CID OVERVIEW

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INTRODUCTION

On December 1, 1984, NASA and the Federal Aviation Administration (FAA) conducted the first remotely piloted air-to-ground crash test of a transport category aircraft. The Full-Scale Transport Controlled Impact Demonstration (CID) was the culmination of 4 years of effort by the two agencies. NASA and the FAA had many objectives during the joint planning and execution of the Controlled Impact Demonstration. NASA's interest was primarily structural crashworthiness. The FAA's primary interest was the demonstration of an antimisting fuel additive's performance. Demonstration of improved crashworthy design features was a secondary objective for the FAA.

This workshop is intended to provide results obtained to date on the performance of the airframe structure and the associated structural loads from the CID test to the industry/university/government community.

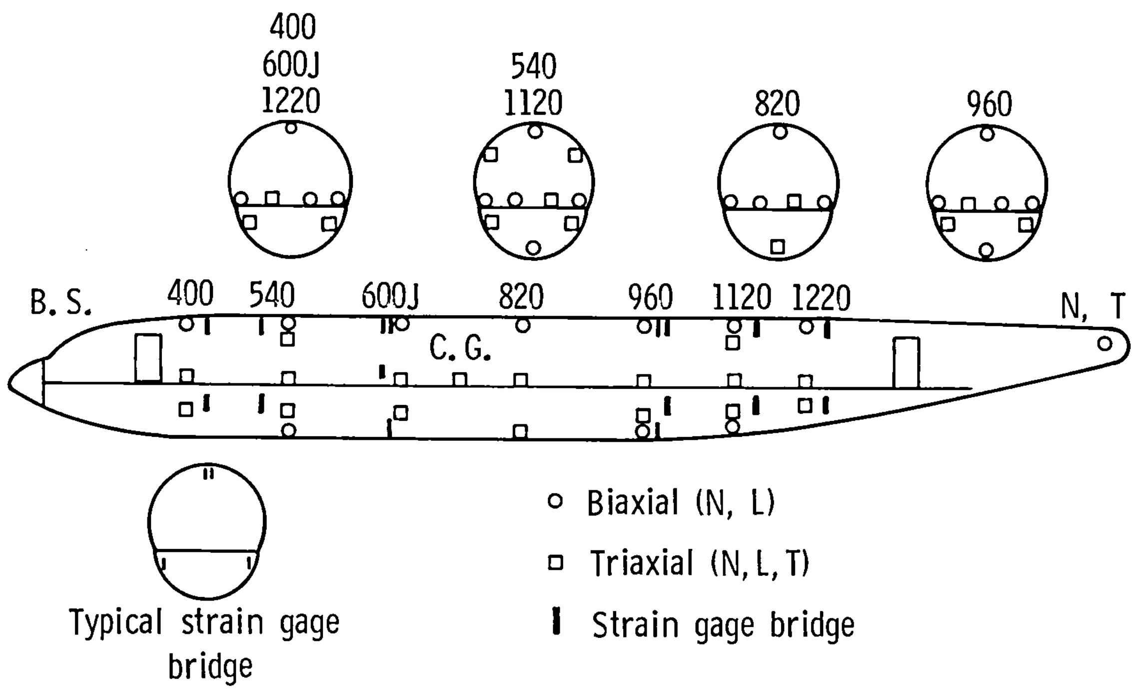
C.I.D. OBJECTIVES

The major C.I.D. objective for the FAA was the antimisting kerosene (AMK) experiment with the modified fuel system. The FAA had a great deal of success during the developmental tests of the AMK and spent a lot of effort at Dryden implementing the fuel degraders and cooler systems for the AMK. However, this workshop is not going to address the AMK experiment. We will concentrate on the NASA structural baseline data experiment that provides information for our future composite structure dynamics program. We are going to describe the crashworthy design features that both NASA and the FAA have onboard the aircraft.

- Verify antimisting fuel (AMK) performance
- Demonstrate operational AMK fuel/propulsion system capability
- Acquire structural baseline data for composite structures program
- Test improved crashworthy design features

C. I. D. FUSELAGE INSTRUMENTATION

This figure shows the instrumentation that we had on the fuselage for the structural loads experiment. The wings were also very heavily instrumented. The structural instrumentation details are presented in reference 1. This data, along with the data from the seats and dummies that were on the aircraft, will be the principal data presented at this workshop.



IMPACT SURVIVABLE SEATS

The majority of the seats onboard were FAA sponsored seats. Those seats are described in reference 2, and reference 3 presents the results of the FAA seat experiments. The two NASA seats onboard the aircraft are described in reference 1 and results are given.

OBJECTIVES

The primary objectives of the workshop are to release, in preliminary fashion, the results of the structural loads data that we obtained from the C.I.D., and also to release the data on the seats, dummies, restraint systems, galleys, bins, and flight data recorders.

The most important purpose of this meeting is to interact with the user community. This is just a preliminary release of data; we would like to make sure that when we complete our data reduction analysis and report that we address the important questions that you help us raise.

- Preliminary release of structural loads data from CID
- Preliminary release of data on seats, dummies, restraint systems, galley, bins, and flight data recorders
- Interaction with user community

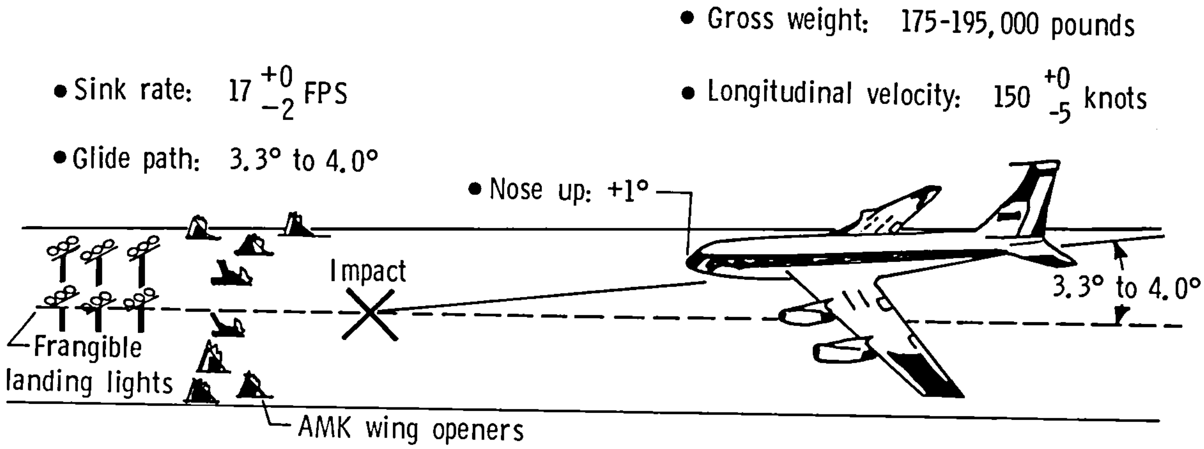
LANGLEY C.I.D. RESPONSIBILITIES

Langley C.I.D. responsibilities were primarily for the structural instrumentation experiment. Langley developed a data acquisition system and photographic system to cover the impact with both general data and photographic coverage of the interior of the aircraft. Langley was responsible for the acquisition of the impact loads, the data reduction and analysis, and correlation with the analytical models that have been developed using the DYCAST computer program.

- Structural instrumentation
- Data acquisition system - hardware/software
- Interior photo coverage
- Impact loads acquisition/analysis
- Aircraft analytical modelling

PLANNED C.I.D. IMPACT SCENARIO

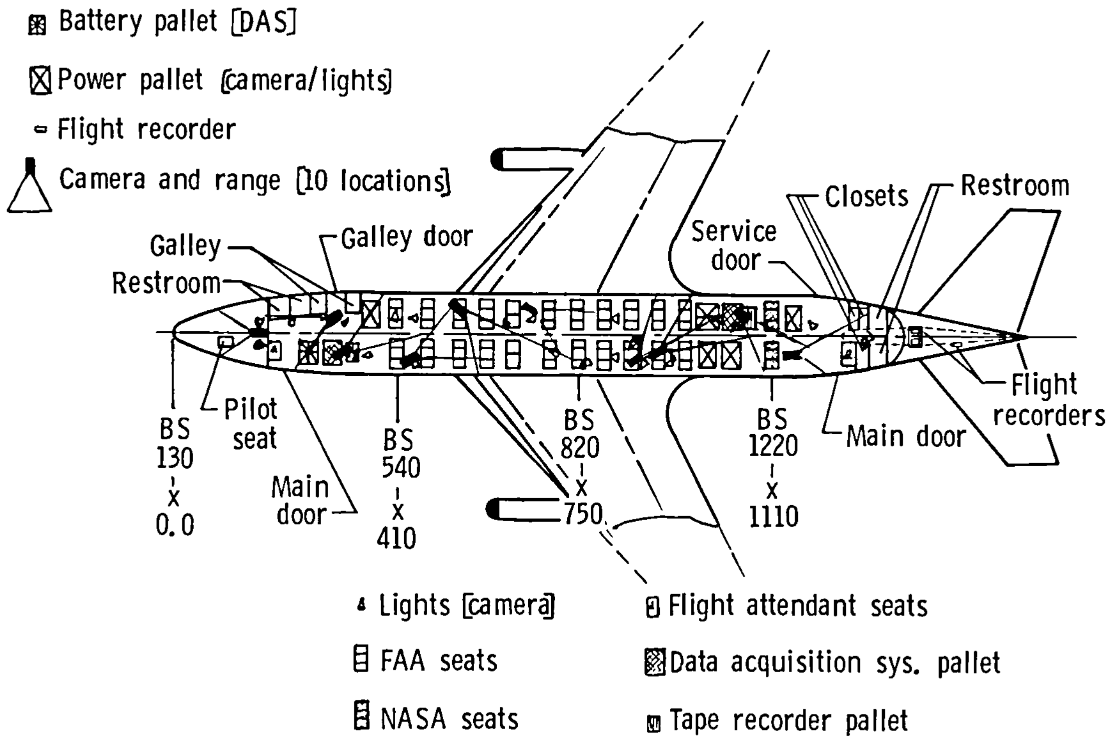
This is a brief description of the planned C.I.D. impact scenario. Barber (ref. 4) goes into more detail. Basically, we were trying to impact in front of the AMK wing openers so that the structural loads impact experiment would occur prior to impact with the wing cutters. We were expecting about 17 feet per second vertical sink rate and longitudinal velocity of 150 knots.



C.I.D. PLAN VIEW

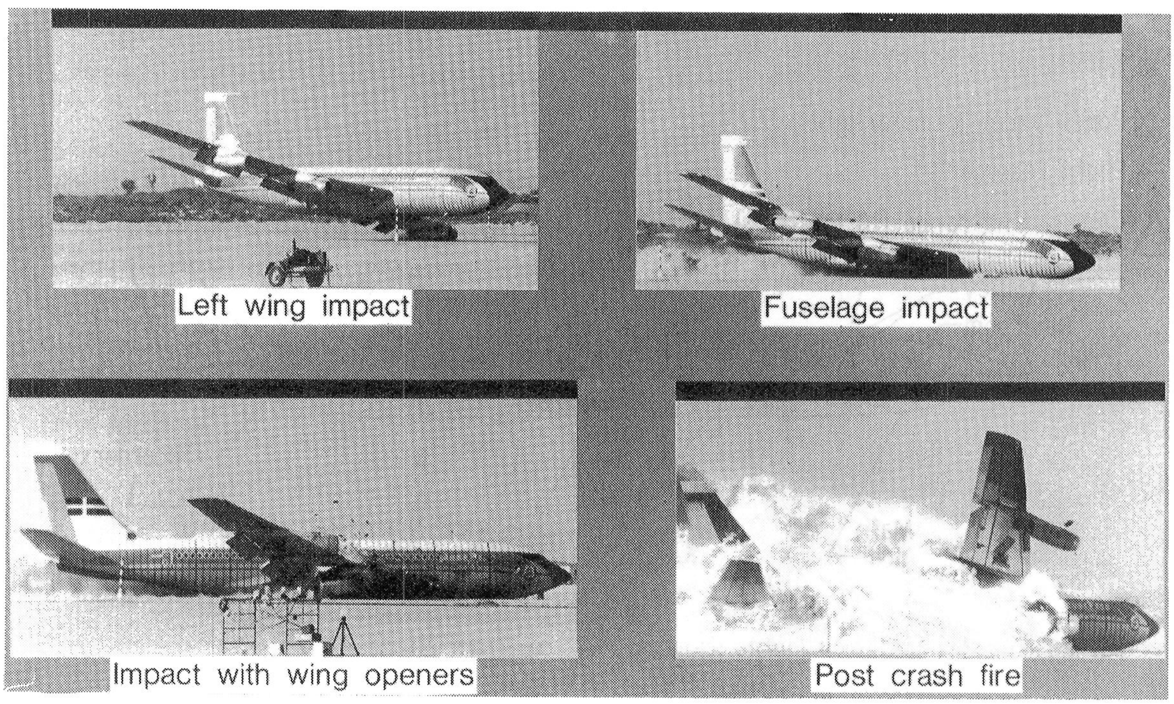
The interior of the aircraft had a large number of seats onboard with data acquisition systems fore and aft. Photographic coverage throughout the fuselage was provided by Langley (10 cameras) and JPL (1 camera). Two nose cameras were installed by Dryden to assist the ground-based pilot. JPL installed a camera on the vertical stabilizer looking down on the fuselage and wings. Ground-based and airborne photographic coverage was provided by JPL.

Note that two longitudinal location identifiers are marked on the plan view. The usual body station (BS) system is used, as well as a longitudinal X-coordinate measured in inches from the nose of the aircraft.



C.I.D. IMPACT SEQUENCE

This sequence of four scenes from a Hulcher camera shows the sequence of events. The primary period of times that are of interest to this workshop are the left wing impact and the impact of the fuselage with the ground. By the time the aircraft impacted the wing cutter, the NASA structural loads experiment was essentially over. However, there were substantial loads that occurred during impact with the wing cutters that are of interest to the seat experimenters. After the aircraft came to rest and was engulfed by fire, the structural and seat loads experiment was over. However, there were some fire-resistant materials experiments onboard, such as seat fire-blocking layers and heat resistant window panes.



Left wing impact

Fuselage impact

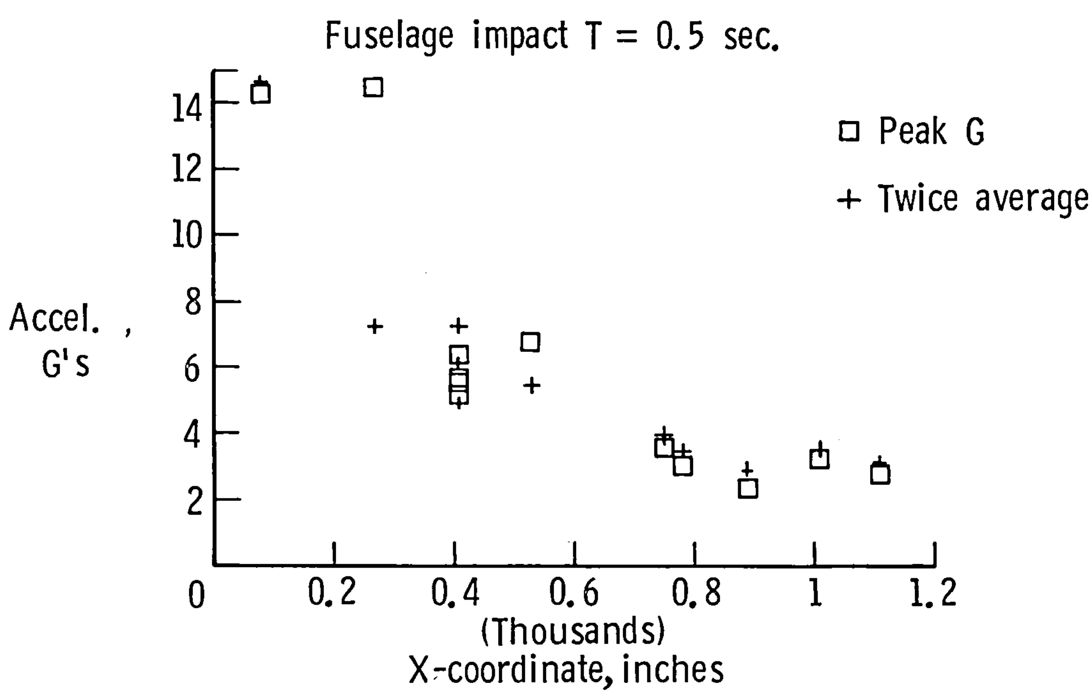
Impact with wing openers

Post crash fire

C.I.D. VERTICAL FLOOR ACCELERATIONS

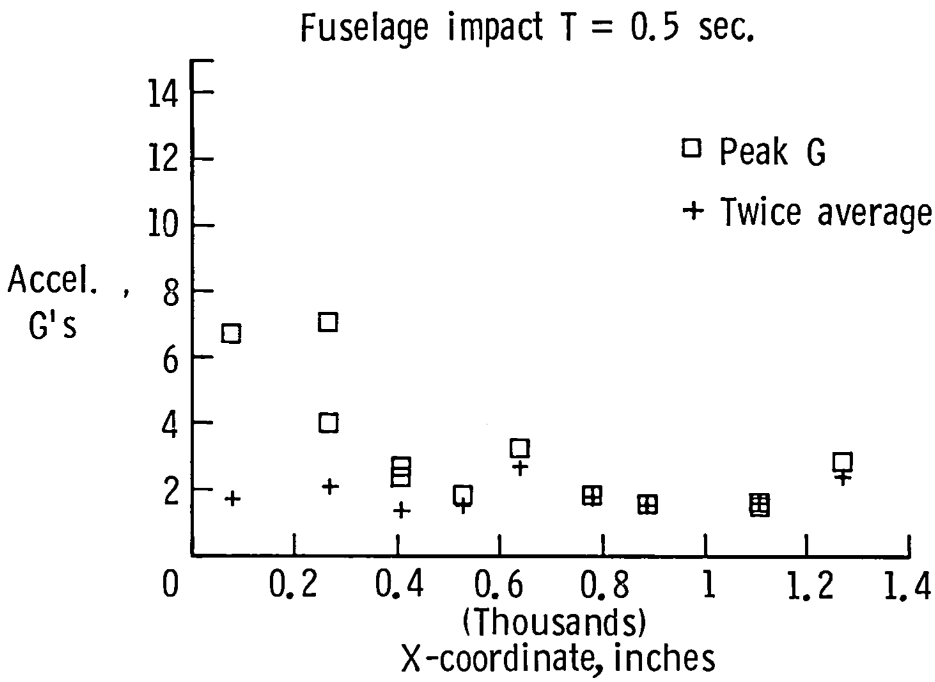
The next four figures give a very brief overview of the structural loads data. On these figures, acceleration (G's) is plotted as a function of an X coordinate, which is simply the distance measured from the nose aft in thousands of inches. Vertical acceleration peaks in the neighborhood of 14 to 15 G's occurred in the nose and forward cabin, substantially dropping off to levels of 7 to 2 G's in the remainder of the fuselage. It was a very, very mild impact from a human tolerance point of view. I believe a fit, young adult male could withstand upwards of 25 G's in a vertical direction for short durations. The C.I.D. aircraft had fairly low levels throughout, which would have been tolerable by a fit and well restrained human.

The peaks from the data are represented by the squares. The plus symbols represent an average peak which is determined by a triangularization technique described by Fasanella (ref. 5). These average peaks correlate very well with the peaks from the actual filtered data, except perhaps in a few instances where high frequency oscillation occurs.



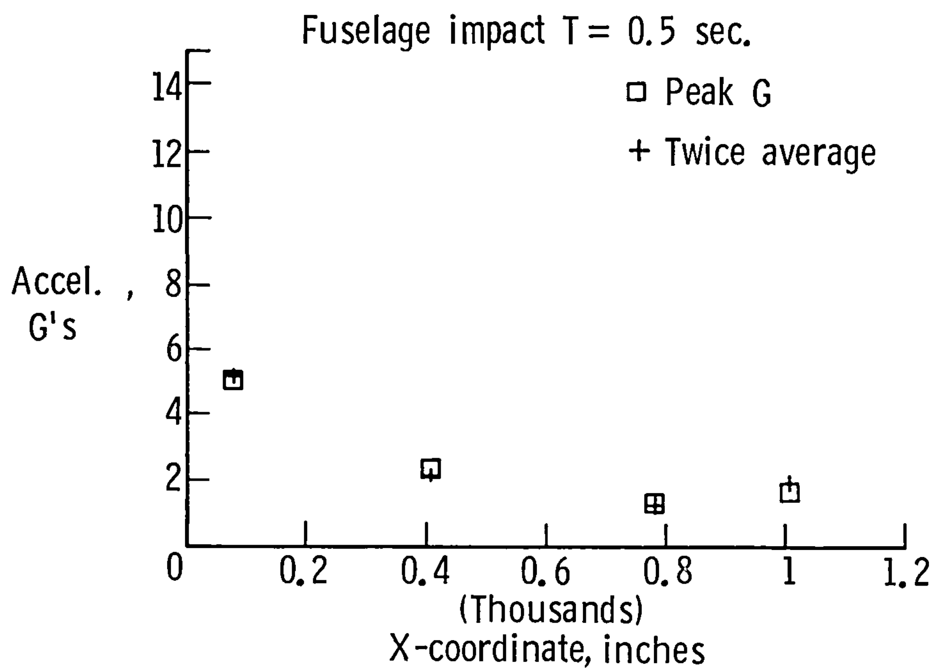
C.I.D. LONGITUDINAL FLOOR ACCELERATIONS

Longitudinally, the acceleration distribution throughout the aircraft was fairly low. Again, the highest levels occurred in the nose and forward cabin, dropping off substantially below 4 G's down around the 2 G-level for most of the aircraft.



C.I.D. TRANSVERSE FLOOR ACCELERATIONS

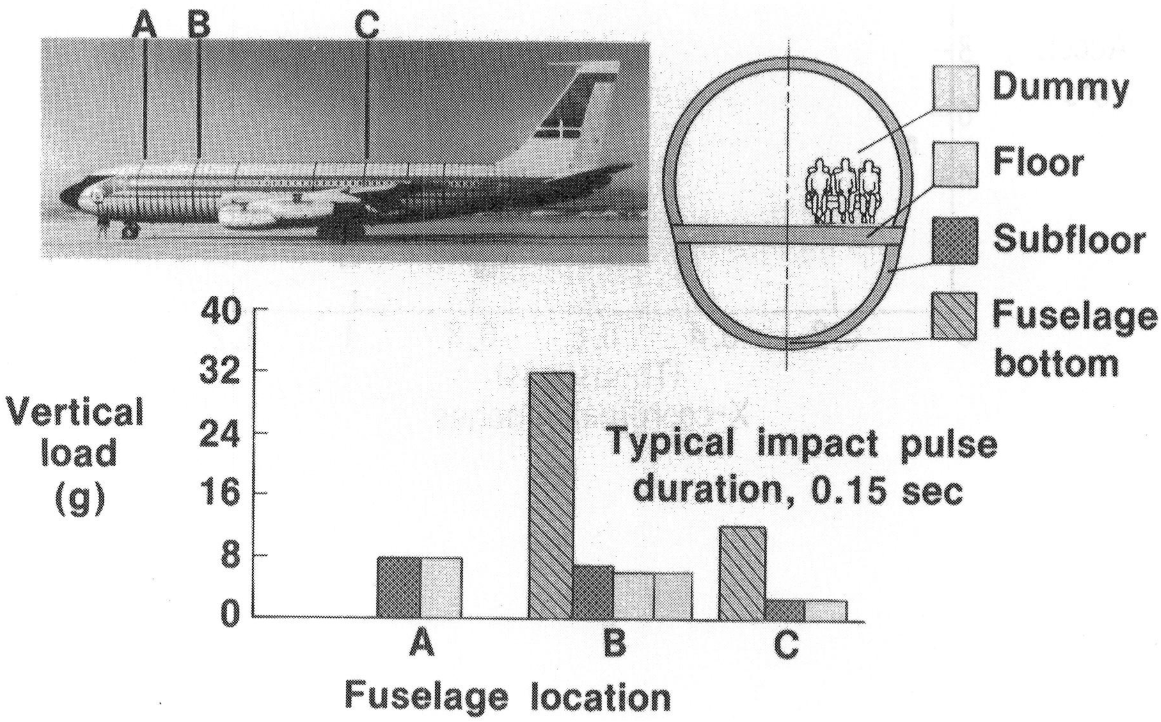
Transverse accelerations along the floor were also generally low -- 5 G's in the nose, down around 2 G's for the remainder of the aircraft.



AIRCRAFT STRUCTURAL RESPONSE

Load transmission from the fuselage bottom up to the dummy is discussed in reference 1. This figure introduces the levels at one particular body station.

Point B is body station 540, about 410 inches back from the nose. The fuselage bottom experienced about 32 G's at impact. By the time the load got up along the side wall and under the floor, the level was reduced to around 7 G's. On the floor and in the pelvis of the dummies, the vertical acceleration was down to 6 G's.



C.I.D. SUMMARY

In summary, the structural loads experiment was very successful. Ninety-seven percent of the channels were active at impact. The data is still being assessed. Only a portion of the data has been presented here; approximately 80 channels of data are available. Analysis of the remaining data is in progress.

Interior photography was also very successful. One hundred percent of the cameras functioned. The film contains unique information on the development of fire and smoke in the interior of the aircraft. From a human tolerance point of view, the C.I.D. was a simulation of a survivable crash.

1. Structural loads experiment was successful
   - 97% of channels active
   - Data being assessed

2. Interior photography successful
   - 100% of cameras functional
   - Significant information

3. CID survivable from impact loads point of view

REFERENCES

1. Alfaro-Bou, Emilio: NASA Experiments on the B-720 Structure and Seats. Full-Scale Transport Controlled Impact Demonstration, NASA CP-2395, 1986, pp. 29-47.

2. Johnson, Richard A.: Controlled Impact Demonstration Seat/Cabin Restraint Systems - FAA. Full-Scale Transport Controlled Impact Demonstration, NASA CP-2395, 1986, pp. 49-60.

3. Cannon, Mark R.; and Zimmerman, Richard E.: Preliminary Floor, Seat, and Dummy Data. Full-Scale Transport Controlled Impact Demonstration, NASA CP-2395, 1986, pp. 125-155.

4. Barber, Russ: CID Flight/Impact. Full-Scale Transport Controlled Impact Demonstration, NASA CP-2395, 1986, pp. 17-28.

5. Fasanella, E. L.: Digital Filtering and Acceleration Pulse Interpretation. Full-Scale Transport Controlled Impact Demonstration, NASA CP-2395, 1986, pp. 103-123.