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University of Dayton Researcher Hopes to Relieve Engine Indigestion

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UNIVERSITY OF DAYTON RESEARCHER HOPES TO RELIEVE ENGINE INDIGESTION

DAYTON, Ohio -- In a severe storm, aircraft engines that ingest too much rain or hail may lose power in flight.

But under a contract with the General Electric Company, scientists at the University of Dayton Research Institute (UDRI) are investigating how hail and rain enter aircraft engines. Engineers at GE will use the data to design engines that minimize the amount of hail and rain that penetrate the engine core.

Within the core is the combustor, where fuel is burned. "Ideally, you want most of the water to go to the bypass part of the engine, rather than into the core," says Jim Luers, a senior research scientist at UDRI and an expert in weather issues such as ice and heavy rain.

According to Luers, a hail ball approaching an engine first sees the engine fan. How hail and rain hit the fan's rounded-off, cone-shaped "hubcap"--the engine spinner--may provide clues to how they find their way into the core.

During tests at UDRI's Impact Physics Laboratory, an ice ball as small as a pea or as large as a marble is loaded into a giant gun. Helium gas is compressed to propel the ice ball down the barrel of the gun toward an engine spinner. High-speed cameras photograph the event, taking 20,000 pictures per second, and lasers calculate the velocity of the speeding ice ball. Luers can determine how the ice ball breaks up after it hits the spinner by reviewing the size, speed and direction of the particles.

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To study the effect of rain on the engine spinner, Luers doesn't wait around for a cloudburst. He makes his own inside a wind tunnel. A pressurized stream of water is shot inside a vibrating tube, which breaks up the stream into drops. These drops are propelled at high speeds--from 35 to 240 miles per hour--inside the wind tunnel.

By changing the water pressure, Luers can vary the speed of the drops. "And by controlling the rate of vibration of the nozzle, we can generate different-size water drops" that an aircraft may encounter in flight, says Luers.

To simulate different aircraft speeds, Luers can also vary the airspeed produced by the fan at the back of the tunnel. After an engine component, such as a spinner or a fan, is placed inside the tunnel, Luers "lets it rain" to create the same effects present when an aircraft flies through a storm.

Luers admits he's been surprised by some of the findings. A hail ball hitting the spinner seems to shatter and spread out in all directions. But preliminary tests in the wind tunnel have shown that while raindrops also shatter into very small particles, they remain near the surface of the spinner after impact.

Carl Studerus, a mechanical engineer and manager of design methods development at GE in Cincinnati, says rebounding characteristics of rain and hail, such as velocities and angles, will be entered into GE's computer models that predict how raindrops and hail particles enter the engine. Results from the computer models will influence engine designs and possibly spinner shapes.

"GE will know where water and hail enter the engine for any kind of spinner they want to design," says Luers. "We provide the missing information they need to allow them to model the total path of the water drop or hail ball all the way into the engine."

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For media interviews, contact **Jim Luers** at (513) 229-3951.