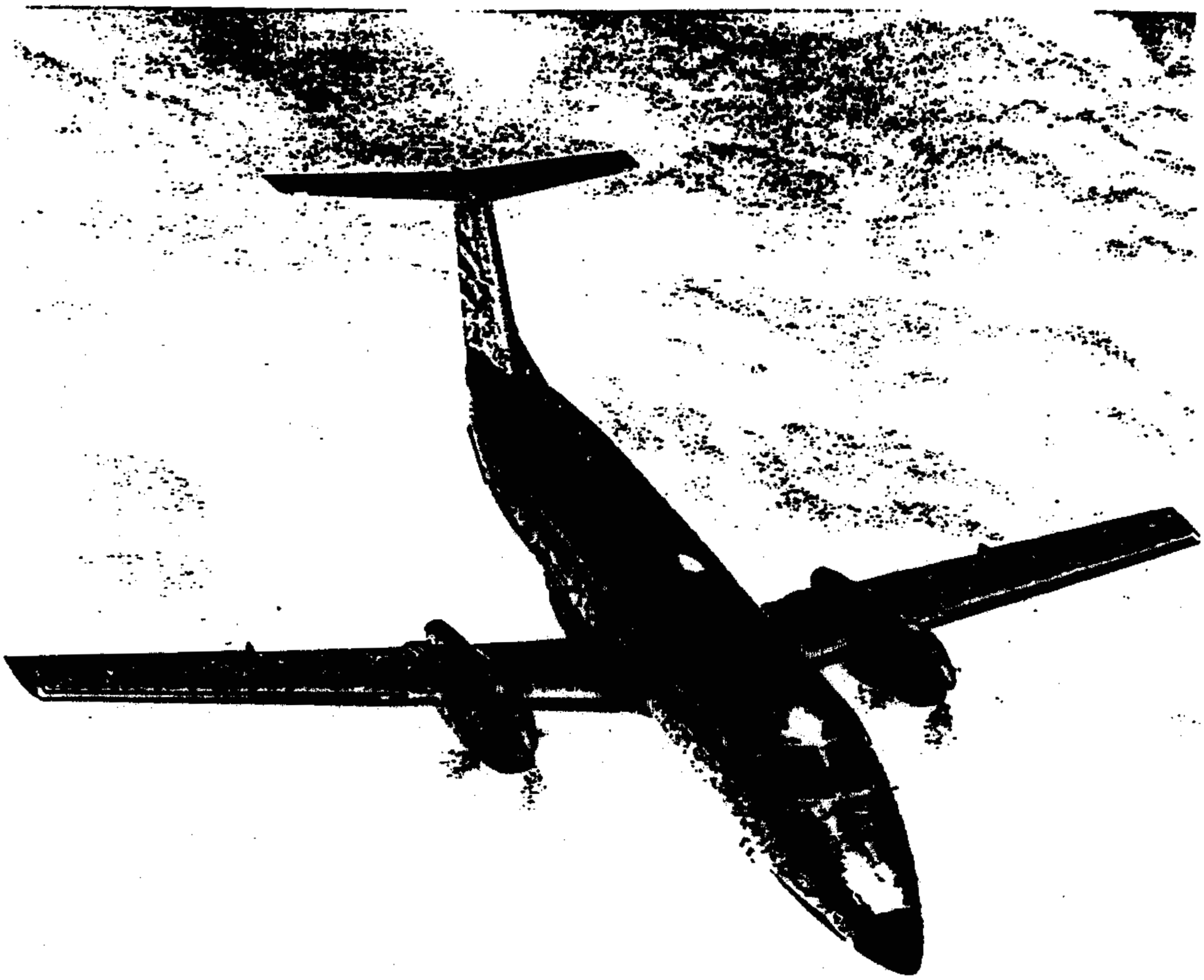
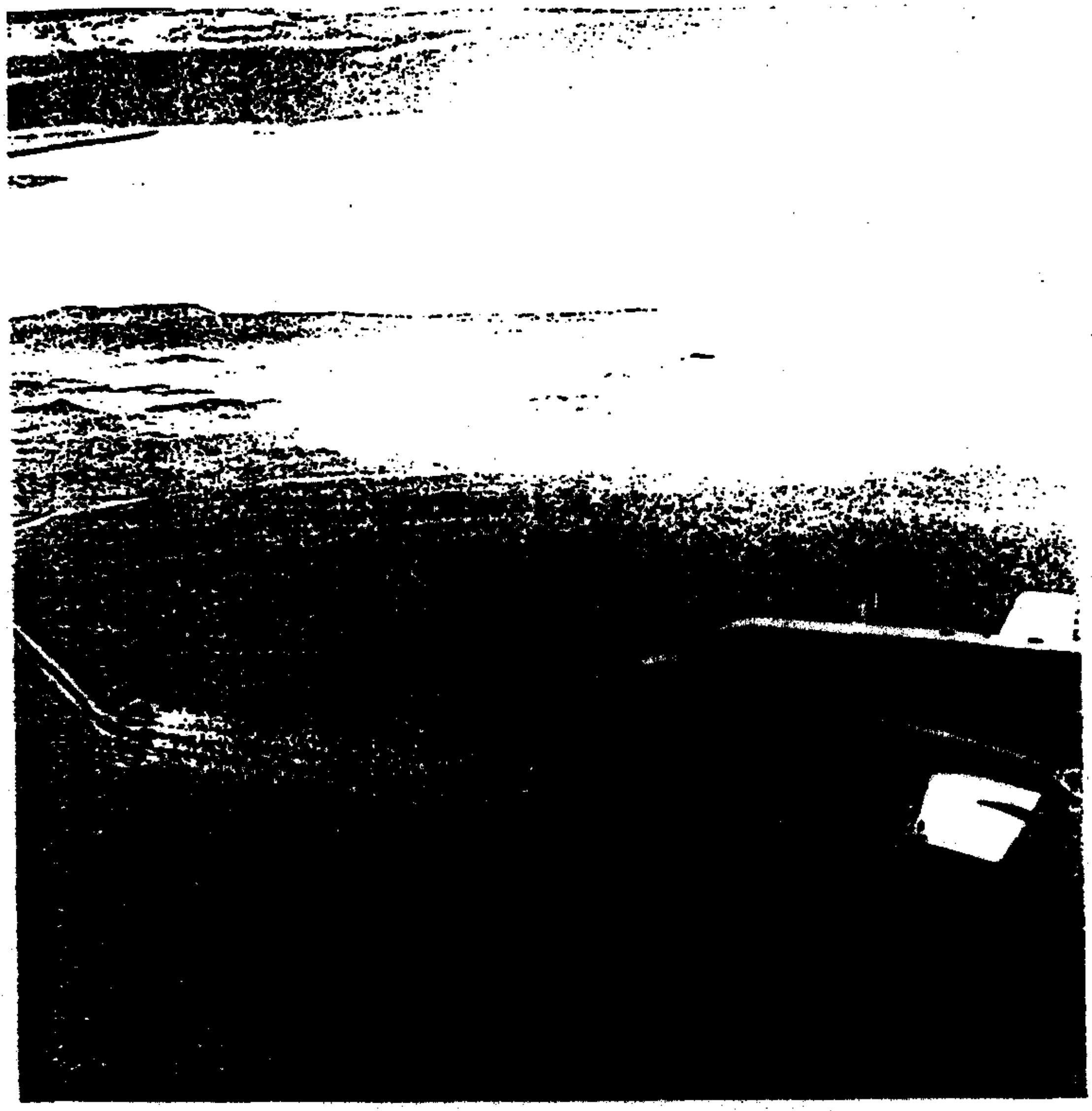
EMBRAER

EMB 120 Brasilia



OPERATION IN ICING CONDITIONS



OPERATION IN ICING CONDITIONS

Summary

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.

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 definition of 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.

V - OPERATING INFORMATION:

Ice Phenomenon Review

Icing conditions exist on the ground or in flight when the ambient temperature is 10 degrees C or below, and visible moisture in any form is present (such as clouds, fog with visibility of one mile or less, rain, snow, sleet or ice crystals).

The shape and amount of ice accretion (adhesion to exposed aircraft surfaces), which are the primary factors influencing the aircraft performance degradation, are dependent on outside air temperature, cloud liquid water content, droplet size, airspeed, and horizontal extent of the icing conditions.

Low temperatures (between minus 10 and minus 20 degrees C, 14 and minus 4 degrees F) with small droplets, promote rapid freezing on the surface, producing a rather white or milky, opaque granular ice, normally called **rime ice**. Rime ice usually contains tiny air pockets and is normally encountered in stratus clouds. However, at temperatures near freezing (between 0 and minus 10 degrees C, 32 and 14 degrees F), higher rates of ice accretion and large droplet sizes create a coating of clear, smooth ice deposited on surfaces called **glaze ice**. This ice is normally formed in cumulus clouds.

Rime ice tends to conform to the shape of the airfoil, while glaze ice often has a single- or double-horned shape (depending on the angle of attack) protruding from the leading edge of the wing.

Unfortunately, general statements about rime and glaze ice do not cover situations which sometimes occur. A rime or glaze ice accretion may form under identical ambient conditions depending on the size and shape of the airfoil in question. Both rime and glaze ice may form simultaneously on different regions of the same surface.

In strato-cumulus clouds, the ice that results is sometimes a mixture of rime and glaze ice and is appropriately called mixed icing.

The amount of ice collected depends upon the distance flown in icing clouds, the concentration of liquid water in the cloud, and the collection efficiency. The longer the icing exposure, the greater the amount of ice collected. This is typical when flying in stratus clouds, with its layer type development. The liquid water content affects the rate of ice accretion. As an example, the cumulus clouds (with large vertical development), with high water content, can cause ice to accumulate much more rapidly than in a stratus cloud formation.

The collection efficiency is a factor which defines how a moving surface accumulates ice. The higher the efficiency, the greater the amount of ice accumulated. Small objects are good ice collectors. As an example, the tail surface has higher collection efficiency than wings because of the smaller leading edge radius and small chord.

Liquid water content (LWC) is the total mass of water contained in all the liquid cloud droplet within a unit volume of cloud. LWC is expressed usually in grams of water per cubic meter (g/m^3). Typical values are 0.1 to 0.8 g/m^3 for stratus cloud types, and 0.2 to 2.5 g/m^3 for cumulus clouds.

The Mean Volumetric Diameter (MVD) is the term which defines droplet size. It is normally expressed in µ (micron – a millionth of a meter), and represents the average water volume of the drops in a cloud. Cloud droplets are typically between 2 and 50 µ in diameter, but values as large as 1000 µ (one millimeter) can occur in freezing rain.

Ice formation occurs less frequently above 22000 feet. Encounters above that altitude are rare and normally classified as light. The minimum temperature normally known as reference for ice formation is minus 40 degrees C (minus 40 degrees F).

Frost is a crystalline layer of ice that occurs when temperature and dewpoint drops below freezing at night. Frost may form over almost the entire aircraft, requiring removal on the ground as part of the pre-flight duties.

Wet snow, the crystallization of water vapor at temperatures slightly below freezing, can cause ice to accrete extremely rapidly. Dry snow by itself is not a critical icing problem, but if combined with supercooled droplets can cause as many problems as wet snow.

Freezing rain encountered in flight may present a condition that is beyond the aircraft certification requirements. In this condition, the supercooled water droplets are large and the temperature of the impacted surface must be initially below freezing. Rapid ice accretion occurs, normally extending beyond the usual area around stagnation point, because of the high collection efficiency of the large drops. Normally it is associated with a temperature inversion (increasing air temperature with height). When warm air overruns cold, rain falls from the warm air to cold air below, freezing upon impact with the aircraft. Ground stations beneath this inversion usually report freezing rain or sleet. In short – sleet at the surface is a indication of freezing rain above.

Often freezing rain is caused by warm fronts where warm moisture rides up the colder air at the surface. Freezing rain is also found in cumulus clouds and thunderstorms.

Freezing drizzle differs primarily from freezing rain by its smaller drop size. It occurs when the drizzle (very small) falls through a layer of below freezing temperature and freeze upon impact with the surface.

Both freezing rain and freezing drizzle can exist down to ground level and thereby cause ice to form quite rapidly on all surfaces even during short exposures.

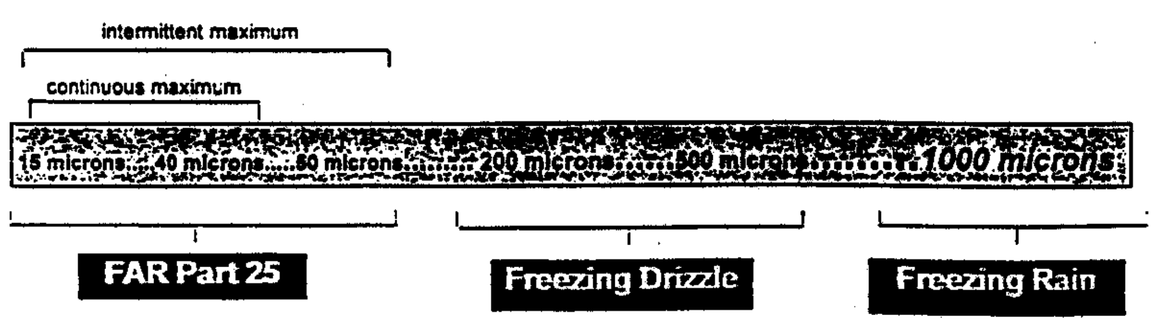
The aerodynamic effects of ice accretion are as follows: lift is reduced, drag is increased, pitch moment may change. This is caused by the ice shape changing the airfoil geometry or the added roughness thickening the boundary layer. Any contamination as thick and rough as medium sandpaper can significantly reduce handling qualities and stall margins. A minor coating of ice may be sufficient to destroy lift such that performance is significantly degraded. Additionally, ice accretion can increase the stall speed and can cause the loss of artificial stall warning.

When drag is increased due to ice, an increase in the angle of attack is required to maintain altitude. In SLD conditions, such an increase in the angle of attack may lead to a stall, followed by an uncommanded roll excursion if ice accretes asymmetrically in the wing, at a speed somewhat above that normal stall for the associated configuration.

Certification Requirements

Certification criteria, at this time, do not consider the problem of the freezing rain and freezing drizzle. A representation of the design criteria shown below is described in terms of mean volumetric diameter (MVD, in microns), for continuous maximum and intermittent maximum conditions, which also shows the correlation with the freezing rain and freezing drizzle. The design envelopes for qualification and certification in SLD conditions have not been established. Under the conditions which prevail in freezing rain, the droplets size can be as large as 1000 microns – far beyond the size of the normal droplet that cause the great variety of ice encountered.

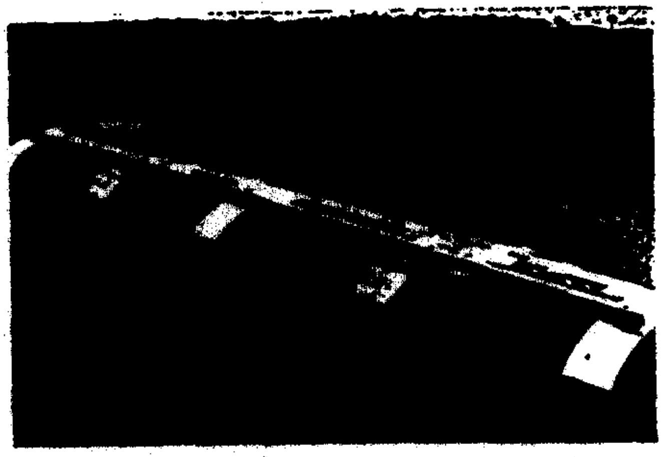
Although not addressed in the certification requirements, freezing rain and freezing drizzle must be taken into consideration when operating in icing conditions.



The Flight Tests

Before carrying out flight tests, wind tunnel and flight simulator tests were performed.
Wind tunnel tests were performed to measure the effect of a quarter round artificial ice shape on the aileron hinge moment. Both 1 inch and ½ inch, positioned at different positions on the wing, were evaluated for various aileron displacements. After completing wind tunnel tests, it was decided that a one inch wooden quarter round molding would be positioned at 6% of the wing chord, a position which corresponds to the end of the last de-icer inflatable tube.
Results obtained in the wind tunnel, such as hinge moment coefficient, estimated loss of lift, drag increase and associated rolling and yawing moments, were introduced in the simulator aerodynamic model. A series of simulated flights were then performed to assess the handling characteristics and controllability of the aircraft prior to performing flight tests with the artificial ice shapes attached to the wing in front of the aileron.
Satisfactory results obtained from the flight simulator provided the assurance that allowed proceeding with a broader flight test program to search for the most critical flight condition while flying in an SLD environment.
The EMB-120 prototype aircraft was then configured for real flight tests. Artificial ice shapes in the form of wooden quarter round molding were installed on the wing upper surface at 6% of local chord, just aft of the last de-icer inflatable tube and ahead of both ailerons. For flight safety reasons, ice shapes on each wing were divided into three segments of equal length and a specially designed device was provided which allowed each segment to be released in flight.
At first, high speed taxies were performed to verify aileron forces and the operation of the releasing devices as well. Following high speed taxies, the aircraft flew with a molding measuring 1/3 of the aileron span attached to both wings, first with a ½ inch wooden molding and then with a 1 inch molding. During both flights, handling characteristics were satisfactory. A third flight was made with a 1 inch molding covering 2/3 of the aileron span on both wings and again handling was satisfactory.
The results obtained with this gradual approach to the most critical condition provided the confidence that the aircraft could be safely flown with a 1 inch molding covering the full aileron span. Based on this fact, EMBRAER decided to proceed with the testing and carry out dry air flight tests, exceeding the original requirements for high speed taxi required by the FAA in a previous meeting.

Subsequently, many tests were carried out with the full length 1 inch wooden quarter round ice shapes ahead of both ailerons, with the special device to release the wood molding in flight. Upon reaching the desired flight condition, the full length molding was released from one wing simulating an extremely conservative total asymmetry. Results showed that the aircraft was fully controllable without any lateral control degradation. Pilot force to maintain wings level was considered to exceed the maximum permitted by the FAR.



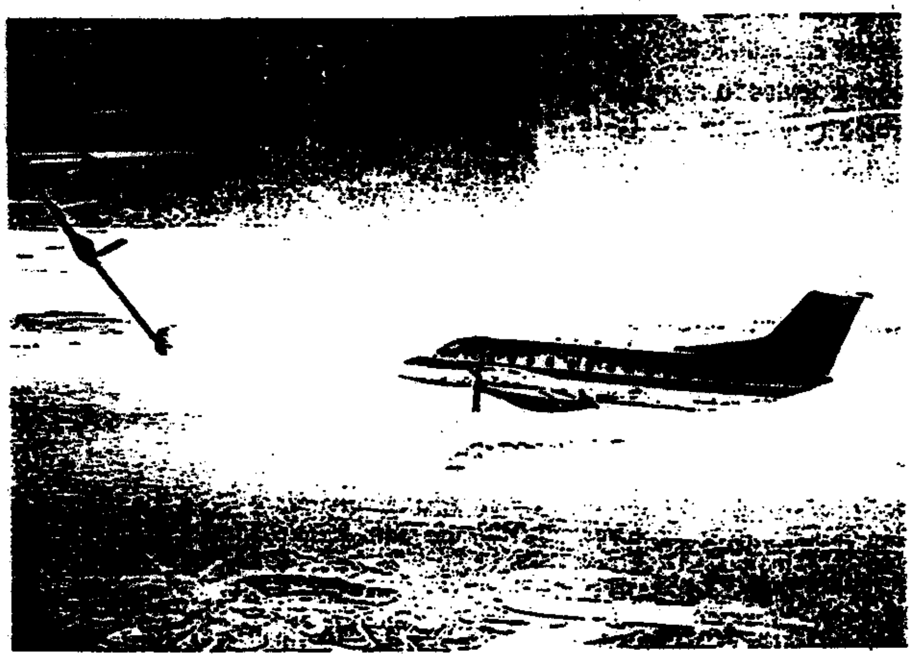
1 inch wooden quarter artificial Ice shape used during dry air ice tests at EMBRAER

The theoretical ice shapes used during these tests were considered much more critical than that accretion which would develop from flying in a real SLD condition, i.e., the aircraft was subjected to a highly conservative test condition. As a result, it was decided that the test program should be extended and the icing tanker used to determine the real ice shapes which would accumulate on the EMB-120 during SLD encounter. In addition, test results from the icing tanker would determine the visual cues that pilots could use to recognize freezing rain and freezing drizzle.

The Icing Tanker Tests

The icing tanker tests were conducted at Edward Air Force Base in December 1995 with the following specific objectives:

- To determine the real shape of the ice accumulated during freezing rain/freezing drizzle exposure; and
- To determine the visual cues to allow pilots to recognize when they are flying in freezing rain/freezing drizzle.



The aircraft used in the test, the EMB-120 S/N 120.038 delivered in 1987, was very representative of in-service aircraft – it was equipped with production de-icers operating normally, with no special surface treatment (ICEX, AGEMASTER etc.) to avoid ice build-up. The aircraft was appropriately instrumented with photo and video cameras that were used for recording all of the tests.

The icing tanker aircraft was a USAF KC-135 equipped with boom-mounted water nozzle array designed to produce an icing cloud with the correct droplet size and water content. A specially equipped Learjet was used in calibrating the water spray and also served as a chase plane. Additional video cameras were installed in the KC-135 and the Learjet.

Test conditions were as follows:

- Exposure time in each test condition: maximum 20 minutes
- Total time elapsed: 5.7 hours
- Temperature: between minus 1 degree C to minus 5 degrees C
- Airspeed: 160 and 175 KIAS
- Gear and flaps: UP
- MVD: 40 μ (normal icing) and 170 μ (SLD condition)

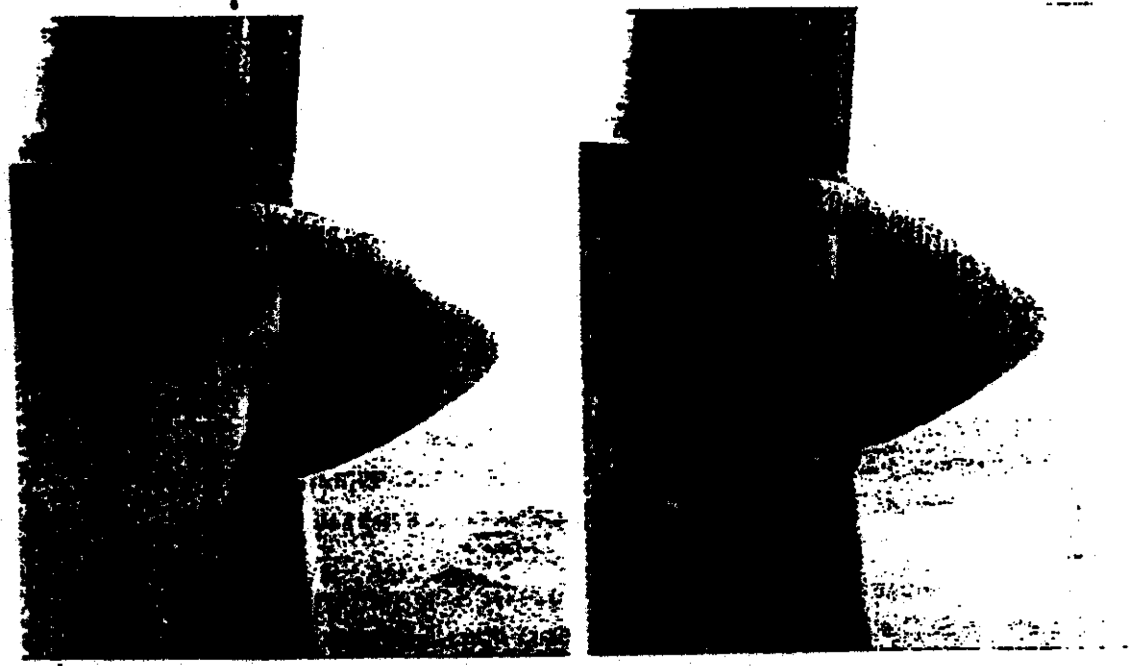
- MVD: 40 μ (normal icing) and 170 μ (SLD condition)
- LWC: 0.5 g/m^3 (normal icing) and 0.65 g/m^3 (SLD condition)

Results of the tests may be summarized as follows:

- All of the ice protection systems exposed to SLD condition (wing and engine air inlet deicers, windshield, propeller and pitot-static tubes) operated normally in removing or preventing ice accumulation. All of the systems were activated according to AFM procedures.
- No ice accumulated on the upper wing surface or on the vortex generators in front of the aileron.
- Engine operation was normal throughout the entire test series.
- Flying qualities, handling and controllability characteristics remained unchanged.
- Ice accumulation on the windshield and propeller blades did not reveal any unique cue that was considered suitable to identify the SLD conditions.
- Ice accumulations on both the wing and propeller spinner revealed different accumulation patterns in SLD condition than that observed in normal icing conditions, and were declared as appropriate visual cues. On the wing, the unique visual cue consists of ice accumulation on the deicing boot aft of the last inflatable tube. On the spinner, it consists of accumulation extending beyond mid length to the aft end of the spinner. Photos and text that follows describe these visual cues more accurately.

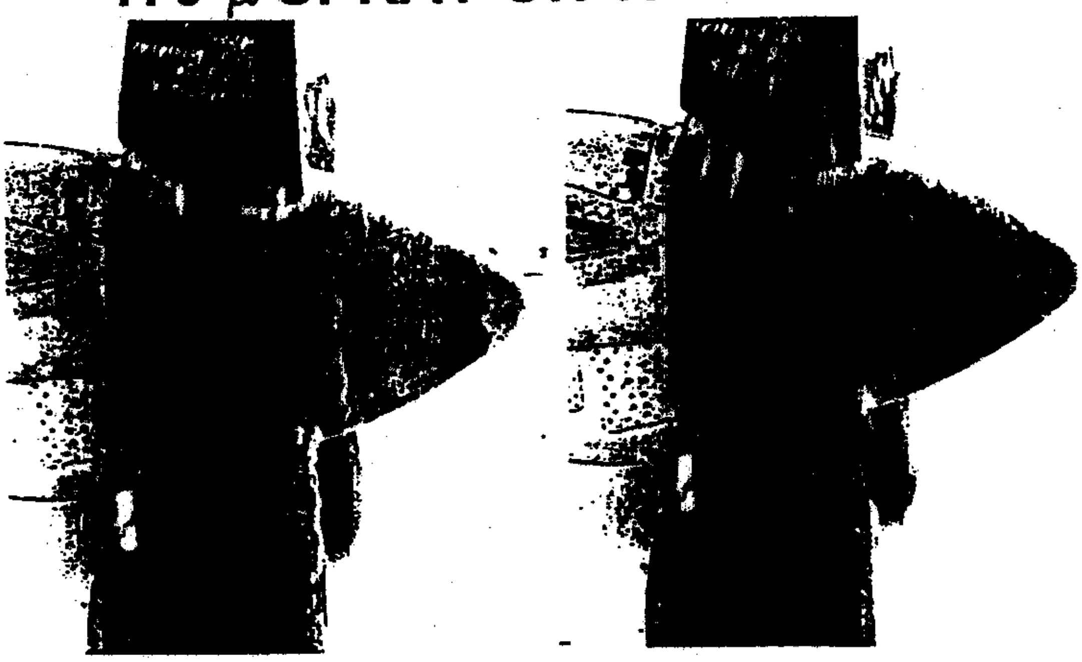
NOTE: Yellow dye was added to the icing tanker spray.

40 μ SPRAY ON THE SPINNER



Normal ice spray on the spinner shows ice accumulation concentrated on forward half.

170 μ SPRAY ON THE SPINNER



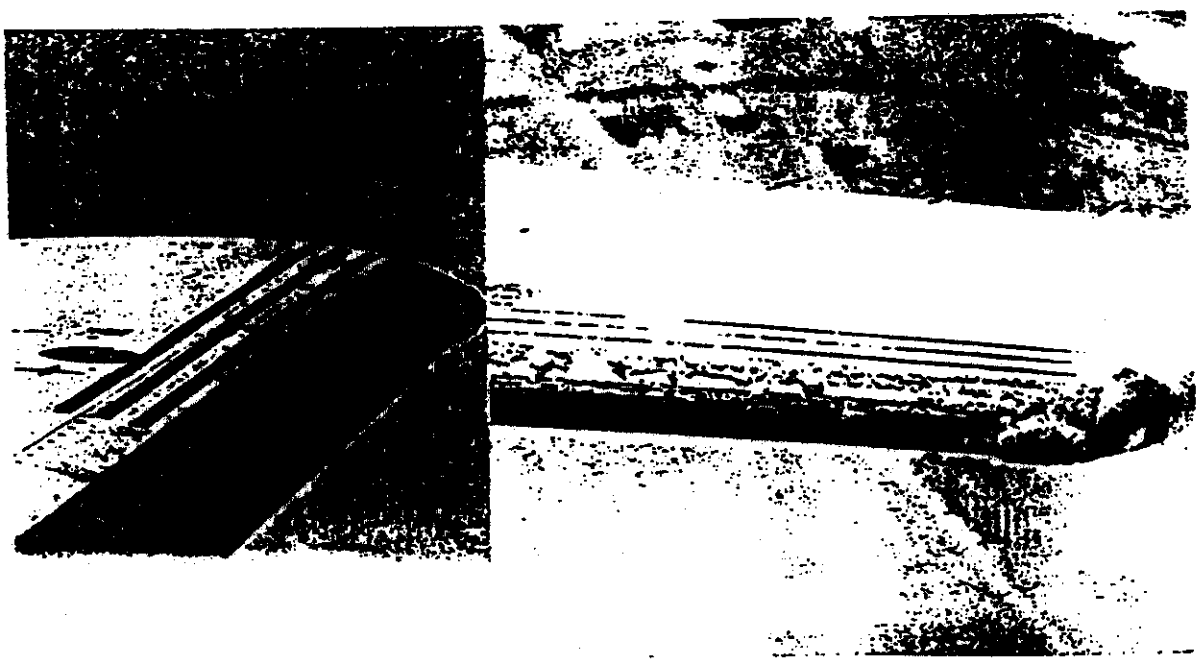
SLD icing concentrated on the aft half of the spinner.

40 μ SPRAY ON THE WING

These photos show normal icing in which ice begins forming on the protected area, where the inflation tubes are provided.

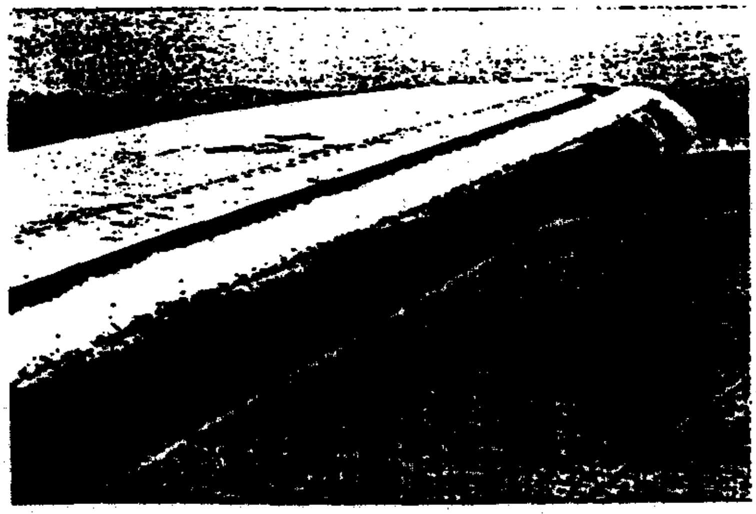
170 μ SPRAY ON THE WING

SLD ice spray on the wing shows ice accumulating on the de-icer aft of the last inflatable rib.



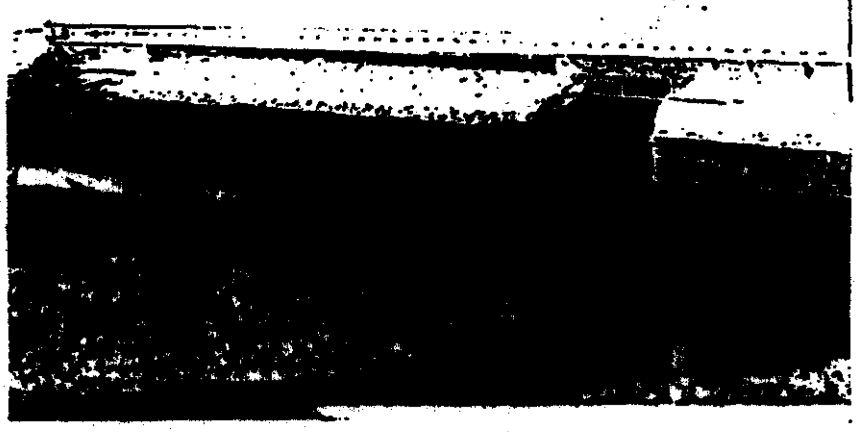
Dry Air Tests with Simulated Ice Shapes

The purpose of the icing tanker tests was to characterize and measure ice shapes and to develop visual cues to aid pilots in recognition of SLD conditions. Using data gathered during tanker tests, dry air tests were conducted at EMBRAER facilities to assess the EMB-120 susceptibility to roll control difficulties when operating in SLD conditions. Simulated ice shapes, approximately twice the amount of ice accreted during icing tanker tests, were attached to the left wing.



Artificial continuous ridge of 1/2 inch thick installed on the left wing, during dry air tests at EMBRAER.

Two configurations of ice shapes were tested at a variety of speeds and conditions, including autopilot on and off. The tests were conducted simulating a sudden shedding of all ice accretion of one wing which could cause an asymmetric ice configuration to be suddenly established.



Mixed ¼ and 1 inch thick artificial ice shape installed on left wing during dry air tests.

Results of these tests were as follows:

- In all test conditions, the EMB-120 demonstrated handling characteristics adequate to safely operate in SLD conditions as tested.
- Control forces were always well below the limits established by FAR's, and there were no control efficiency reduction or any characteristic that could represent

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.

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.

The SLD Condition Visual Cues

The icing tanker tests identified two unique cues that are definitive in identifying SLD condition.

First is the build-up of irregular ridges of ice on the de-icing boots just aft of the last inflatable tube. This ridge will develop to an irregular distribution of horns along the leading edge, if flight in SLD condition is sustained.

Second is the layer of ice found on the spinner. Under the conditions for which the aircraft was certified, ice concentrates on the forward half of the spinner. In SLD conditions, ice concentrates in the aft half of the spinner, accumulating throughout the blade root region to the aft end of the spinner.

The pictures below clearly show the difference in accumulation patterns between SLD and normal icing conditions.

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.

NORMAL ICE ON THE WING

This photo shows a 1 inch thick accumulation before inflation is initiated. Observe that accumulation in normal icing conditions actually occurs at the leading edge stagnation point.
After inflation, only traces of ice will remain on the de-icer.

SLD CONDITION ON THE WING

Observe accumulation beginning aft of the protected area, behind the last inflatable tube. This ice cannot be shed.

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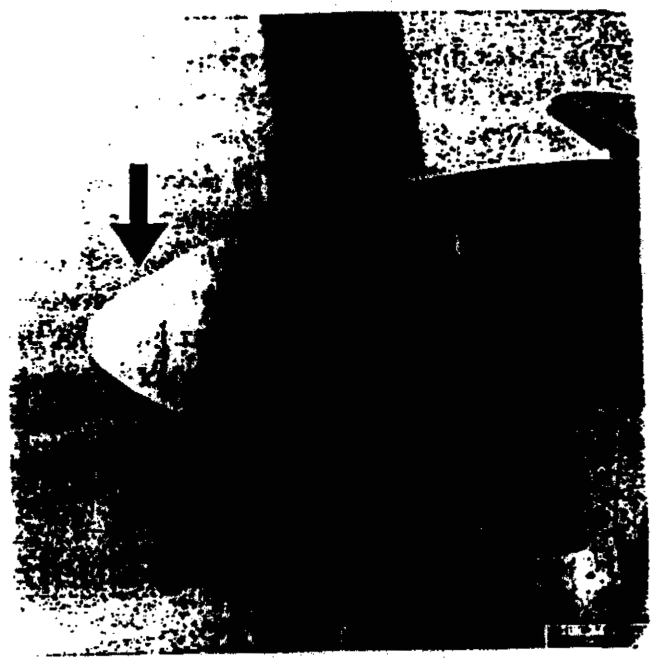
NORMAL ICE ON THE SPINNER

Ice accumulates on the forward half of the spinner.



SLD CONDITION ON THE SPINNER

Ice accumulation concentrates on the aft portion of the spinner, extending to the blade root region.

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.

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.

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.

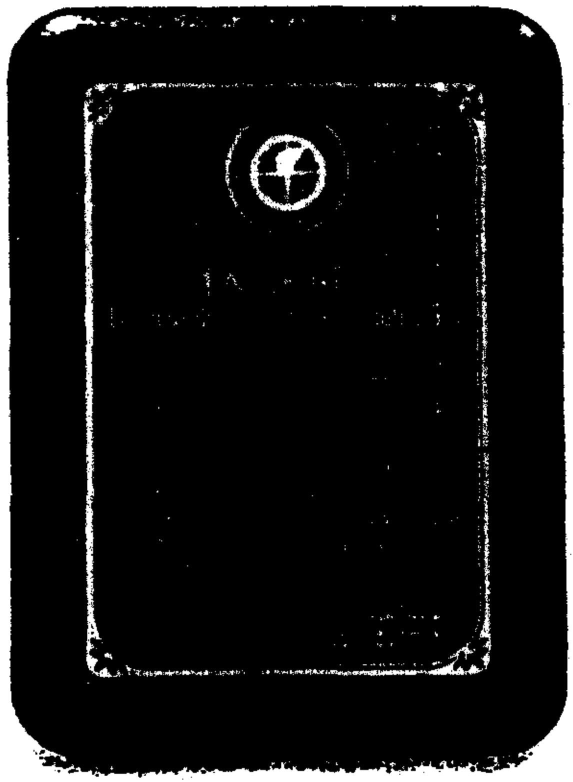
  With AP engaged, use HDG and ½ Ø. Disengage autopilot if you suspect or observe abnormal operation. When disengaging autopilot, hold control column firmly to prevent roll excursion resulting from an out-of-trim condition that may have been masked by the autopilot. Retrim the aircraft if necessary.
- **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............$V_{REF45\ or\ 25}$+5 kt plus Δ gust
- Touchdown with normal flare technique, delaying power reduction until just before touchdown.

THE SAFETY AWARD

After such an extensive evaluation program, which demanded so many hours flown, required significant engineering effort, involved the professionalism of the EMBRAER technicians, and that ended by confirming the distinguished flying qualities of the EMB-120, the acknowledgment of the certification authority confirms the EMBRAER's solid worldwide reputation and commitment to safety.



VI - TECHNICAL PUBLICATION INFORMATION

None.