



BCA Aviation Safety

The Role of the Manufacturer in an Airplane Accident Investigation

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Boeing Commercial Airplanes

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Agenda

Boeing Accident Investigation

- Boeing Information
- Accident Statistics
- Accident Investigation Preparation
- Assistance Provided by Boeing to an Investigation
- Boeing Safety Process



The Boeing Company

- Established in 1916
- First 707 delivered in 1958: 20,300+ total airplanes delivered since,
- ~12500 Active airplanes
- 165,000+ employees world-wide
- 311 Field Reps
- 149 bases

The Boeing Company

Air Safety Investigation

Incidents are majority of work

- **In last 3 years**

- ~300 Incidents
- 26 Accidents
- 17 Launches (these include both incident and accident)

- **Incident sometimes more work than accidents**

- Result in a launch
- Involve lab and analysis work
- Result in a final report

Agenda

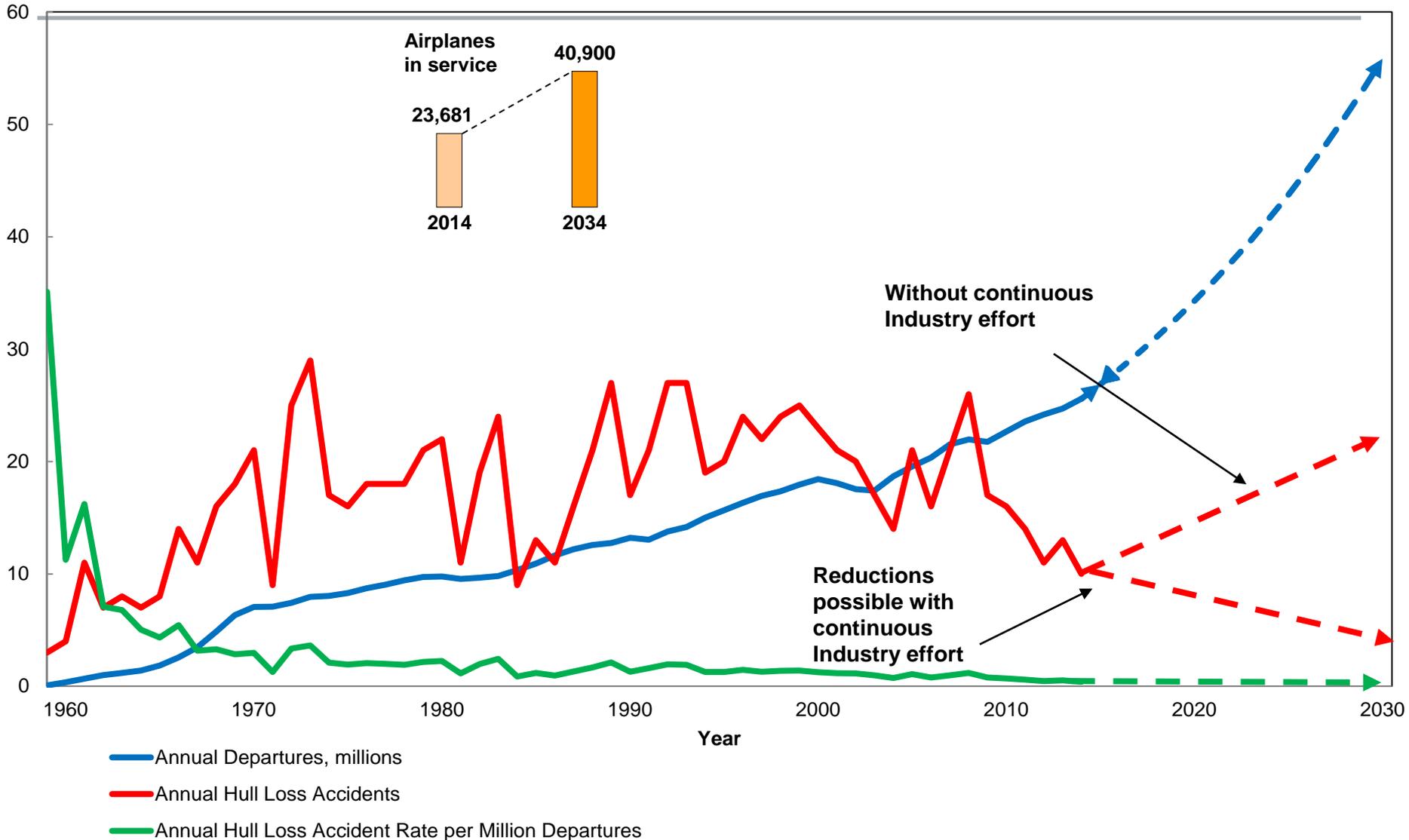
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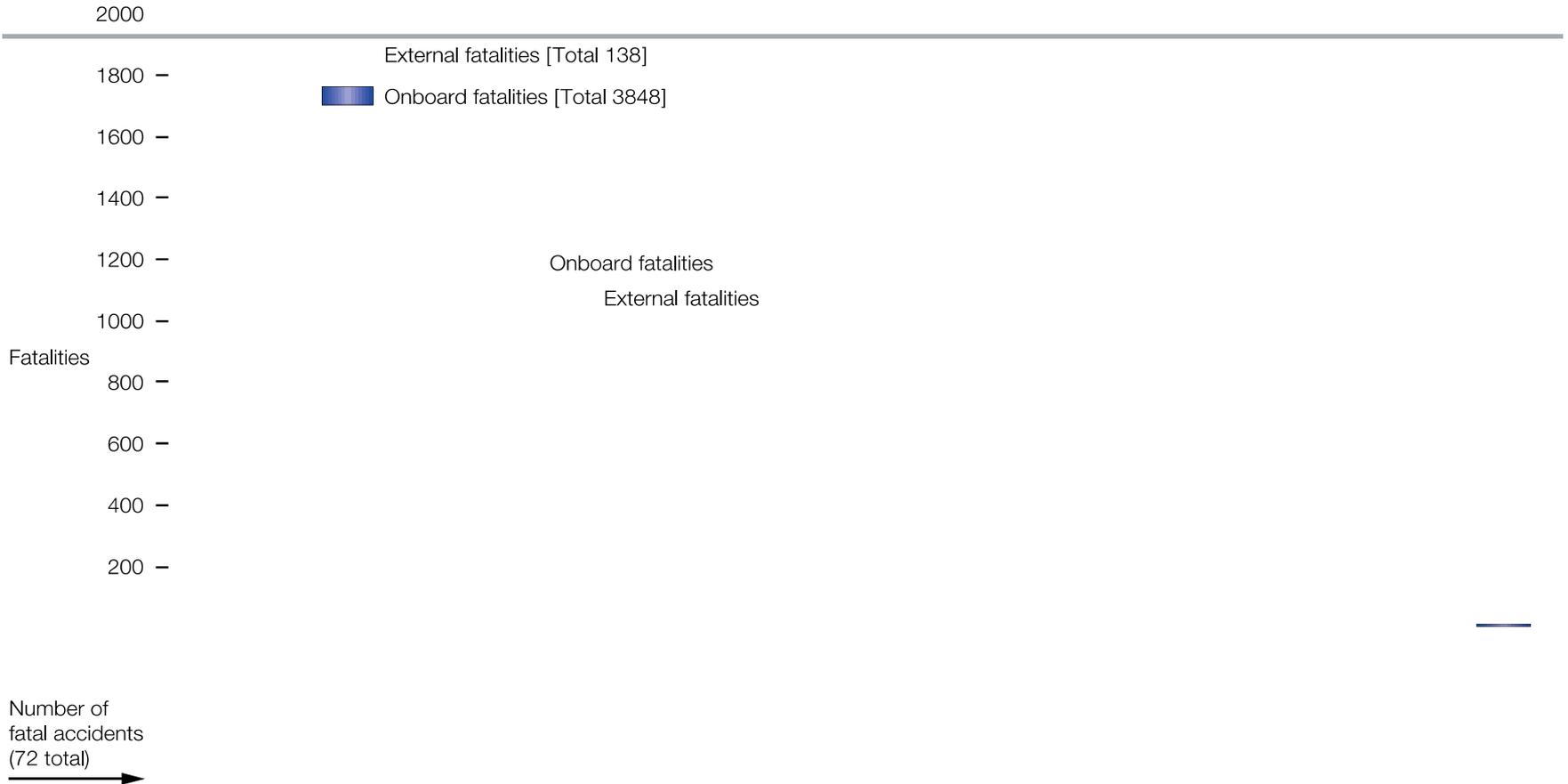
We Must Continuously Improve Safety to Keep the Number of Accidents in Decline as Departures Increase

Note: Data reflects years 1959 through 2014 for Western-built Commercial Jet Transports with Maximum Take-off Weight at or above 60,000 Pounds



Fatalities by CICTT Aviation Occurrence Categories

Fatal Accidents | Worldwide Commercial Jet Fleet | 2004 through 2013



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Accident Investigation Per ICAO Annex 13

State (Country)
of Occurrence

Investigator-in-Charge

Accredited
Representatives

State of
Registry

State of
Manufacture
(NTSB)

State of Design

State of the
Operator

Boeing
(ASI)

Regulator
(FAA)

Other OEM

Technical
Advisors

Airline

Parties to the
investigation

Launch Preparation

Boeing Accident Investigation

- **24/7/365 communications +1-206-544-7500 (BCA Operations Center)**
- **Maintain call list**
- **Team member training, Go-Team Conference, Bloodborne Pathogens, HR**
- **Medical Requirements**
- **Pre-selected expert team members**

Investigator	Structures
Flight Operations	Landing Gear
Human Factors	Flight Controls
Survival Factors	Airplane Systems
Propulsion	•
•	•
•	•
- **Pinger Training- (Investigators only)**
- **(Employee Assistance Program (upon return from site))**

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Boeing Assistance During an Investigation

Boeing Accident Investigation

- **What Boeing Brings to the Accident Investigation Process**
 - Field Phase Support
 - Trained Personnel
 - Access to SME's at Boeing

 - Post Field Phase (examples)
 - Lab Capabilities
 - Analysis
 - Additional Expertise

Boeing Support | Field Phase

Boeing Accident Investigation



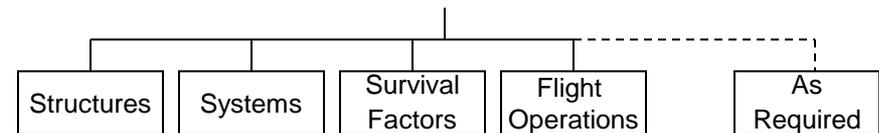
Field Team

- **ASI Investigator**
- **Technical Specialists**
 - Structures
 - Systems
 - Survival Factors
 - Flight Operations
 - As Required



Home Support Team

- **ASI Investigator**
- **Senior Manager - Program**



Boeing has a large well-trained technical workforce with detailed knowledge of the design, certification, manufacture, maintenance, and in-service operation of these airplanes.

Boeing Support | Post Field Phase

Boeing Accident Investigation

Boeing Capabilities

- **Lab and Test Facilities:**

- EQA laboratory (teardown/documentation)
- BMT laboratory (metallurgical)
- Noise laboratory (CVR sound analysis)
- Simulators (Pilot-in-the-loop, motion based)
- Airplane ground or flight test

- **Analysis:**

- FDR data analysis
- Runway track analysis
- Data visualization

Boeing Tools and Capabilities: EQA Lab

Boeing Accident Investigation

- EQA: Equipment Quality Analysis Laboratory
- Complete photographic examination, electrical testing, hydraulic testing, and environmental chamber testing of individual components
- X-ray; Computed Tomography / Digital Radiography scan equipment available
- No charge for this service. All activities done under direction of investigation.
- Quarantine room; NTSB access only. Investigation personnel always invited to participate.



Boeing Tools and Capabilities: M&PT

Boeing Accident Investigation

- **M&PT: Material and Process Technology**
- Complete metallurgical examination including Scanning Electronic Microscopy
 - Material verification; hardness scan, surface preparation & finish, etc.
 - Fracture face analysis
 - Corrosion detection

Boeing Tools and Capabilities: FDR

Boeing Accident Investigation

■ From Foil to Solid State

- Most recorders record anywhere from 18 parameters to well over 1000; generally 25 hours worth
- Many are still tape based, digital recorders
- 787: 'Dual Combi' recorders; two individual units

RIPS

(Recorder Independent Power Supply – CVR function only)



Forward Enhance Airborne Flight Recorder (EAFR)
Both FDR & CVR

Boeing Tools and Capabilities: FDR

Boeing Accident Investigation

- **Boeing typically receives data from investigation authority**
 - We convert raw data into engineering units (for plotting & analysis)
- **FDR Data Analysis**
 - Direct plotting
 - Desktop Simulation using certified aerodynamic models developed for each model type
 - Kin Con Analysis (Kinematic Consistency; independent way of performance verification)
 - Runway Track Analysis

Boeing Multi-Model Full Flight Simulator

M-Cab Overview – Hardware Overview

- **Engineering Cab**
 - Multi-model (707, 727, 737, 747, 767, 777 & 787)
- **Cab based on 767 Shell**
 - Generic interior
 - 2 Pilot, 3 Observer Seats
- **Uses same aerodynamic model as training simulators**
 - Open loop (normal mode)
 - Backdrive (used to re-create accident scenarios)
 - Software models of airplane systems



M-Cab Overview

- **Replaceable Control Stand / Aisle Stand**
 - 737 and 777 styles
- **Programmable Instrument Displays**
- **Replaceable Mode Control Panel**
 - 737 and 767 styles
- **Replaceable Control Column/Wheel**
 - 737 and 777 styles
- **Generic Overhead Panel**

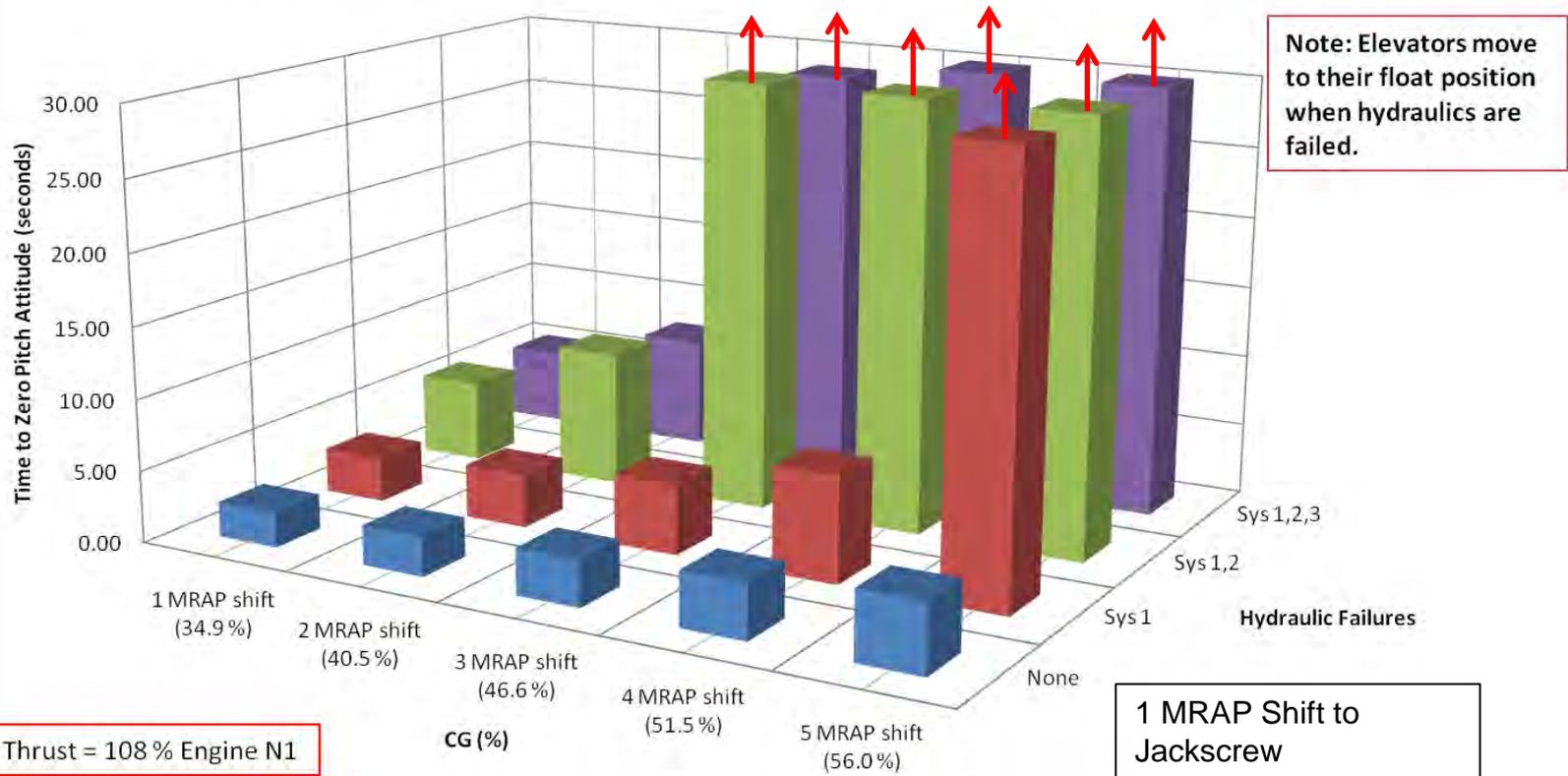


Simulation Scenarios



Simulation Scenarios

Simulation Scenario Results (Max Thrust, MRAP Shift to Jackscrew)



	1 MRAP shift (34.9 %)	2 MRAP shift (40.5 %)	3 MRAP shift (46.6 %)	4 MRAP shift (51.5 %)	5 MRAP shift (56.0 %)
None	2.46	2.75	3.22	3.81	4.76
Sys 1	3.14	3.74	4.92	7.36	30.00
Sys 1,2	5.73	9.46	30.00	30.00	30.00
Sys 1,2,3	5.24	7.76	28.77	30.00	30.00

Flight Vis Simulation



Investigation Process | Summary

Boeing Accident Investigation

- **Our responsibilities include:**
 - Be prepared to launch
 - Assist and advise
 - Make changes as necessary

- **Our goal: Prevention**