

# Ice Accretions on Modern Airfoils Investigated

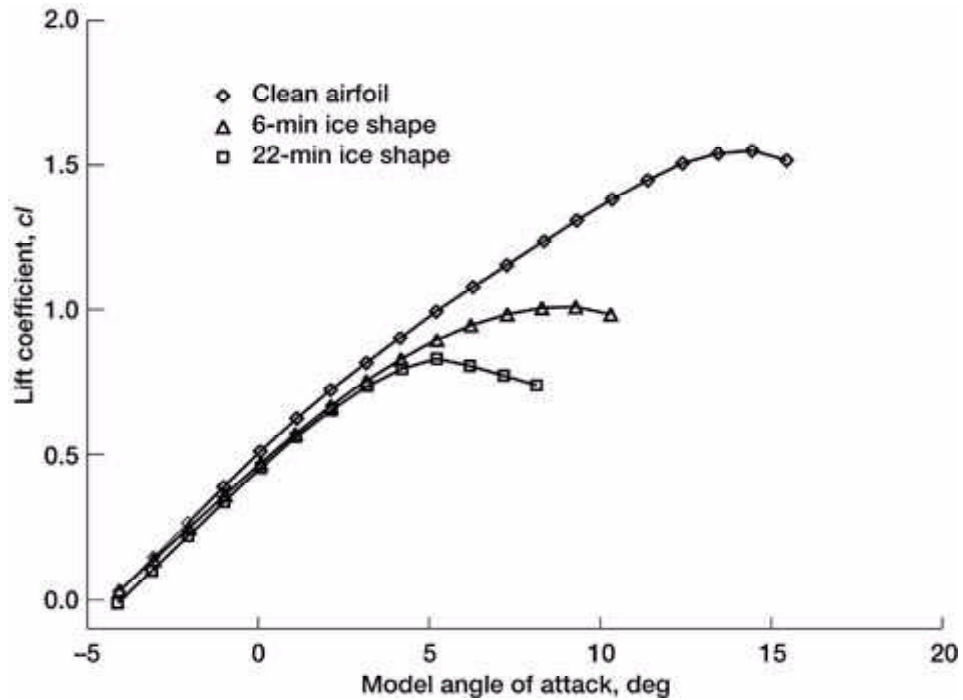
The Icing Branch at the NASA Glenn Research Center at Lewis Field initiated and conducted the Modern Airfoils Ice Accretions project to identify ice shapes and determine their effects on the aerodynamic performance of aircraft, particularly on lift and drag. Previous aircraft ice shape and performance documentation focused on a few, older airfoils. This permitted more basic studies of the ice accretion process to be undertaken. However, having established both a working data base of ice shapes and the capability to predict these shapes for basic airfoils, questions arose about how ice might accrete differently on airfoils more representative of those being designed and flown on various aircraft today. Similarly, information about how these ice shapes would affect aerodynamic performance was needed.

Three modern airfoils were selected for this project. One was representative of a commercial transport airfoil, one of a business jet airfoil, and one of a general aviation airfoil. Each was exposed to a range of icing conditions in Glenn's Icing Research Tunnel (IRT). All the ice shapes accreted on the models were recorded with tracings, photographs, and ice depth measurements. The photograph shows one of the airfoils with ice accreted in the Icing Research Tunnel. Molds, which can be used to replicate ice shapes accurately, were made of selected ice shapes. Researchers will use the resulting data base in designing ice protection for aircraft and in validating ice-accretion-prediction computer programs. Lift and drag measurements made of the iced airfoils will, in addition to providing information about the effects of various ice shapes on the aerodynamic performance of an airfoil, help validate computational fluid dynamics programs that predict aerodynamic performance.



*General aviation airfoil with ice accreted in the Icing Research Tunnel.*

To further investigate the ways that ice shapes affect the aerodynamic performance of modern airfoils, Glenn's Icing Branch conducted tests in the Low Turbulence Pressure Tunnel (LTPT) at the NASA Langley Research Center. This wind tunnel's unique airflow characteristics allow aerodynamic performance measurements to be made over a wide range of operating conditions. Important scaling factors can be varied so that the aerodynamic performance is accurately simulated for larger airfoils, such as those used on full-scale aircraft. Castings of the ice shapes were made from selected molds. These castings were attached to the airfoil in the LTPT so that aerodynamic performance measurements could be made. The graph gives an example of the results of these tests.



*Effect of ice shapes on airfoil lift characteristics.*

The modern airfoil project is complete, and final reports will be published in January 2000. In addition, Glenn's Icing Branch is planning follow-on tests to investigate the aerodynamic performance of other iced airfoils. These tests are to include detailed flow-field measurements of both local and unsteady flows over iced airfoils.

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