AM 66-12

INJURY POTENTIALS OF LIGHT-AIRCRAFT INSTRUMENT PANELS

John J. Swearingen, M.S.

Approved by

J. Robert Dille, M.D.
Chief, Civil Aeromedical Institute

Released by

P. V. Siegel, M.D.
Federal Air Surgeon

April 1966

FEDERAL AVIATION AGENCY
Office of Aviation Medicine

INJURY POTENTIALS OF LIGHT-AIRCRAFT INSTRUMENT PANELS

I. Introduction.

Many accident investigators have reported that 70% to 80% of all deaths and injuries in crash decelerations are from face or head injuries, or both, caused by body flailing.[1-6] Most light aircraft are not equipped with shoulder harnesses or even feasible attachment points for them. With only seat-belt restraint, pilots and passengers are striking their heads on nonyielding instrument panels, producing needless deaths in survivable crashes. The death rate in light-aircraft crashes (30) is five times greater than for automobiles (6.4) based on 100,000,000 passenger miles.[7] The total deaths in light-aircraft crashes is about 1,000 per year at the present time,[7] but since light aircraft are rapidly increasing in numbers—150,000 by 1975 [8]—one would expect this figure to continue to increase unless design features can eliminate the needless loss of life caused by head impact. Studies are underway at CAMI to determine feasible attachment points for shoulder-harness retrofit in present light aircraft.

II. Discussion.

Figure 1 shows the g-force curves obtained by catapulting an instrumented dummy head against a typical unprotected panel at 17.6, 26.7, and 42.2 ft/sec. Even the lowest impact velocity produced a peak g reading of 165 g, and, since it did not deform, the edge of the panel was applied

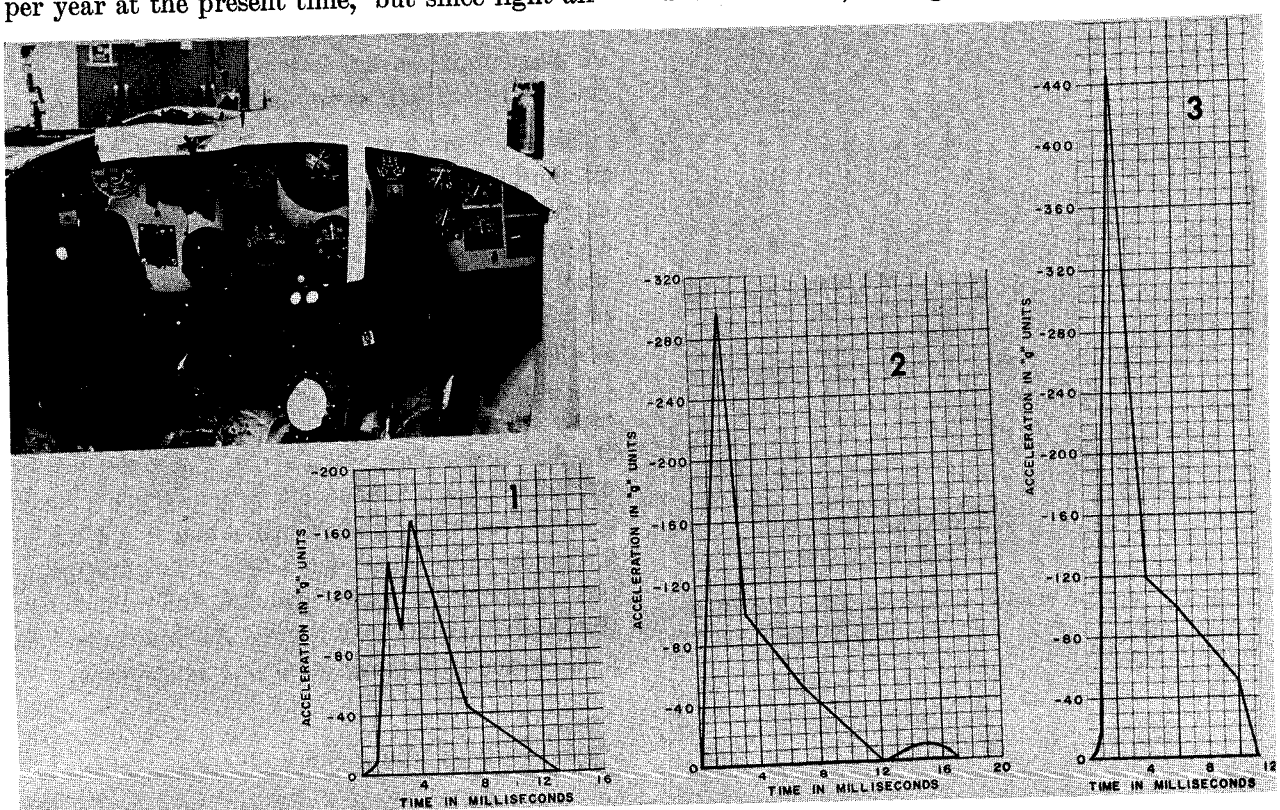


FIGURE 1. A typical light-aircraft instrument panel showing g-force curves obtained with head impacts of (1) 17.6 ft/sec, (2) 26.7 ft/sec, and (3) 42.2 ft/sec.

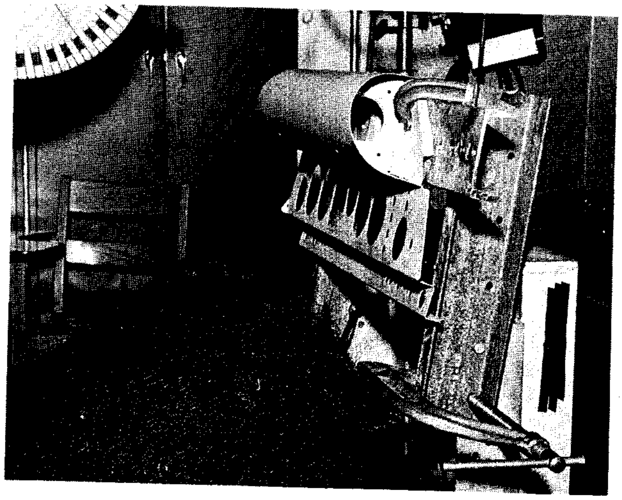
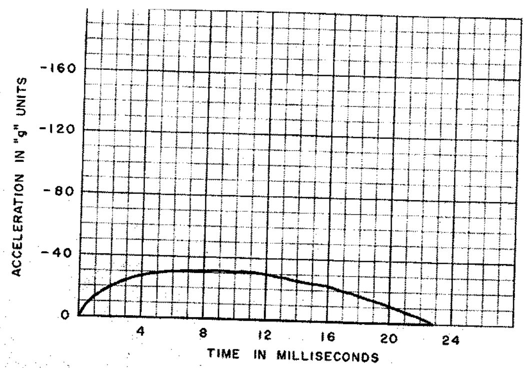


FIGURE 2. An oblique view of the cylindrical aluminum energy attenuator used by one aircraft company on its aerial-applicator aircraft.



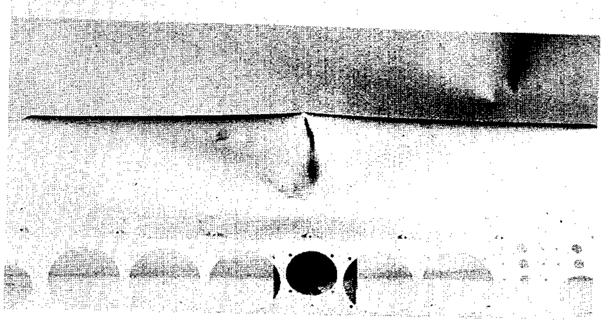


FIGURE 3. View of energy attenuator after a 15-ft/sec head impact with the instrumented dummy head.

against a very small area of the head, perhaps not more than ½ sq in. According to a previous study by the author,[9] the forehead (the strongest part of the face) cannot withstand more than 80g on 1 sq in. without skull fracture. Hence, all three tests on this panel would have produced fatal head injuries in aircraft crashes.

Figure 2 shows an oblique view of a lightweight semicylinder of aluminum that one company has added to the top of its instrument panel (total weight 1¼ aircraft pounds, probable installation cost $50.00 or less). Figure 3 shows the g forces produced when this cylinder was impacted with our instrumented dummy head at 15 ft/sec. Note by comparing Figure 1 and Figure 3 that the attenuator dropped the peak g force from 165 to 30 in the 15-ft/sec impact and from 295 to 115 in the 25-ft/sec impact (Figure 4). At the same time, since the light metal deformed to fit the forehead, the area of the head taking the impact load was increased from ½ sq in. to approximately 8 sq in. The forehead can take over 200g if it is applied to the contoured surface of 3 sq in. or more.[9] Thus, one can readily see the effectiveness of this simple energy attenuator for decreasing the number of deaths in light-aircraft crashes.

Since it has been established[10] that head impacts of 40 ft/sec occur in survivable crashes, an energy attenuator similar to the one discussed above but made of heavier aluminum and filled with a crushable foam was fabricated in our laboratory and impacted with the instrumented dummy head at 41.1 ft/sec (Figure 5). (Total weight 1½ pounds, probable installation cost $50.00 or less.) A comparison of the g force of the 40-ft/sec impact shown in Figure 1 against an unprotected panel with that shown in Figure 5 shows a drop from 440g on a small surface to 100g on a considerably larger contoured surface, bringing the impact force well within the tolerable range that under actual crash conditions would produce no more than a few minutes of unconsciousness.

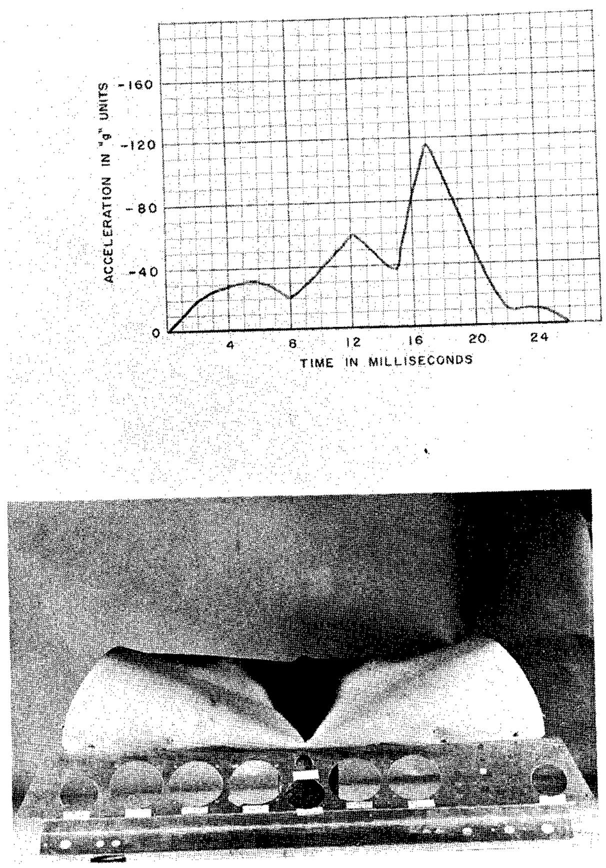


FIGURE 4. Picture and g-force curve of the energy attenuator after a 25-ft/sec impact.

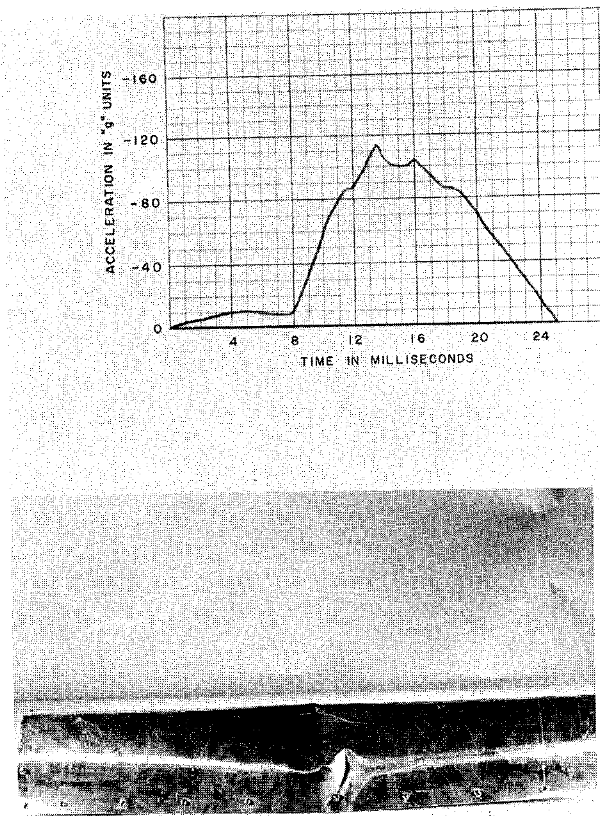


FIGURE 5. Test results of a 41.1-ft/sec head impact against a small semicylinder of 0.035 H–34 tempered aluminum filled with a crushable foam.

III. Conclusions.

Simple attenuators for reduction of head injuries in light-aircraft crashes have been described, tested, and discussed. Such devices could be installed on present aircraft with meager weight and cost penalty and would save hundreds of lives in survivable crashes.

REFERENCES

1. DEHAVEN, H.: The Site, Frequency and Dangerousness of Injury Sustained by 800 Survivors of Light-Plane Accidents. Department of Public Health and Preventive Medicine, Cornell University Medical College, New York, N.Y., July 1952.
2. HASBROOK, A. H.: "Crash-Safe" Design Can Make Many Accidents Survivable. *Space Aeronautics:* 79–80, 87, Sept. 1960.
3. HAYNES, A. L., and LISSNER, H. R.: Experimental Head Impact Studies. *Proceedings of Fifth Stapp Automotive Crash and Field Demonstration Conference.* Minneapolis: Univ. of Minn., 1962, 158–170.
4. HUELKE, D. F., GIKAS, P. W., and HENDRIX, R. C.: Patterns of Injury in Fatal Automobile Accidents. *Proceedings of the Sixth Stapp Car Crash and Field Demonstration Conference.* Holloman Air Force Base, New Mexico, November 1962, 44–58.
5. MARROW, D. J.: Analysis of Injuries of 1942 Persons in 1422 Light Plane Accidents. CAA Medical Service Records, Washington, D.C. Unpublished data, 1949.
6. MOORE, J. O., TOURIN, B., and GARRETT, J. W.: Study of Crash Injury Patterns as Related to Two Periods of Vehicular Design. Department of Public Health and Preventive Medicine, Cornell University Medical College, New York, N.Y., March 1955.
7. FEDERAL AVIATION AGENCY: Sixth Annual Report: Appendix B, Washington, D.C., January 1965.
8. HALABY, NAJEEB E., FAA Administrator: Speech Before the ATC, Miami Beach, October 30, 1961.
9. SWEARINGEN, JOHN J.: Tolerances of the Human Face to Crash Impact. Office of Aviation Medicine Report AM 65–20, July 1965.
10. Studies of high-speed movies taken of dummy flailing in the 1964 FAA–AvSER crash test of a DC–7 aircraft.

U.S. GOVERNMENT PRINTING OFFICE: 1966 O—224-075