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USAARL REPORT NO. 72-07

DYNAMIC AND CRASHWORTHY EVALUATION OF THE UH-1B, C, D, H, MEDICAL ATTENDANT'S SEAT

By

Errol B. Barber
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January 1972

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

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The challenge was to evaluate the crashworthiness of the UH-1 Medical Attendant's Seat and investigate the feasibility of modifications to improve the seat and its restraint system. This report is a record of USAARL's involvement, from researching the background to achieve a proper direction for study, through accident statistics, stress analysis, dynamic test program, reduction of data, interpretation conclusion and finally feasible recommendations. The seat was found to be completely noncrash-worthy and a direct contributor of serious injuries to its occupants mostly to the upper torso and head because of poor occupant restraint. Its construction and manufacture did not meet all of the design criteria of military seat specifications. The dynamic tests of the seat demonstrated that with the addition of an inertia reel, shoulder harness, and attachment of the lap belt to the floor a seat occupant could be satisfactorily restrained despite serious seat failure during a crash. The proposed modifications in kit form will provide the seat's occupant with the greatest increase in safety and retention, should crash occur, for the lowest dollar investment and "down time" required for its installation.

This seat should not be considered for incorporation into any future military aircraft.

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APPROVED: ROBERT W. BAILEY
Colonel, MSC
Commanding

FORWARD

The dynamic test portions of this report were accomplished under contract DABCO1-71-0141. The work was performed by Dynamic Science, Phoenix, Arizona.

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INTRODUCTION:

THE PROBLEM

The UH-1 Medical Attendant's Seat (Jump Seat)* is a lightweight aluminum tubular structure designed to be folded or unfolded for storage or use. This seat is officially authorized for use in the aft facing position but has been widely used by the aviation training commands, CONUS and worldwide commands, including those in Southeast Asia, in the sideward and forward facing positions.

Injuries and fatalities have been directly attributed to design inadequacies of this seat. This generated a priority message dated September 1969 from the Commanding General, Third United States Army to Fort Rucker, addressees included the US Army Board for Aviation Accident Research, the US Army Aeromedical Research Laboratory, and the Commanding General, Aviation Systems Command. The message requested an expedited maintenance work order (MWO) to modify the Medical Attendant's Seat to lessen the crash hazards. The installation of a shoulder harness was suggested.

BACKGROUND

The Bioengineering and Evaluation Division, USAARL, and the Life Sciences Division, USABAAR conducted a complete review of the history, design characteristics, and accident statistics of this seat. Correspondence from the field indicated that many individuals have been severely injured or killed as a result of seat collapse and/or facial impact with seat backs and other cockpit objects during forward jackknifing as a result of hard landings and crashes. See Figures 1 and 2. Two thousand twenty-seven major accidents were reviewed covering the period 1 January 1967 through 30 September 1970. Fourteen accident reports made mention of injuries or fatalities received while sitting in the Medical Attendant's Seat. Table I describes this information in more detail. It has been determined that additional personnel received varying degrees of injury while occupying the UH-1 Medical Attendant's Seat during a

* The terms, Medical Attendant's Seat and Jump Seat, are used interchangeably in this report.

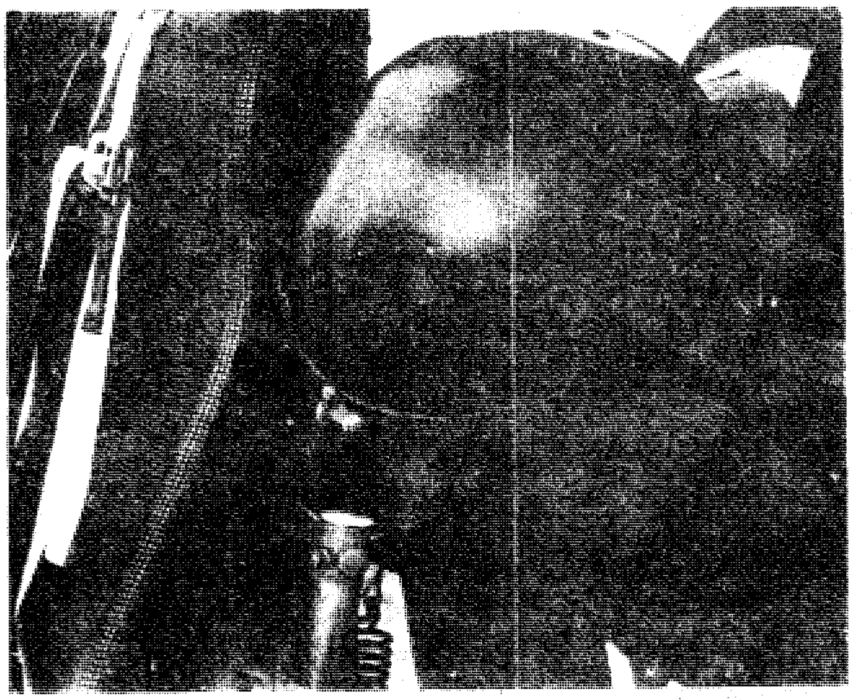


Figure 1. Possible Fatal or Morbid Injuries When Seat is Installed Behind Pilot - Copilot Seats with Maximum Rearward Adjustment.

Figure 2. Demonstration of Head - Seat Contact is Allowed by Basic Seat When Used Behind Crew Seat and Without Shoulder Harness.

crash sequence but were not reported to occupy that position. Essentially no combat information exists on injuries received while sitting in this seat.

TABLE I

67-70 UH-1 JUMP SEAT INJURIES IN MAJOR ACCIDENTS*

"Nonsurvivable"

Model	Type Injuries	Cause
UH-1B	Fatal - Multiple	Impact Forces, seat Disintegration
UH-1A	Fatal - Multiple	As above

"Survivable"

Model	Type Injuries	Cause
UH-1A	Major - Facial	Lack of restraint Seat Torn Loose
UH-1B	Major - Back Fractures	Lack of restraint Seat Collapse
UH-1B	**Minor - Thorax	Lack of restraint
UH-1B	Minor - Type Unknown	Lack of restraint
UH-1B	Major - Facial	Lack of restraint
UH-1B	Minor - Facial and Back	Lack of restraint Seat Collapse
UH-1B	Minor - Facial	Lack of restraint
UH-1B	Minor - Facial, Extremities	Lack of restraint
UH-1D	Minor - Facial	Lack of restraint
UH-1D	Minor - Facial	Lack of restraint
UH-1D	Major - Facial	Lack of restraint
UH-1D	Major - Facial, Neck Dislocation	Lack of restraint

* This is not an all inclusive list but represents available USABAAR data. At least five additional major injuries are known. At least three major injuries from minor accidents are known.

** Major Facial injuries prevented by lowered helmet visor.

Only UH-1 aircraft in the Fort Rucker and Hunter-Stewart training commands were originally considered for modification. In December 1969, the US Army Aeromedical Research Laboratory queried safety officers and flight surgeons of all major aviation commands and subcommands in CONUS, Europe and Southeast Asia regarding the various uses of the Medical Attendant's Seat in UH-1 aircraft. The responses indicated that the Medical Attendant's Seat is used worldwide in configurations other than aft facing. Within the training command, an estimated 600 to 800 UH-1 helicopters are used as trainers and on the average, eight students per helicopter per day are exposed to the hazards of sitting in a forward facing Jump Seat. The seat is used in this position to better utilize the flight hours available in a given helicopter by putting an additional student in the middle position. In combat and non-combat commands, the seat is used in the side facing position for command and control operations and observation. It is used in the forward facing position for training, command and control operations, observation, administrative and check-ride flights.

Because there was an identified hazard and large numbers of personnel were exposed to this hazard on an Army wide basis, the US Army Aeromedical Research Laboratory undertook a bio-engineering and dynamic evaluation of this seat.

The objectives of this evaluation were: (1) To determine any deficiencies in the seat's crashworthy design and to assess their significance. (2) To recommend any feasible modifications which could be incorporated into the current design but improve occupant retention and crashworthiness. (3) To prepare sufficient justification to recommend the adaptation of an entirely new seat design should the evaluation results warrant this action. (4) To develop data for the purpose of adapting an upgraded and realistic set of military specifications governing the design and quality control aspects of similar seats.

DESCRIPTION OF THE SEAT

The UH-1B, C, D, H Medical Attendant's Seat (Jump Seat) is a lightweight tubular structure constructed of 2024ST aluminum alloy. The seat is classified as a Type A-10 and manufactured in accordance with MIL-S-5822. The seat back and seat pan is constructed of nylon in accordance with MIL-C-7219. The basic seat has a design criteria of weighing less than 12 pounds and the capability of being folded and unfolded in less than 10 seconds. The seat has four legs to which collared, quick disconnects are attached. These mate with studs recessed within the aircraft floor. The only safety feature with which the seat is presently equipped is the standard 1-3/4" type C-3A aviation lap belt. The lap belt is attached to lap belt rings located at the rear most aspect of the seat pan.

The Medical Attendant's Seat designed for the UH-1A aircraft was a welded steel structure and not a subject of this evaluation or report.

Seats for the B, C, D and H models are manufactured by the C. R. Daniels Company in Daniels, Maryland. The government part numbers for seats available for each model aircraft are listed in Table II.

TABLE II

SEAT PART NUMBERS FOR UH-1 AIRCRAFT

UH-1B	204-070-023-1 204-070-023-2 204-070-023-5
UH-1C	As Above
UH-1D	205-070-703-1 205-070-703-5 205-070-703-7
UH-1H	As Above

All Medical Attendant's Seats are not interchangeable with all UH-1 aircraft. As a result of production line changes, the floor geometry of the attachment studs varies from aircraft model to model and within a model group. Some floors have a rectangular stud geometry. The Medical Attendant's Seat has a square leg geometry and can be placed into the aircraft in the forward, side or aft facing positions behind either the pilot or copilot seat or in the center directly behind the radio console. A one-time check of 150 aircraft at Fort Rucker indicated that 18 seats were inadequately matched to floor or tie-down geometry. Of the 18 seats, most had required forcing of the seat structure in order to lock all four legs to the floor. An additional five seats had only two or three legs attached to the floor because of geometry differences.

The basic design strength of the seat is outlined in MIL-8-5822A and is shown in Table III. The manufacturer is required to proof load the seat to the values indicated under the column entitled proof loads. The ultimate strength of the seat prior to failure under static load is listed in the ultimate load column.

TABLE III

REQUIRED STRENGTH OF BASIC SEAT

Force Direction	Point of Application	Static Loads Proof (Pounds)	(Pounds) Ultimate
Vertical-down	Seat Bottom	2,000	3,000
Vertical-down	Seat Back	670	1,000
Lateral	Point 10.5" above seat & 11.5" forward of Back	1,335	2,000
Forward & up at 40°	Lap Belt with equal distribution	960	1,440
*Forward Horizontal	*Shoulder Harness at take up Reel	600	900
Vertical-up	Lap Belt Attachments	1,000	1,500

*Basic Seat does not include shoulder harness.

It must be noted that the Type A-10 (MIL-S-5822) classification is for adjustable pilot's seats for installation in short range aircraft requiring medium strength with floor attachment points. The military specification makes no indication of the materials to be used for seat pan or seat back construction. This specification does not cover seats that are intended to be folded or utilized other than in the pilot's position. All fittings and joints requiring disassembly for installation and removal of the seat from the airplane or disassembly of the component parts of the seat are required to be bolted or otherwise pinned.

METHODS AND MATERIALS:

A literature search on the seat revealed that the structural characteristics were unknown. As a preliminary evaluation prior to establishing a test program, a rigorous analysis of the seat structure was performed using straight-forward Strength of Materials procedures. From the analysis, the seat configurations to be tested were determined and the outline of the test procedures was established. The tests were performed under contract by Dynamic Science in Phoenix, Arizona.

Stress Analysis

The basic approach to a problem of this nature is to simplify the appearance of the structural members as much as possible in a diagram for clarity. Figure 3 below represents the Medical Attendant's Seat structure from the seat down to the attaching pins.

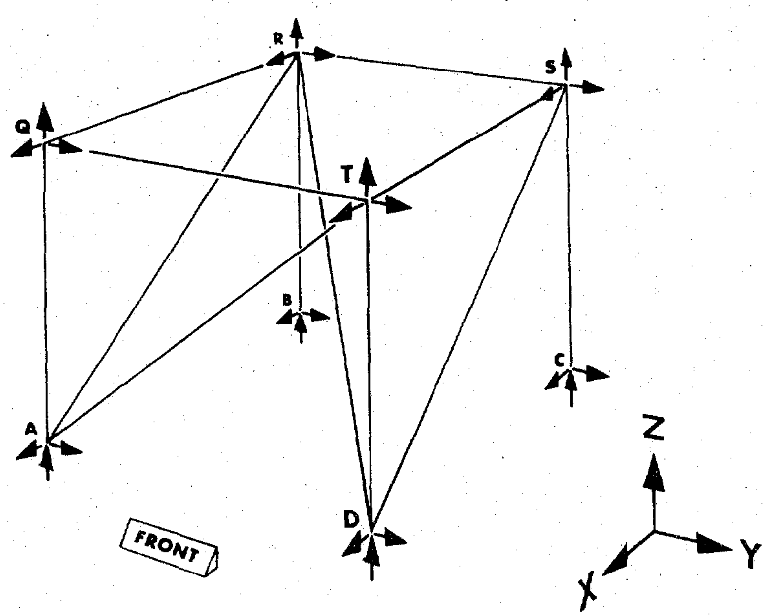


Figure 3. Representation of Structural Members for Analysis.

The approach is then to assume an input, a force at the bottom of the legs where the seat is attached. This force is then followed through each member, joint and interface of the structure of the seat. Although it is a gross over simplification of the method, essentially what must be done at each point on every member is to balance the forces and moments, or torques at that point. Thus, the basic equations for a static analysis of any body are:

$$\Sigma F = 0$$

$$\Sigma M = 0$$

Whatever effect the hypothesized force may have at a particular point, according to the strength at that point, is noted for reference. When the force has been resolved in every possible direction and the effects analyzed at every potential failure point, the analysis is complete and the interpretation must follow.

Approach

From the static analysis it was found that the weakest apparent member in the basic seat was the horizontal bolt securing the right rear female tab to the rear lateral seat pan frame member. The analysis predicted that this bolt would shear at an input to the seat of 7.4G, vertical deceleration. To allow for variation in the properties of materials and accuracies of instrumentation, the upper limit of input for the tests was placed at 8.0G. A low level of input, 4G, was used for each test as a baseline to see how the loading changed in the seat with changes in configuration.

Seat Configuration

Four configurations were developed for testing, ranging from the basic seat to one that was believed to be the best improvement in light of the analysis, within the limitations of cost and availability. The variations in these seats are discussed below:

CONFIGURATION 1

The first configuration (Figure 4) was the basic jump seat. The type C-3A lap belt is used with this seat, attached to rings on the side of the seat.

CONFIGURATION 2

The second configuration (Figure 5) was the basic jump seat with one variation, i.e., the lap belt was threaded through the lap belt rings and attached to the helicopter floor 22 inches aft of the rear legs of the jump seat.

CONFIGURATION 3

The third configuration (Figure 6) was the basic jump seat with four variations. The variations included the addition of a shoulder harness, an inertia reel with lock handle, aluminum inertia reel support extrusion, and two tie-down cables. A Type G-1 shoulder harness with a Type MA-6 inertia reel was attached to the seat through an aluminum plate extrusion. The extrusion was attached to the back of the rear seat legs by/with four #10 bolts. The inertia reel lock handle was attached to the left longitudinal frame tube with two #10 bolts. A push-pull cable connected the inertia reel lock to the inertia reel. The lap belt buckle tang was passed through eyes sewn in the ends of the shoulder harness. The lap belt was attached to the seat through the lap belt rings. Two tie-down cables anchored the seat to the helicopter floor 22 inches aft of the rear legs. The cables attached to the seat through the lap belt rings. This seat configuration was also used in a controlled helicopter crash test. A shoulder harness guide was used on the top of the seat back in the vertical and longitudinal tests but not in the helicopter test.

CONFIGURATION 4

The fourth configuration (Figure 7) had the same four variations as the third configuration, and in addition, the aluminum U-shaped seat back tube was replaced with a steel tube. A shoulder harness guide was welded to the top of the steel back tube.

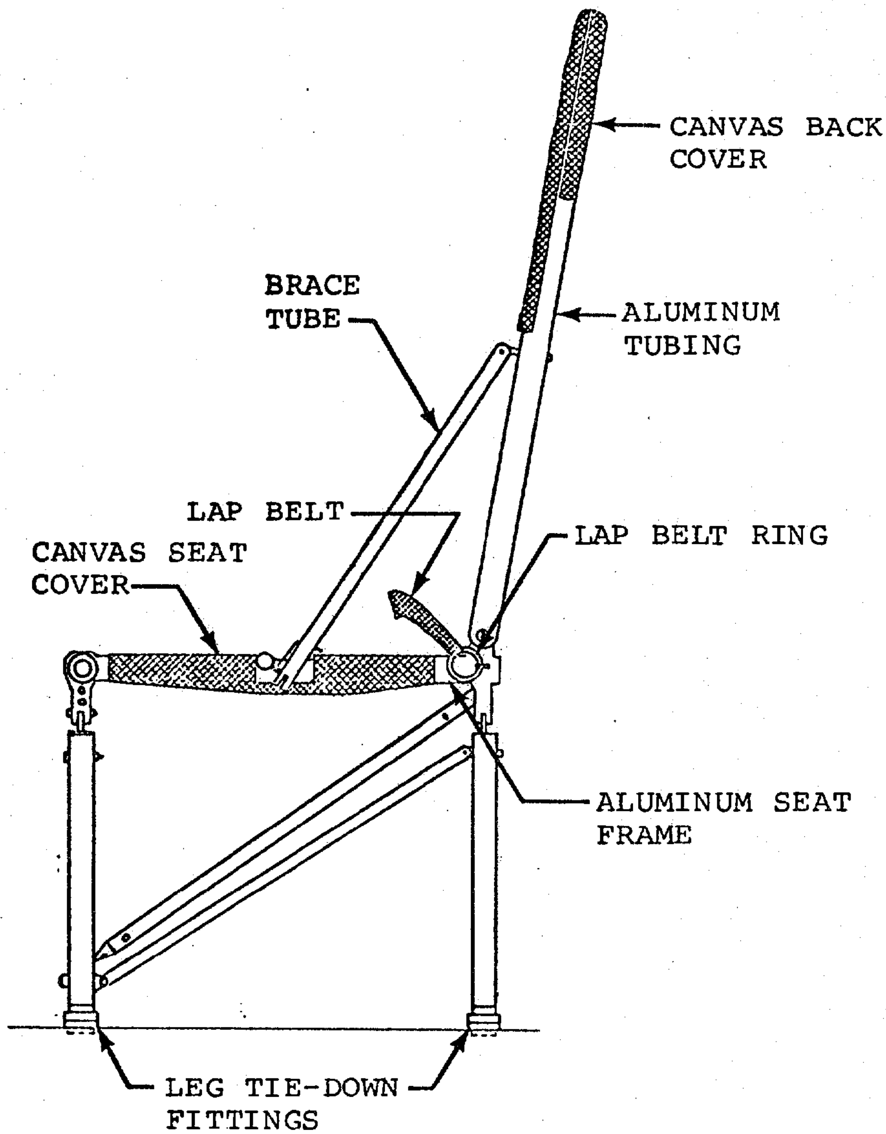


Figure 4 Jump Seat Configuration 1.

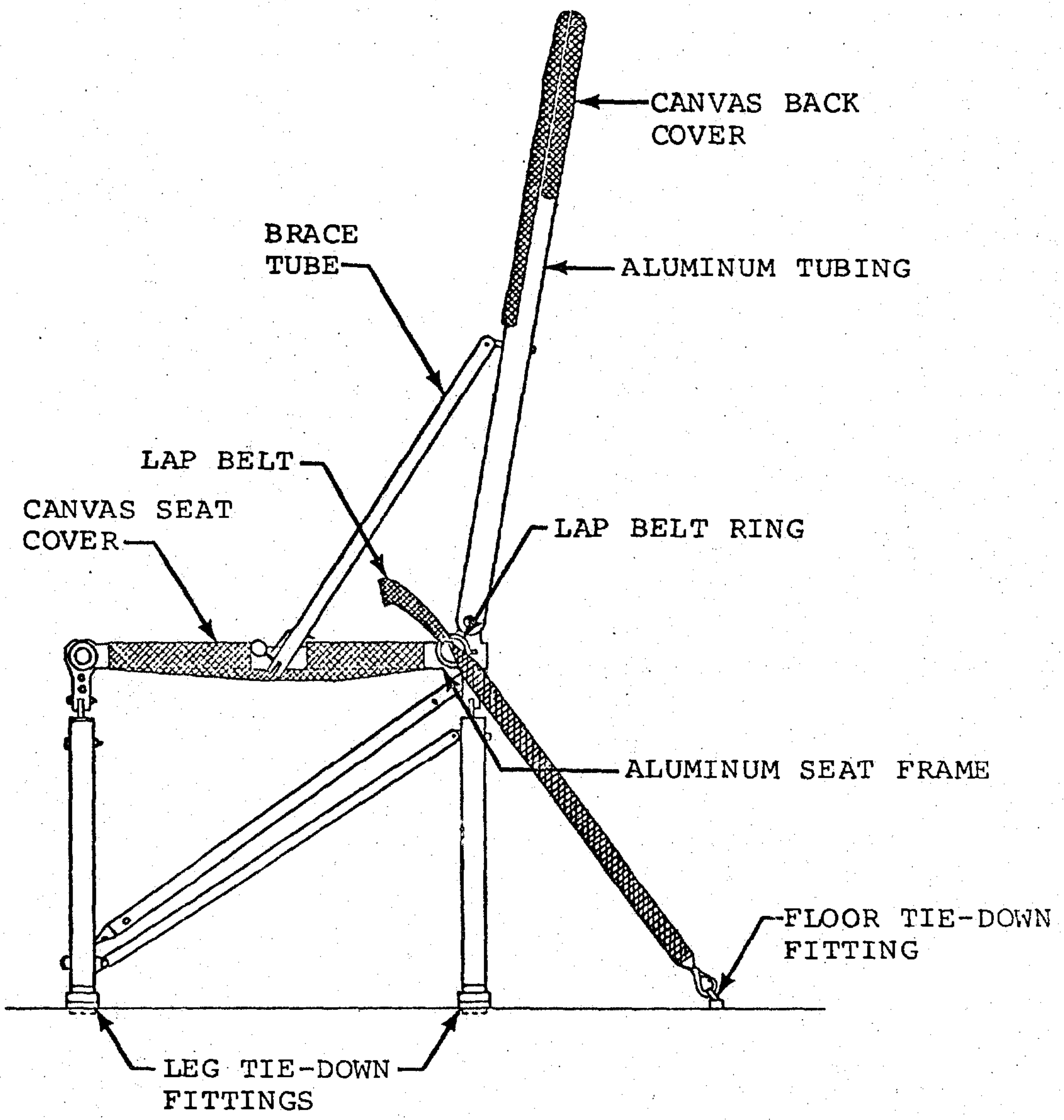


Figure 5 Jump Seat Configuration 2.

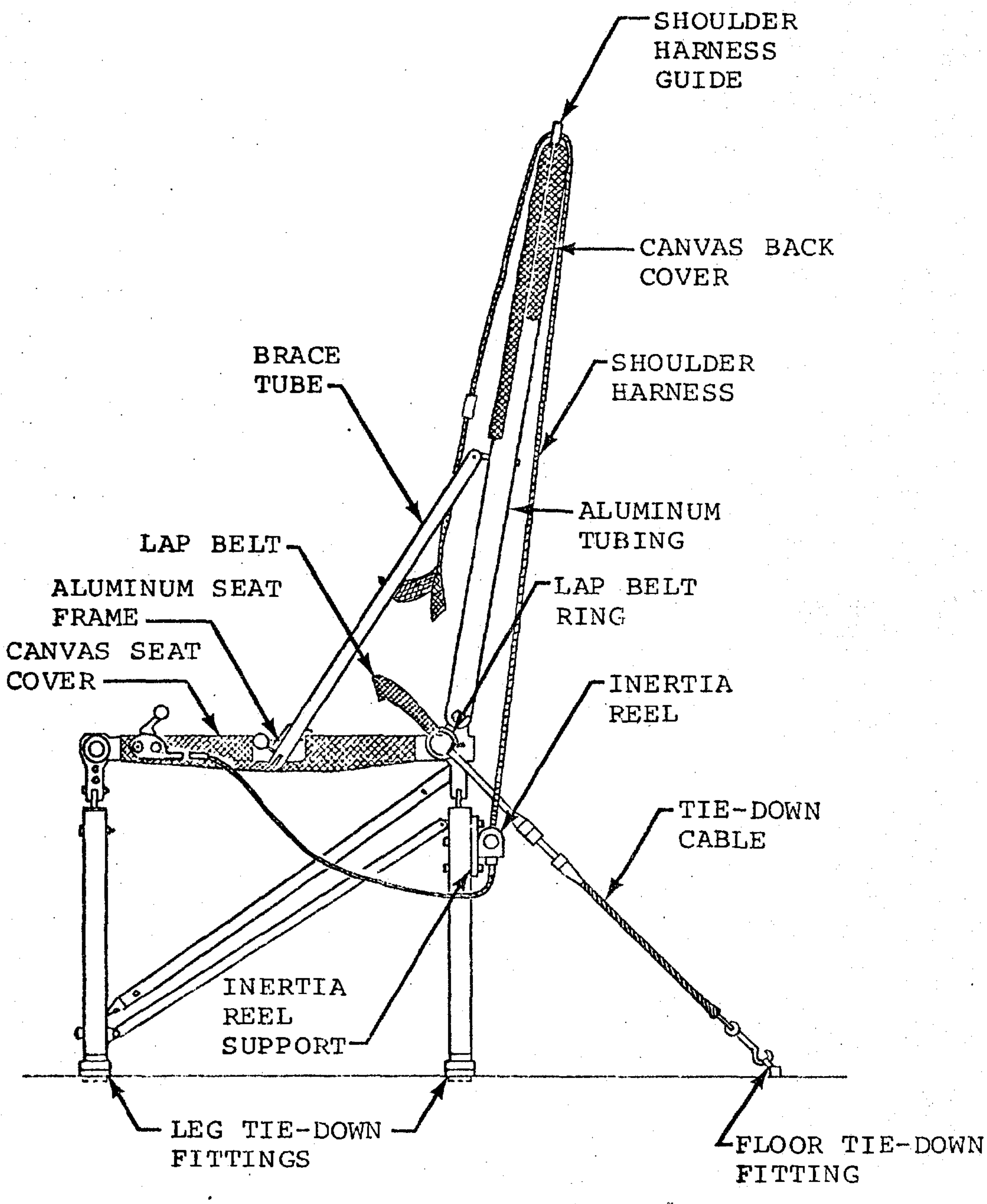


Figure 6   Jump Seat Configuration 3.

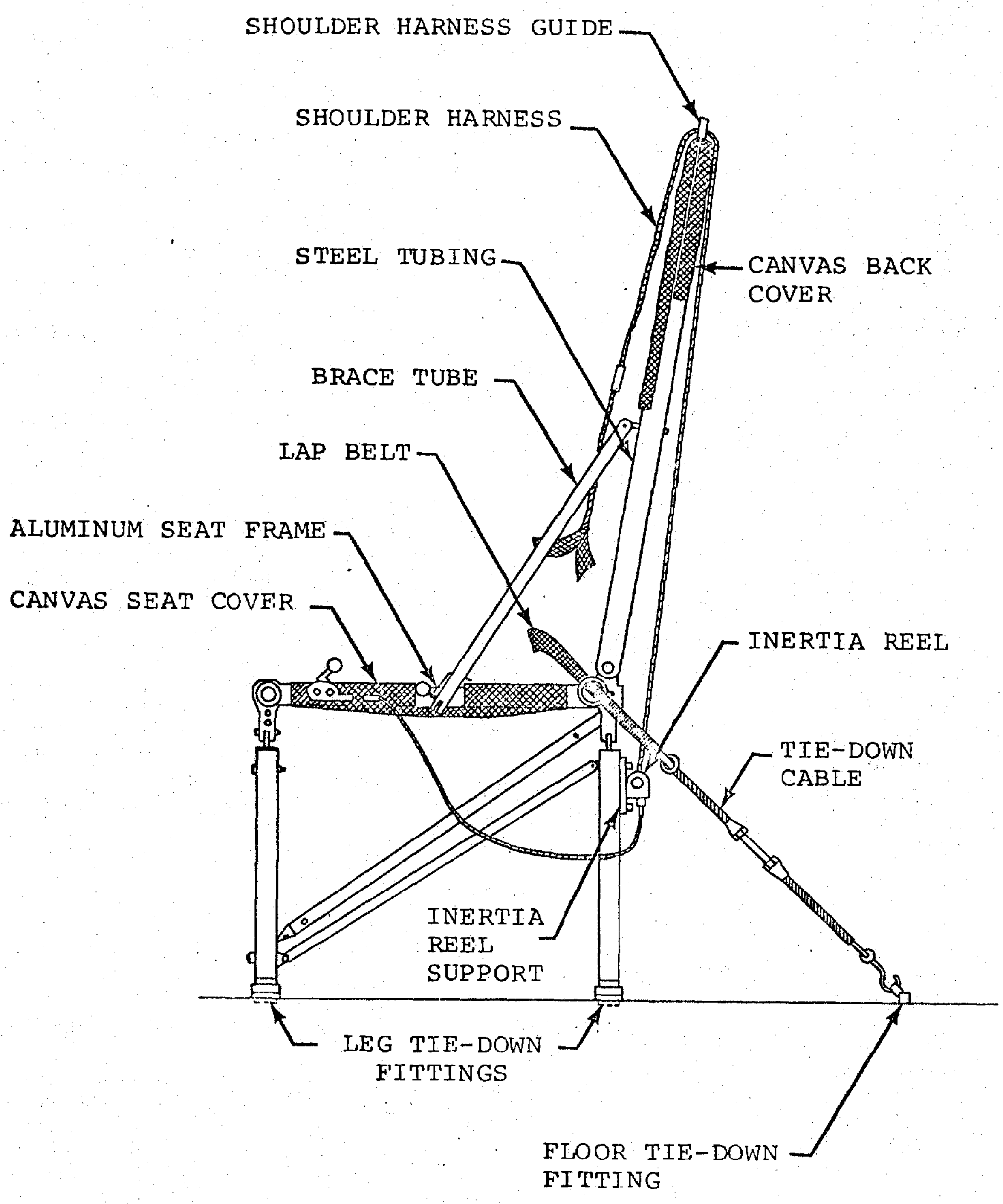


Figure 7. Jump Seat Configuration 4.

TEST PROCEDURES

Eight seats were supplied to Dynamic Science for dynamic testing and a matrix for 16 tests was developed. Seat configurations 1, 2, and 3 were tested both at a 4G input level and at an 8G input level. Configuration 3 was tested at inputs of 12G and 16G in the droptower. Configuration 4 was tested only at an 8G input level. The seats were oriented to provide a triaxial combined test loading using a drop tower as the test facility and to provide a biaxial test loading using a longitudinal accelerator. In addition, one of the seats was installed in a UH-1 helicopter which was crash tested in a program involving development of an advanced crashworthy fuel system.

In all tests, the seat occupant was an anthropomorphic dummy representative of a 95th percentile Army aviator. The test seat and dummy were instrumented with accelerometers and load cells to measure pertinent data. In addition, the front seat legs were mounted on special test fixtures which permitted the measurement of longitudinal, lateral, and vertical loads. (See Figure 8) Vertical loads were measured in the back legs of the seats. Loads were also measured in the lap belt, shoulder harness, and tie-down cables.

Table IV presents a summary of seat configurations by test number. Test conditions for all dynamic tests are given in Table V.

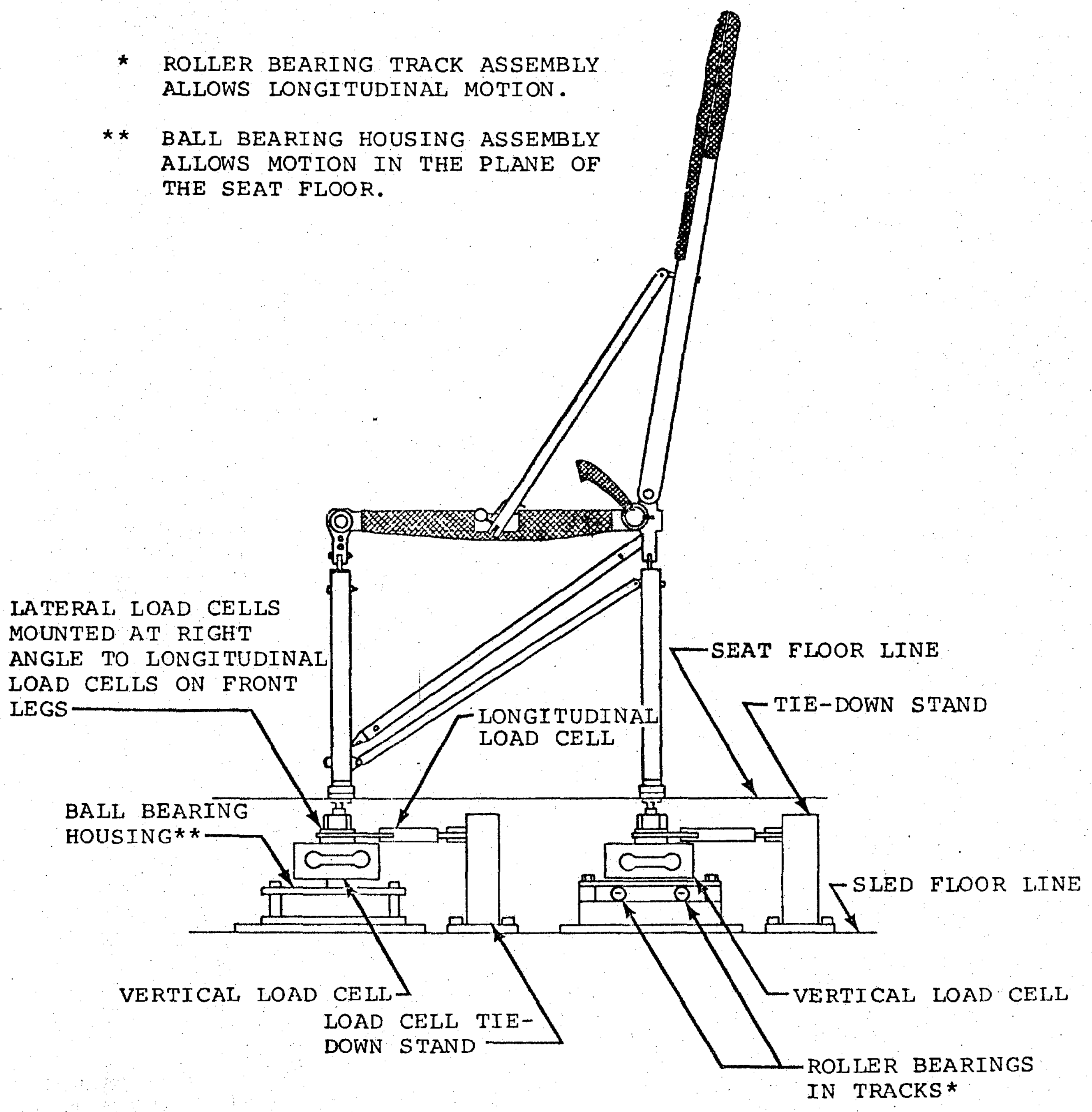


Figure 8 Seat Mount Load Cell Locations.

TABLE IV. SEAT CONFIGURATION

TEST NO.	SEAT ORIENTATION	SEAT CONFIGURATION	LAP BELT	SHOULDER HARNESS	CABLE
1	See Figure 9	Seat 1	Attached to Seat	None	None
2	↕	Seat 1	Attached to Seat	None	None
3	↕	Seat 2	Attached to Floor	None	None
4	↕	Seat 2	Attached to Floor	None	None
5	↕	Seat 3	Attached to Seat	Installed with Inertia Reel	Installed
6	↕	Seat 3	Attached to Seat	Installed with Inertia Reel	Installed
7	↕	Seat 3	Attached to Seat	Installed with Inertia Reel	Installed
8	See Figure 9	Seat 3	Attached to Seat	Installed with Inertia Reel	Installed
9	See Figure 10	Seat 1	Attached to Seat	None	None
10	↕	Seat 1	Attached to Seat	None	None
11	↕	Seat 2	Attached to Floor	None	None
12	↕	Seat 2	Attached to Floor	None	None
13	↕	Seat 3	Attached to Seat	Installed with Inertia Reel	Installed
14	↕	Seat 3	Attached to Seat	Installed with Inertia Reel	Installed
15	See Figure 11	Seat 4	Attached to Seat	Installed with Inertia Reel	Installed
16	Helicopter	Seat 3	Attached to Seat	Installed with Inertia Reel	Installed

TABLE V. DYNAMIC TEST CONDITIONS

	TEST NO.	ORIENTATION OF SEAT	PEAK ACCELERATION (G)	VELOCITY CHANGE (ft/sec)	TIME DURATION (sec)
VERTICAL	1	See Figure 9	4	35	.282
	2	↕	8	35	.156
	3	↕	4	35	.282
	4	↕	8	35	.156
	5	↕	4	35	.282
	6	↕	8	35	.156
	7	↕	12	35	.282
	8	See Figure 9	16	35	.156
HORIZONTAL	9	See Figure 10	4	35	.282
	10	↕	8	35	.156
	11	↕	4	35	.282
	12	↕	8	35	.156
	13	↕	4	35	.282
	14	↕	8	35	.156
	15	See Figure 10	8	35	.282
	16	Helicopter	-Helicopter Crash Test-		

Each seat configuration was in turn subjected to the designed inputs as dictated by the test outline. All vertical tests were run in succession, then all longitudinal tests. Configuration 3 was also installed in a Huey fuselage and subjected to controlled crash conditions.

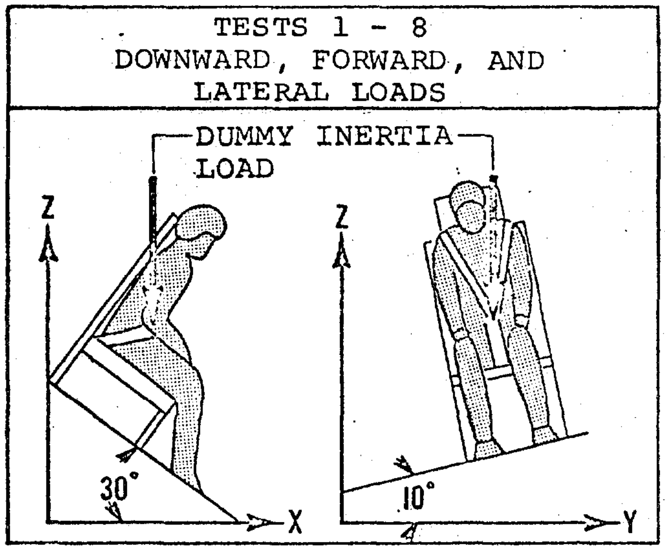


Figure 9. Seat Orientation For Drop Tests.

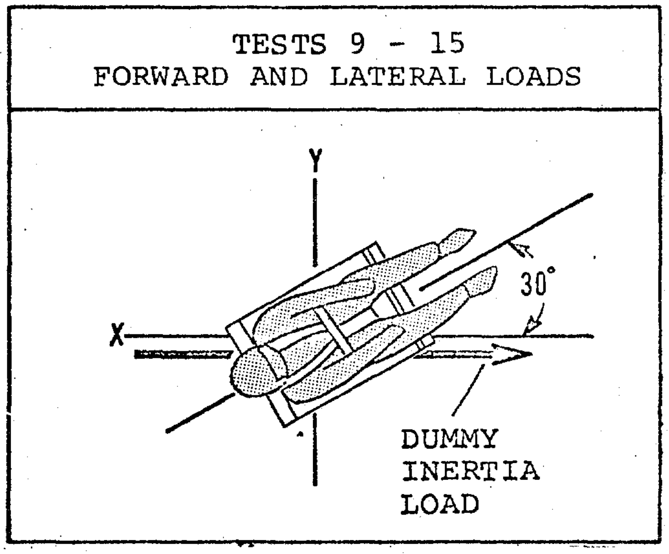


Figure 10. Seat Orientation For Sled Tests.

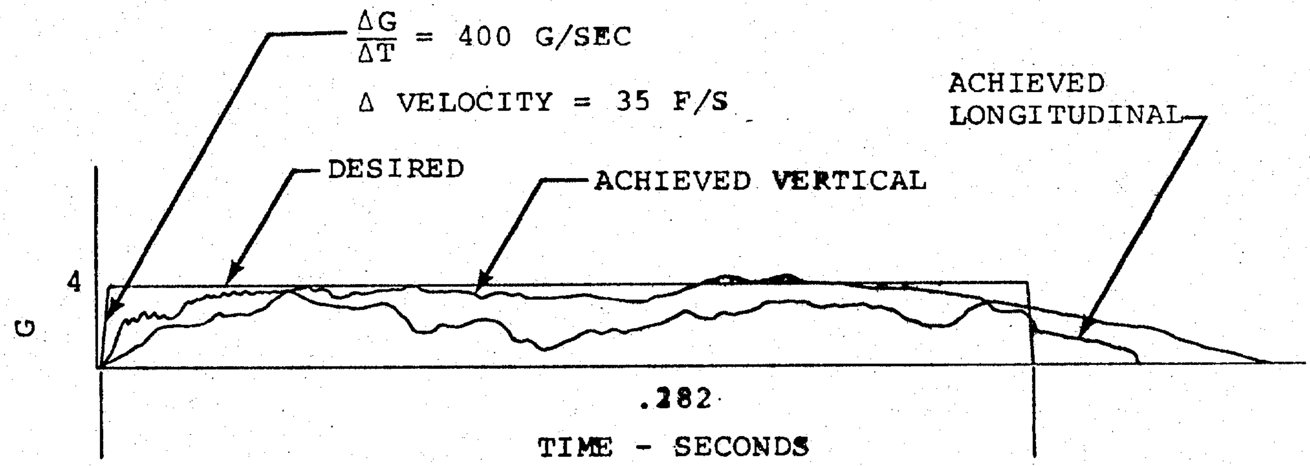


Figure 11. 4G Test Pulse.

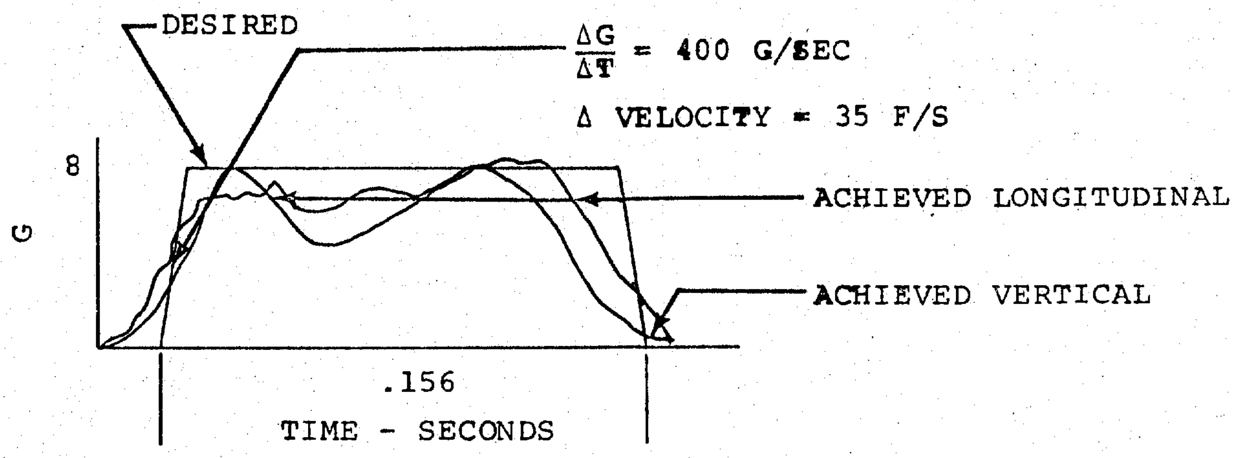


Figure 12. 8G Test Pulse.

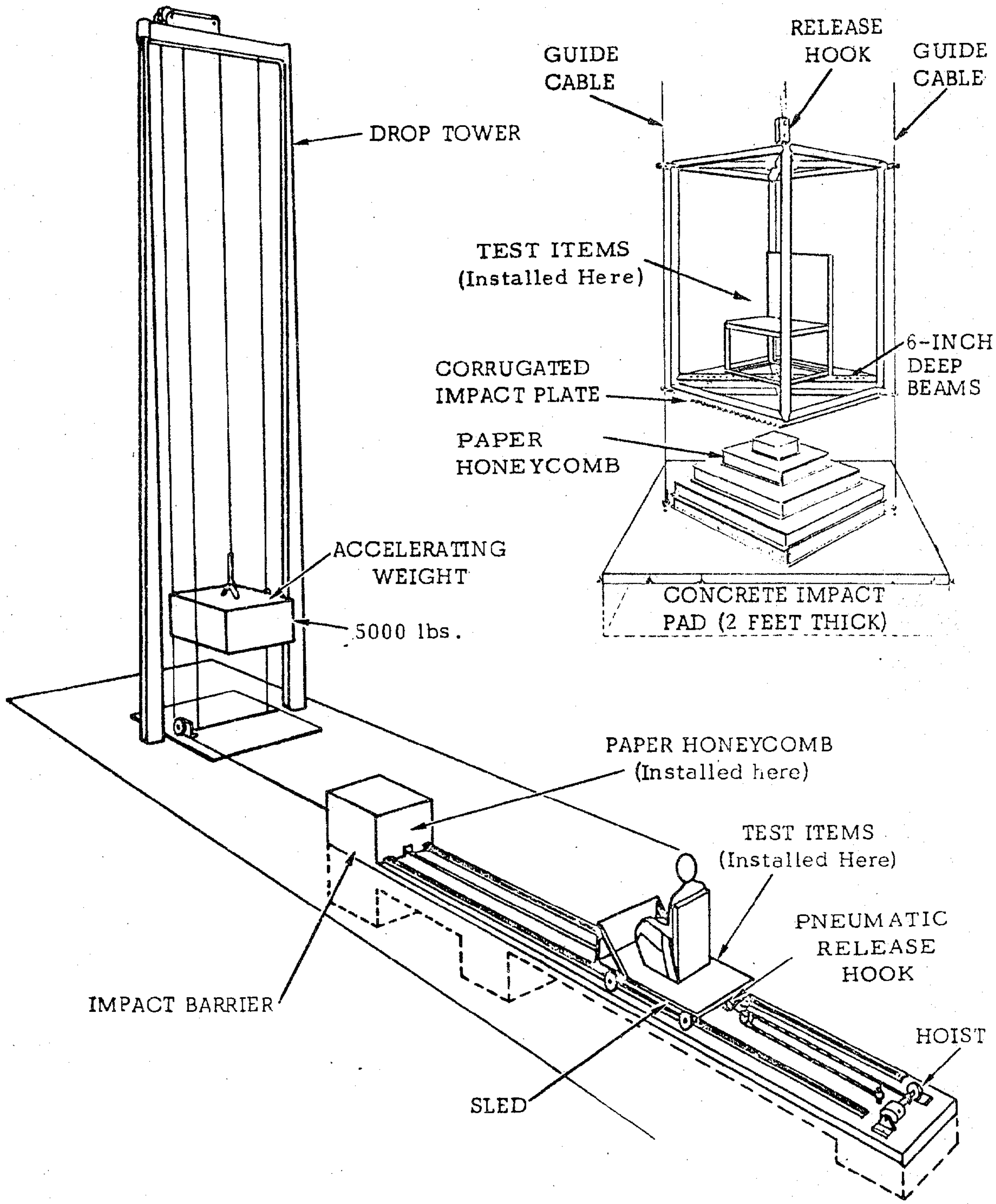


Figure 13 Drop Tower and Longitudinal Accelerator Installation.

Drop Tower Vertical Test Procedure

The drop tower facility shown in Figure 13 was used to produce the vertical input accelerations for Tests 1 through 8. The drop cage was modified to mount the seat in the required orientation to produce triaxial loading (See Figure 10) in accordance with design outlines given in the Crash Survival Design Guide.* The seat mount shown in Figure 8 was fabricated to accept the seat and the required instrumentation which included load measurements in the longitudinal, lateral, and vertical axes on the front legs and vertical axis only on the back legs. The seat was installed in the cage and the cage raised to the proper height to give the required input velocity when released. Upon release, the cage impacted a stack of paper honeycomb that was designed to produce the desired input deceleration pulse.

Calibration tests were conducted for Tests 1 through 8 to verify the honeycomb stack design. Figures 11 and 12 show the achieved input test pulses superimposed on the desired pulses. Deceleration from the relatively high impact velocity at the low G levels made it impossible to completely match the rate of onset and trapazoidal shape of the desired deceleration time traces. The deceleration plateaus and velocity changes were achieved, however, and the test pulses were judged adequate to fulfill the test objectives.

Two high-speed Photo-sonic cameras operating at 500 frames per second were positioned near the drop tower to provide overall left side and back views of the test assembly. The vertical cage structure and seat mount structure were striped with alternating white and black 1-inch tape to aid in photographic measurement of vertical deflection.

An Alderson P-95 anthropometric dummy was installed in each seat tested and instrumented as shown in Appendix I.

*USAAVLABS TECHNICAL REPORT 70-72.

Longitudinal Accelerator Tests Procedure

The drop tower was converted to the longitudinal accelerator mode as shown in Figure 13 to produce the longitudinal input pulses for Test 9-15. To perform this conversion the drop tower was fitted with a 5,000-pound weight connected through a cable and a series of pulleys to a sled mounted on the horizontal track. In operation the sled was drawn back along the track, raising the weight in the tower to the prescribed height. When released, the sled was accelerated by the falling weight to specified velocity. The falling weight was stopped by a pile of sand, allowing the sled to run free and impact a stack of paper honeycomb mounted on the face of the impact barrier, creating the deceleration pulse on the sled. The seat was oriented on the sled as shown in Figure 10.

As was done for the drop tests, calibration tests were performed to verify the honeycomb stack design and drop height for the horizontal tests. The calibration tests indicated peak decelerations slightly lower than the design pulse peaks and shaped slightly different than the design pulses as shown in Figures 11 and 12. The calibration test pulses were judged satisfactory and testing was conducted

Two Photo-sonic high-speed cameras operating at 500 frames per second were positioned to provide overall side and back views of the seat during impact.

An Alderson P-95 anthropometric dummy was installed in each seat tested and instrumented as shown in Appendix I.

Helicopter Dynamic Test

A UH-1 helicopter was crash tested in an autorotation attitude as part of an advanced fuel system crashworthiness program. A Configuration 3 jump seat was installed in this helicopter in the forward-facing position behind the cockpit center console as shown in Figure 14. An Alderson P-95 anthropometric dummy was installed in the jump seat. The seat and dummy were instrumented as shown in Appendix I. Seven high-speed cameras were placed around the crash test site. In addition, there were three on-board cameras, two of which had the jump seat in their field of view. The helicopter was guided down a cable as shown in Figure 15. Several boulders and two stumps were placed in the crash impact area to test the fuel system.

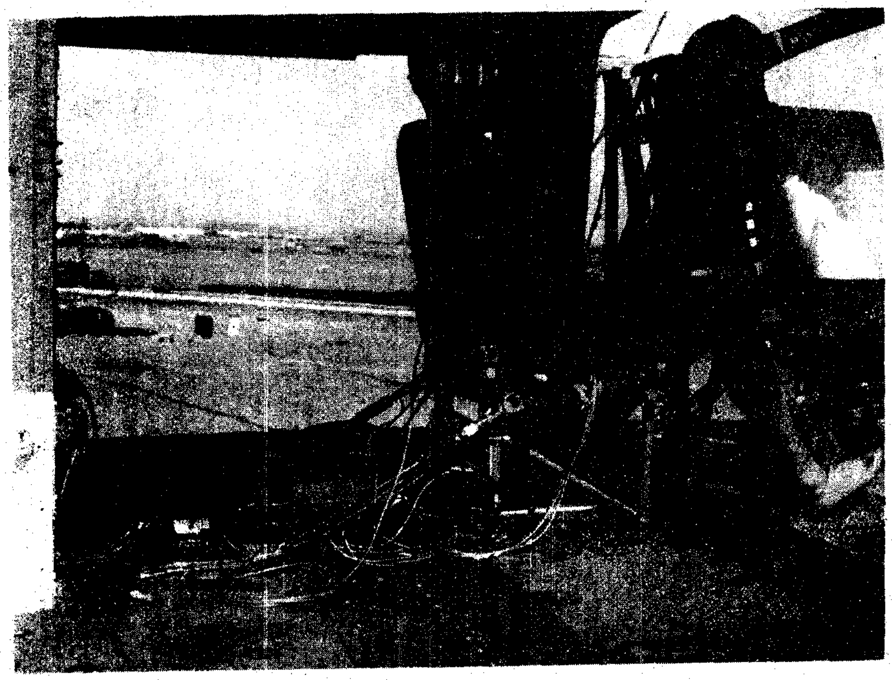


FIGURE 14

Installation of Seat in UH-1D, Controlled Crash

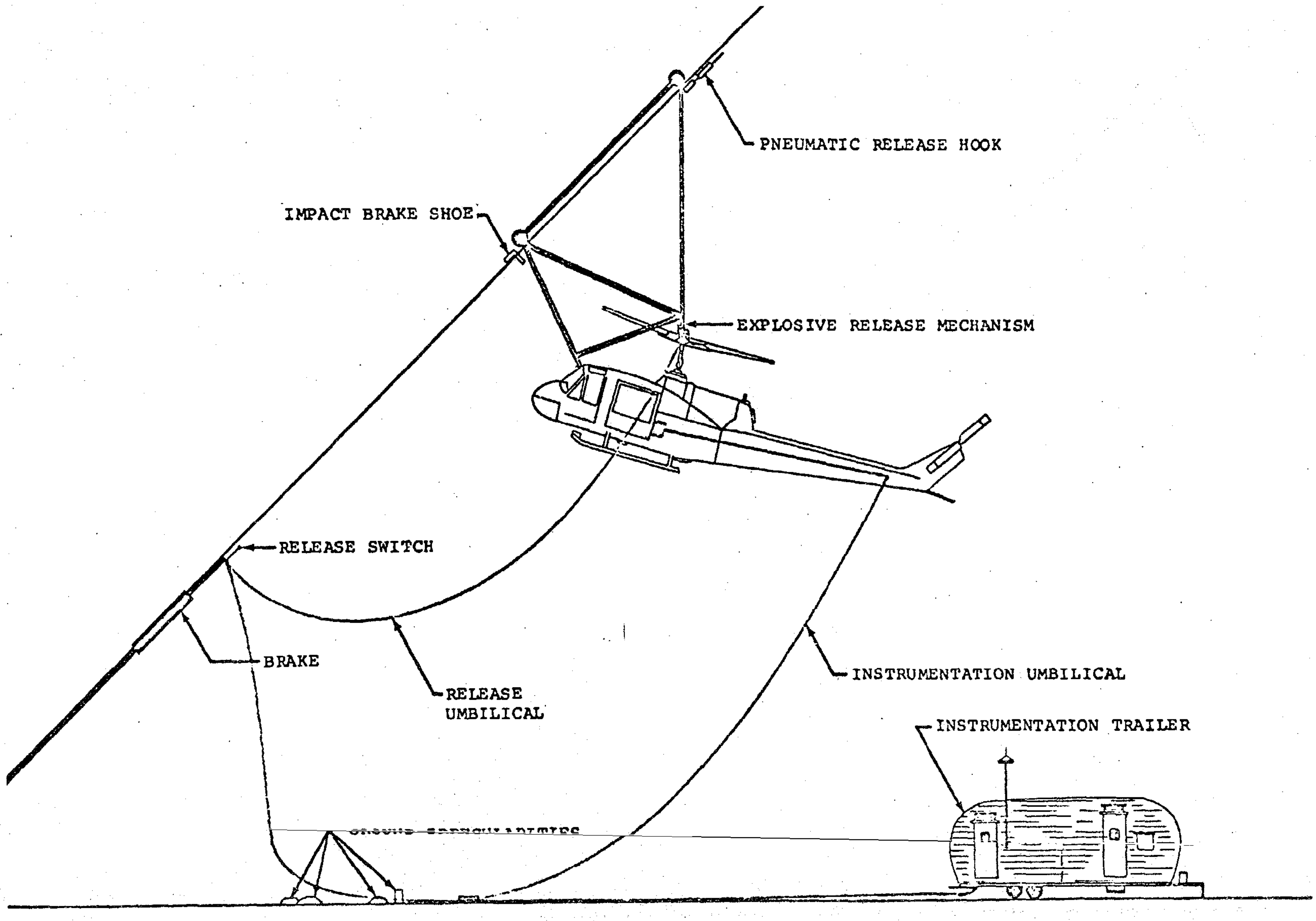


Figure 15. Schematic of Test 16 Setup.

TEST INSTRUMENTATION

The accelerometers used in this test program were Statham instruments, Models A5 and A6. This instrument provides a frequency response in excess of 200 cps. All the force transducers used were calibrated strain links fabricated by Dynamic Science except for two Lebow Model 3371 lap belt force transducers used in Tests 9 through 15.

All instrumentation was installed in accordance with Table VI.

The measurements listed in Table VI were recorded on a Magnetic tape recording system. The magnetic tape recording system utilized a constant band width AM/FM multiplex modulation technique in which the analog signal from the transducer is converted by a subcarrier oscillator into a frequency deviation proportional to the input signal amplitude. Seven of these subcarrier oscillator outputs may be combined in a mixer amplifier and the resulting composite signal recorded on one track of a 14-track tape recorder.

The data recorded on the magnetic tape recording system were recovered by utilizing a compatible data processing system. In this system a playback tape recorder removes the composite signal from each track of the test tape and processes it through a series of FM discriminators which separate the composite signal into various subcarrier frequency deviations. The frequency deviations are then converted to an analog signal which is recorded directly on an oscillograph plotter. The resulting oscillograph record is then processed and is available as a scaled analog plot of the recorder parameter.

Photographic Instrumentation

Two Photo-sonic Model 16-1B high-speed cameras operating at 500 frames per second were used to record the dynamic response of the seat and dummy during each test. One camera was mounted to photograph the side of the seat/dummy installation while the other installed to provide an overall back view of the seat/dummy installation.

TABLE VI INSTRUMENTATION

Measurement	Direction	Range	Number Required
Common For Vertical and Longitudinal Tests			
Seat Leg Load	Vertical	0-2000 lb	4
Front Leg Load	Longitudinal	0-4000 lb	2
Front Leg Load	Lateral	0-4000 lb	2
Lap Belt Load	Right and Left	0-4000 lb	2
Tie-Down Cable Load	Right and Left	0-5000 lb	2
Occupant Chest Deceleration	Vertical	0-100 G	1
Occupant Chest Deceleration	Longitudinal	0-25 G	1
Occupant Chest Deceleration	Lateral	0-50 G	1
Occupant Pelvis Deceleration	Vertical	0-100 G	1
Occupant Pelvis Deceleration	Longitudinal	0-10 G	1
Occupant Pelvis Deceleration	Lateral	0-100 G	1
Seat Floor Deceleration	Vertical	0-100 G	1
Seat Floor Deceleration	Longitudinal	0-100 G	1
Shoulder Harness Load	Longitudinal	0-4000 lb	1
Vertical Tests Only			
Cage Floor Deceleration	Vertical	0-50 G	1
Cage Floor Deceleration	Longitudinal	0-50 G	1
Longitudinal Tests Only			
Sled Floor Deceleration	Longitudinal	0-50 G	1
Sled Floor Deceleration	Lateral	0-50 G	1
Helicopter Crash			
Lap Belt Load	Left	0-4000 lb	1
Shoulder Harness Load	Longitudinal	0-4000 lb	1
Occupant Chest Deceleration	Vertical	0-100 G	1
Occupant Chest Deceleration	Longitudinal	0-100 G	1
Tie-Down Cable Load	Right and Left	0-4000 lb	2
Seat Floor Deceleration	Vertical	0-200 G	1
Seat Floor Deceleration	Longitudinal	0-100 G	1
Seat Floor Deceleration	Lateral	0-100 G	1

TABLE VII DYNAMIC TEST DATA SUMMARY

	Vertical								Longitudinal							Crash
Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Seat Configuration	1	1	2	2	3	3	3	3	1	1	2	2	3	3	4	3
Left Front Seat Leg (lb)	226	465	202	405	306	405	917	1305	249	354	235	857	213	391	328	
Right Front Seat Leg (lb)	682	1565	688	1670	520	887	1500	1960	950	1860	1460	1800	487	1410	1730	
Left Rear Seat Leg (lb)	158	580	129			306	892	383	635	1180	246	284	588	630	842	
Right Rear Seat Leg (lb)	106	304	202		430	707	1400	1120	500	1170	233	500	637	940	634	
Left Front Leg Longitudinal (lb)	193	355	96	211	77	116	270	298	377	645	207	640	91	116	324	
Right Front Leg Longitudinal (lb)	295	703	333	527	15	129	372	352	700	1140	261	474	68		1110	
Left Front Leg Lateral (lb)	37	105	106	132	48	117	125	230	220	318	362	790	152	316	632	
Right Front Leg Lateral (lb)	144	354	208	297	87	173	795	423	282	450	288	695	260	506	308	
Left Lap Belt (lb)	96	445	265	565	973	500	410	245	695	1360	895	1750	446	1340	1240	970
Right Lap Belt (lb)		218	153	436	93		142	136	502	975	385	825	202	850	586	
Left Anchor Cable (lb)					376	520	627	810					515	865		728
Right Anchor Cable (lb)					350	389	1010	1010					661	1560		674
Dummy Chest Longitudinal (G)	4.17		6.10	8.80	5.86	21.40		16.20	4.75	10.80	8.57	18.40	5.98	9.68	8.65	12.20
Dummy Chest Vertical (G)	15.30	18.30	15.10	33.20	12.70	30.90	28.80	23.80	4.81	14.30	12.10	24.80	1.57	13.90	6.61	34.80
Dummy Chest Lateral (G)	3.23	5.64	2.33	4.92	2.32	8.00	20.00	8.83	4.15	14.20	3.53	23.40	3.56	10.30	7.70	
Dummy Pelvis Longitudinal (G)	3.38	6.69	3.26	4.22		4.48	7.94	7.15	3.68	12.40	3.56	8.45	4.17	8.45	8.91	
Dummy Pelvis Vertical (G)	7.65	15.80	7.50	13.40	7.31	14.30		40.00	5.85	10.10	4.83	12.10	3.70	10.50	7.30	
Dummy Pelvis Lateral (G)	2.10	3.86	2.04	4.22	1.75	3.10	6.31	6.88	5.44	13.10	3.61	9.80	3.63	10.20	7.34	
Seat Floor Vertical (G)	4.40	7.33	3.78	8.72	3.54	8.07	6.00	16.00								54.40
Seat Floor Longitudinal (G)	2.41	4.80	2.78	5.34	2.18		6.40	6.50	3.57	7.06	2.62	7.60	3.57	7.51	6.15	17.80
Cage Floor Vertical (G)	5.10*	8.50	4.10	9.65	4.50	9.40	14.20	16.90								
Cage Floor Longitudinal (G)	4.72	9.75	4.87	6.37	4.38											
Seat Floor Lateral (G)									1.84	3.62	1.74	4.14	1.64	3.16	4.35	13.00
Sled Floor Longitudinal (G)									3.74	7.83	3.48	7.87	3.48	7.74	7.50	
Shoulder Harness (lb)							199	153					164	531	326	280
Resultant Input Velocity Change (ft/sec)	37.10	32.30	36.50	45.70	46.40	39.40	33.00	27.90	27.00	32.10	25.80	46.00	29.90	32.90	32.90	
Rate of Onset (G/sec)	212	187	163	179	209	168	409	242	134	204	74	369	116	185	211	

*Calculated from seat mount floor vertical deceleration.

RESULTS:

Vertical Dynamic Tests

The vertical test series was conducted in planned sequence. Each seat configuration was subjected to a 4G and an 8G pulse in Tests 1 through 6. Seat Configuration 3 was subjected to a 12G and a 16G test pulse as well.

The data recording system described in Appendix I functioned properly during all tests. A summary of maximum deceleration and force readings for each dynamic test is presented in Table VII. Deceleration-time histories of Test 1 through 16 as pertinent for use as a baseline or history of a failure, are presented in Appendix II.

Test 1: Seat Configuration 1 was subjected to a planned 4G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The input achieved a peak of 5.1G, a velocity change of 37.1 fps, and a rate of onset of 212.1 G/sec.

Post-test inspection showed no apparent damage. Figures 16 and 17 show a pre-test side view and a post-test side view, respectively. Dummy chest and pelvic deceleration showed overshoot and reached peak magnitudes of 15.3G and 7.65G, respectively.

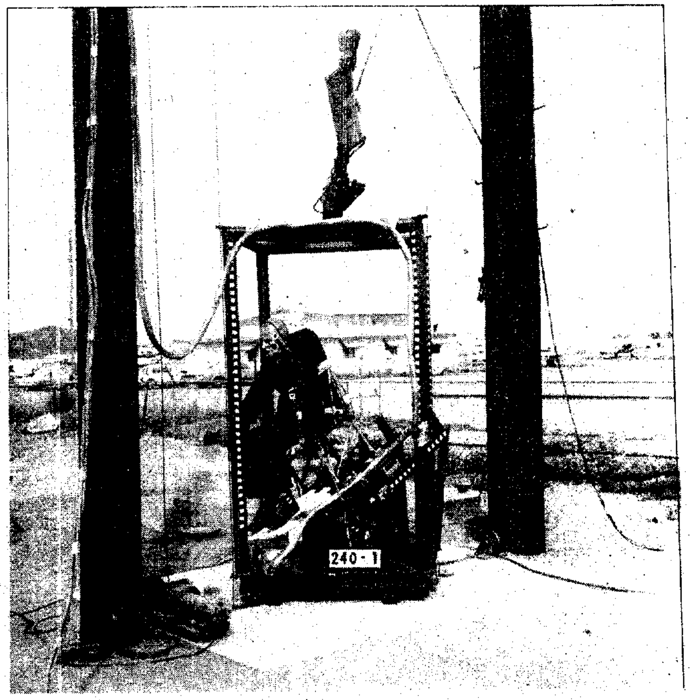


Figure 16. Seat Configuration 1 before Test 1.

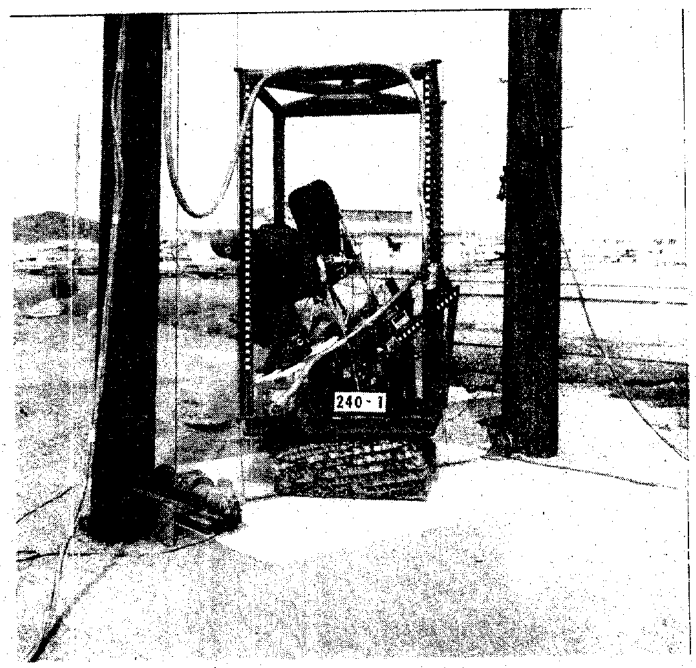


Figure 17. Seat Configuration 1 after Test 1.

Figure 18. Seat Configuration 1 after Test 2.

Test 2: This test of seat Configuration 1 was planned to be an 8G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The test input pulse had a peak of 8.5G, a velocity change of 32.3 fps, and a rate of onset of 187 G/sec.

Post-test inspection revealed no apparent damage. Figure 18 shows a post-test side view. Dummy chest and pelvis showed overshoot with vertical decelerations of 18.3G and 15.8G, respectively.

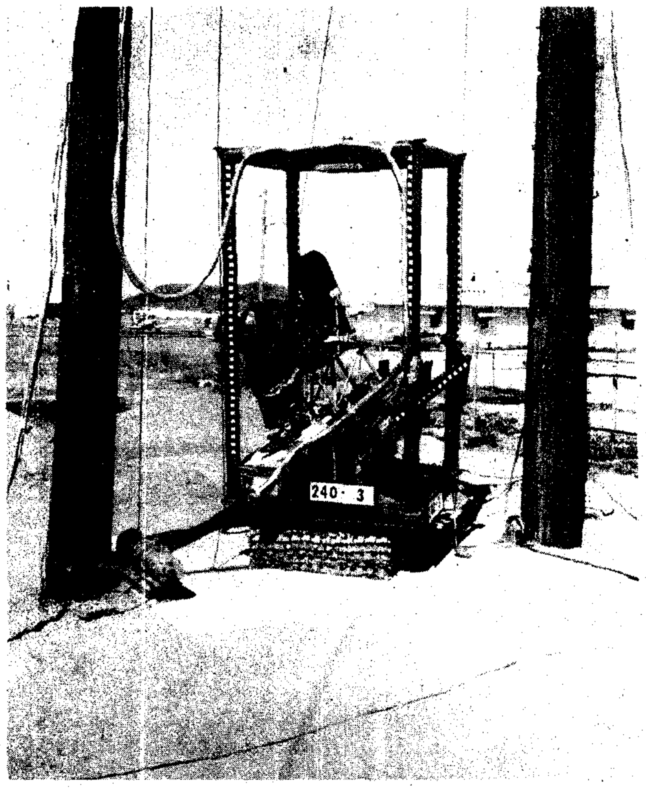


Figure 19. Seat Configuration 2 after Test 3.

Test 3: This test on Seat Configuration 2 was planned to be a 4G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting test pulse had a peak of 4.10G, a velocity change of 36.5 fps, and a rate of onset of 163 G/sec.

Post-test inspection revealed no apparent damage. Figure 19 shows a post-test inspection side view. Peak dummy chest and pelvic vertical decelerations were 15.G and 7.5G, respectively.

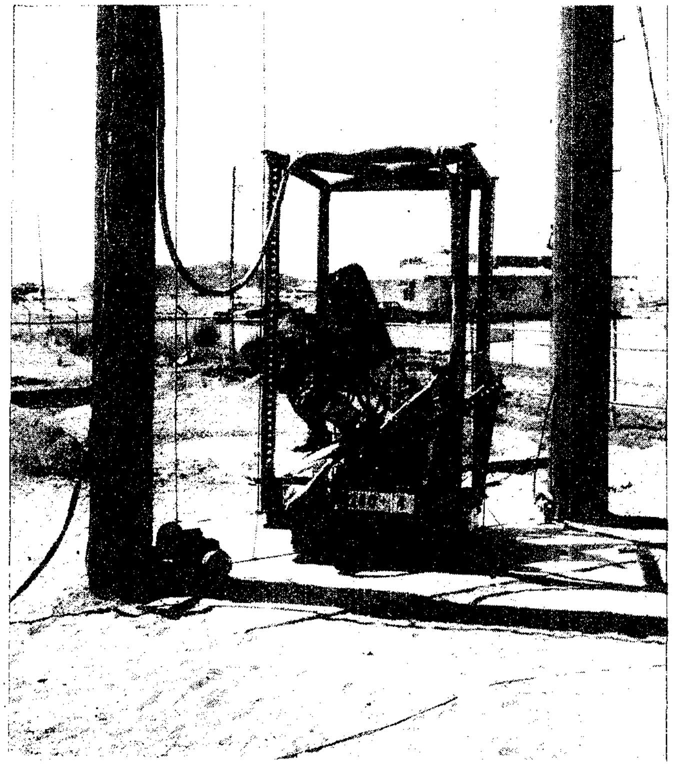


Figure 20. Seat Configuration 2 after Test 4.

Test 4: This test on seat Configuration 2 was planned to be an 8G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 9.65G, a velocity change of 45.7 fps, and a rate of onset of 179 G/sec.

Post-test inspection revealed no apparent damage. Figure 20 shows a post-test side view. The dummy chest showed a very high peak vertical deceleration of 33.2G. The peak pelvic deceleration was 13.4G.

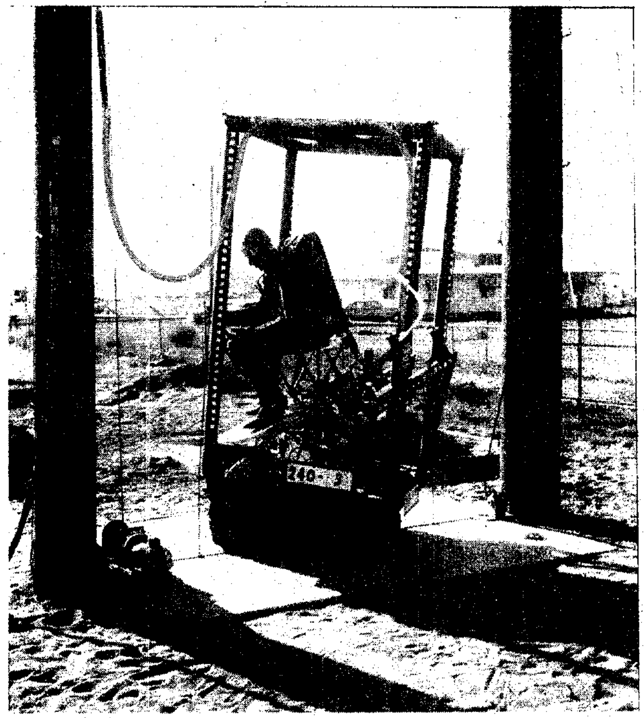


Figure 21. Seat Configuration 3 after Test 5.

Test 5: This test of seat Configuration 3 was planned to be a 4G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting test pulse had a peak of 4.50G, a velocity change of 46.4 fps, and a rate of onset of 209 G/sec.

Post-test inspection revealed no apparent damage. Figure 21 shows a post-test seat side view. Peak dummy chest and pelvic vertical decelerations were 12.7G and 7.31G, respectively.

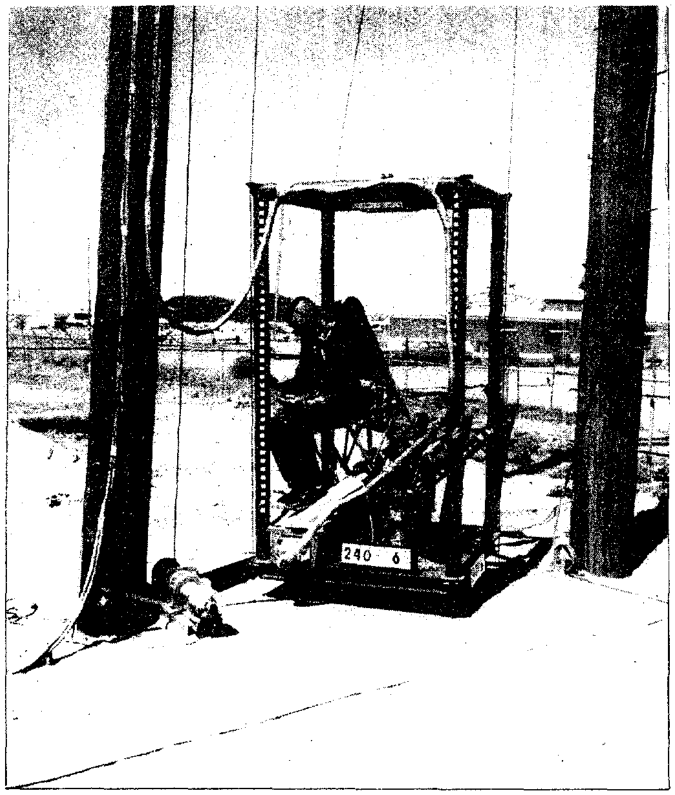


Figure 22. Seat Configuration 3 after Test 6.

Test 6: This test on seat Configuration 3 was planned to be an 8G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 9.40G, a velocity change of 39.4 fps, and a rate of onset of 168 G/sec.

Post-test inspection revealed no apparent damage. Figure 22 shows a post-test side view. Peak dummy chest and pelvic vertical decelerations were 30.9G and 14.3G, respectively.

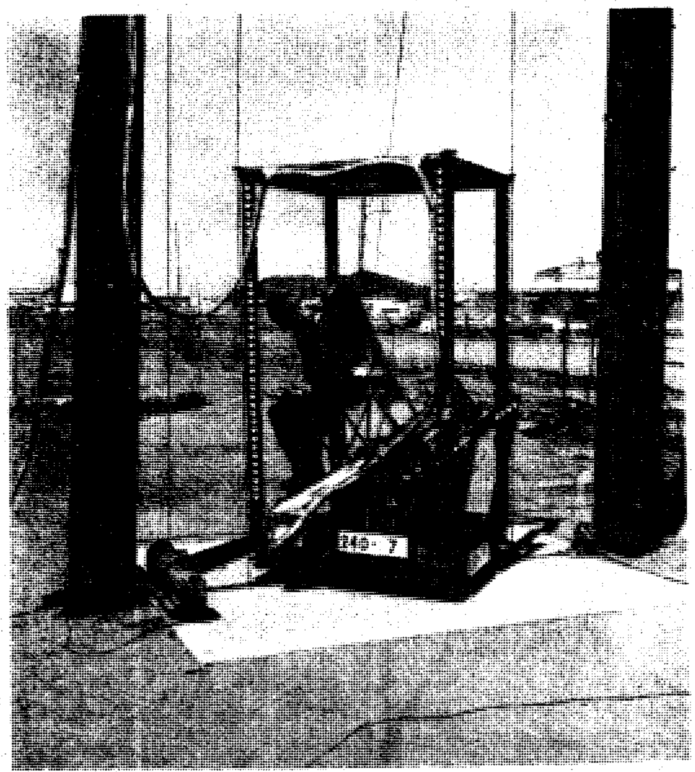


Figure 23. Seat Configuration 3 after Test 7.

Test 7: This test on seat Configuration 3 was planned to be a 12G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 14.2G, a velocity change of 33 fps, and a rate of onset of 409 G/sec.

Post-test inspection revealed no apparent damage although, when the test film was viewed, the seat back was seen to deflect elastically a considerable distance upon impact. Figure 23 shows a post-test side view. Peak dummy chest vertical deceleration was 28.8G.

Test 8: This test on seat Configuration 3 was planned to be a 16G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 16.9G, a velocity change of 27.9 fps, and a rate of onset of 242 G/sec. Figure 24 shows a side view of the seat mounted in the drop tower cage just prior to test.

Post-test inspection revealed seat failure in four places. The seat front lateral cross tube failed in the center at a 1/8-inch diameter hole where a screw fastens the seat canvas to the structure, the seat right front corner joint pulled out, the seat back tube failed on the left side at the back brace tube, and the canvas seat also failed. Figure 26 shows a post-test seat side view. Peak dummy chest vertical deceleration was 23.8G. The pelvis experienced a very high vertical deceleration of 40G. (See Figures 24 thru 31.)

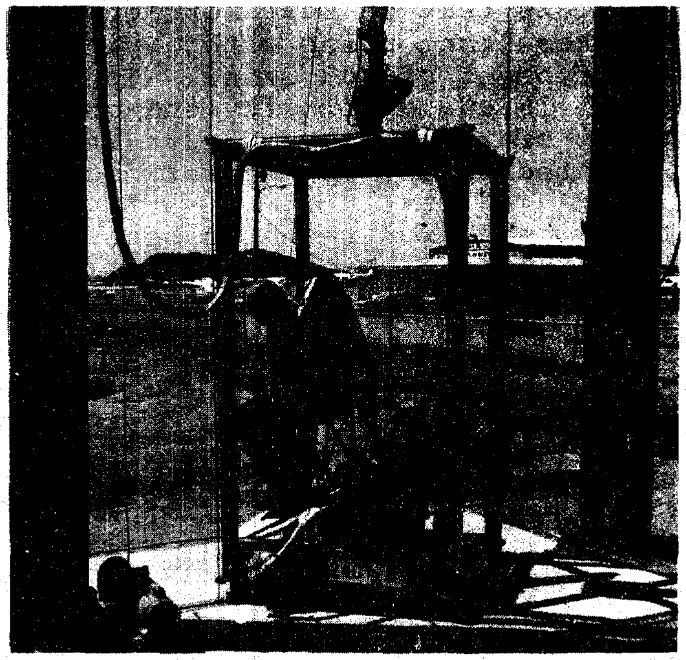


Figure 24. Seat Configuration 3 Before Test 8.

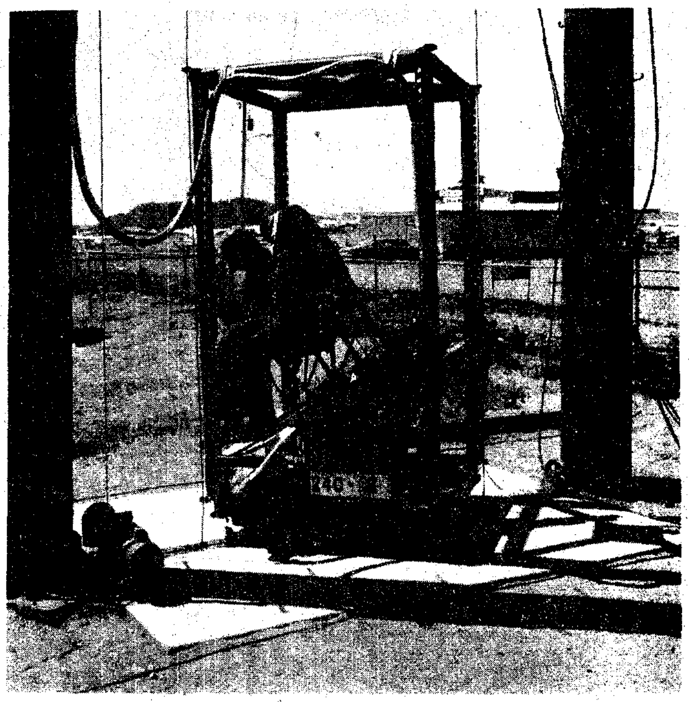


Figure 25. Seat Configuration 3 After Test 8.

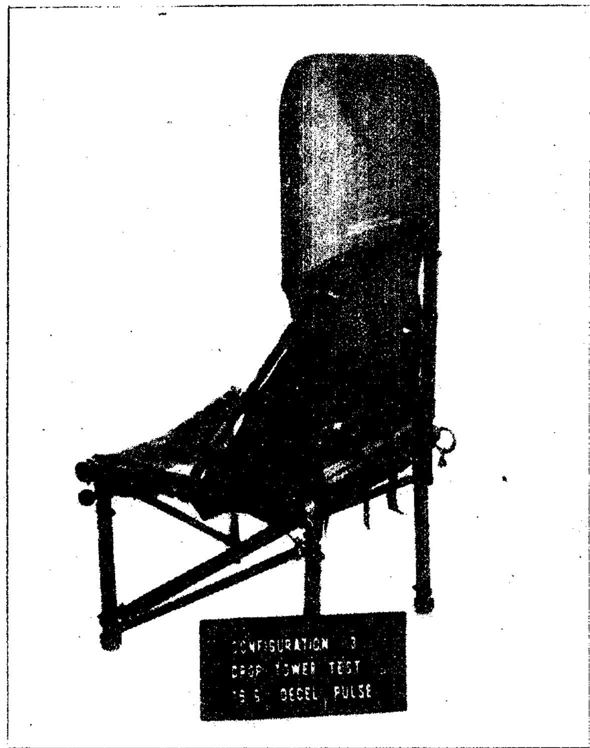


Figure 26. Overall, Configuration 3 After Test 8.

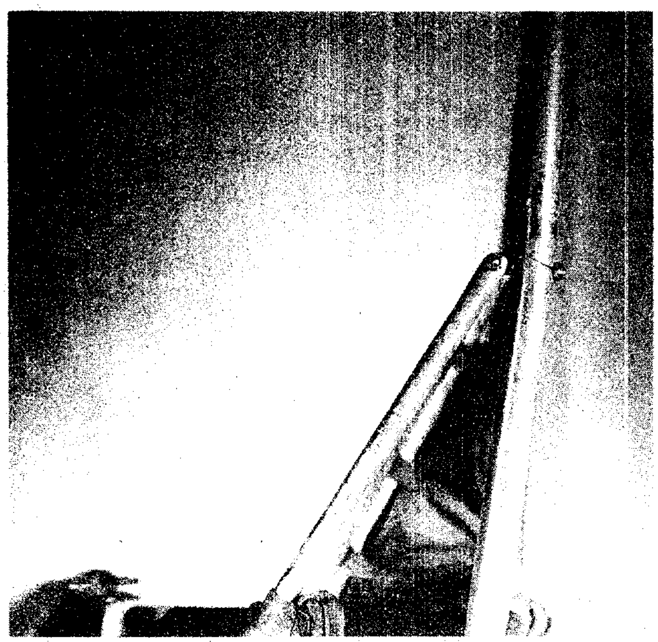


Figure 27. Closeup of Seat Back Failure
Slip-out of Joint in Background.

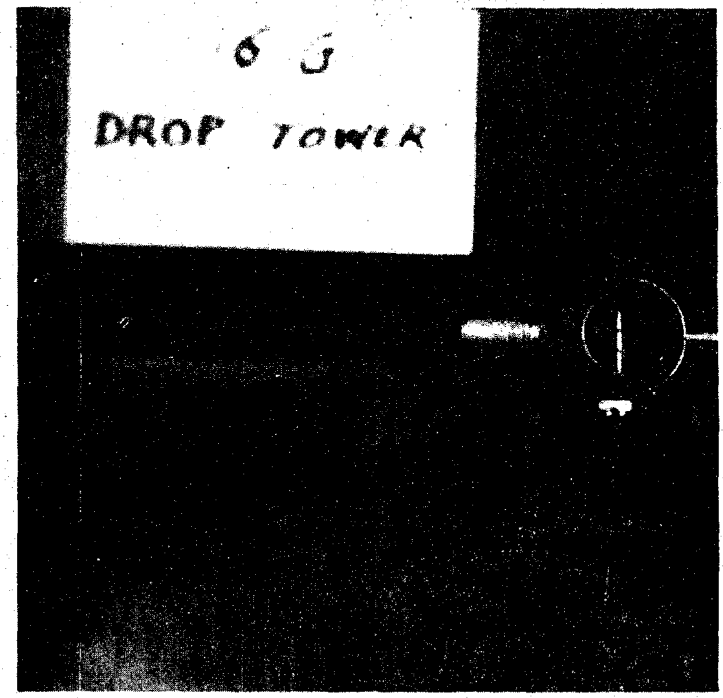


Figure 28. Slipped Joint Right Front

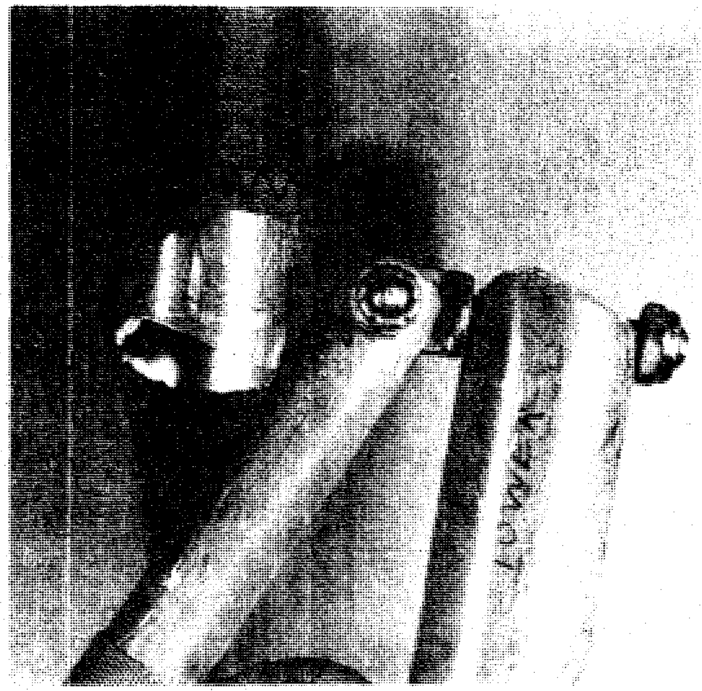


Figure 29. Closeup of Failed Seat Back

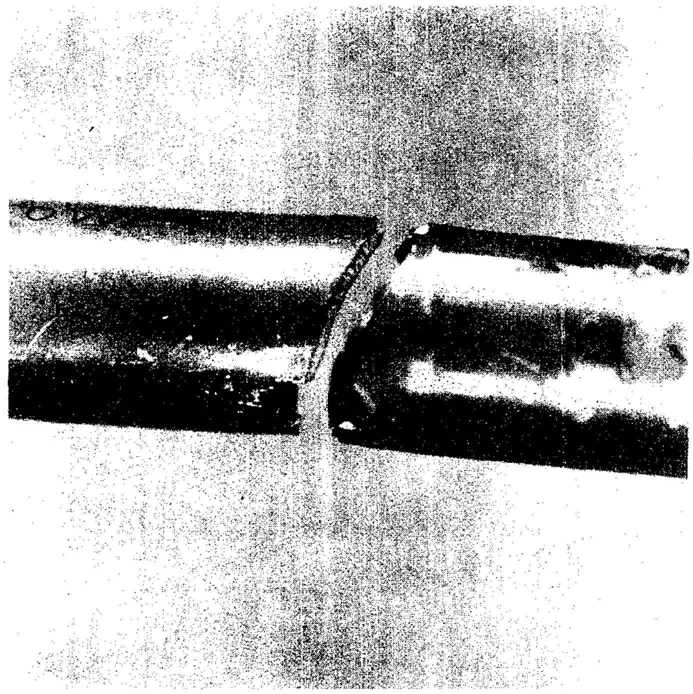


Figure 30. Closeup, Seat Back Failure

From the nature of the failure it is obvious that the aluminum seat back is very brittle in nature. The support tube pin served as a pivot about which only 150 + ft-lbs were necessary to fail the notch-sensitive tube.

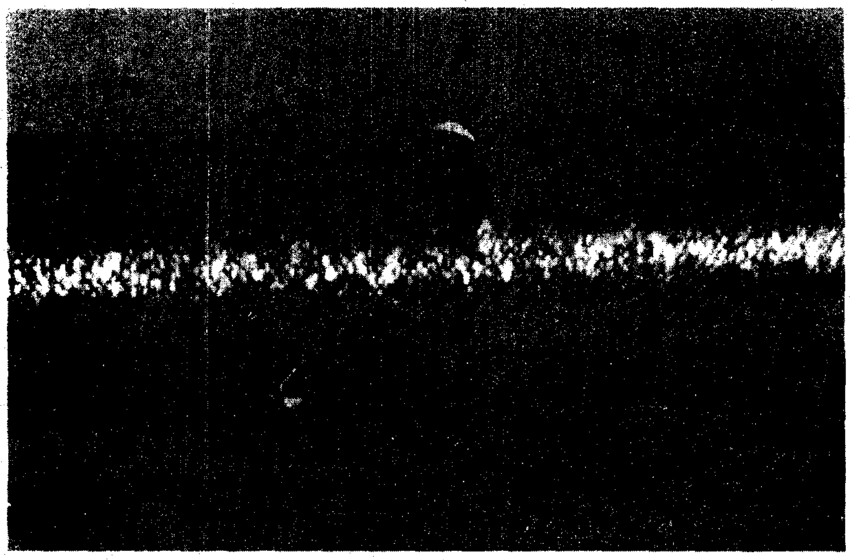


Figure 31. Front Seat Tube Failure

This failure originated in the center hole used to attach the seat canvas. It is a brittle fracture and failed in tension and shear.

Longitudinal Dynamic Tests

The test series as shown in Table V was conducted as planned for Tests 9 - 14. Test 14 produced failures on seat Configuration 3. Therefore, Test 15 was re-defined to be an 8G test of seat Configuration 4 instead of a 12G test on Configuration 5.

The data recording system described earlier functioned properly during all tests. A summary of data including maximum deceleration and force readings for each dynamic test is presented in Table VIII.

Test 9: This test on seat Configuration 1 was planned to be a 4G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 3.74G, a velocity change of 27 fps, and a rate of onset of 134 G/sec. Figure 32 shows a side view of the seat mounted on the accelerator sled just prior to test.

Post-test inspection revealed no apparent damage. Figure 33 shows a post-test side view. The maximum deceleration recorded in the dummy was 5.85G measured in the vertical direction in the pelvis.

Figure 32. Seat Configuration 1 Before Test 9.

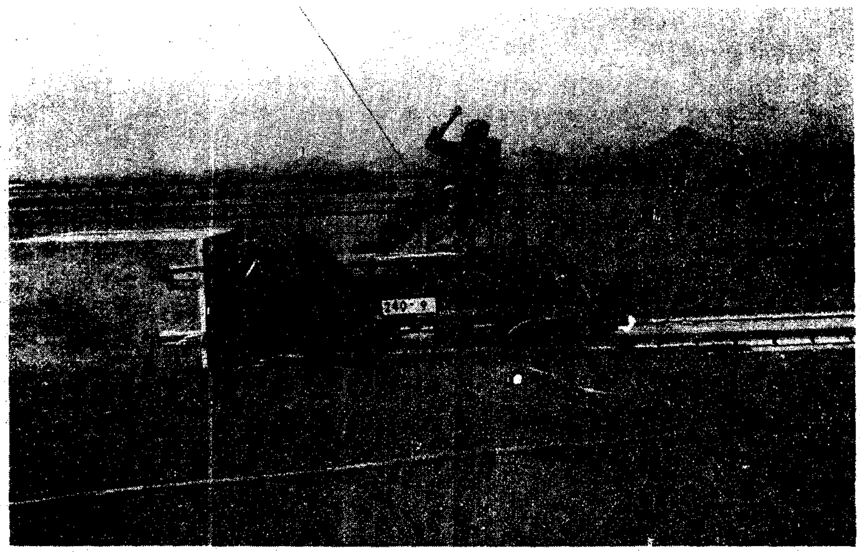


Figure 33. Seat Configuration 1 After Test 9.

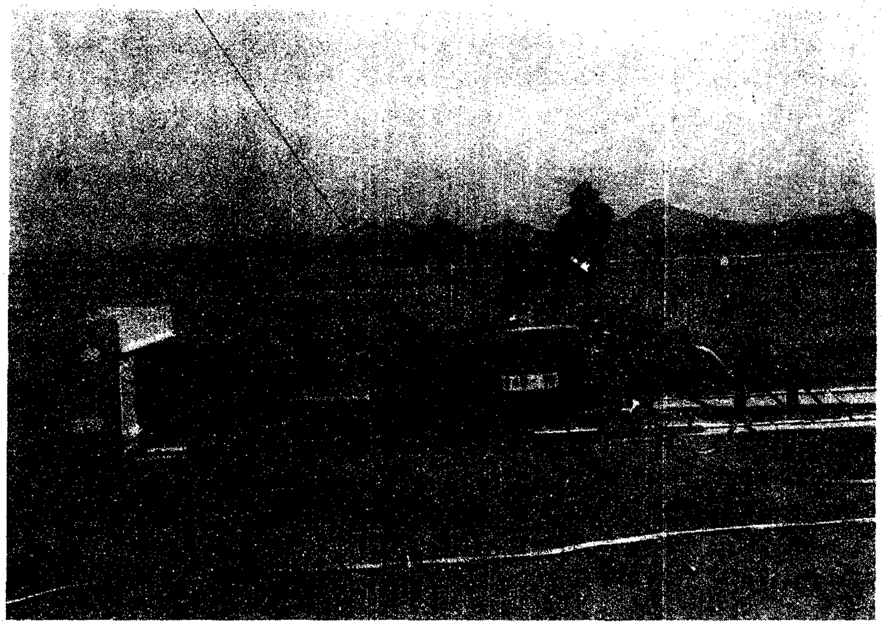


Figure 34. Seat Configuration 1 Before Test 10.

Test 10. This seat on Seat Configuration 1 was planned to be an 8G resultant pulse with a velocity change of 35 fps and a rate of onset of 400G/sec. The resulting input pulse had a peak of 7.83G, a velocity change of 32.1 fps, and a rate of onset of 204G/sec.

Post-test inspection revealed a broken left side lap belt anchor ring (See Figures 35 and 37). This allowed the dummy to move out of the seat onto the right side of the sled during impact. The dummy and instrumentation were not damaged, however, high decelerations resulted. The highest deceleration measured was a 24.2G lateral chest deceleration.

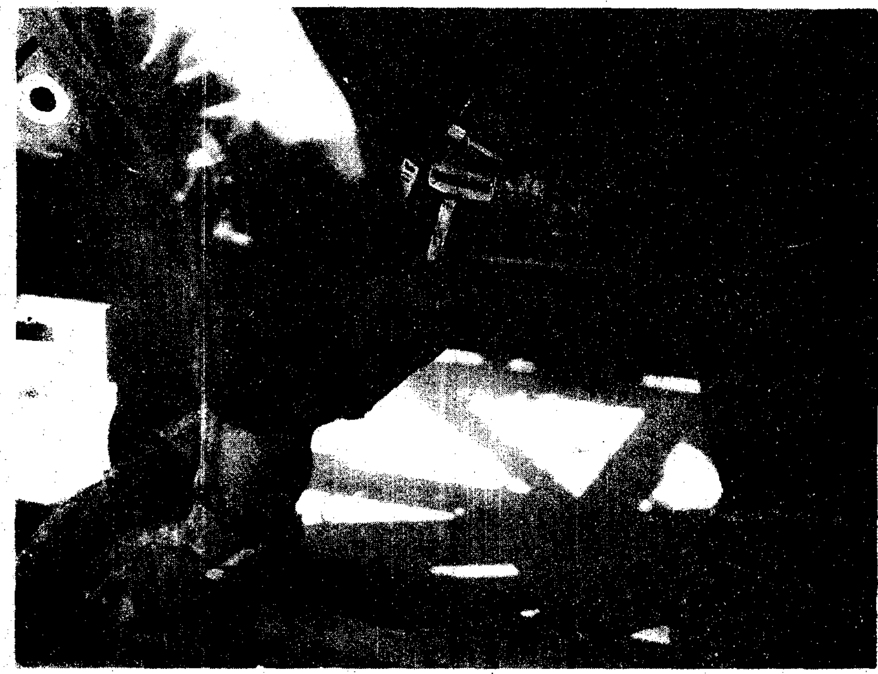


Figure 35. Broken Lap Belt Anchor Ring Sustained in Test 10.

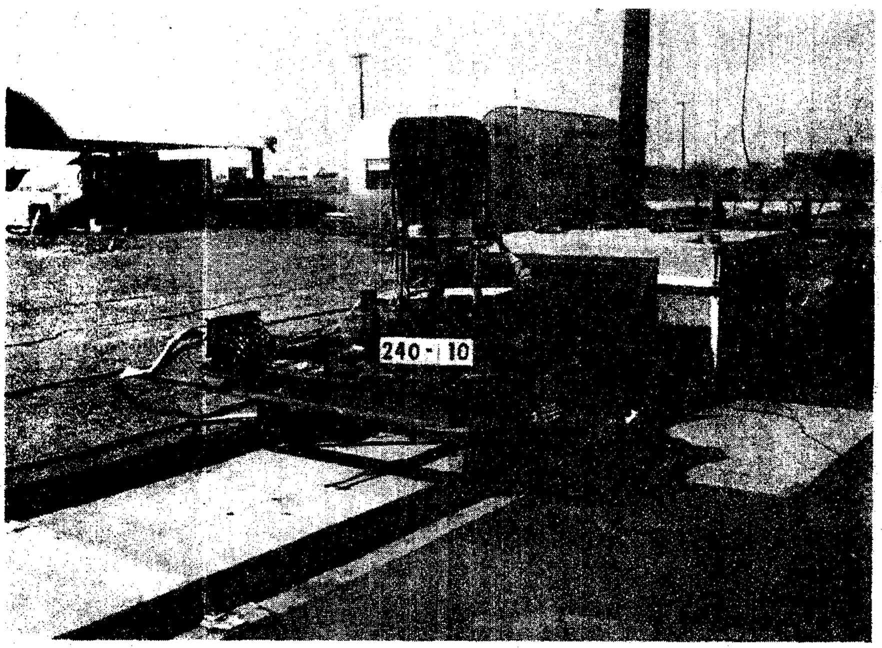


Figure 36. Post-test Position of Dummy in Test 10.

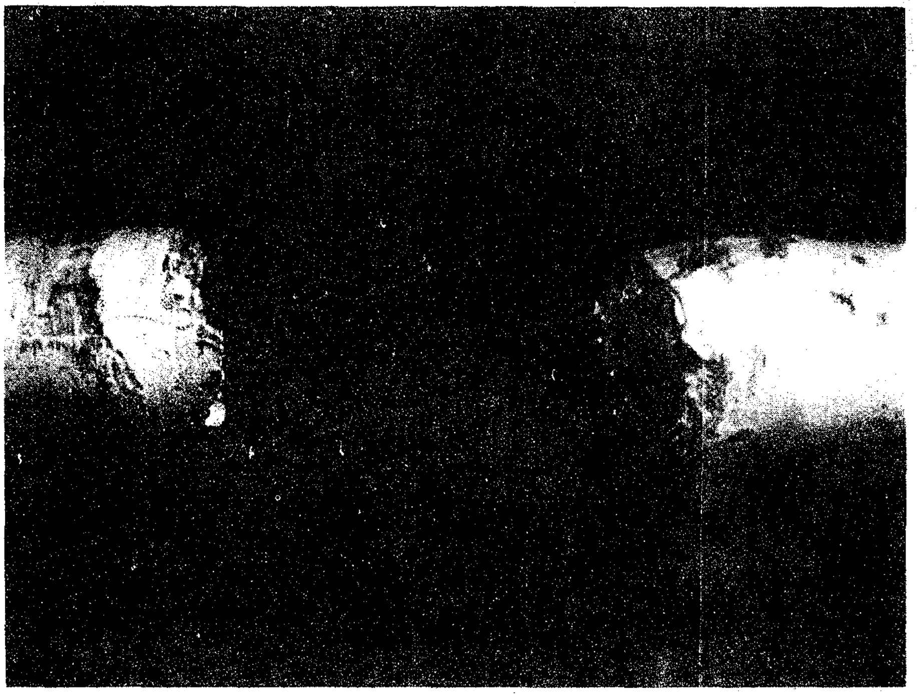


Figure 37. Closeup of Failed Lap Belt Attachments Rings.

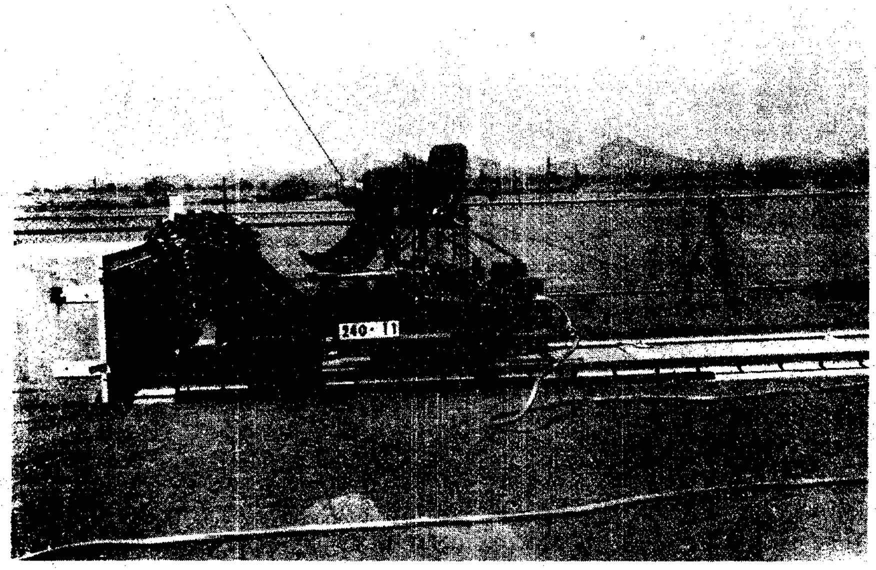


Figure 38. Seat Configuration 2 after Test 11.

Test 11: This test on Seat Configuration 2 was planned to be a 4G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 3.48G, a velocity change of 25.8 fps, and a rate of onset of 74 G/sec.

Post-test inspection revealed no apparent damage. Figure 38 shows a post-test side view. The maximum deceleration measured in the dummy was 12.1G vertical in the chest.

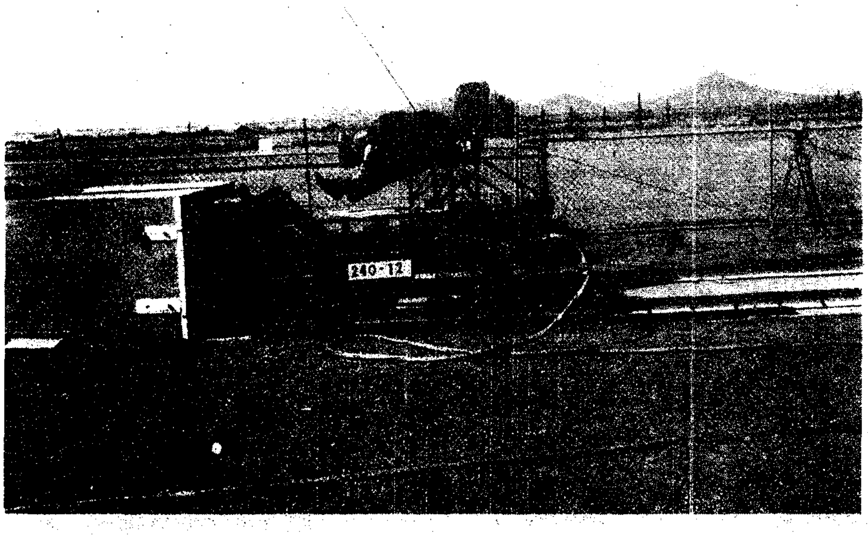


Figure 39. Seat Configuration 2 after Test 12.

Test 12: This test on Seat Configuration 2 was planned to be an 8G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 7.87G, a velocity change of 46 fps, and a rate of onset of 369 G/sec.

Post-test inspection revealed no apparent damage. Figure 39 shows a post-test side view. There was a relatively high vertical chest deceleration as the dummy jack-knifed violently The highest deceleration was 24.8G in the vertical direction in the chest.

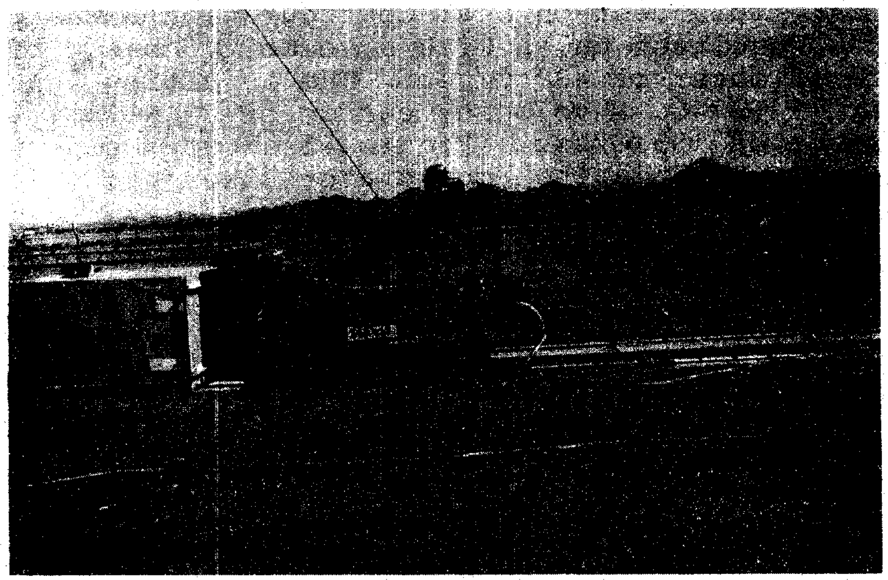


Figure 40. Seat Configuration 3 after Test 13.

Test 13: This test on seat Configuration 3 was planned to be a 4G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 3.48G, a velocity change of 29.9 fps, and a rate of onset of 116 G/sec.

Post-test inspection revealed no apparent damage. Figure 40 shows a post-test side view. Maximum deceleration was measured in the chest and was 5.98G in the longitudinal direction.

Test 14: This test on seat Configuration 3 was planned to be an 8G resultant pulse with a velocity change of 35 fps and a rate of onset of 400 G/sec. The resulting input pulse had a peak of 7.74G, a velocity change of 32.9 fps, and a rate of onset of 185 G/sec. Figure 41 shows a side view of the seat mounted in the accelerator sled just prior to test.

Post-test inspection revealed four failures as shown in Figures 42 thru 44. The seat back tube failed at the back brace tube bolt holes, the left lap belt ring weld failed, the right front seat joint started to pull loose, and the seat canvas failed. The dummy moved out of the seat and onto the left side of the sled; however, the dummy and instrumentation were not damaged. (See Figures 41 thru 44.) The maximum dummy deceleration was measured in the chest and was 13.9G in the vertical direction.

Figure 41. Seat Configuration 3 Before Test 14.

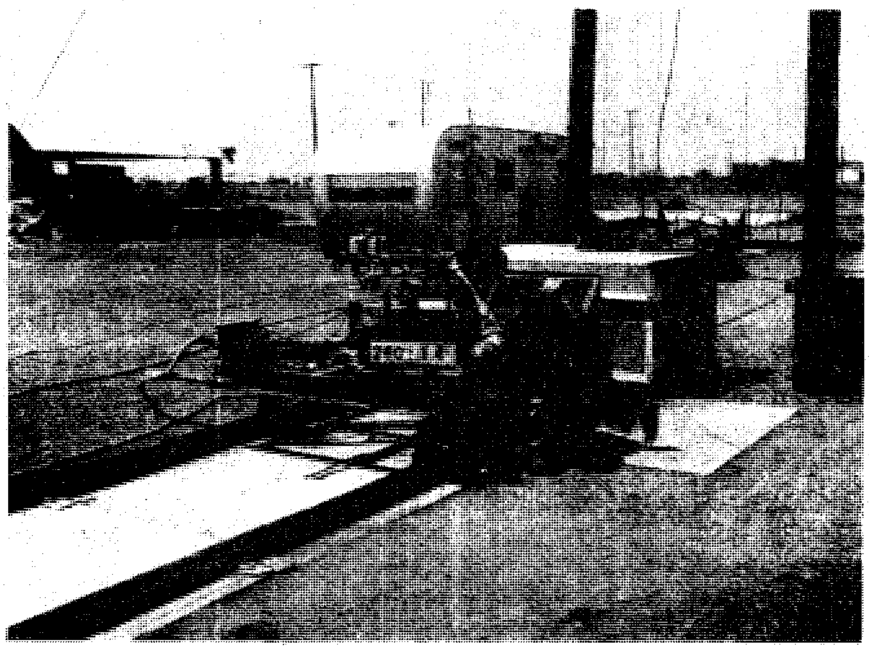


Figure 42. Post-test Position of Dummy After Test 14.

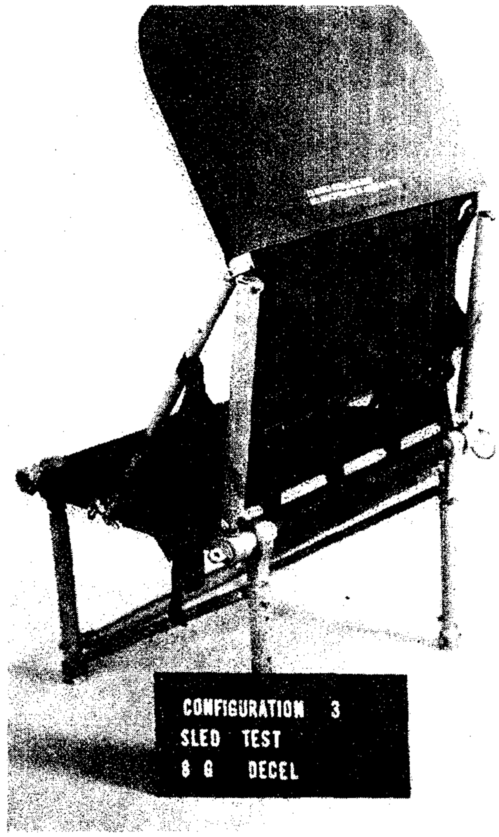


Figure 43. 8G Input, Configuration 3.

Note the absence of the left lap belt attachment ring which broke at 1,340 lbs. Refer to Figure 55 on page 63 for a picture and discussion of this type failure. Note also that the failure of the seat back on both sides occurred at the support tube pin. The torque causing these failures was 530 + lbs-ft total, applied near the center of the two failures.

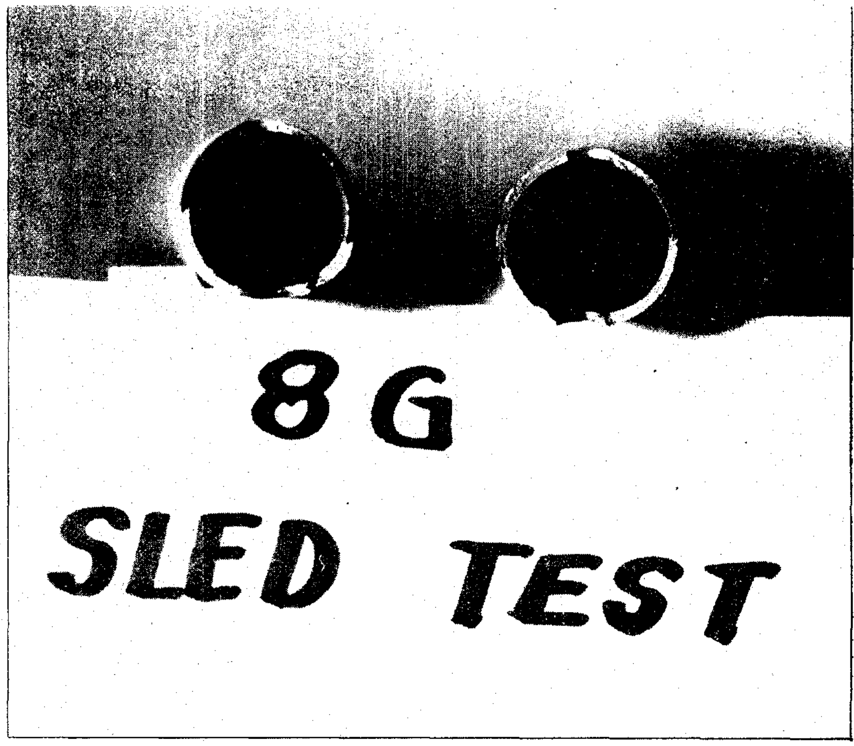


Figure 44. End View of Failed Seat Back Tubes.

The picture in Figure 44 shows an end-to-end view of one of the failures of the seat back tube.

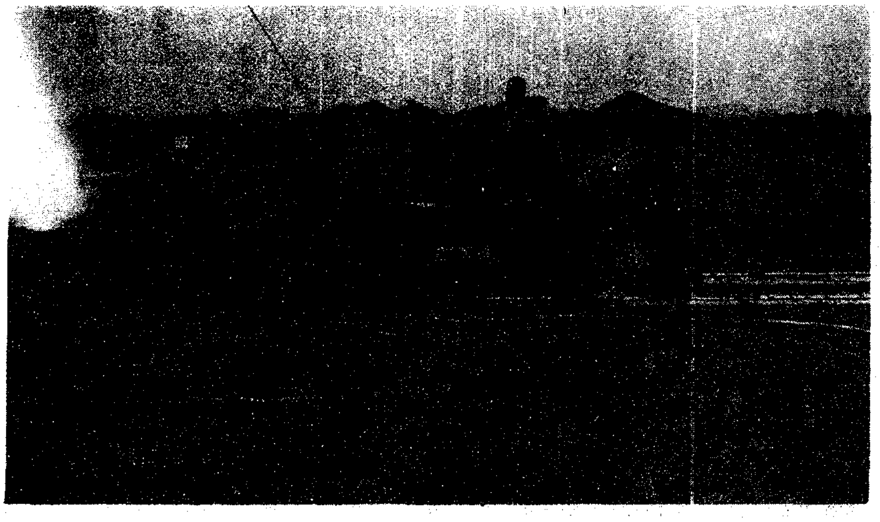


Figure 45. Seat Configuration 4 Before Test 15.

Test 15: For this test the aluminum seat back frame tube was replaced with a steel tube of the same dimensions in view of the recurring failures of the aluminum tube. This test on seat Configuration 4 was planned to be an 8G resultant pulse identical to the pulses of Tests 10, 12, and 14. The resulting input pulse had a peak of 7.50G, a velocity change of 32.9 fps, and a rate of onset 211 G/sec. Figure 45 shows a side view of the seat mounted in the accelerator sled just prior to test.

Post-test inspection revealed four failures or incipient failures. The right and left side longitudinal seat tubes failed at the back brace tube joints (shown in Figures 47 and 50), the left side steel seat back tube was bent at the stiffener, the left side back brace tube was bent, and the male tangs on the upper end of all four leg assemblies were bent. The leg fittings were probably bent as a result of load shifting after failure of the longitudinal seat tubes. (See Figure 49) The maximum deceleration measured in the dummy was 8.91G in the longitudinal direction in the pelvis.

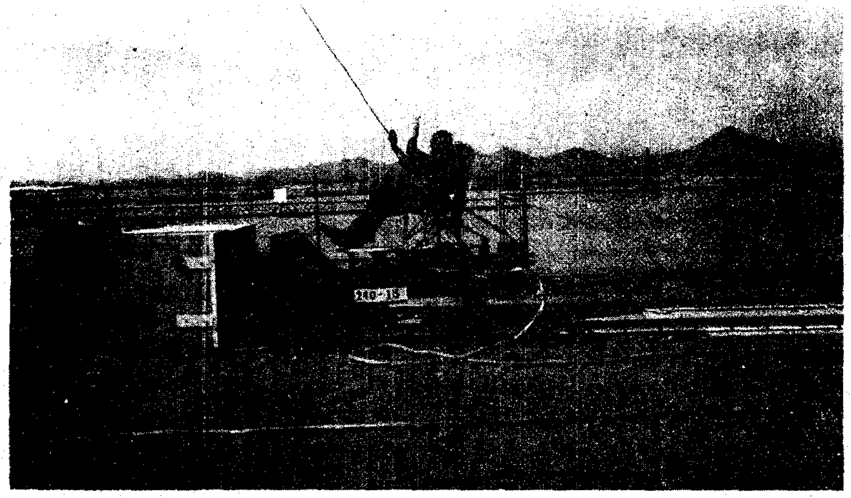


Figure 46. Seat Configuration 4 After Test 15.

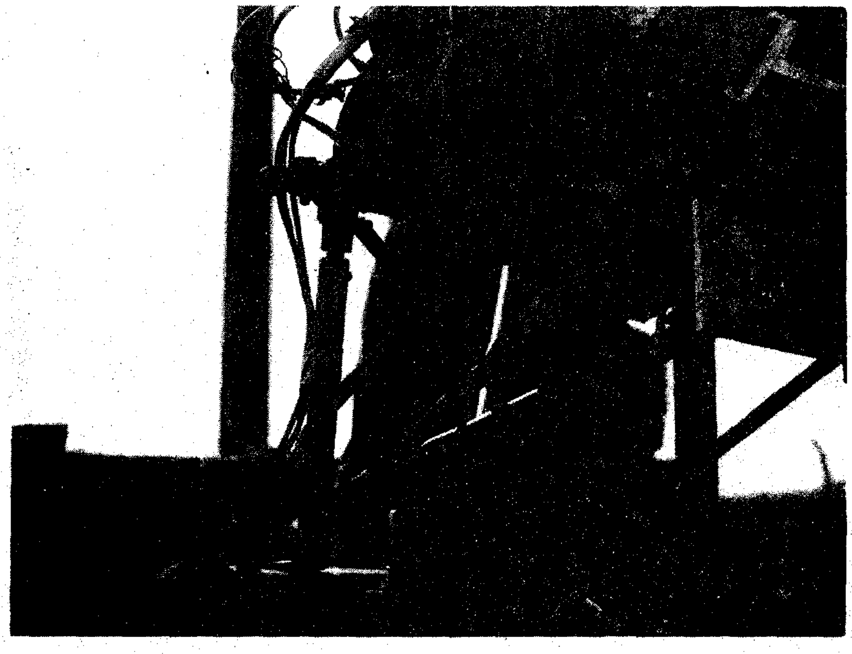


Figure 47. Failed Longitudinal Seat Tubes Sustained in Test 15.

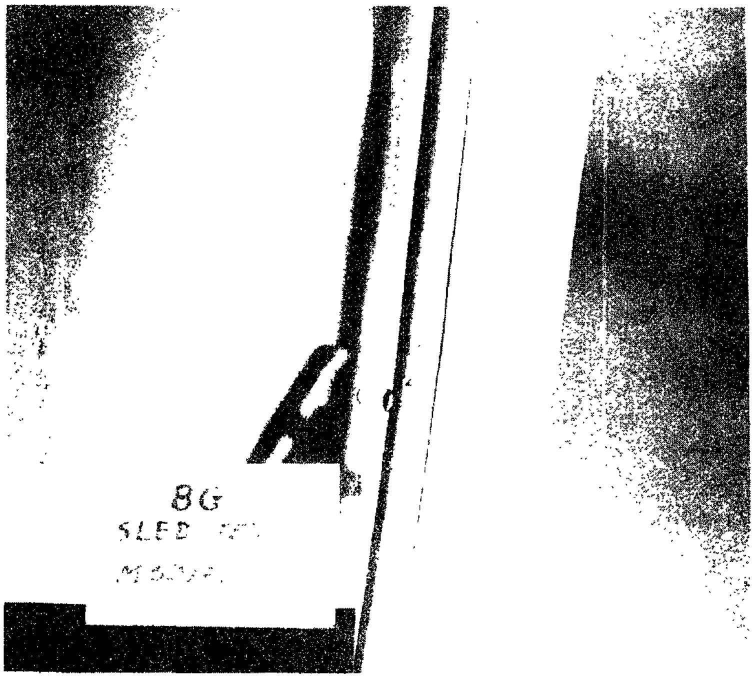


Figure 48. Bent Steel Seat Back Tube

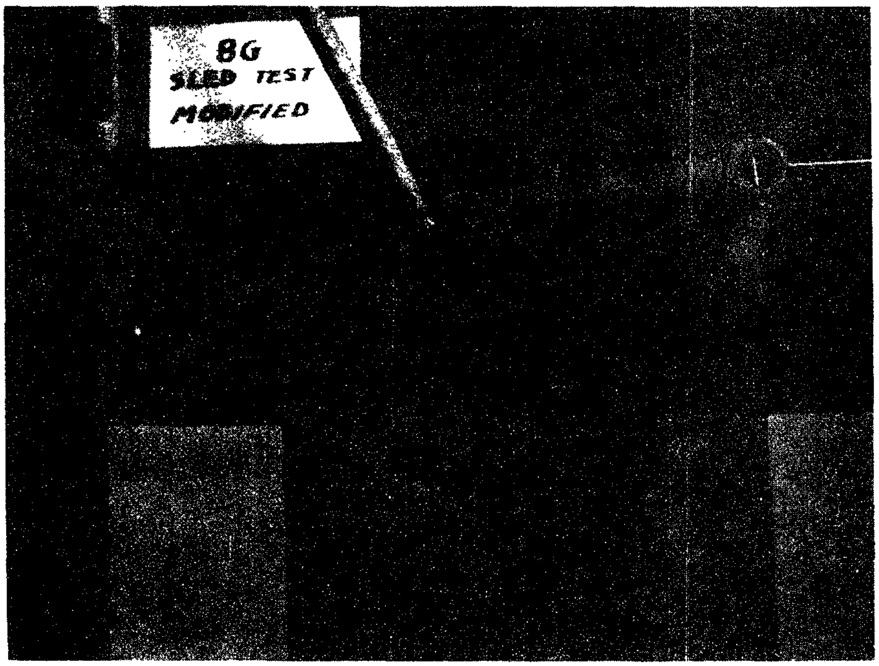


Figure 49. Longitudinal Frame Failures, Tabs Bent. Bracket on Seat Back was not used in Test.

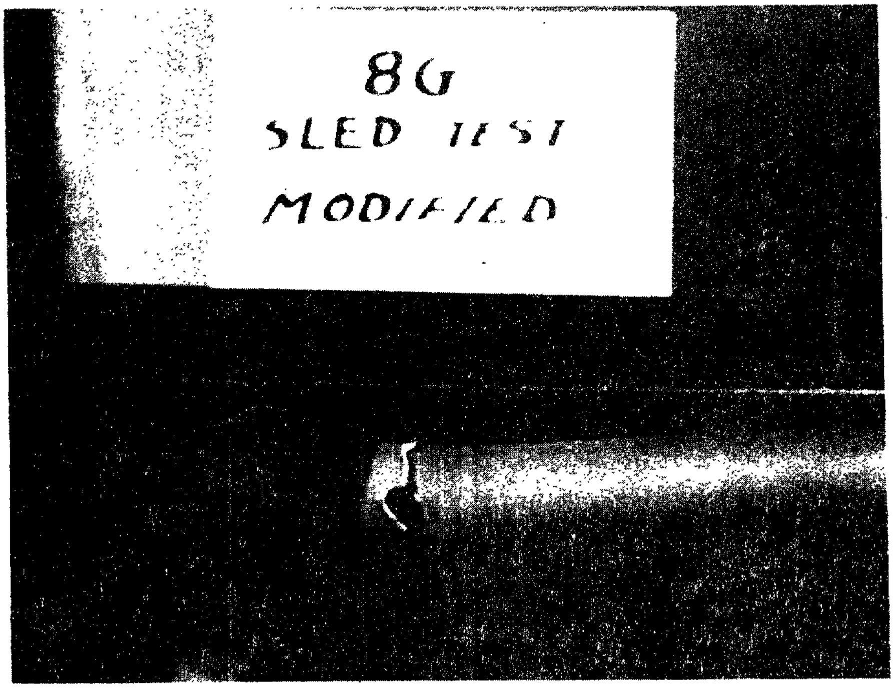


Figure 50. Closeup Longitudinal Frame Failure

The peak input vertical deceleration on the test helicopter floor under the jump seat was 54.4G. The maximum lap belt load was 970 pounds. The peak dummy chest vertical deceleration was 34.8G.

The seat was damaged in two places. The seat front lateral cross tube broke in the center at a 1/8-inch diameter hole that the seat canvas fastener fits into, (shown in Figures 51-54). The seat canvas split longitudinally in the center and failed. Although the shoulder harness slipped off the seat back, the dummy remained in the seat.

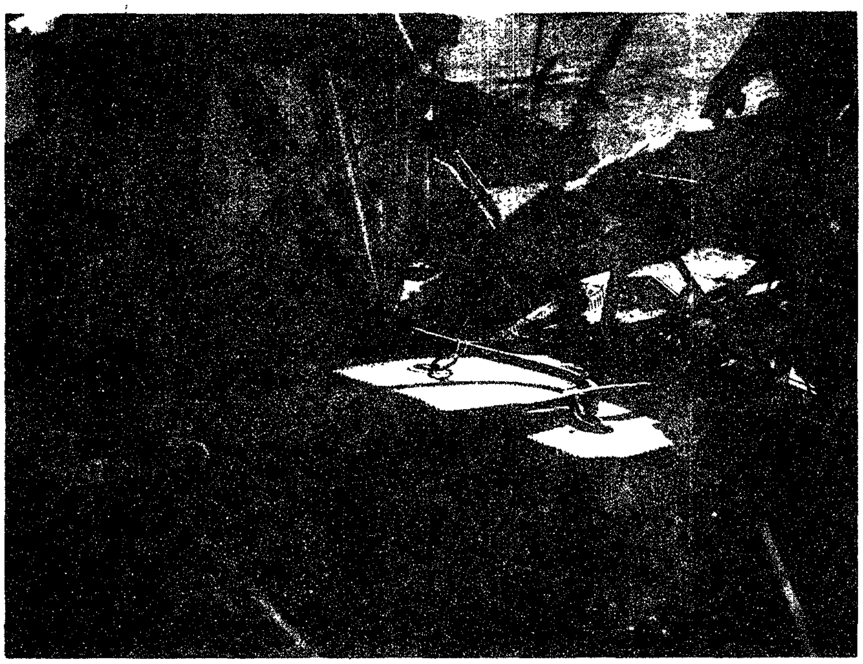


Figure 51. Front Cross Tube Failure Sustained in Helicopter Crash Test.

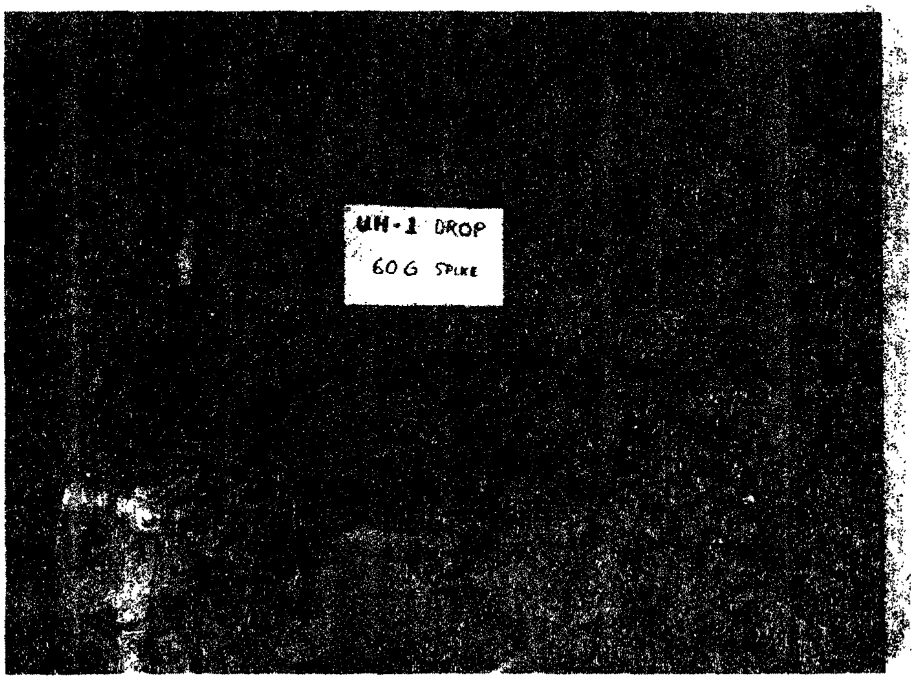


Figure 52. Front Cross Tube Failure

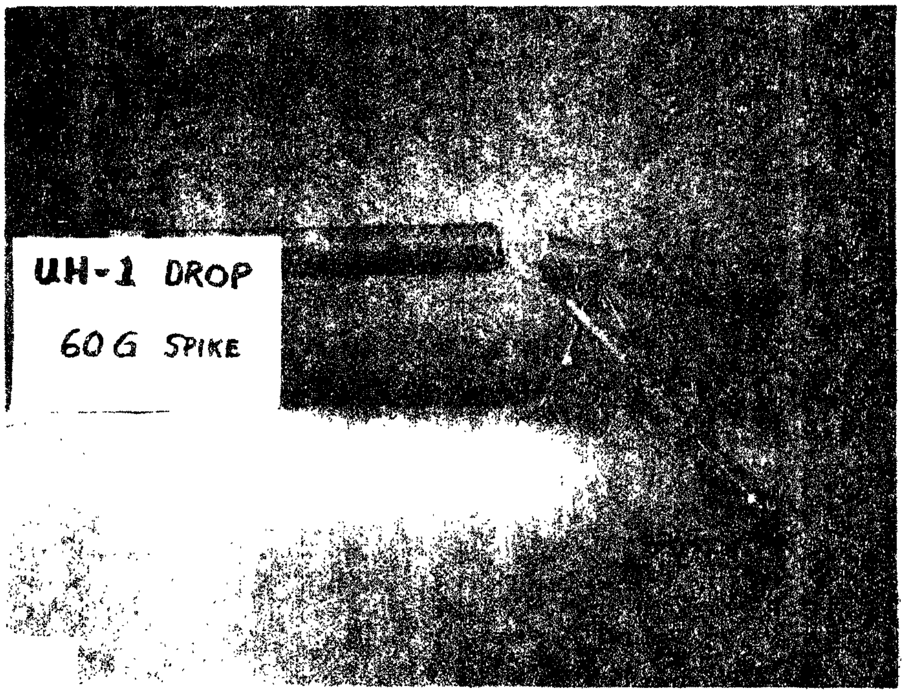


Figure 53. Closeup of Front Cross Tube. Note Break Through Screw Hole.

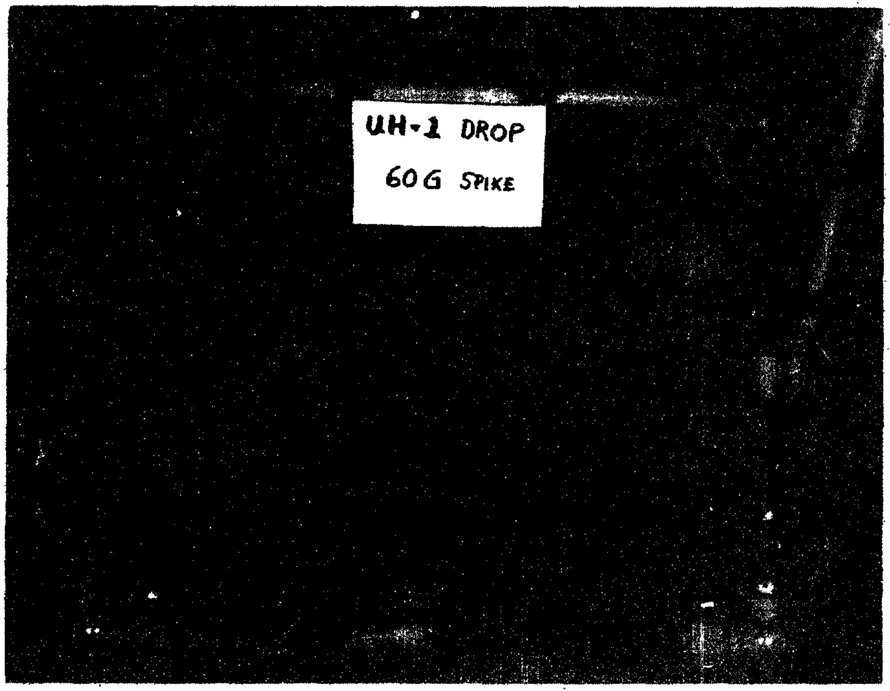


Figure 54   Torn Canvas From Shear and Tension.

DISCUSSION OF TEST RESULTS

Vertical Drop Tests

In the vertical tests, seat Configuration 3 produced lower dummy decelerations and slightly lower seat leg loads. The dummy decelerations (28G) are within tolerance for survival but dynmaic overshoot is a serious hazard. The vertical load measured in the right front leg of seat Configuration 3 during the 12G test was 1,500 pounds. The same load measured on seat Configuration 2 during the 8G test was 1,670 pounds.

Lap belt loads were relatively low in all vertical tests an the left side loads were always higher than the right side as would be expected from the seat orientation relative to the velocity vector. No lap belt attachment rings failed in the vertical test. The two shoulder harness loads measured during Tests 7 and 8 were both very low. Tie-down cable loads were well within the cable limit strength of 1,500 pounds. The highest cable load was 1,010 pounds during the 16G test on seat Configuration 3.

In summary, seat Configuration 3 withstood the dynamic loads imposed by a 12G pulse and failed under the loads imposed by a 16G pulse.

Longitudinal Sled Tests

In the longitudinal tests seat Configurations 3 and 4 generally produced lower dummy decelerations and slightly lower seat leg loads. Lap belt loads were generally at least twice as high as for similar vertical tests. For example, on seat Configuration 3 the right lap belt load during the 4G longitudinal test was 202 pounds and during the 4G vertical test it was 93 pounds. Lap belt loads were biased with the left side experiencing the highest load. Shoulder harness loads were higher than during the vertical tests with the highest load being 531 pounds during the 8G impact of seat Configuration 3. The tie-down cable loads were higher than lap belt loads with the highest being 1,500 pounds during the same test. Frequent lap belt attachment ring failure occurred when the belts were attached to the rings.

In summary, both seat Configurations 3 and 4 failed under the dynamic loads imposed by the 8G sled test. The prime failures were in different members, however, all metal failures were brittle in nature. The aluminum tubular seat back of Configuration 3 failed at the back brace interface, whereas the steel tubular seat back frame of Configuration 4 held and transmitted sufficient load to the braces to fail the aluminum tube seat frame on the lower end.

Helicopter Tests

The helicopter crash did not load the seat completely as intended because the shoulder harness slipped off the seat back. Also, the floor panel to which the tie-down cables were attached partially pulled loose and deflected upward. Nevertheless, the failures that occurred in the front lateral seat cross tube and seat canvas were very similar to the ones that occurred during Tests 8 and 14. The front seat legs did not punch through the floor as expected. The dummy remained in the seat and did not hit its head on the cockpit center console. All four of the quick-disconnect legs remained attached to the floor studs.

General

The failures experienced during the tests were not entirely as anticipated from the mathematical analysis done earlier. It is difficult to explain the problems involved with analyzing a complex structure statically and testing the structure dynamically. So many tradeoffs and assumptions must be made in order to avoid total indeterminacy, that some accuracy is lost. However, the methods are valid indicators and are the only possible way to "get a feel" of the problem and a guide of how to set up the test program. Although the failed members were different than predicted, the original level of failure prediction proved to be the most important aspect, and it was determined by the analysis.

Lap Belt Attachment Ring Failures

An X-ray, metalurgical, and tensile evaluation was performed on two unfailed and one failed ring. X-ray and visual examination demonstrated voids, gas holes, and incomplete welds. The weld failures during the dynamic tests and static tensile tests appear brittle (ductility is desired). Weld hardness on specimens examined ranged from 20 Rockwell C to 44 Rockwell C (equivalent to hardened steel). There is no evidence of weld annealing. Ultimate tensile strength ranged from 2,000 pounds to 6,600 pounds. This compares with the expected values from the hardness values. In general, the welds are of unacceptable quality and must be considered unsafe for the lap belt attachment point.

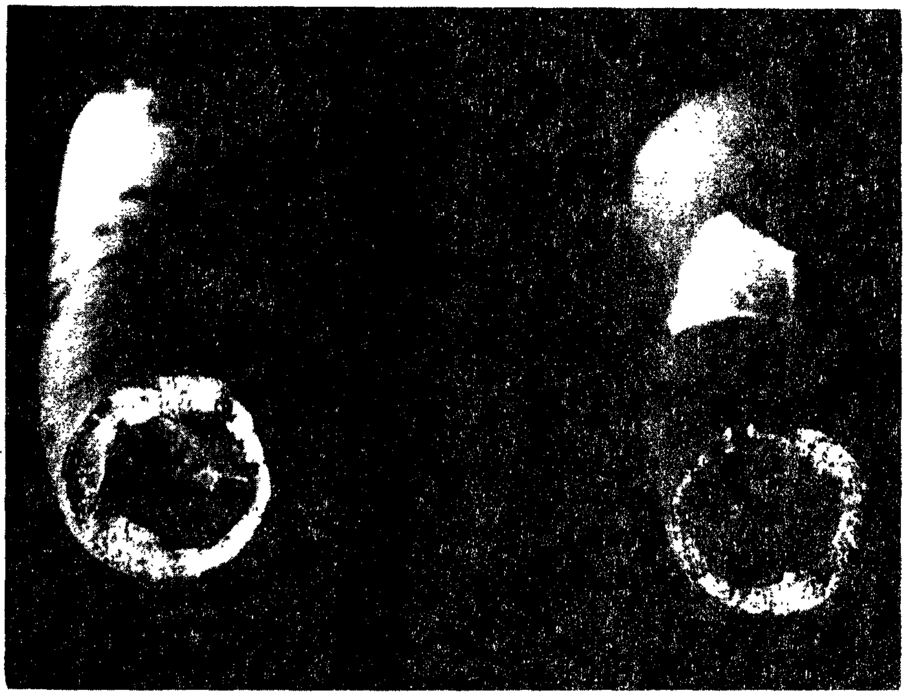


Figure 55. 4x Magnification of the Failed Weld Portion of a Lap Belt Attachment Ring. The Lighter Colored Area Around the Circumference of the Ring is Brittle Weld Material. The Arrow Points to a Blow (Gas) Hole.

CONCLUSIONS:

The following conclusions were reached as a result of this test program:

1. The basic seat structure and configuration does not provide adequate restraint, particularly in the longitudinal and lateral loading directions to prevent injury during a minor crash sequence.

2. The frame materials in the seat do not provide sufficient strength or ductility. Failures are brittle in nature, starting at bolt holes and thus lead to catastrophic results.

3. The nylon seat pan strength is insufficient when considered as the primary link that holds the seat pan structure together.

4. The slip-in type joints at the front of the seat frame represent inadequate design and noncompliance to the Military Standard.

5. Lap belt attachment ring weld quality is unacceptable. X-rays reveal incomplete welds and voids in welded areas.

6. Seat Configuration 3 withstood a triaxial (primarily vertical) dynamic test pulse of 12G but failed at 16G, demonstrating inadequate strength and ductility in both the back frame and the seat front cross tube.

7. Seat Configuration 3 withstood a biaxial (primarily longitudinal) dynamic test pulse of 4G but failed at 8G, again demonstrating inadequate strength and ductility in the back frame structure.

8. Seat Configuration 4 also failed at 8G, demonstrating inadequate strength and ductility in seat side tubes.

9. Seat Configuration 3 and 4 failed at 8G longitudinally because of inadequate strength to support the shoulder harness load imposed on the seat back.

10. The tie-down cable and attaching the lap belt to cargo rings on floor performed well and helped hold the seat and dummy in place. This configuration could be expected to assist in restraining the seats occupant should catastrophic seat failure occur, especially at the seat-floor junctions.

11. The lap belt only restraint is inadequate, even for the unmodified seat. The jack-knifing that occurred when the dummy was restrained only with a lap belt could allow a head strike on the cockpit center console or primary crew position seat backs. This is demonstrated in the actual accident data.

12. The addition of a shoulder harness and inertia reel did not further compromise the existing low strength level of the basic seat and served to adequately restrain the dummy even after seat failure.

13. No crash pulse energy will be absorbed by this seat and the occupant will be exposed to serious dynamic overshoot.

RECOMMENDATIONS:

In view of the observed failures brought to light in the test program and from the areas of inadequate design discovered by the stress analysis of the current seat, the Safety Design Branch, Bioengineering Division, USAARL makes the following recommendations:

1. The addition of an inertia reel mounted to the rear seat legs on a 3/16" extruded aluminum plate.

2. The addition of a shoulder harness, with a guide loop, attached to the inertia reel at one end and attachable to the current lap belt on the other.

3. The mounting of the inertia reel lock control by means of (2) two bolts in such location as to pin the left front slip-type seat joint.

4. Pin the right front slip-type joint in the same manner as in item #3 with (1) one bolt.

5. Attach the lap belt hooks to the cargo rings on the floor at the rear seat legs.

6. The current lap belt attachment rings on the sides of the seat are <u>not</u> to be used in their present state. If for any reason it is necessary to attach any restraint system to one of these rings, follow this procedure: Cut the entire weld area out, bevel the ends completely, bend the ring to bring the ends together, reweld completely and thoroughly, making sure the entire area is uniformly heated, allow the area to anneal by natural air cooling.

These recommendations should be implemented using the parts described by a proposed modification kit discussed in Appendix I of this report. The installation of this kit in the prescribed manner by the instruction sheet provided with it, will insure the potential occupant of the greatest increase in crashworthiness for the lowest possible cost of the kit and the shortest time required to install it.

APPENDIX I

UH-1 MEDICAL ATTENDANT'S SEAT CRASHWORTHY MODIFICATION KIT

This kit to increase the crashworthiness of the Medical Attendant's seat should be made available wherever aircraft using the seat are in service. In the event a kit is not available all parts are available in any aircraft maintenance shop or can be fabricated with a minimum of tools and skill. Implementation of the kit is straightforward, requiring only wrenches and a drill, and should be installed at the earliest convenience.

Following are pictures of the parts of the kit and its correct installation on the seat.

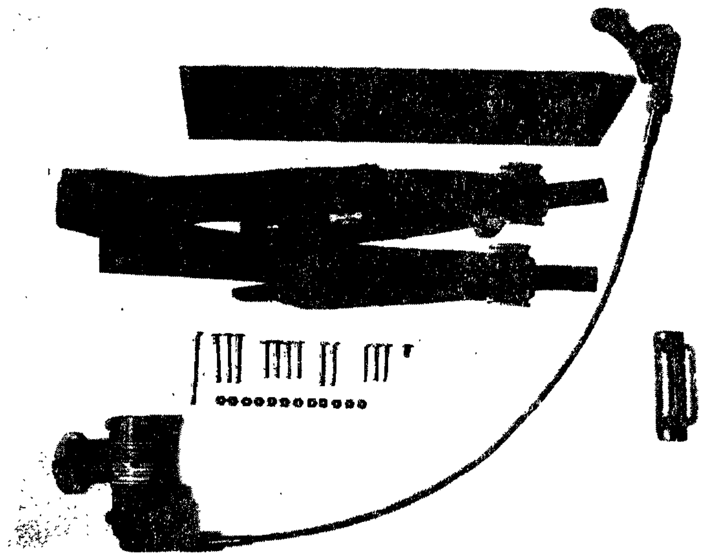


Figure 56. The UH-1 Medical Attendant's Seat Crashworthy Modification Kit

UH-1 MEDICAL ATTENDANT'S SEAT CRASHWORTH MODIFICATION KIT

Contents of the Kit:

ITEM	SPEC	PART #	QTY REQD
Bracket, Inertia Reel Mount	16 1/2x3 1/2"x3/16" Extruded Aluminum		1
Inertia Reel, Roller Type	MIL SPEC R-8236	0106176-0	1
Harness, Shoulder	MIL SPEC	57D677	1
Loop, Shoulder Harness Retention	(See Figure 59) Mild Steel		1
Bolt	#10-32 UNF	AN3-3A	1
Bolt	#10-32 UNF	AN3-3A	3
Bolt	#10-32 UNF	AN3-11A	3
Bolt	#10-32 UNF	AN3-14A	4
Bolt	#10-32 UNF	AN3-16A	2
Bolt	#10-32 UNF	AN3-24A	1
Nut, Self Locking	#10-32UNJF-3B	MS 21042-3	14

THE ONLY NON-PRODUCTION PIECES

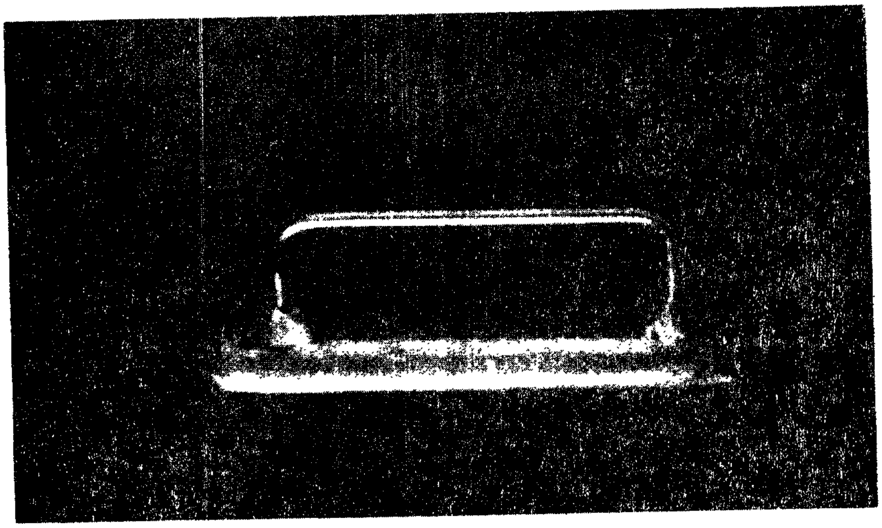


Figure 57. Shoulder Harness Guide Loop

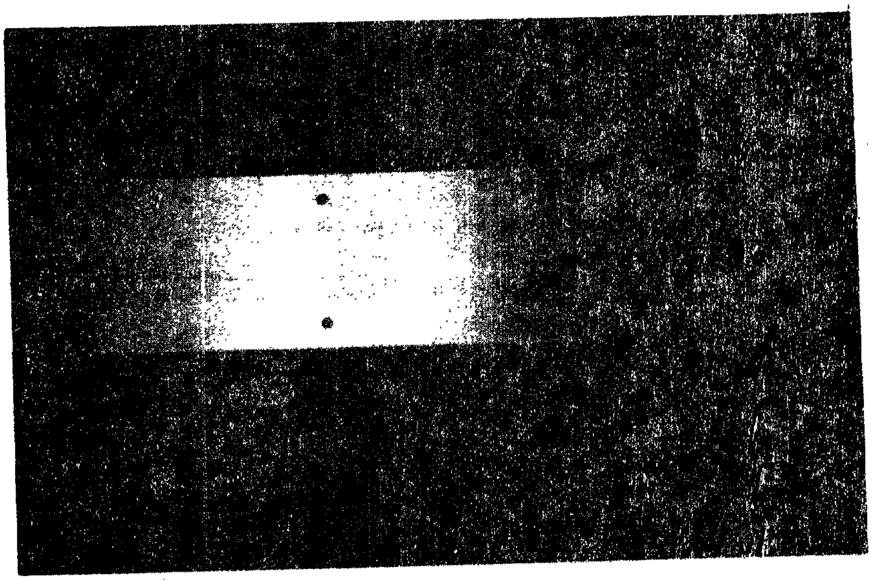


Figure 58. Inertia Reel Mounting Bracket

The following drawings give sizes and specifications of the two nonstandard parts of the kit. Use any aircraft quality #10 bolts of appropriate length for attachment.

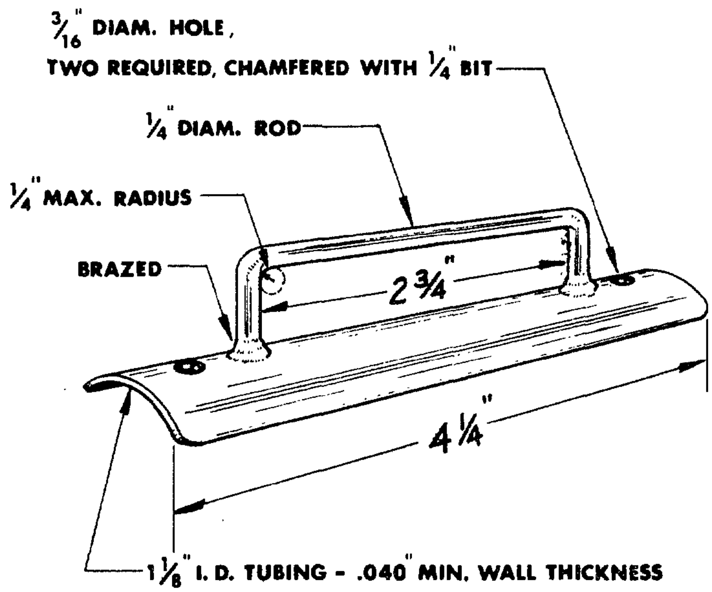
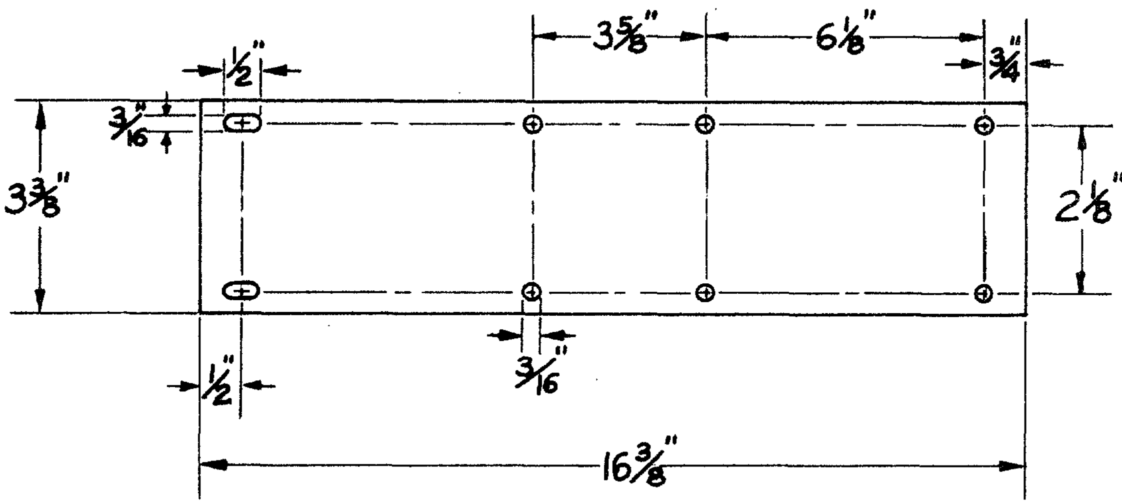


Figure 59. Shoulder Harness Retention Loop



CONSTRUCTION IS TO BE FROM 3/16" THICK ALUMINUM PLATE, WITH BOTH SIDES OF ALL HOLES CHAMFERED WITH A 1/4" BIT.

Figure 60. Inertia Reel Mounting Bracket

Figure 61. Correct Installed Position of Seat with Kit. Note Routing of Lap Belt Secured by Canvas Strap on Side.

The current lap belt attachment rings on the sides of the seat are not to be used in their present state. If for any reason it is necessary to attach any restraint system to one of these rings, follow this procedure: Cut the entire weld area out, bevel the ends completely, bend the ring to bring the ends together, reweld completely and thoroughly, making sure the entire area is uniformly heated, allow the area to anneal by natural air cooling.

In cases that may arise under special circumstances where there is insufficient adjustment of the lap belt to comfortably or safely retain an occupant, this alternate method for attaching the lap belt may be employed. Detach the lap belt from the attachment ring in use and reattach the belt to the appropriate cargo tie-down ring using (2) two seat support cables used on the crew seats of UH-1A helicopter, one cable to each end of the belt.

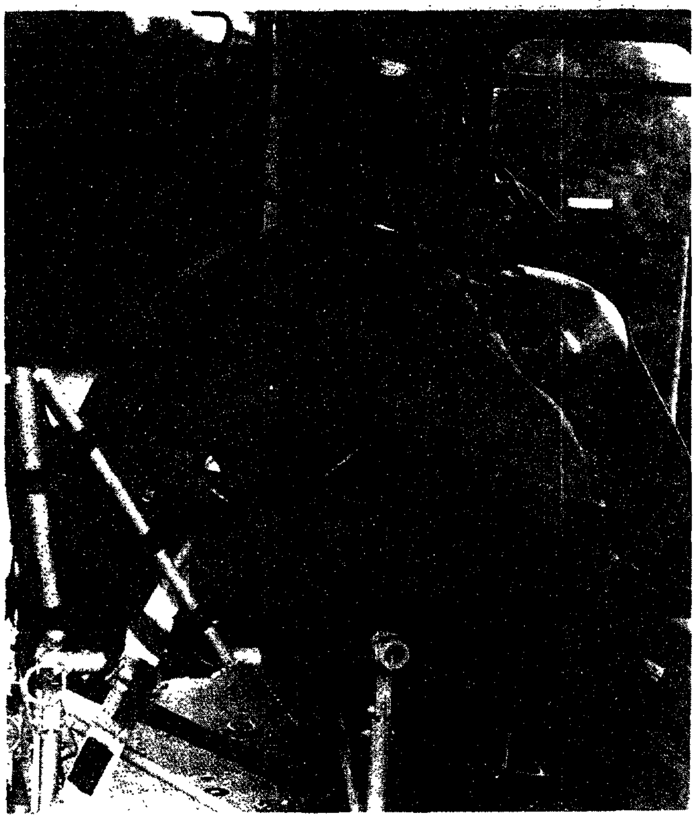


Figure 62. Good Demonstration of Degree of Voluntary Freedom of Movement with Inertia Reel Unlocked.

Figure 63. Even When Shoulder Harness is Fully Extended and Seat is Installed in the Center Position, Face Seat-Back Contact is Prevented.

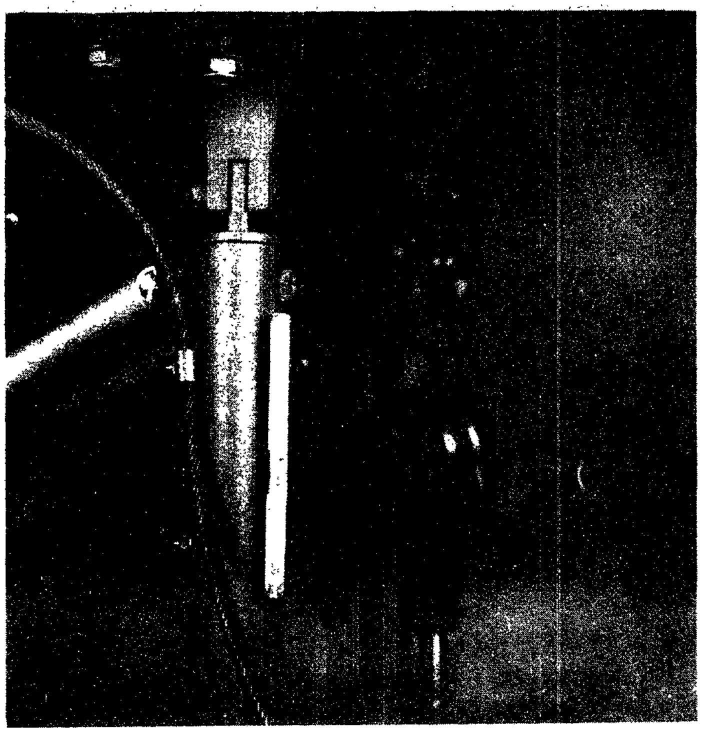


Figure 64. Correct Installed Position of Inertia Reel Mounting Plate. Note Locking Cable Secured to Upper Mounting Bolt.

Figure 65. Note Slight Rearward Tilt of Shoulder Harness Guide Loop to Prevent the Unprotected Head from Striking the Small Surface Area of the Top of the Loop During Whiplash.

The seat, when used in the forward facing position as an observer's seat, should be installed only in the center location directly behind the radio console. In either side position, the occupant could contact a number of objects, as shown in the following picture, in the event of inertia reel failure or excessive looseness in the shoulder harness.

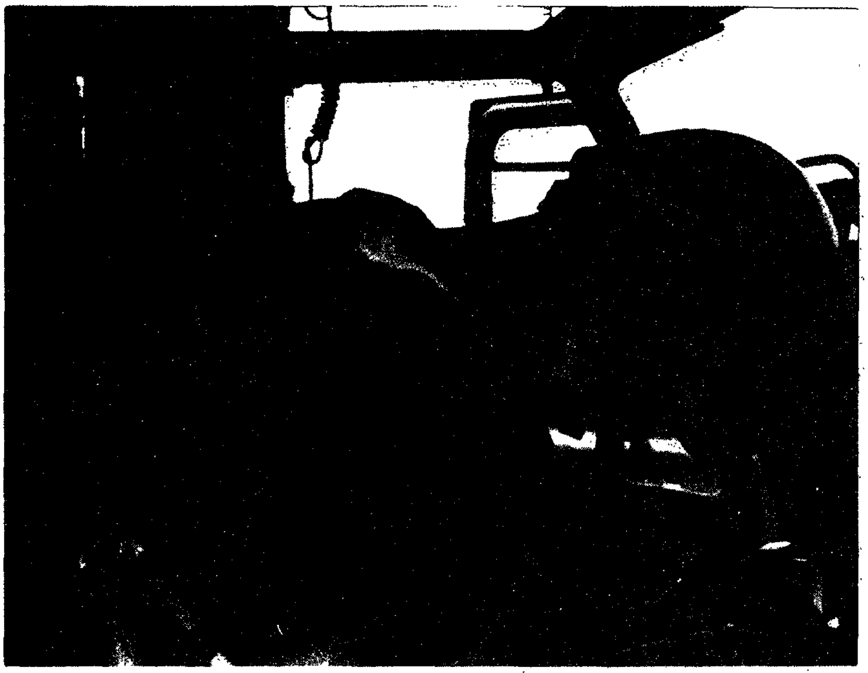


Figure 66. Demonstration of maximum forward flexion and torso bending with the shoulder harness locked. This occupant is seated behind a crew seat while he would not be expected to contact the crew seat with his face any submarining or seat collapse could result in body - seat contact even though he is restrained.