Aircraft Icing Sensor

Aircraft icing is a severe weather hazard. The buildup of ice changes the shape of the aerodynamic surfaces, which can alter the flow of air around critical components, particularly wings and engine inlets.

Aircraft are equipped with various devices to remove ice from critical components, including pneumatic boots, ice-melting heaters and other systems. A further need is for a system that alerts a pilot to the fact that ice is building up and can be used to automatically control the ice protection system. Generally, two types of detectors have been employed for that purpose, one that detects a differential pressure effect when ice forms over exposed holes, another that measures the changes in resonance of a vibrating probe as ice collects on it. These techniques have certain disadvantages: ice tends to build up on the probe areas more than it does on critical surfaces, and the probes protrude into the airstream, thus must be mounted on the fuselage rather than the wing.

Looking for improved safety and fuel economy, Simmonds Precision Products, Inc., a subsidiary of Hercules Incorporated located at Vergennes, Vermont, undertook to develop a highly accurate, reliable ice detection system utilizing the latest advances in ultrasonics. The Simmonds Precision system is based on technology developed under a NASA grant by researchers at Massachusetts Institute of Technology (MIT) and on tests of the MIT-developed system, in a wind tunnel and in flight, at Lewis Research Center. Simmonds Precision is producing the system under license from MIT.

The Simmonds system consists of an ultrasonic sensor (above) and a signal conditioner. The sensor has a piezoelectric ceramic crystal (PCC) that sends an ultrasonic pulse into an ice layer and detects an echo returning from the ice; the time elapsed in the pulse-echo round trip provides a basis for calculating ice thickness.

Simmonds offers an alternative system with two PCCs, one a transmitter and the other a receiver for picking up the return echo. This technique offers detection of ice at much smaller thickness values, but at the cost of some ability to detect thicker ice.

Among the advantages of the Simmonds system are the small size of the sensor (an exposed diameter of half an inch), which allows its placement in areas previously inaccessible; it can be flush-mounted directly on surfaces, including airfoils, with no disturbance of airflow. In the photo below, the sensor (white dot) is mounted within the engine inlet of a turboprop aircraft. Other sensor advantages include high accuracy and insensitivity to salt spray, fog, chemicals and abrasion. Both sensor and signal conditioner offer high reliability, light weight and low power consumption.