



EMBRAER -120 Brasilia Simulated Ice Shapes Incident

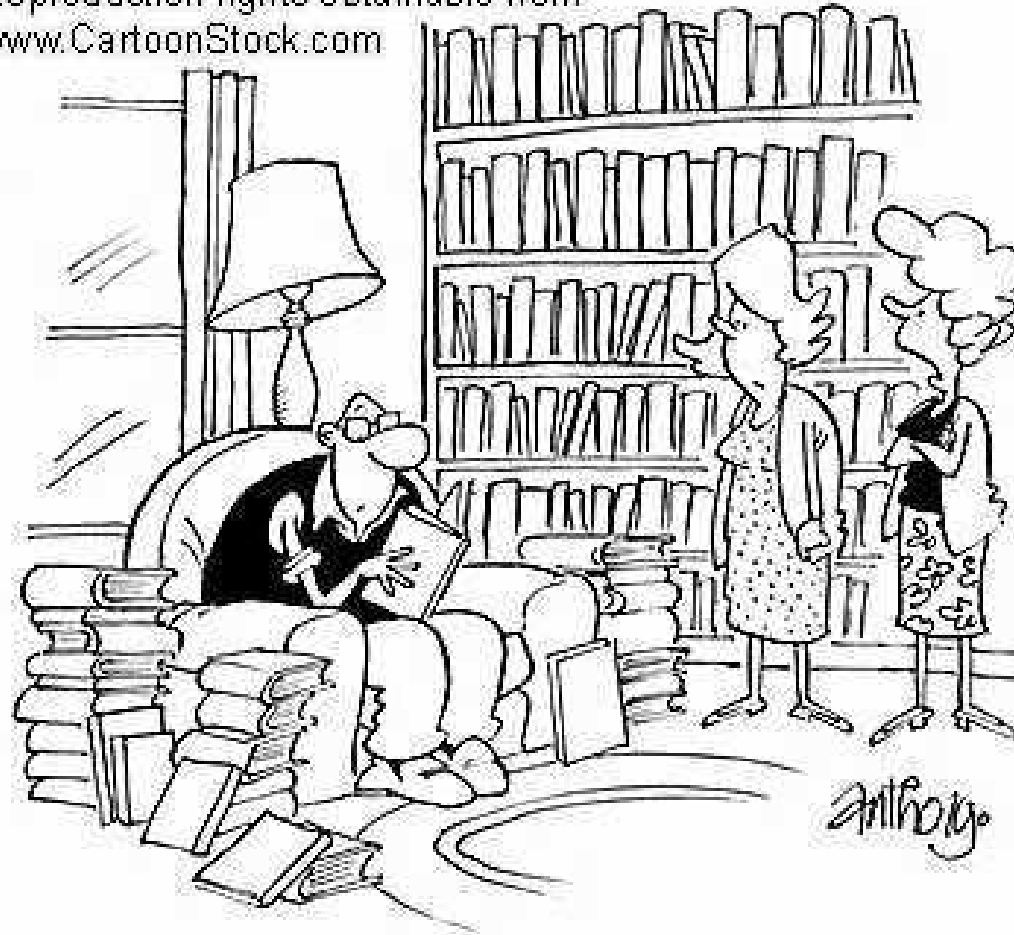
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Roberto Becker

Flight Test Safety Workshop
Seattle May/2012

"I Learned about Flight Testing From.....".

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"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.

OUTLINE



Overview



Background



Analysis



Organizational Changes



Lessons Learned

Organizational Safety -
Actual Status



Questions



Overview

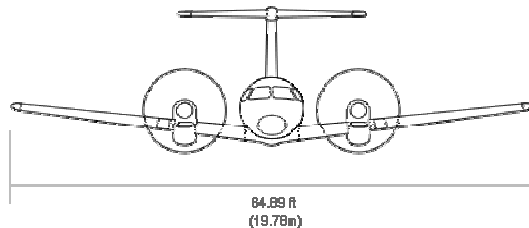
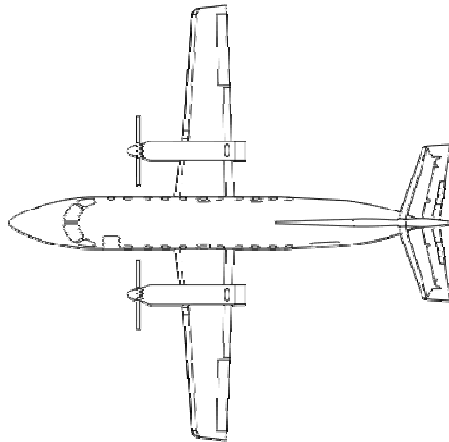
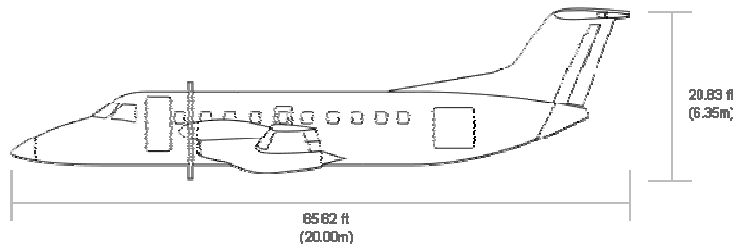
Scenario

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



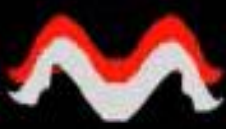
- Ø Embraer was accessing an Inter-Cycle Ice Handling Qualities, required by FAA
- Ø Simulated Ice Shapes installed on Wings, Vertical and Horizontal Stabilizer
- Ø At 16,5Kft, during a Turning Stall (30 deg), Landing configuration (DN/ 45) aircraft departed from the controlled flight
- Ø Extreme pitch down attitude, with no effective pitch control;
- Ø Tail Chute was deployed and PF regained aircraft control at aprox. 8,500 ft;
- Ø Max airspeed was 241 kts, RTB and safe landing at SBSJ



10 DEG DWN



2002 PAULO M RIBEIRO



10 DEG UP

Background



Background

Prototype & Ice Shapes Installation

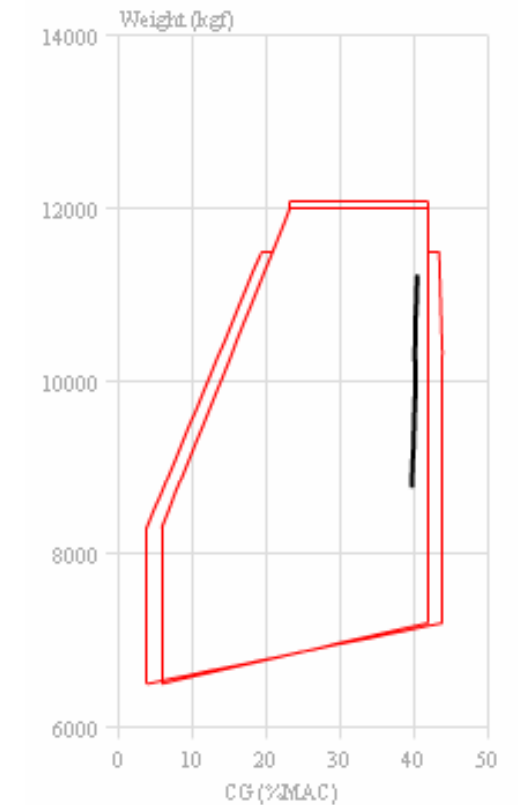
Ø Aircraft EMB-120 Brasília – S/N 001 – PT-ZBA

Ø First Flight: 1983 – FH: 4370 / FC: 3380

Ø Date: 04/Oct/2001

Ø Simulated Ice Shapes (Inter-Cycle Ice) installed on the wings leading edge, Horizontal and Vertical Stabilizers and all unprotected areas

Ø 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

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Background



Background



Inter-Cycle Ice & Unprotected Areas Ice Shapes

Background



Ice Shapes installed on LH Wing Tip

Background

Maintenance (Prototype & Ice Shapes)

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



Background



Ballast attachment - Prototype rear section

Background

Ballast attachment - Prototype center section



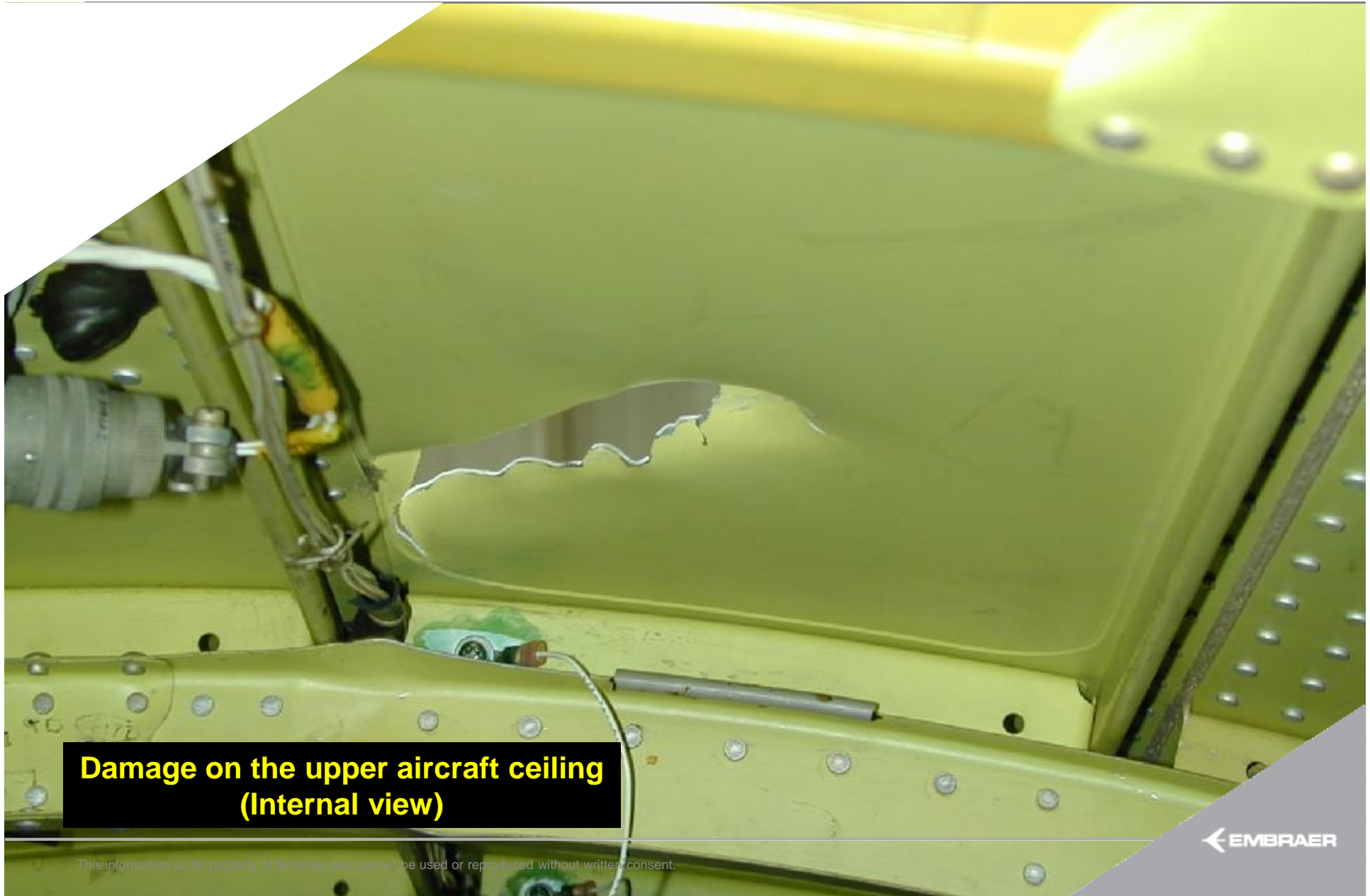
Background

Aircraft Damages



- Ø Several Ice shapes installed on the leading edges were damaged
- Ø 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)**

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Background



**Damage on the upper aircraft ceiling
(External view)**

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Background



RH wing leading edge – damage on the simulated ice shapes

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Background



LH wing leading edge – damage on the simulated ice shapes

Analysis

Air Safety

EMB 120-001

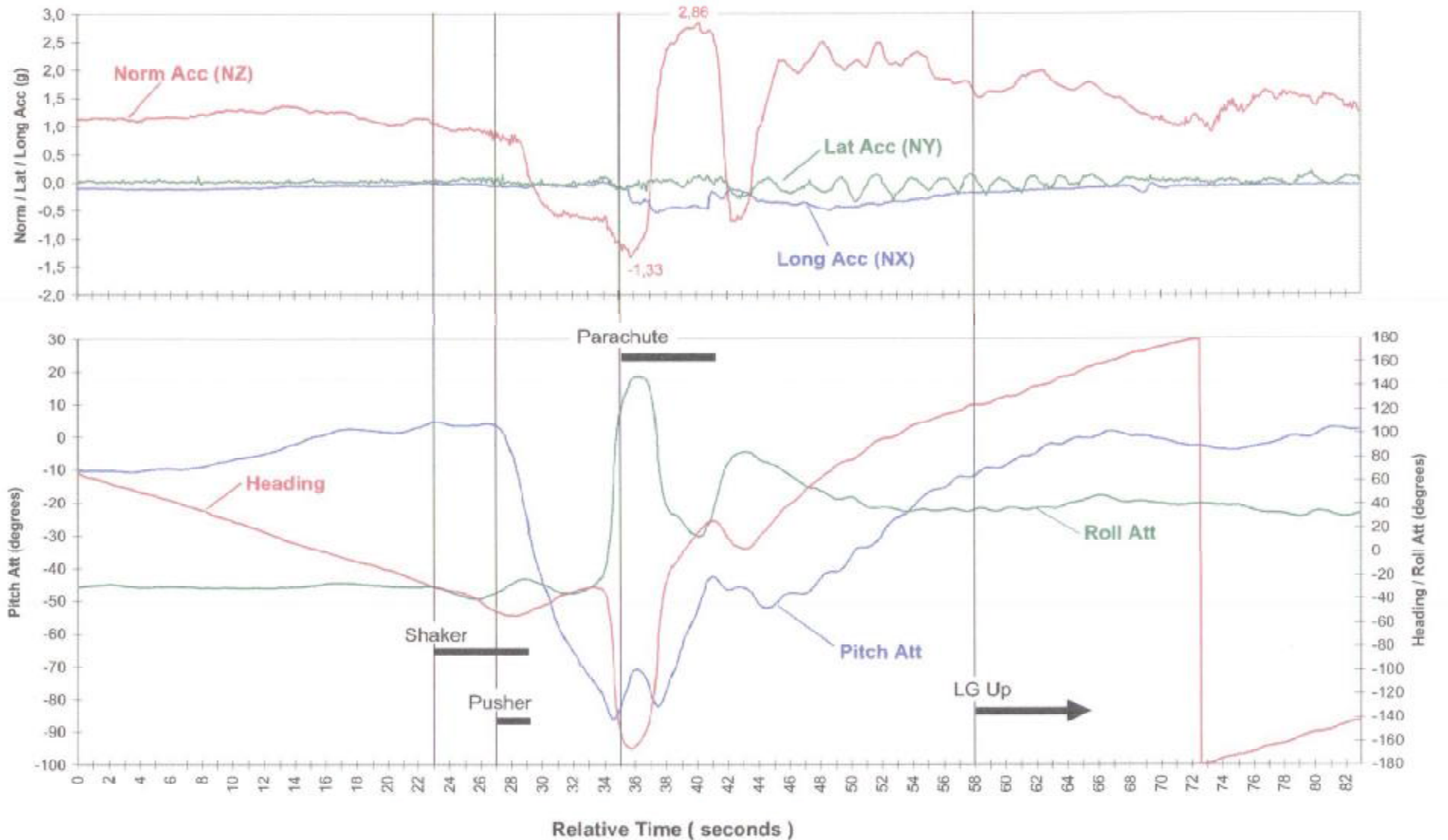
Embraer

PT-ZBA

Event Date: 04.Out.2001

FTI Readout

G4

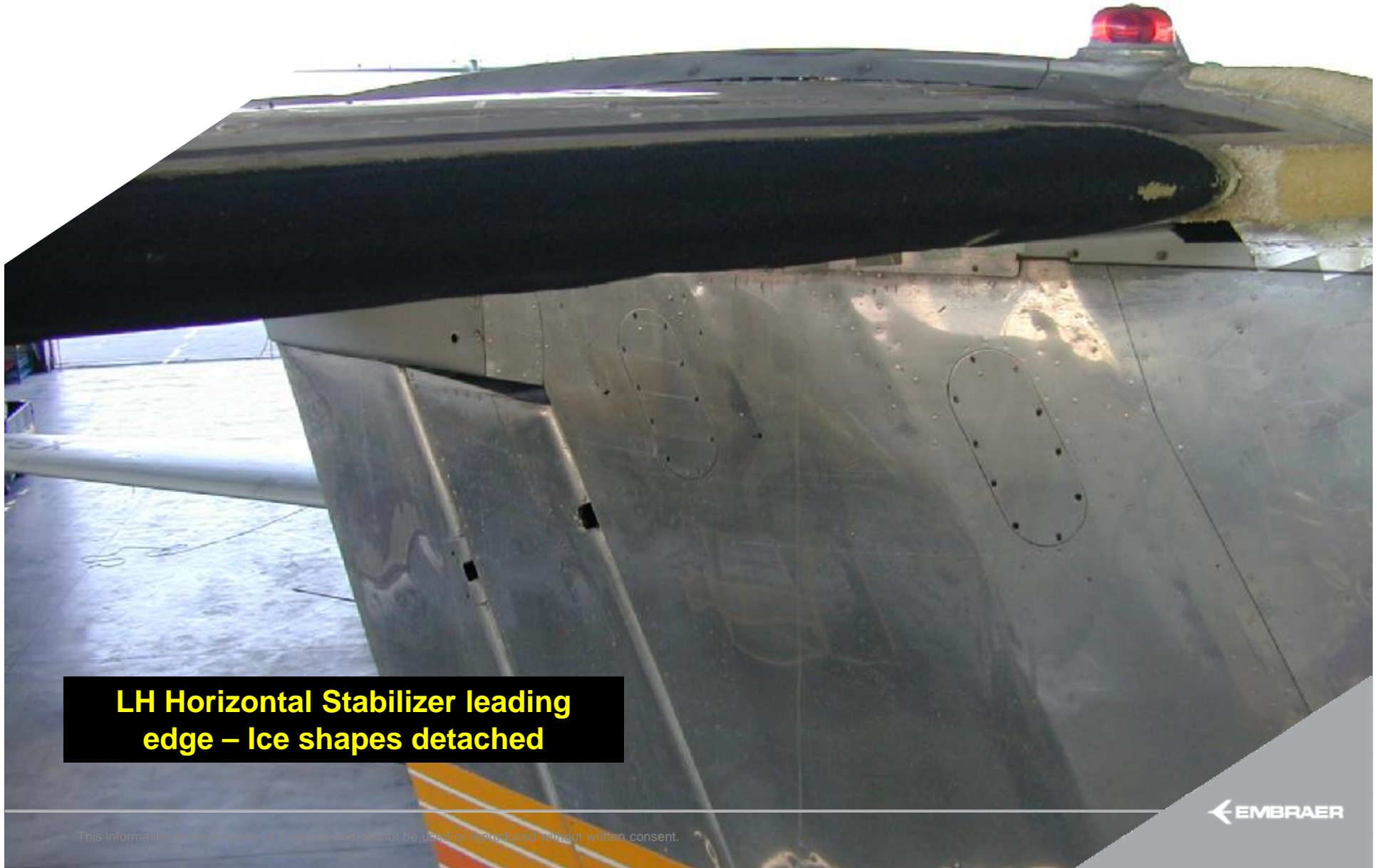


Analysis



RH Horizontal Stabilizer lower surface leading edge – Ice shapes detached

Analysis



LH Horizontal Stabilizer leading edge – Ice shapes detached

Analysis



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:

Ø Standardize the Safety Assessment Process (minimizing individual evaluation) – Ref.: FAA Order 4040.26



Ø Implement a Technical Review Board & Safety Committee

Ø Standardize the technical analysis and mitigations procedures applied to each and every test

Ø Correlate the test risk levels to the:

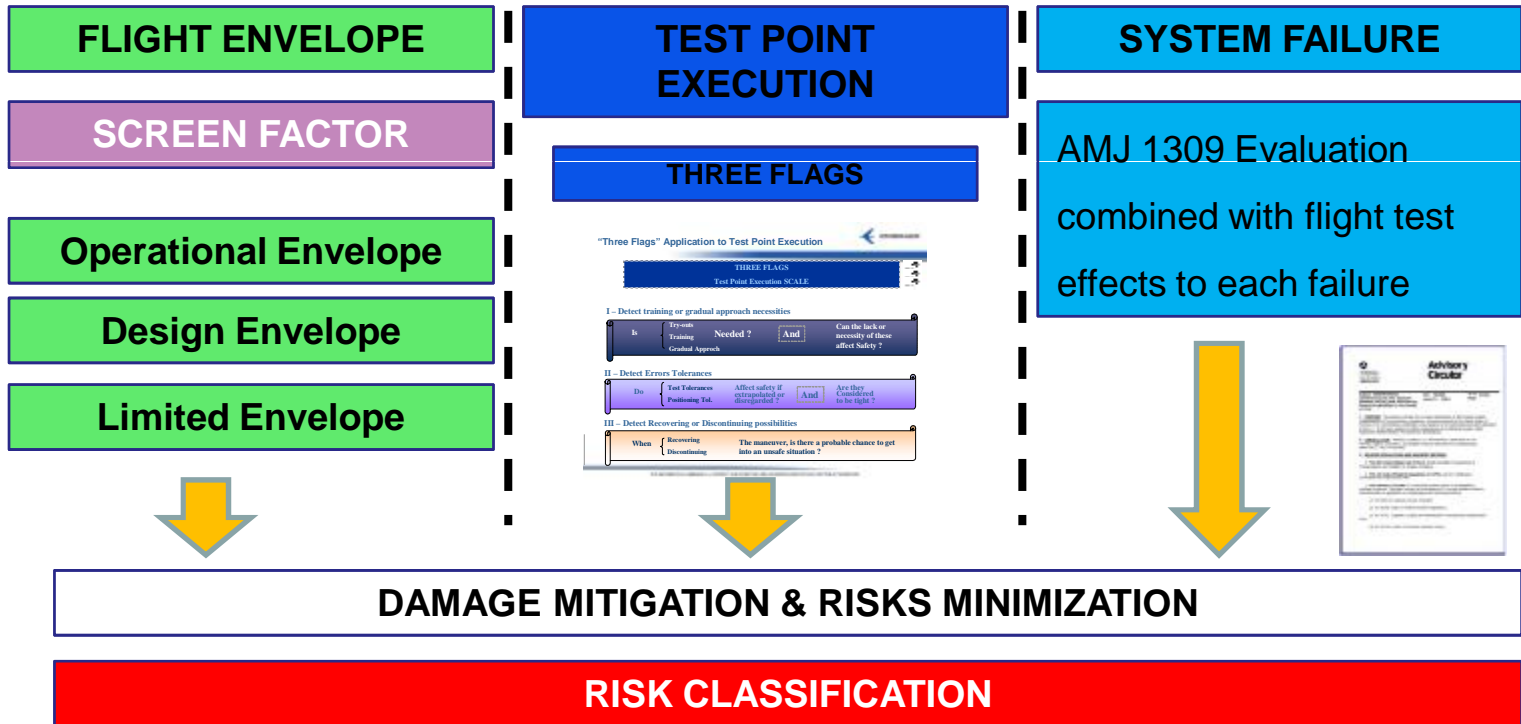
1. [Required crew experience;](#)
2. [Required meteorological conditions;](#)
3. [Required FTO review and approval levels;](#)
4. [Support and safety equipment.](#)



Organizational Changes

EMBRAER FLIGHT TEST RISK ASSESSMENT METHOD

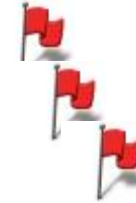
MANEUVER TO BE EXECUTED



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

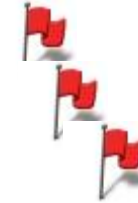
Hazardous or catastrophic effects might result from the proposed tests if predictions are incorrect?



Lessons Learned

“Three Flags” Application to Test Point Execution

THREE FLAGS Test Point Execution SCALE



I – Detect training or gradual approach necessity

Is	Try-outs Training Gradual Approach	Needed?	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 Discontinuing	The maneuver, is there a probable chance to get into an unsafe situation?		



Organizational Changes

Risk Classification	Experience (Years at FT activity)	Experience (Flight Hours)	Minimum Pilot Qualification Required
LOW	≥ 1	≥ 1.000	PPA3
MEDIUM	≥ 2	≥ 1.000	PPA2
HIGH	≥ 5	≥ 1.500	PPA1
1° FLIGHT	≥ 10	≥ 2.000	PPA1

Risk Classification	Experience (Years at FT activity)	Experience (Flight Hours)	FTE Qualification
LOW	-	≥ 10	C
MEDIUM	≥ 1	≥ 100	B
HIGH	≥ 3	≥ 200	A
1° FLIGH	≥ 5	≥ 500	A*

Risk Classification	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

FLIGHT TEST

Site Map: Approval Flow

Aircraft << Test >> Activities Ficsas Coordination Administration Preferences Permissions Help

FTO #52312 :: 550-001-00027 :: High Speed Taxi and Tail Chute Deployment

Test Order Aircraft Request Xfer Attach Crew Report Follow up **Approval Flow** Video Complementary Information

FTE and Pilot have already prepared this FTOR. You can

[Return FTOR to edit mode](#)

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

Approval Flow

User	On	Modified to
Eduardo Galdo Camelier	19/Mar/2012 16:12	Crew Prepared: FTOR(-)
Ramiro Teodoro Silveira	19/Mar/2012 16:07	FTE Prepared
Ramiro Teodoro Silveira	19/Mar/2012 13:54	Uploaded
Alexandre Villaça Garcia de Figueiredo	15/Mar/2012 17:07	FTO Approved
Roberto Becker	15/Mar/2012 17:06	FTO Waiting Pilot Approval
Guilherme Monteiro Da Silva	15/Mar/2012 16:49	FTO Modified

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
- ...



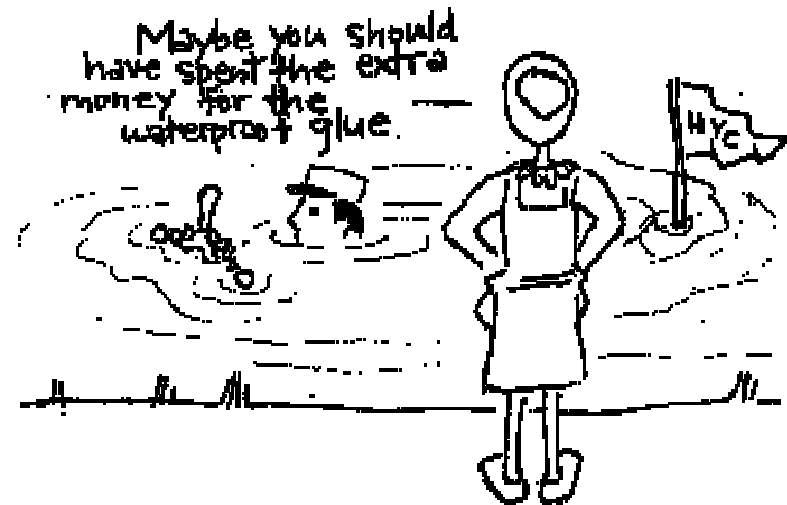
Lessons Learned



- ∅ 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

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



Organization Safety – Actual Status

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



“Hard work conquers all”

LOONEY TUNES

Questions ?



“That’s all Folks!”

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Thank You !



FOR THE JOURNEY

