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Navigating the Skies Safely: Building Resilience in Aviation Safety

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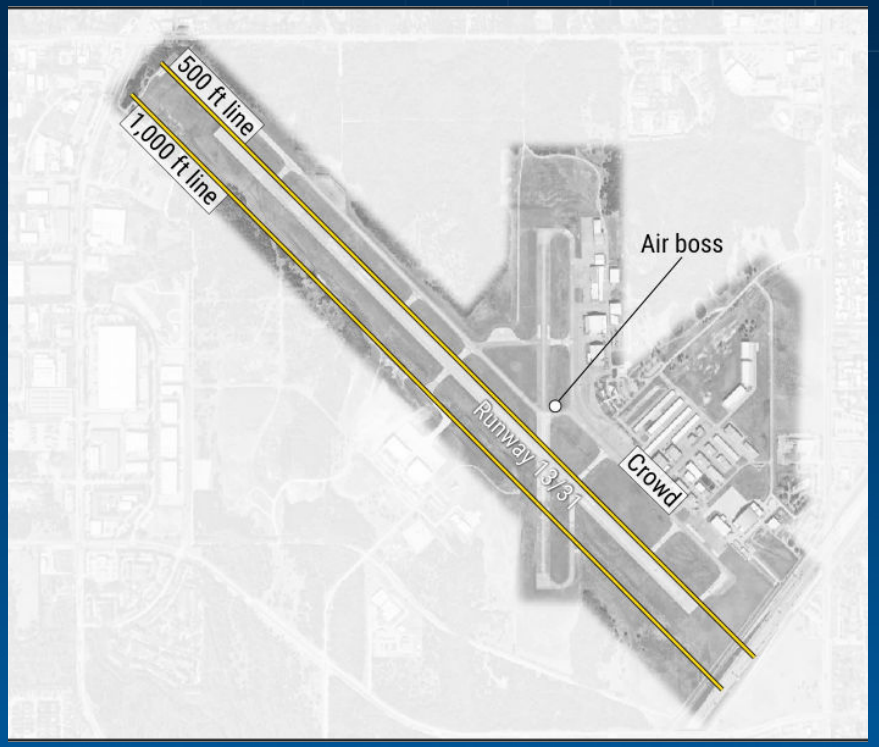
In-Flight Collision During Air Show
Commemorative Air Force

Dallas, Texas
November 12, 2022

Runway, Show lines, Crowd, and Air Boss

Questions:

- What was briefed?
- Which aircraft was to be on which show line?
- What was the altitude separation?
- What were the Air Boss directives?



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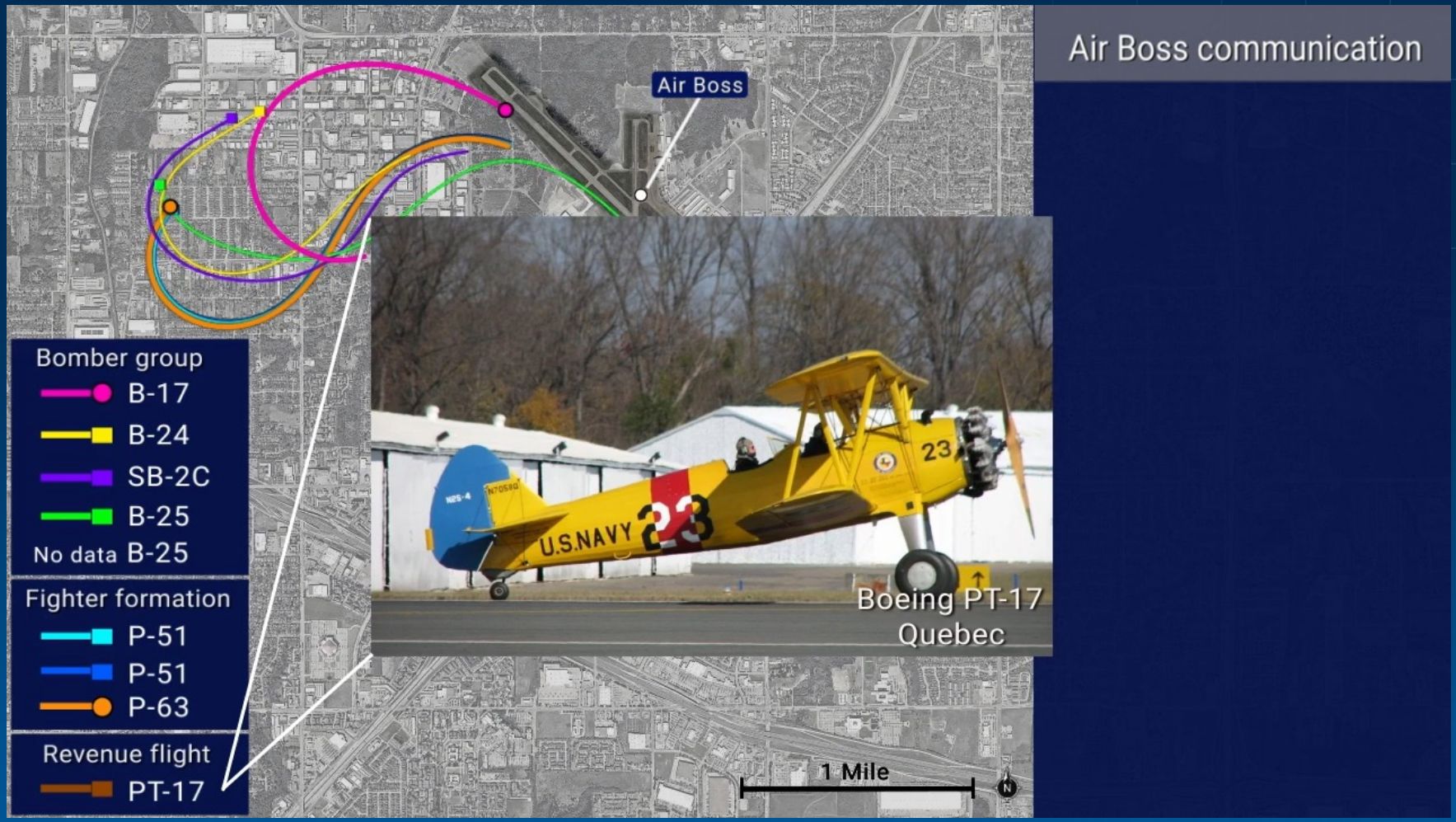
Air Boss communication
Air Boss
Bomber group
B-17
B-24
SB-2C
B-25
No data B-25
Fighter formation
P-51
P-51
P-63
Revenue flight
PT-17
U.S.NAVY 23
Boeing PT-17
Quebec
1 Mile
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Visibility Simulation

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Visibility Simulation

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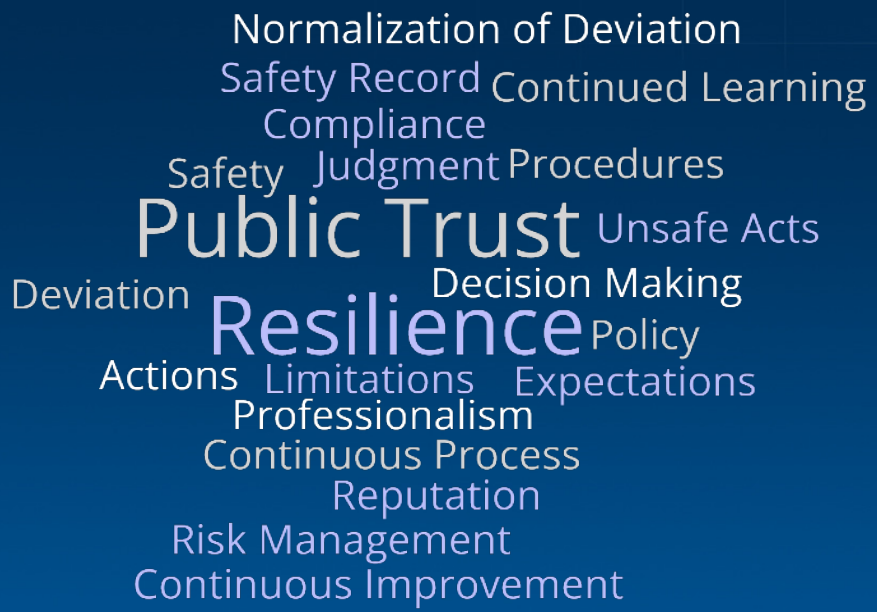
Probable Cause

- Air boss's and organizer's lack of an adequate, prebriefed aircraft separation plan for the air show performance
- Relying instead on the air boss's real-time deconfliction directives and the see-and-avoid strategy for collision avoidance, which allowed for the loss of separation
- Diminished ability of the accident pilots to see and avoid the other aircraft due to flight path geometry
- Out-the-window view obscuration by aircraft structures
- Attention demands associated with the air show performance, and the inherent limitations of human performance that can make it difficult to see another aircraft

Recognize Professional & Personal Limitations



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Recognize Professional & Personal Limitations

- Limitations are the guard rails for staying within the envelope
- Decisions made every day impact your operation's margin of safety
  - Practical drift – practices that have deviated from policy
  - Cutting corners
  - Not preparing for contingencies
- Mitigating and eliminating identifiable risks allows for a greater margin of safety when an unexpected event occurs

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Ramp Agent Ingestion into the Engine

Montgomery, Alabama
December 31, 2022

Accident Sequence

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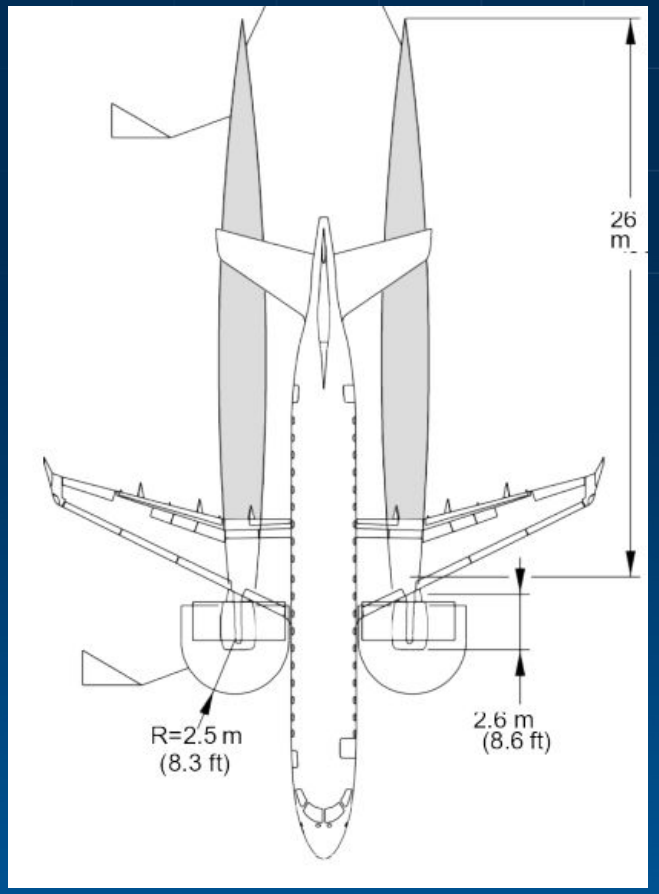
Factuals and Training

- Briefings
- American Eagle Ground Operations Manual
  - Chapter 2 Ramp Safety, section 2.1, stated in part, "**To Keep Employees Alive and Aircraft Intact, You Will…NEVER** approach an aircraft to position ground equipment next to an aircraft or open cargo bin doors until the engines are shut down and the rotating beacon(s) turned off
  - The engine must be spooled down before entering the ingestion zone. This can take between 30-60 seconds, depending on aircraft type. This applies to both wing and fuselage/tail mounted engines. You must wait until you can clearly see the individual fan blades before entering the ingestion zone

Training

Chapter 4, Aircraft Movement, section 4.6.1

- Jet engines spin with powerful speed and are extremely dangerous until spooled down. The area in front of the engine is called the ingestion zone. The ingestion zone for all aircraft types is 15 feet. You must never enter the ingestion zone until the engine has spooled down
- The jetblast zone at American Airlines and American Eagle is 100 feet for each aircraft when the engines are at idle speed



Inlet and exhaust hazard area (E 175 Airport Planning Manual)

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Probable Cause

The ramp agent's cognitive impairment, which resulted in her

(1) inconsistent behavior with trained procedures and pre-landing briefings,

(2) presence on the left side of the airplane while the left engine was still operating, and

(3) subsequent ingestion into the engine

Safety Issues

- Fitness for duty / Medical condition
  - Cannabis has the potential to cause cognitive and psychomotor impairment and can worsen cognitive impairment in individuals with multiple sclerosis
- Company policy on drug and alcohol use
- The Department of Transportation does not consider ramp personnel positions to be safety sensitive, so the company was not required to provide mandatory drug and alcohol training and perform required drug and alcohol testing, including random testing on its ramp personnel

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Challenger 300, N300ER In-flight Upset

Windsor Locks, Connecticut
March 3, 2023

Preflight Interruption

Abort & Takeoff from EEN

- CAS cyan advisory “RUDDER LIMITER FAULT” message
  - Two avionics stall tests (STALL/RUD LIM test) to clear
- Fault message discussion
  - Call maintenance, No - “it’s advisory only”
- No FD command bars on attitude pitch indicator
  - Elected to continue takeoff
- No V-speed bugs displayed

During the Climb

- Autopilot was engaged
- Multiple CAS messages
- PIC ask for the checklist?
- Attempted to re-input V speeds
- PIC attempted autopilot engage/reengage multiple times
- SIC finally selected the PRI STAB TRIM FAIL checklist

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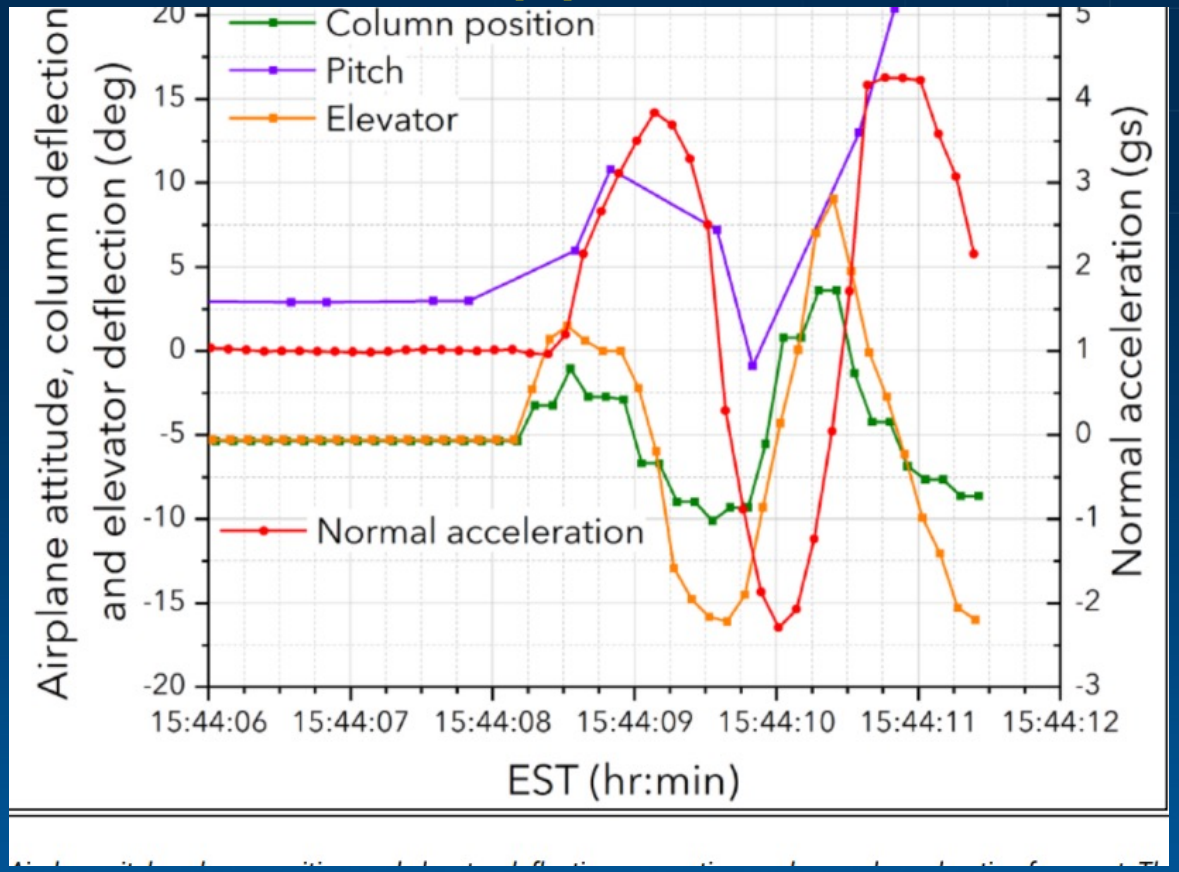
What Happened Next!



Airplane pitch, column position, and elevator deflection versus time and normal acceleration for event. The dots on each trace show each sample of the FDR channel.

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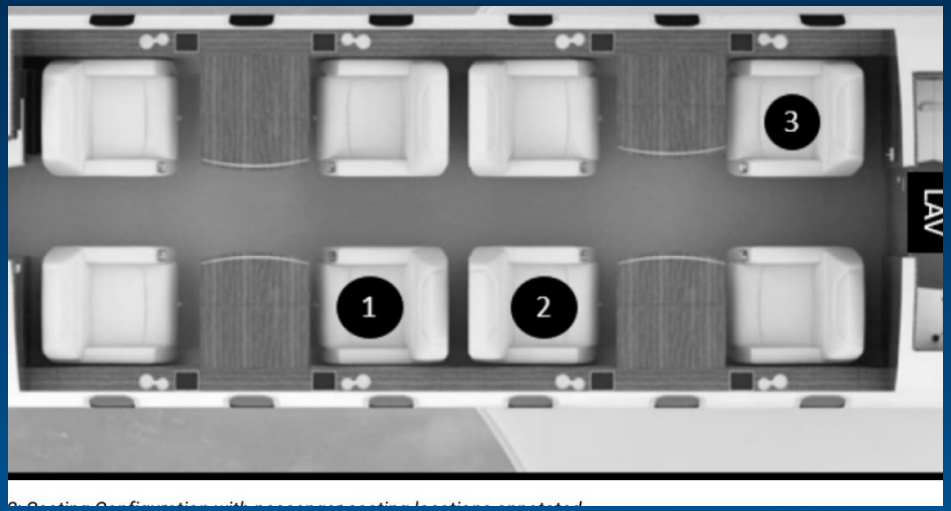
Aftermath

- PIC – “turn it on, turn it on” with electronic voice announcing “stall” multiple times
- After regaining control: SIC – “we shouldn’t have had the autopilot on”, PIC – “yeah”
- Flight crew alerted that a passenger had been seriously injured
- Flight crew diverted to BDL

Cabin Damage



(Photograph Courtesy Federal Bureau of Investigations)

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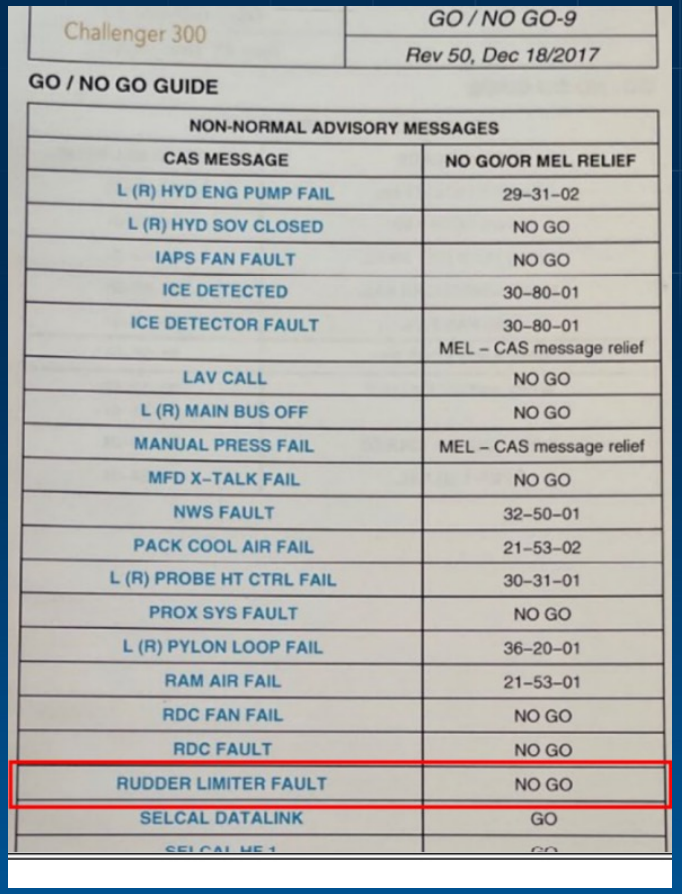
Probable Cause

The flight crew's failure to remove the right side pitot probe cover before flight, their decision to depart with a No-Go advisory message following an aborted takeoff, and their selection of the incorrect non-normal checklist in flight, which resulted in an in-flight upset that exceeded the maneuvering load factor limitations of the airplane and resulted in fatal injuries to a passenger whose seatbelt was not fastened. Contributing to the severity of the in-flight upset were the pilot-in-command's (PIC) decision to continue the climb and use the autopilot while troubleshooting the non-normal situation, and the PIC's pilot-induced oscillations following the autopilot disconnecting from the out-of-trim condition. Also contributing to the accident was the crew's inadequate crew resource management

Safety Issues

CRM – Crew Resource Management

- QRH and maintenance guidance
- Continue flight with CAS messages
- Continued use of autopilot
  - PIC agreed not to use but continued use with no comms with SIC
  - Confusion in picking appropriate checklist
- Specific checklist



Challenger 300	GO / NO GO-9 Rev 50, Dec 18/2017

GO / NO GO GUIDE

NON-NORMAL ADVISORY MESSAGES	
CAS MESSAGE	NO GO/OR MEL RELIEF
L (R) HYD ENG PUMP FAIL	29–31–02
L (R) HYD SOV CLOSED	NO GO
IAPS FAN FAULT	NO GO
ICE DETECTED	30–80–01
ICE DETECTOR FAULT	30–80–01 MEL – CAS message relief
LAV CALL	NO GO
L (R) MAIN BUS OFF	NO GO
MANUAL PRESS FAIL	MEL – CAS message relief
MFD X–TALK FAIL	NO GO
NWS FAULT	32–50–01
PACK COOL AIR FAIL	21–53–02
L (R) PROBE HT CTRL FAIL	30–31–01
PROX SYS FAULT	NO GO
L (R) PYLON LOOP FAIL	36–20–01
RAM AIR FAIL	21–53–01
RDC FAN FAIL	NO GO
RDC FAULT	NO GO
RUDDER LIMITER FAULT	NO GO
SELCAL DATALINK	GO

Go/No Go QRH Guidance [Excerpt] with rudder limiter fault message annotated by red box

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Safety Issues

AP STAB TRIM FAIL (C)

WARNING: An abrupt change in control force, or an out of trim situation may be experienced when disconnecting the autopilot.

SMKG/BELTS should be selected on.

CAUTION: Minimize changes to airspeed and configuration to minimize control forces and out of trim situation.

1. Flight controls ..... Hold firmly
2. Autopilot ..... Use control wheel MSW switch to disconnect
3. Autopilot ..... Do not use
4. Retrim airplane if necessary.

Stabilizer trim unresponsive in one or both directions, trim moving slower than normal or inconsistently, trim moving opposite to command.

Yes

5. Refer to Chapter 5, CAUTIONS PROCEDURES, FLIGHT CONTROLS, Stabilizer Trim Malfunction

No

END

Figure 6: Temporary revision for AP STAB TRIM FAIL.

AP HOLDING LWD

or

AP HOLDING RWD

or

AP HOLDING NOSE DOWN

or

AP HOLDING NOSE UP

Condition: Autopilot is holding control force in the direction indicated.

Objective: Correct mistrim condition.

⚠WARNING: An abrupt change in control force, or an out of trim situation may be experienced when disconnecting the autopilot.

SMKG / BELTS should be selected on.

⚠CAUTION: Minimize changes to airspeed and configuration to minimize control forces and out of trim situation.

(1) Flight controls ..... HOLD FIRMLY

(2) Autopilot ..... DISCONNECT using control wheel MSW switch

(3) Retrim airplane if necessary.

(4) Autopilot ..... AS DESIRED

– COMPLETE –

Figure 7: Autopilot Holding Left/Right Wing Down and Nose Up/Down Checklist.

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Safety Issues

- Seat belt expectations

- The crew's continuation of the flight with an unairworthy airplane directly contributed to the subsequent series of CAS messages, which the crew misdiagnosed during the climb, resulting in the in-flight upset and loss of airplane control

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Flight-Test Baseline Data Collection Accident Flight - Cessna 208B EX Caravan N2069B

Snohomish, WA
November 18, 2022

Pilot and Aircraft Information

- Contracted by Raisbeck through ODA program
- August 1, 2022 recurrent training for DER/FTD
- Total time 11,270 hrs - make and model 232 hours
- Right seat pilot observer total time 10,900 hrs and C208 5000 hrs
- FAA issued Special Airworthiness Certificate in Experimental Category for R&D on November 12, 2022
- Aircraft Payload Extender (APE) III, Increased weights w/ limitations
  - Vmo 175 KIAS and Vfe 125 KIAS

Accident Flight

- 8th flight of the baseline testing to complete the previous days flight test card
- Other flights included familiarization, weight & balance measurement, mid and forward CG, aft CG static, then aft CG dynamic stalls
- Intentional accelerated stall
  - 96 KIAS, prop RPM – full fwd, flaps fully extended, torque 930 ft-lbs, 30 degree left bank, 3-5 KIAS/sec decel rate
- After the stall: rapid left roll 120 degrees, pitch angle - 60 degrees
- Exceedances: Rapid increasing airspeed exceeding Vfe and Vmo with torque increase to 2200 ft-lbs +

Inflight Breakup

- Peak airspeed 223 KIAS
  - 98 KIAS above Vfe & 48 KIAS above Vmo

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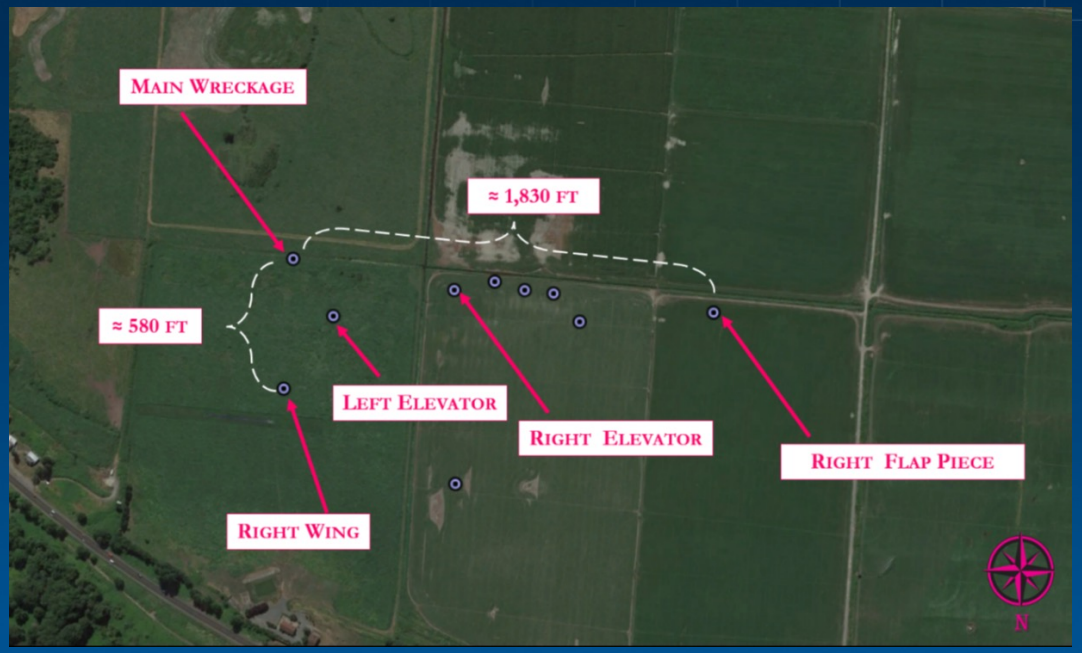
Inflight Breakup

- Right wing and strut separated
- Right flap was separated into numerous pieces and scattered
- Left wing separated from fuselage on ground impact
  - Flap attached and retracted



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Right Wing (bottom)
≈ 25°
Inboard Flap
≈ 60°

Probable Cause

The pilot's improper recovery following a departure from controlled flight after an intentional aerodynamic stall, which resulted in an exceedance of airspeed limitations, airframe overstress, and a subsequent inflight breakup

Safety Issues

- Test flight 07
- Electronic Stability Protection
- Test flight mitigation procedures
- Reduce power immediately
- Flight test data acquisition

Test Flight 07 Exceedances

- 30 degrees left bank, flaps extended, idle power, “unaccelerated” stall
- “pass” if bank angle does not exceed 60 degrees in direction of turn or 30 degrees in direction opposite the turn
- Aircraft exceeded allowable roll limit and exceeded Vmo
  - 83 degrees and 183 KIAS
  - Req. inspection and documentation

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Electronic Stability Protection

- Optional feature that is intended to discourage the exceedance of attitude and established airspeed parameters
- Engages when the aircraft exceeds one or more conditions (pitch, roll, and/or Vmo) beyond the normal flight parameters
- Can be enabled/disabled or interrupted
- Engaged at 45 – 75 degrees angle of bank
- Engaged at 19 degrees nose up, 20 degrees nose down
- Videos of previous flights in the airplane suggested that pilot was unfamiliar with the ESP system, as he did not deactivate it before the flight nor discuss the forces it was applying during the flight

Test Flight Mitigation Procedures

- FAA Order 4040.26C, Aircraft Certification Service Flight Test Risk Management Program, outlines risk management requirements for certification flight tests
- Test Plan included Test Hazard Analysis (THA) worksheets that identified hazards, causes and effects, mitigation measures, and emergency procedures
- THA 9.5, which focused on aft CG stall characteristics, identified "departure from controlled flight" as a hazard caused by "unpredicted aerodynamic response" or "improper control inputs,"
- Risk for THA 9,5 was assessed as "medium"

Test Flight Mitigation Procedures & Data Acq.

- Flight Test Safety Database (FTSD) assessment for stall characteristics testing, labeled THA 56, assigned a **"high" risk level** and included mitigations absent in THA 9.5, such as ensuring all stalls are coordinated**, immediately retarding throttles to idle** during departures from controlled flight, and halting testing if roll angle limits are exceeded

- The airplane's flight test data acquisition system, used as part of the flight test program, was destroyed in the accident and no flight test data for the accident flight was recovered

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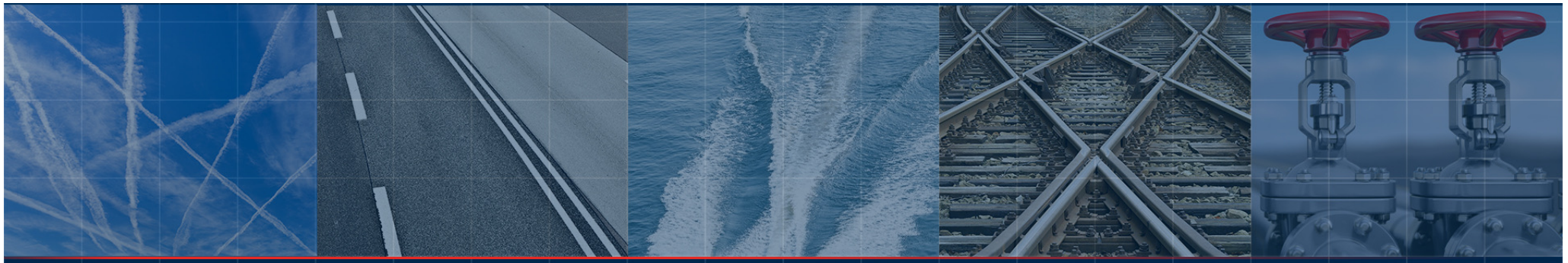

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