TRENDS

The fuselage of Aloha Airlines flight 243 ripped open last year. Airlines hope to prevent such accidents by testing planes for flaws.

Detecting Threats to Airplane Safety

In the middle of the night, airport technicians x-ray doors, send high-frequency sound into bolts, and examine wheels and rivets with electromagnetism. The goal is to detect cracks before they threaten safety. Today, all commercial aircraft undergo "non-destructive tests" (NDTs) to uncover flaws that age brings about in metal.

Designing ways to test a plane throughout its lifetime is integral to designing the aircraft itself. The plane must be strong enough to prevent undetectable cracks from threatening safety or performance. "If you can detect a crack that's half an inch long," then a wing might be riddled with quarter-inch cracks, points out MIT professor of aeronautics Paul A. Lagace.

In addition to direct visual inspection, three main non-destructive tests protect aircraft: eddy-current probes, high-frequency pulses, and x-rays. "Eddy current is our primary method for finding fatigue cracks," says Douglass Aircraft's Douglas J. Hagemaier, known as the father of NDT in aviation. Each time a commercial airliner's tires are changed—roughly once a month for DC-9s—an eddy-current tester electronically inspects wheel hubs, a special danger point during takeoff and landing.

The eddy-current probe resembles a small pen. Connected to a screen, the probe fits into a "shoe" that follows the contour of the wheel. "The probe produces a magnetic field, which induces a small current in the wheel itself," says Roger Hamelin, USAIR's lead inspector in Boston, explaining that "any flaw in the wheel will obstruct that current." Eddy currents can find cracks five-eighths of an inch below the surface.

Eddy-current techniques also inspect the lap joints where rivets connect one aluminum panel to another. Sometimes corrosion destroys the bond that reinforces the joint, Hagemaier notes, as happened to Aloha Airlines Flight 243 in 1988. When the Boeing 737's cabin pealed apart, a flight attendant was whisked to her death. According to Hagemaier, when the bond weakened, "the stress went into the rivet joints, and they started to crack because they were overloaded. You have numerous cracks in a line, and the thing just unzips like a piece of toilet paper."

Larger parts—such as the U-shaped shackles securing ailerons, flaps, and spoilers—are tested by sending high-frequency pulses into metal and listening to the echoes. "It takes a certain amount of time for the signal to get from the top of the bolt to the bottom," says Joseph Garza, USAIR's inspection supervisor. "If you have a crack, the signal gets back faster."

On parts too large or complex for ultrasound, inspectors find cracks the same way doctors find them in bones—with x-rays. But while medical x-rays tend to be 50 to 150 kilovolts, aircraft are blasted with 200 to 300 kilovolts.

On DC-9s, x-rays augment a more informal test. The back-door plates sometimes crack after thousands of pressurizations, and often telltale brown tobacco stains from escaping air reveal the defects. But "we are getting that less and less" as people smoke less, Garza observes. Instead of relying on smokers, the FAA mandates x-rays every 1,000 to 15,000 landings, depending on the door's history.

X-rays are also used to examine jet-engine combustion chambers. In a vault at its Atlanta Technical Operations Center, Delta Airlines keeps a highly radioactive capsule of iridium-192. Technicians place x-ray film around engine parts and put the capsule inside the engine. The two-hour procedure reveals cracks half an inch long, says Marvin Morris, NDT foreman for Delta's quality-control division. Regulations allow engine cracks eight inches long.

Firsthand Views

Because handling highly radioactive iridium is dangerous, other airlines prefer direct visual inspection. At USAIR's Boston hangar is a collection of long tubes with eyepieces on the end called borascopes. Inside each tube are two fiber-optic bundles—one carries light in, and the

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other carries the image out. "This takes the place of the isotope x-rays," Garza says. "We get much better definition and it's much safer." USAIR's newest borascope has a dime-sized television camera at the end of a six-foot cable. Technicians insert the cable through the engine's spark-plug holes and snake it about with pressurized air.

"A person can go out and borascope an engine, store [the image] on tape, transfer it by telephone line to Tulsa, and then an engineer here can look at the blades to see what the conditions are," says Burl Nethercutt, a project engineer at American Airline's NDT lab. "The engineer doesn't have to listen to somebody describe over the telephone what the problem is. He can see it firsthand."

In the future, "electronic sheerography" could uncover flaws inside an airplane body or wings. Developed by Laser Tech of Norristown, Pa., this technique combines holography and electronic image processing. First, a laser beam spread by a special lens illuminates a part, says Laser Tech president John Newman. Then the air pressure is lowered slightly to stress the part, and a computer monitors changes in its shape. If there is a flaw, one section bends more than another.

Finally, thermography NDT is just in the laboratory stage. "We take a source of heat, like a heat lamp or heat gun, and blow it on one side," says Robert Green, director of at the John Hopkins Center for Non-Destructive Evaluation. An infrared camera watches the part as it is heated. According to Green, a flawed part won't heat uniformly.

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Chernobyl Fallout

What health threat is posed by the small amount of radon in your home? Or by living near a nuclear plant? And what will be the health legacy of the Chernobyl disaster? These questions result from the hotly disputed topic of the dangers from low doses of so-called ionizing radiation.

The most controversial view belongs to statistician Jay Gould, an advisor to the Environmental Protection Agency during the Carter administration, and University of Pittsburgh radiologist Ernest Sternglass. They suggest that 35,000 to 40,000 more Americans died in the summer of 1986 than could be expected from previous mortality statistics. Analyzing the deaths by geographical region, the researchers believe the results closely correspond to Chernobyl fallout.

To add to the controversy, Sternglass cites research by California ornithologists, who found that bird populations fell dramatically during the same period. For 11 years, researchers at Point Reyes Bird Observatory have counted the "reproductive success" of various species. Estimates based on environmental factors such as rainfall had indicated that more birds than usual would have been born in 1986. But the populations of most species dropped 62.3 percent from the 10-year mean.

Sternglass says this corroborates his theory that extremely low levels of ionizing radiation can be harmful. The mechanism, he says, is that even extremely little radiation produces "free radicals," oxygen molecules that have an extra electron. Even in tiny amounts, these charged oxygen molecules have been shown to damage the body's immune system. Sternglass points out that the additional deaths in 1986 were not cancers. "They seem to have occurred in people with illnesses dying a little sooner, people suffering from pneumonia, heart disease, and AIDS."

In the volatile atmosphere of the debate, Arthur Upton, former head of the National Cancer Institute, accuses Sternglass of "selecting bits of data that fit his hypothesis." And most researchers contend that Chernobyl produced far too little ionizing radiation in the United States to see any health effects. Even John Gofman, an outspoken advocate of tighter radiation standards, says that while he respects the statistical work, "I just don't believe their conclusions."

A medical physician and biophysicist from the University of California at Berkeley, Gofman says that countries like Germany, with hundreds of times the U.S. fallout, haven't reported markedly higher numbers of deaths. Nevertheless, no one has been able to explain the unusual mortality data.

While few experts go as far as Sternglass and Gould, a growing body of data suggests that small amounts of ionizing radiation may be much more harmful than previously anticipated. But how much?

In part, the debate is intense simply because the implications are great. Even by current measures, a recent Environmental Protection Agency assessment of radon dangers estimates that the radioactive gas may cause 20,000 cancer deaths each year.

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