APPENDIX G—EMBRAER ICING GUIDANCE/PROCEDURES

EMBRAER
EMB120 Brasilia
OPERATIONAL BULLETIN

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I - DOCUMENT EFFECTIVITY: ALL EMB 120 A/C

This bulletin is issued by EMBRAER as the need arises to quickly transmit technical and operational information. It is distributed to EMB-120 BRASILIA operators and to any personnel who need early advice of this information.
The matter published in this bulletin may not be approved by Airworthiness Authorities at the time of issuing. In the event of conflict with the approved publication (AFM, WB, MMEL, or CDL) the approved information shall prevail.

II - SUBJECT: OPERATION IN ICING CONDITIONS

III - REASON:

To provide information and recommendations regarding the aircraft operation in icing conditions.

IV - BACKGROUND INFORMATION:

In October 1994, a transport category aircraft was involved in an accident which resulted from an in-flight loss of control and a subsequent dive until the aircraft crashed into the ground. Although the investigation has not yet made a finding of the probable cause of the accident, the in-flight loss of control of the aircraft is suspected to have been caused by ice accretion on the upper surface of the wing aft of the protected area which resulted in airflow separation and abnormal aileron force necessary to maintain coordinated flight. It was noted that weather at the time of the accident involved atmospheric conditions outside the icing envelope specified in Appendix C of part 25 of the Federal Aviation Regulations (14 CFR part 25) used for certification of the aircraft. Such atmospheric conditions, involving freezing rain and freezing drizzle, are referred to as supercooled large droplets (SLD) and are also described as severe icing. SLD condition is not addressed in the appendix C and the FAA has not required that aircraft demonstrate the capability of safely flying in those icing conditions.

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Since the potentially unsafe condition of flying in severe icing conditions outside of the envelope for which the aircraft is certified is not limited to the type of aircraft that was involved in the accident, EMBRAER was required to conduct a series of tests to evaluate the roll control characteristics of the EMB-120 while flying in SLD conditions.

During these tests, the EMB-120 was operated in a spray of supercooled water droplets generated by an icing tanker simulating the typical SLD environment. The results of the tests allowed for the determination of aircraft specific visual cues which can be used by flight crews to identify when the aircraft is operating in icing conditions for which the aircraft has not been certified. In addition, these tests allowed for the defir ... realistic representation of the ice shapes, in terms of thickness, width and pattern on the wing, that could occur in flight. These ice shapes were then reproduced artificially and extensive tests were flown in dry air to assess the handling qualities of the aircraft.

Results of these tests, as well as the related procedures during operation in freezing rain/freezing drizzle are included herein. EMBRAER highly recommends that this document be distributed to all personnel involved with flight operations within operators' organizational structure.

a degradation of the flight qualities.

- Aircraft operation in SLD conditions with autopilot engaged was found to be adequate under the conditions tested.
- Operational recommendation when flying in SLD conditions:

- Minimum icing speed is 160 kt, which must be increased if buffet appears.
- Use of the autopilot HDG and ½ ϕ modes while flying in icing conditions.
- Increased airspeed on final approach: V_{REF} + 5 kt plus Δ gust.

All tests conducted in relation to the SLD conditions were not targeted at certifying the aircraft to fly under these conditions. The EMB-120 is still not approved for flight in freezing rain and freezing drizzle. Upon recognizing SLD conditions in flight, per visual cues as stated in "SLD CONDITIONS VISUAL CUES", the crew must take immediate action to leave the SLD condition as soon as possible.

Monitoring Ice Formation

Monitoring of ice starts on ground. Contamination on ground may be caused by falling snow (wet or dry), slush or frost. Frost or ice can form following a cold soaked period at altitude or overnight at the ramp. If it rains on a cold-soaked wing, clear ice, difficult to detect, can form. Frost often occurs on wing lower surface as a result of humidity which condenses and freezes on the wing surfaces where fuel is at 0 degrees C or colder. Some conditions, such as freezing rain, freezing fog or high humidity can cause a kind of frost or ice that is also difficult to detect. While on ground, the rule is obvious: **never takeoff with snow or ice adhering to any part of the aircraft.**

The only way to ensure that wings, control surfaces and propellers are free from ice is through close visual inspection prior to takeoff. At intermediate stops, an external walk around is necessary because of the possibility of ice reforming after landing.

In addition to a visual inspection, touching the ice accretion may provide additional cues regarding ice thickness and roughness. Do not touch the surfaces with bare hands, as the skin may stick to a freezing surface.

Ice should be prevented and avoided. Before taking off, every pilot should analyze the weather situation contained in weather briefings from a flight service station or an authorized aviation meteorological source. Also pay special attention to pilots reports (PIREPS) of ice (or no ice) along the intended route of flight.

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In flight, ice monitoring starts when the outside air temperature is near freezing. Closely monitor the temperature indicator so that, when moisture is present, a look at the windshield, windshield wipers, engine air inlets, spinner, and wing leading edge will tell you if ice is starting to accumulate. During climb and descent, watch the temperature indicator for any temperature inversion. Listening to the SIGMETS may also help in determining if ice conditions exists outside of the aircraft.

When ice starts to build up, check the type and build-up rate to determine the severity of the ice encountered. If it is rough and milky, it is rime ice. If it is clear and horn-shaped, it is the glaze ice. If the ice build-up is slow, you may be flying in a stratus cloud, and its horizontal extent may cause a large ice accumulation. Another clue comes from the size of the water droplets (that you can see at night by turning on the landing lights) – small droplets, usually found in stratus cloud, tend to form rime ice. At night, turn on wing inspection lights to assist in defining rate and type of ice accumulation.

Another tool that can be used to alert the crew to the presence of ice is through performance changes. Airspeed decreases as a result of the increased drag. The pitch angle may be higher than normal to maintain a given altitude.

After the condition of ice is evaluated, develop a plan based on the facts. Do not hesitate to leave the icing conditions if necessary. Make the air traffic controller aware of the current situation and that you may be requesting altitude changes or expeditious handling due to icing conditions.

Heavy or severe ice is defined as that situation where the rate of ice accumulation is such that the deicing or anti-icing equipment fails to reduce or control the hazard. Continuously monitor the leading edge de-icers on the wing, observing the remaining ice between two consecutive cycles. It is characteristic of pneumatic deicing system that all the ice accretion cannot be eliminated because of the continuos accretion between the cycles.

Operation in Icing Conditions

The procedures for operation in *NORMAL* icing conditions are specified in the approved AFM. The aircraft has demonstrated that flight in icing requires no special procedures beyond those already contained in the manual. Such procedures are re-stated and reinforced in this document to provide pilots with a clear understanding of the procedures and recommendations.

During the icing test series, the aircraft demonstrated nominal control response even when flying in SLD conditions. As such, the procedures to be used under those conditions do not differ significantly from that of the normal icing. The procedures are presented here in a checklist format as a memory aid.

All procedures and speeds presented herein must be applied as long as ice is adhering to the aircraft. After the aircraft is free of ice, normal operation should be resumed.

Flight in Normal Icing Conditions

External Safety Inspection

Operating regulations (FAR 91.209) clearly state that no pilot may takeoff an aircraft that is contaminated by frost, snow or ice. Regarding the air carriers (FAR 121.629), the regulations are very specific about whether and how aircraft can operate in icing conditions.

The ground check should follow the EXTERNAL SAFETY INSPECTION contained in the approved AFM, with special emphasis on the surfaces that may collect ice: wing and leading edge, horizontal stabilizer upper and lower surfaces and leading edge, rudder and vertical stabilizer, fuselage, Pitot/AOA/TAT probes, static ports; antennas, all intakes and outlets, landing gear and wheel well, and engine.

When the aircraft is contaminated, application of deicing or anti-icing fluid, or both, may be required. While deicing removes the contamination, anti-icing prevents the accumulation for certain period of time.

Tests were performed to assure no performance or handling degradation due to fluid application. Approved deice/anti-ice fluids for the EMB-120 are stated in Operational Bulletin 120-004/93.

Ensure that the aircraft is clean before takeoff, by checking that critical areas have been properly deiced and anti-iced. If any ice or snow has accumulated, do not assume it will blow off during takeoff roll. Try to minimize the time between fluid application and the start of takeoff roll. Charted holdover times for de-ice and anti-ice products should be viewed conservatively. Holdover times can be significantly reduced due to many factors influencing fluid effectiveness. If contamination is building up, or the holdover time expires, do a pre-takeoff contamination check and if necessary go back for one another fluid application.

After Engine Starting/Takeoff

If ice is forecast, ice protection systems must be tested according to the procedures prescribed in the approved AFM. After testing is concluded, leave the protection systems on if the takeoff will be performed in icing conditions. Never leave the ground in known or forecast icing conditions with any ice protection system inoperative.

Takeoff procedures and speeds contained in the approved AFM remain unchanged.

To avoid the risk of engine malfunction during takeoff run due to ingestion of contaminants, turn engine ignition on prior to setting takeoff power. Takeoff should be performed using the static takeoff technique: apply takeoff power before releasing brakes. Check that engine limits are not exceeded.

Climb/Cruise

Monitor ice continuously during climb/cruise. **At the first sign of ice formation, turn all ice protection systems on.**

Manual climb (autopilot off) is initiated at a speed not less than 160 KIAS, at a constant pitch angle and climb power setting. When reaching 160 KIAS, pitch should be reduced in order to maintain that speed.

To climb with autopilot on, trim the aircraft with climb power and at least 170 KIAS. Then engage autopilot and select IAS mode to maintain the minimum required speed. Avoid the use of pitch hold for climb.

CLIMB mode, mainly on those MOD 67G autopilots with 155 KIAS climb speed, is not recommended. Instead, use IAS mode at 170 KIAS. With AP engaged, use HDG and ½ Ø bank mode.

Continuously monitor airspeed and autopilot operation. Be alert for mistrimmed condition that may be masked by the autopilot. Periodically disengage the autopilot and check trims – keep the aircraft trimmed all the time.

With autopilot on or off, increase airspeed if buffet onsets.

Upon attaining the desired flight altitude, accelerate with climb power until the aircraft reaches the desired cruise speed. Then set cruise power.

During climb/cruise, maintain NH above 80% for proper operation of the ice protection systems. Also observe the NP established by performance requirements during climb, which may be either 100 or 90%. Propeller vibration may occur due to ice accumulation on the blades. Cycling the propeller RPM may aid in shedding ice from the blades.

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Descent/Holding/Landing

Descent in icing conditions is normally accomplished by selecting DSC mode on the FD control panel. Airspeed is not a problem as it will be close to VMO. HDG mode and ½ Ø are still recommended. Keep the aircraft trimmed all the time.

Observe the holding procedures contained in the approved AFM. Flaps up, minimum NP is 85 %. Minimum airspeed is 160 KIAS, which must be increased if aerodynamic buffeting occurs.

Apply a minimum 5 kt increase plus Δ gust to the approach and landing speeds to compensate for the ice effect. In addition, refer to the landing performance charts and apply the gradient/weight increments as required.

Should a failure occur in any deice or anti-ice equipment, the appropriated procedures can be found in the ABNORMAL PROCEDURES SECTION of the Airplane Flight Manual. Refer to these procedures and apply the necessary corrections to speeds and use the correct flap setting for landing.

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Flight in SLD Conditions

Prior to departure, a thorough study of the weather condition is required. If weather reports or forecasts indicate the possibility of freezing rain or drizzle along the route of flight, serious consideration should be given to alternate routing to avoid the forecast areas and altitudes should be chosen to avoid the temperature ranges conducive to SLD conditions. Formulate contingency plans ahead of time in the event that you should inadvertently encounter SLD conditions.

Tests with simulated ice shapes following the icing tanker flights has demonstrated the satisfactory handling characteristics of the EMB-120 aircraft under freezing rain and freezing drizzle conditions. Airplane handling was demonstrated to be adequate for safe operation. Aileron control forces are somewhat increased, but still are well within the normal certification limited values. Autopilot operation in SLD conditions was found to be adequate for safe operation of the aircraft.

Nevertheless, the EMB-120 is NOT certificated for continued flight into SLD conditions. Visual cues to recognize SLD conditions are stated under the "SLD CONDITION VISUAL CUES" heading.

While flying in icing conditions, continuously monitor the wing boots for ridge development aft of the last inflatable rib. If ridges are developing, confirm the condition by checking for ice formation on the spinner in the blade root area. If SLD conditions are confirmed, you are operating outside the certified aircraft envelope and must depart icing conditions immediately.

Should the aircraft inadvertently encounter SLD conditions, the following procedures apply:

- **Gear..............................UP**
- **Flaps.............................UP**
  In icing conditions, use of flaps is restricted to takeoff, approach and landing only. When the flaps have been extended for approach and landing, they may not be retracted unless the upper surface of the wing aft of the protected area is clear of ice, or unless flap retraction is essential for go-around.
- **Airspeed.......................160 KIAS MINIMUM.**
  If buffet onset occurs, increase airspeed until buffet subsides.
- **Autopilot ....AS REQUIRED.**
  With AP engaged, use HDG and ½ Ø. Disengage autopilot if you suspect or observe abnormal operation. When disengaging autopilot, hold control column firmly to prevent roll excursion resulting from an out-of-trim condition that may have been masked by the autopilot. Retrim the aircraft if necessary.
- **Leave and avoid SLD conditions.**
- **Avoid excessive and abrupt roll maneuvering which can lead to wing tip stall.**

Landing after or during SLD conditions:

- **Gear..............................DOWN**
- **Flaps.............................45 or 25°**
- **Landing Speed.............$V_{REF 45\ or\ 25}$+5 kt plus Δ gust**
- **Touchdown with normal flare technique, delaying power reduction until just before touchdown.**