezoidal pulse. The head excursion values appeared to be independent of the sled pulse type. The standard seat and the production seat displayed essentially similar response differences between the three types of sled pulses.

Recommendations for use and improvement of the standard seat are as follows:

1. If closer correlation of the head excursion and peak acceleration values with those obtained using the production seat are desired, further development of the seat cushion leading edge stiffness and bottoming characteristics is recommended.

2. Additional cost savings could be realized, and the logistics problem arising from large quantities of foam cushions reduced, if the foam slabs were tested to determine the number of impact tests for which they could be reusable, without deterioration of characteristics or performance.

3. The standard seat was developed to reproduce the performance of the production bench seat for child restraint testing only, it should not be assumed that its performance would also be comparable to the production seat under different test conditions.

# APPENDIX A

## RECYCLING PROCEDURE FOR STANDARD SEAT

# APPENDIX A

## RECYCLING PROCEDURE FOR STANDARD SEAT

After performing an impact test with the standard seat, it is necessary to replace both seat back deflection control elements and (if desired) the foam slabs. The following is the recommended recycling procedure for this task:

### DISASSEMBLY

1) Loosen and remove the shoulder bolt from both pivot blocks on one side of the seat.

2) Slide each pivot block off the bent deformable element.

3) Remove the bent deformable element from the seatback frame loading slot.

4) Repeat the above three steps on the other side of the seat.

CAUTION: Loosening the second set of pivot blocks allows the seatback to rotate freely and it will tend to swing rearward.

5) Remove the two nubs holding the seatback vinyl cover upper restraining strap on its bolts and slip the strap grommets off the bolts. There are two other restraining straps on the covers, but only the upper seatback strap need be removed during recycling.

6) Tilt the seatback rearward, unzip the vinyl covers, and remove all the foam slabs.

### REASSEMBLY

1) Install fresh foam slabs in both the cushion and seatback vinyl covers while observing the following:

a.) Wider (24 inch) foam is for seatback, narrower (20 inch) foam is for seat cushion.

b.) The two inch thick foam slab is installed first, against the plywood backing, for both the seatback and cushion.

c) The four inch thick foam slab is then placed over the two inch slab for both the seatback and cushion.

2) Rezipper the vinyl covers around the new foam slabs taking care to avoid bunching of the foam in the corners.

3) Reattach the four pivot blocks to the standard seat base frame using the proper shoulder bolts. The shoulder bolts should only be lightly snugged -- finger tight is adequate.

4) Pivot the seatback upwards to approximately the normal test position and insert a new deformable element through one of the outboard pivot blocks, guide it through the loading slot in the seatback frame, and then through the corresponding inboard pivot block. Small movements of the seatback will allow the proper alignment of the loading slot for inserting the deformable element as described.

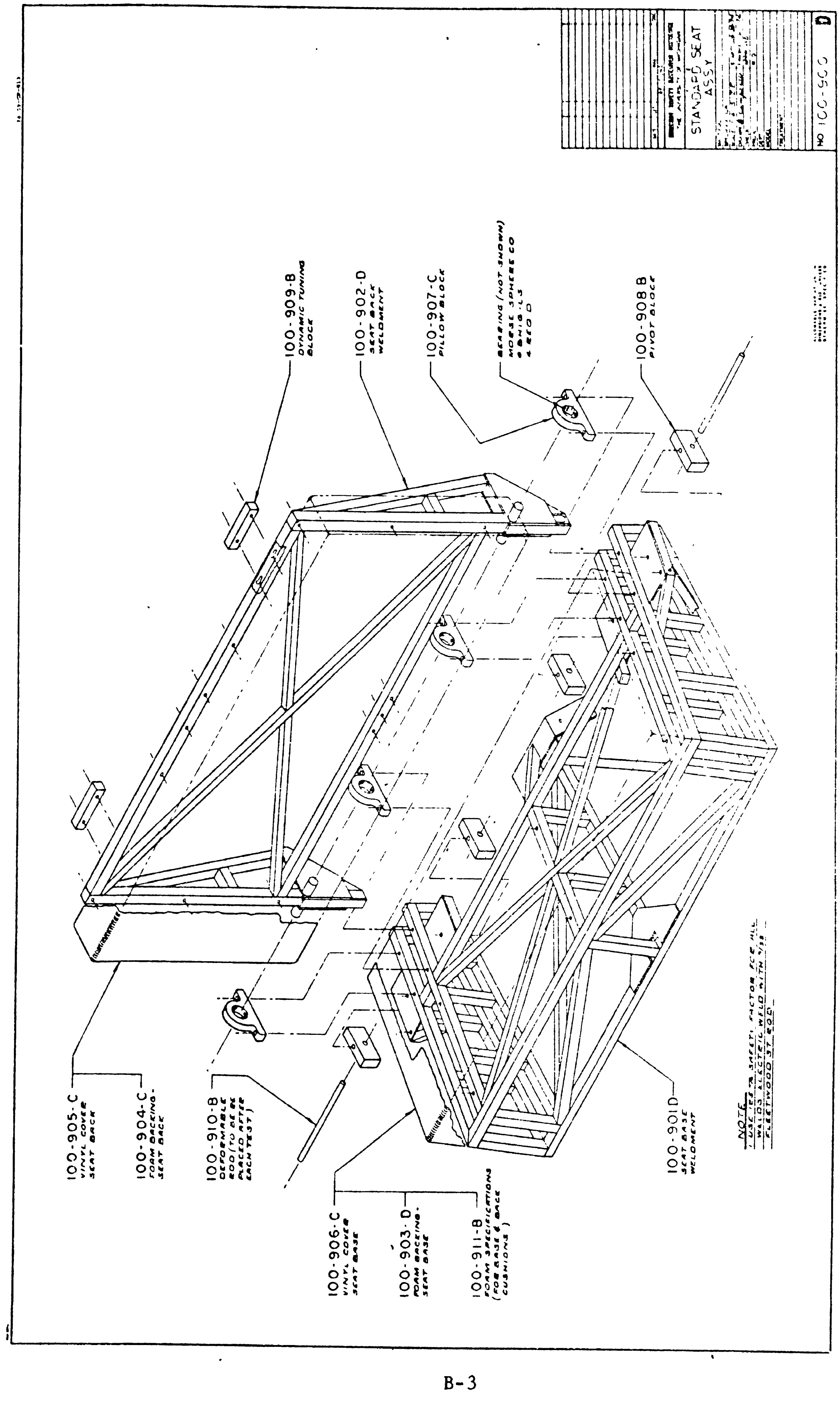
5) Repeat the above procedure to install the deformable element on the other side of the seat.

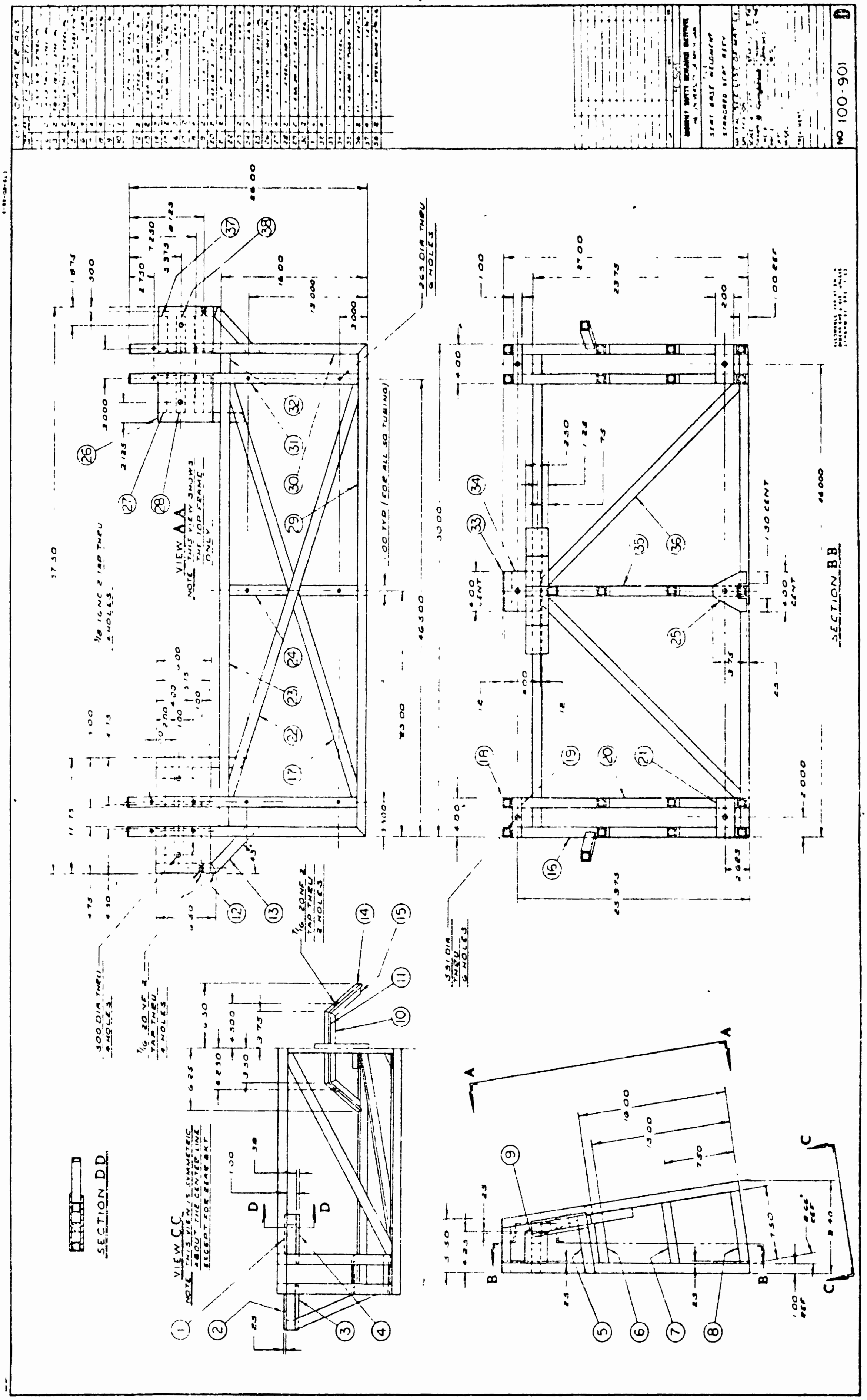
6) Reposition the grommets on the seatback vinyl cover upper retaining strap over their bolts on the seatback frame, and spin on the nuts finger tight to hold them.

All replaceable elements have now been renewed and the standard seat is ready for the next impact test.

APPENDIX B

DOT Stnadard Seat Drawings


STANDARD SEAT ASSY
NO 100-900
D
100-909-B DYNAMIC TUNING BLOCK
100-902-D SEAT BACK WELDMENT
100-907-C PILLOW BLOCK
BEARING (NOT SHOWN)
100-908 B PIVOT BLOCK
100-905-C VINYL COVER SEAT BACK
100-904-C FOAM BACKING-SEAT BACK
100-910-B DEFORMABLE ROD (TO BE RE PLACED AFTER EACH TEST)
100-906-C VINYL COVER SEAT BASE
100-903-D FOAM BACKING-SEAT BASE
100-911-B FOAM SPECIFICATIONS (FOR BASE & BACK CUSHIONS)
100-901D SEAT BASE WELDMENT
NOTE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VIEW CC
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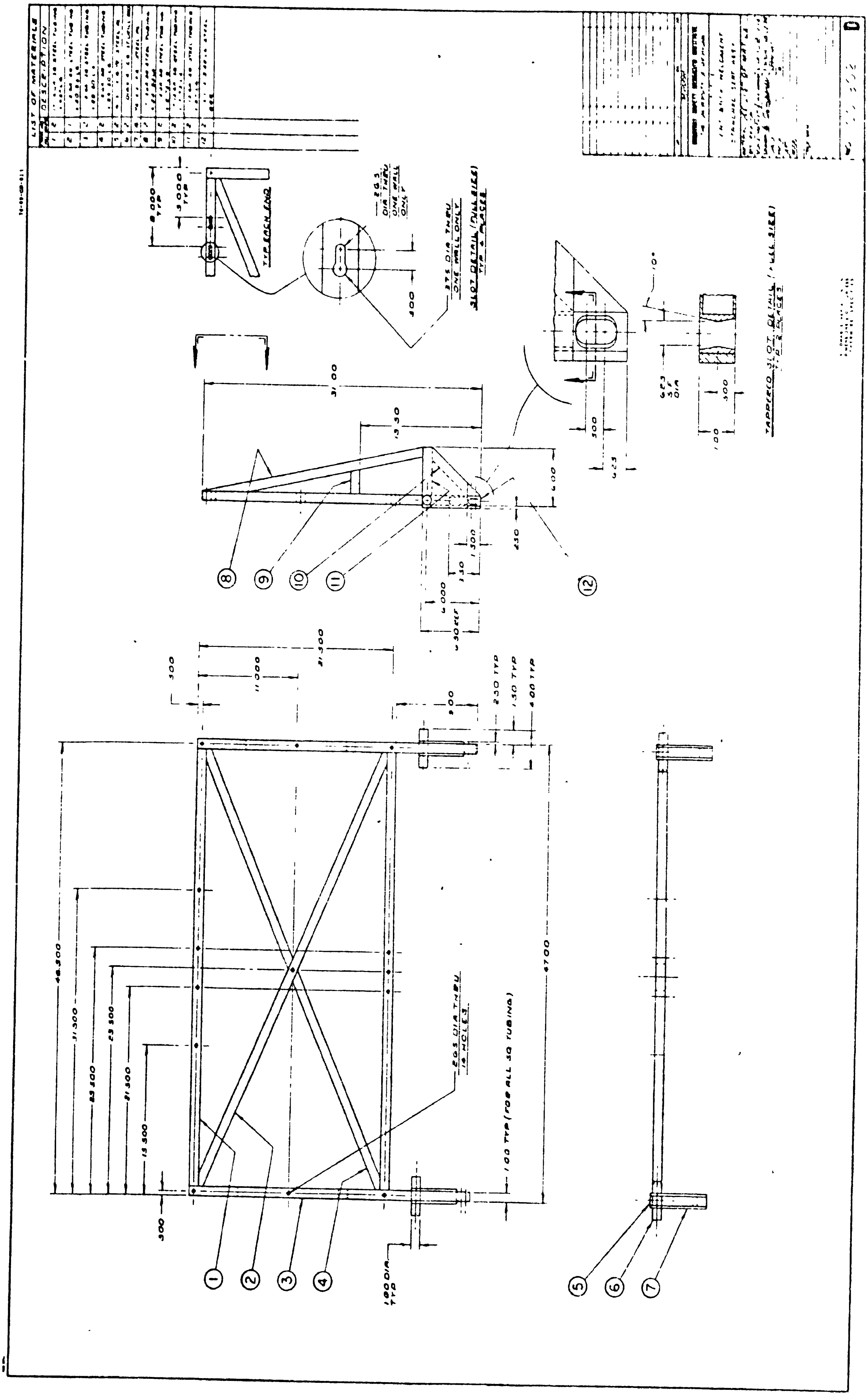

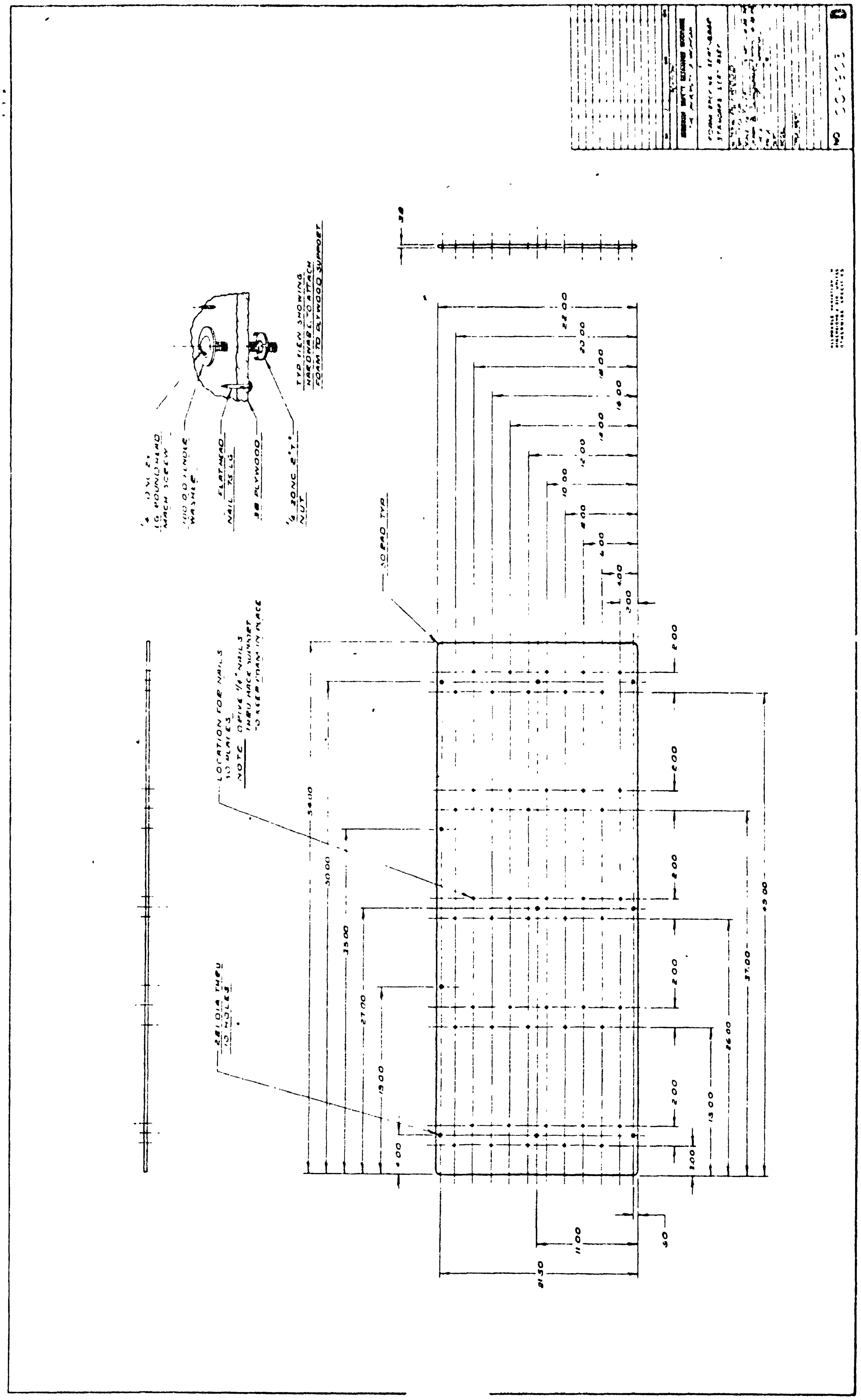

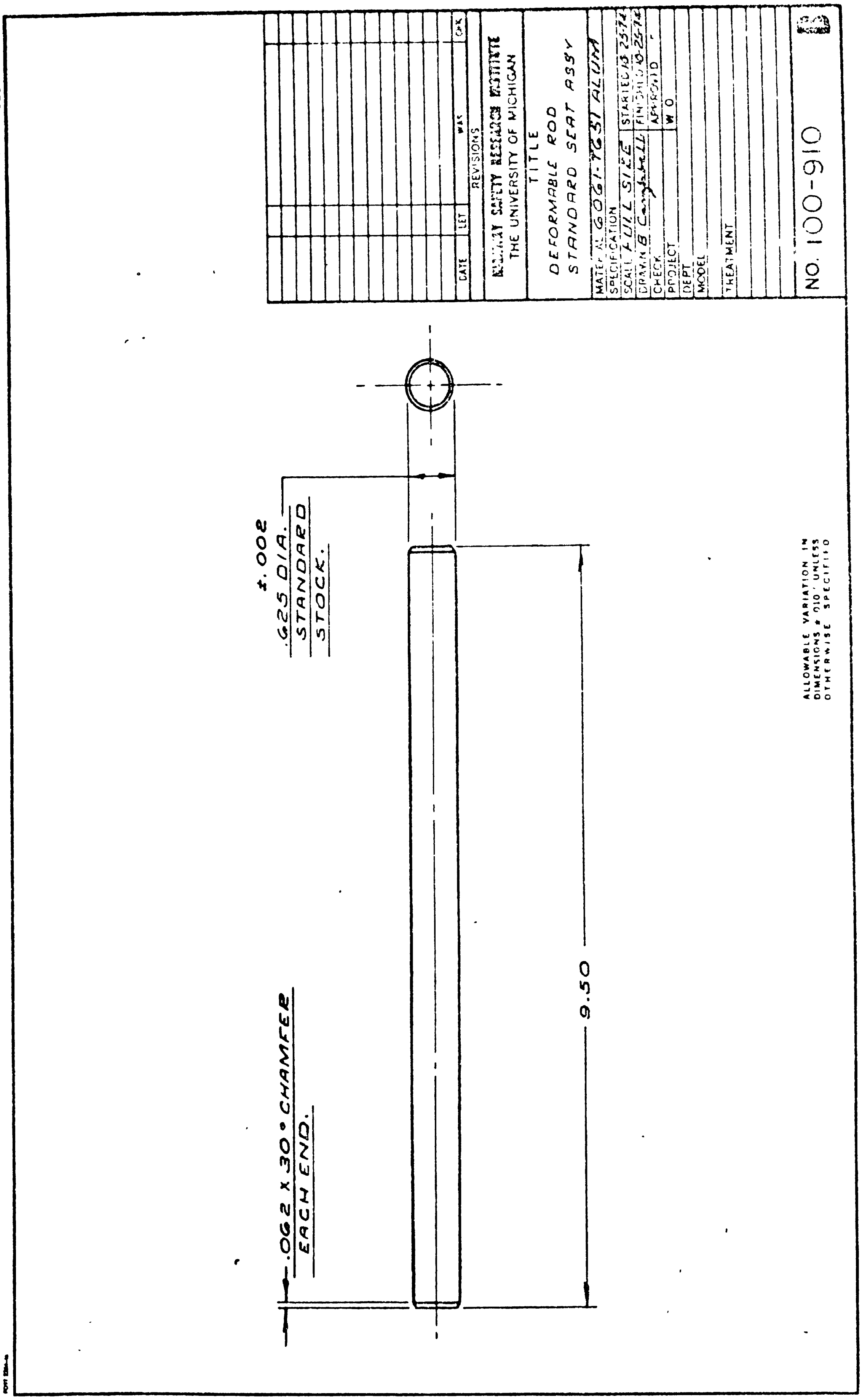
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THE UNIVERSITY OF MICHIGAN
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MATERIAL 6061-T6ST ALUM
SPECIFICATION
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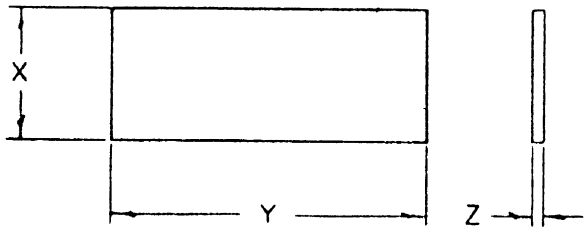
9.50
ALLOWABLE VARIATION IN
DIMENSIONS ± .010" UNLESS
OTHERWISE SPECIFIED




| FORM POSITION | FORM TYPE | X | Y | Z |
|---|---|---|---|---|
| SEATBACK LOWER (AGAINST PLYWOOD BACKING) | A | 24 | 54 | 2 |
| SEATBACK UPPER | B | 24 | 54 | 4 |
| SEAT BASE LOWER (AGAINST PLYWOOD BACKING) | A | 20 | 54 | 2 |
| SEAT BASE UPPER | B | 20 | 54 | 4 |

## POLYURETHANE SEATING FORM SPECIFICATIONS

| SPECIFICATION | | FORM A | FORM B |
|---|---|---|---|
| DESCRIPTION | | EXTRA FIRM HIGH DENSITY GRADE | MEDIUM SOFT GRADE |
| DENSITY - PCF | | 2.70 ± .10 | 1.50 +.05/-.10 |
| *INDENT LOAD - LBS - 4 THK @ 25% DEFLECTION | | 45 - 55 | 21 - 27 |
| INDENT LOAD RATIO (65/25) - MIN | | 2.0 | 1.9 |
| TENSILE - PSI - MIN | | 12 | 12 |
| ELONGATION - % - MIN | | 175 | 175 |
| TEAR RESISTANCE - LBS/IN. - MIN | | 1.75 | 1.75 |
| *COMPRESSION SET | METHOD B - ORIGINAL 50% - MAX | 15.0 | |
| | 22 HRS @ 158°F - 90% - MAX | | 20.0 |
| HUMIDITY AGED 5 HRS @ 250°F | 50% MAX | 20.0 | 20.0 |
| | 90% MAX | | 20.0 |

SAMPLE SOURCE: UNITED FOAM CORPORATION
BREMAN, INDIANA
FORM A : THEIR FORM #2028
FORM B : THEIR FORM #2021

*ASTM D 2406 68 (METHOD B)

ALLOWABLE VARIATION IN DIMENSIONS ± .010" UNLESS OTHERWISE SPECIFIED

| DATE | LET | WAS | CHK |
|---|---|---|---|

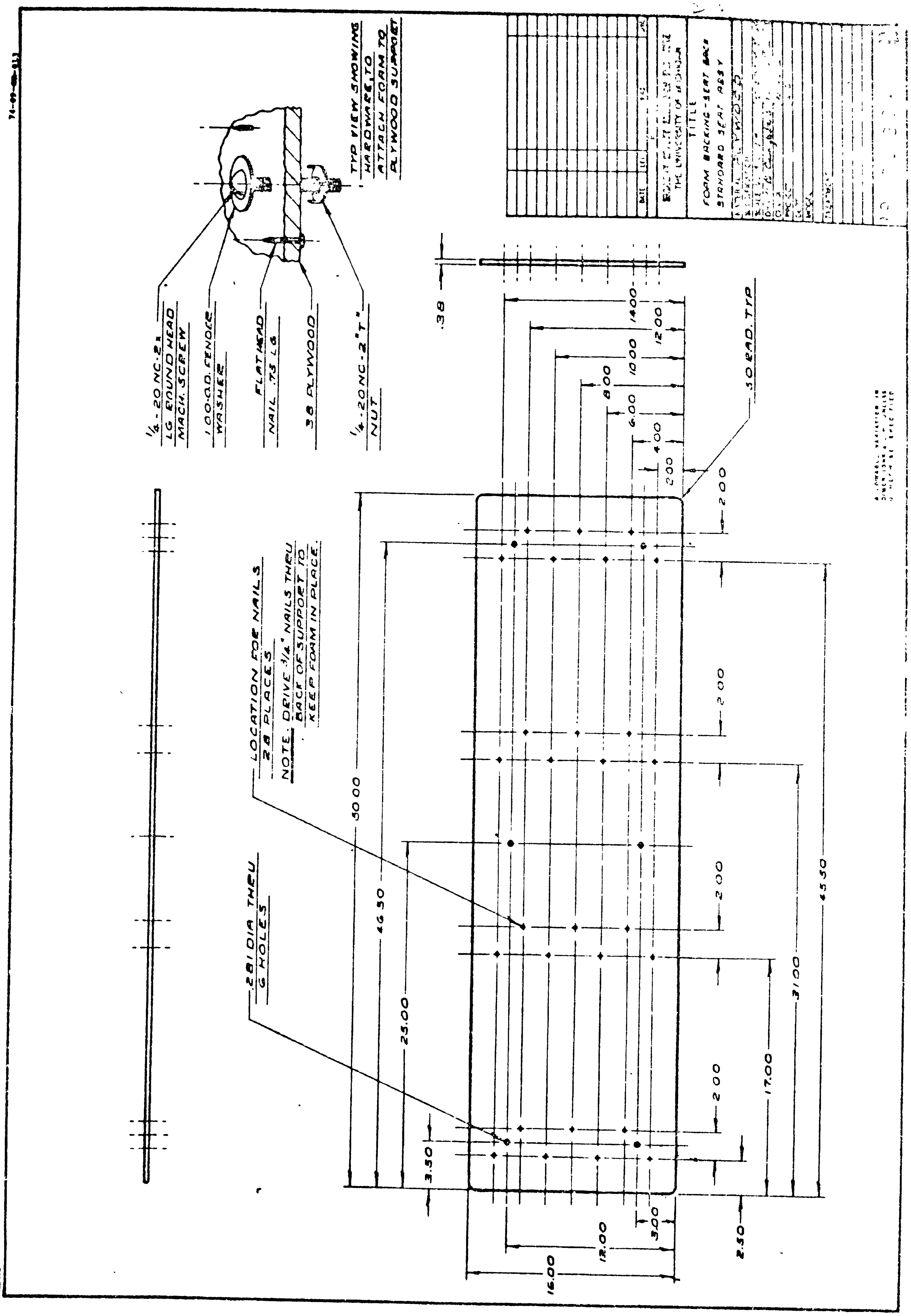
REVISIONS

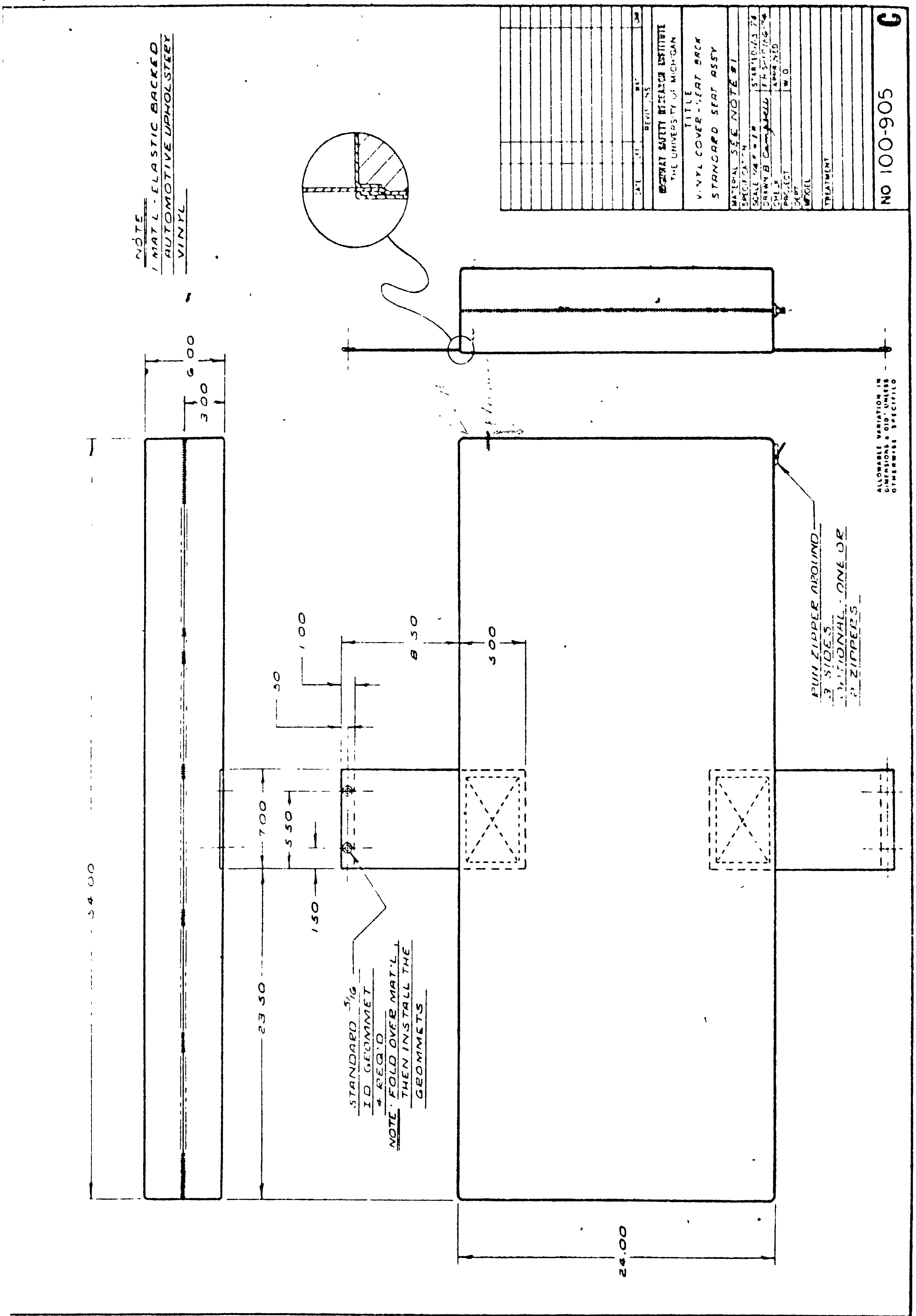
HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN

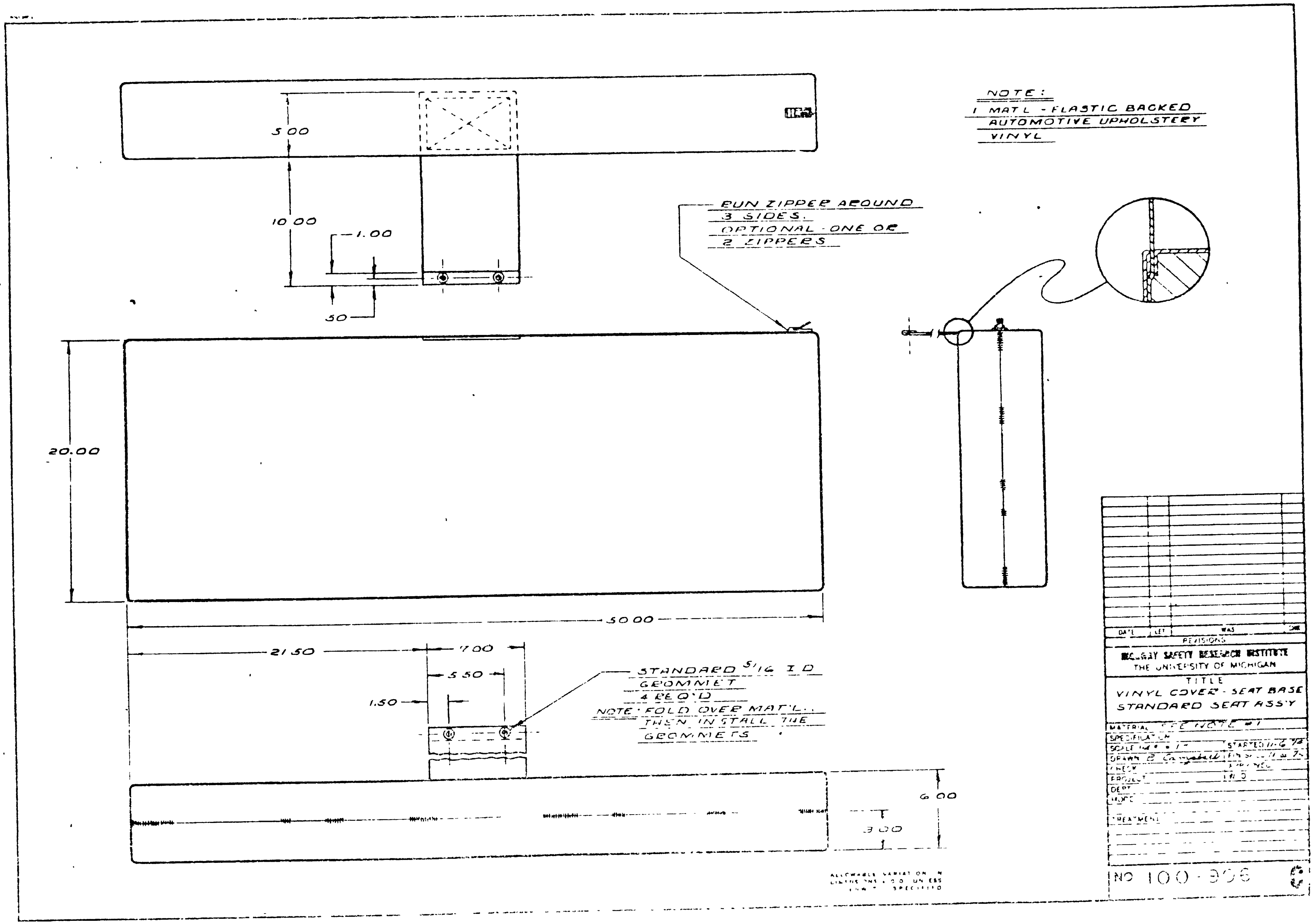
TITLE
FORM SPECIFICATIONS
STANDARD SEAT ASS'Y

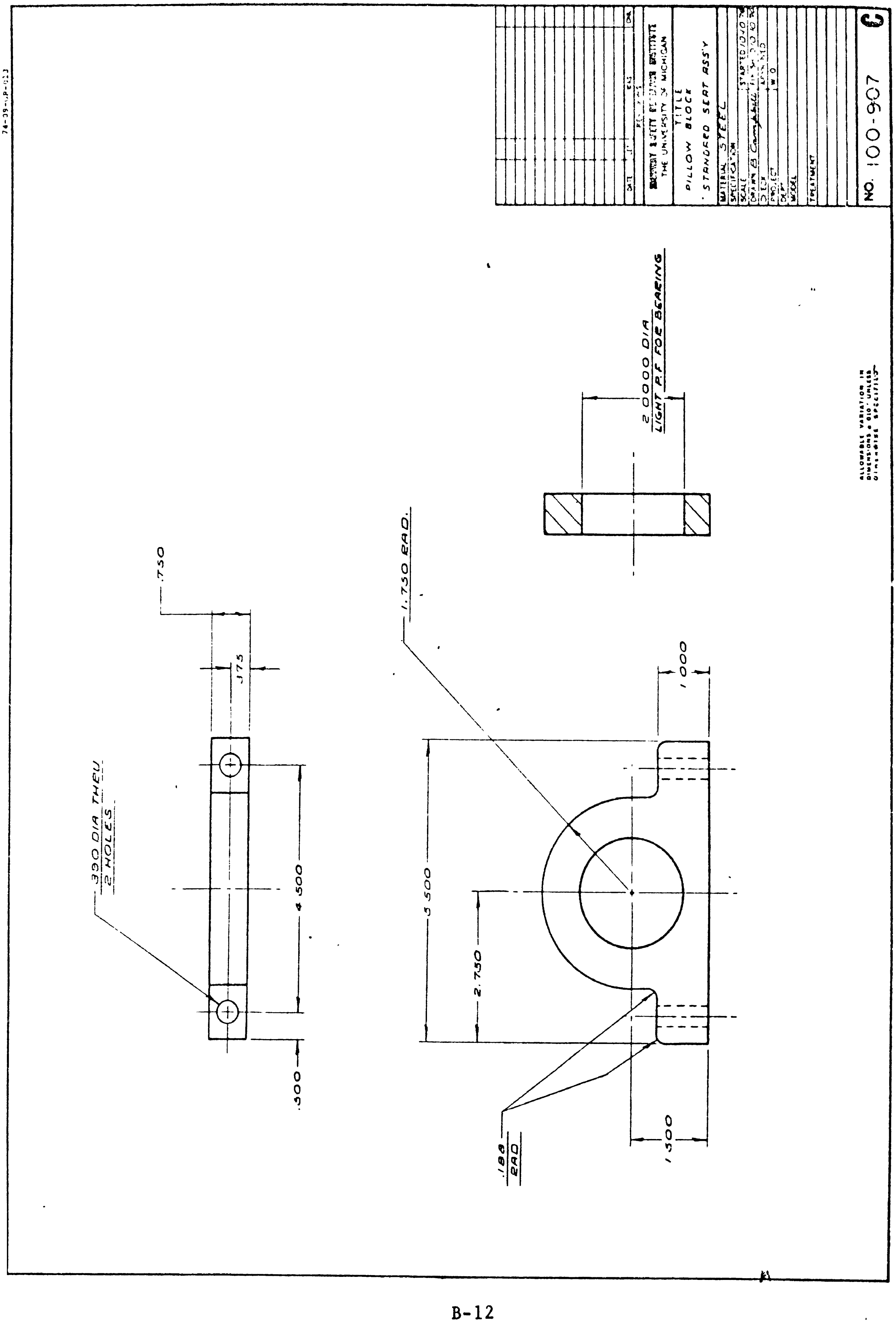
| | |
|---|---|
| MATERIAL SEE DWG. | |
| SPECIFICATION | |
| SCALE | STARTED 11-6-74 |
| DRAWN R J M | FINISHED 11-6-74 |
| CHECK | APPROVED |
| PROJECT | W O |
| DEPT | |
| MODEL | |
| TREATMENT | |

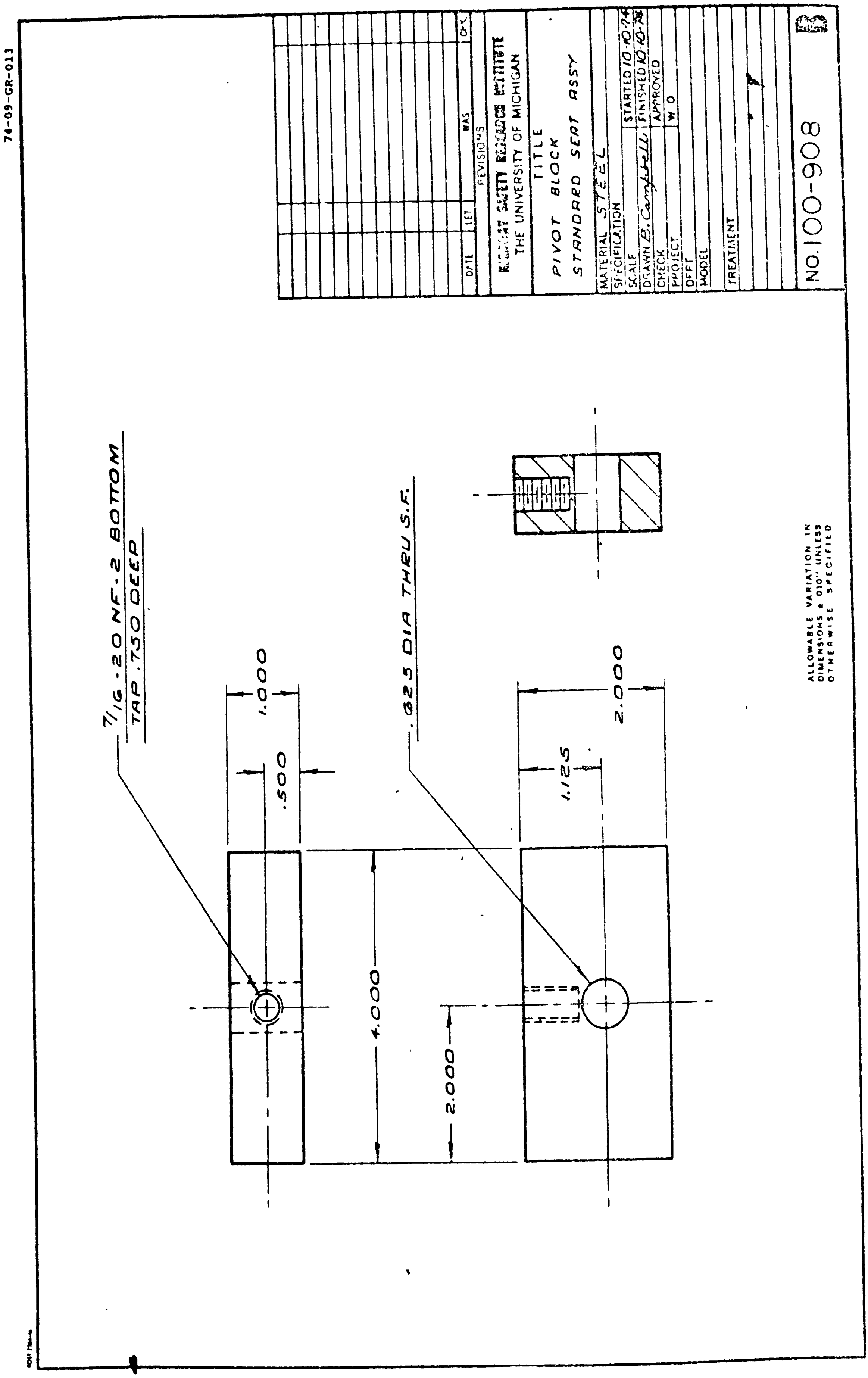
NO. 100-911 B

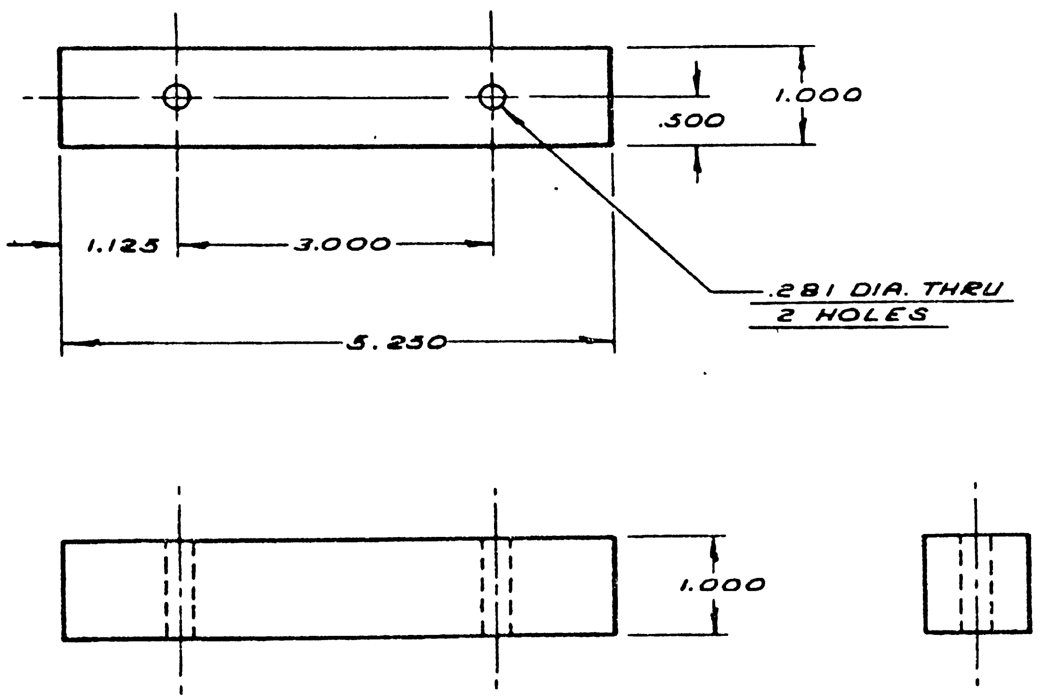

TYP VIEW SHOWING HARDWARE TO ATTACH FORM TO PLYWOOD SUPPORT
1/4-20 NC-2 x LG ROUNDHEAD MACH. SCREW
1.00 O.D. FENDER WASHER
FLATHEAD NAIL .75 LG
.38 PLYWOOD
1/4-20 NC-2 "T" NUT
LOCATION FOR NAILS 28 PLACES
NOTE: DRIVE 3/4" NAILS THRU BACK OF SUPPORT TO KEEP FORM IN PLACE.
.281 DIA THRU 6 HOLES
.50 RAD. TYP
.38
14.00
12.00
10.00
8.00
6.00
4.00
2.00
30.00
46.50
25.00
3.50
45.50
31.00
17.00
2.50
3.00
12.00
16.00
TITLE
FORM BACKING-SEAT BACK
STANDARD SEAT ASSY


NOTE
1 MAT'L - ELASTIC BACKED AUTOMOTIVE UPHOLSTERY VINYL
HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN
TITLE
VINYL COVER - SEAT BACK
STANDARD SEAT ASSY
MATERIAL SEE NOTE #1
TREATMENT
NO 100-905
C
RUN ZIPPER AROUND 3 SIDES. OPTIONAL. ONE OR 2 ZIPPERS
STANDARD 5/16 I.D. GROMMET 4 REQ'D
NOTE: FOLD OVER MAT'L THEN INSTALL THE GROMMETS
6.00
3.00
34.00
24.00
23.50
7.00
5.50
1.50
8.50
1.00
.50
3.00


NOTE:
1 MAT'L - PLASTIC BACKED AUTOMOTIVE UPHOLSTERY VINYL
RUN ZIPPER AROUND 3 SIDES. OPTIONAL - ONE OR 2 ZIPPERS
STANDARD 5/16 I.D GROMMET 4 REQ'D
NOTE: FOLD OVER MAT'L. THEN INSTALL THE GROMMETS
5.00
10.00
1.00
.50
20.00
50.00
21.50
7.00
5.50
1.50
6.00
3.00
HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN
TITLE
VINYL COVER - SEAT BASE
STANDARD SEAT ASS'Y
NO 100-906


THE UNIVERSITY OF MICHIGAN
TITLE
PILLOW BLOCK
STANDARD SEAT ASS'Y
MATERIAL STEEL
SPECIFICATION
SCALE
DRAWN B Campbell
PROJECT
MODEL
TREATMENT
NO. 100-907
C
2.0000 DIA
LIGHT P.F FOR BEARING
1.750 RAD.
.750
.375
.390 DIA THRU
2 HOLES
4.500
.500
5.500
2.750
1.000
1.500
.188
RAD


74-09-GR-013
7/16-20 NF-2 BOTTOM
TAP .750 DEEP
.625 DIA THRU S.F.
1.000
.500
2.000
1.125
4.000
2.000
ALLOWABLE VARIATION IN DIMENSIONS ± .010" UNLESS OTHERWISE SPECIFIED
DATE
LET
REVISIONS
WAS
CHK
THE UNIVERSITY OF MICHIGAN
TITLE
PIVOT BLOCK
STANDARD SEAT ASSY
MATERIAL STEEL
SPECIFICATION
SCALE
STARTED 10-10-74
DRAWN B. Campbell
FINISHED 10-10-74
CHECK
APPROVED
PROJECT
W O
DEPT
MODEL
TREATMENT
NO. 100-908




ALLOWABLE VARIATION IN DIMENSIONS ± .010" UNLESS OTHERWISE SPECIFIED

| DATE | LET | WAS | CHK |
|---|---|---|---|

REVISIONS

THE UNIVERSITY OF MICHIGAN

TITLE

DYNAMIC TUNING BLOCK
STANDARD SEAT ASS'Y

MATERIAL STEEL
SPECIFICATION
SCALE
DRAWN B. Campbell
CHECK
PROJECT
DEPT.
MODEL
TREATMENT

NO. 100-909