ISSUE PAPER

PROJECT: GENERIC AIRPLANE COMPANY
Model XYZ

ITEM: S-2
STAGE: 2

REG. REF.: §§ 21.16, 21.21(b)(2), 25.1419

DATE: June 25, 1998

NATIONAL POLICY REF.: ANM-100 Memorandum dated July 23, 1997 (Signed: Ron Wojnar)

ISSUE STATUS: OPEN

SUBJECT: Roll Control in Supercooled Large Droplet Conditions

BRANCH ACTION: ANM-111, 112

Based on GIP # S-x13

COMPLIANCE TARGET: Pre-TC

KNOWN UNSAFE CONDITION

STATEMENT OF ISSUE:

The requirements for the certification of an airplane with ice protection provisions are defined in º 25.1419. The current regulation requires that an airplane with ice protection provisions must be able to safely operate in the conditions defined in the Federal Aviation Regulations, part 25, appendix C. The regulation is not adequate to address freezing drizzle and freezing rain conditions (hereafter called supercooled large droplets or SLD) that are outside of the appendix C envelope.

BACKGROUND:

On October 31, 1994, an Aerospatiale ATR-72-212 was involved in an accident in which severe icing conditions were reported in the area. During extensive testing the accident profile was replicated by ice shapes developed from testing in an icing cloud having droplets in the size range of freezing drizzle at a temperature near freezing. This condition created a ridge of ice aft of the deicing boots and forward of the ailerons, which resulted in uncommanded motion of the ailerons and rapid roll of the aircraft.

The National Transportation Safety Board recommended that the FAA develop a test procedure to identify unsafe aileron hinge moment characteristics. The procedure described herein is the procedure used during the FAA's program to screen airplanes for

susceptibility to aileron control anomalies. The airplanes that were evaluated in the program are used in regularly scheduled passenger service equipped with non-powered controls and pneumatic deicing boots.

FAA POSITION:

The FAA has identified the susceptibility to loss of control following exposure to supercooled large droplets as an unsafe condition that may exist on other airplanes. The FAA is particularly concerned with airplanes with non-powered flight controls, since non-powered flight controls do not have the physical advantage of hydraulic or electrical power to assist the pilot in overcoming the large control forces that may exist from differential pressure resulting from flow separation over the roll control surfaces.

The FAA proposes to test airplanes with non-powered roll controls and pneumatic deicing boots for susceptibility to roll control anomalies in certain supercooled large droplet conditions. This test is not intended to certify an airplane for flight in supercooled large droplets or any other conditions which are outside of the appendix C icing envelope.

The following test is proposed:

a. Tests and analyses must show that the airplane characteristics meet the criteria specified in paragraph b. following a 20 minute icing encounter:

1. with supercooled droplets having maximum diameters of approximately 400 μm (microns),
2. an LWC (liquid water content) of approximately 0.6 grams per cubic meter[1],
3. a median volumetric diameter of approximately 170 microns[2],
4. temperatures near freezing such that runback conditions exist at the stagnation line[3], and
5. at holding speeds and approved holding configurations.

b. When manually flying the airplane:

1. The pilot roll force to counter any uncommanded roll control surface deflection may not exceed 50 pounds with two hands available for control, and

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[1] For this condition, the LWC strongly affects the rate at which the ice feature develops. A higher LWC results in more rapid formation of the ice feature while a lower LWC results in a slower formation of the ice feature. The LWC should be adequate to produce an ice feature during the exposure interval that will start to self shed and then reform.

[2] The cloud physics instrumentation, calibration, and data processing methodologies must be acceptable to the FAA.

[3] For this test, temperature is a critical factor. Not only is the temperature critical to the development of the ice shape and dimension, static air temperature excursions above freezing, although short in duration, can reverse the ice accretion process.

2. the airplane must not exhibit a hazardous degradation of flying qualities. Rapid control force onset, unsteady and oscillatory forces must be considered carefully as these dynamic conditions may be hazardous even though the peak force may be less than the static limit.

c. The tests and analyses in paragraph a. must consider the effects of asymmetric shedding of the ice.

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d. There must be a means for the flightcrew to determine when the airplane has entered into a supercooled large droplet environment, to enable the crew to take appropriate action.

e. There must be appropriate crew information provided in the airplane flight manual that describes the limitations and procedures to be observed while exiting the supercooled large droplet environment. The FAA finds the limitations and procedures contained in AD 96-09-25 are an acceptable means of compliance with this paragraph. These limitations and procedures include but are not limited to:

1. visual cues that the airplane is in severe icing conditions,
2. prohibition on the use of the autopilot when the visual cues are observed,
3. all icing detection lights operative prior to flight into icing conditions at night,
4. immediate exiting of the severe icing conditions, and
5. if the flaps are extended, do not retract them until the airframe is clear of ice.

Note: For paragraph e.5., the retraction of the flaps is contingent upon the aircraft having a means to determine if the airframe is clear of ice.

f. One means of compliance with paragraphs a., b., and c. is to perform a high speed taxi test to evaluate control wheel force characteristics that may result from flow separation over the roll control surfaces induced by an artificial ice shape as described below. The testing should include the following:

1. Installation of a one-inch high quarter-round molding, flat side forward, located on the upper surface of the wing, at the chord position aft of the active portion of the boots and forward of the non-powered roll control surfaces (i.e. ailerons and/or inflight spoilers) that produces the most adverse lateral wheel force.
2. Locate this shape in front of the roll control surfaces on one wing only. As a minimum the shape must cover the entire span of the roll control surface.
3. Perform high speed taxi tests with the flaps retracted and at various angles of attack. The maximum angle of attack should be obtained at the highest takeoff weight such that the airplane does not become airborne.
4. Measure the forces required to maintain wings level.
5. Extrapolate the maximum forces obtained from the high speed taxi tests to the maximum speeds expected while in holding conditions. In most cases the

maximum forces will occur at the maximum angle of attack achieved during the high speed taxi tests.

6. The extrapolated forces may not exceed 50 pounds with two hands available for control.

7. Airplanes equipped with non-powered inflight spoilers may require tunnel or flight testing to evaluate the effect on airplane control and handling characteristics.

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FCCA POSITION:

APPLICANT POSITION:

CONCLUSION:

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