Controlled Impact Demonstration

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In 1984, NASA Dryden Flight Research Center and the Federal Aviation Administration teamed up in a unique flight experiment called the Controlled Impact Demonstration to test a promising fuel additive for retarding or suppressing fire in a real-world aircraft crash-landing scenario. When blended with standard Jet-A fuel, the FM-9 additive, a high-molecular-weight, long-chain polymer, had demonstrated the capability to inhibit ignition and flame propagation of the released fuel in simulated impact tests.

An obsolete Boeing 720 four-engine airliner was obtained from the FAA for the project, which would conclude with an intentional crash-landing of the remotely piloted aircraft into several steel structures set up on Rogers Dry Lake at Edwards Air Force Base to rip open wing fuel tanks.

This anti-misting kerosene with the FM-9 additive could not be introduced directly into a gas turbine engine due to several potential problems, such as clogging of filters. The modified fuel had to be restored to nearly Jet-A standard before being introduced into the engine for burning. This restoration was accomplished on the Boeing 720 using a device called a degrader that was installed on each of the aircraft's four Pratt & Whitney JT3C-7 engines.

In addition to the fuels research, NASA Langley Research Center was involved in a structural loads measurement experiment that included having instrumented dummies occupy seats in the passenger cabin. The plane was also instrumented for a variety of other impact-survivability experiments, including new seat designs, flight data recorders, galley and stowage-bin attachments, cabin fireproof materials, and burn-resistant windows.

Before the final flight on Dec. 1, 1984, more than four years of effort were required to set up final impact conditions considered survivable by the FAA. NASA

NASA**facts**

Dryden developed the remote piloting techniques necessary for the Boeing 720 to be flown with no flight crew on board; General Electric installed and tested the degraders for each engine; and the FAA refined the fuel with the FM-9 anti-misting additive.

A series of 14 preliminary flights was made to introduce the modified fuel incrementally into some of the fuel tanks and engines while engine performance was monitored. During the 14 flights made with safety pilots on board, the Boeing 720 was controlled remotely by a pilot in a ground-based console for 16 hours and 22 minutes, including 10 takeoffs, 69 controlled landing approaches, and 13 landings on the abort runway.

On the morning of Dec. 1, 1984, the remotely controlled Boeing 720 transport took off from Edwards on the 15th and final flight in the program. The fuel tanks were filled with 76,000 pounds of the modified Jet-A fuel and all engines ran normally from start-up to impact during the nine-minute flight. Flown by NASA research pilot Fitzhugh Fulton from the NASA Dryden Remotely Controlled Vehicle Facility, the airliner made a left-hand departure and climbed to an altitude of 2,300 feet. The flight plan called for the aircraft to touch down wheels-up on a specially prepared runway on the east side of the dry lakebed with its wings level and exactly on the center line, allowing the fuselage to remain intact as the wings were sliced open by eight steel posts cemented into the lakebed.

The Boeing 720 began a descent to landing with its landing gear retracted, with final approach along a roughly 3.8-degree glide slope. As the jetliner descended through the decision height of 150 feet above ground level, the aircraft was slightly to the right of the desired path, but appeared to have enough altitude for the remote pilot to maneuver it back to the center line of the runway. Data acquisition systems had been activated, and the aircraft was committed to impact.

As the Boeing 720 neared the lakebed, its left wing dropped and contacted the ground first, short of the wing cutters. This caused the nose of the airliner to swing to the left as it skidded on the lakebed surface at about a 45-degree angle. As a result, one wing cutter struck the inboard engine on the right wing, destroying the engine and causing a massive fuel leak that immediately burst into flame. The airliner continued to yaw to the left until it was nearly sideways, causing the damaged right wing to break off and fold over and the fuselage to be engulfed in a massive fuel-fed fireball. The fire took more than an hour to fully extinguish.

The Controlled Impact Demonstration marked the end of FAA attempts to order airlines to use the anti-misting additive in airliner fuel. Although proponents argued that the modified fuel prevented a hotter, more catastrophic fire during the test, FAA requirements for the additive were cancelled.

The demonstration underscored an often-overlooked aspect of aeronautical research. Although small-scale ground tests had indicated that the anti-misting additive would be effective in reducing post-crash fires, the full-scale demonstration in a real-world flight environment showed that the modified anti-misting fuel was ineffective in reducing the propagation or intensity of fire.

Despite this result, much useful safety-related data was obtained during the Controlled Impact Demonstration. Cameras inside the airliner showed crash dummies being shaken and small panels falling during the crash-landing, although the seats remained attached to the floor. The new seat designs, flight data recorders, galley and stowage-bin attachments, fireproof materials and windows were tested under real-world conditions. Research data from the project in these areas yielded new data on impact survivability that helped the FAA establish new rules regarding fire prevention and fire-retardant materials.

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