EMBRAER -120 Brasilia
Simulated Ice Shapes Incident

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Flight Test Safety Workshop
Seattle May/2012
"I Learned about Flight Testing From......".

*IT'S HIS AMBITION TO HAVE AN ANSWER FOR EVERYTHING*
This presentation intends to cover some technical aspects of an EMB-120 Brasilia incident which happened during one of the last test flights of Inter-cycle Ice Evaluation performed in the Prototype EMB-120 s/n 001 (PT-ZBA) at early 01’s, and also emphasizes the organization and procedural changes and lessons learned resulting from that incident.
Overview

Scenario

- EMB-120 was an “Old-Low Priority Program” inside the company
- At that time there were 2 new programs (EMB-145XR and EMBRAER 170) running at the same time
- The Ice trials were in place for approx. 4 years, due to a long FAA interaction
- Risk Assessment and Hazard Analysis were based mainly on the FTEs and Pilots experience. No formal processes
- There was no formal definition regarding minimum safety equipment associated with the test risk

"You're reordering your priorities? — Since when do you have priorities?"
Overview

Embrraer was accessing an Inter-Cycle Ice Handling Qualities, required by FAA

Simulated Ice Shapes installed on Wings, Vertical and Horizontal Stabilizer

At 16,5Kft, during a Turning Stall (30 deg), Landing configuration (DN/45) aircraft departed from the controlled flight

Extreme pitch down attitude, with no effective pitch control;

Tail Chute was deployed and PF regained aircraft control at aprox. 8,500 ft;

Max airspeed was 241 kts, RTB and safe landing at SBSJ
Background
Background

Prototype & Ice Shapes Installation

- Aircraft EMB-120 Brasília – S/N 001 – PT-ZBA
- Date: 04/Oct/2001
- Simulated Ice Shapes (Inter-Cycle Ice) installed on the wings leading edge, Horizontal and Vertical Stabilizers and all unprotected areas
- Heavy Weight (24,700 lb) and Aft CG (40.5%)

- Inter-Cycle Ice = Ice that builds up on the Wings, Horizontal and Vertical Stabilizers leading edge between two consecutive anti-ice Boots cycles (3 minutes)
Background

Simulated Ice Shapes installed on RH Wing
Background

Simulated Ice Shapes Horizontal & Vertical Stabilizers
Background

Inter-Cycle Ice & Unprotected Areas Ice Shapes
Background

Ice Shapes installed on LH Wing Tip
Background

Maintenance (Prototype & Ice Shapes)

- Prototype not fully representative from series aircraft and difficult to maintain
- Lack of good Configuration Control and Tech Publications
- Aircraft was parked outside Hangar for a long time
- Lack of inspections on the Ice shapes (Horizontal Stabilizer)
- Poor plumb ballast attachment
- No FDR installation, only FTI data

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Background
Background

Ballast attachment - Prototype center section
Background

Aircraft Damages

- Several Ice shapes installed on the leading edges were damaged.
- Two plumb ballasts got loose during the nose down upset and damaged the aircraft superior fuselage and floor.
**Background**

Damage on the upper aircraft ceiling
*(Internal view)*
Background

Damage on the upper aircraft ceiling (External view)
Background

RH wing leading edge – damage on the simulated ice shapes
Background

LH wing leading edge – damage on the simulated ice shapes
Analysis

RH Horizontal Stabilizer lower surface leading edge – Ice shapes detached
Analysis

LH Horizontal Stabilizer leading edge – Ice shapes detached
Paper sand – installed on the leading edge of the Horizontal and Vertical Stabilizers
Organizational Changes

From that incident, EMBRAER came up with a set of internal normative documents (ENS) to:

- Standardize the Safety Assessment Process (minimizing individual evaluation) – Ref.: FAA Order 4040.26
- Implement a Technical Review Board & Safety Committee
- Standardize the technical analysis and mitigations procedures applied to each and every test
- Correlate the test risk levels to the:
  1. Required crew experience;
  2. Required meteorological conditions;
  3. Required FTO review and approval levels;
  4. Support and safety equipment.
EMBRAER -120 Brasilia Simulated Ice Shapes Incident

Organizational Changes

EMBRAER FLIGHT TEST RISK ASSESSMENT METHOD

MANEUVER TO BE EXECUTED

- FLIGHT ENVELOPE
- SCREEN FACTOR
- Operational Envelope
- Design Envelope
- Limited Envelope

TEST POINT EXECUTION

THREE FLAGS

I - Detect training or gradual approach necessities
Can the lack or necessity of these affect Safety?

II - Detect Errors Tolerances
Do they affect safety if extrapolated or disregarded?
And are they considered to be tight?

III - Detect Recovering or Discontinuing possibilities
When the maneuver is there a probable chance to get into an unsafe situation?

SYSTEM FAILURE

AMJ 1309 Evaluation combined with flight test effects to each failure

DAMAGE MITIGATION & RISKS MINIMIZATION

RISK CLASSIFICATION

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Lessons Learned

“Screen Factor” Application to High Risk Detection

THREE FLAGS
Screen Factor Tool

I – Detect Expertise on the Proposed Tests

Previous tests are sufficient to predict a safe behavior of the new proposed tests?

II – Detect Limitations of Modeling Tools

Best available modeling tools are sufficient to predict a safe behavior for the new proposed tests?

III – Detect Type of Possible Effects of the Proposed Test

Hazardous or catastrophic effects might result from the proposed tests if predictions are incorrect?
Lessons Learned

“Three Flags” Application to Test Point Execution

I – Detect training or gradual approach necessity

Is the need for 
Try-outs Needed? 
Training 
Gradual Approach 
And 
Can the lack or 
necessity of these affect safety?

II – Detect Errors Tolerances

Do Test Tolerances 
Positioning Tol. 
Affect safety if extrapolated or disregarded? 
And 
Are they considered to be tight?

III – Detect Recovering or Discontinuing Possibilities

When 
Recovering 
The maneuver, is there a probable chance to get into an unsafe situation?

Discontinuing
Organizational Changes

<table>
<thead>
<tr>
<th>Risk Classification</th>
<th>Experience (Years at FT activity)</th>
<th>Experience (Flight Hours)</th>
<th>Minimum Pilot Qualification Required</th>
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<tr>
<td>LOW</td>
<td>≥ 1</td>
<td>≥ 1.000</td>
<td>PPA3</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>≥ 2</td>
<td>≥ 1.000</td>
<td>PPA2</td>
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<tr>
<td>HIGH</td>
<td>≥ 5</td>
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<tr>
<td>1° FLIGHT</td>
<td>≥ 10</td>
<td>≥ 2.000</td>
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<tr>
<th>Risk Classification</th>
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<th>Experience (Flight Hours)</th>
<th>FTE Qualification</th>
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<td>≥ 10</td>
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<tr>
<td>MEDIUM</td>
<td>≥ 1</td>
<td>≥ 100</td>
<td>B</td>
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<tr>
<td>HIGH</td>
<td>≥ 3</td>
<td>≥ 200</td>
<td>A</td>
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<tr>
<td>1° FLIGHT</td>
<td>≥ 5</td>
<td>≥ 500</td>
<td>A*</td>
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</tbody>
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**METEOROLOGICAL CONDITION (AIRPORT/TEST AREA)**

- **LOW**: Visual or IMC, as required by the flight test order and maneuver recovering procedures.
- **MEDIUM**: Visual or IMC, as required by the flight test order and maneuver recovering procedures.
- **HIGH**: Only Visual. Night Flights are prohibited.
- **1° FLIGHT**: Only Visual. Night Flights are prohibited.
### Organizational Changes

#### Required Review and Approval Levels

FTE and Pilot have already prepared this FTCR. You can

**Test Risk: High**
- **Max FTE class: A+**
- Due to the risk of this test, this FTO must be approved by DEN or a combination of GFT+GOV

<table>
<thead>
<tr>
<th>Approval Flow</th>
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<tbody>
<tr>
<td>User</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Eduardo Galbio Camelier</td>
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<tr>
<td>Ramiro Teodoro Silveira</td>
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<td>Ramiro Teodoro Silveira</td>
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<tr>
<td>Alexandre Vilela Garcia de Figueiredo</td>
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<tr>
<td>Roberto Becker</td>
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<td>Gisela Mestrum Delven</td>
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Organizational Changes

Required Support & Safety Equipment

- Safety Chase
- Search and Rescue
- Fire Fighters
- Medical Support
- Telemetry
- On-Board Safety Analysis

- Tail Chute
- Safety Parachutes & Helmets
- …
Lessons Learned

- There is no such thing as a “easy test point”!! There is a test point well planned, briefed and executed as planned.

- Care must be taken when training “young people” in “old-programs”

- People have their own individualities and experience levels

- Individual evaluations (based on individual experience) will produce different results even when starting from the same point.

- Organizations are similar to aircraft and have an inertia proportional to their mass (or size).
Lessons Learned

- Complete redesign of all ballast attachment devices
- New Artificial Ice Shapes Adhesives / Resigns and Materials are now employed
- For longer Flight Test Campaigns, any “special equipment/device” installed shall have a dedicated appreciation regarding its “expiration time”
- Ongoing Research Project for new Artificial Ice Shapes materials and gluing processes
Organization Safety – Actual Status

- Well established Risk Assessment Process
- RA Process is a “corporate” process, not individual one
- Each individual Flight Test Campaign has its Risk Evaluation – Ref.: NASA/FAA Flight Test Safety Database
- Each FTO has a dedicated review and approval process
- Technical Review Board and Safety Committee
- Weekly Safety Meetings
- Test Pilots and Flight Test Engineers as a part of the Embraer Safety Committee
- Flight Test Practices Community - where the best practices and lessons learned are disseminated

“Hard work conquers all”
Questions

"That's all Folks!"
Thank You!