AIRA 3-D Ice Accretion Code Workshop

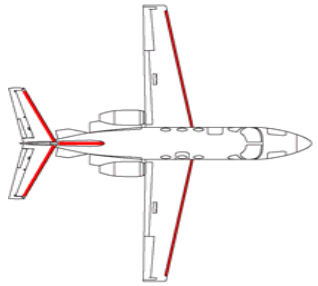
AIAA ASE August 4, 2010

Suggested Topics

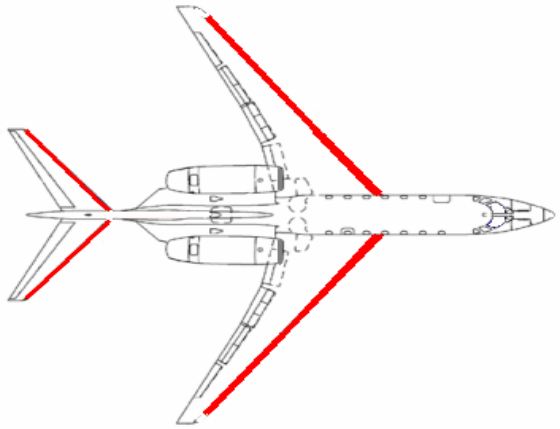
- Current use of 3-D ice accretion codes
- Issues for acceptance by the regulatory authorities
- Validation experiences from icing or dry-air tunnel testing required to support code acceptance
- Interest in supporting and approaches for validation data and inter-code comparisons studies
- Interest in supporting future AIRA working groups to continue developing the principles of this workshop

Protected Areas

- Small aircraft typically protect a much larger percentage of the airframe
- Large proportion of available energy is required for ice protection
- Protected areas provide the majority of aerodynamic effect on small aircraft
- Developed through mix of test and analysis



~90% Protected Area



~88% Protected Area

Artificial Ice Shapes

- Unprotected shapes are limited to:
  - Small unprotected areas (normal operations)
  - System malfunction cases
- Many of current product line has relatively low sweep
- As such additional fidelity of 3D detail (such as scallops) would not have a significant effect

Cessna Use of 3D Ice Codes

- Most work is performed with 2D codes
  - Inadvertent encounter ice shapes
  - Unprotected areas, system malfunctions
  - Collection characteristics for heat transfer
- Use 3D codes when appropriate
  - Examining lift distribution effects on unprotected shapes
  - Radome/forward fuselage accumulations
  - Windshield impingement areas
- Fidelity of LEWICE 3D shapes is limited
  - Single time step approach
  - Based on 2D ice accretion models

Emerging SLD Rulemaking

- Notice of proposed rulemaking released in June
- The certification options are:
  - Detect and exit all SLD
  - Detect and exit a portion
  - Unrestricted operation
- The detect and exit options will require a method to determine when the conditions require exiting
  - Visual cues

Visual Cues

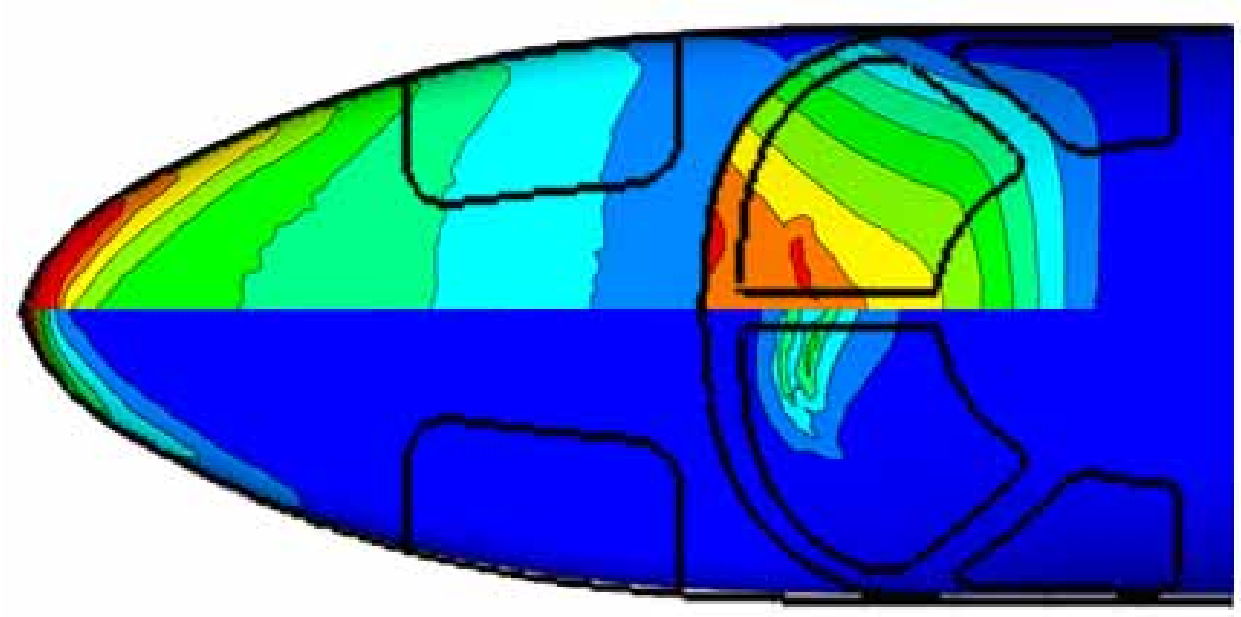
- “Generic” visual cues were first developed from the post-Roselawn safety review
- Published as part of the “severe icing” AD of the mid-90’s
  - Unusually extensive ice accreted on the airframe in areas not normally observed to collect ice.
  - Accumulation of ice on the lower surface of the wing aft of the protected area.
  - Accumulation of ice on the propeller spinner farther aft than normally observed.

Impingement Aft of Protected Areas

NASA Photos

Application of 3D CFD for SLD

- Can a side window be used as a visual cue?
- What icing conditions will produce cues?
- How much ice is subject to shedding?
- Large drop effects will be significant



Issues For Acceptance

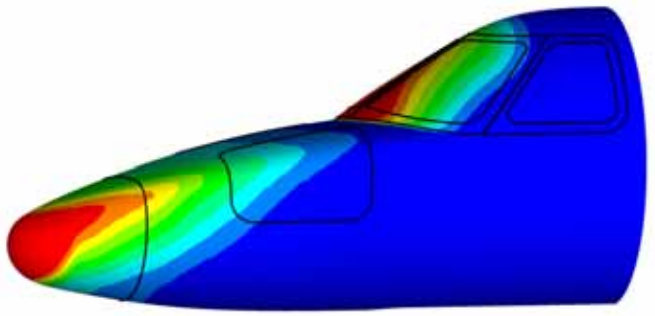
- The term validation is used in a lot of advisory materials
  - No generally accepted definition
- A strict validation over a full range of conditions is not possible w/ FZDZ and FZRA
  - No test capabilities for producing full distributions
- Limited validation can be performed
  - Results match a specific test condition fairly well (including distribution effects)

Certification Validation

- Validation from a certification perspective typically looks at aircraft level effects, e.g.
  - Measured surface temperatures are same as or conservative to analysis
  - Flight characteristics similar to or no worse than simulated ice shape effects
- Validation of ice shapes is challenging
  - Limited unprotected areas, variable natural icing conditions
- Can require some qualitative judgment
  - e.g. Impingement limits are typically not a distinct line, distributions are variable

Validation Experiences

- Early SLD impingement validation efforts have been promising
- Difficult to perform precise validations with flight articles
  - Cannot produce drop distribution effects
  - Difficult to verify thickness (beta)



Future Support

- Interesting in supporting future activities for validation
  - Particularly in areas of interest
  - Current resources are limited
  - Subject to proprietary restrictions

Thank You!

Questions?