CONTROLLED IMPACT DEMONSTRATION
SEAT/CABIN RESTRAINT SYSTEMS - FAA

Richard A. Johnson
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey

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INTRODUCTION

Five years ago, the FAA initiated a program to determine the adequacy of existing occupant restraint system protection. This effort began with a contracted industry study of survivable accidents and extended to over 100 systems and full-scale aircraft drop tests performed at the FAA Civil Aeromedical Institute (CAMI) and the FAA Technical Center. These studies and related tests formed the basis for the development and selection of the FAA onboard experiments which concerned occupant seta restraint and the retention of mass items in the cabin. I will briefly discuss these experiments and related instrumentation as part of the overall pretest discussion.

SEAT/CABIN RESTRAINT SYSTEMS--FAA

- EXPERIMENTS
- INSTRUMENTATION

OBJECTIVE

The FAA restraint system experiments consisted of 24 standard and modified seats, 2 standard galleys and 2 standard overhead compartments. Under the CID program, the experimental objective was to demonstrate the effectiveness of individual restraint system designs when exposed to a survivable air-to-ground impact condition. What we were looking for was the performance exhibited by standard and modified designs, performance differences resulting from their installed cabin location, and interrelating performance demonstrated by test article and attaching floor and/or fuselage structure.

DEMONSTRATE THE EFFECTIVENESS OF EXISTING AND IMPROVED SEAT/CABIN RESTRAINT SYSTEM CONCEPTS

SEAT/RESTRAINT EXPERIMENT

Of the 24 seat experiments, 11 were standard inservice designs of single, dual and triple occupant configurations. The remaining 13 seats were modified versions featuring improved energy absorption, higher strength and increased floor track retention as [C] in which 4 different seat modifications were developed [C,G,I,K]. Also, in the case of 9 seat designs, there were 2 test articles each of which were arranged in two separate fore and aft groupings in the cabin.

STANDARD		MODIFIED	
A - TRIPLE PAX.	(2)	C′ - (C) W/FITTING	(1)
B - TRIPLE PAX.	(2)	E - (A) E/A LEG/BRACE	(2)
C - TRIPLE PAX.	(2)	F - (B) E/A BRACE	(2)
* D - DUAL PAX	(2)	G - (C) E/A BELT	(2)
J - TRIPLE PAX.	(1)	H - (B) E/A LEG	(2)
* A - DUAL F/A	(1)	I - (C) E/A LEG	(2)
D - SINGLE PILOT	(1)	* K - (C) E/A LEG	(1)
		A′ - (A) STRENGTHEN	(1)
	11		13

* AFT FACING

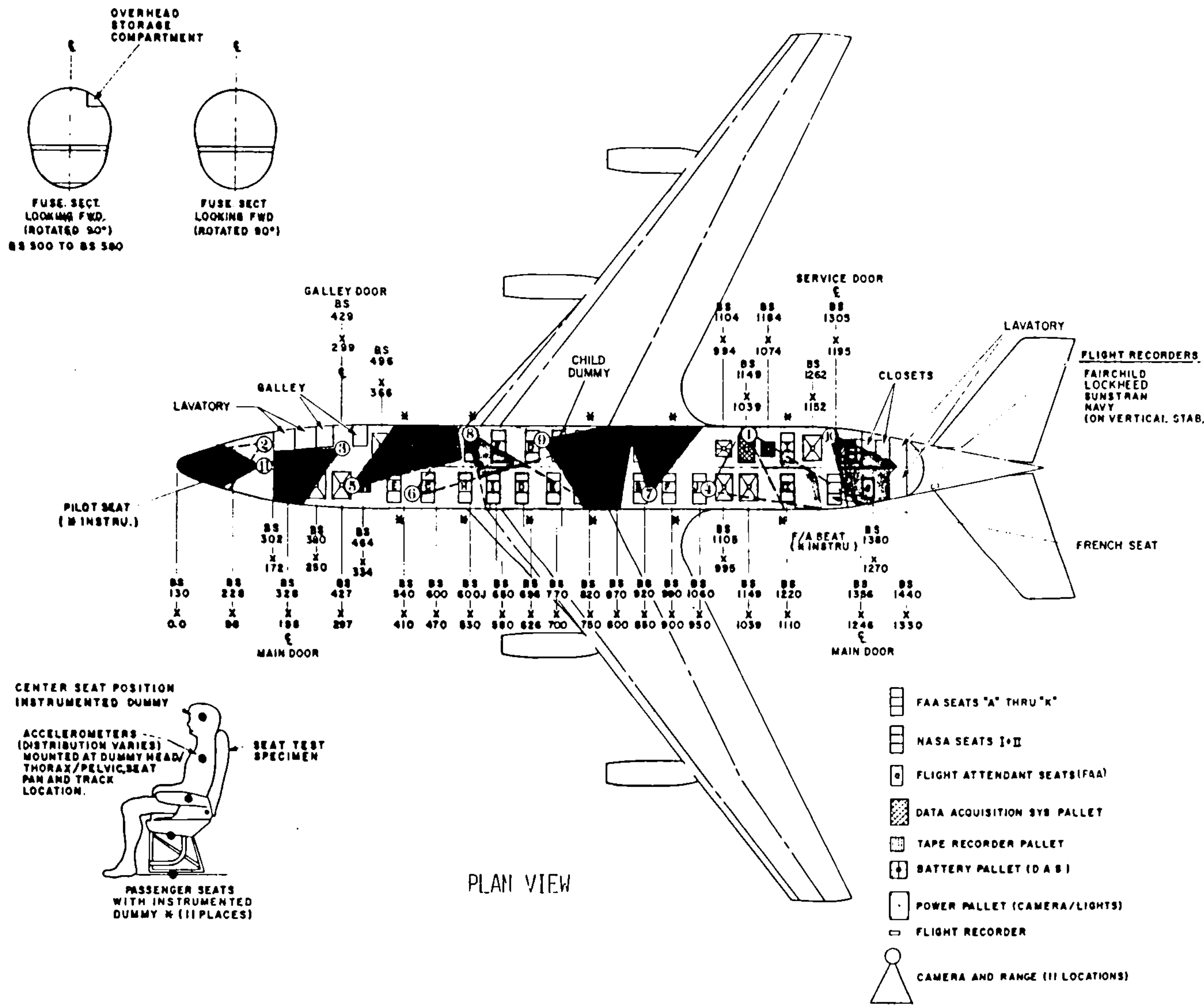
CABIN RESTRAINT EXPERIMENTS

The other restraint system experiment consisted of 2 standard overhead stowage compartments and 2 galley modules. Again, we are concerned with the retention of stowed equipment and carry-on articles. The overhead compartments were loaded with test weights up to their maximum capacity, and each of the galleys was filled with test articles: aft with normal galley equipment, forward with hazardous material test packages (an experiment sponsored by the DOT Office of Hazardous Materials).

- STOWAGE COMPARTMENTS: (2) STANDARD OVERHEAD COMPARTMENTS CONTAINING TEST WEIGHTS
- GALLEYS: (2) STANDARD FORE/AFT GALLEYS CONTAINING HAZARDOUS MATERIAL TEST PACKAGES/GALLEY EQUIPMENT

PLAN VIEW

This is a plan view of the aircraft showing the distribution of the FAA seat/cabin restraint system experiments in gray (beginning in the forward cabin section with the pilot seat, forward flight attendant seat, two groupings of standard and modified passenger seats and aft flight attendant seat). Also shown are the galleys and overhead compartments. The instrumentation varied between each of the test articles. This side view position shows a typical accelerometer installation involving floor, seat, and instrumented dummy. The 11 numbers identified throughout the cabin area represent camera positions from which high-speed movies were obtained during the test sequence.



INSTRUMENTATION

A breakdown of instrumentation and distribution is shown here beginning with 11 instrumented type anthropomorphic dummies and 185 sensors which provided for acceleration and load measurements at the various experiment and associated structure locations. The onboard cameras provided additional coverage of these experiments, including the areas of cabin which were not instrumented.

• DUMMIES:	(TOTAL)	(66)
	INSTRUMENTED	11
	NON-INSTRUMENTED	55
• ACCELEROMETERS:	(TOTAL)	(156)
	DUMMY	46
	SEAT	69
	FLOOR (AT SEAT)	38
	STOWAGE COMPARTMENT	3
• LOAD CELLS:	(TOTAL)	(29)
	LAP BELT	22
	SHOULDER HARNESS	4
	STOWAGE COMPARTMENT	3
• ONBOARD CAMERAS:	(TOTAL)	(11)
	COCKPIT	2
	CABIN	9

SEAT/RESTRAINT MODIFICATIONS

As previously stated, seat modifications were aimed at improving the energy absorbing capability and floor track retention with consideration given to floor deformation. An emphasis was placed on the development of such improvements within acceptable cost/weight limits, while at the same time maintaining current practices relative to underseat stowage, seat pitch and overall accessibility.

- IMPROVED ENERGY ABSORPTION DESIGN
- IMPROVED FLOOR RETENTION DESIGN

SEAT DESIGN CRITERIA

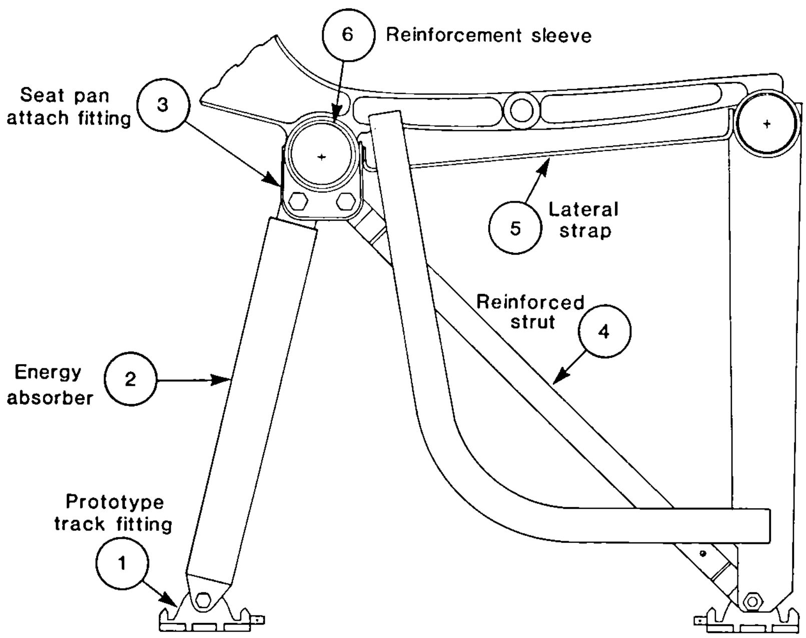
The criteria applied to the design of each of the seat modifications were established on the basis of previous accident studies and data obtained from current inservice seat tests, as well as full-scale tests, such as the L-1649. The selected criteria are shown next to current FAR 25 minimums, and include a triangular 18G peak dynamic pulse in the longitudinal direction and a 10G static load in the vertical and lateral directions.

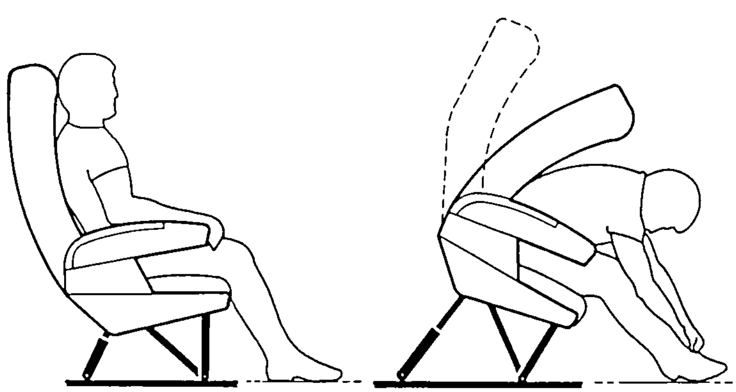
	STANDARD (FAR 25)	MODIFIED
FORWARD	9.0 G	18 G*
DOWNWARD	4.5 G	10 G
SIDEWARD	1.5 G	10 G

* DYNAMIC TRIANGULAR PULSE 35 FPS

TYPICAL SEAT RESTRAINT MODIFICATION

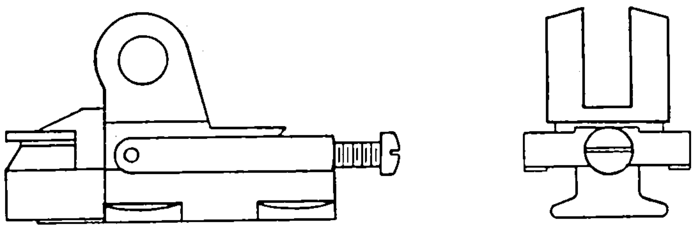
The concept of using energy absorption devices to limit the loads of both the occupant and floor attachment structure is not new. However, in many cases such devices developed in the past resulted in heavier, more complex seat configurations. This represents a typical CID seat modification which included the replacement of two aft legs with special energy absorber devices. As shown in the side view, other modification changes included strengthening various parts of the seat structure and increasing floor retention by adding improved track fittings to each of the four seat legs.



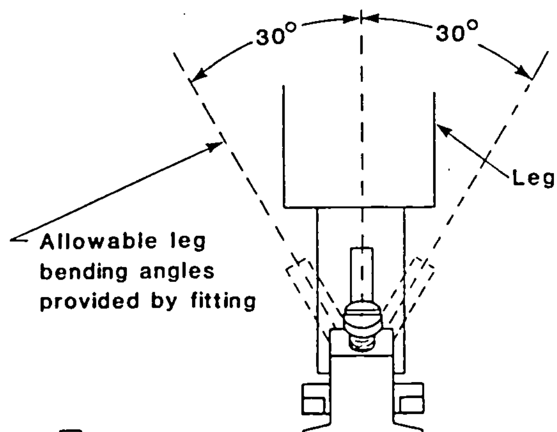


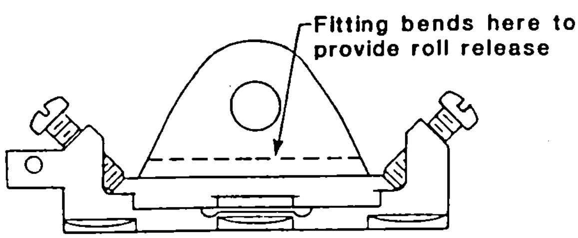
TRACK FITTINGS

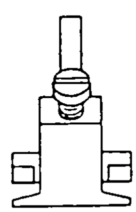
The fitting illustrated in the upper left hand corner is a standard rear leg type fitting which normally contains two interlocking track studs and a leg attachment point which allows release around the pitch axis. Unlike standard forward leg fittings which are represented by a single non-lock stud only, the standard rear leg fitting is designed to resist shear loads in the longitudinal direction. As shown below, the modified seats were fitted with these improved fittings on all four legs. These fittings featured a stronger triple lock stud design which included plastic hinges that allowed for release about both the pitch and roll axes. The combination of the multiple release type fitting and the aforementioned energy absorbing legs assured improved seat-track retention during realistic conditions of adverse floor deformation.



STANDARD TRACK FITTING







PROTOTYPE TRACK FITTING

TYPICAL LAB TEST RESULTS

This typifies the dynamic test results between one of the CID standards and a modified seat design. Shown are the window-side leg forces versus pulse duration. At a 9G 50-ft/sec dynamic pulse, the leg of the standard seat detached from the track fitting at 5900 lbs. The energy absorbing leg of the modified design stroked 3 inches and limited the load on the fitting to 5370 lb for 110 seconds. No failure was observed on the modified seate(weight increase due to the energy absorbers was 2 percent).