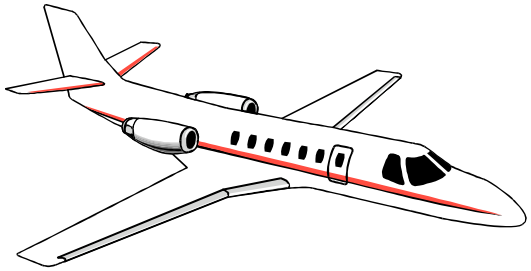
FAA In-Flight Icing/Ground De-Icing International Conference and Exhibition



In-Flight Icing Report Out

June 20, 2003

Airplane In-Flight Icing

Topic Track Organizers

Jim Riley	FAA
Eric Duvivier	DGAC
Roger Gent	QinetiQ
Tom Bond	NASA

Airplane In-Flight Icing

Sessions & Organizers

1. In-Flight Icing Operational Issues
   Cliff Barrow, CAA
2. Ice Accretion Effects on Airplane Operation and Handling
   Mike Bragg, UIUC and Tom Ratvasky, NASA
3. Ice Protection Development and Program Experience and Ice Detector Evaluation Issues
   Eric Duvivier, DGAC and Thomas Scherer, Airbus
4. Ice Accretion Physics and Development of Supercooled Large Droplet Engineering Tools
   Jim Riley, FAA and Dean Miller, NASA
5. In-Flight Icing Simulation (Computer Codes, Icing Wind Tunnels, and Tankers)
   Roger Gent, QinetiQ and Mark Potapczuk, NASA

In-Flight Icing Operational Issues

- Main Themes
  - Seen progress, but continued, long term effort still needed to reduce icing-related accidents (still on NTSB's "Most Wanted")
  - Language confusion and direct coherent, rules and operational guidelines for pilots to operate in icing. Need further efforts to work airworthiness rules, certification standards, and proven aircraft capability compatible with AFMs, Ops Manuals, and Operating Practices
  - Continuing efforts to refine icing terminology to be more useful, accurate, and adopted internationally
  - Value of providing and using all available weather information

In-Flight Icing Operational Issues

- Issues and Concerns
  - Pilots need to get high quality, accurate, and up-to-date information to make the right decisions
  - Need to harmonize terminology with aviation community to ensure usable criteria
  - In spite of the FAR 121.629(a) prohibition against operations in icing conditions that might adversely effect the safety of flight, pilots are directed by air carriers, with FAA approval, to takeoff and land in observed/reported freezing drizzle and freezing fog
  - Air carriers are not being provided the operational and regulatory support and tools they need to operate safely in the known hazard of in-flight icing which exceeds the certification basis of their aircraft

Ice Accretion Effects on Airplane Operation and Handling

- Main Themes
  - Improvement in our understanding of the effects of ice on aerodynamics and performance and control
    - Demonstration of Re# insensitivity for large ice shapes
    - Effects of ice shape size, position, 2D/3D nature shown
    - Ice effects measurable using Parameter ID methods
  - Aerodynamic research focuses on aircraft safety
  - Recognition that aircraft safety is driven by the effects of ice on aerodynamics, performance, and handling qualities
  - New work on:
    - Residual and intercycle ice
    - Snow contaminated / holdover

Ice Accretion Effects on Airplane Operation and Handling

- Issues and Concerns
  - How to deal with penalties from residual/intercycle ice
  - How to properly simulate ice for aerodynamic tests and measurements
  - Ice effects on propeller performance not well understood
- Observations
  - Current extensive dataset is mainly limited to one research aircraft - need to expand the database
  - We have made a lot of progress since 1996, but we still do not know much about three-dimensional iced aerodynamics

Ice Protection Development and Program Experience and Ice Detector Evaluation Issues

- Main Themes
  - Ice protection technologies
    - Development of new thermal system
    - Update of manufacturer designs
    - Residual and inter-cycle ice of pneumatic de-icing systems
  - Icing flight test experiences
  - In-flight ice detectors
    - Icing wind tunnel evaluation
    - Critical temperature considerations in icing wind tunnel testing

Ice Protection Development and Program Experience and Ice Detector Evaluation Issues

- Issues and Concerns
  - Icing flight testing for certification:
    - Reduce icing flight testing for certification by more extensive use of analytical methods
    - Safety issues should be part of the complex process of writing Airworthiness requirement and its interpretative material.
  - Critical temperature measurements
    - Consider test results in the context of measurement uncertainty
    - Differences in critical temperature on the order of the uncertainty of the measurement tools currently available - need better test/analytical/measurement methods
  - Research on propeller icing effects needed

Ice Accretion Physics and Development of Supercooled Large Droplet Engineering Tools

- Main Themes
  - Supercooled large droplet plans and initial research accomplishments
    - Droplet dynamics: splashing, breakup, and mass loss
    - Collection efficiency
  - Review of Appendix C scaling methods & relevant icing physics
  - Mixed phase - new results on effects on ice shape growth and thermal power requirements
  - Major improvements - new imaging methods (hi speed, close-up, high resolution) allow examination and quantification of micro-physical events

Ice Accretion Physics and Development of Supercooled Large Droplet Engineering Tools

- Issues and Concerns
  - Are thermal effects of droplets splashing major contributor to the ice mass loss?
  - Present work on mixed phase is focused on airframe - need to look at engines and inlets

- Observations
  - Simulation of splash physics work in progress - still not fully understood
  - Collaborative nature of SLD research with international effort very positive. Move towards this relationship on other subjects!

In-Flight Icing Simulation

- Main Themes
  - Good summary of status on codes, tankers, and tunnels
  - Perspective on icing simulation expectations were provided by FAA
  - Status of new CIRA Icing Wind Tunnel
  - Recent developments in ice accretion codes were presented
  - Starting to see movement from 2D to 3D ice accretion modeling

In-Flight Icing Simulation

- Issues and Concerns
  - Need for requirements on validation of simulation tools
    - What degree of accuracy do we need
    - Requirements driven by the aerodynamics
    - Quantification methods required to support validation process
    - Quality (measurement methods, accuracy/fidelity, etc.) of the validation data
  - Need to establish validation datasets for 3D modeling
  - Need more flight test data for validation of simulation methods
- Observations
  - Improvements in icing simulation tools require greater understanding of icing physics
  - New codes still being developed

Common Themes

- Significant progress since 1996 FAA International Icing Conference
- Moving from 2D to 3D in our understanding of ice accretion and aerodynamics
- Differences between simulation methods still need to be resolved

….Finally….

Thank you!

Your input was very important

These events help research groups and regulatory agencies better understand important operational issues.