Aircraft Icing

Aircraft icing continues to be one of the major safety threats to aircraft operations during hazardous weather conditions and can result in catastrophic accidents unless adequate precautions are taken.

Potentially hazardous icing conditions occur not only in flight but also on the ground prior to flight. Ice accumulations on the order of a few thousandths of an inch on critical aircraft surfaces have been shown to significantly reduce aircraft lift. During ground operations it is essential that an aircraft be aerodynamically clean prior to takeoff. During in-flight operations in icing conditions, the aircraft must be provided with ice protection systems that allow safe flight without degrading aircraft performance. This includes both aerodynamic performance and aircraft controllability and freedom from mechanical damage due to ice shedding and ice ingestion. In recent years a number of aircraft accidents have been attributed to various aspects of aircraft icing. Large turbojet transport airplanes have not experienced any significant safety problems during in-flight icing conditions; they have experienced a number of serious accidents during takeoff in ground icing conditions, such as snow and freezing drizzle. On the other hand, small general aviation and commuter airplanes have experienced serious accidents resulting from ice accumulation during in-flight operations. Thus, the research and development effort of the FAA Aircraft Icing Program encompasses activities directed at enhancing flight safety during both ground and in-flight aircraft operations in icing conditions. The FAA William J. Hughes Technical Center has supported the investigation and development of technologies to provide area coverage of ice detection and fluid failure on aircraft upper wing surfaces prior to takeoff. The photograph above shows a hand-held system developed with FAA support that is now in operational use.

Before an ice protection system can be designed, there must be a clear definition of the atmospheric conditions in which the aircraft will operate. These conditions can include supercooled clouds, freezing precipitation, mixed conditions, ice crystals, and supercooled ground fog. Associated with these conditions are temperature, altitude, duration, liquid water content, and droplet size. Supercooled large droplets (SLD) have been identified as a factor in the recent in-flight icing accident of an ATR-72 aircraft. Thus, there are activities underway within the aircraft icing program to characterize the icing environment with emphasis on SLD conditions. Also, accidents have been attributed to the tail plane stalling of certain classes of commuter aircraft when subjected to ice accretions. Another ongoing project within the icing program is to develop design criteria for that class of airplanes to significantly reduce their susceptibility to icing induced tail plane stalls. This also includes the development and

Safety

design of flight test criteria and procedures to identify susceptible designs during aircraft certification actions.

In recent years, some accidents by large transport category and commuter aircraft have indicated a lack of knowledge concerning the degradation of an aircraft's aerodynamic performance during ground operations in conditions conducive to aircraft icing such as when the aircraft is exposed to falling snow and/or other freezing precipitation prior to takeoff. Currently, freezing point depressant (FPD) fluids serve as the main agent for the removal of onground ice accumulations and provides limited protection to aircraft surfaces during ground operations under icing conditions.

These FPD fluids are constantly changing and may exhibit special rheological and pseudoplastic properties, which enhance their time of effectiveness without an attendant increase in aerodynamic penalties. The time of effectiveness of these fluids in various precipitation conditions is referred to as holdover times (HOT) and is employed by the airlines and operators during ground operations to determine allowable times for taxi and takeoff. Each season, new fluids are introduced, and although the Society of Automotive Engineers (SAE) Aerospace Material Specifications exist, constant testing and evaluations are required to ensure the safe and effective use of these fluids. The FAA Aircraft Icing Program, in conjunction with Transport Canada, has several ongoing activities to this effect and each year provides new/revised HOT tables for adoption and dissemination by the FAA to airlines throughout the US. In addition, investigations are underway to develop methods and procedures that would allow fluid manufacturers to determine holdover time for their fluids under laboratory conditions, thus potentially alleviating the current practice of conducting outdoor testing each winter icing season.

Another area of investigation in the Aircraft Icing Program is that of aircraft ice detector technology and related sensor developments. This addresses onground detection of ice contamination on aircraft surfaces and failures of deicing fluids and the remote detection of in-flight icing conditions such that these conditions can be circumnavigated. Results from one of the surface ice detection projects has resulted in a mature system technology that was put into operation by airlines during the 1996-97 winter icing season.

The Aircraft Icing Program has a diverse group of dedicated engineers, scientists, and meteorologists who are well versed in all aspects of aircraft ice protection system technology, icing meteorological climatology, aircraft icing regulations and certification criteria, and aircraft operational procedures to facilitate safe aircraft operations in both ground and airborne icing conditions.

To find out more about the Aircraft Icing Research and Development Program, contact:

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