U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: CERTIFICATION OF PART 23 AIRPLANES FOR FLIGHT IN ICING CONDITIONS

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Initiated by: ACE-100

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Change: 1

1. PURPOSE. This change revises existing material in two sentences. The change number and the date of the changed material are shown at the top of each changed page. Vertical bars in the margin indicate the changed material. Pages having no changes retain the same heading information.

2. PRINCIPAL CHANGES.

Paragraphs 12c(3)(b)2 and 12c(3)(c) are revised.

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S/

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obtained. The exposure should be sufficiently stabilized to obtain valid data. It is often difficult to obtain temperature stabilization in brief exposures. Additional exposures may be required to allow extrapolation to the envelope critical conditions by analysis. Test data obtained during these exposures may be used to validate the analytical methods used and the results of any preceding simulated icing tests.

2. Intermittent Maximum Icing Conditions. Past experience has shown that flight testing in natural intermittent maximum icing conditions may be hazardous due to accompanying severe turbulence and possible hail encounters that may extensively damage the test airplane. When design analyses show that the critical ice protection design points (that is, heat loads, critical shapes, accumulation, and accumulation rates, and so forth) are adequate under these conditions, and sufficient ground or flight test data exists to verify the analysis, then hazardous flight testing should be avoided.

3. Number of Icing Encounters. There should be sufficient icing encounters to achieve all test plan objectives. The natural icing performance and handling qualities matrix in Table 3 of this AC consists of at least three encounters.

(c) How Much Ice Should Be Allowed to Accrete?

1. Normal Ice Protection System Operation. Sufficient data should be taken to allow correlation with dry air tests using simulated ice shapes. This should be accomplished with a target accretion thickness equivalent to the 45-minute dry air ice shapes on an unprotected part of the wing. Handling qualities and performance should be subjectively reviewed and determined to be in general correlation with those found in dry air testing. Refer to paragraph 13.a. for performance, stability, control and maneuverability requirements.

2. Delayed Ice Protection System Activation. In addition, flying qualities and performance should be qualitatively evaluated with the ice accumulations existing just prior to operation of deice (as opposed to anti-ice) components. The ice protection systems are to be activated by the flight crew in accordance with approved AFM procedures when icing conditions exist; however, for anti-ice components, tests should be conducted that simulate inadvertent icing encounters in which the pilot may not recognize that the airplane is about to enter an icing condition and the anti-ice component may not be activated until actual ice build-up is noticed. A delayed ice accumulation event of 30 seconds to two minutes has been used in these tests to simulate the flight crew's failure to recognize an icing condition. For engine ice protection systems, which for aft fuselage mounted engines can include the inboard wing ice protection system, a delay of two minutes is utilized to validate the ice shedding analyses and § 33.77 ice slab test results. For the delayed ice accumulation time event, consideration should be given to the icing conditions; the icing recognition means available, recommended crew procedures, and ice protection system performance of the particular aircraft. The tests to be accomplished are summarized in Table 3 of paragraph 13c of this AC.

(a) What Should Be Evaluated During Natural Icing Tests? All systems and components of the basic airplane should continue to function as intended when operating in an icing environment. Some considerations are:

1. Engine operation and equipment operation such as oil cooling and generator cooling under maximum load should be monitored during icing tests and be found acceptable for this operation If data is analyzed in accordance with § 23.1043, the temperatures need to be corrected only to 32 degrees F, not a hot day. Natural icing flight tests should include evaluation of ice protection systems with bleed air from engines when the throttle is at the flight idle stop. Refer to AC 20-147 for additional guidance for turbojet engines.

2. Engine alternate induction air sources should remain functional in an icing environment.

3. Fuel system venting should not be affected by ice accumulation.

4. Retractable landing gear should be available for landing following an icing encounter. Gear retraction should not result in an unsafe indication because of ice accretion.

5. Ice shedding from components including antennas and propellers should cause no more than cosmetic damage to other parts of the airplane, including aft-mounted engines and propellers. If flight testing is used to validate shedding trajectories, there should be dedicated test points to evaluate shedding. Examples would be flying in warmer temperatures to facilitate ice shedding, and evaluating various operational angles of attack and sideslip.

6. Stall Warning and Maneuver Margin. With ice accretions on the airplane, acceptable stall warning (aerodynamic or artificial) and stall protection, if a stall protection system is installed, should be provided to validate the results of the dry air ice shape testing. The stall warning should meet the requirements of § 23.207(a), (b), and (c). The type of stall warning in icing conditions should be the same as in no icing conditions. Biasing of the stall warning and stall protection system, i.e. resetting trigger points to lower angles of attack when ice protection is initiated, may be necessary to achieve required maneuver margins to stall. The maneuver margin requirements § 23.207(d) should be demonstrated in icing conditions. The stall warning margin should be evaluated with various ice accretions as summarized in Table 3. See paragraph 13.c.

NOTE 1: This test and any stall or handling qualities tests should be accomplished in daytime visual meteorological conditions, after accreting ice, for safety. .

7. Performance, Stability, Controllability. See paragraph 13.c.

8. Ice detection cues or ice detection system operation that the pilot relies on for timely operation of ice protection equipment should be evaluated in all anticipated flight conditions, including night.