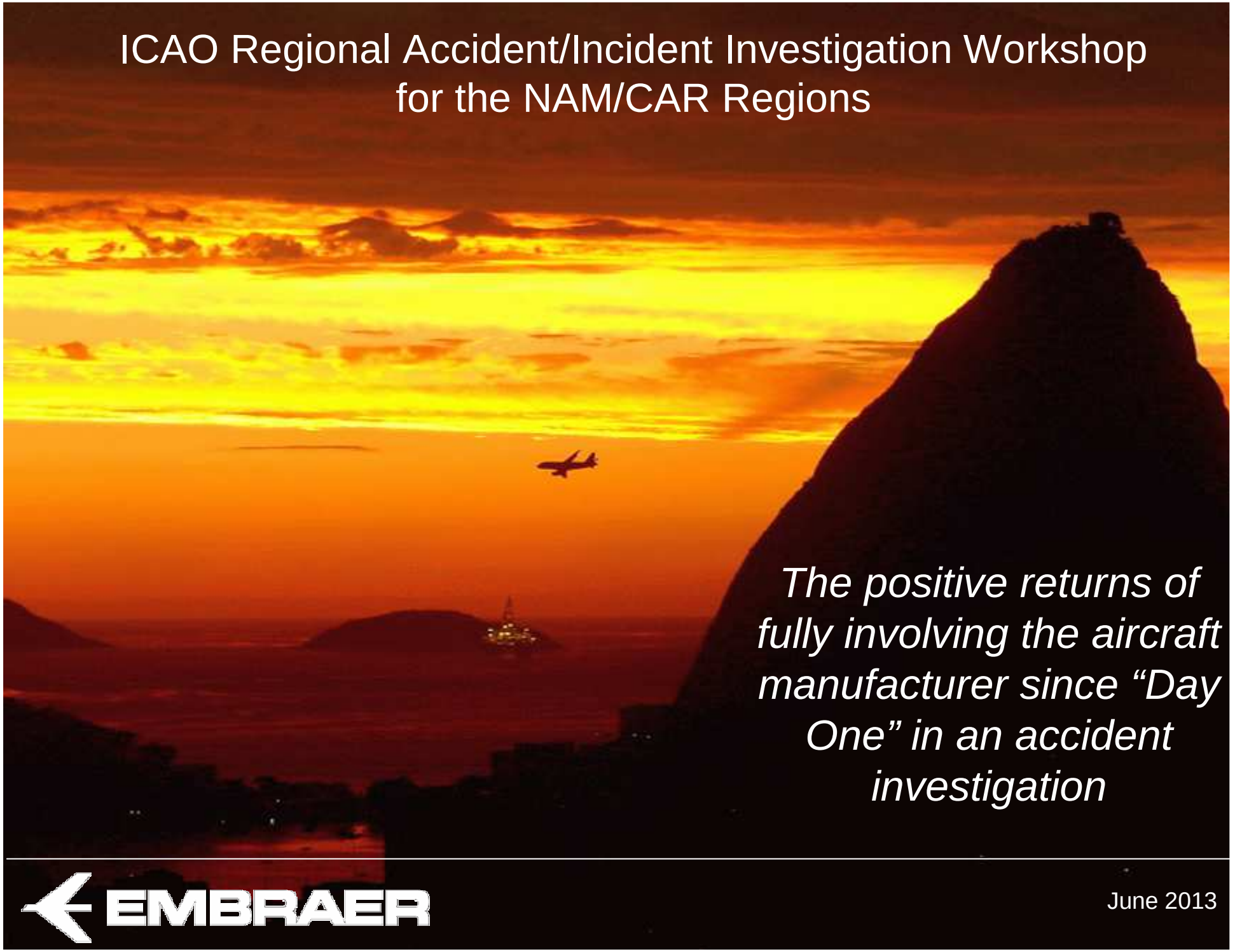
ICAO Regional Accident/Incident Investigation Workshop for the NAM/CAR Regions



The positive returns of fully involving the aircraft manufacturer since “Day One” in an accident investigation

EMBRAER

June 2013

The positive returns of fully involving the aircraft manufacturer since “Day One” in an accident investigation

Objective and Outline:

To provide the audience with an overview on the positive returns of fully involving the aircraft manufacturer in an accident investigation.

Topics

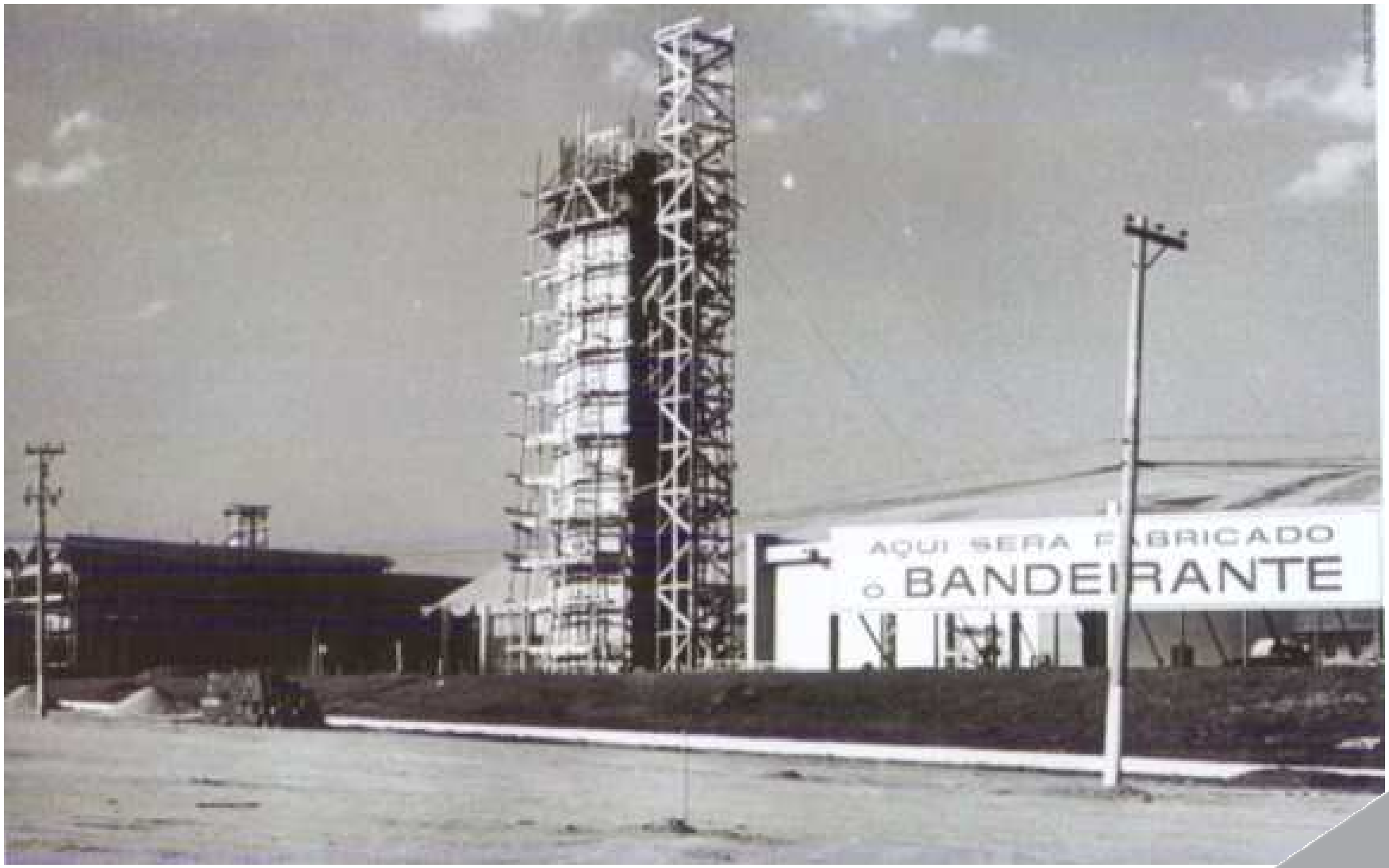
- Embraer at a glance;
- The Continuing Airworthiness process requirements;
- The Manufacturer responsibilities regarding its products during their lifetime to keep the fleet flying safely;
- How Embraer is prepared to assist the investigations conducted by the national authorities;

Topics

- **Embraer at a glance;**
- The Continuing Airworthiness process requirements;
- The Manufacturer responsibilities regarding its products during their lifetime to keep the fleet flying safely;
- How Embraer is prepared to assist the investigations conducted by the national authorities;

The EMB-110 Bandeirante Prototype at CTA - 1969

02 January 1970: the birth of EMBRAER



The first EMBRAER Product – EMB-110 Bandeirante - 1973

The first EMBRAER Product – EMB-110 Bandeirante - 1973

19 October, 1976 (and still flying)

ANAC

AGÊNCIA NACIONAL DE AVIAÇÃO CIVIL - BRASIL

CERTIFICADO DE TIPO
(Type Certificate)

AERONAVE (AIRCRAFT)

NÚMERO: **7202**
(Number)

Este Certificado, emitido com base na Lei 7565 "Código Brasileiro de Aeronáutica", de 19 de dezembro de 1986, é conferido
(This Certificate, issued in the basis of the Law 7565 "Código Brasileiro de Aeronáutica", dated 19 December 1986, is granted to

EMPRESA BRASILEIRA DE AERONÁUTICA S.A.

por ter o projeto de tipo do produto abaixo citado satisfeito às condições de aeronavegabilidade do Regulamento Brasileiro da Aviação
for having the type design of the product mentioned below met the airworthiness requirements of the "Regulamento Brasileiro da Aviação

Civil RBHA nº 1340 desde que sejam observadas as limitações operacionais e demais condições prescritas neste regulamento e
Civil" RBHA No. provided are not exceeded the operational limitations and other conditions prescribed in the Regulation and

na Especificação de **AERONAVE (AIRCRAFT)** No. **EA-7202-15**
in the Type Certificate Data Sheet No.

Modelos (Models): **EMB - 110 (FAB), EMB - 110 C**

Este Certificado e a respectiva Especificação de **AERONAVE (AIRCRAFT)** do qual faz parte serão válidos até que
(This Certificate and its Type Certificate Data Sheet which is a part hereof shall remain in effect until

sejam cancelados por devolução, suspensos, revogados ou um prazo limite seja estabelecido pela Agência Nacional de Aviação Civil.
surrendered, suspended, revoked or a termination date is otherwise established by the Agência Nacional de Aviação Civil.)

Data do Pedido de Certificação: **06 de fevereiro de 1976**
(Date of Application) (February)

Revisado em **29 de setembro de 2010**
(Revised on) (September)

Data de Emissão: **19 de outubro de 1976**
(Date of Issuance) (October)

HÉLIO TARQUÍNIO JÚNIOR
Gerente-Geral Substituto, Certificação de Produto Aeronáutico
(Acting Manager, Aeronautical Product Certification)

DINO ISHIKURA
Superintendente de Aeronavegabilidade
(Airworthiness Superintendent)

F-200-01J (04.10)

Este Certificado poderá ser transferido, porém uma notificação deverá ser enviada à ANAC
(This Certificate may be transferred, but a notification must be sent to ANAC)

WE HAVE DEVELOPED OUR BUSINESS IN THE AREAS OF:

COMMERCIAL AVIATION

EXECUTIVE AVIATION

EMBRAER DEFENSE & SECURITY

WE ARE HERE TO SERVE **OUR CUSTOMERS**

COMMERCIAL AVIATION

Regional Jets

ERJ 135	ERJ 140	ERJ 145	ERJ 145 XR
37 seats range*: 1,750 nm LR version Cruise 0.78 M	44 seats range*: 1,650 nm LR version Cruise 0.78 M	50 seats range*: 1,550 nm LR version Cruise 0.78 M	50 seats range*: 2,000 nm XL version Cruise 0.80 M

* Single-class configuration: pitch 31” - FAR domestic reserves (45 min) + alternate of 100 nm; 91 kg (200 lb) per pax and 76 kg (168 lb) per crew member

E-Jets

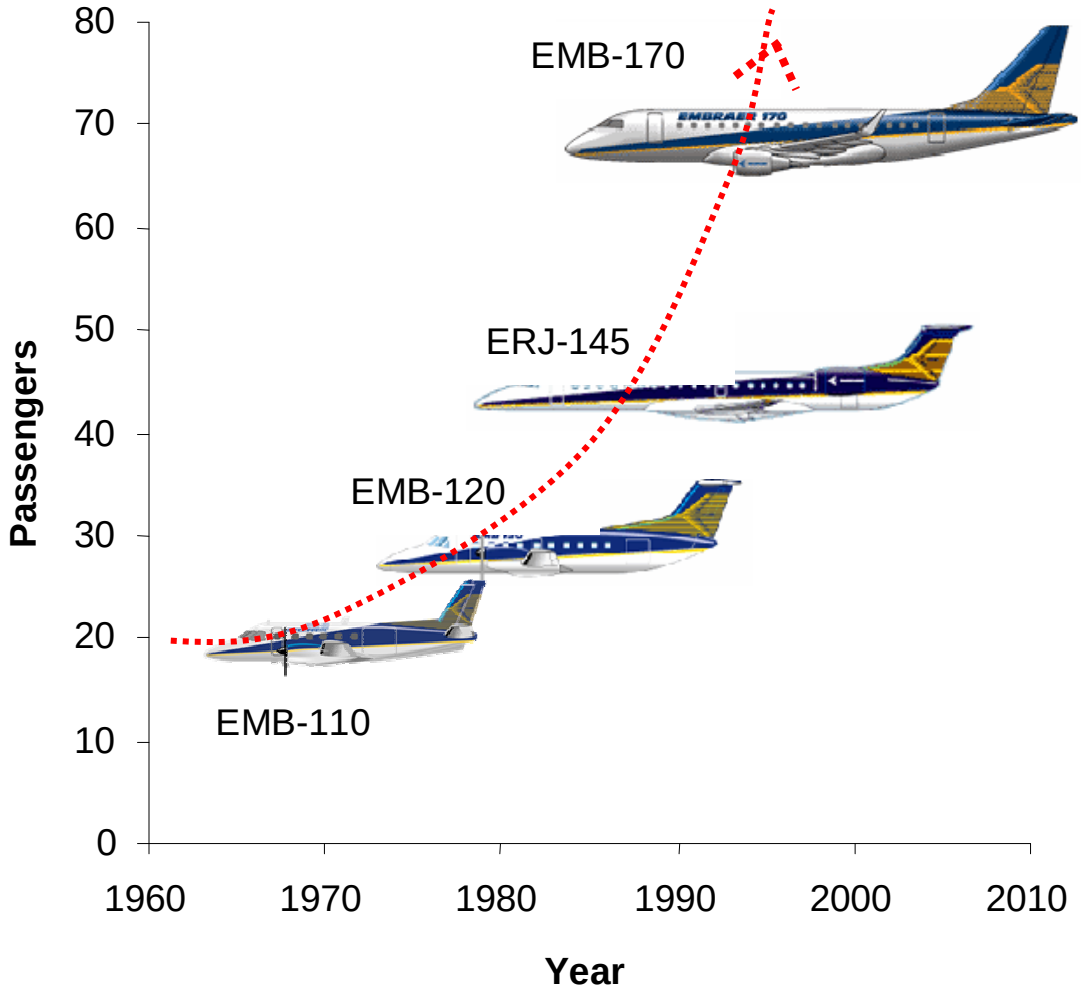
EMBRAER 170	EMBRAER 175	EMBRAER 190	EMBRAER 195
70 to 78 seats range*: 2,100 nm	78 to 88 seats range*: 2,000 nm	98 to 114 seats range*: 2,400 nm	108 to 124 seats range*: 2,200 nm

* AR Version, single-class configuration: pitch 32”- Long-Range Cruise, FAR domestic reserves (45 min) + alternate of 100 nm; 100 kg (220 lb) per pax and 80 kg (176 lb) per crew member.


BRITISH AIRWAYS
ba.com
EMBRAER

Embraer Products – Evolution Timeline

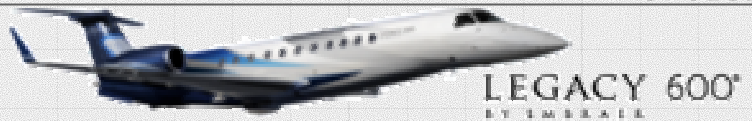
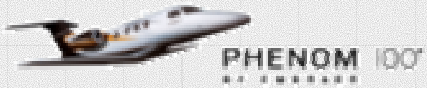
Embraer has produced aircraft from small GA to large commercial jets, currently operating in the five continents.



Commercial Jets

* Schedule and non-schedule companies, and only E-Jets and ERJ families

EXECUTIVE AVIATION

Ultra-Large	
Ultra-Long Range	
Large	
Super Mid-Size	
Mid-Size	
Mid-Light	
Light	
Entry	

Prototype Flying

EXECUTIVE AVIATION

MORE THAN **600** AIRCRAFT DELIVERED
IN OVER **45** COUNTRIES

January/2013


WE ARE HERE TO SERVE **OUR CUSTOMERS**
EMBRAER DEFENSE AND SECURITY
EMBRAER

EMBRAER DEFENSE AND SECURITY

Intelligence, Surveillance and Reconnaissance (ISR) Systems

EMB 145 AEW&C / MP / Multi-Intel

Light Attack and Advanced Training

Super Tucano

Tactical Military Transport

KC-390

Transport of Authorities

Aircraft Modernization

Unmanned Aerial Vehicle (UAV)

EMBRAER DEFENSE AND SECURITY

EMBRAER DEFENSE AND SECURITY

OVER **50** ARMED FORCES IN **48** COUNTRIES

Note: Except undisclosed customers

January/2013

Regional
General Aviation
Agricultural

EMBRAER

Topics

- Embraer at a glance;
- **The Continuing Airworthiness process requirements;**
- The Manufacturer responsibilities regarding its products during their lifetime to keep the fleet flying safely and customers satisfied;
- How Embraer is prepared to assist the investigations conducted by the national authorities.

What is Airworthiness?

What is Airworthiness ?

b. Airworthy. *To be Airworthy:*

(1) The aircraft must conform to its Type Certificate (TC). *Conformity to type design is considered attained when the aircraft configuration and the components installed are consistent with the drawings, specifications, and other data that are part of the TC and would include any Supplemental Type Certificate (STC) and field approved alterations incorporated into the aircraft.*

(2) The aircraft must be in a condition for safe operation. *The condition of the aircraft relative to wear and deterioration (e.g., skin corrosion, window delamination/crazing, fluid leaks, tire wear, etc.) must be acceptable.*

(FAA AC 120-77)

What is Continuing Airworthiness ?

Continuing Airworthiness *- all of the processes ensuring that, at any time in its life, an aeroplane complies with the technical conditions fixed to the issue of the Certificate of Airworthiness and is in a condition for safe operation*

ICAO Document No 9713 – 1998

What is Continuing Airworthiness ?

AD Issuance

The Aviation Administration that provides the Type Certificate of an airplane issues an AD when an **unsafe condition** is found to exist in a product and the condition is likely to exist or develop in other products of the same type design.

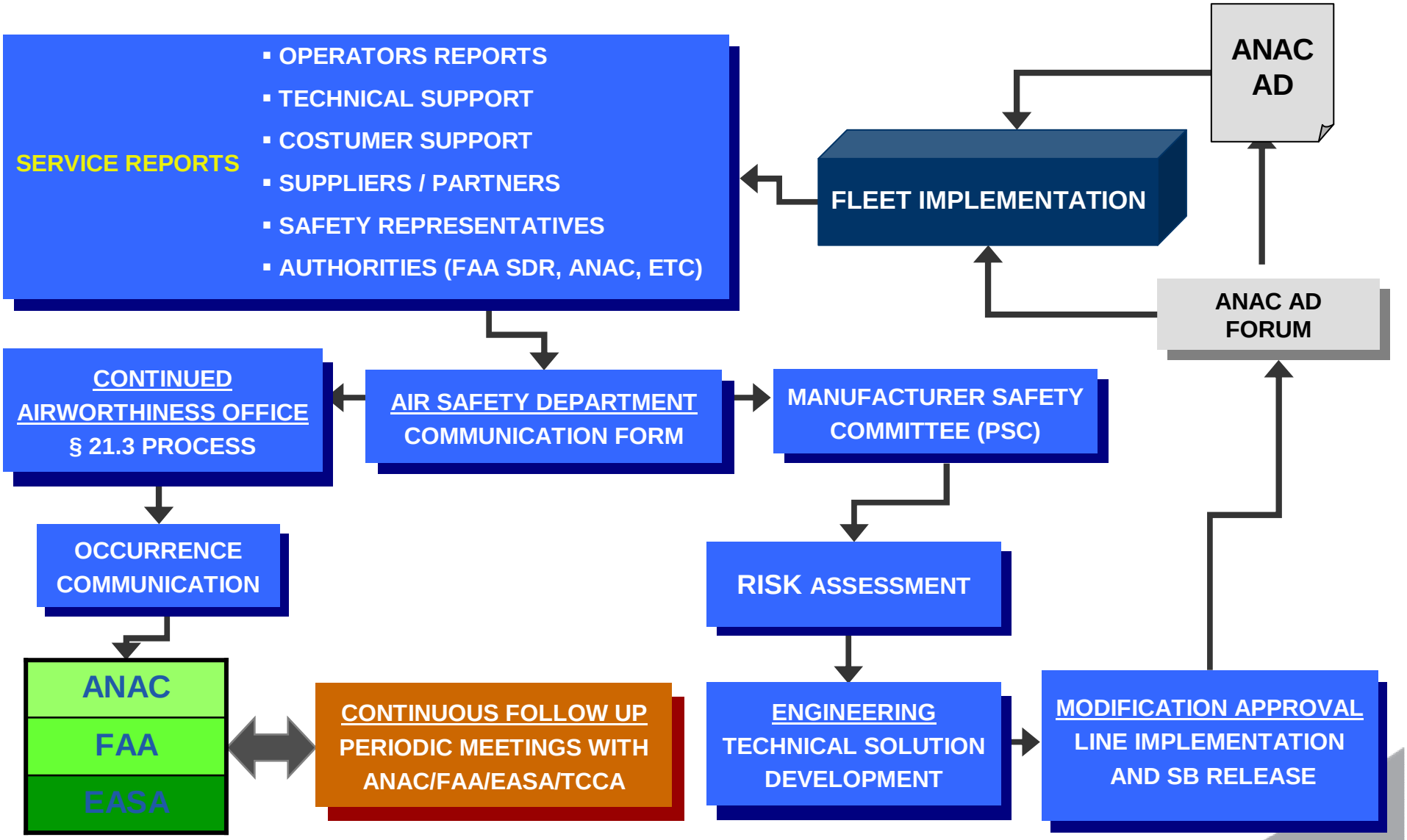
ADs are used to notify aircraft owners and operators of unsafe conditions and the **actions required to resolve** those conditions.

What is Continuing Airworthiness ?

Continuing Airworthiness at EMBRAER:

- Occurrence Reporting to Aviation Authorities
- Follow-up of all in-service difficulties
- Relevant issues identification
- Taking part in the technical discussion related to continuing airworthiness, including risk analyses
- Managing the approval process for the technical solutions safety-related
- Monitoring the AD and NPRM processes
- Follow-up the efficacy of the solutions in operation.

Continuing Airworthiness Process Workflow



The Airworthiness Directives Process

ANAC ADs

ANAC
AGÊNCIA NACIONAL DE AVIAÇÃO CIVIL – BRAZIL

BRAZILIAN AIRWORTHINESS DIRECTIVE

AD No.: 2010-10-01 Effective Date: 27 Oct. 2010

The following Brazilian Airworthiness Directive (AD), issued by the Agência Nacional de Aviação Civil (ANAC) in accordance with provisions of Chapter IV, Title III of Código Brasileiro de Aeronáutica – Law No. 7,565 dated 19 December 1986 – and Regulamento Brasileiro de Homologação Aeronáutica (RBHA) 39, applies to all aircraft registered in the Registro Aeronáutico Brasileiro. No person may operate an aircraft to which this AD applies, unless it has previously complied with the requirements established herein.

AD No. 2010-10-01 - EMBRAER - Amendment 39-1322.

APPLICABILITY:

This Airworthiness Directive (AD) applies to Embraer Model ERJ 170-100 LR, ERJ 170-100SE, ERJ 170-100 STD, ERJ 170-100 SU, ERJ 170-200 LR, ERJ 170-200 STD and ERJ 170-200 SU airplanes; all serial numbers.

NOTE 1: This AD requires revisions to certain operator maintenance documents to include new inspections tasks or modification of existing ones and its respective thresholds and intervals. Compliance with these inspections is required by Regulamento Brasileiro de Homologação Aeronautica – RBHA 91.403(c). For airplanes that have been previously modified, altered, or repaired in the areas addressed by these inspections, the operator may not be able to accomplish the described inspections. In this situation, to comply with RBHA 91.403(c), the operator must request approval for an alternative method of compliance. The request should include a description of changes to the required inspections that will ensure the continued operational safety of the airplane. An alternative method of compliance or adjustment of the compliance time that provides an acceptable level of safety may be used if approved by the Manager, Product Certification Branch (GGCP).

CANCELLATION / REVISION:

Not applicable.

REASON:

During the airplane full scale fatigue test, cracks were found in some structural components of the airplane. Analysis of these cracks resulted in modifications on the Airworthiness Limitation Section (ALS) of Embraer ERJ 170 Maintenance Review Board Report (MRBR), to include new inspections tasks or modification of the current ones and its respective thresholds and intervals.

Failure to inspect these structural components, according to the new or revised tasks, thresholds and intervals, could prevent a timely detection of fatigue cracking. These cracks, if not properly addressed, could adversely affect the structural integrity of the airplane.

Since this condition may occur in other airplanes of the same type and affects flight safety, a corrective action is required. Thus, sufficient reason exists to request compliance with this AD in the indicated time limit.

REQUIRED ACTION:

Revision of the Airworthiness Limitations Section (ALS) of the Instructions for Continued Airworthiness (ICA) to incorporate new and/or modified structural inspections.

COMPLIANCE:

Required as indicated below, unless already accomplished.

Within 60 days after the effective date of this AD, revise the ALS of the ICA to incorporate the new or revised tasks specified in Appendix A, Part 2, Airworthiness Limitations

Form F-900-04E

ANAC AD accepted or endorsed by other validation authorities.

Transport Canada

CAAC

Once an ANAC AD is issued, FAA starts the NPRM process.

[Federal Register Volume 76, Number 45 (Tuesday, March 8, 2011)]
[Rules and Regulations]
[Pages 12556-12558]
From the Federal Register Online via the Government Printing Office [www.gpo.gov]
[FR Doc No: 2011-5292]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 39

[Docket No. FAA-2011-0157; Directorate Identifier 2010-NM-261-AD; Amendment 39-16630; AD 2011-04-09]

RIN 2120-AA64

Airworthiness Directives; Various Transport Category Airplanes Equipped With Chemical Oxygen Generators Installed in a Lavatory

AGENCY: Federal Aviation Administration (FAA), Department of Transportation (DOT).

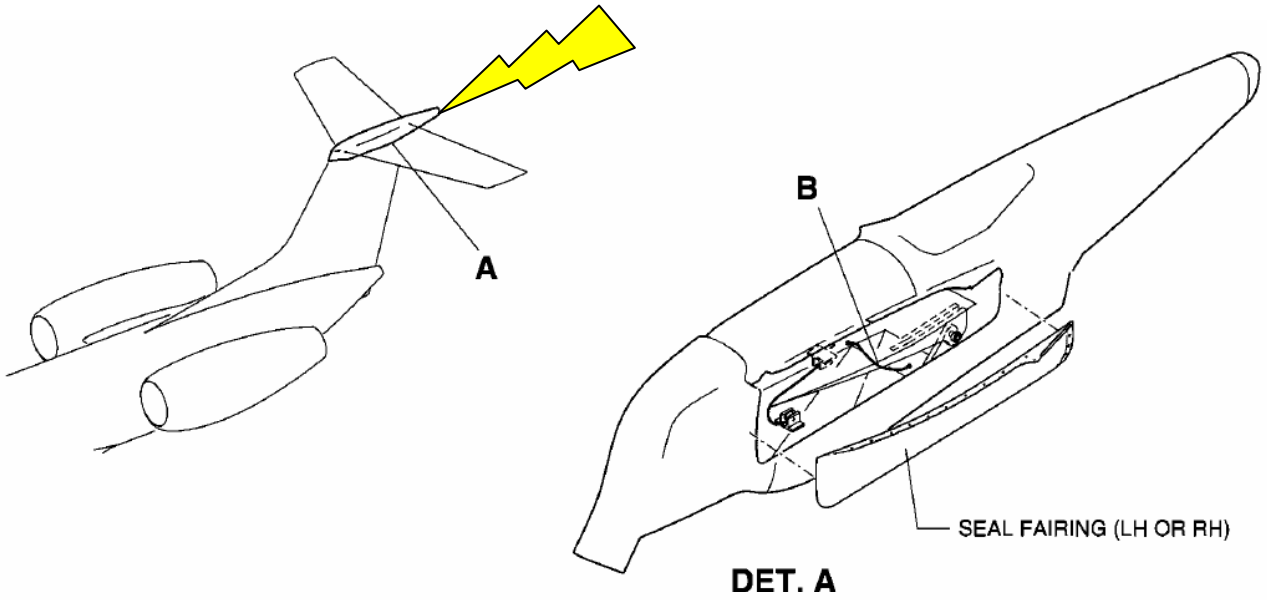
ACTION: Final rule; request for comments.

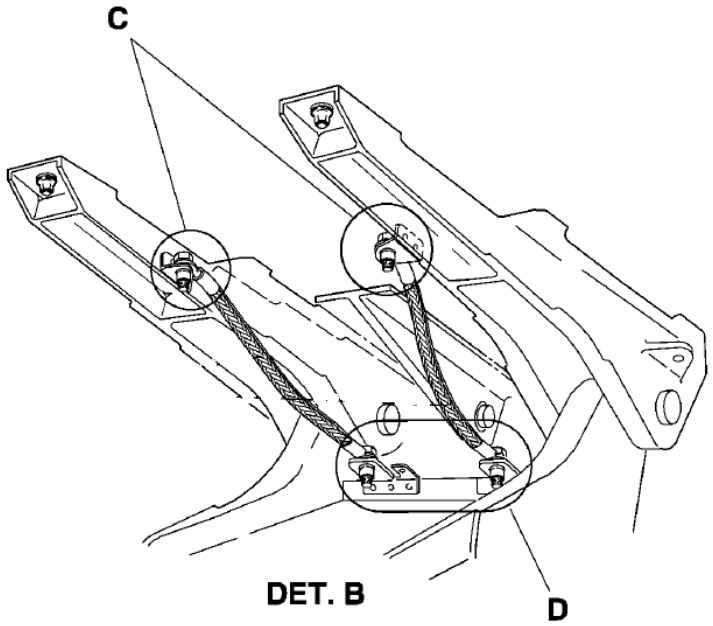
Service Difficulties Meeting process results

- 29 Service Difficulties Meetings for EMB-120/EMB-145 since 2001
- 19 Service Difficulties Meetings for ERJ 170/ERJ 190 since 2004
- ANAC, FAA, EASA and TCCA attendance
- Discussion and follow up of all relevant items.

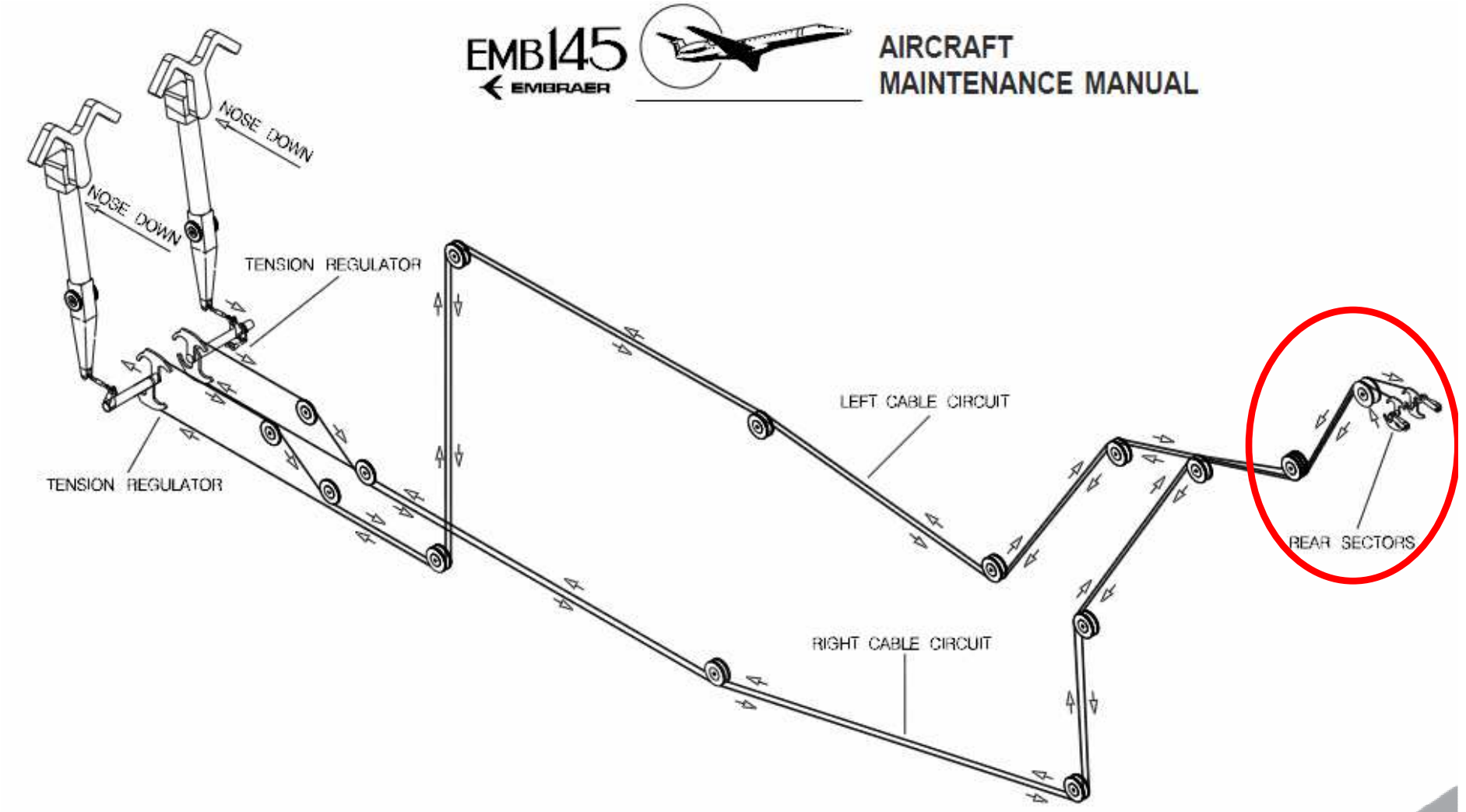
Example: Elevator control cable damage due to lightning strike

Closing the Loop - Service Difficulties



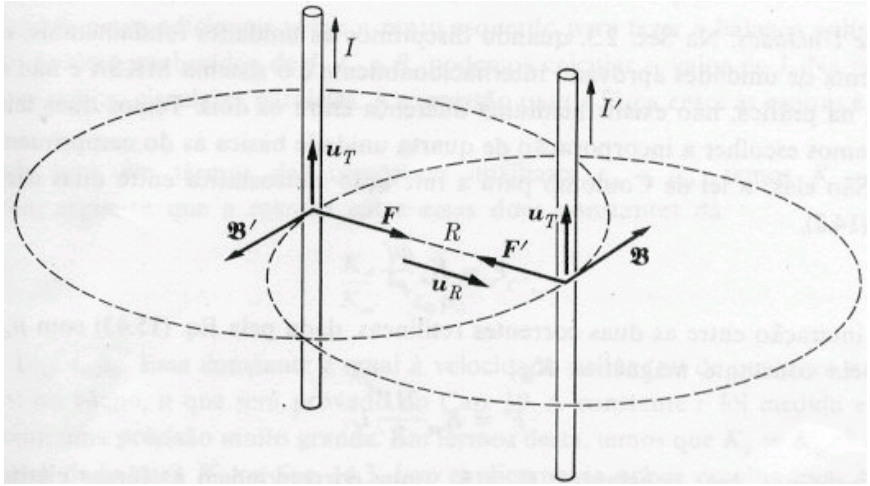


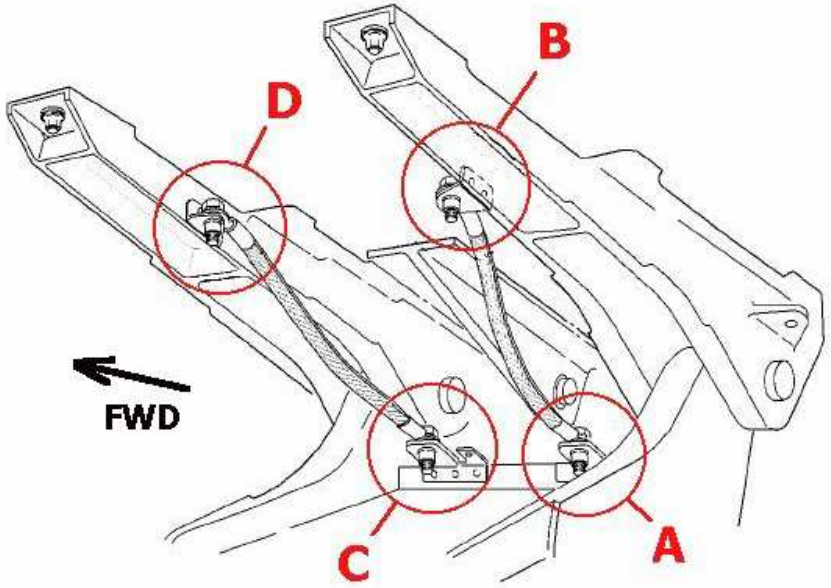
Closing the Loop - Service Difficulties



Closing the Loop - Service Difficulties

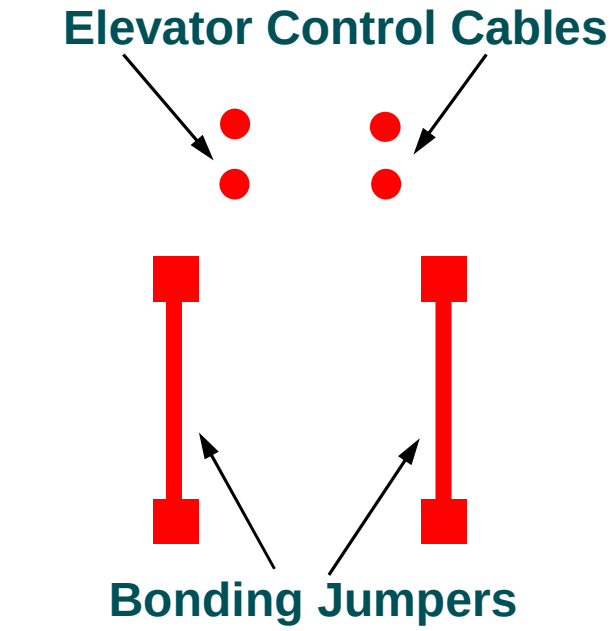
Bonding jumper terminal with traction damage

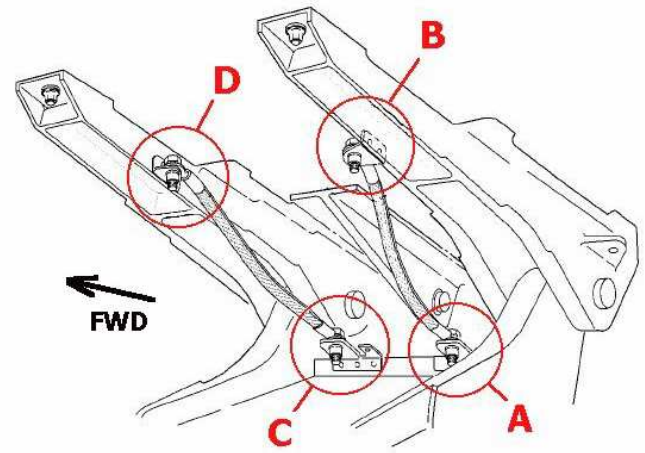


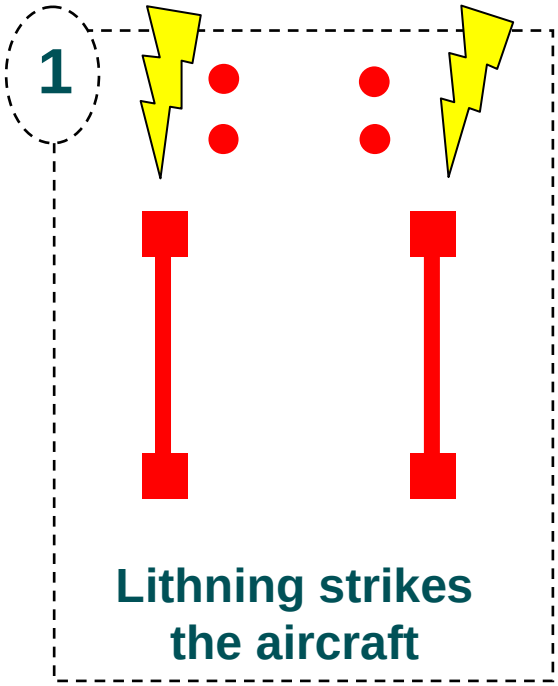


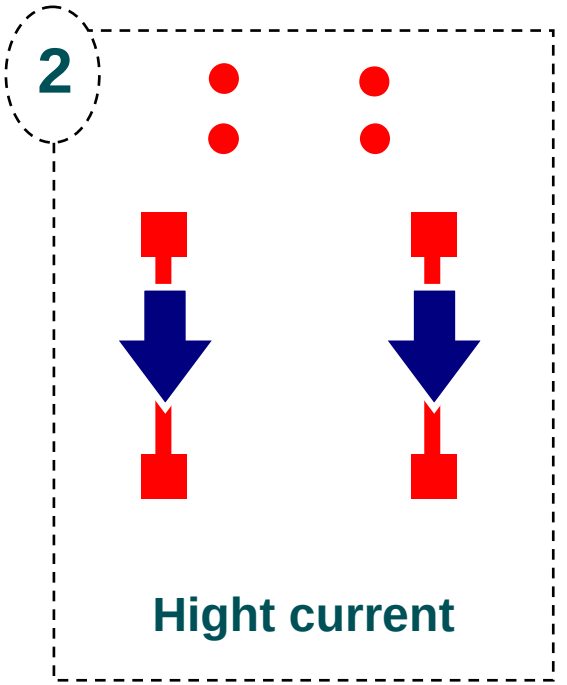
$$\vec{F} = -\vec{\mu}_R \frac{\mu_0 \vec{I}\,\vec{I}'}{2R\pi} L'$$

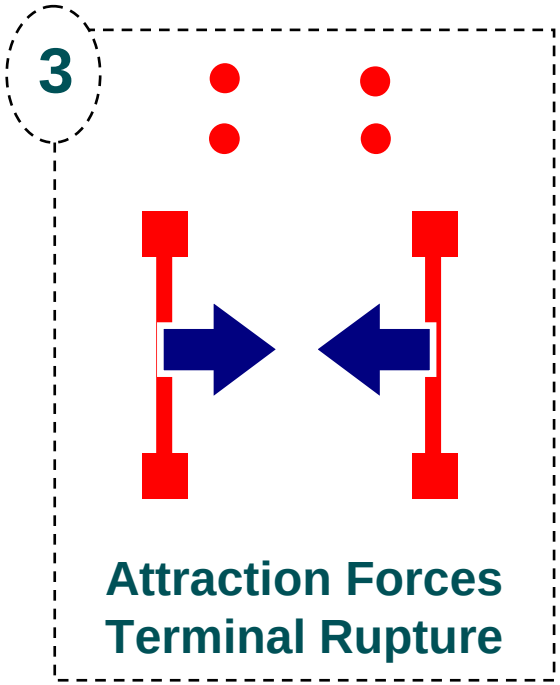
Example

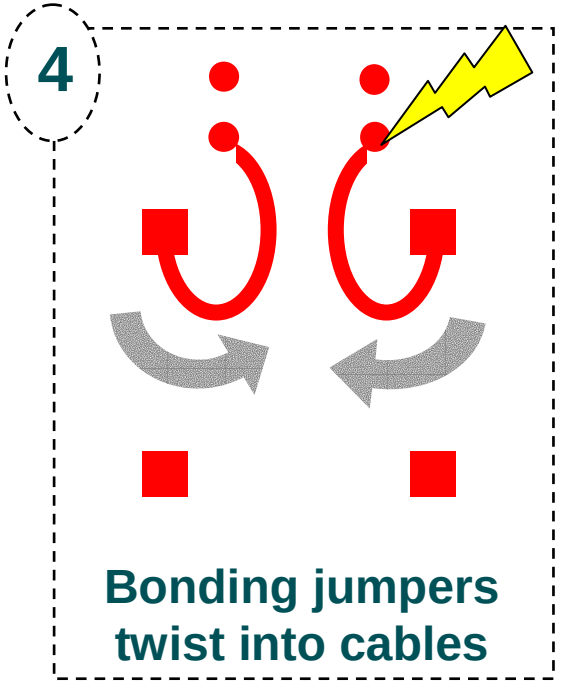

Elevator Control Cables
Bonding Jumpers


B
D
FWD
C
A


1
Lithning strikes
the aircraft

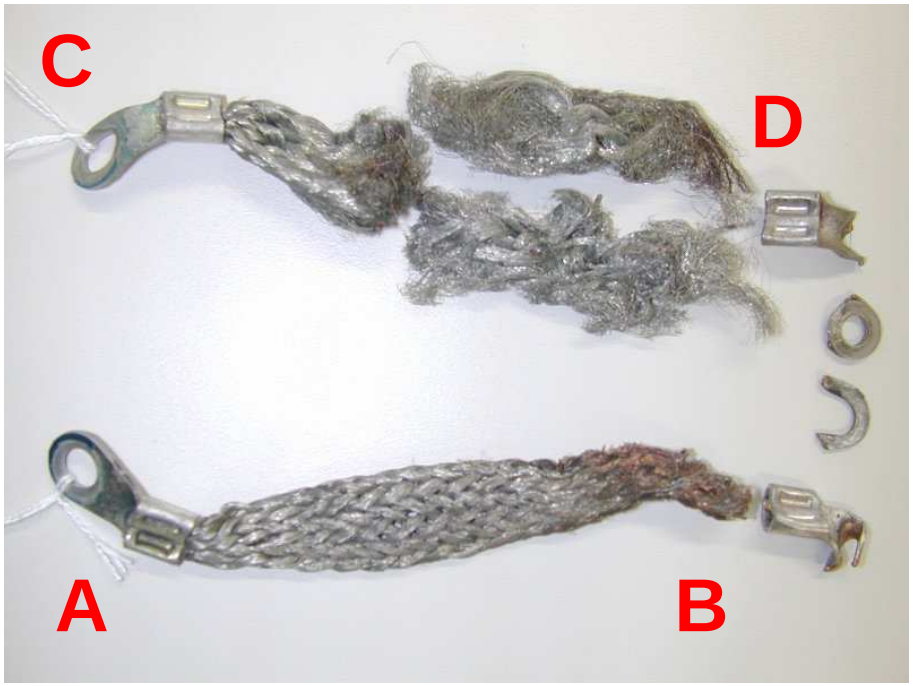

2
Hight current

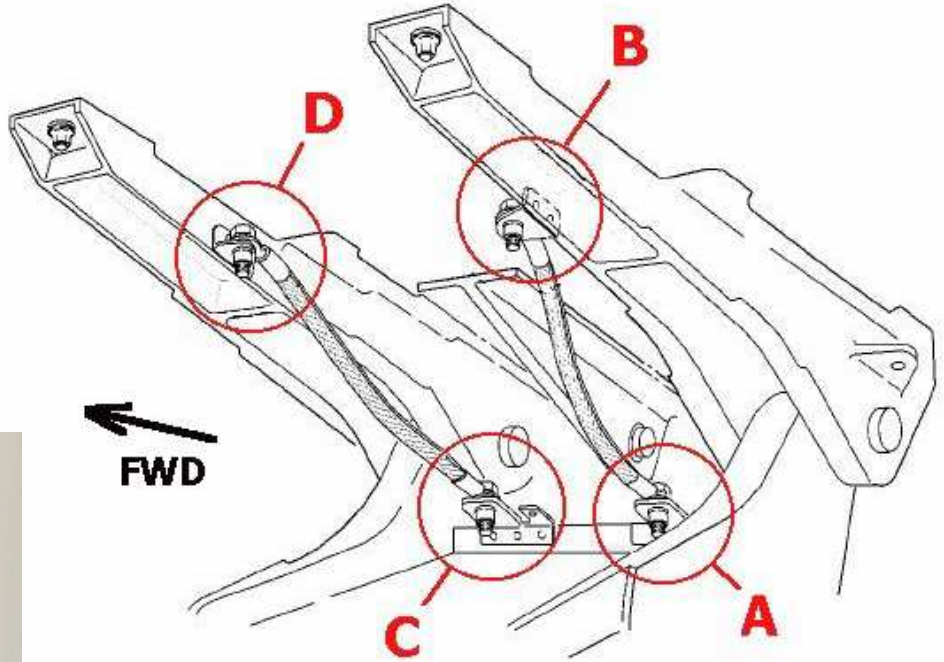

3
Attraction Forces
Terminal Rupture


4
Bonding jumpers
twist into cables

Closing the Loop - Service Difficulties

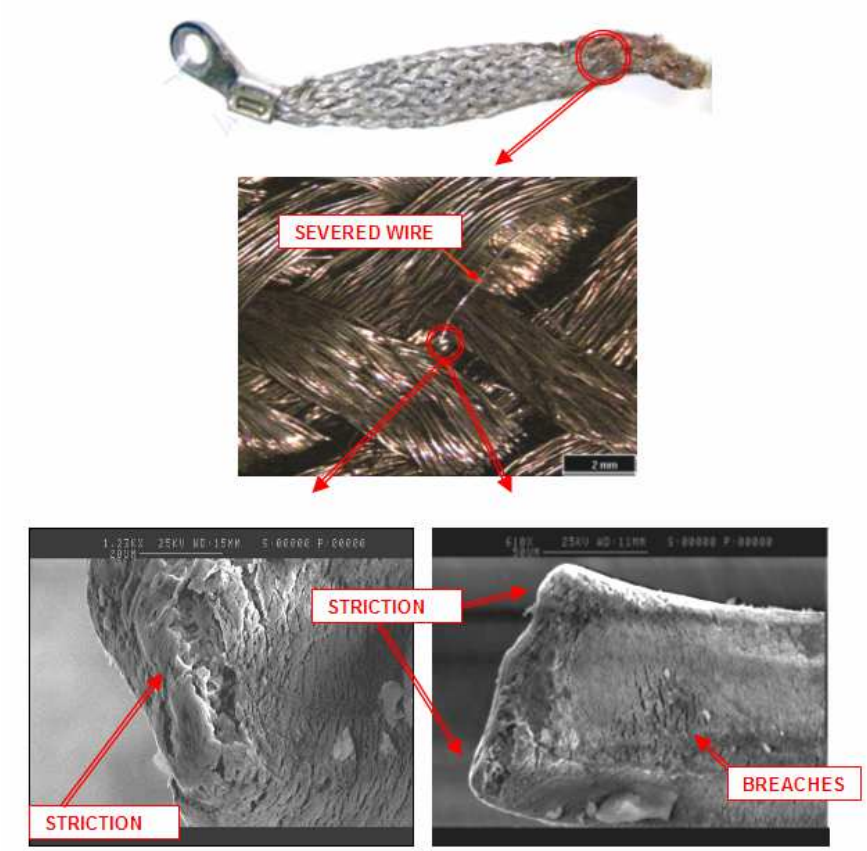
Bonding Jumpers Damage





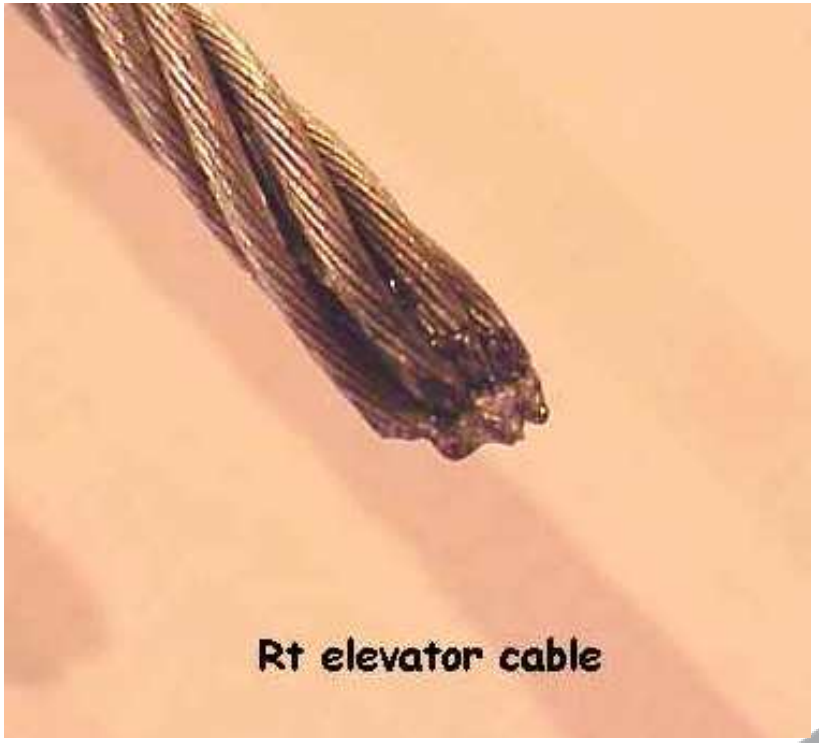
Service Difficulties Meeting process results

Bonding Jumpers Damage



Closing the Loop - Service Difficulties

Cable Damage



Closing the Loop - Service Difficulties

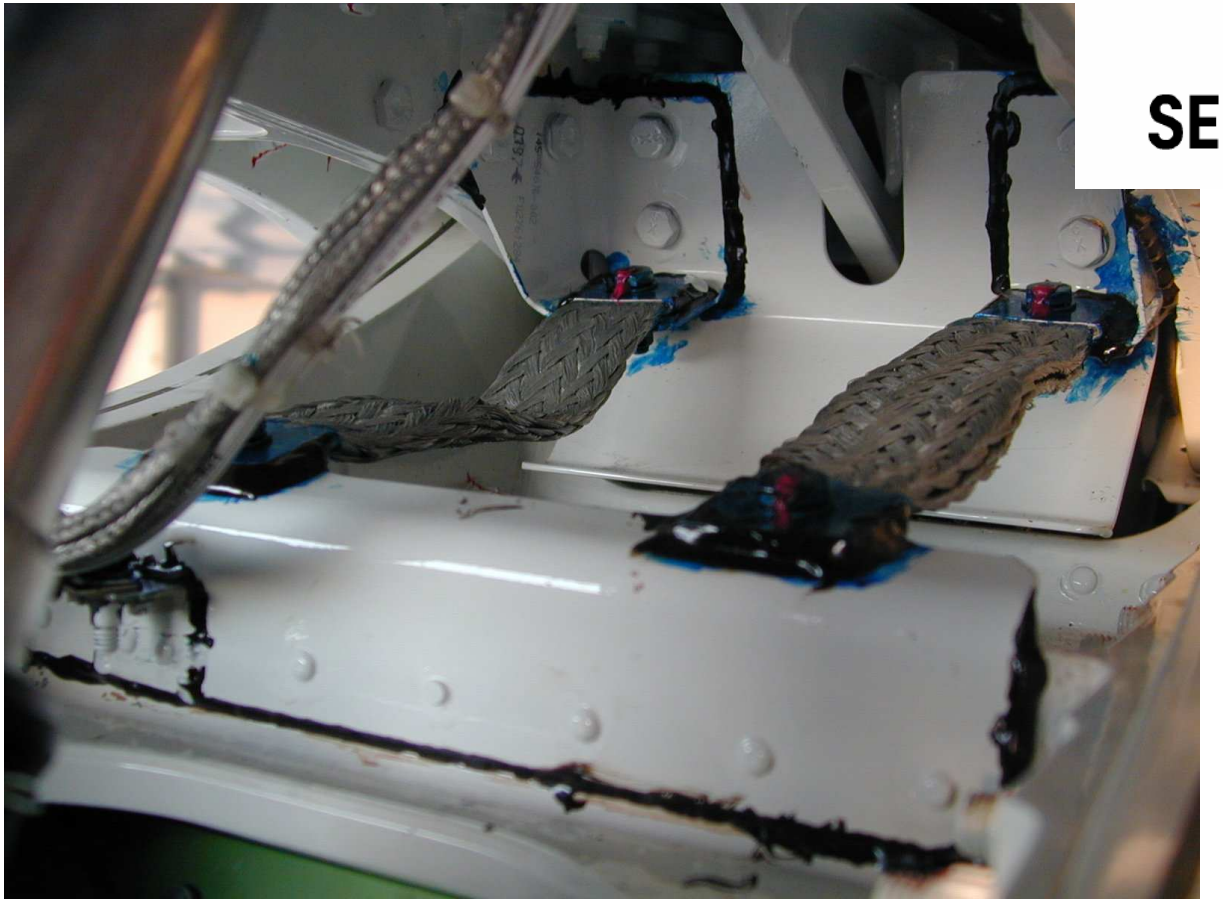
Solution: Service Bulletin 145-55-0028 (Mandatory)

DAC AD: 2001-06-03R2

EMPRESA BRASILEIRA DE AERONÁUTICA S/A - S.JOSÉ DOS CAMPOS - SP

EMBRAER

SERVICE BULLETIN



Topics

- Embraer at a glance;
- The Continuing Airworthiness process requirements;
- **The Manufacturer responsibilities regarding its products during their lifetime to keep the fleet flying safely;**
- How Embraer is prepared to assist regionally-wise the investigations conducted by the national authorities;
- Brief examples.

Manufacturer Responsibilities & Product Safety

To start coordinating technical expertise for the investigation action upon learning of an **aircraft accident involving its product:**

- Contacting the airline involved, through the Technical Support area
- Contacting the official agency through the Regional Air Safety office, offering assistance
- Contacting the country's investigation agency to recommend appointment of the Accredited Representative and Advisors (ICAO Annex 13)
- Put in action the **Crisis Plan**
- Defining Go-Team members to travel to the site
- To provide updates to headquarters on the related circumstances.

Manufacturer Responsibilities & Product Safety

If a safety issue is identified, the company will act to Close-the-Loop:

- Closing-the-Loop: a Flight Safety issue coordination action:
  - Accident Investigation Team and the Air Safety Department
  - Engineering, Design, Program
  - Drafting, review of SBs, OBs, FOLs, etc.
  - Technical support to implement the actions
  - Product Integrity contacting the certification authorities for mandating actions.

Manufacturer Responsibilities & Product Safety

Will take immediate corrective action upon learning of an aircraft system malfunction or failure and issue warnings to users:

- Reports to Operators
  - Operator Bulletins
  - Flight Operators Support Letters
- New Airworthiness Directives
- Service Bulletins
- Revisions to AFMs/MMs

Topics

- Embraer at a glance;
- The Continuing Airworthiness process requirements;
- The Manufacturer responsibilities regarding its products during their lifetime to keep the fleet flying safely;
- **How Embraer is prepared to assist the investigations conducted by the national authorities;**

Topics

- **How Embraer is prepared to assist the investigations conducted by the national authorities;**

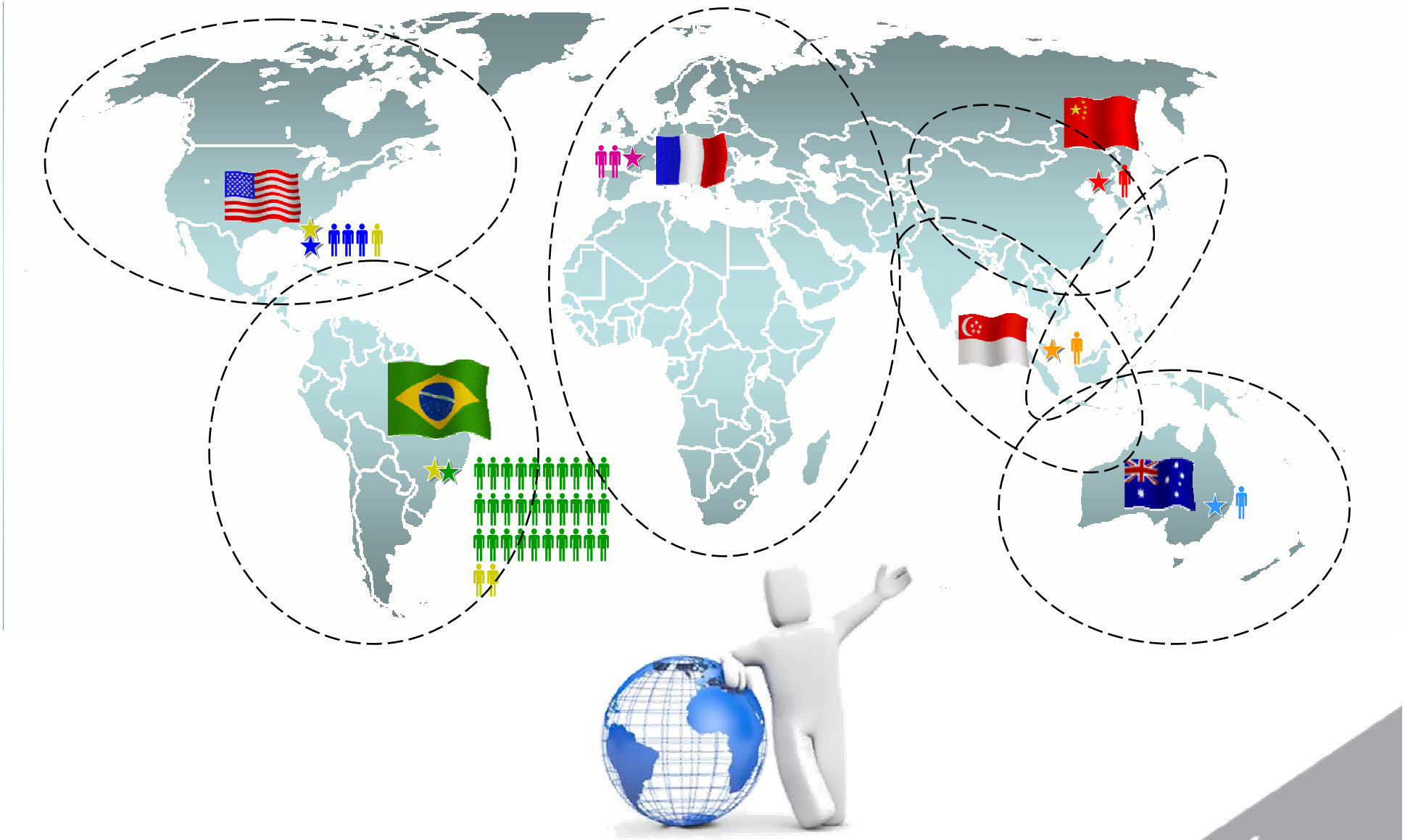
Topics

- **How Embraer is prepared to assist the investigations conducted by the national authorities;**
  - The Embraer air safety team
  - The interface with CENIPA and other authorities
  - The initial action on crash site
  - The challenge of the aircraft growing complexity
  - The challenge of software investigation
  - The Embraer resources for investigations

Topics

- How Embraer is prepared to assist the investigations conducted by the national authorities;
- **The Embraer air safety team**
- The interface with CENIPA and other authorities
- The initial action on crash site
- The challenge of the aircraft growing complexity
- The challenge of software investigation
- The Embraer resources for investigations

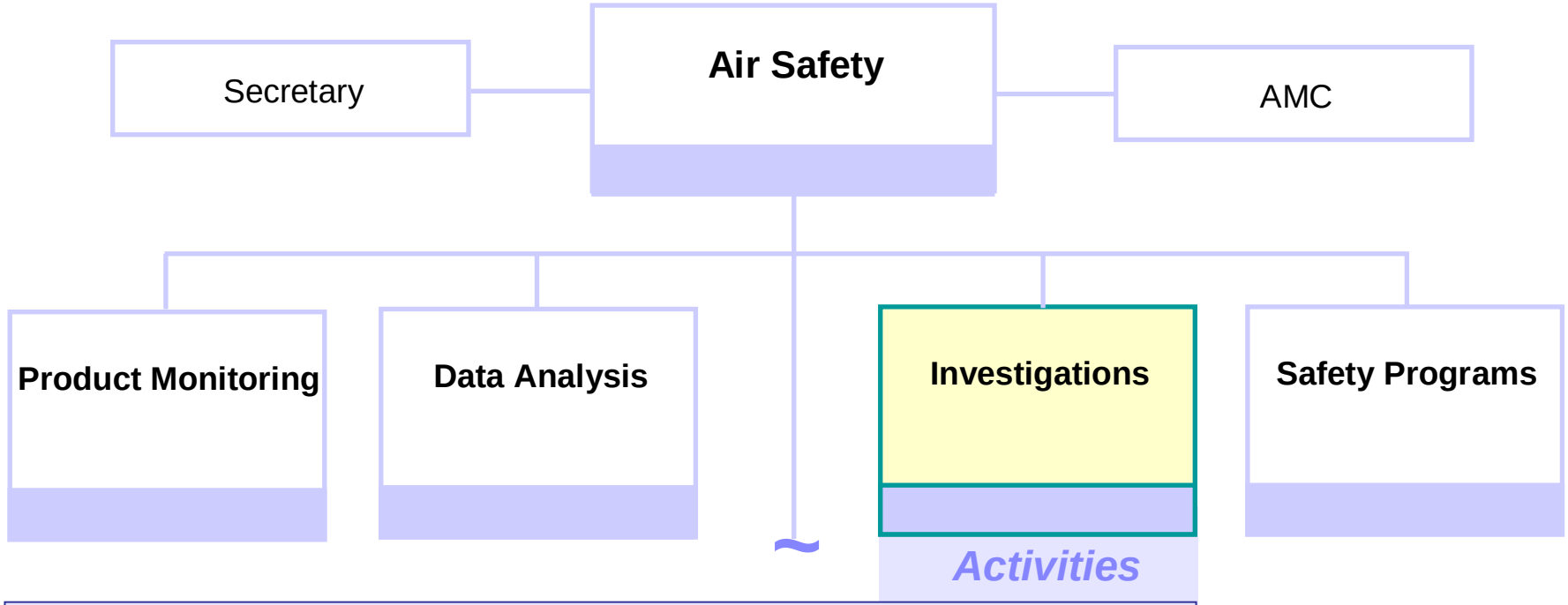
Embraer Air Safety offices to assist the Regions of the World



The Embraer Air Safety Team

- Continuous training in accident investigation
- International experience
- Development of new investigation techniques

Embraer Safety Team: Activities & Processes



- Official Investigations..... ENS-007076
- Embraer Crisis Management Plan..... ENS-002711
- Communication to Operators (ERFR)..... ENS-002710
- Reporting Process..... ENS-002712
- Air Safety Technical Advisory Reports..... ENS-007075
- Operational Factors Monitoring..... ENS-008244
- Survival Factors Monitoring..... In preparation

ENS = Embraer Normative System

Topics

- **How Embraer is prepared to assist the investigations conducted by the national authorities;**
- The Embraer air safety team
- **The interface with CENIPA and other authorities**
- The initial action on crash site
- The challenge of the aircraft growing complexity
- The challenge of software investigation
- The Embraer resources for investigations

As advisor of CENIPA, Embraer can assist in:

- Participating in all areas of the investigation:
  - Visiting accident scene and examine wreckage
  - Obtaining witness information and suggesting areas of questioning
  - Accessing all relevant evidence and documents
  - Participating in read-outs of recorded media
  - Participating in off-scene investigation activities and testing
  - Making assumptions in respect of various elements of investigation
- Assisting the IIC and the Accredited Representative in reviewing and commenting upon draft reports.

The “Machine”

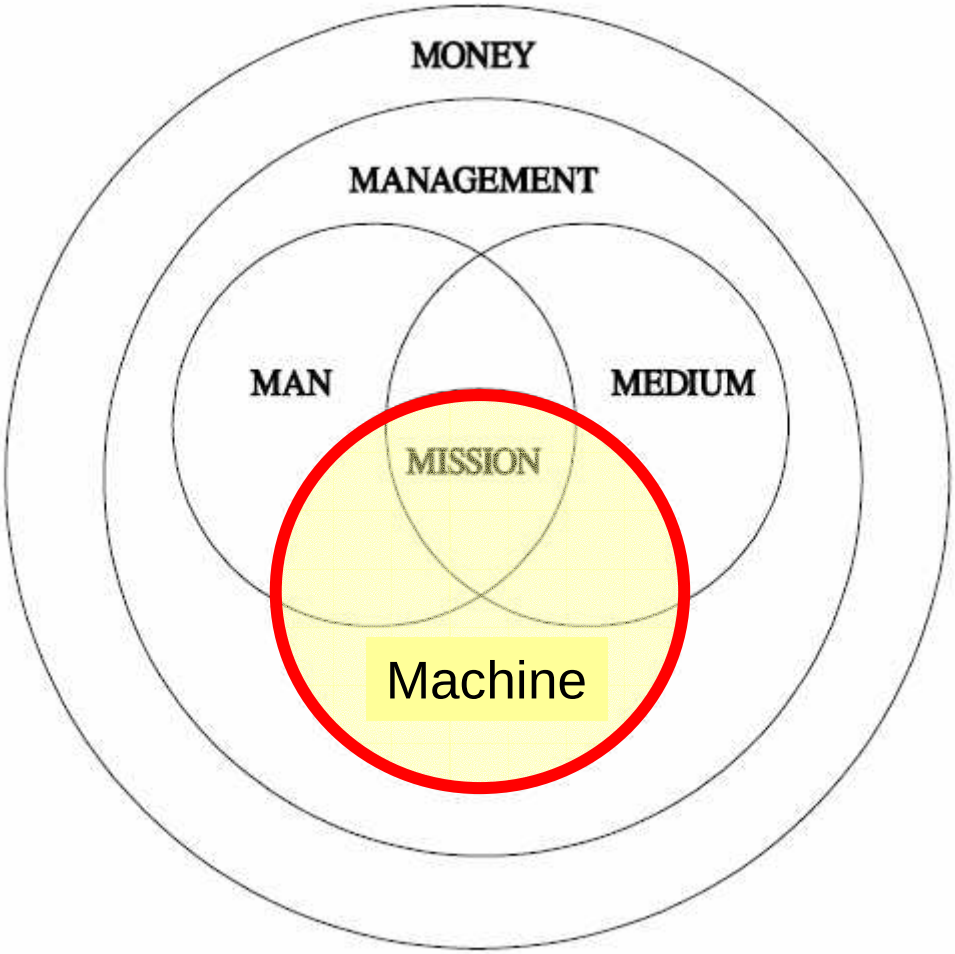


Figure 3.3.1 The Six "M" Model for Organizational Investigation

Man

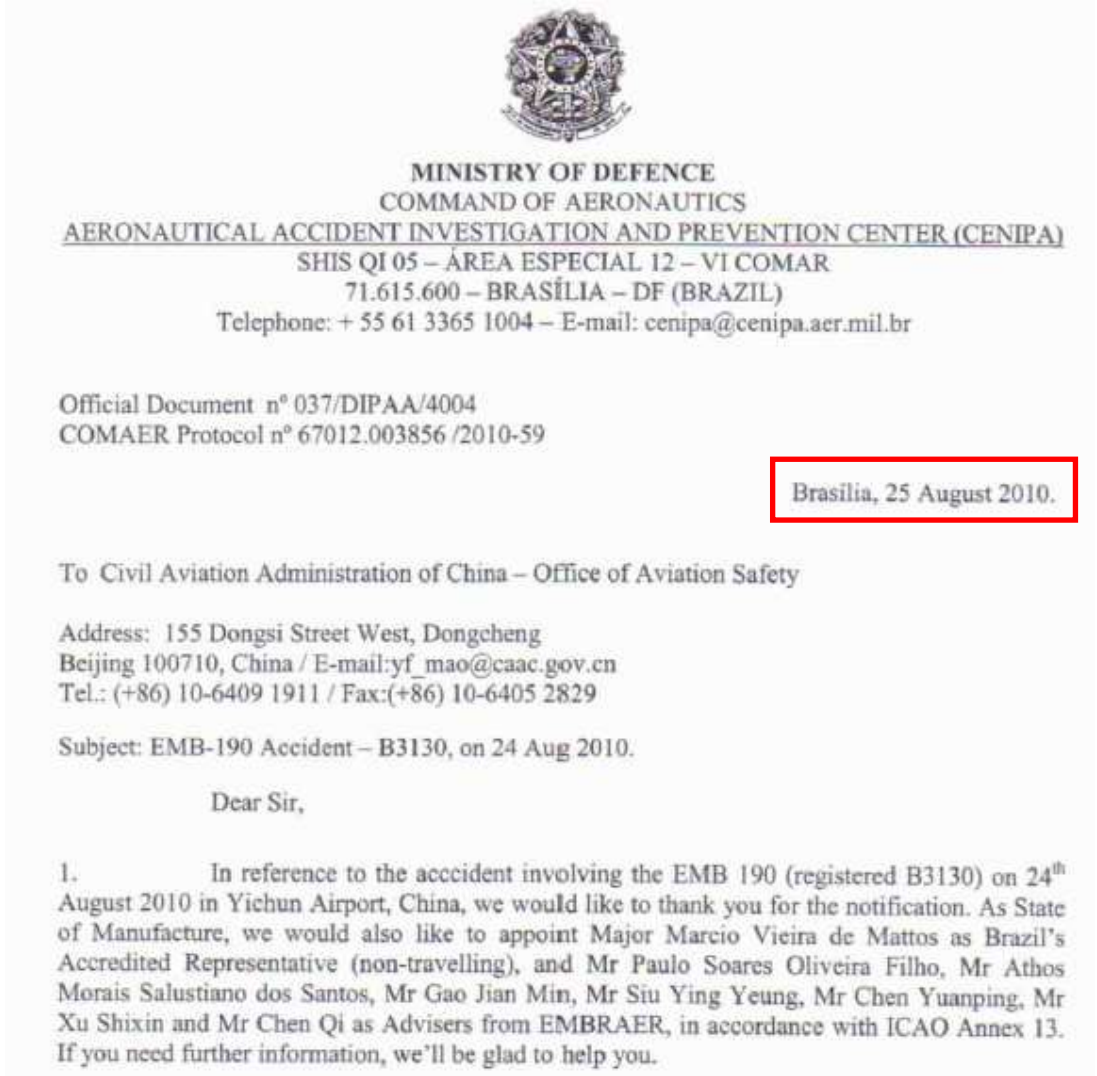
Medium Machine

CENIPA = Brazilian Prevention and Investigation Authority

ICAO Doc 9756-AN/965 Manual of Aircraft Accident and Incident Investigation
Part III — Investigation

The interface with CENIPA and other authorities

Quick designation



MINISTRY OF DEFENCE
COMMAND OF AERONAUTICS
AERONAUTICAL ACCIDENT INVESTIGATION AND PREVENTION CENTER (CENIPA)
SHIS QI 05 – ÁREA ESPECIAL 12 – VI COMAR
71.615.600 – BRASÍLIA – DF (BRAZIL)
Telephone: + 55 61 3365 1004 – E-mail: cenipa@cenipa.aer.mil.br

Official Document nº 037/DIPAA/4004
COMAER Protocol nº 67012.003856 /2010-59

Brasília, 25 August 2010.

To Civil Aviation Administration of China – Office of Aviation Safety

Address: 155 Dongsi Street West, Dongcheng
Beijing 100710, China / E-mail:yf_mao@caac.gov.cn
Tel.: (+86) 10-6409 1911 / Fax:(+86) 10-6405 2829

Subject: EMB-190 Accident – B3130, on 24 Aug 2010.

Dear Sir,

1. In reference to the acccident involving the EMB 190 (registered B3130) on 24th August 2010 in Yichun Airport, China, we would like to thank you for the notification. As State of Manufacture, we would also like to appoint Major Marcio Vieira de Mattos as Brazil's Accredited Representative (non-travelling), and Mr Paulo Soares Oliveira Filho, Mr Athos Morais Salustiano dos Santos, Mr Gao Jian Min, Mr Siu Ying Yeung, Mr Chen Yuanping, Mr Xu Shixin and Mr Chen Qi as Advisers from EMBRAER, in accordance with ICAO Annex 13. If you need further information, we'll be glad to help you.

ERJ-190, CFIT, China

Designation of Accredited Representative and Advisors by CENIPA:

Accident date:
24.Aug.2010

Designation Letter:
25.Aug.2010

Working together with the Brazilian Investigation Authority (CENIPA)

Contributing to Formal Investigation Trainings with CENIPA

Topics

- **How Embraer is prepared to assist the investigations conducted by the national authorities;**
  - The Embraer air safety team
  - The interface with CENIPA and other authorities
  - **The initial action on crash site**
  - The challenge of the aircraft growing complexity
  - The challenge of software investigation
  - The Embraer resources for investigations

Case study 1

ERJ-190, CFIT, China, 24.Aug.2010

Case study

ERJ-190, CFIT, China, 24.Aug.2010

ERJ-190, CFIT, China, 24.Aug.2010

- **Time:** 21:36 (Local time)
- **Flight:** VD 8387 Harbin to Yichun (north China)
- **Descrition:** During final approach to Yichun (north China) the aircraft impacted trees and shrubs, crashing about 700m before the runway paved surface and aligned with runway center line. Post-crash fire consumed the aircraft.
- **Conditions:** non-precison approach
  at night
  with fog

Case study: ERJ-190, China, Aug 2010 Media Photos

Case study: ERJ-190, China, Aug 2010 Media Photos

Case study: ERJ-190, China, Aug 2010 Media Photos

Case study: ERJ-190, China, Aug 2010

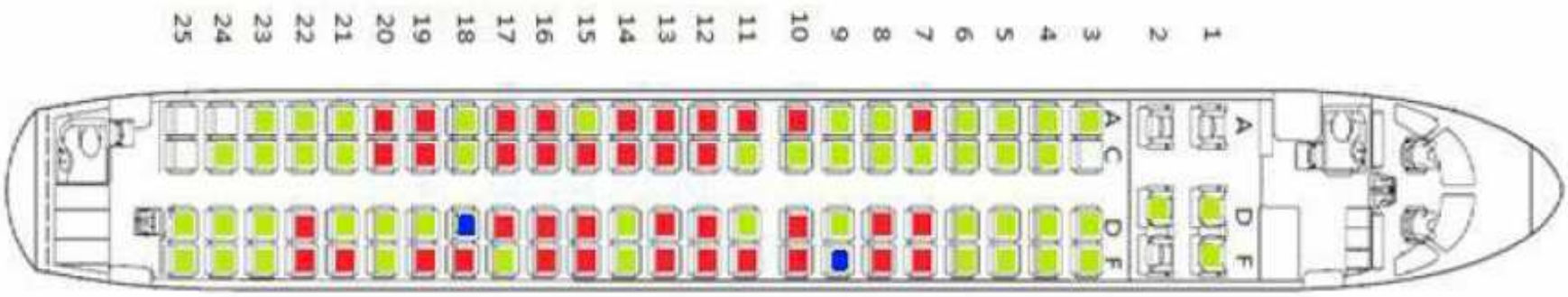


Figure 2-7 Casualties and Injuries Distribution Map

Note:

Red color represents persons died in the disaster, and green color represents survivors;

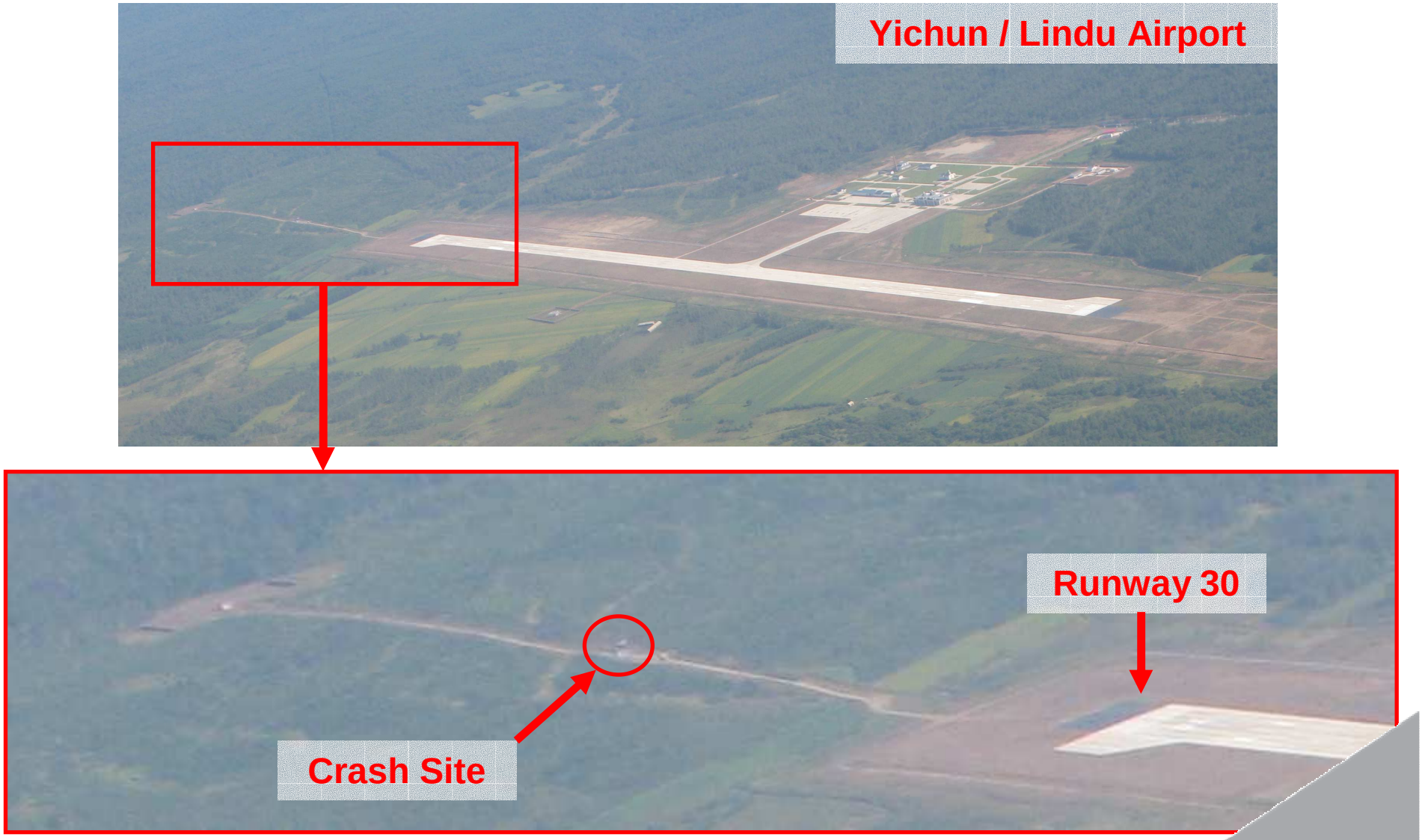
Blank represents nobody there;

Blue color represents passengers died after sending to hospital.

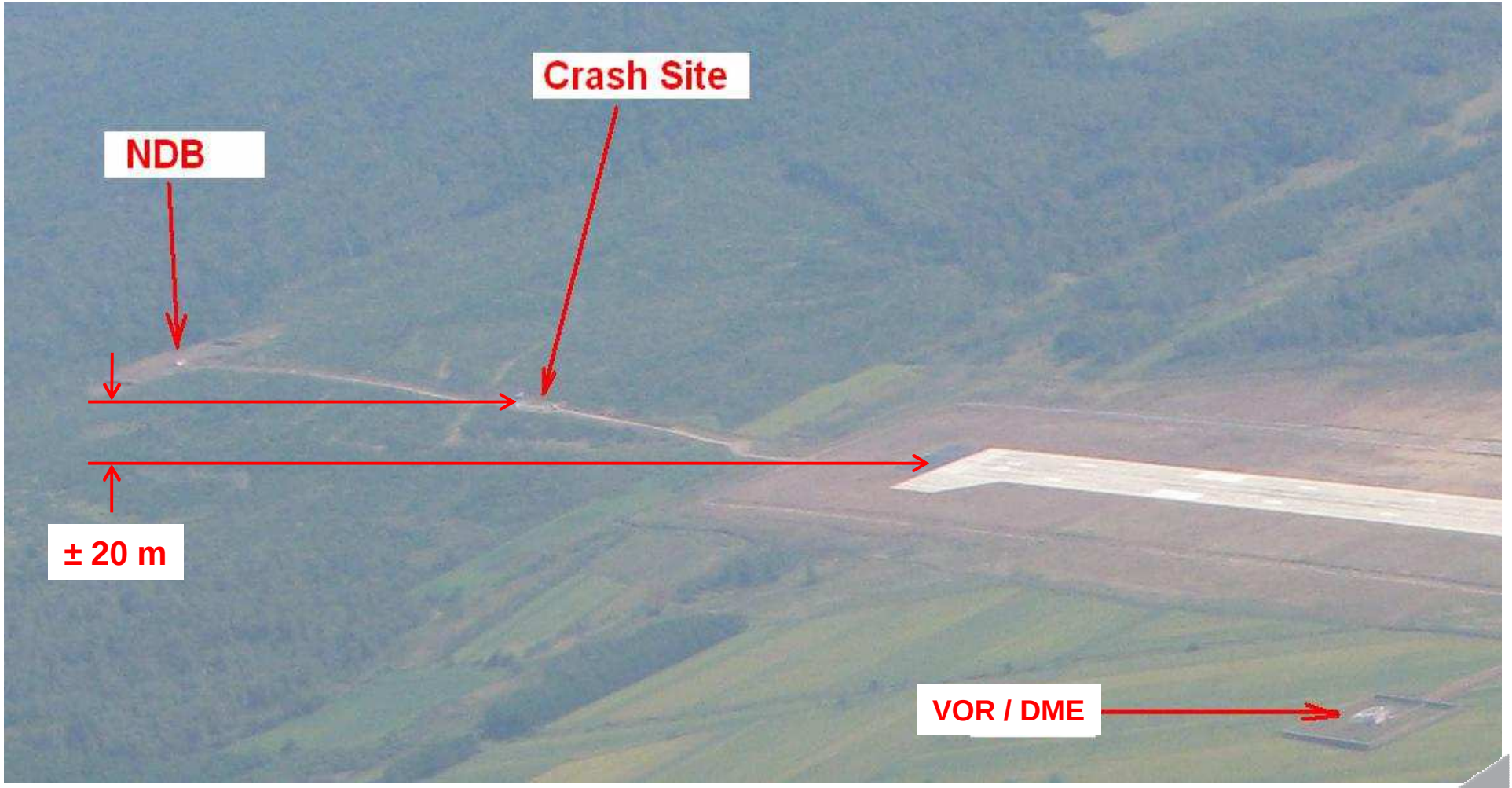
Injuries

- 96 people in all on board, including 5 crew members
- 91 passengers
- 3 crew members and 41 passengers suffered fatal injuries
- 2 crew members and 33 passengers were serious injured
- 17 passengers were minor injuried in the accident.
- The captain and the In-flight Security Officer (IFSO) survived.

Case study: ERJ-190, China, Aug 2010



Case study: ERJ-190, China, Aug 2010



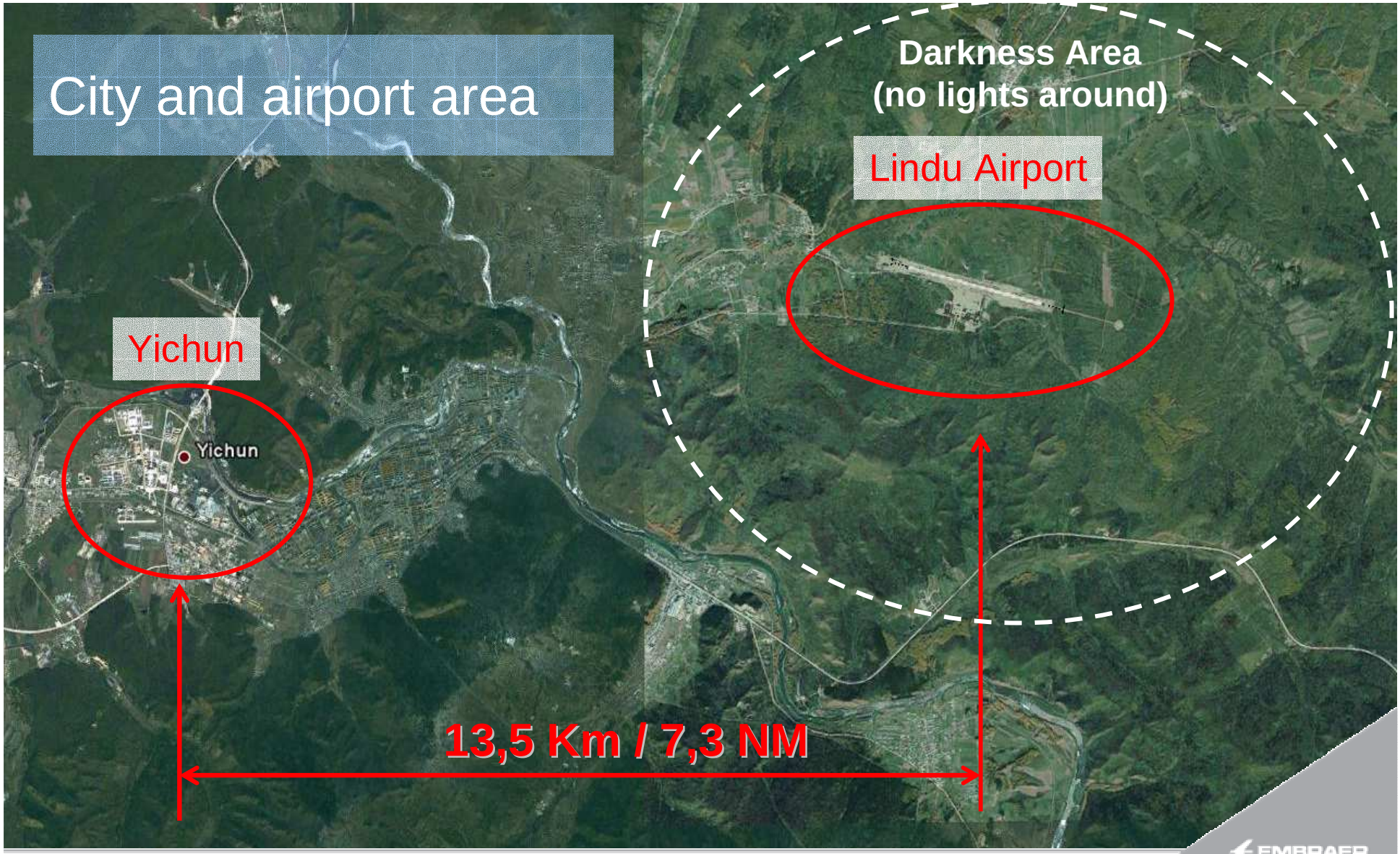
Case study: ERJ-190, China, Aug 2010

Flight route and location of the event

EMBRAER

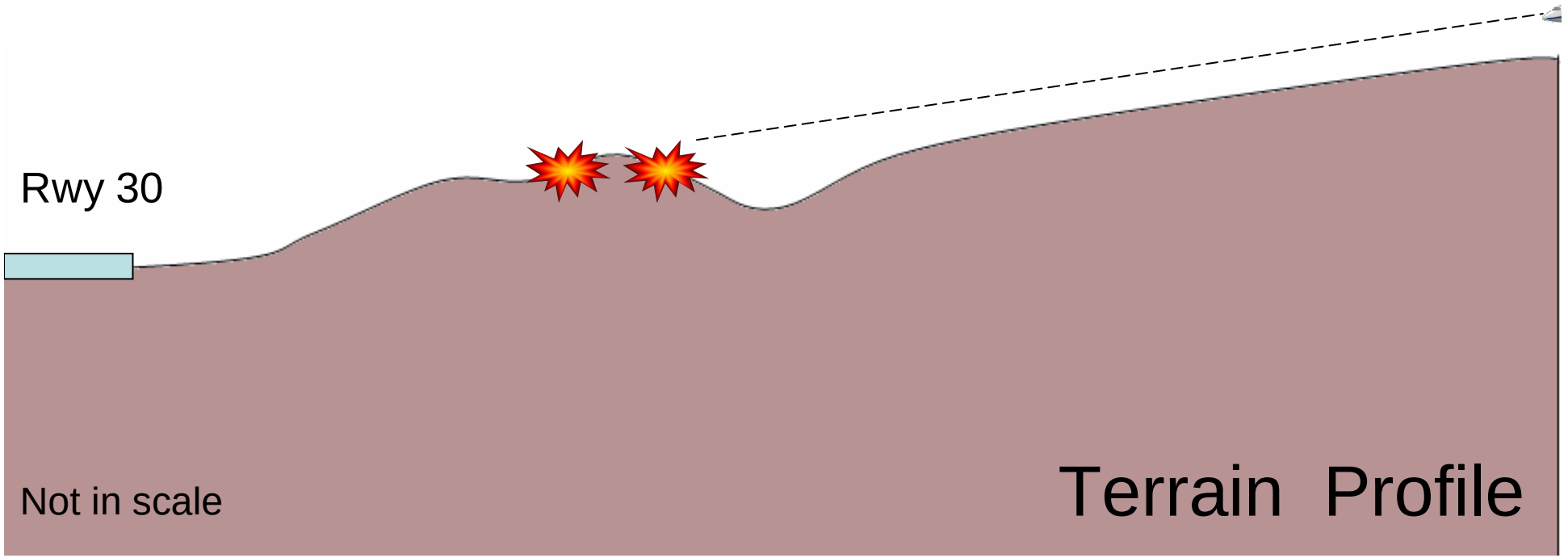
Case study: ERJ-190, China, Aug 2010

Case study: ERJ-190, China, Aug 2010



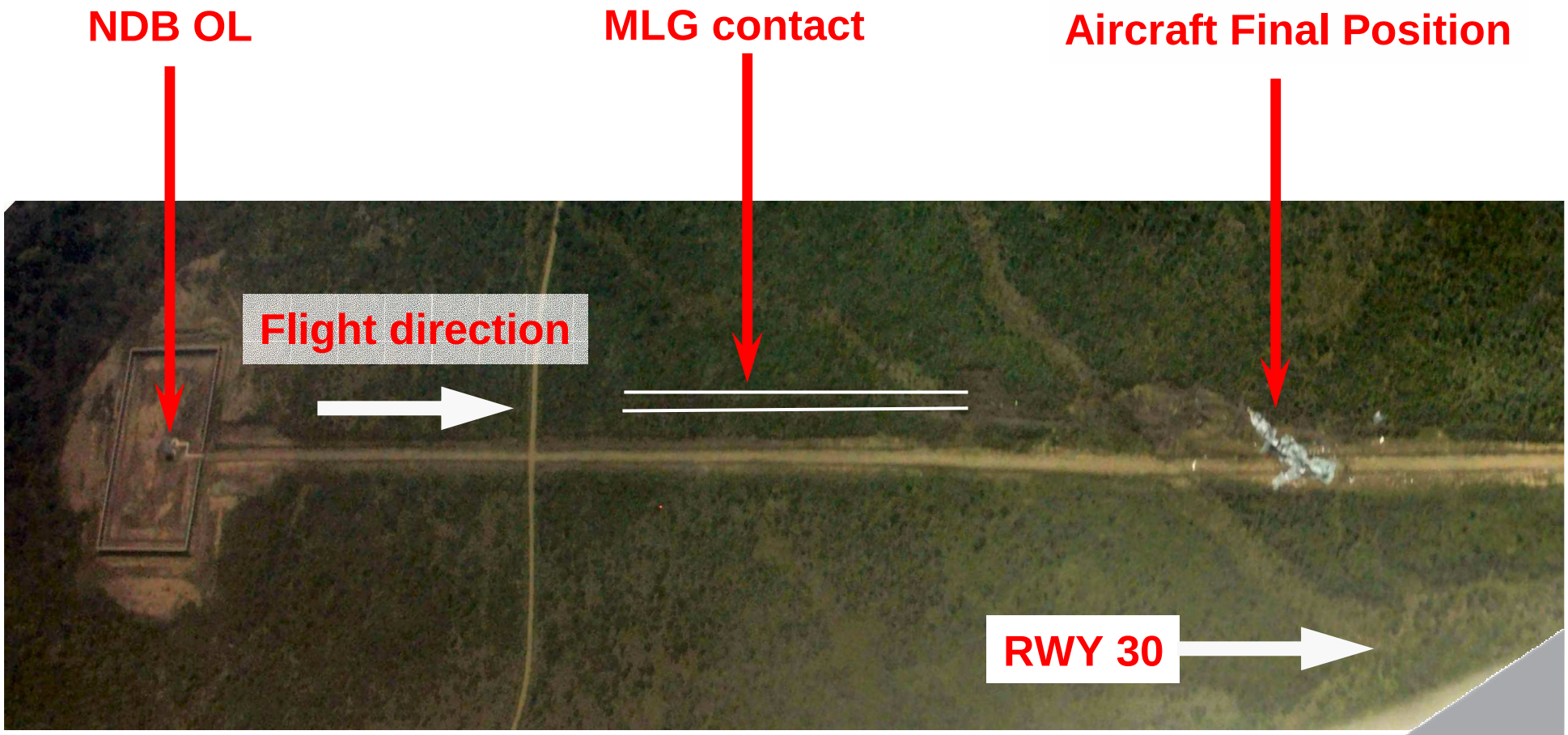
Case study: ERJ-190, China, Aug 2010

Aircraft Trajectory and Terrain Profile



Case study: ERJ-190, China, Aug 2010

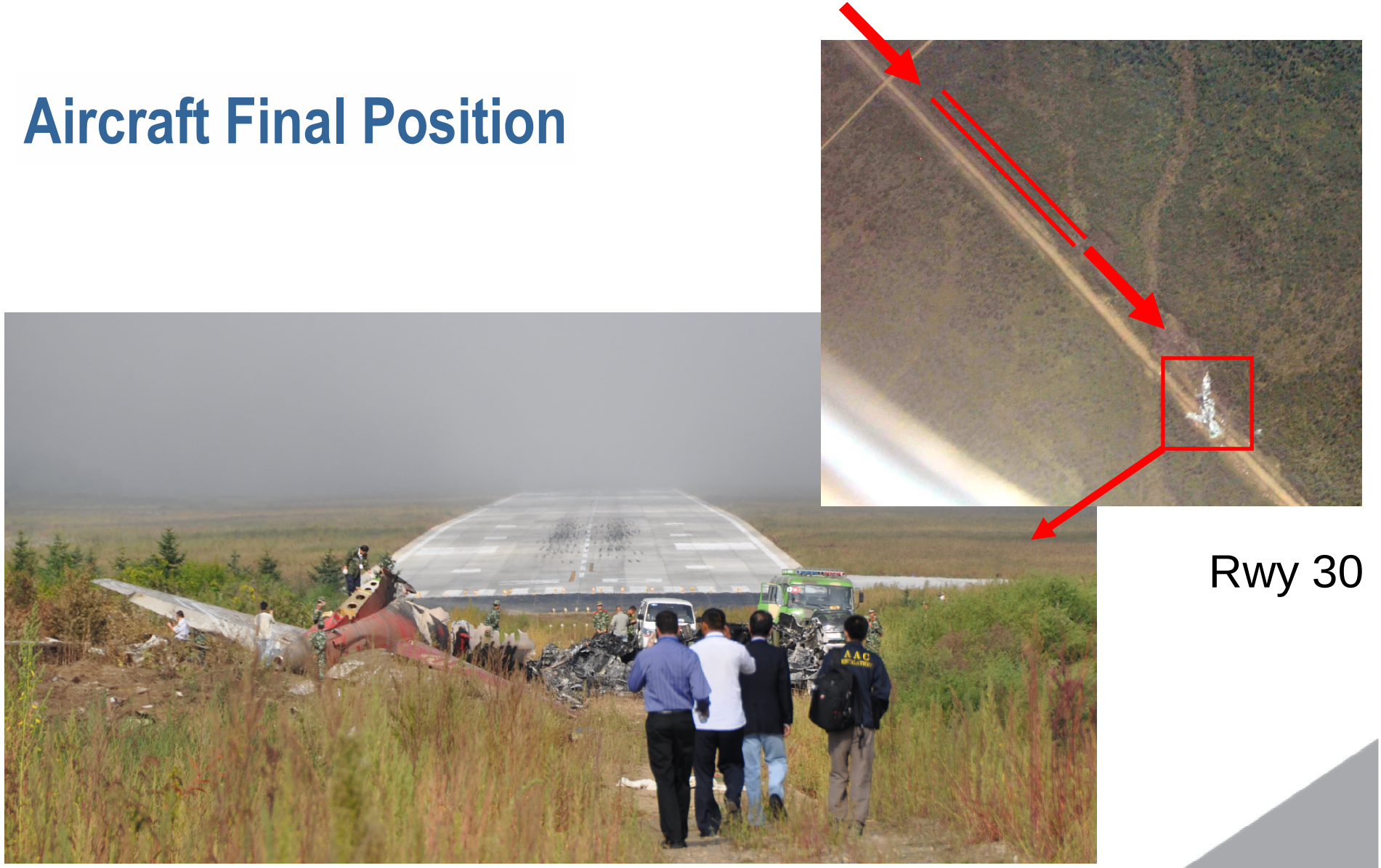
Crash Site



Case study: ERJ-190, China, Aug 2010

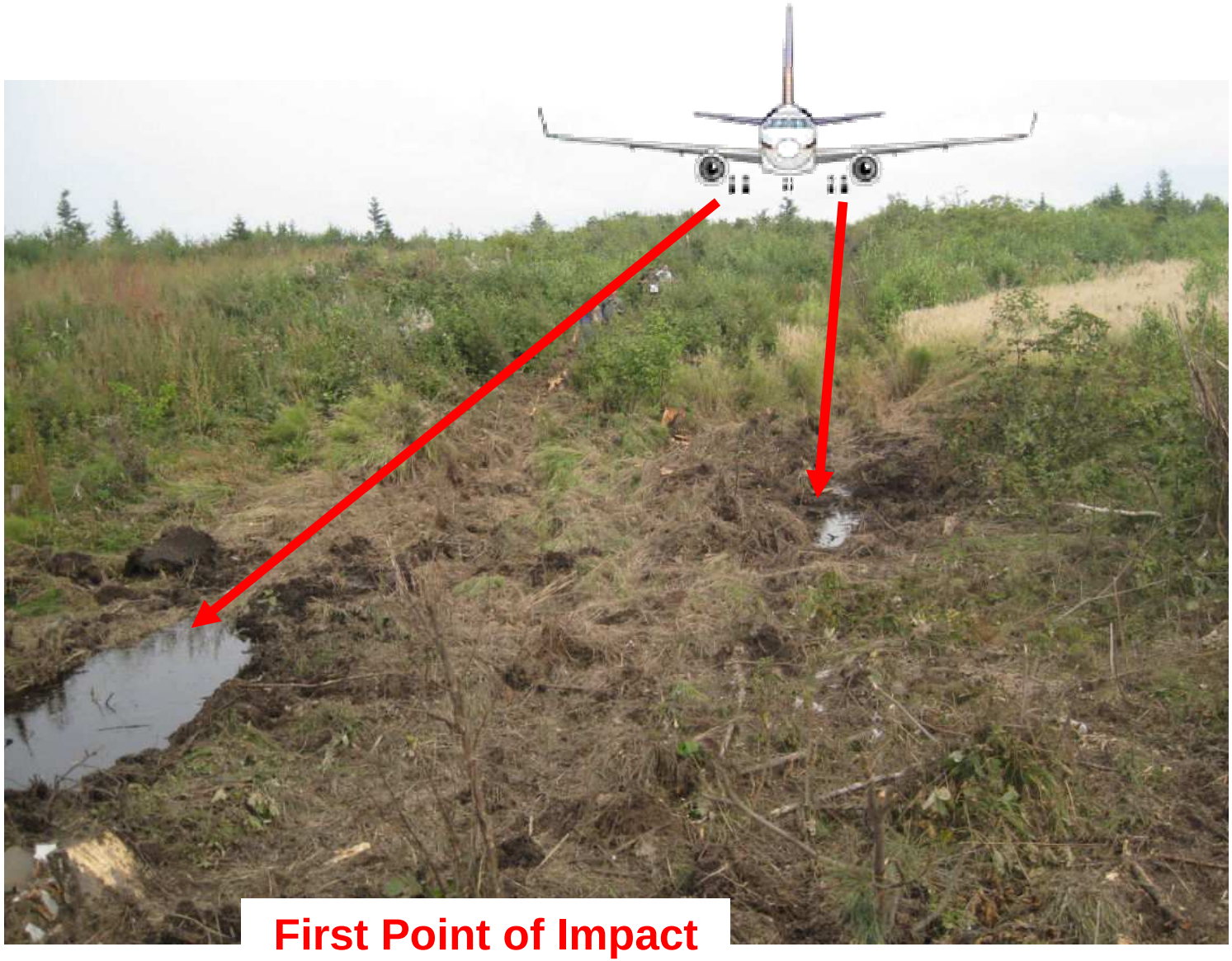
Case study: ERJ-190, China, Aug 2010

Aircraft Final Position

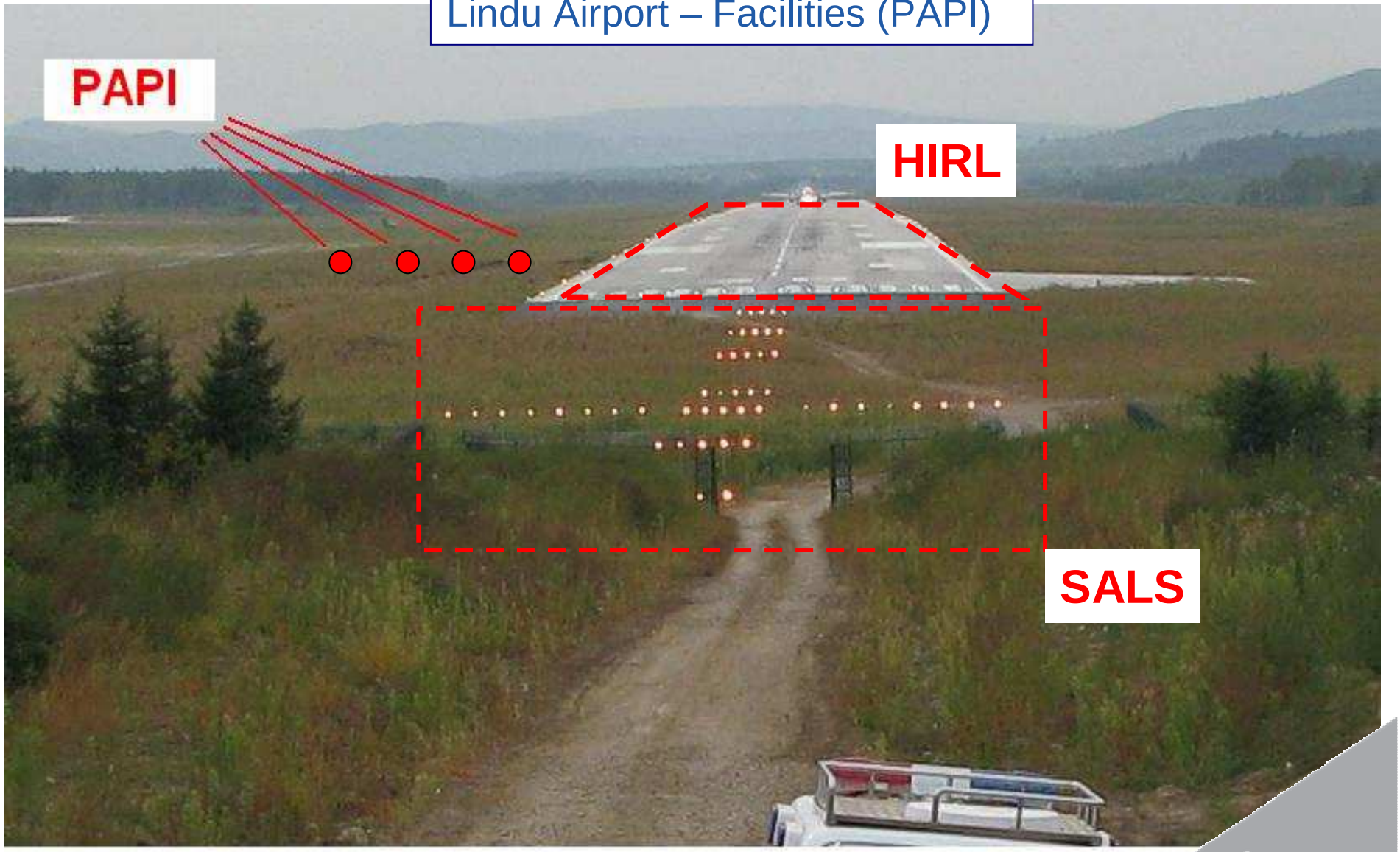


Rwy 30

Case study: ERJ-190, China, Aug 2010



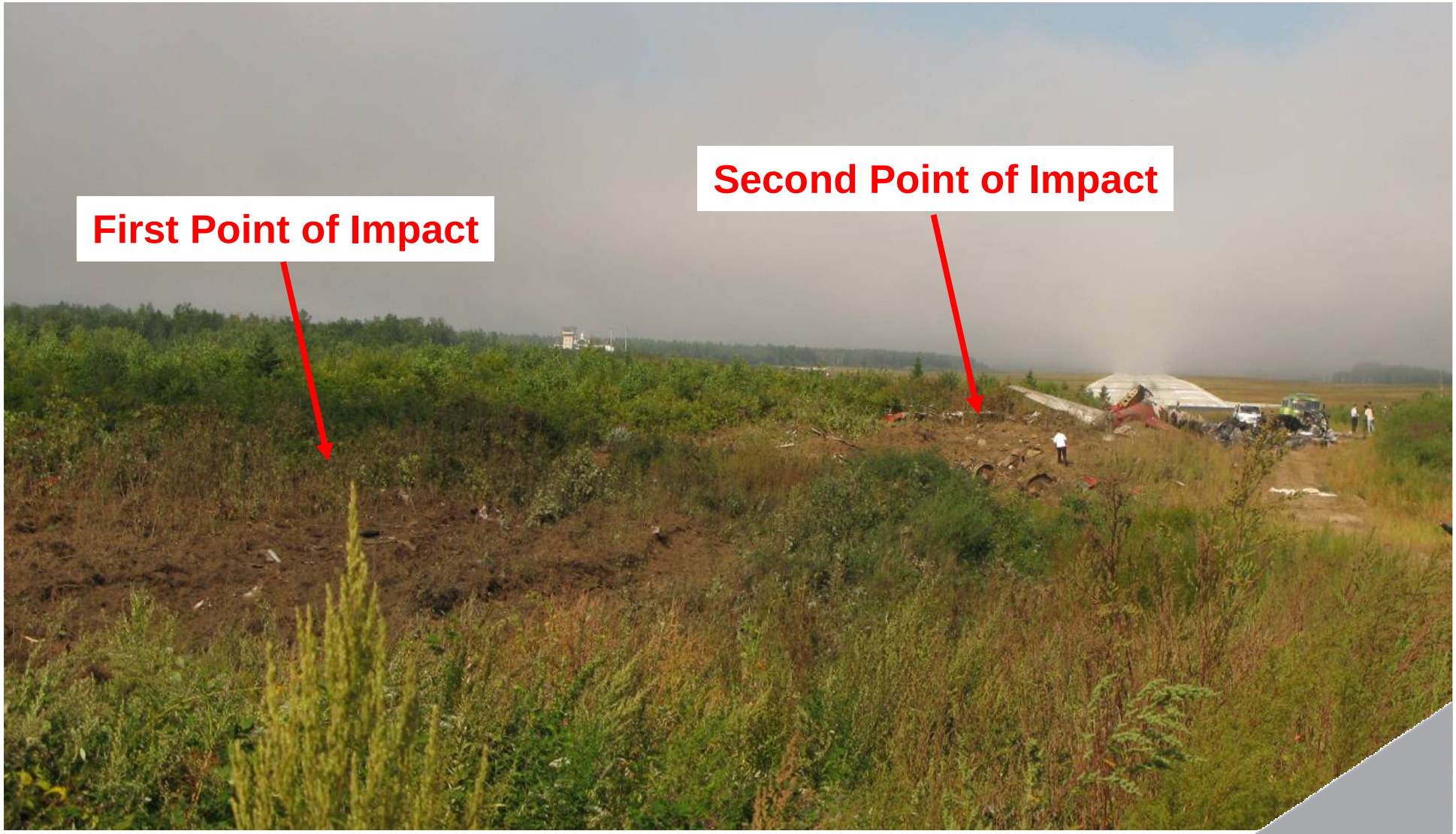
Case study: ERJ-190, China, Aug 2010



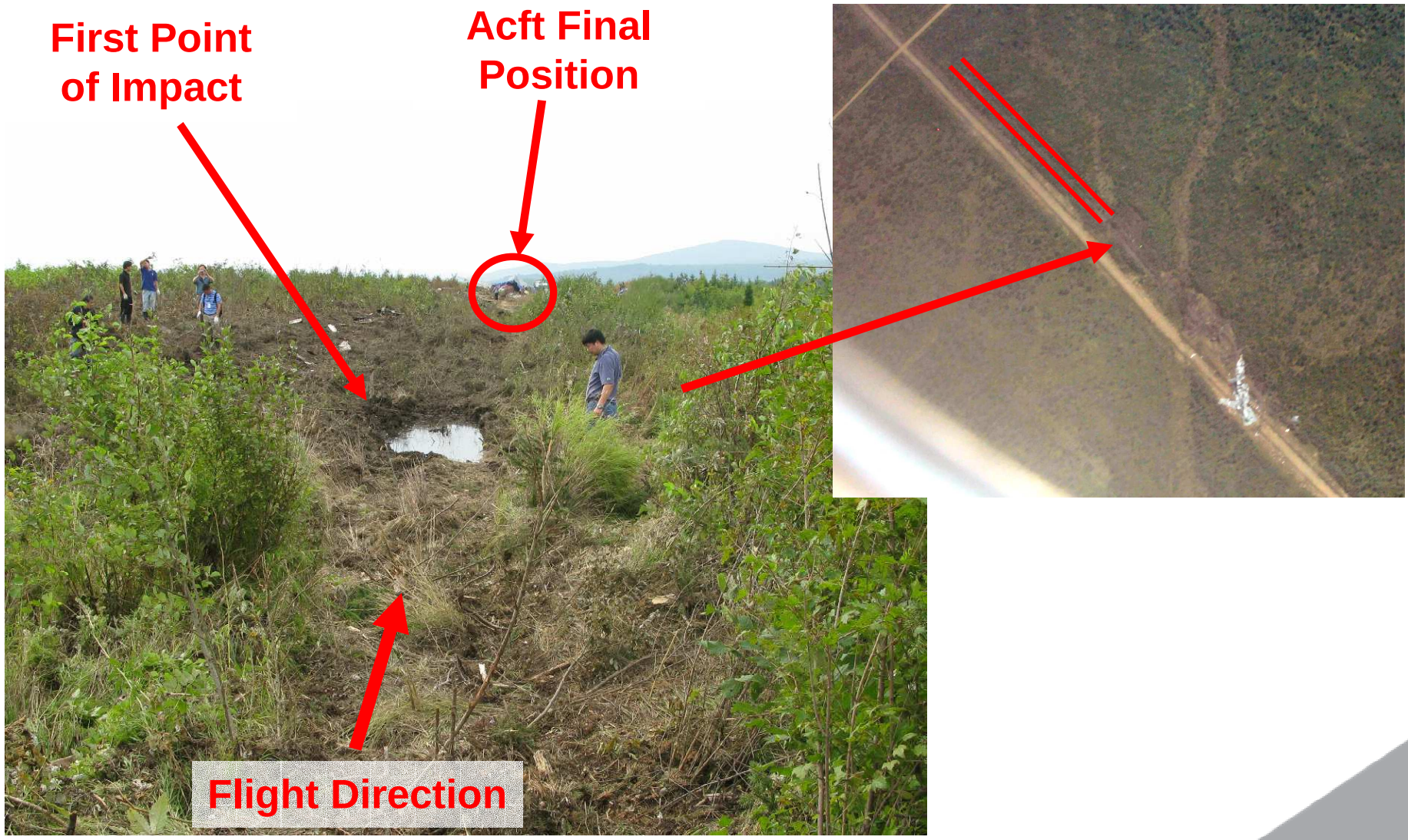
Case study: ERJ-190, China, Aug 2010

Case study: ERJ-190, China, Aug 2010

Crash Site

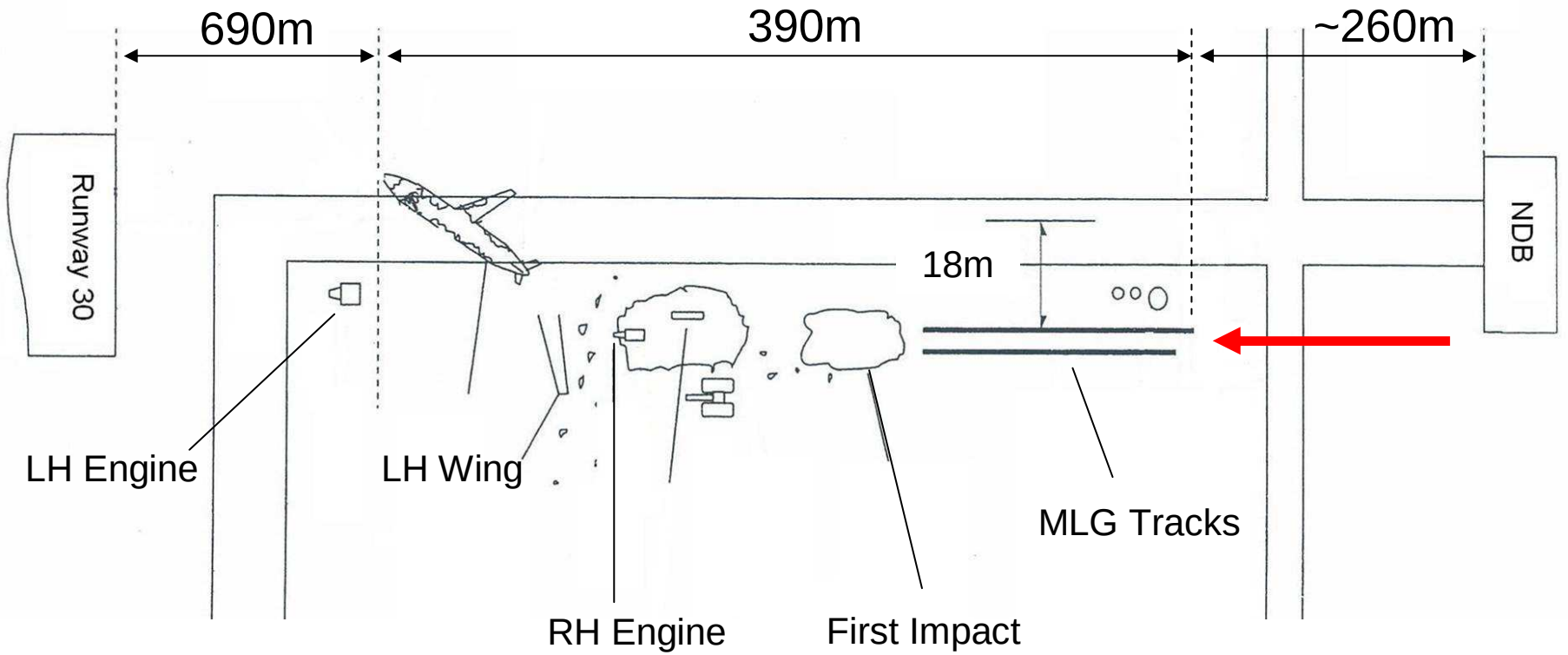


Case study: ERJ-190, China, Aug 2010



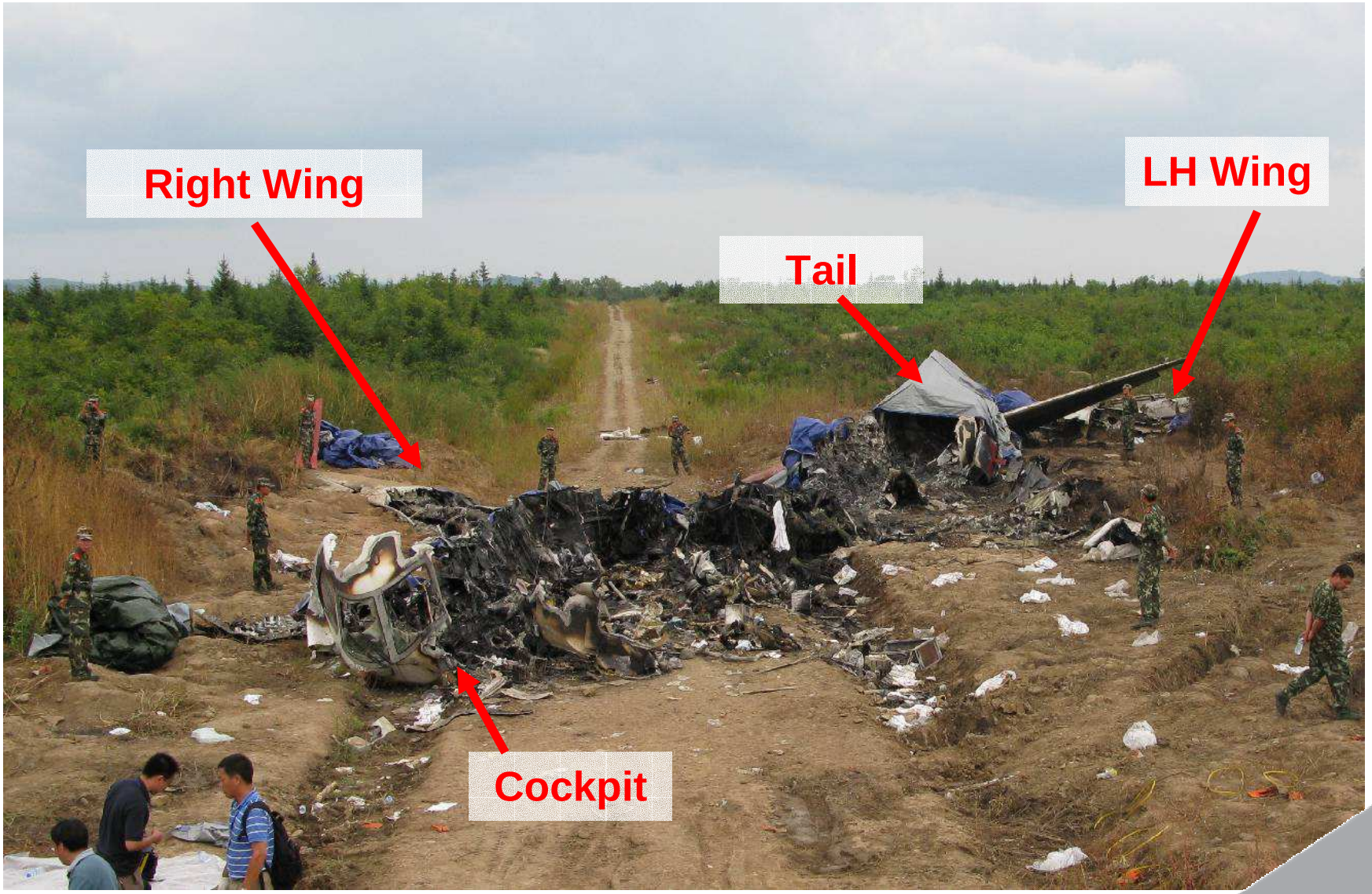
Case study: ERJ-190, China, Aug 2010

Crash Site Sketch



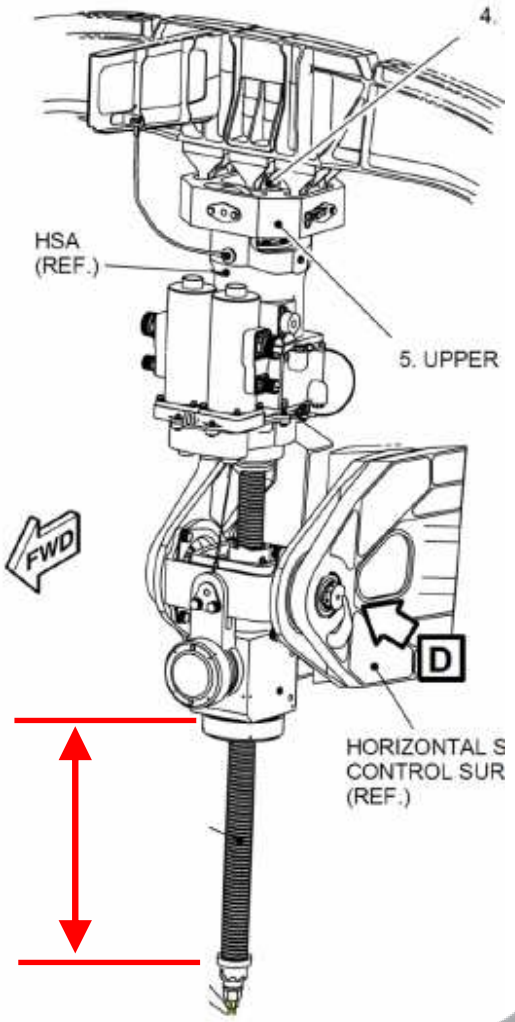
Not in scale

Case study: ERJ-190, China, Aug 2010



Case study: ERJ-190, China, Aug 2010

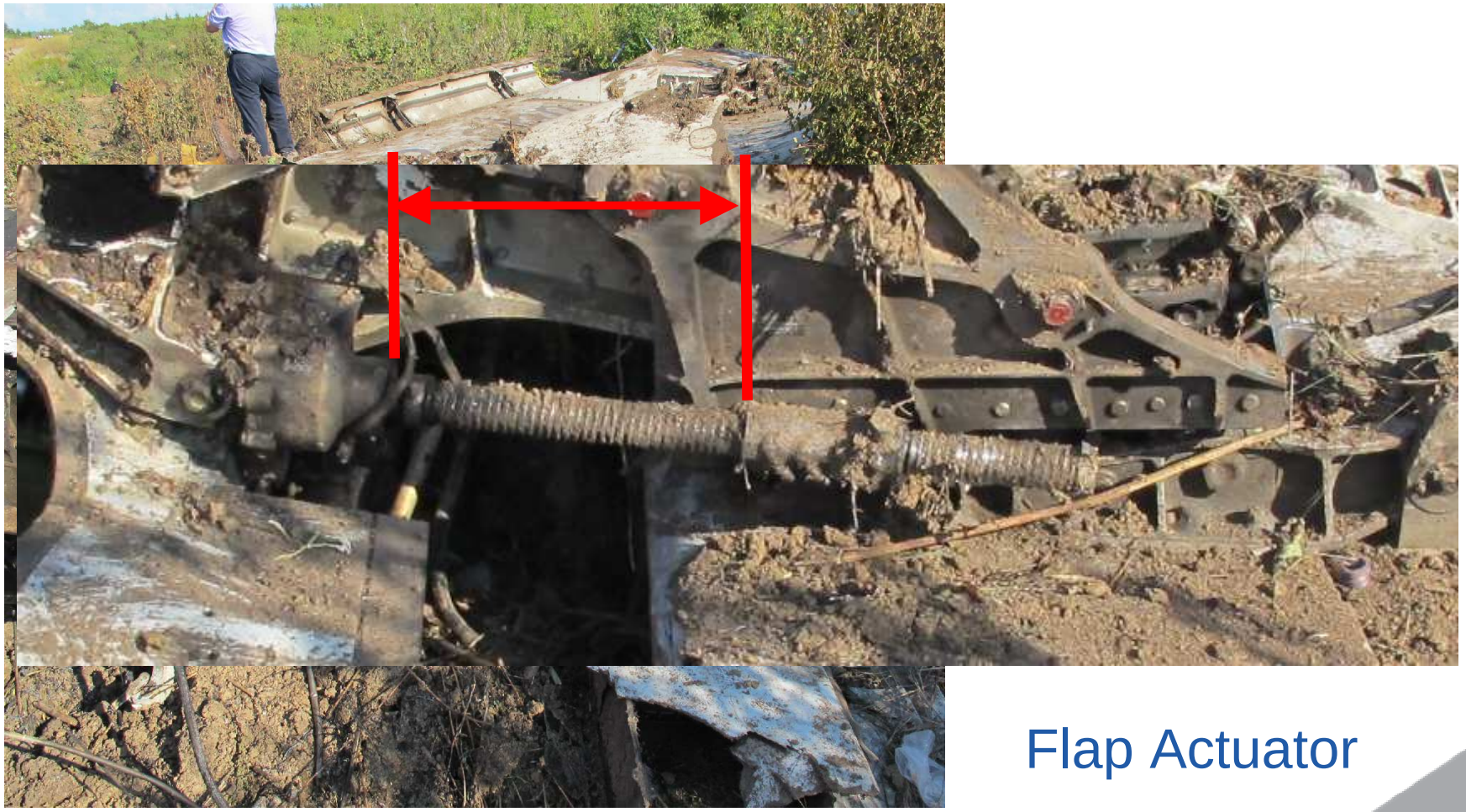
Evidences obtained from specific components



Pitch Trim Actuator

Case study: ERJ-190, China, Aug 2010

Evidences obtained from specific components



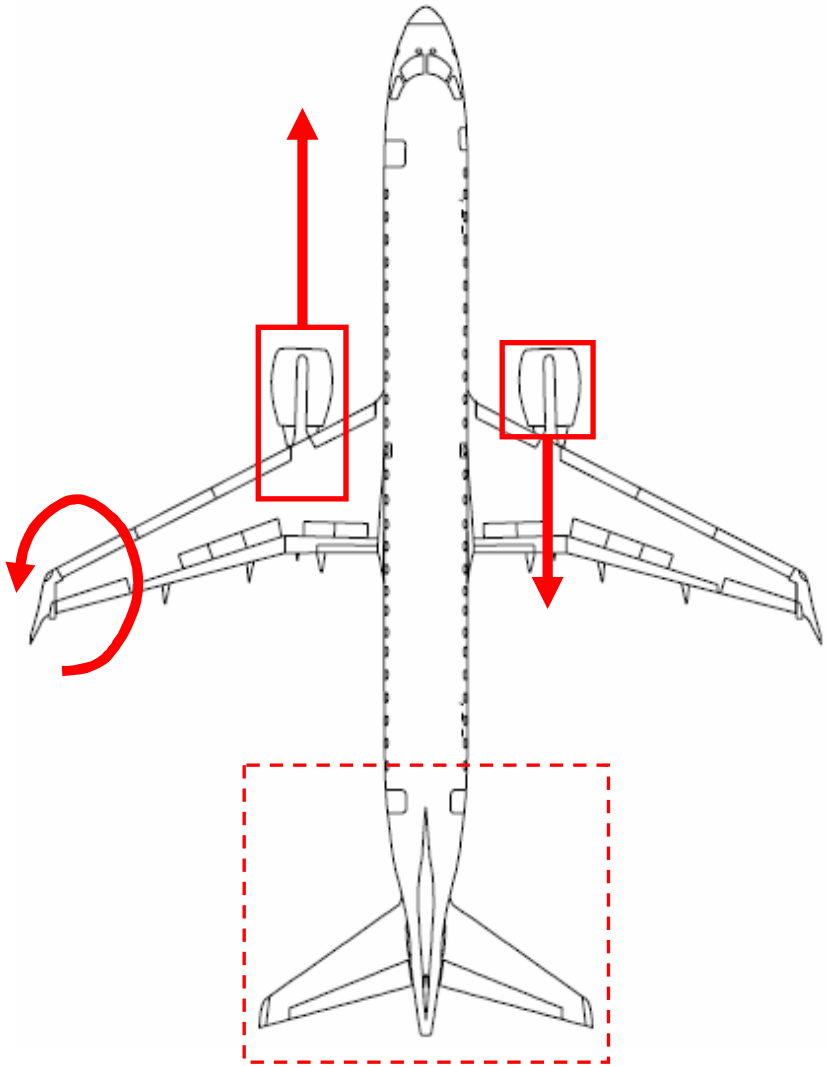
Flap Actuator

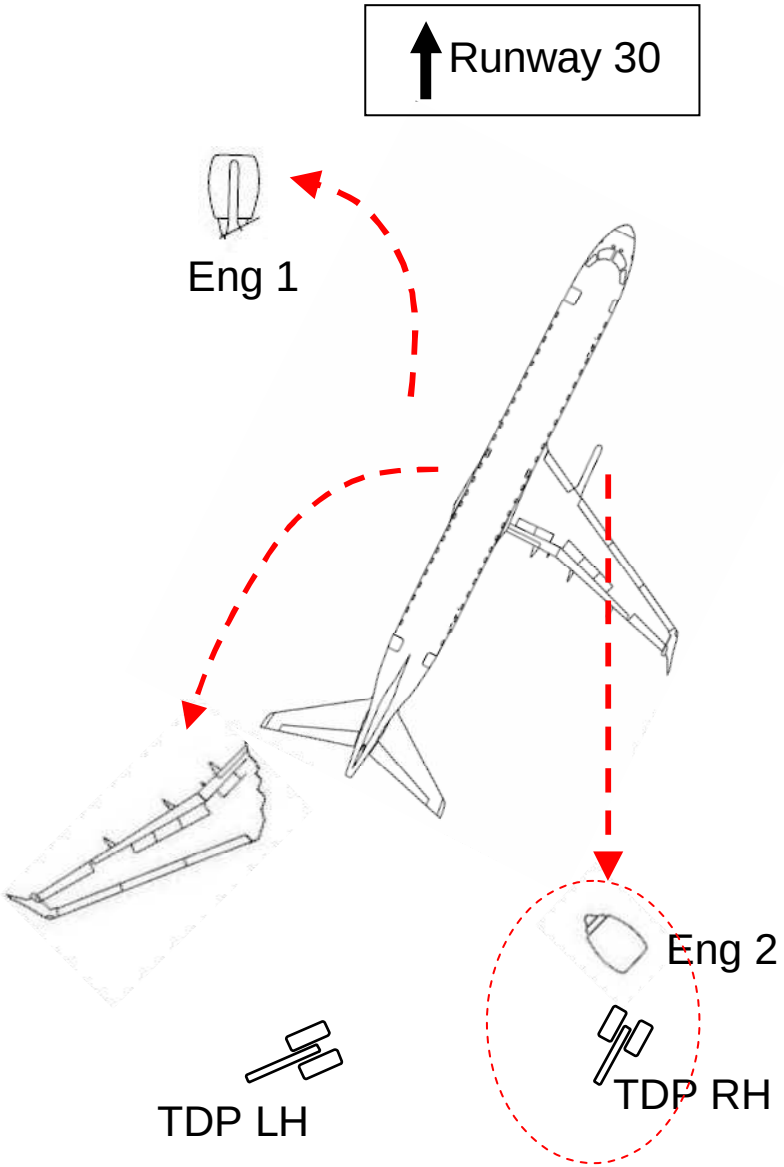
Case study: ERJ-190, China, Aug 2010

Components and Parts Identification

Case study: ERJ-190, China, Aug 2010

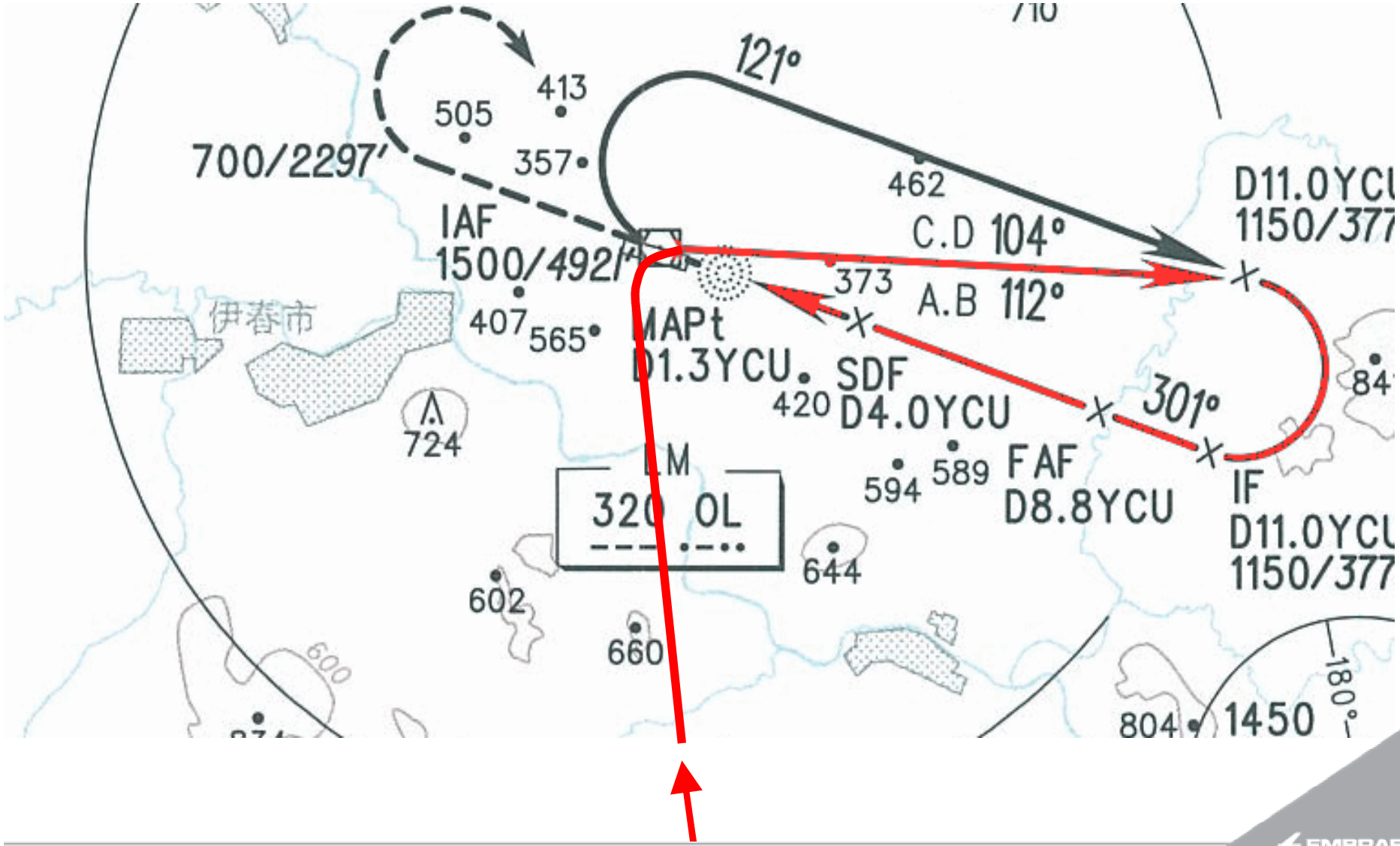
Aircraft damage





Case study: ERJ-190, China, Aug 2010

Charts – Arrival and Landing



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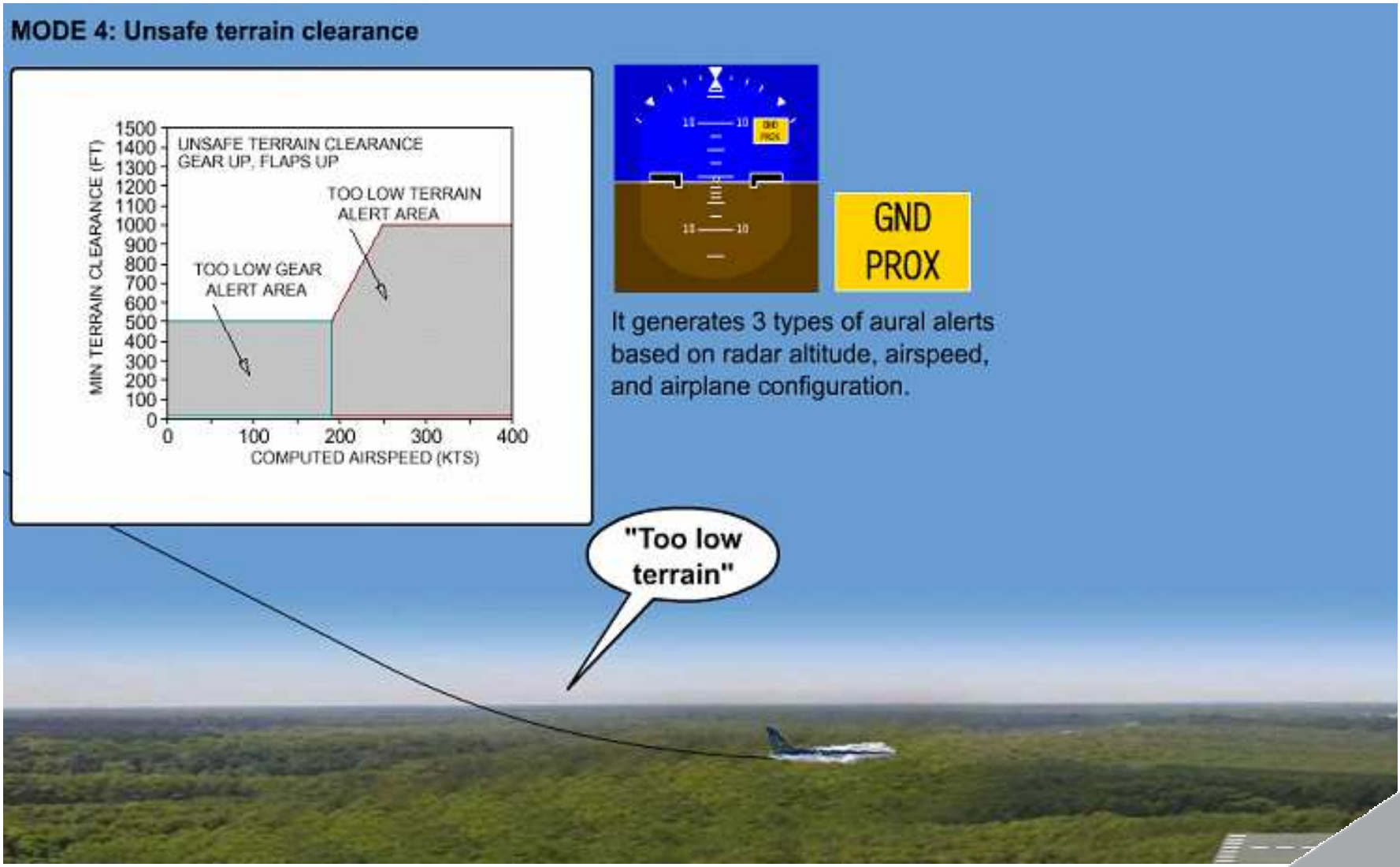
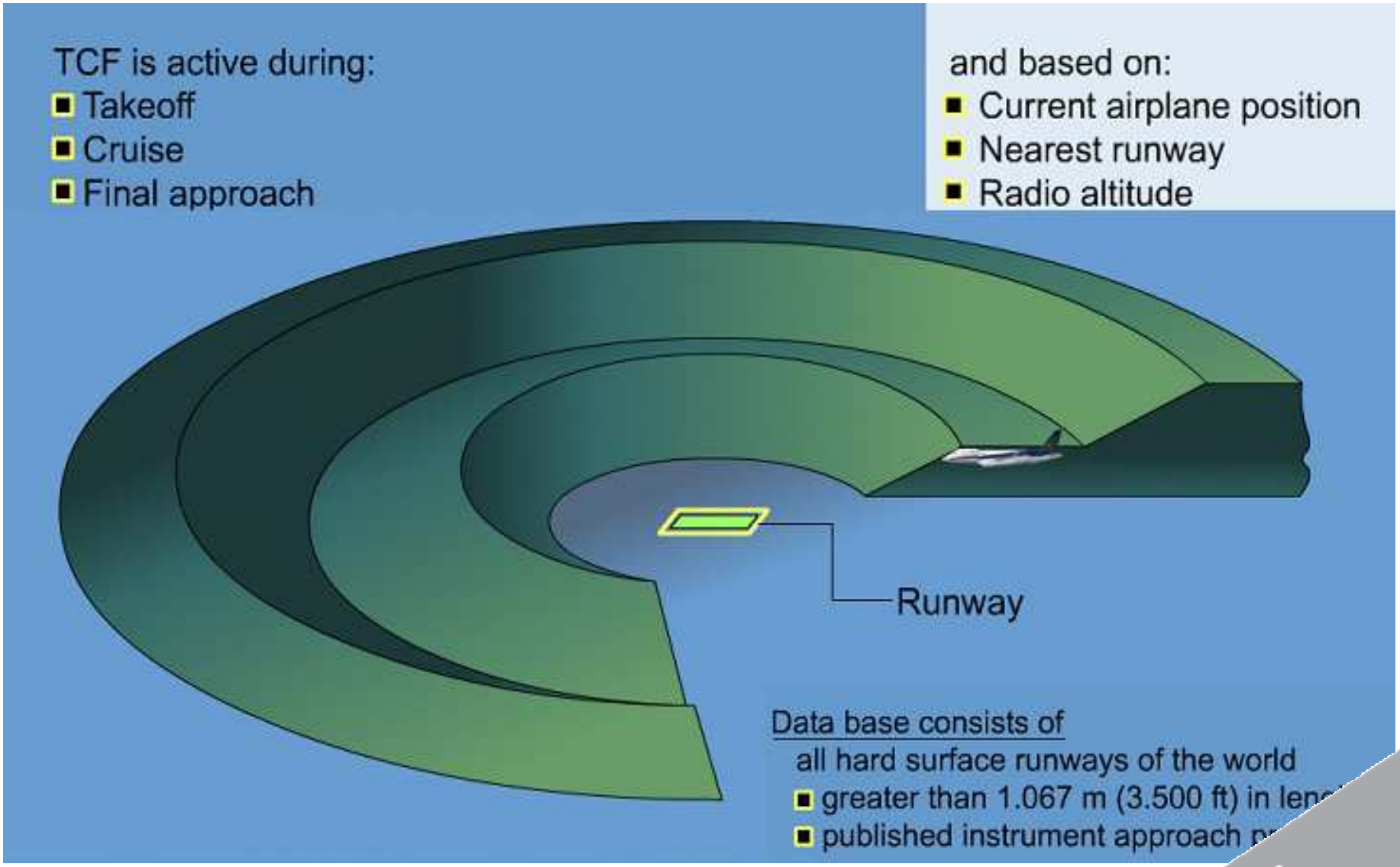
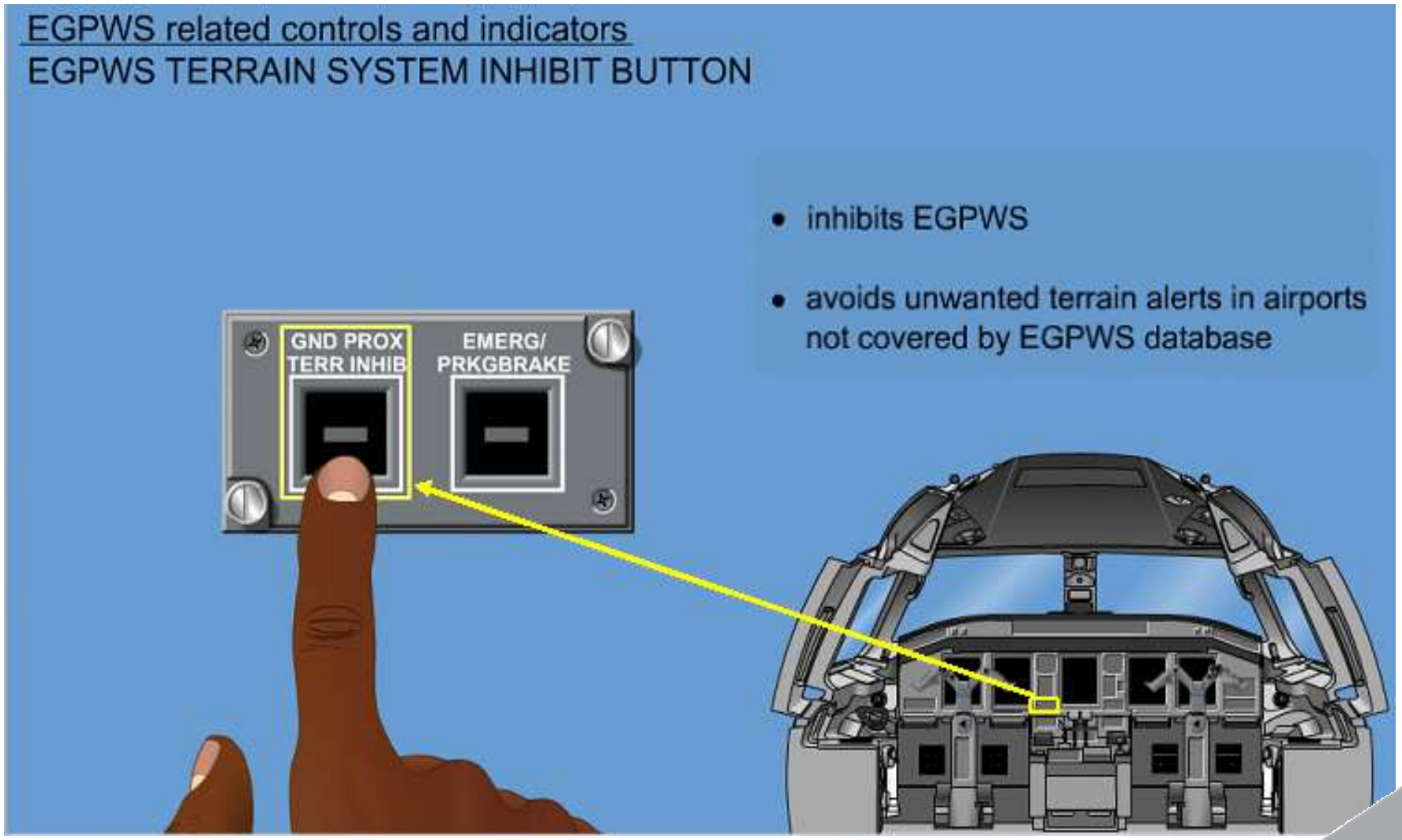
EGPWS Mode 4 (6 modes total)



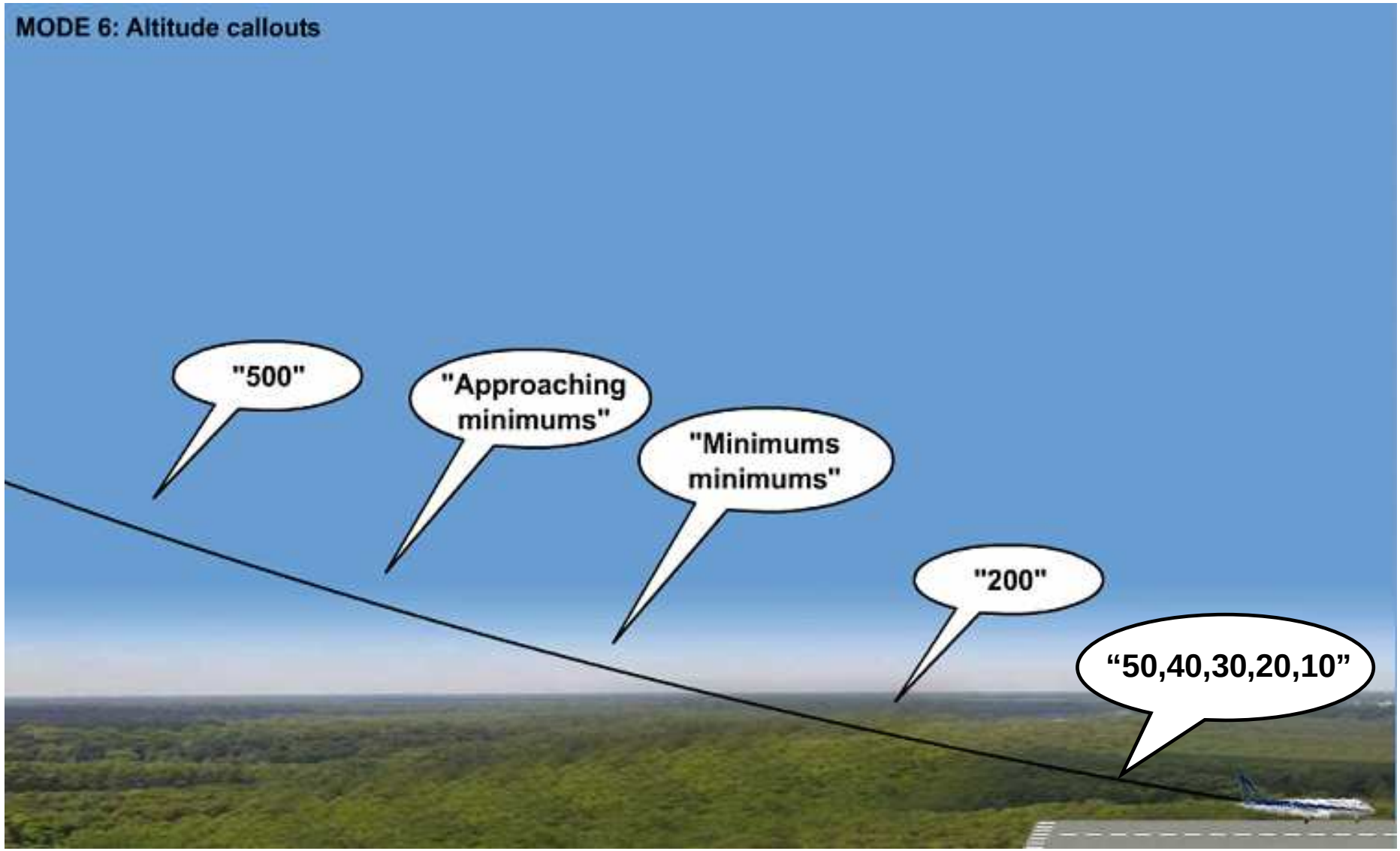
EGPWS Envelope



EGPWS – GNP PROX TERR INHIB



EGPWS Mode 6 (6 modes total)



Case study 2

ERJ-190, Runway Overrun, Quito, 17.Sep.2011

ERJ-190, Runway Overrun, Quito, 17.Sep.2011

ERJ-190, Runway Overrun, Quito, 17.Sep.2011

JUNTA INVESTIGADORA DE
ACCIDENTES
D.G.A.C.-ECUADOR

INFORME FINAL DEL ACCIDENTE DE LA AERONAVE EMBRAER 190, MATRÍCULA HC-CEZ

CONSEJO NACIONAL DE AVIACION CIVIL
J I A

DATOS GENERALES

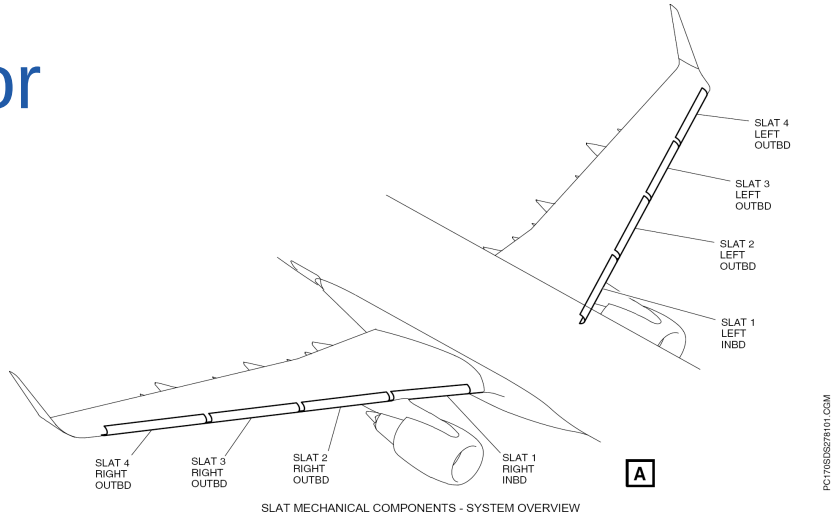
MARCA Y MODELO DE LA AERONAVE:	Embraer, ERJ-190
MATRICULA DE LA AERONAVE:	HC-CEZ

ERJ-190, Runway Overrun, Quito, 17.Sep.2011

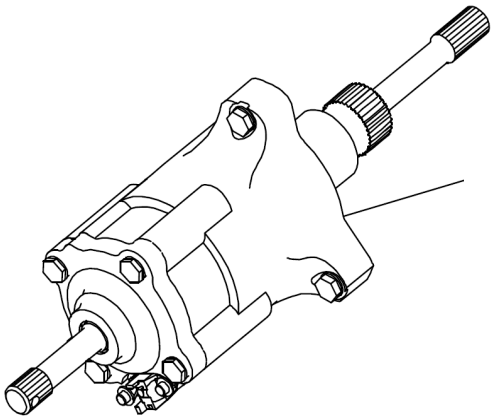
ERJ-190, Runway Overrun, Quito, 17.Sep.2011

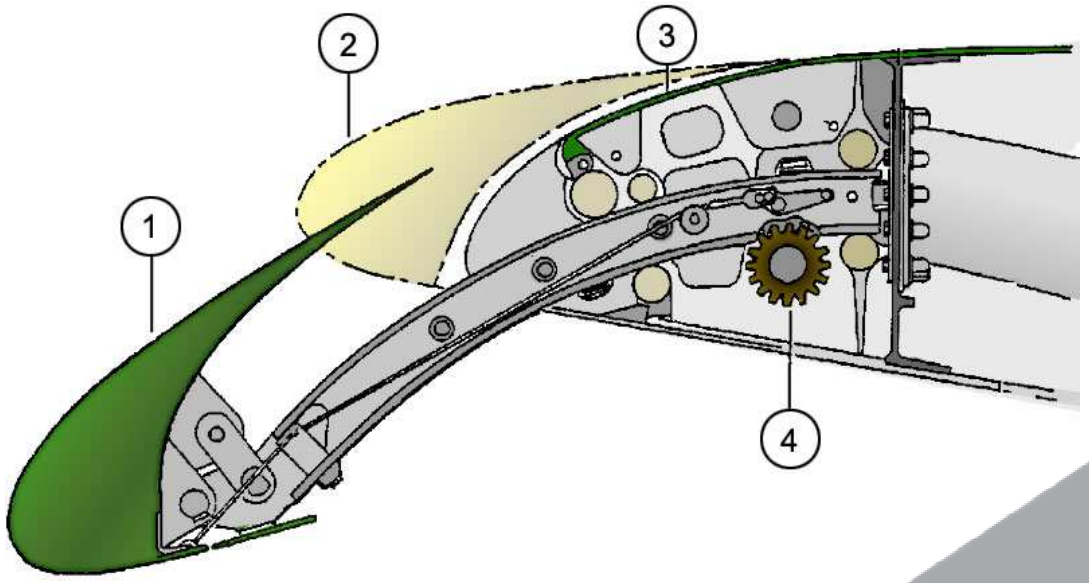
ERJ-190, Runway Overrun, Quito, 17.Sep.2011

Slat Actuator



SLAT MECHANICAL COMPONENTS - SYSTEM OVERVIEW



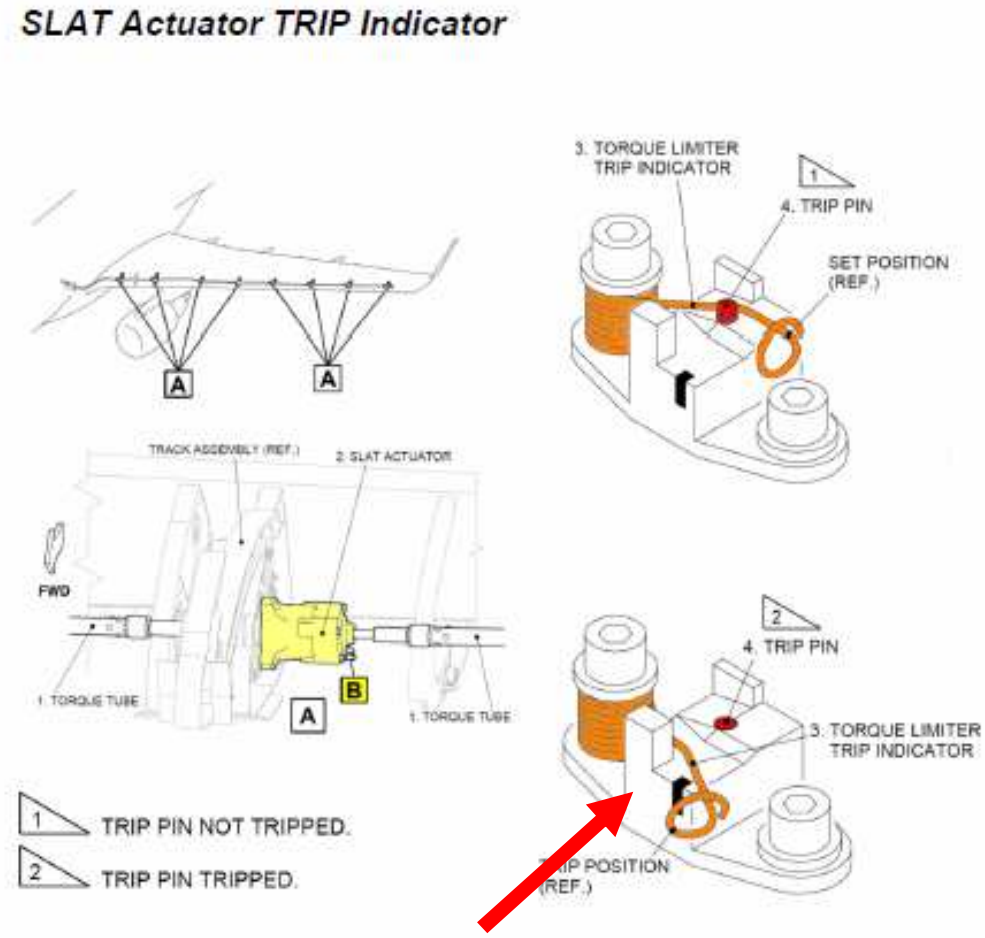


ERJ-190, Runway Overrun, Quito, 17.Sep.2011

Non-Volatile Memories

ERJ-190, Runway Overrun, Quito, 17.Sep.2011

Slat Actuator Trip Indicator

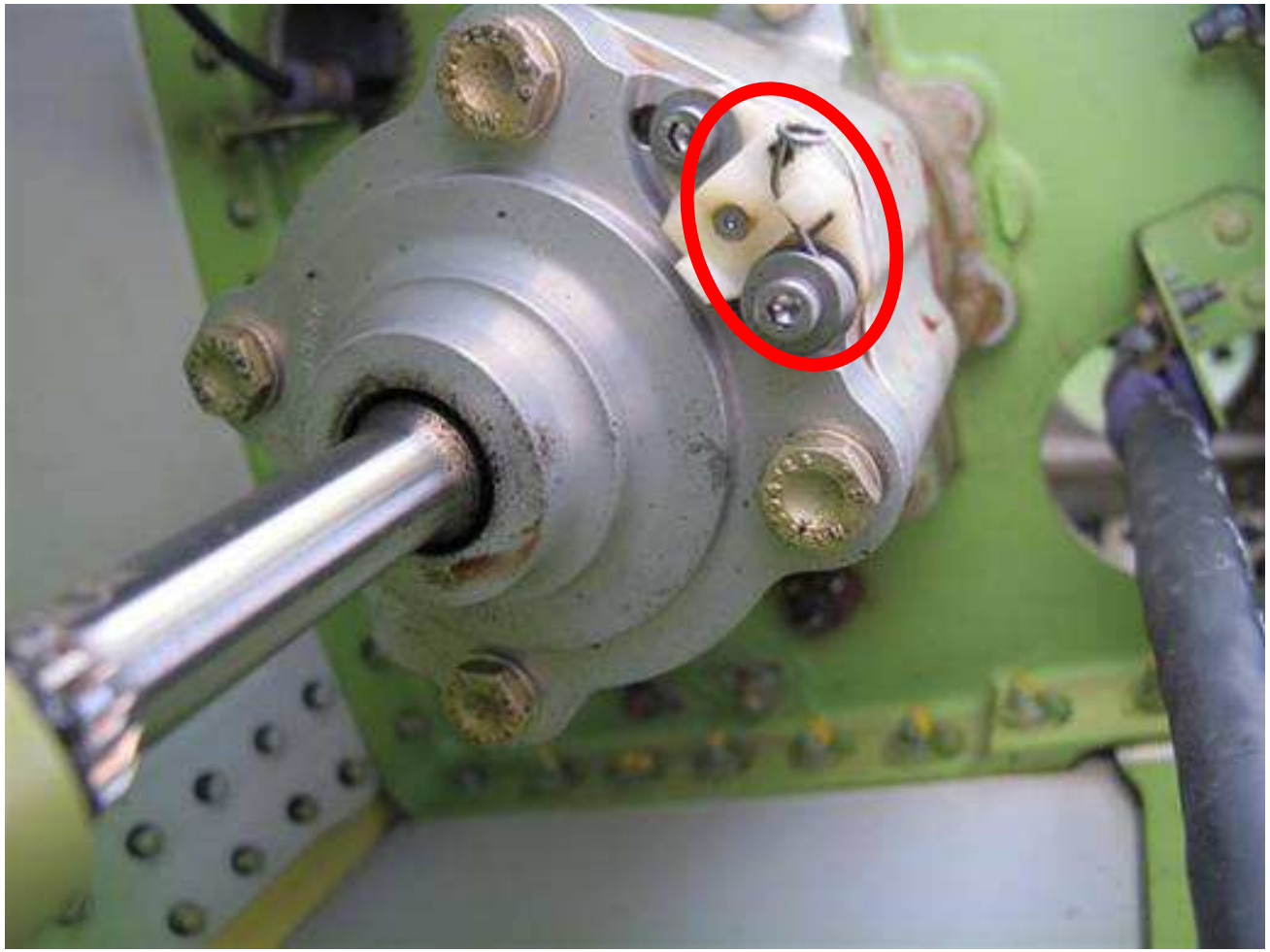


Slat Actuator - General Visual Inspection 27-81-01-210-801-A

EMBRAER

ERJ-190, Runway Overrun, Quito, 17.Sep.2011

Slat Actuator (OTI) OvertorqueTrip Indicator



Embraer Actions

EMBRAER

SERVICE BULLETIN

FLIGHT CONTROLS - SLAT ACTUATOR REPLACEMENT - SEALING MODIFICATION

(3) EXPECTED BENEFITS

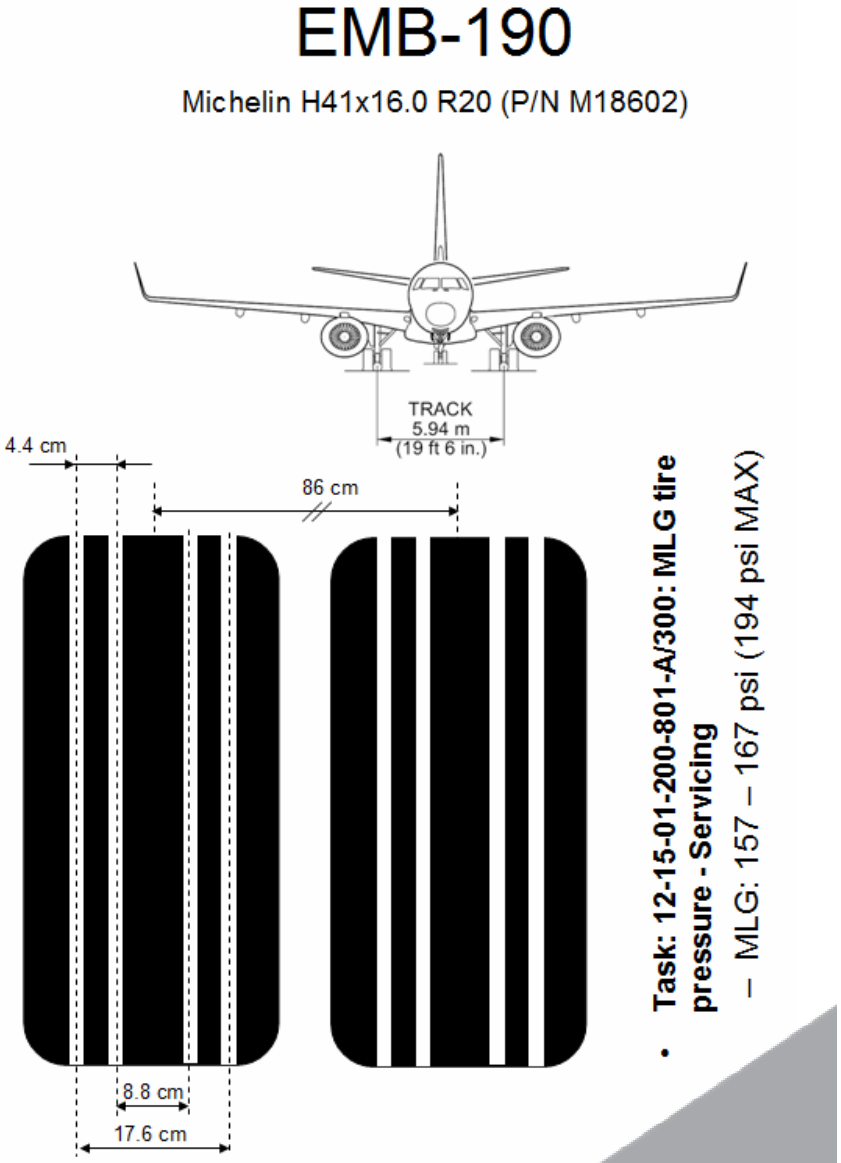
This modification is intended to prevent moisture ingress and provide improved reliability of the actuator and, consequently, reduce the instances of the SLAT FAIL CAS messages displayed on the EICAS.

DATE: 23/Dec/2010
REVISION No.:

SB No.: 190-27-0031
PAGE: 1 of 57

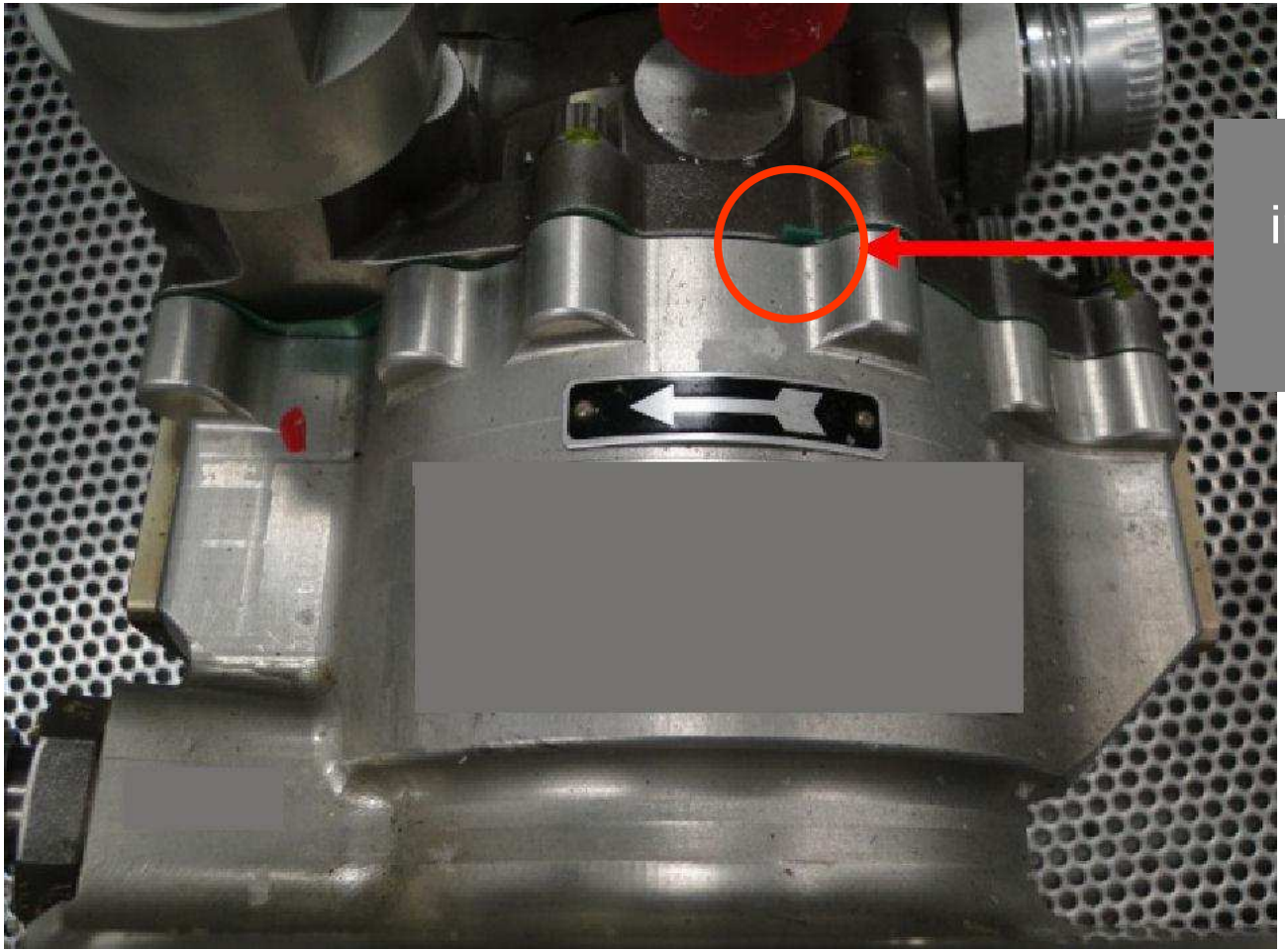
The initial action on crash site

Tire marks on the runway (Footprint)



The initial action on crash site

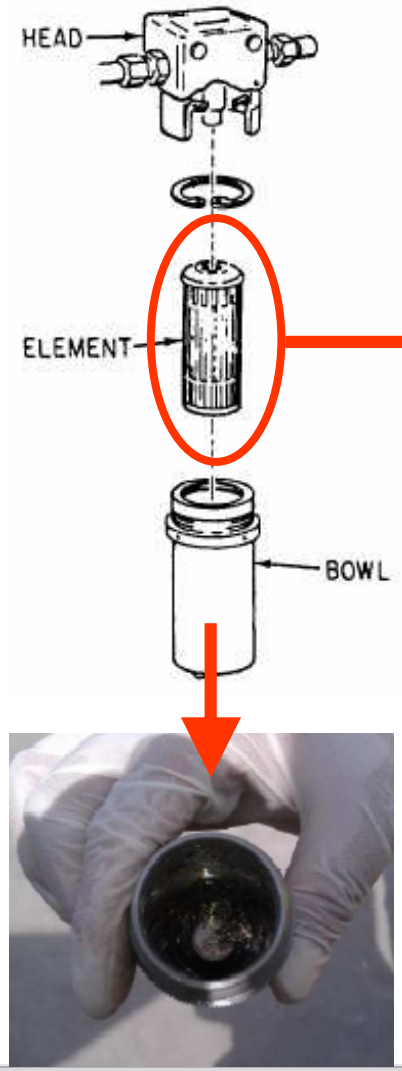
Example: Hydraulic Pumps

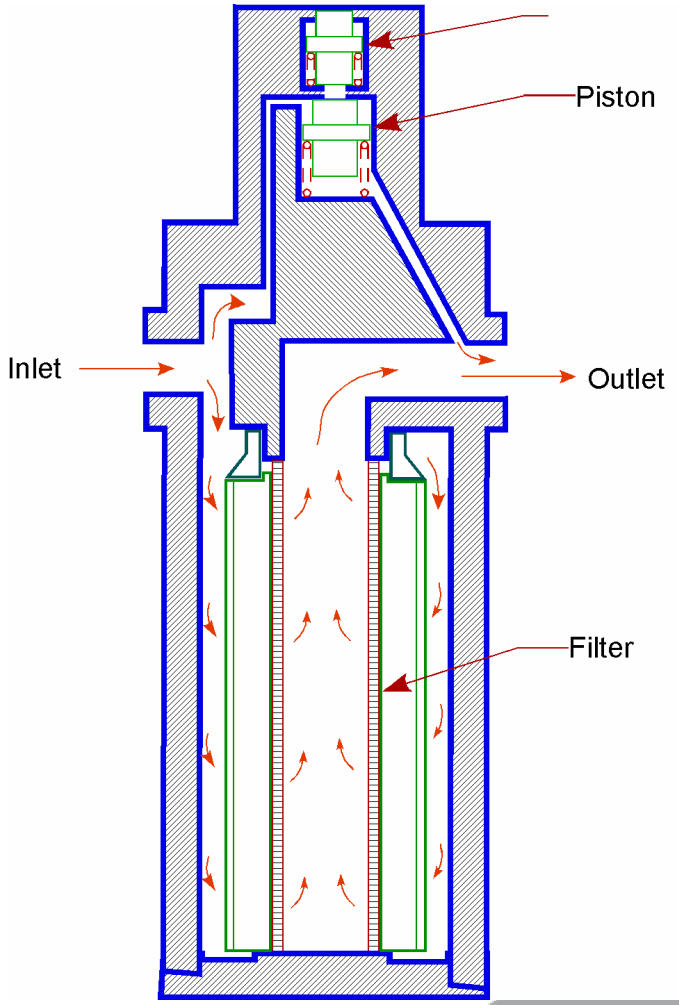


Gasket extruded indicating an above specification case drain pressure

The initial action on crash site

Example: Hydraulic Filters





The initial action on crash site

Example: Hydraulic Filters

DPI = Differential Pressure Indicator

The initial action on crash site

List of the components to be remove from aircraft Example: Brake System

APPENDIX B – EQUIPMENT PART LIST

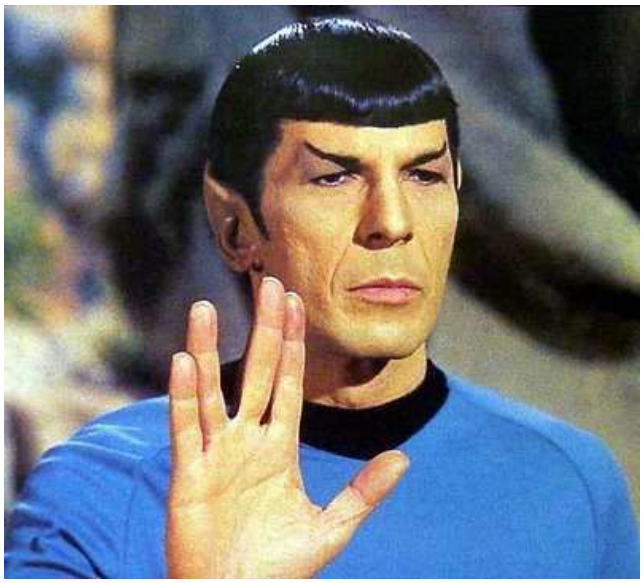
ITEM	EQUIPMENT DESCRIPTION	P/N	SUPPLIER	WEIGHT (kg)	LOCATION	QTY PER A/C
1	Pedal Position Transducer	Q3008	Curtiss Wright	0.277	Pedal mechanism	2
2	Brake Control Unit	90005034-1	MABS	1.406	Rear fuselage	1
		90005034-2	MABS	1.406	Rear fuselage	1
		90005034-3	MABS	1.406	Rear fuselage	1
		90005034-4	MABS	1.406	Rear fuselage	1
3	Main Brake Shutoff Valve	90005027	MABS	0.408	Wing fuselage fairing	1
4	Brake Control Valve	90005035-1	MABS	0.676	Wing fuselage fairing	2
		90005035-2	MABS	0.676	Wing fuselage fairing	2
5	Main Brake System Pressure Transducer	90005191-1	MABS	0.113	Wing fuselage fairing	2
6	Wheel Speed Transducer	90005036	MABS	0.218	Main landing gear axle	2
7	Check Valve	1049-8-6	Tactair	0.046	Wing fuselage fairing	1
8	Emergency / Parking Brake Valve	11056-1	Tactair	0.950	Wing fuselage fairing	1
		11056-5	Tactair	0.950	Wing fuselage fairing	1

Topics

- **How Embraer is prepared to assist the investigations conducted by the national authorities;**
- The Embraer air safety team
- The interface with CENIPA and other authorities
- The initial action on crash site
- **The challenge of the aircraft growing complexity**
- The challenge of software investigation
- The Embraer resources for investigations

The challenge of the aircraft growing complexity

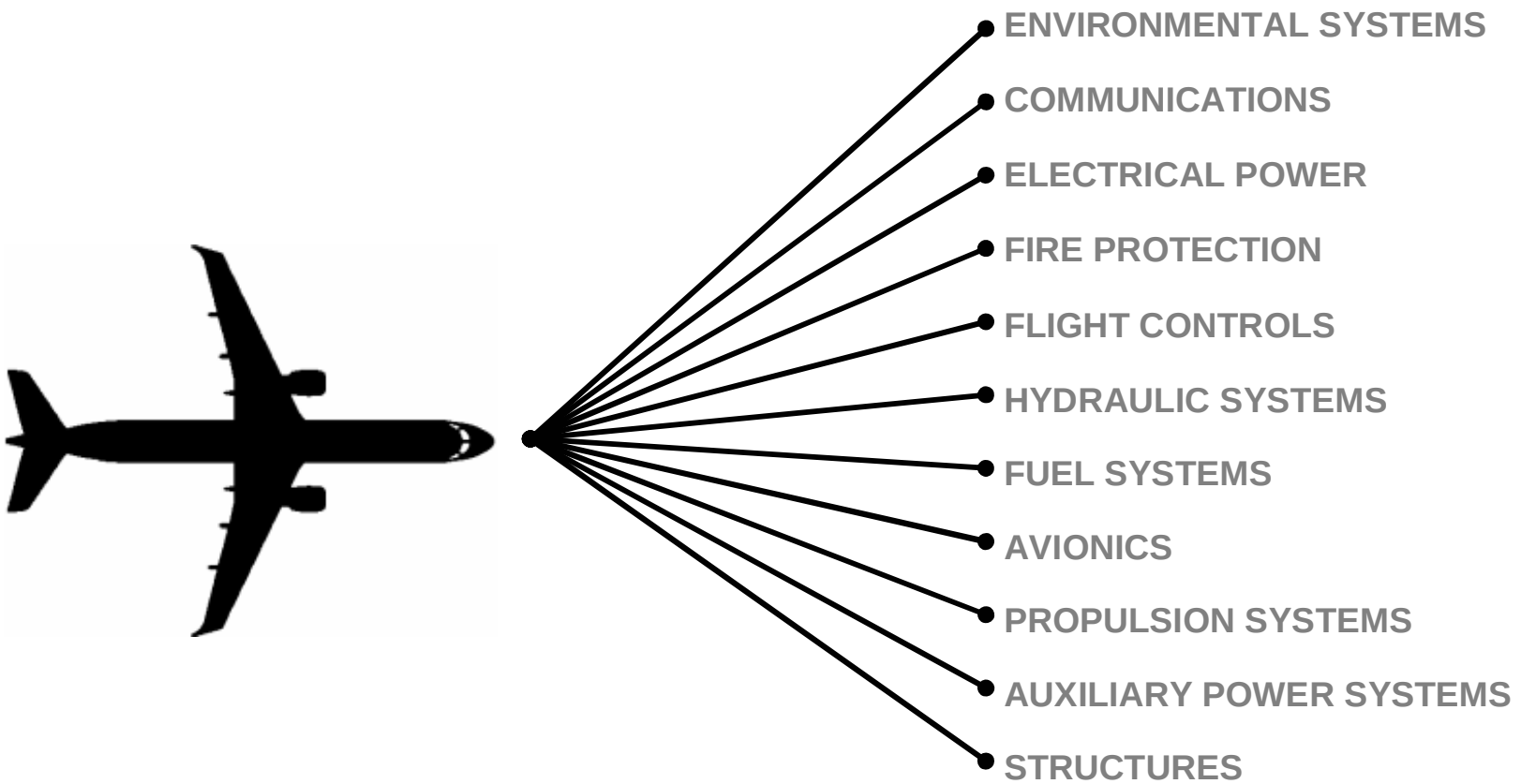
The challenge of the aircraft growing complexity



If you don't have
"Spock"
in your team ...

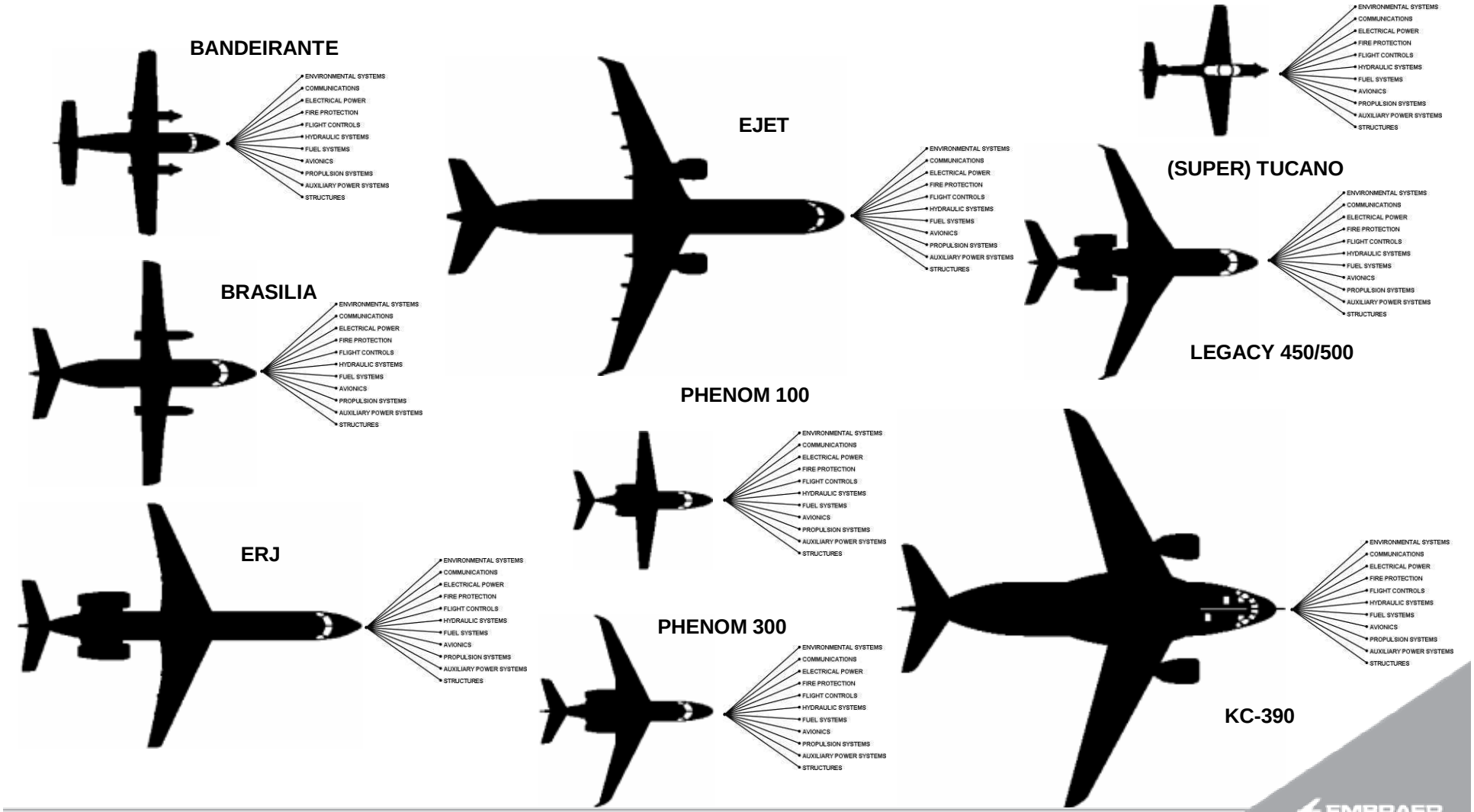
The challenge of the aircraft growing complexity

Aircraft Systems: Diversity of technologies

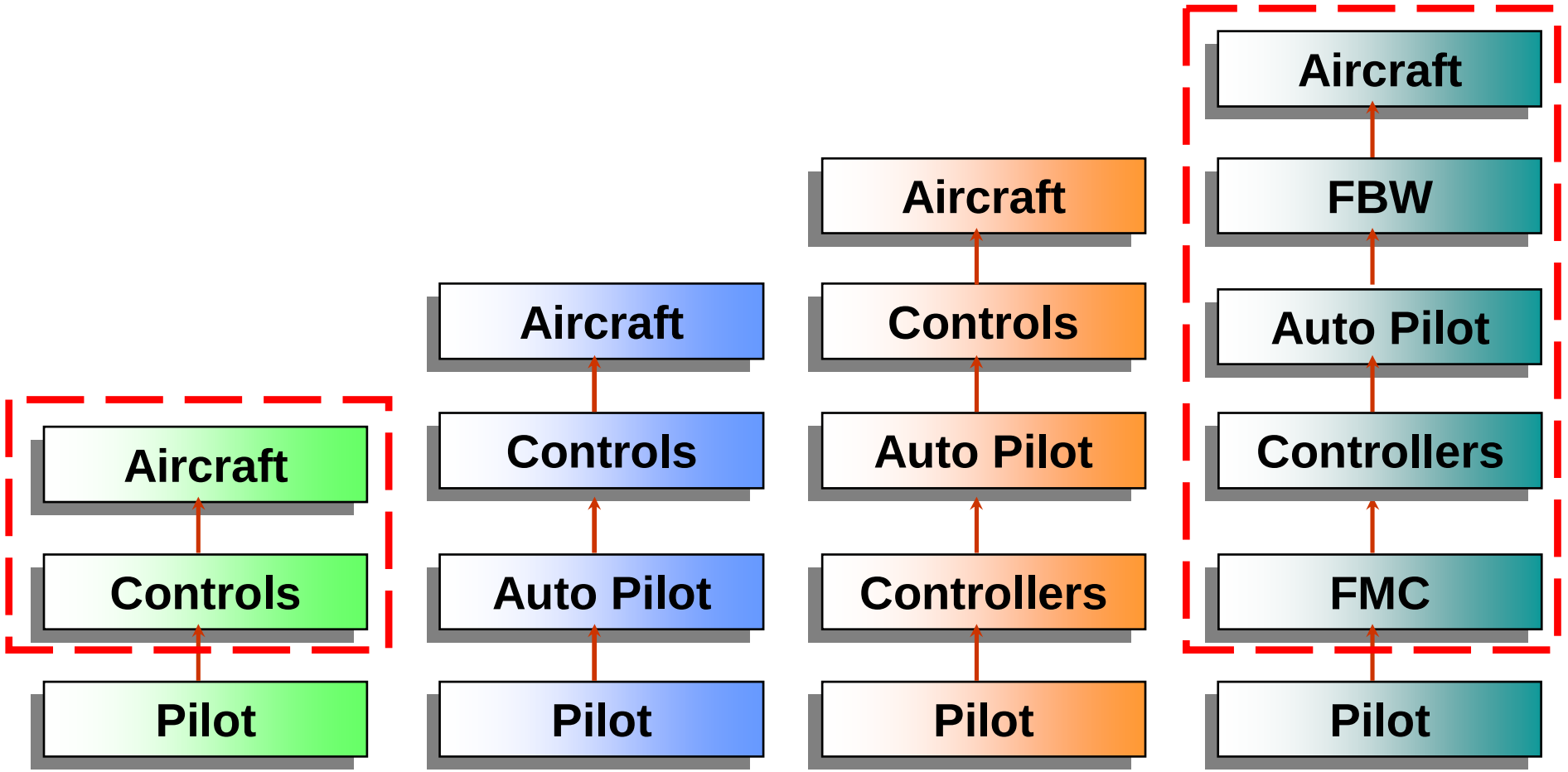


The challenge of the aircraft growing complexity

No way for one person to know everything !



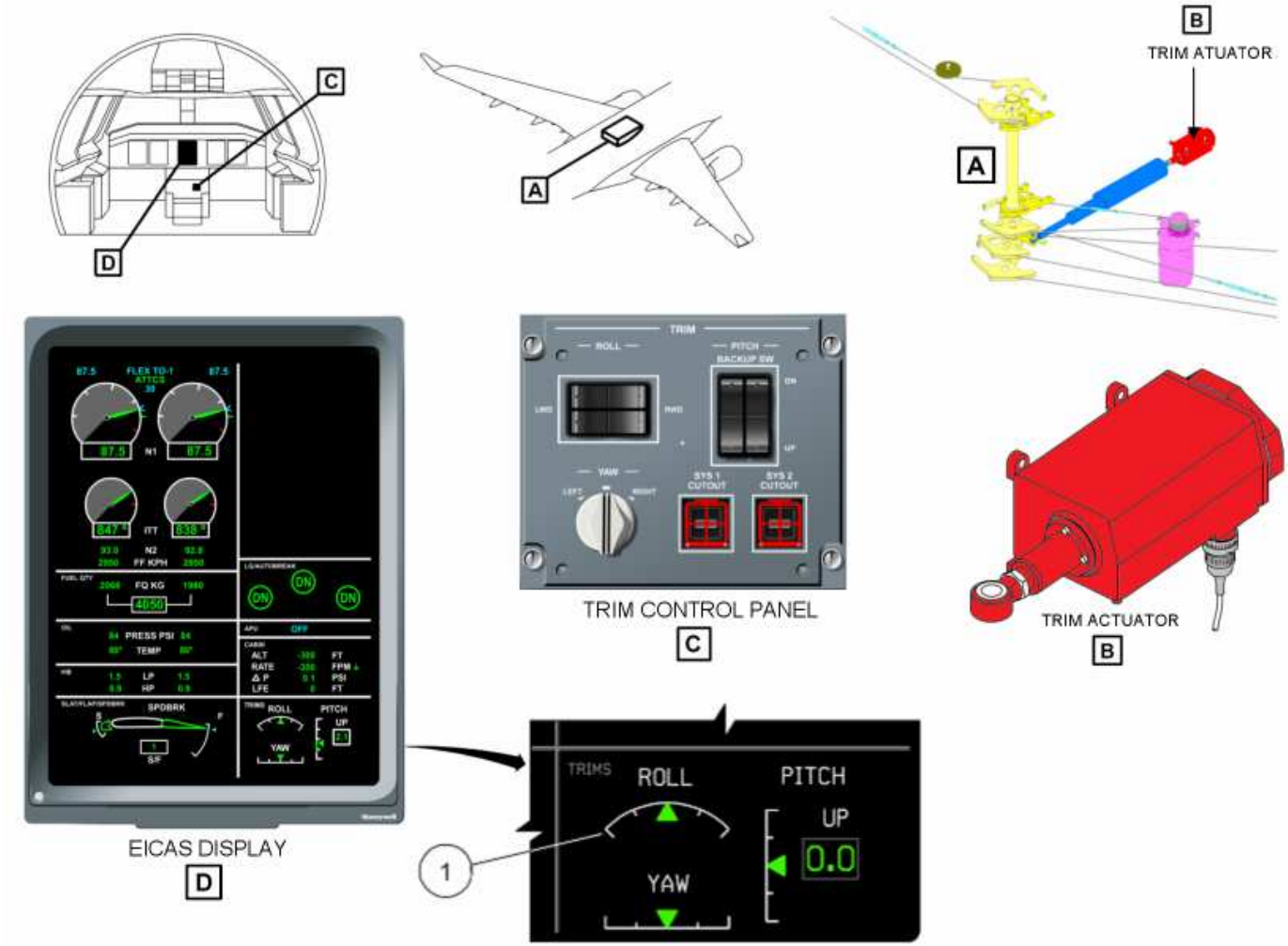
The challenge of the aircraft growing complexity



The challenge of the aircraft growing complexity

Visual Systems Description

Aileron Trim - Aileron Trim Actuator



The challenge of the aircraft growing complexity

Training Videos

Topics

- **How Embraer is prepared to assist the investigations conducted by the national authorities;**
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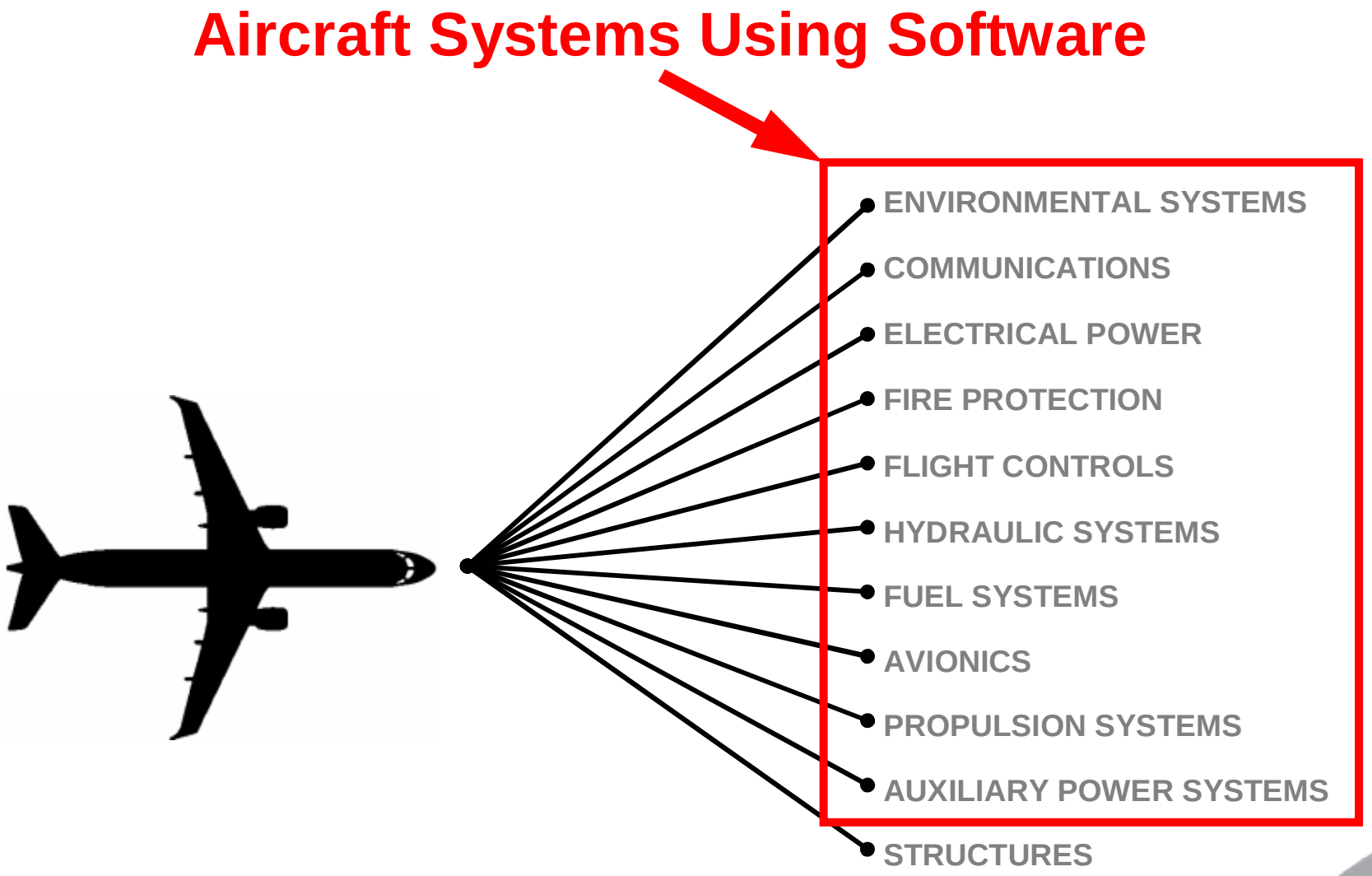
  - **The challenge of software investigation**
  - The Embraer resources for investigations

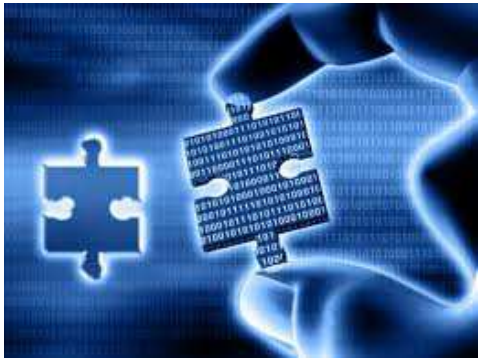
Software investigation: The challenge



Software investigation: The challenge

“Historically, the emphasis during investigations of aircraft accidents has been on pilot error and/or mechanical failures.

Given the dominant role that software plays in today’s aircraft and air traffic control systems, this emphasis is slowly changing to include software.”



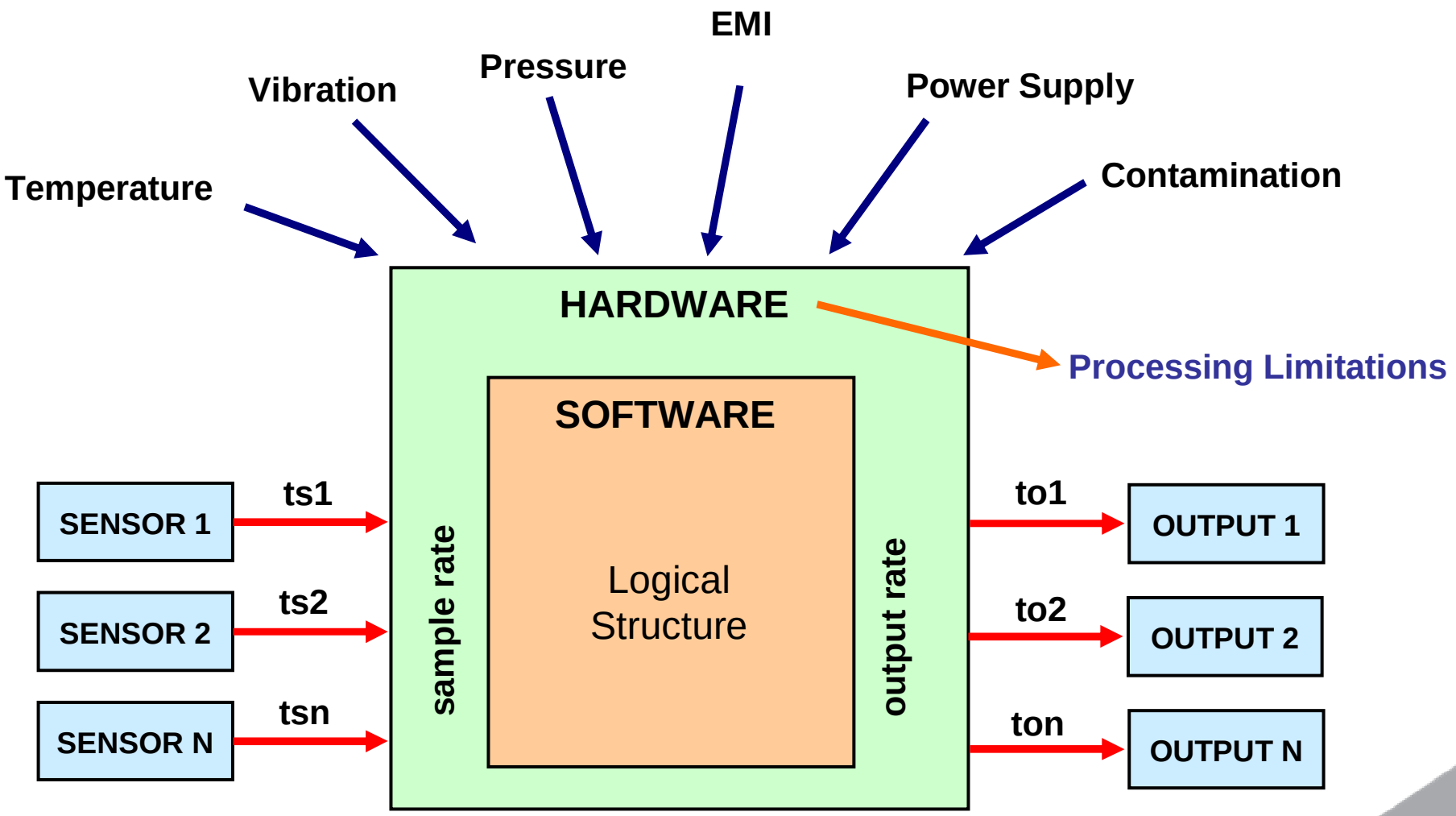
Source: “Software Safety and Reliability”, Debra S. Herrmann, IEEE Computer Society, 1999

Software investigation: The challenge

Important considerations about software

- Software is invisible, intangible, abstract
- There are no physical laws underlying software behaviour
- There are no physical constraints on software complexity
- Software never wears out, traditional reliability measures don’t apply
- Software can be replicated perfectly, no manufacturing variability

Software investigation: The challenge



Topics

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  - The challenge of software investigation
- **The Embraer resources for investigations**

Recorders Guide Card

EMBRAER-170/175/190/195 and Lineage

FDR - Flight Data Recorder *and* CVR - Cockpit Voice Recorder

BASIC DATA

In this aircraft family, both FDR and CVR functions are combined in a single unit called Digital Voice and Data Recorder (**DVDR**), manufactured by Honeywell. In some specific aircraft, variant installation uses similar unit manufactured by L3 Comm and is called Cockpit Voice and Data Recorder (**CVDR**). Two identical DVDR (or CVDR) units are installed in this aircraft model.

Dataframe: 256 wps

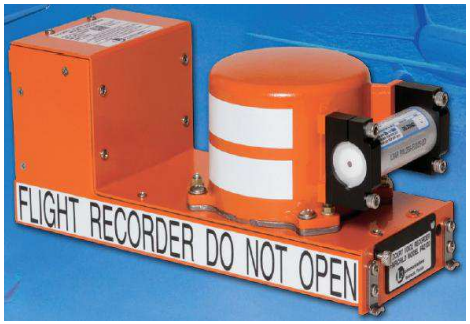
Recorded Parameters: aprox. 850

Dataframe Specification documents: 170EBD047 for Embraer-170/175
190EBD018 for Embraer-190/195

DVDR Honeywell (standard)

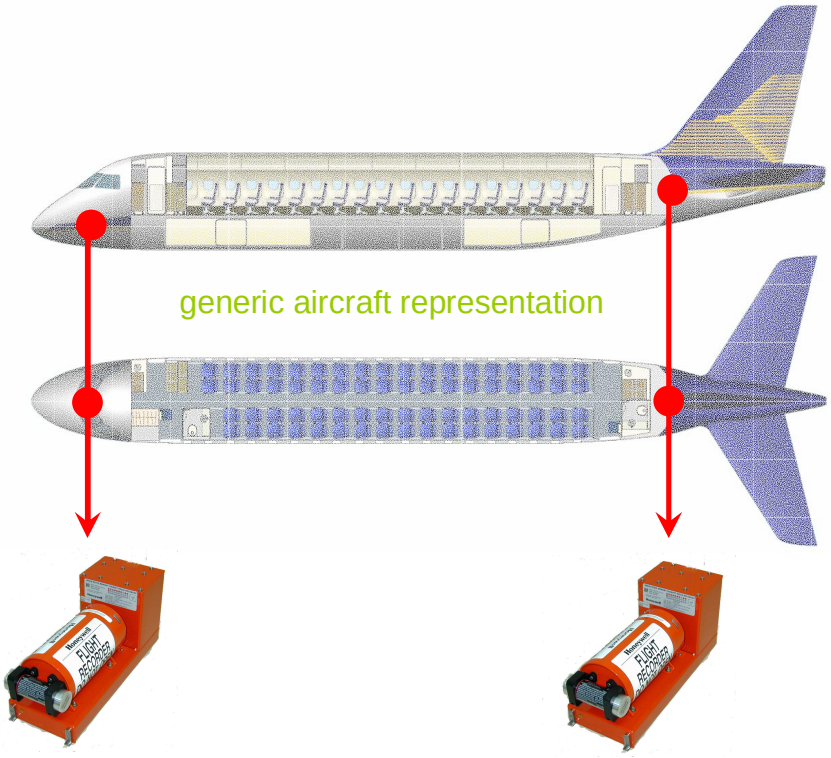
- Part Number: 980-6025-001
- Model: N/A
- Recording: 25h of flight data
  2h of audio

CVDR L3 Comm (variant)



- Part Number: 2100-3083-10
- Model: FA2100
- Recording: ~ 60h of flight data
  2h of audio
- Alitalia, Hainan

LOCATION



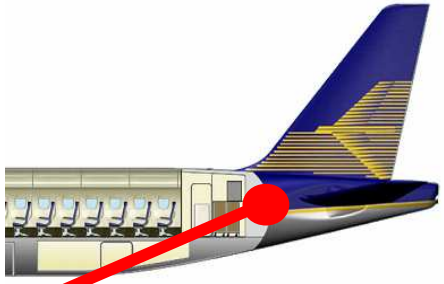
Forward Avionics Compartment

Aft Avionics Compartment (Behind Aft Galley)

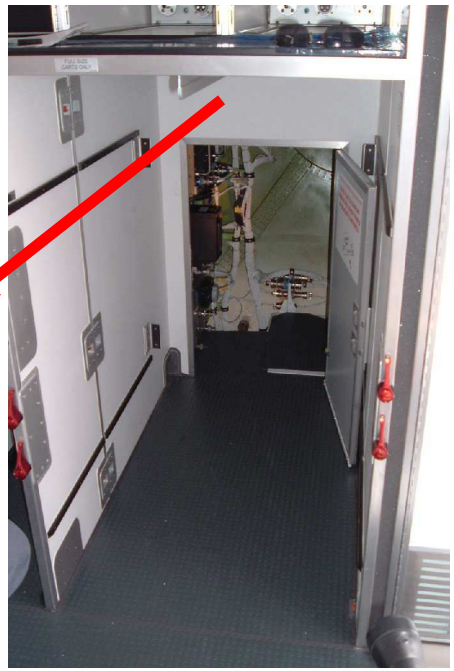
EMBRAER-170/175/190/195 and Lineage

FDR - Flight Data Recorder *and* CVR - Cockpit Voice Recorder

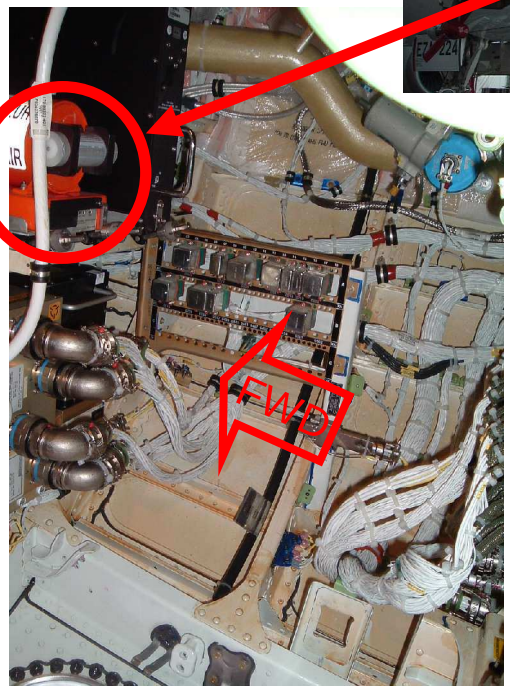
ACCESS – REAR UNIT



Rear Galley
(Trolleys Removed)



ACCESS – FRONT UNIT



Forward
Avionics
Compartment

EMBRAER-170/175/190/195 and Lineage

FDR - Flight Data Recorder *and* CVR - Cockpit Voice Recorder

LINEAGE ACCESS TO DVDR REAR UNIT

Rear Bagagge Compartment

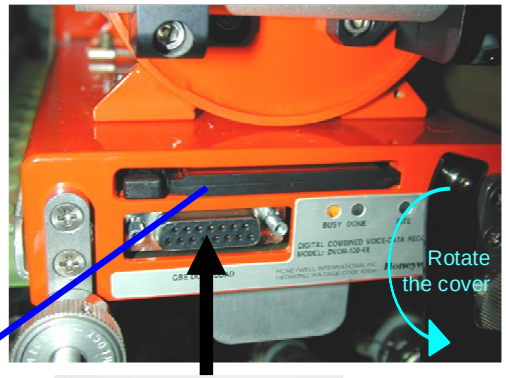
EMBRAER-170/175/190/195 and Lineage

FDR - Flight Data Recorder and CVR - Cockpit Voice Recorder

Downloading FDR Data

Honeywell DVDR

The Honeywell DVDR has an built-in PCMCIA slot which enables the user to download the data recorded in FDR portion by using only a memory card (task number 31-31-00-970-801-A). **Alternatively**, it is also possible to download the FDR data by using a Hand Held Download Unit (HHDLU) connected to the RS-422 interface connector on the DVDR unit front panel (task number 31-31-00-970-802-A). **CVR audio can not be downloaded on wing**.



PCMCIA Card

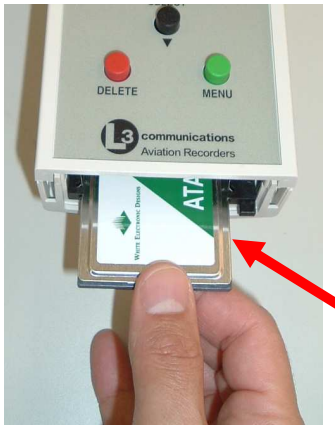
Note: the PCMCIA card must contain a specific file inside, a file called 'atc_key.txt'. Otherwise the download data will be encrypted and EMBRAER does not have any toll to decrypt the data.

Honeywell Hand Held Download Unit
PN: 964-0446-021

L3 Comm CVDR

The L3 Comm CVDR does not have the PCMCIA slot facility for FDR download. The download must be done by using the FA2100 Portable Interface Unit. Refer to Alitalia AMM task number 31-31-00-970-802-A.

Loosen the screw to open the cover to get access to the DVDR connector.

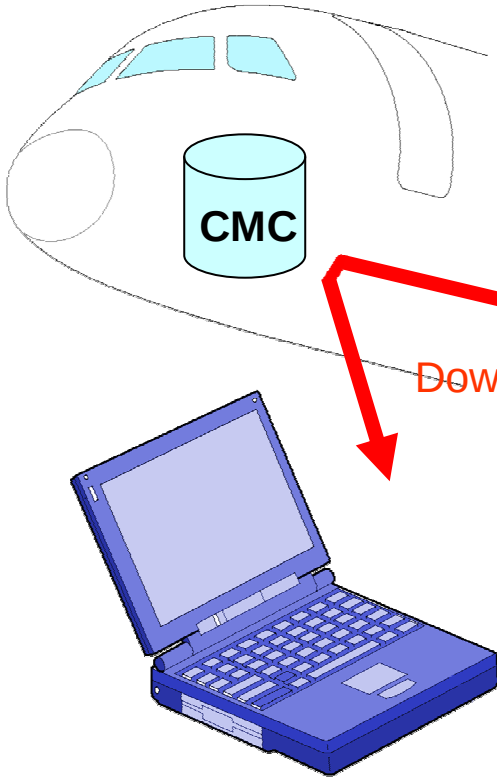


L3 Comm Po
PN

EMBRAER-170/175/190/195 and Lineage

CMC – Central Maintenance Computer (On-Board Diagnostics System)

Downloading CMC data



DMU – Optional Equipment

EMBRAER-170/175/190/195 and Lineage

QAR – Quick Access Recorder

Location

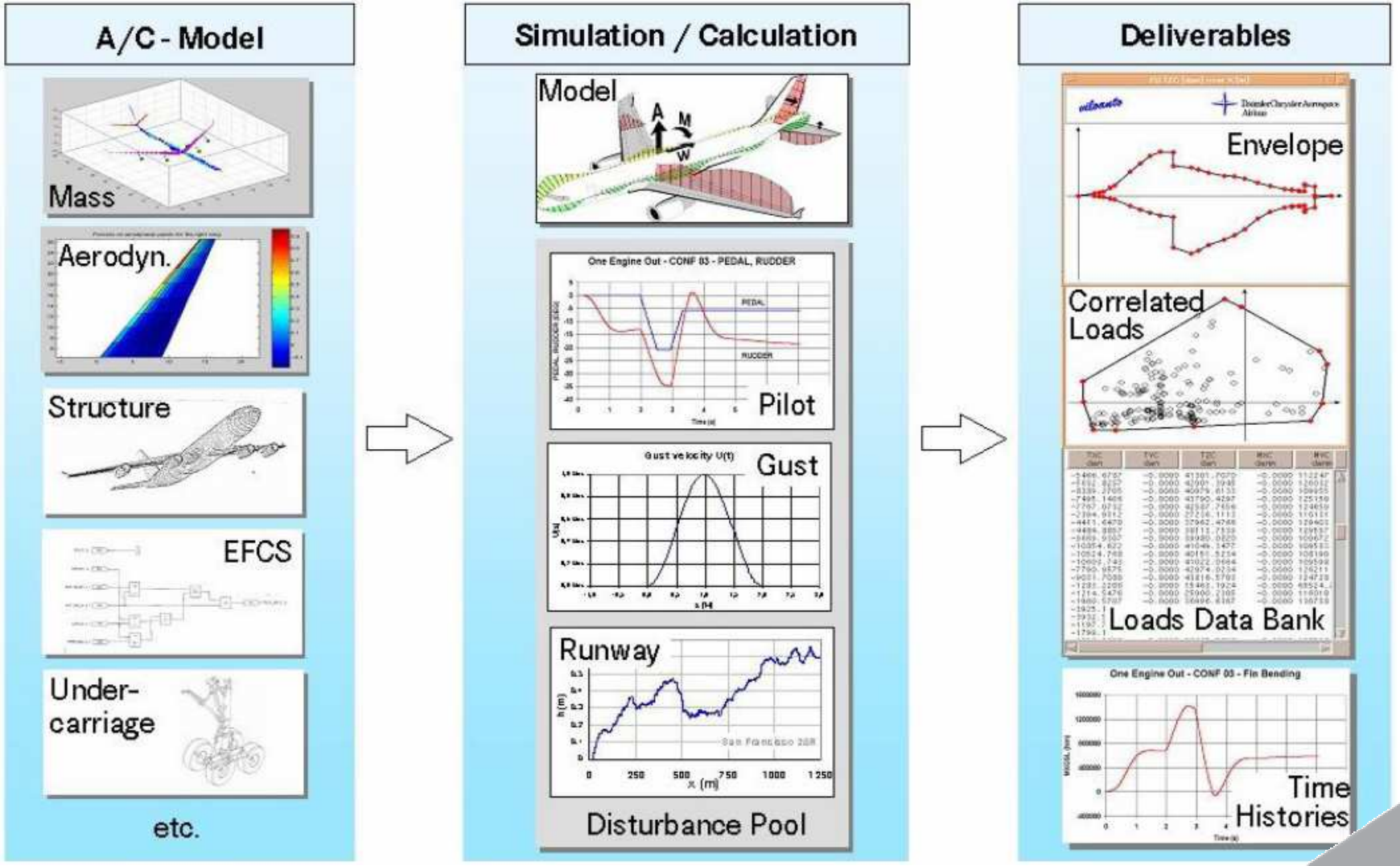
Avionica Mini QAR

Sagem QAR

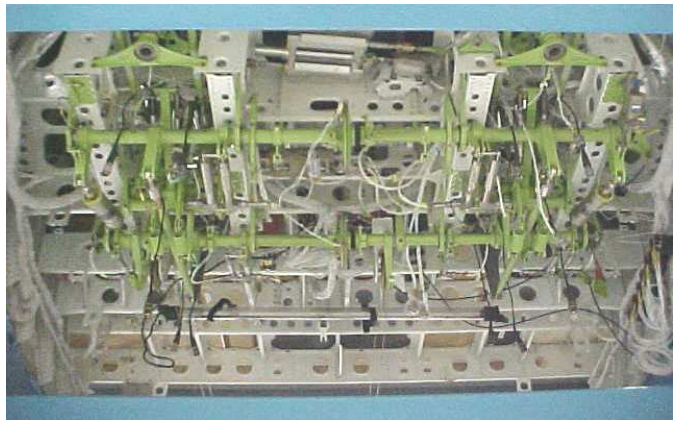
Teledyne QAR

Sagem QAR	**Teledyne QAR**	**Avionica Mini QAR**
P/N ED35E109-04-00	P/N 2235400-06	P/N 804-0105-03
Delivered by EMBRAER	Alitalia, Hainan	Flybe
~1200 parameters	~2000 parameters	
512 wps	1024 wps	
Data frame Docs.:	Data frame Docs.:	
170EBD062 (170)	ARD-ACAA01-IDMU	
190EBD203 (190)	(issued by Teledyne)	

Computer Simulations



Iron Birds & Integration Labs



Iron Birds & Integration Labs

Example: Legacy N600XL and 737 Collision

COMANDO DA AERONÁUTICA
ESTADO-MAIOR DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO
DE ACIDENTES AERONÁUTICOS

RELATÓRIO FINAL
A-022/CENIPA/2008

OCORRÊNCIA: ACIDENTE AERONÁUTICO

AERONAVES: PR – GTD e N600XL

MODELOS: B- 737 8EH e EMB-135 BJ LEGACY

DATA: 29 SET 2006

Legacy N600XL and 737 Collision

Legacy N600XL and 737 Collision

Tests at Cachimbo FAB Air Force Base

Iron Birds & Integration Labs

RF A-022/CENIPA/2008		PR- GTD / N600XL	29 SET 2006

Figura 5. Bancada de integração Primus 1000

Figura 6. Bancada de integração Primus 1000 e TCAS

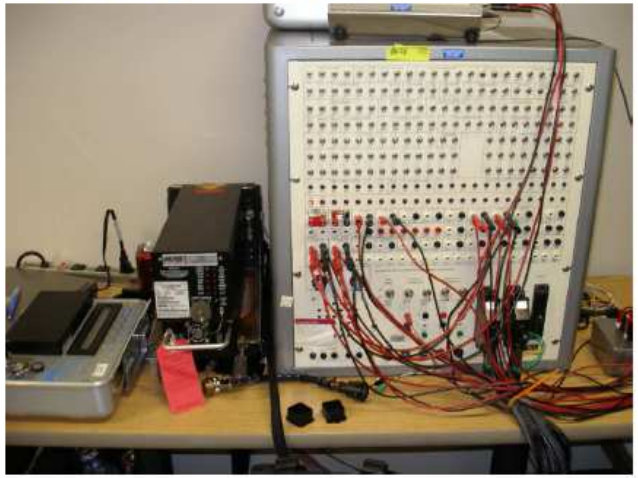


Figura 7. Bancada TCAS

Figura 8. Bancada Primus II (Radio Navegação)

Legacy N600XL and 737 Collision

(Information based on: Final Report A-022/CENIPA/2008)

FR A-022/CENIPA/2008	PR-GTD and N600XL	29 SEPT 2006

The following possible hypotheses were listed in the attempt to explain this fact:

- ~~Intentional switch-off of the Transponder by the crew;~~ → **Discarded**
- ~~Transponder failure (continuous or intermittent)~~ → **Discarded**
- ~~Inadvertent switch-off, through the handling of the Laptop;~~ → **Discarded**
- ~~Inadvertent switch-off, through the use of the *footrest*; and~~ → **Discarded**
- **Inadvertent switch-off, during familiarization/operation of the RMU.**

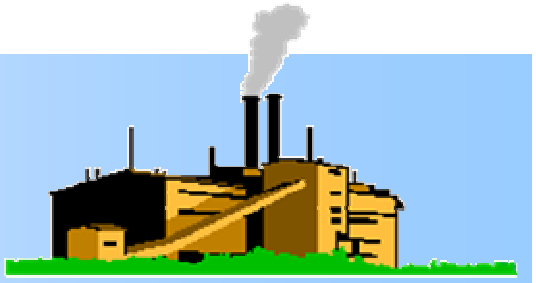
The hypothesis above was considered the most likely to have occurred

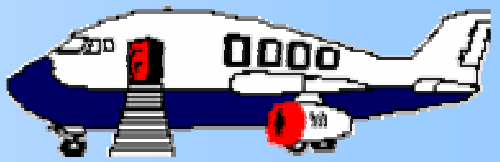
241/266

EMBRAER

More than “machine” and not only “manufacturer”

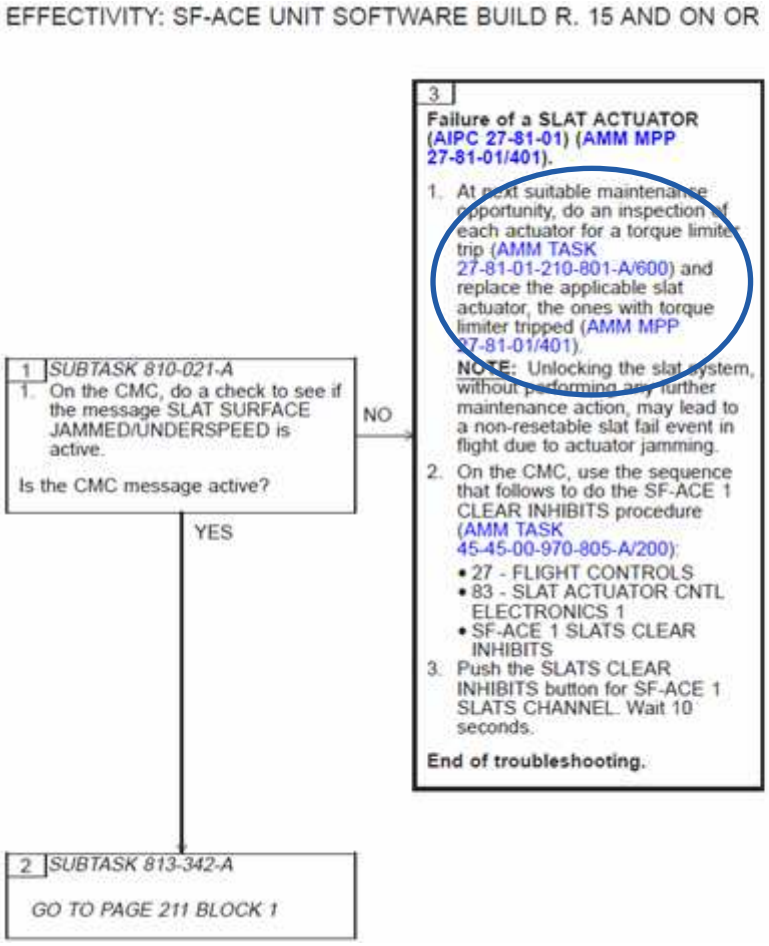
- Development Process
- Ground and Flight Tests
- Type Certification Process
- Systems, Parts and Components
- Acft Manufacturing & Assembly





- Maintenance Publications
- Operational Publications
- Training Publications
- News Letters
- Technical Support
- Continuing Airworthiness

Operational & Maintenance Publications



EFFECTIVITY: SF-ACE UNIT SOFTWARE BUILD R. 15 AND ON OR

1 SUBTASK 810-021-A

1. On the CMC, do a check to see if the message SLAT SURFACE JAMMED/UNDERSPEED is active.

Is the CMC message active?

NO

YES

2 SUBTASK 813-342-A

GO TO PAGE 211 BLOCK 1

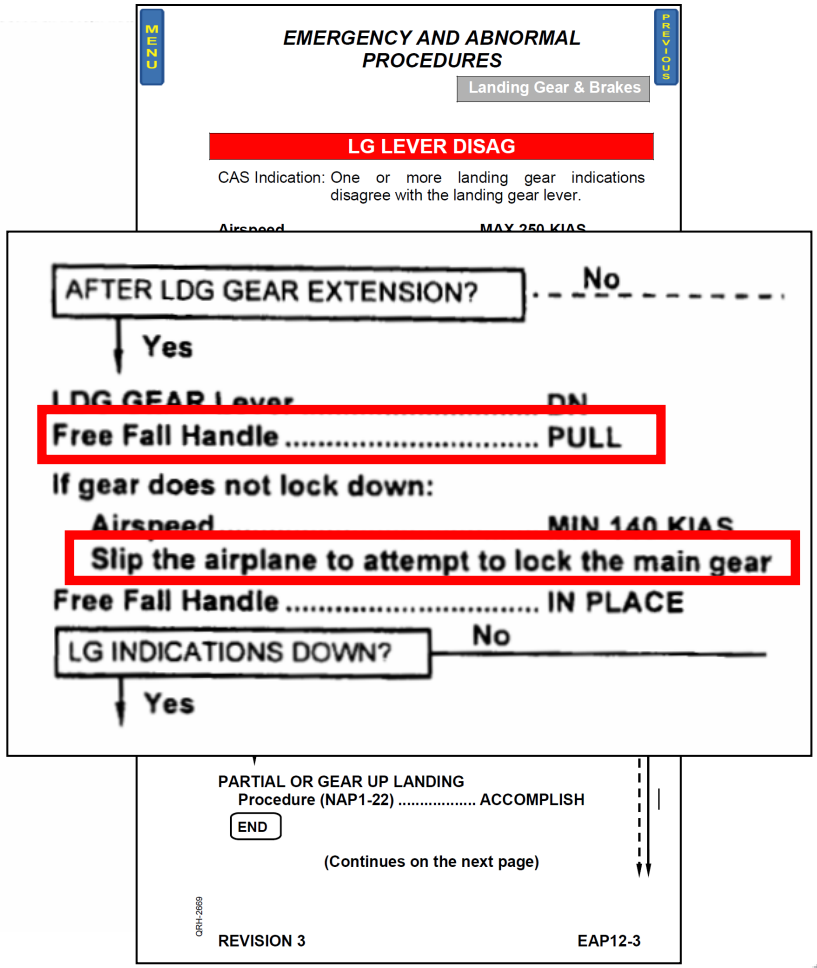
3

Failure of a SLAT ACTUATOR (AIPC 27-81-01) (AMM MPP 27-81-01/401).

1. At next suitable maintenance opportunity, do an inspection of each actuator for a torque limiter trip (AMM TASK 27-81-01-210-801-A/600) and replace the applicable slat actuator, the ones with torque limiter tripped (AMM MPP 27-81-01/401).

   NOTE: Unlocking the slat system, without performing any further maintenance action, may lead to a non-resetable slat fail event in flight due to actuator jamming.
2. On the CMC, use the sequence that follows to do the SF-ACE 1 CLEAR INHIBITS procedure (AMM TASK 45-45-00-970-805-A/200):
   - 27 - FLIGHT CONTROLS
   - 83 - SLAT ACTUATOR CNTL ELECTRONICS 1
   - SF-ACE 1 SLATS CLEAR INHIBITS
3. Push the SLATS CLEAR INHIBITS button for SF-ACE 1 SLATS CHANNEL. Wait 10 seconds.

End of troubleshooting.



MENU

EMERGENCY AND ABNORMAL PROCEDURES

PREVIOUS

Landing Gear & Brakes

LG LEVER DISAG

CAS Indication: One or more landing gear indications disagree with the landing gear lever.

Airspeed ... MAX 250 KIAS

AFTER LDG GEAR EXTENSION? ... No

Yes

LDG GEAR Lever ... DN

Free Fall Handle ..... PULL

If gear does not lock down:

Airspeed ... MIN 140 KIAS

Slip the airplane to attempt to lock the main gear

Free Fall Handle ..... IN PLACE

LG INDICATIONS DOWN? ... No

Yes

PARTIAL OR GEAR UP LANDING Procedure (NAP1-22) ..... ACCOMPLISH

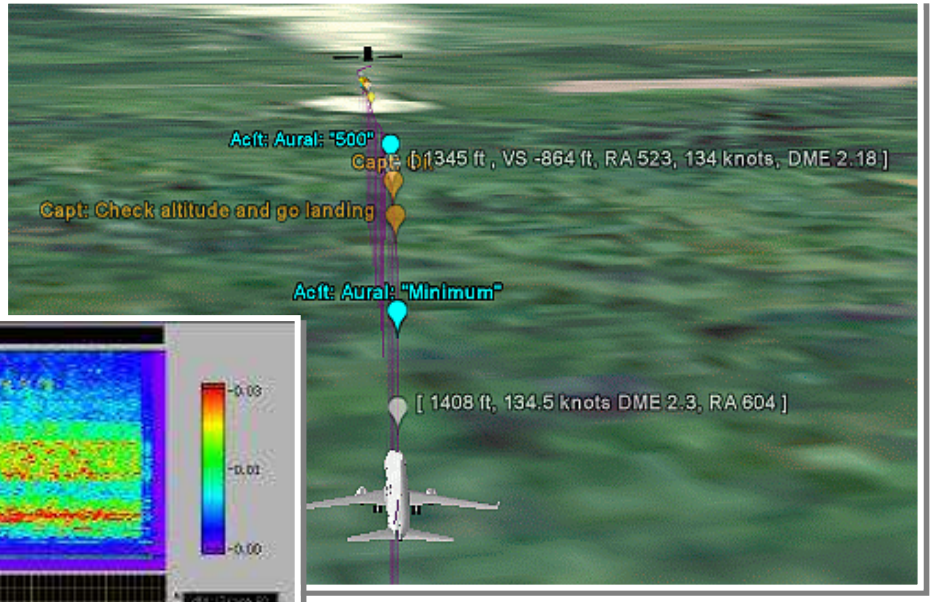
END

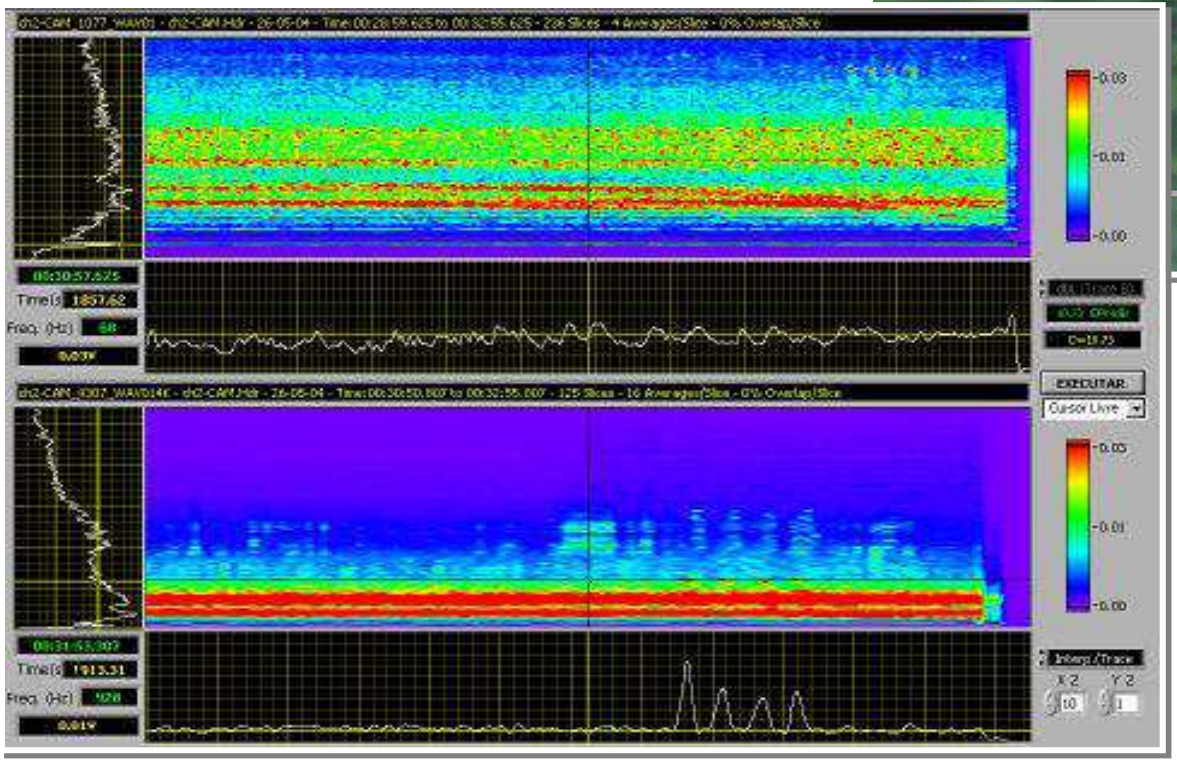
(Continues on the next page)

ORH-2689

CVR Analysis

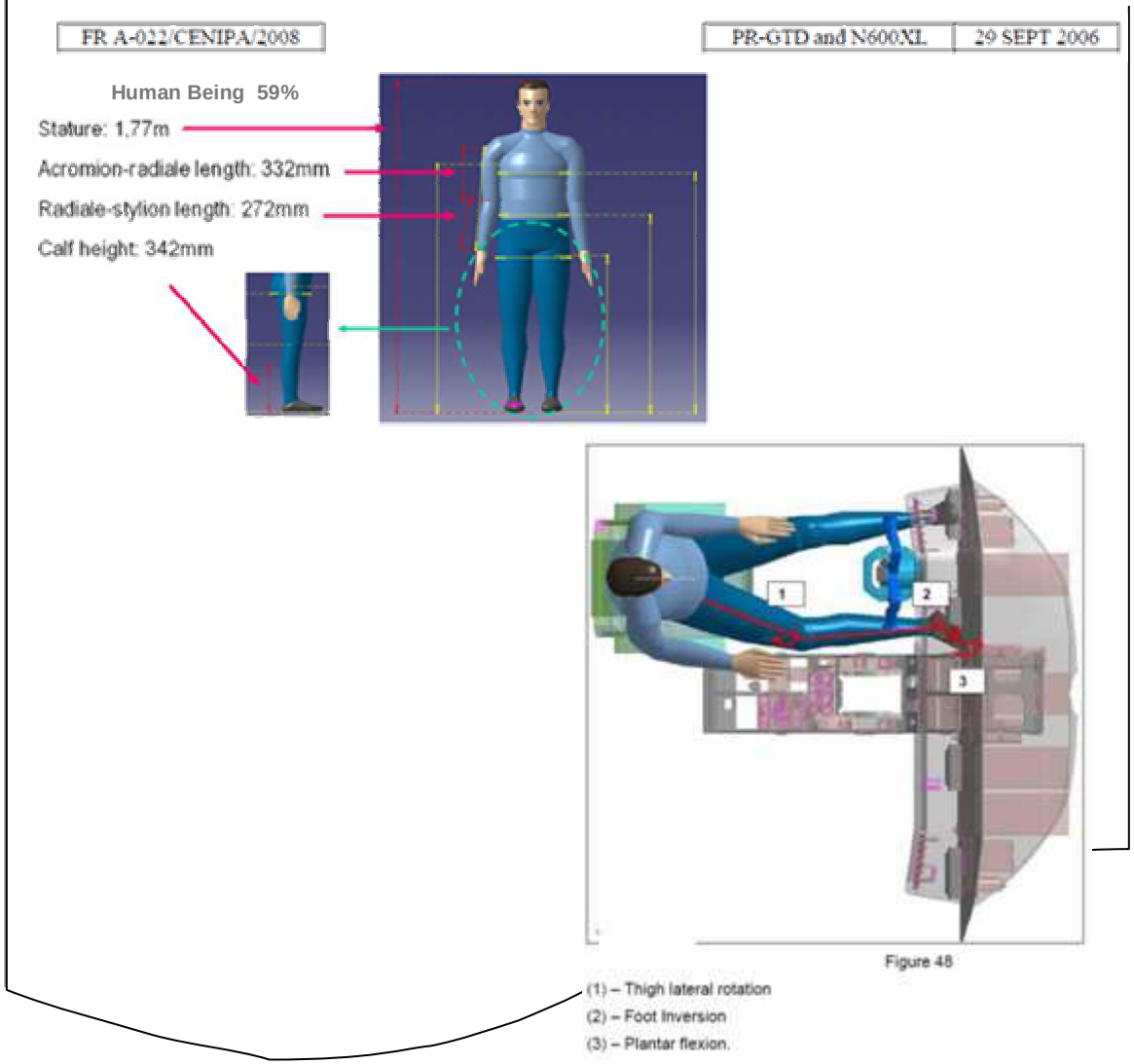
- Transcription (with synchonization)
- Spectral analysis





Working together with the Investigation Authority

Ergonomic Analyses

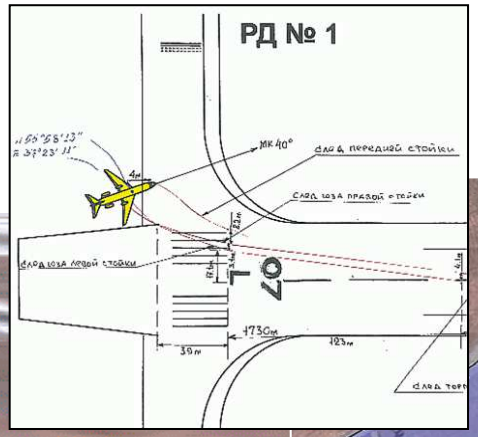


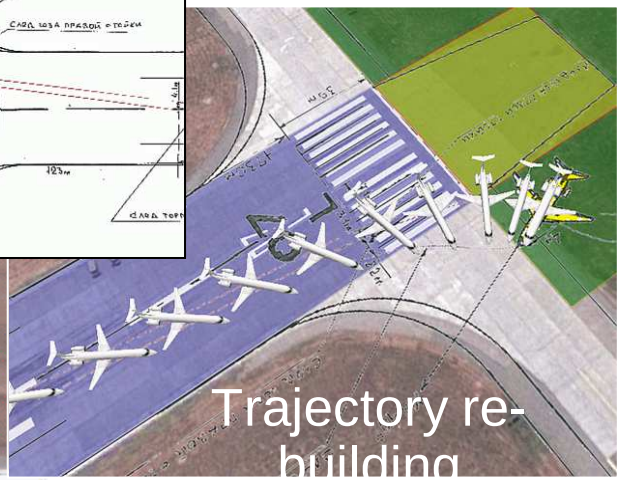
Ergonomic Analysis

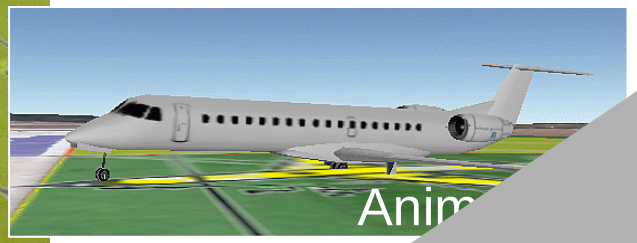
- Thigh flexion;
- Thigh abduction;
- Thigh rotation;
- Leg flexion;
- Leg rotation;
- Planter flexion; and
- Foot invertion.

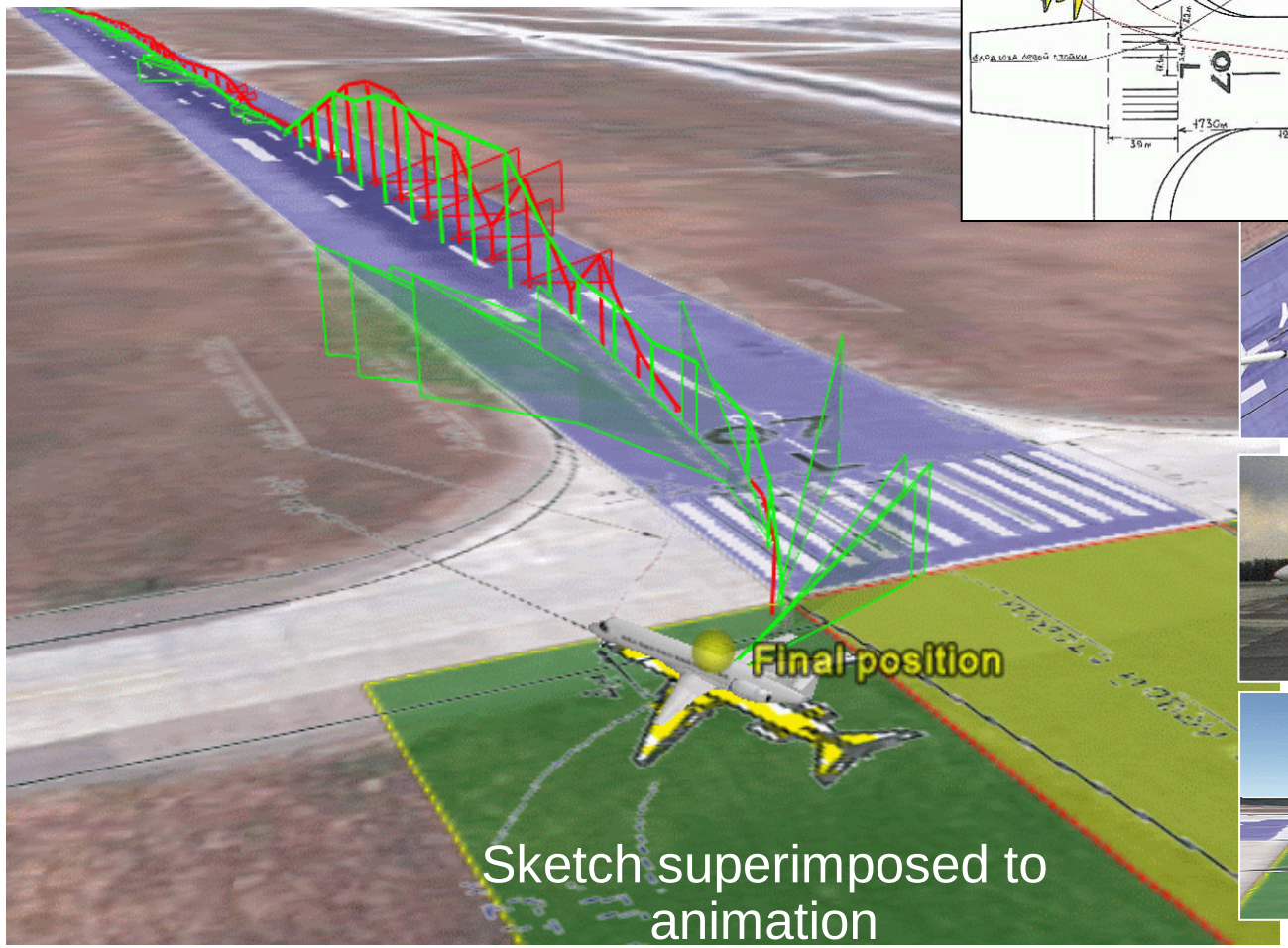
Flight Data Analysis

- Graphical reconstruction
  - From sketches, charts, pictures...









EMBRAER

Flight Data Analysis

Supporting Investigations

- Runway Excursion Events
- Landing NLG Up
- Collision with the ground
- Brake Fail
- Burst
- Runway Overrun
- Others


Questions
EMBRAER
Commercial Jets


THANK YOU !
EMBRAER
Commercial Jets