LOC Accident / Incident Data Set

- NTSB LOC data collection
- Dick Newman (Crew Systems) and Tony Lambregts
  - 2008 paper
  - Frequently quoted
- NASA
- Wouldn’t it be nice to work together?
- Broader LOC dataset
LOC Accident / Incident Data Set

• Data Sources
  • Aircraft Accident Reports on DVD (R. Dorsett, 2006)
  • Australian Transport Safety Bureau (ATSB)
  • Aviation Safety Network (ASN)
  • Canadian Transportation Safety Board (TSB)
  • Flightglobal (Ascend Database)
  • French Bureau d’Enquêtes et d’Analyses pour la sécurité de l’aviation civile (BEA)
  • German Bundesstelle für Flugunfalluntersuchung (BFU)
  • International Civil Aviation Organization (ICAO)
  • Irish Air Accident Investigation Unit (AAIU)
  • National Transportation Safety Board (NTSB)

• Search Criteria
  • “loss-of-control”
  • “upset”
  • “unusual attitude”
  • “stall”
  • “uncontrolled”
Stall Examples

- Pinnacle Airlines, Flight 3701
  - Bombardier CL-600-2B19
  - Aircraft stalled at high altitude

- Colgan Air Flight 3407
  - Bombardier DHC-8-400
  - Stalled on approach to Buffalo
Breaking The Accident Chain

• Addressing elements in the sequence
• Train cue recognition
• Account for human nature
  • Train crews for all cues
Precursor Sequence

Colgan Air 3407 (2/12/2009)

Normal Flight

Crew Fatigue / Impairment

Loss of Energy State Awareness / Inappropriate Energy Management

Stall / Departure

Improper / Ineffective Recovery

LOC

Pinnacle 3701 (10/14/2004)

Normal Flight

Loss of Energy State Awareness / Inappropriate Energy Management

Stall / Departure

Improper / Ineffective Recovery

Engine failure

Ground Impact
Stall Cues

• Stick Shaker
  • Ignored

• Stick Pusher
  • Fought
  • Stick pusher dynamics not recognized

• Un-commanded Roll
  • Not recognized
Icing and Contaminated Airfoils

Photo Courtesy of NASA Glenn
Upsets from Stalls due to Icing

- **Saab 340: Eildon Weir, Australia,**
  - November 1998
  - 2300-foot altitude loss
- **Saab 340: Albury, Australia,**
  - June 2004
  - 40-foot altitude loss
- **Saab 340: San Luis Obispo, CA, USA**
  - January 2006
  - 5000-foot altitude loss
Saab 340
Icing Event Comparison

Lift Coefficient - $C_L$

Angle of Attack - $\alpha$ (deg)

- Albury
- Eildon Weir
- American Eagle 3008
- No ice lift curve
CRJ Icing Event Comparison

- Fredericton no ice (sim sweep)
- Baotou no ice (sim sweep)
- Fredericton
- Baotou

C_L vs. Angle of attack
Precursor Sequence
Ice Contamination

Normal Flight → Icing → Stall / Departure → Improper / Ineffective Recovery → LOC
Stall Cues with Ice

- **Stick Shaker**
  - May be after departure
- **Stick Pusher**
  - May be after departure
- **Natural stall cues**
  - Un-commanded Roll
  - Buffet
  - Stall break
Summary

- Elements of LOC sequences have been identified
  - Stall leading element
- Need to address multiple points in accident chain for best affect.
- New training we are outlining this week addresses most LOC factors
  - Some elements may be better addressed by technologies
Spatial Distortion

• In pitch
  • Typical go-around in IMC
  • Acceleration produces illusion of pitch up
    • Pilot pitches down flies into ground

• In Roll
  • Slow roll develops pilot doesn’t feel
  • Then confused when bank angle warning or g’s alert to roll but feel level
Atmospheric Disturbance
Recommendation A-10-22

Require 14 Code of Federal Regulations Part 121, 135 and 91K operators and 14 Code of Federal Regulations Part 142 training centers to develop and conduct training that incorporates stalls that are fully developed; are unexpected; involve autopilot disengagement; and include airplane-specific features such as a reference speeds switch.
Recommendation A-10-23

• Require all 14 Code of Federal Regulations Part 121, 135, and 91K operators of stick pusher-equipped aircraft to provide their pilots with pusher familiarization simulator training.
Define and codify minimum simulator model fidelity requirements to support an expanded set of stall recovery training requirements, including recovery from stalls that are fully developed. These simulator fidelity requirements should address areas such as required angle-of-attack and sideslip angle ranges, motion cueing, proof-of-match with post-stall flight test data, and warnings to indicate when the simulator flight envelope has been exceeded.
The Administrator of the Federal Aviation Administration shall conduct a rulemaking proceeding to require part 121 air carriers to provide flight crewmembers with ground training and flight training or flight simulator training —

A. To recognize and avoid a stall upset of an aircraft or, if not avoided, to recover from the stall;
Recommendation A-11-46

Define and codify minimum simulator model fidelity requirements for aerodynamic degradations resulting from airframe ice accumulation. These requirements should be consistent with performance degradations that the National Transportation Safety Board and other agencies have extracted during the investigations of icing accidents and incidents.
Recommendation A-11-47

Once the simulator model fidelity requirements requested in Safety Recommendation A-11-46 are implemented, require that flight crews of all aircraft certificated for flight in icing conditions be trained in flight training simulators that meet these fidelity requirements. Such simulation training should emphasize the following: (1) cues for recognizing changes in the aircraft’s flight characteristics as airframe icing develops; (2) procedures for monitoring and maintaining appropriate airspeeds in icing conditions, including the use of icing airspeed reference indices; and (3) procedures for responding to decaying airspeed situations, stall protection system activation, and early stalls that can occur without stall protection system activation.
### Accident

<table>
<thead>
<tr>
<th>Accident</th>
<th>Shaker</th>
<th>Pusher</th>
<th>Break</th>
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<tbody>
<tr>
<td>Airborne Express DC-8-63 December 22, 1996</td>
<td>IO</td>
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<td>NR</td>
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<tr>
<td>China Airlines Flight 676, A300-622, February 16, 1998</td>
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<td>Thai Airways Flight 261, Airbus A310-300, December 11, 1998</td>
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<td>Pinnacle Airlines Flight 3701 Bombardier CL-600-2B19, October 14, 2004</td>
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<td>United Express Flight 6291 Jetstream 4101, January 7, 1994</td>
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<td>Pulkova Flight 612, TU-154M, August 22, 2006</td>
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<td>West Caribbean airlines MD-82 near Machiques, Venezuela, August 16, 2005</td>
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<td>Continental Connection Flight 3407 Bombardier DHC-8-400, February 12, 2009</td>
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</table>

IO = Inoperative  
UK = Unknown  
NR = Not responded to
### Stall Upsets (icing)

#### Accident/Incident

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<tr>
<th>Aircraft</th>
<th>Location</th>
<th>Date</th>
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<th>Break</th>
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<tr>
<td>Saab 340A, VH-KEQ</td>
<td>Albury, New South Wales Australia</td>
<td>June 18, 2004</td>
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<td>Saab 340B, VH-OLM</td>
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<td>Air Canada Flight 646</td>
<td>Canadair CL-600-2B219</td>
<td>December 16, 1997</td>
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<td>Cessna Citation 560</td>
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<td>February 16, 2005</td>
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<td>Comair Flight 3272</td>
<td>Embraer EMB-120RT,</td>
<td>January 9, 1997</td>
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<td>Skywest Flight 3855</td>
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<td>ComAir Flight 5054</td>
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<td>Empire Airlines Flight 8284</td>
<td>ATR-42, Lubbock TX</td>
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</table>

**IO** = Inoperative  
**UK** = Unknown  
**PR** = Proper response  
**NR** = Not responded to  
**ES** = Early stall