Crash City For General Aviation: What Happens Beside *Splat?*

Dozens of aircraft are being deliberately crashed into the ground as the FAA and NASA study the anatomy of impact.

by Jonathan Eberhart

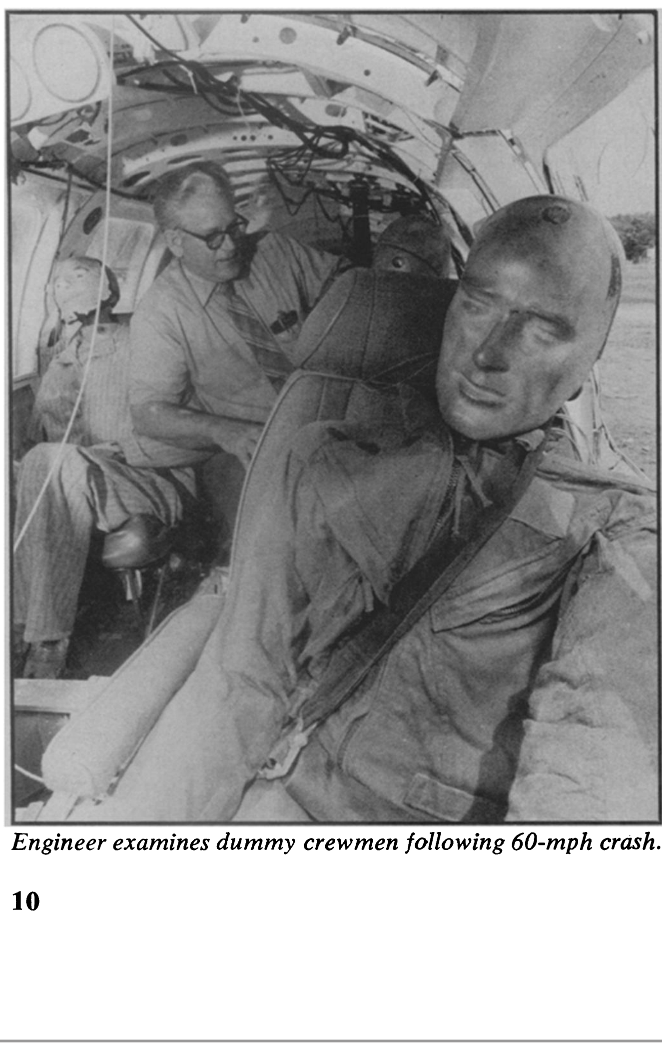
Out of the flood—straight into the ground.

As spring was completing its segue into summer in 1972, Hurricane Agnes smote the eastern United States a mighty blow, destroying lives and homes, creating overnight islands and wreaking havoc everywhere it went. One of the casualties was an airplane factory in Lockhaven, Pa., where Piper Aviation had been building small single- and twin-engined craft for the general aviation business. Small planes, but many of them worth somewhere in the neighborhood of a quarter million dollars apiece.

Agnes' contribution to the factory was instant flood. As the water inundated the aircraft—some still on the assembly line, others awaiting sale or delivery—silt worked its way into seams, overlapping joints and rivet holes. The water alone would have been enough to cause worries about the hastening of metal fatigue, but in addition it carried corrosive chemicals washed down from a nearby paper plant. After inspecting the damage, the Federal Aviation Administration deemed the aircraft unflightworthy, an irretrievable loss to Piper in the millions of dollars.

Not that it will make Piper's accountants any happier, but some good has come out of the tragedy. Buying the suddenly unflyable aircraft at scrap prices, the FAA and NASA have embarked on the first large-scale study of the "crashworthiness" of general aviation aircraft—complete with real crashes.

At NASA's Langley Research Center in Hampton, Va., stands a huge construction of girders, one and a third football fields long and 240 feet high, looking for all the world like the frame of a swing set in some mythical playground of giants. It was built and first used for drop tests of the Apollo lunar module, to be sure the spidery spacecraft could withstand the shock and vibration of landing on the moon. Now it's collision city, two crashes into a years-long program of deliberately hurling the grounded planes from the



Engineer examines dummy crewmen following 60-mph crash.

Test director Victor Vaughn checks "wreck" at Langley.

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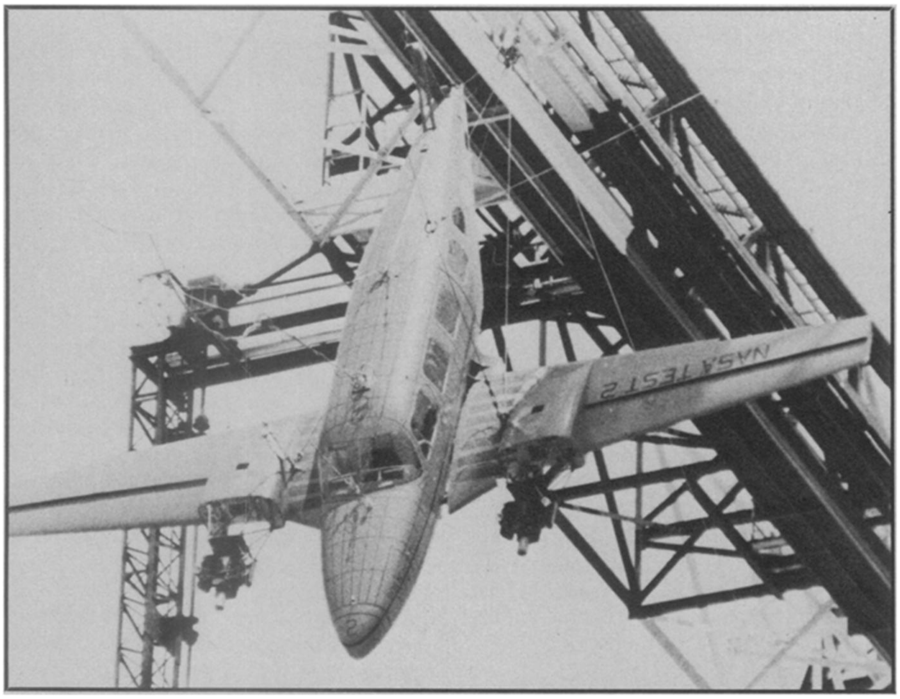
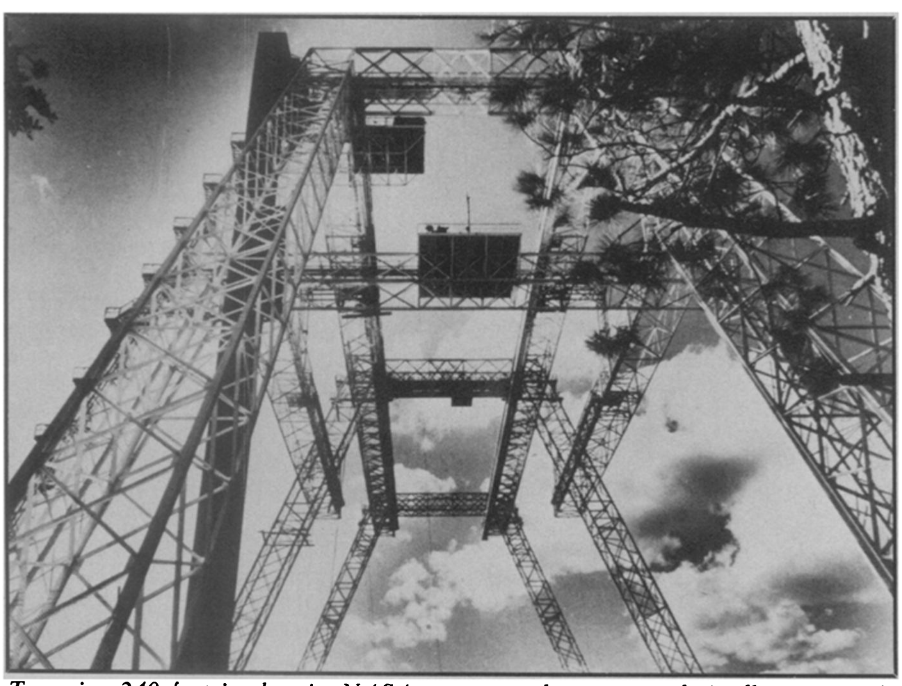
heights of the frame into the hard concrete below.

Both Government agencies have been quick to point out, particularly to allay earlier fears of the General Aviation Manufacturers Association, that the name of the game at Langley is research, not consumer testing. The purpose of the calculated drops is to learn what happens when a light plane crashes, not to find fault with anyone's designs. There has always been a shortage of real data on crash responses in light planes, so the FAA's safety and construction standards for general aviation have had to be based on indirect information such as materials tolerances and after-the-fact reconstructions of accidents. Research has been largely confined to individual components and partial structures, and to computer simulations based on these limited results.

Now NASA has 34 real, live planes to drop from its Langley torture tower, laden with sensors, crewed by instrumented dummies and recorded by 20 high-speed movie cameras. Another 19 of the flooded fleet are at the National Aviation Facility Experimental Center in Atlantic City, N.J., where the FAA plans to smack some into a shock-absorbing wall on a compressed-air sled and catapult the rest into a hillside. Three more are in FAA hands for similar testing in Oklahoma City. "If we were in a position where we had to go out and buy these airplanes," says the FAA's Herb Spicer, "we might not be in this test program."



Except for engines and tail, it's a whole plane getting the drop treatment.


Towering 240 feet in the air, NASA torture rack once tested Apollo mooncraft.

The first two crashes on the Langley rack did not use planes at all, but "iron maidens" made of steel I-beams fastened into the approximate shape of fuselage and wings. As the first steps in a five-year program, they were needed to check out the instrumentation, the cameras, and even the method of dropping the planes.

The drop technique is far more complicated than merely pushing the test aircraft off a roof. The program is supposed to cover crashes over a range of angles up to 60 degrees and speeds from barely moving (such as in the case of a collapsing landing gear) to at least 60 miles per hour. To do this, the planes are hung like pendulums from cables mounted at several points on their structure. Changing the length of the cables and the arc through which the planes swing varies the force and angle of the impact. The problem was made still more difficult when NASA adopted a suggestion by the General Aviation Manufacturers Association to vary the pitch—the difference in height between the plane's nose and tail—in the tests. In addition, so that the planes would be in free fall when they struck the ground, carefully timed explosive bolts were provided to disconnect the cables just one tenth of a second before impact.

The instrumentation is a story in itself. Fifty accelerometers measure the forces on different parts of the aircraft during the fraction of a second at and after the crash. Realistic dummies, also instrumented, simulate the flexibility, weight distribution and breakable joints of human occupants. Three cameras in the cockpit and 17 more on the ground and on the test rack film the impact and its effects at up to 8,000 frames per second, to show the sequence and speed at which the energy of the crash works its way through the structure—and its occupants. (In Oklahoma City, where the FAA does much of its human factors testing, the dummies are even more realistic, including such features as concussions and the amount of protection afforded by the rib cage.) The instruments in the planes and the dummies are connected to a recording device by an umbilical cable that stays attached during the crash but disconnects during the skid that follows.

The two agencies have different responsibilities in the test program. NASA's domain is the airframe—the main aircraft structure—while the FAA will analyze data on the dummies, seats and restraint systems such as lap belts and

Continued on Page 15

. . . Crash

shoulder harnesses.

Only two aircraft have been crashed so far, on Feb. 7 and May 8. These, plus a third scheduled for June 26, have been stripped-down vehicles without engines, tails, landing gear and other components, but with solid ballast replacing some of the parts and water in the fuel tanks, providing almost normal weight of about 6,000 pounds. Late in September the Army will step in with a super-crash of its own, a 30,000-pound CH-47 "Chinook" helicopter (with a full "crew" of nine dummies). After that, NASA will begin using its 20 complete aircraft, with 11 more stripped-down ones to be inserted at various points to test particular ideas or problems as they arise in the course of the program.

It is far too early for quantitative results to be available, and most of them will be in the form of numerical values to be used in fine-tuning subsequent computer simulations. Both NASA and the FAA agree, however, that even the first crash revealed what had been a widespread misconception in the limited studies of the past: "It was brought home to us loud and clear," says Langley's Robert Thomson, that there are two, not one, major impacts in a crash.

The assumption had been that a plane hitting the ground nose first gets one big jolt which is then transmitted rearward through the structure. The tests show that after the nose hits, the shock of the fuselage falling to earth behind it is a second substantial blow. At 60 miles per hour, says Thomson, the vertical loads in the second shock may be as high as 50 times the force of gravity, although they last for only two or three hundredths of a second.

The goals of the NASA and FAA research (the FAA will probably do its Atlantic City catapulting as the NASA data develop) are several. Most of the project officials at both agencies speak in terms of "developing the tool," meaning the computer analysis technique on which they must rely in the future when there are no flood-damaged airframes to throw around. It seems likely, however, that at some point the data will go into helping the FAA draw up more accurate, useful and rationally based safety standards for general aviation manufacturers. Improved safety would seem an almost certain result, although officials are reluctant to suggest that the program will result in anything that sounds like clamping down on the plane-builders. "Remember," goes the line, "it's not consumer testing."

True enough, but thanks to deadly Hurricane Agnes, the consumer—pilot and passenger alike—should benefit.

. . . Breeders

Two more major issues have gained attention; the problem of radioactive waste storage and the uncertainty over reactor safety and potential accidents.

Many radioactive wastes (highly radioactive by-products produced during fission and fuel processing) will have to be stored for thousands of years before the radioactivity has died down completely. Some of the fission products are short-lived, but some, like plutonium, will emit neutrons for over 200,000 years. Breeder wastes essentially will not differ from other nuclear wastes, but there may be more of them, Soule said. The AEC is researching ways to store the wastes in stable geologic formations that have been undisturbed by seismographic activity for 200,000 years, which have not undergone any geologic changes in that time, and which do not drain into water tables.

"We are now investigating the possibilities of using dome salt formations, granite, limestone or shale deposits. Our criteria for choosing a site for geologic storage will be to find one where materials can be confined without maintenance indefinitely. It must be close enough to the surface to excavate and yet not so close that there are worries about people in the distant future wanting to get in to mine valuable minerals, or getting in by accident or erosion. The minerals we are investigating are so abundant, close to the surface, that it is hard to conceive of someone wanting to drill down 5,000 feet in order to get them out," Soule said.

In addition to researching long-term geologic storage, Soule outlined three proposed methods of retrievable surface interim storage. (Wastes would be stored on a short-term basis, perhaps 10 to 30 years, Soule said, until a suitable long-term method is chosen.) (1) Stainless steel basins filled with water inside reinforced concrete modular buildings could hold sealed canisters of hot wastes. This method is already being used in several locations. (2) The canisters could be sealed in concrete vaults designed with vents so that air enters at the bottom, cools the canister and rises by natural convection, carrying away the heat passively. "Where there is no electrically powered cooling system, there is none to conk out," Soule said. These vaults would sit on a paved surface in a guarded, enclosed area. (3) Wastes could be sealed in individual casks made of steel and concrete that would sit on a paved, guarded surface and be cooled by the air.

The EPA and NRDC assessments came down heavily on the AEC's waste-management proposals. The EPA is concerned that the reliability of current low-level waste storage has not been demonstrated, and that no long-term method is in sight. Cochran says, "We are 25 years into the nuclear age, and we have no permanent storage method, and the interim storage methods are unsatisfactory. There would be more radioactivity stored at one of these interim repositories than from a full scale nuclear war. A person could drive up to one in a van with a small nuclear weapon inside, or shoot one from a small cannon." If the weapon exploded and vaporized the canisters, the radioactive wastes would be carried up in a mushroom cloud and dumped all over the earth, he said.

The last major issue, reactor safety, is a complex one. Because the LMFBR would have a fast, unmoderated reaction, the time for safety systems to scram and shut down the reactor would be much shorter than for slow reactors. In a light-water reactor, there is no possibility of a nuclear explosion taking place, but a small one is possible in an LMFBR. The AEC says that the probability of the sequential accident factors necessary to bring on a nuclear explosion is tiny, and makes the event "extremely unlikely." The NRDC contends that such words are subjective, and that not enough solid data exist on the probability of an accident for realistic assessment of the risks to be made.

There are probably no right or wrong answers to the breeder issues—only degrees of confidence. The AEC demonstrates a traditional American "can-do" attitude. Whatever technological problems exist, they are convinced that the answers lie within the grasp of the scientific mind and the computer. And they have certainly overcome immense design and engineering problems in demonstrating the breeder thus far.

But Cochran feels they haven't come far enough. "They are more confident than I am about their computer codes, about their ability to fabricate equipment without flaws, about the possibility of operating the breeder without human failure, and about the backup and safeguards systems. I don't see the need for the breeder in the time frame they are projecting, and developing a technology before it is economically useful is a waste of money."

At this point, EPA plans to circumvent the upcoming public hearings, and instead, hold a series of meetings with the AEC to work out questions left unanswered in the environmental draft statement. After the meetings, Meyers said, "The AEC will have to decide what changes to make, if any. They don't have to do anything, but if they find our comments valid, we hope that they will alter some of the breeder plans in favor of the environment." □