NTSB National Transportation Safety Board

Office of Aviation Safety

Loss of Control Safety Seminar

May 14, 2016

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Loss of Control – What's the issue?

- While airline accidents have become relatively rare….
- Hundreds continue to die annually in fixed wing loss of control general aviation accidents.
- So, how does our community fix this?

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CICTT LOC definition:

- CAST/ICAO Common Taxonomy Team (CICTT)

"…an extreme manifestation of a deviation from intended flight path."

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In Simpler Terms

- The airplane won’t go where the pilot wants it to go
- The airplane does go where the pilot doesn’t want it to go
- It’s a surprise when it happens

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LOC? (Anyone Can Have a Bad Day)

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NTSB (data) common conventions

- LOCI is known as a “defining event” and best describes the accident scenario

- LOCI (as a defining event) generally involves an aerodynamically sound airplane; it may not be mechanically sound but is still controllable

NTSB Data 2008-2014 (In-flight)

- Total All Accidents: 9,751
- Total Fixed Wing Accidents: 8,730
- LOCI Fixed Wing Accidents: 1,518
  (17.4% of all FW)

(LOC/stall is the “defining event.”)

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GA Fatal Flights

- Total fatal: 1,553
- LOCI fatal: 721
  (46.4% of FW Fatal Accidents)

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Number of Fatalities

- Total FW fatalities: 2,698

- LOCI FW fatalities: 1,237
  (45.8% of FW Fatalities)

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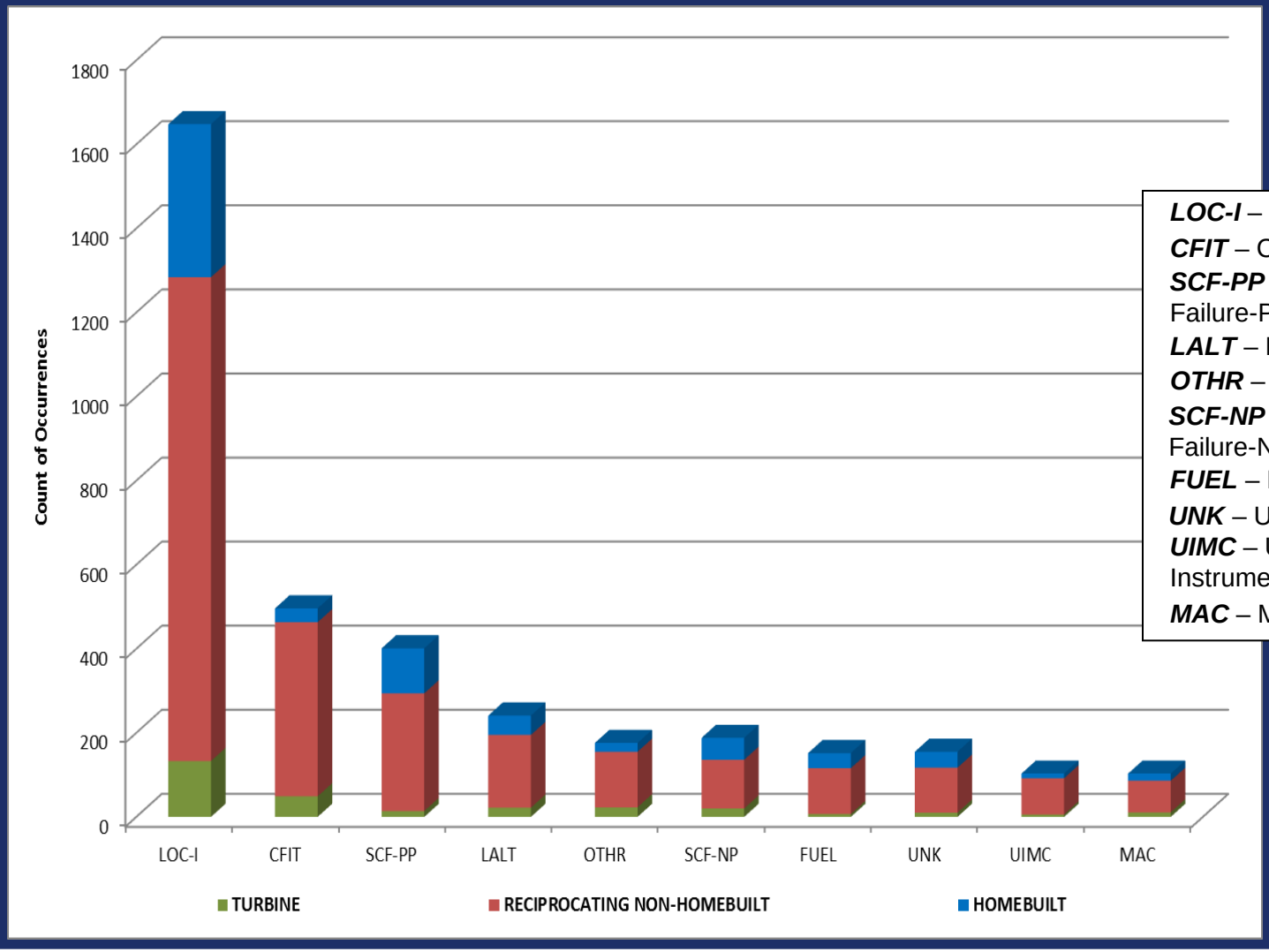
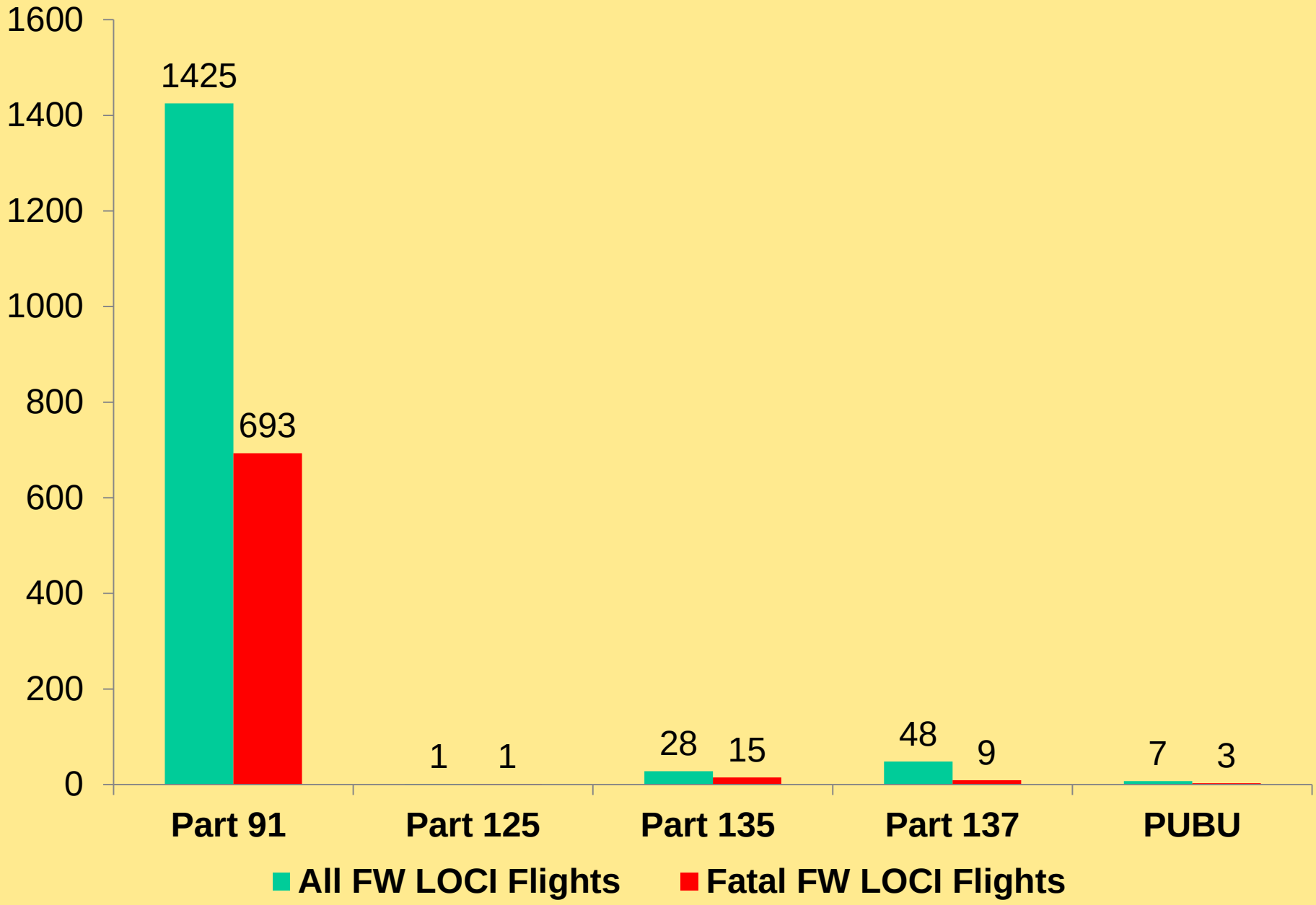
GA Joint Steering Committee Pareto CY2001–CY2013

Source: NTSB Aviation Accident/Incident Database
NOTE: Approximately 70% of the NTSB reports are final for CY2013

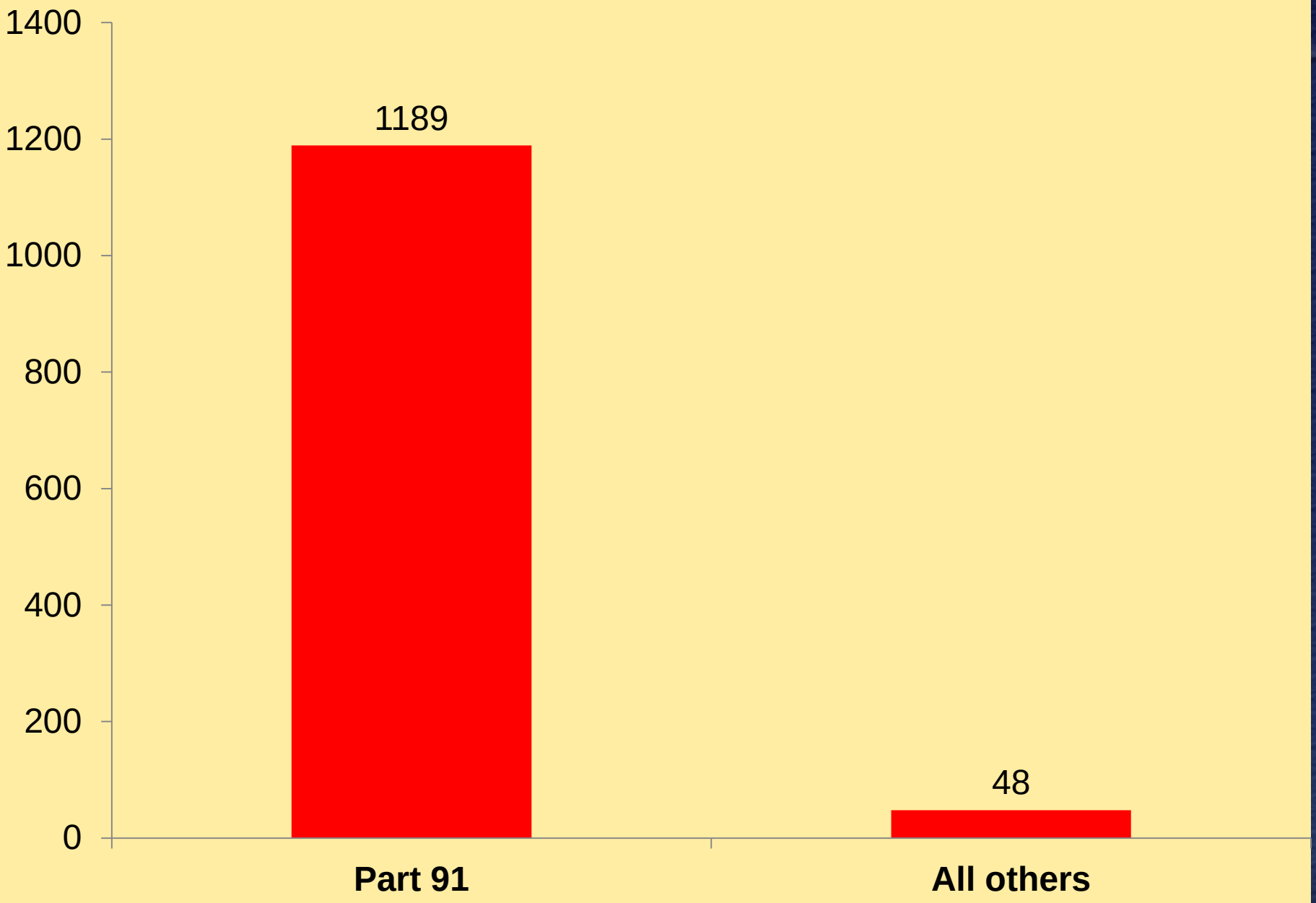


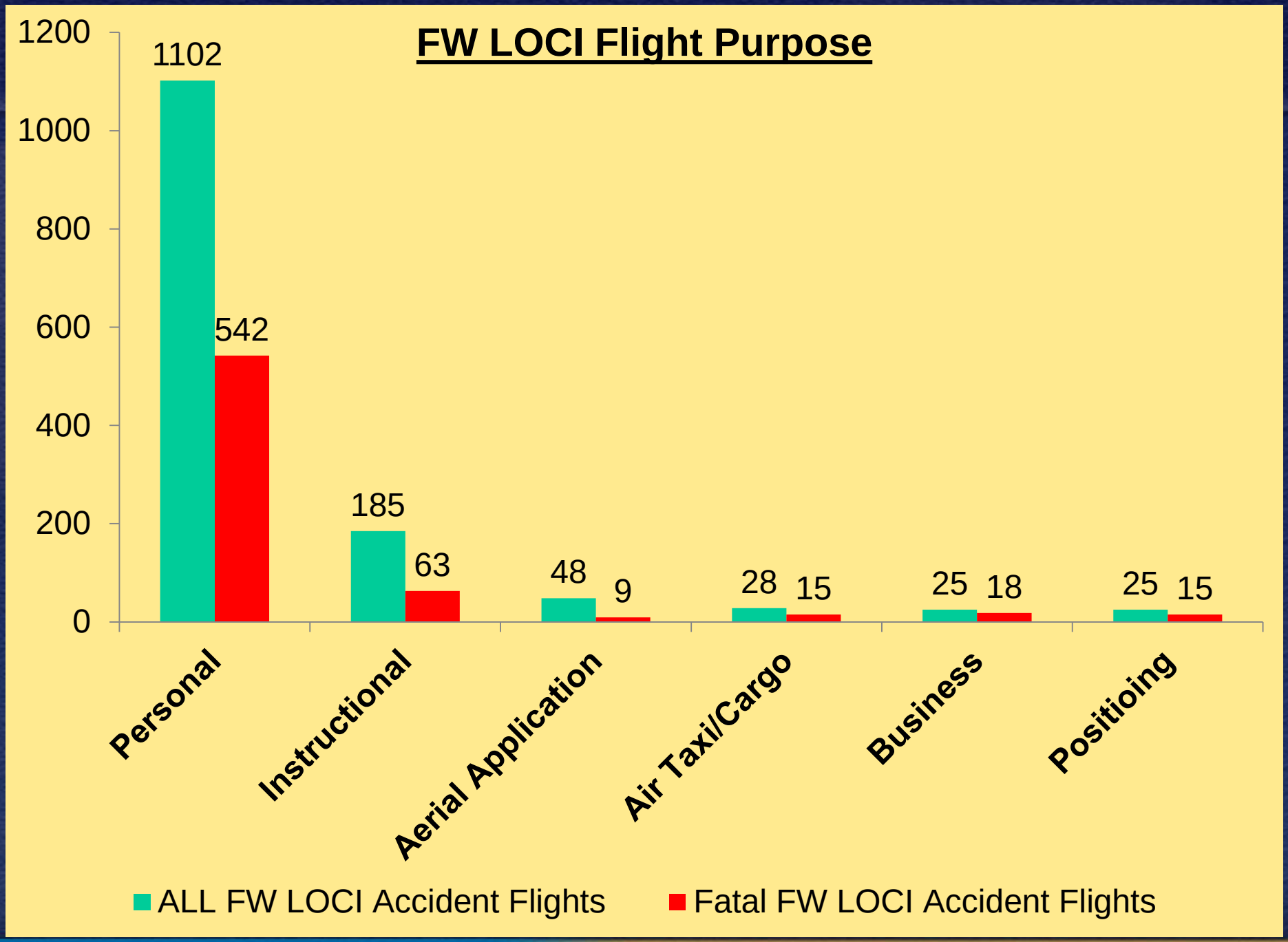
LOC-I – Loss of Control Inflight
CFIT – Controlled Flight Into Terrain
SCF-PP – System Component Failure-Powerplant
LALT – Low Altitude Operations
OTHR – Other
SCF-NP – System Component Failure-Non-Powerplant
FUEL – Fuel Related
UNK – Unknown or Undetermined
UIMC – Unintended flight in Instrument Meteorological Condition
MAC – Midair Collisions

FW LOCI by FAR



FW LOCI Fatalities




FW LOCI Flight Purpose
1200
1000
800
600
400
200
0
1102
542
185
63
48
9
28
15
25
18
25
15
Personal
Instructional
Aerial Application
Air Taxi/Cargo
Business
Positioning
ALL FW LOCI Accident Flights
Fatal FW LOCI Accident Flights

Fatal Instructional Flights
Highest Fatality Phases - Flight Crews

	Solo	CFI/SP	CFI/PP	CFI/CP	CFI/ATP	OTHER/UNK
Initial Climb	3	4	5	1	0	1
Maneuvering	2	5	11	6	1	2
App/Pattern	4	2	9	1	0	0
Totals	9	11	25	8	1	3

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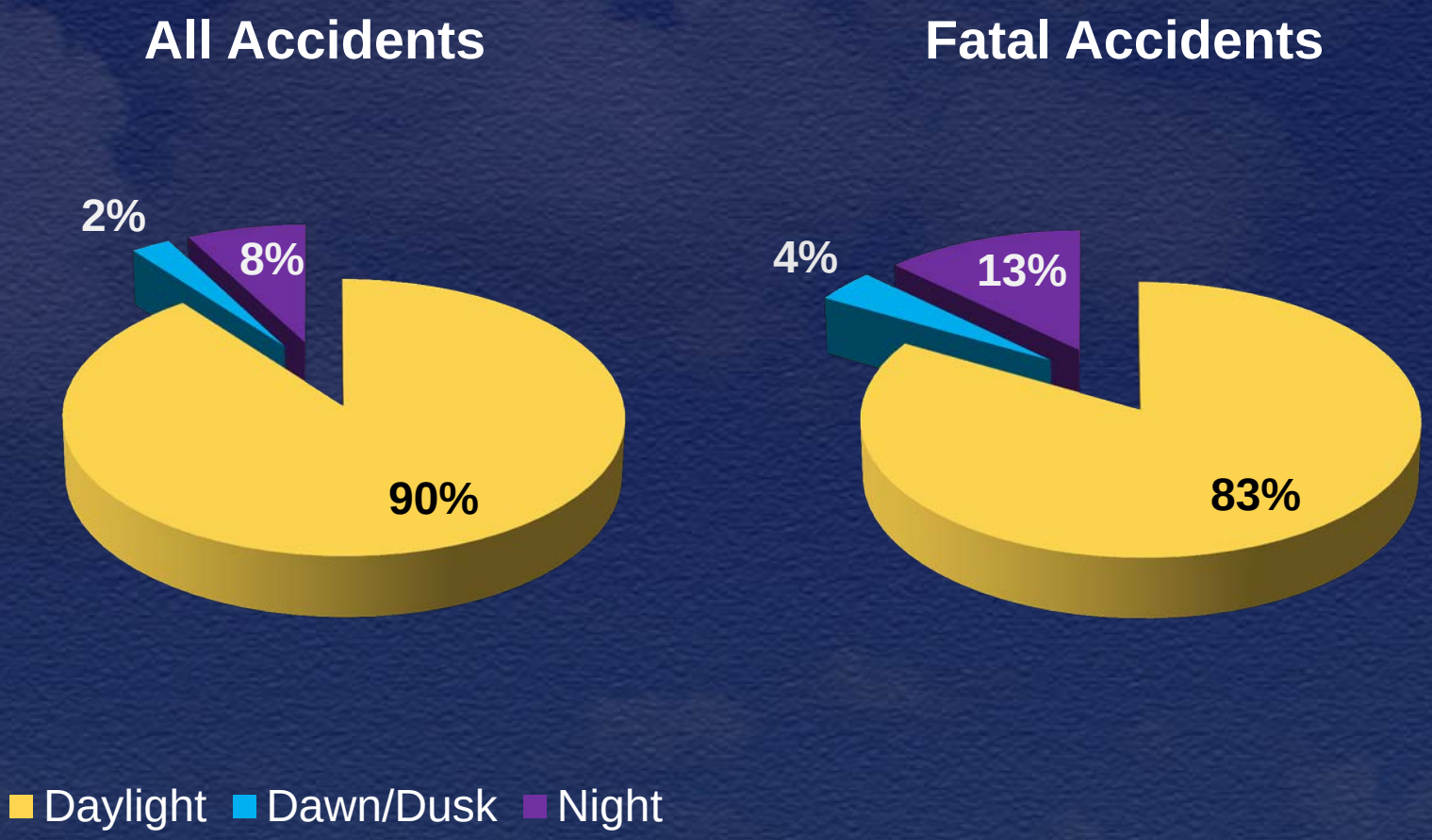
GA FW LOCI Light Conditions



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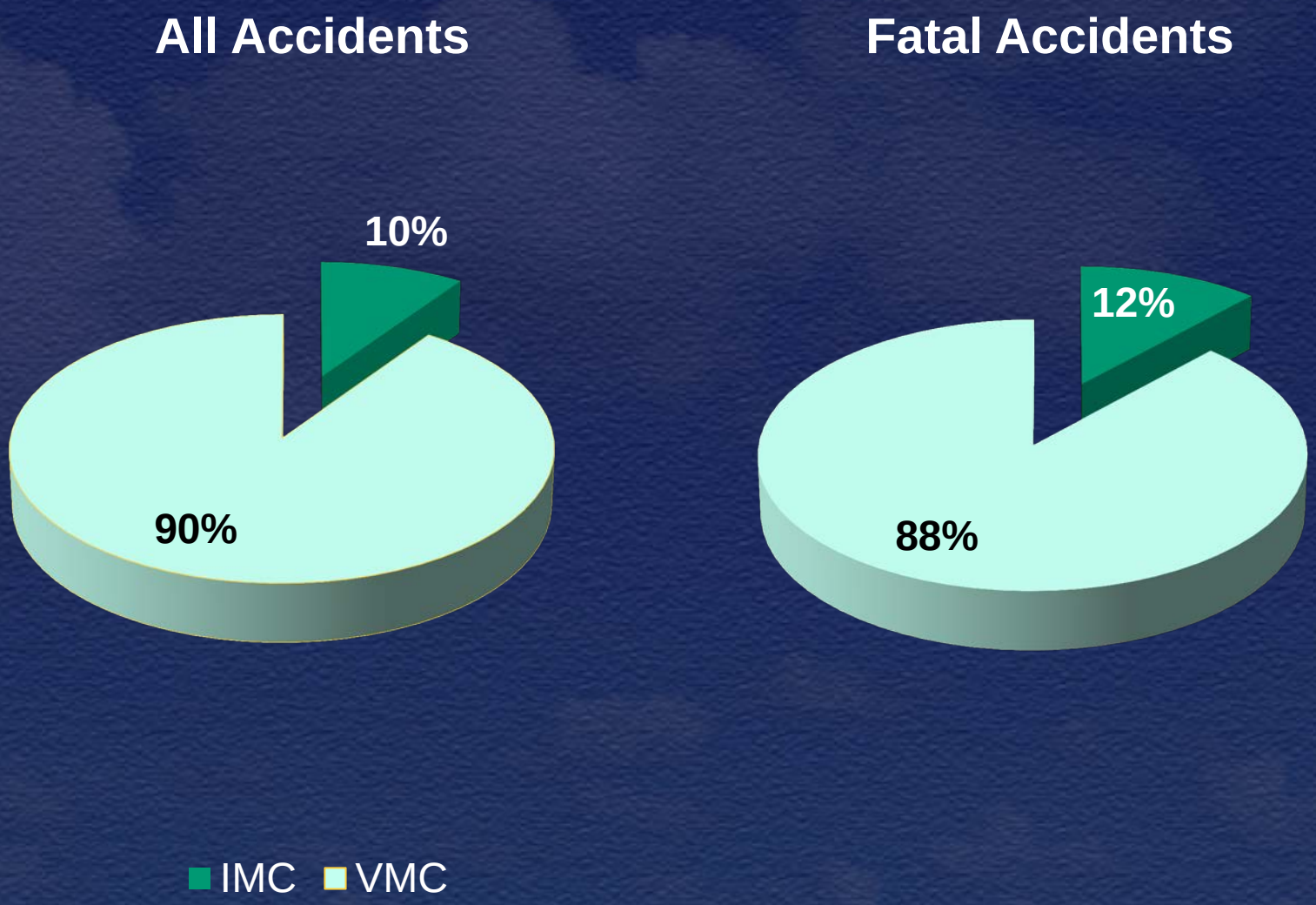
GA FW LOCI Weather Conditions



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What phases do they occur?

- Takeoff –To 35 feet/gear up selection.
- Initial Climb – Takeoff to first power reduction or 1,000 feet above runway.
- En Route - From end of Initial Climb through cruise, descent to VFR pattern altitude or 1,000 feet above runway elevation, whichever comes first. (IFR: descent to IAF)

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- Approach - From the point of VFR pattern entry, or 1,000 feet above the runway elevation, to the beginning of the landing flare. (IFR : IAF to landing flare.)

- Landing - Beginning of the landing flare until aircraft exits the landing runway, comes to a stop on the runway, or when power is applied for takeoff in the case of a touch-and-go landing.

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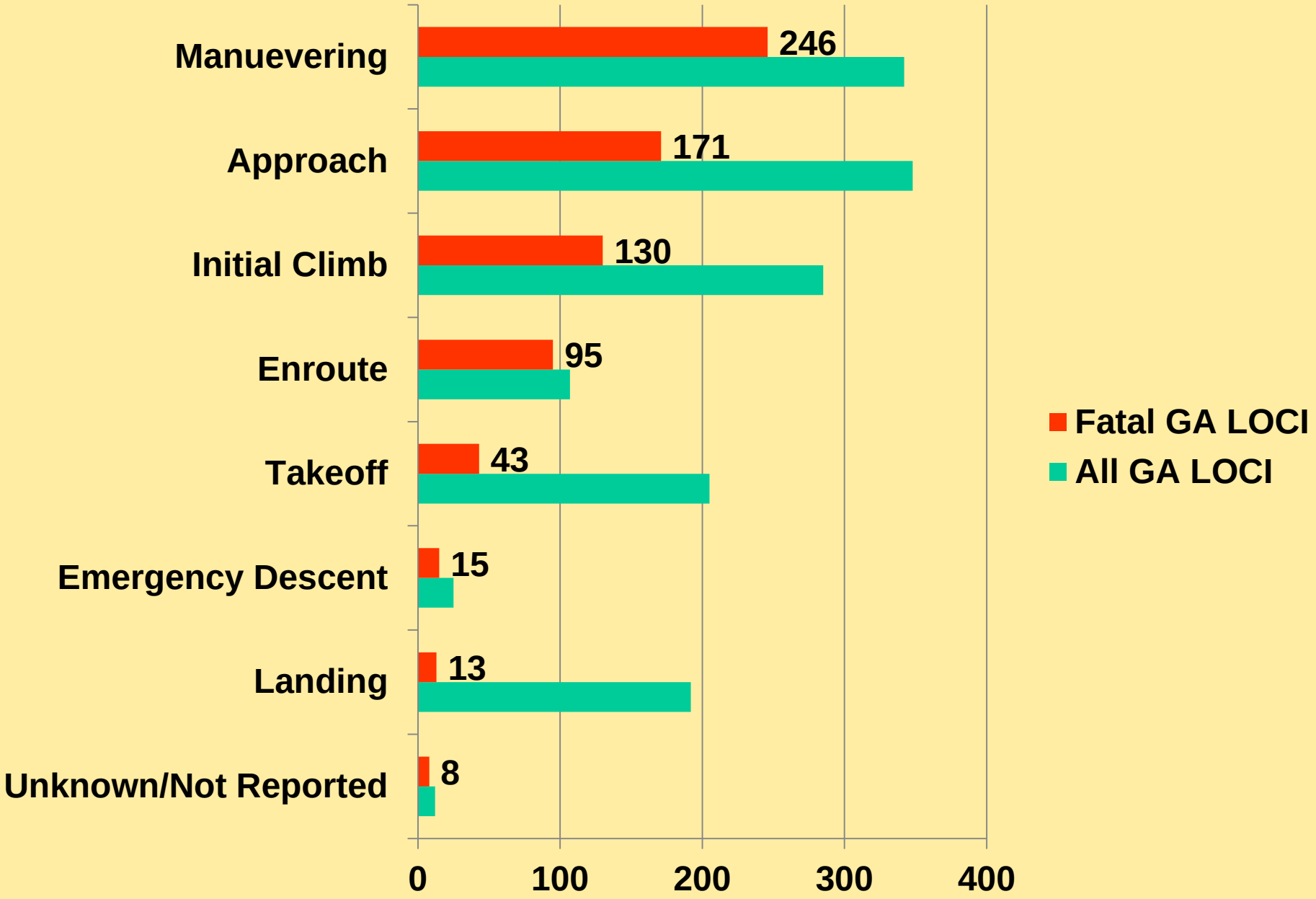
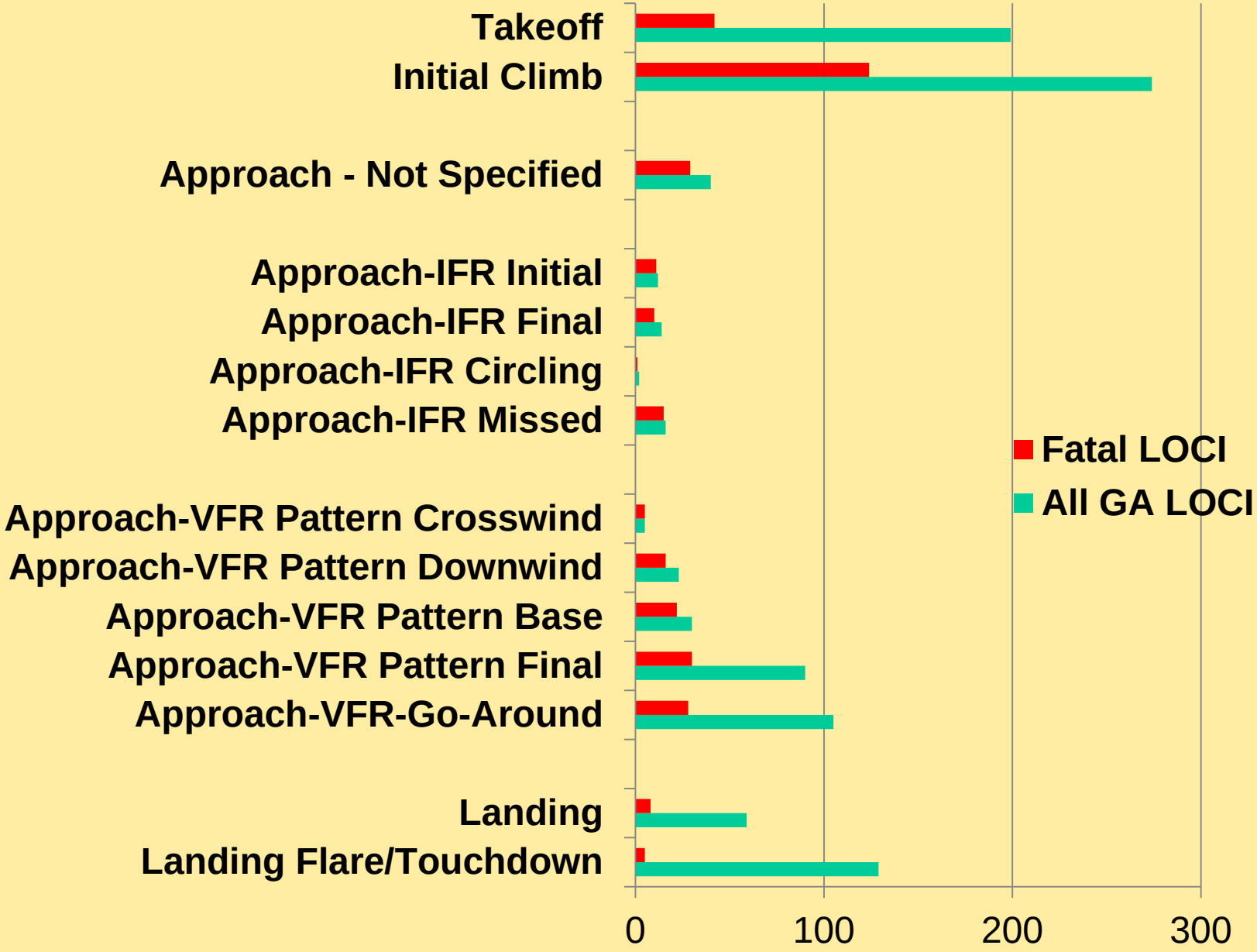
- **Maneuvering -** Low altitude/aerobatic flight operations.

- **Missed Approach/Go-Around**
  - From the first application of power until the aircraft re-enters the sequence for a VFR pattern (go-around) or until the aircraft reaches the IAF for another approach (IFR). (Considered a sub-phase of approach.)

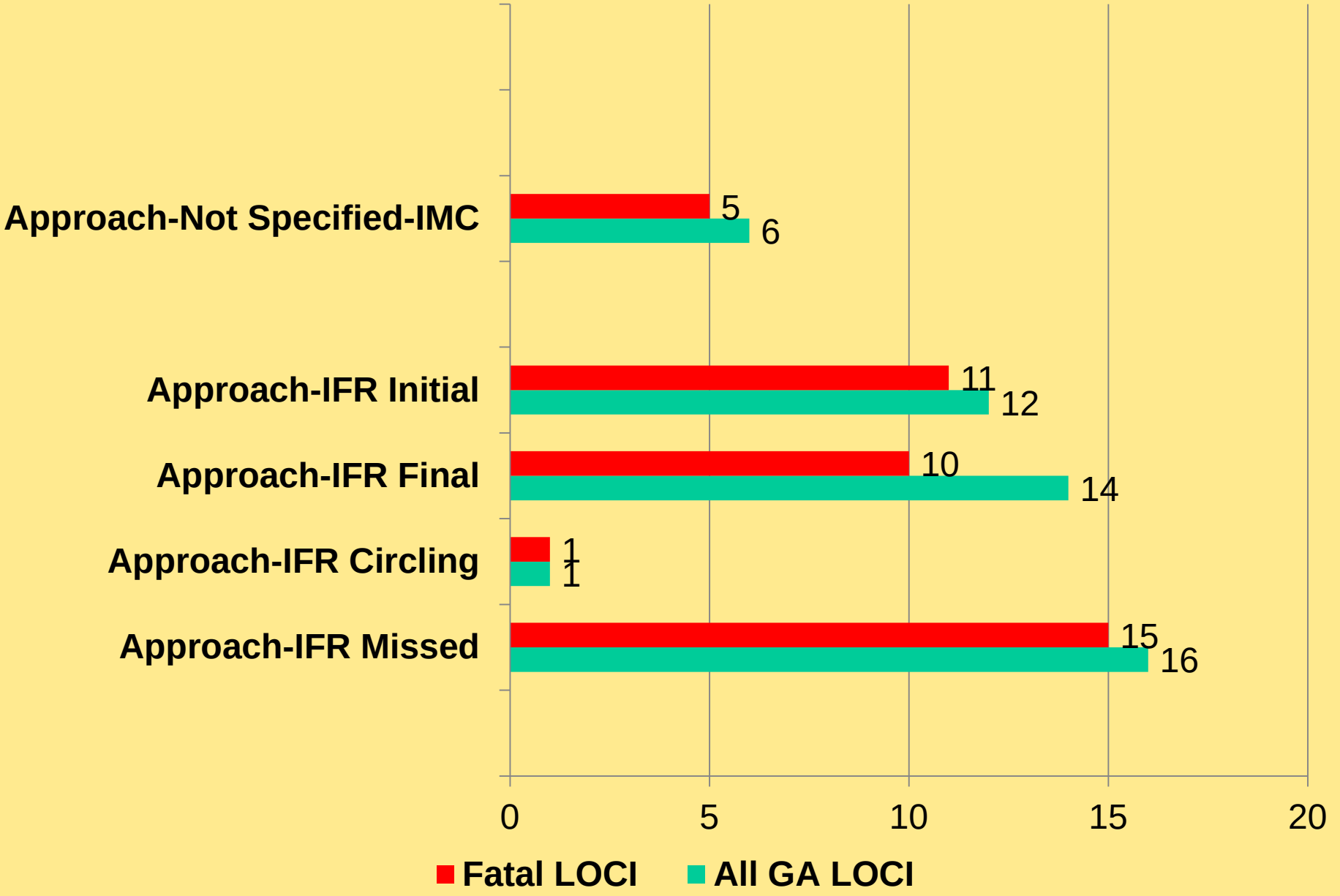
LOCI by Flight Phase 2008-2014



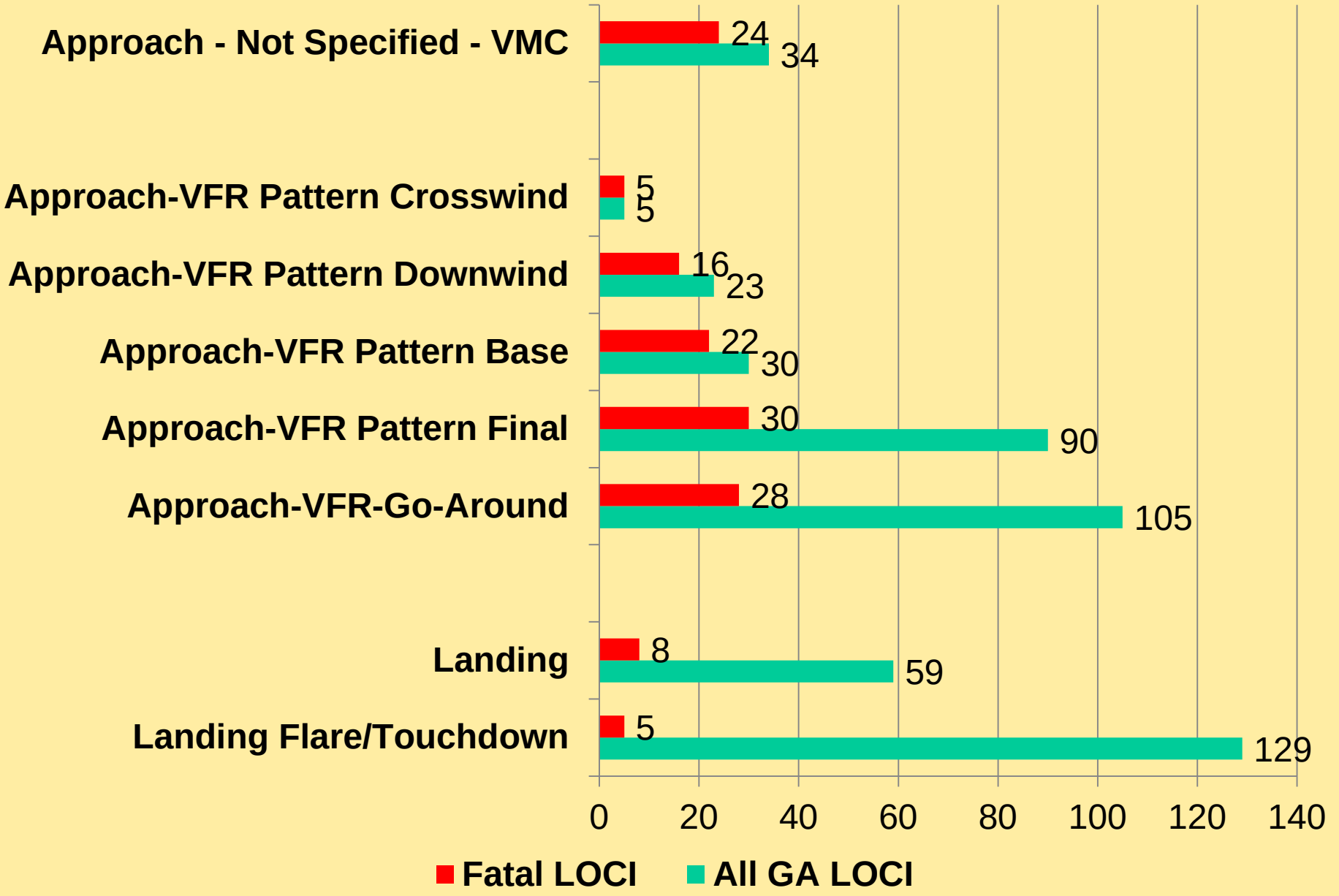
Airport FW LOCI



IFR/IMC Approach LOCI Airport



VFR/VMC LOCI Airport Approach



When NTSB investigates…

- We look at the:
  - Man (Woman)
  - Machine
  - Environment
  - Or, with LOC, what did the man do with the machine to end up where it did?

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In the process, we may ask….

- What was the pilot trying to do?
- What aerodynamic forces were involved?
- Why didn’t the airplane want to fly?
- Did a straight wing become a swept wing?

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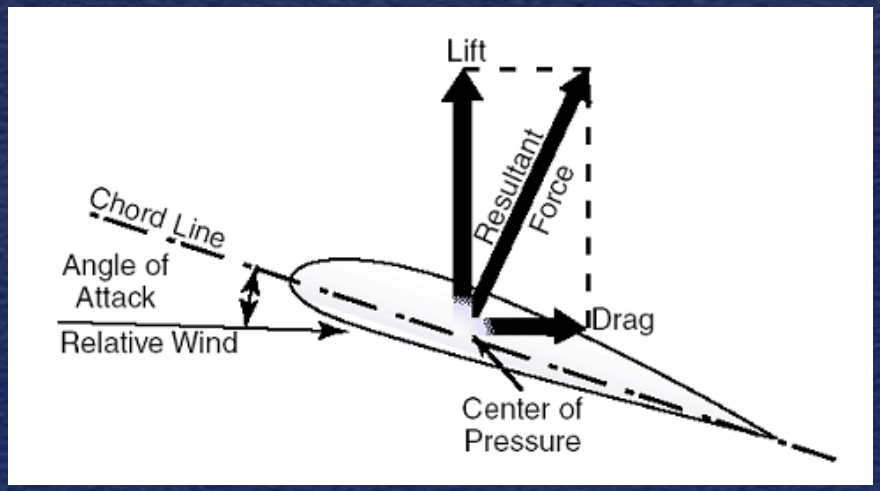
What is Angle of Attack?

- Difference between the relative wind and the wing chordline.



- AOA is primarily determined by airplane speed and attitude.

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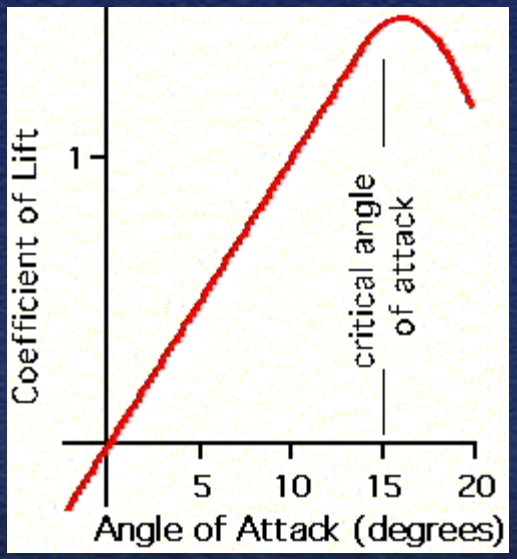
Why do we care?

- When AOA changes so does the amount of lift produced.
- Increased AOA is associated with increasing CL up to max then CL decreases.
- Critical AOA is at max CL



LOC accident investigations

- Typically involve some type of stall
  - Straight Stall
  - Accelerated Stall
  - Takeoff/Climb Stall
    - Back Side of the Power Curve
  - Yawing Stall (Spin)
  - Skidded Turn/Cross-Controlled Stall
- For multi-engines: Vmc roll

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Aviation Proverb on How to Stall

- If you want to go up, pull back on the yoke.
- If you want to go down, pull back a little more.
- If you want to go down real fast and spin around and around, just keep pulling back [and add a little yaw.]

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ERA13FA201 St Lucie, FL

- Kitfox
- April 14, 2013
- 1 fatal
- PC: The pilot's failure to maintain adequate airspeed during the turn to final, which resulted in an exceedance of wing critical angle-of-attack and a subsequent aerodynamic stall. Contributing to the accident was the pilot's combined use of two sedating antihistamines, which resulted in his impairment.

Accelerated Stalls

- Occur when an airplane stalls at a higher indicated airspeed due to higher maneuvering loads.

- Airplane stall speed increases as angle of bank increases. (In proportion to the square root of the load factor.)

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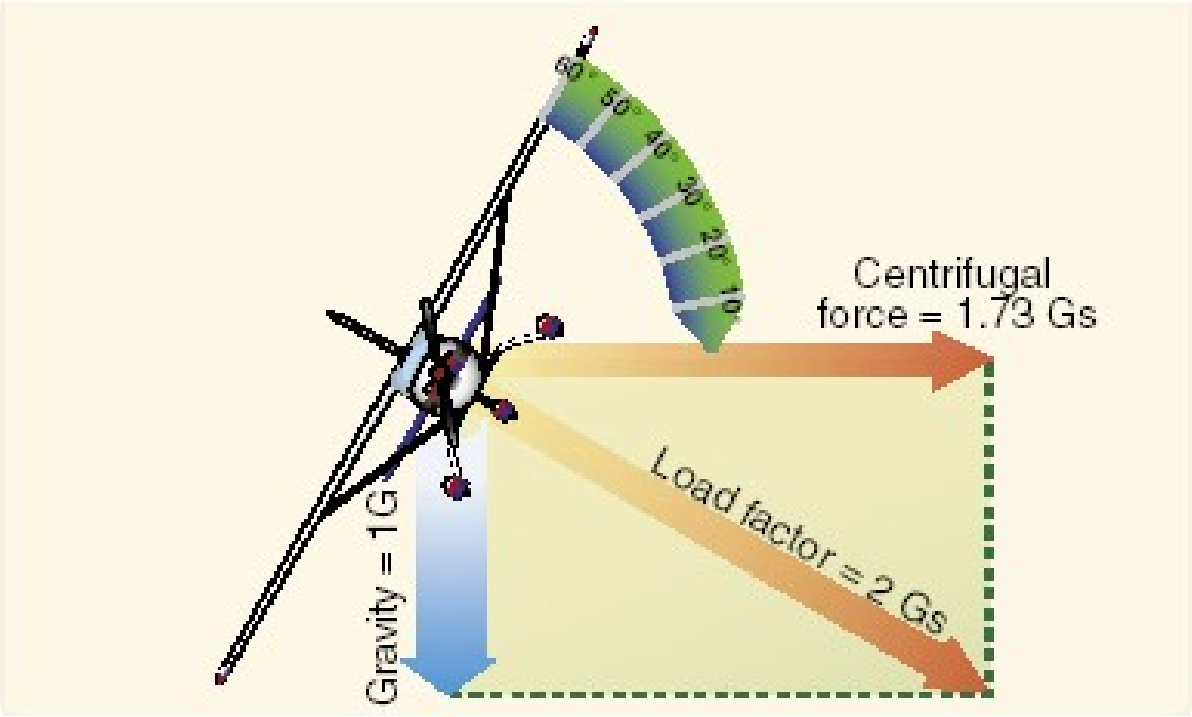
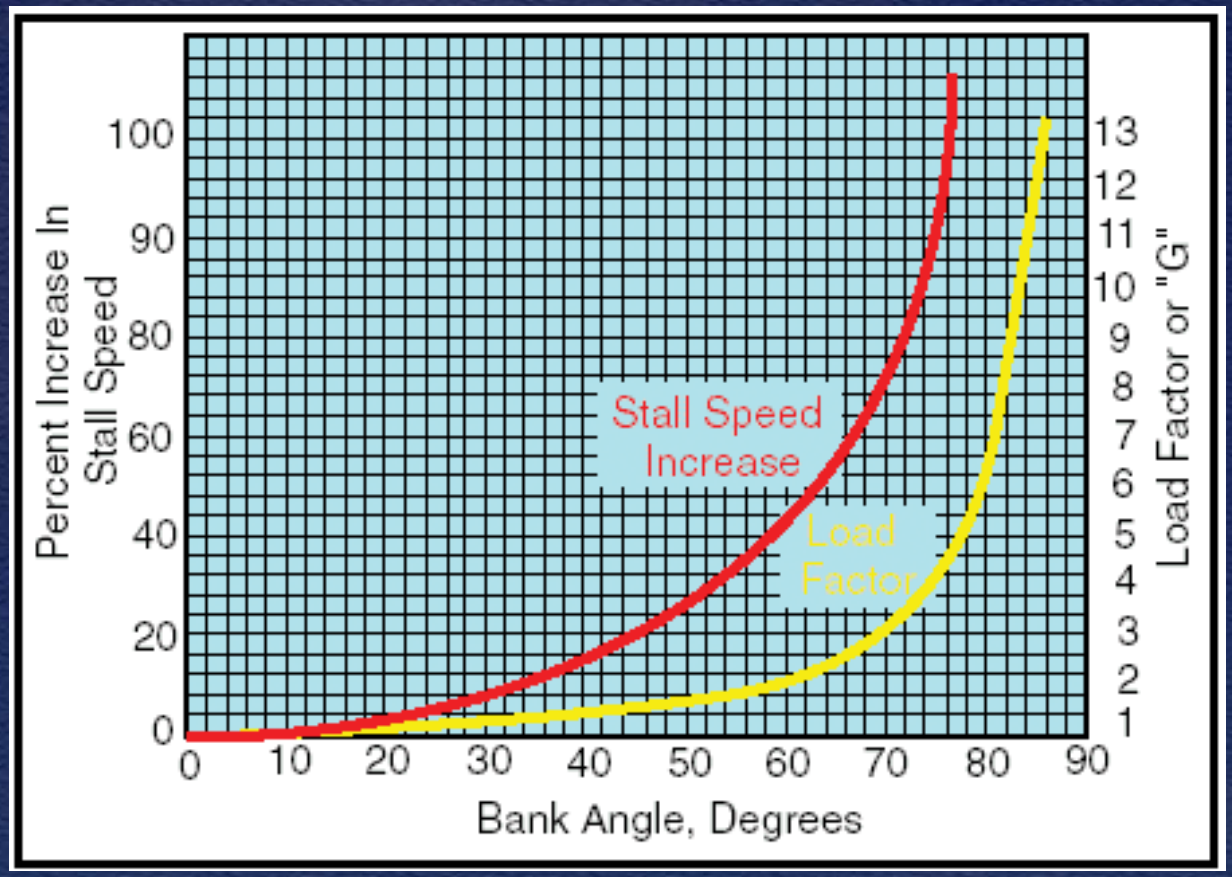


Figure 4-44. *Two forces cause load factor during turns.*


Percent Increase In Stall Speed
100
90
80
60
40
20
0
Stall Speed Increase
Load Factor
13
12
11
10
9
8
7
6
5
4
3
2
1
Load Factor or "G"
0
10
20
30
40
50
60
70
80
90
Bank Angle, Degrees

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ERA12FA196 Melbourne, FL

- Cirrus SR22
- February 29, 2012
- 3 fatal
- PC: The pilot's abrupt maneuver in response to a perceived traffic conflict, which resulted in an accelerated stall and a loss of airplane control at low altitude. Contributing to the accident was the air traffic controller's incomplete instructions, which resulted in improper sequencing of traffic landing on the same runway.

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22:01:05
Last radar return
22:01:00
22:00:54 I'm on a real short base for nine right to land now Four Sierra Romeo.
22:00:57 Four Sierra Romeo no Sir, I needed you to extend to follow the Cirrus out there on a mile final, cut it in tight now, cut it in tight for nine right.
22:00:47 Four Sierra Romeo do you have the ah Cirrus there he's about a mile final for nine right?
22:00:24 Cleared to land on nine right Four Sierra Romeo.
Melbourne International Airport
Melbourne Beach
Grumman Pl
Commerce Dr
W NASA Blvd
Carissa Rd
Erna Nixon Park
Melbourne Village
Norman
Basswood Ave
Balsam Ave
Crane Rd
Crane
Rd Hibiscus Blvd W
West Melbourne
Isla St
Towhee Dr
Penn St
Gateway Dr
Gateway Blvd
Evans Rd
Tower Access Rd
Ted Huff Rd
Harry Sutton Rd
Eddie Allen Rd
Excella Rd
Woody Burke Rd
NASA Blvd W
Harris Blvd
Buttonwood Rd
Hackney Dr
Langley Dr
Polebrook Rd
Hickam Dr
Glenmore
Lund Circle
Norman Dr
Yesta Circle
Patrick Circle
Espanola Way
Central Blvd
Palm Blvd
East Ct
West Ct
Imogene Dr
Acacia Ave
Live Oak Ave
Flamingo Rd
Pine St
Laurel Oak St
Dayton Blvd
Campbell Dr
Laila Dr W
Laila Dr E
Laila Ct
Woodland Dr
Bry-Lynn Dr
Wickham Rd S
Mintons Corner
W New Haven Ave
509
508

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Photo 1: View of Main Wreckage As Found

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DEN84FA308 Tabernash Co, CO

- Cessna L-19E
- August 10, 1984
- Found Aug 23, 1987
- 2 fatal
- PC: None Stated (But narrative discussed stall warning horn, 60-degree angle of bank and DA of 13,000 feet)

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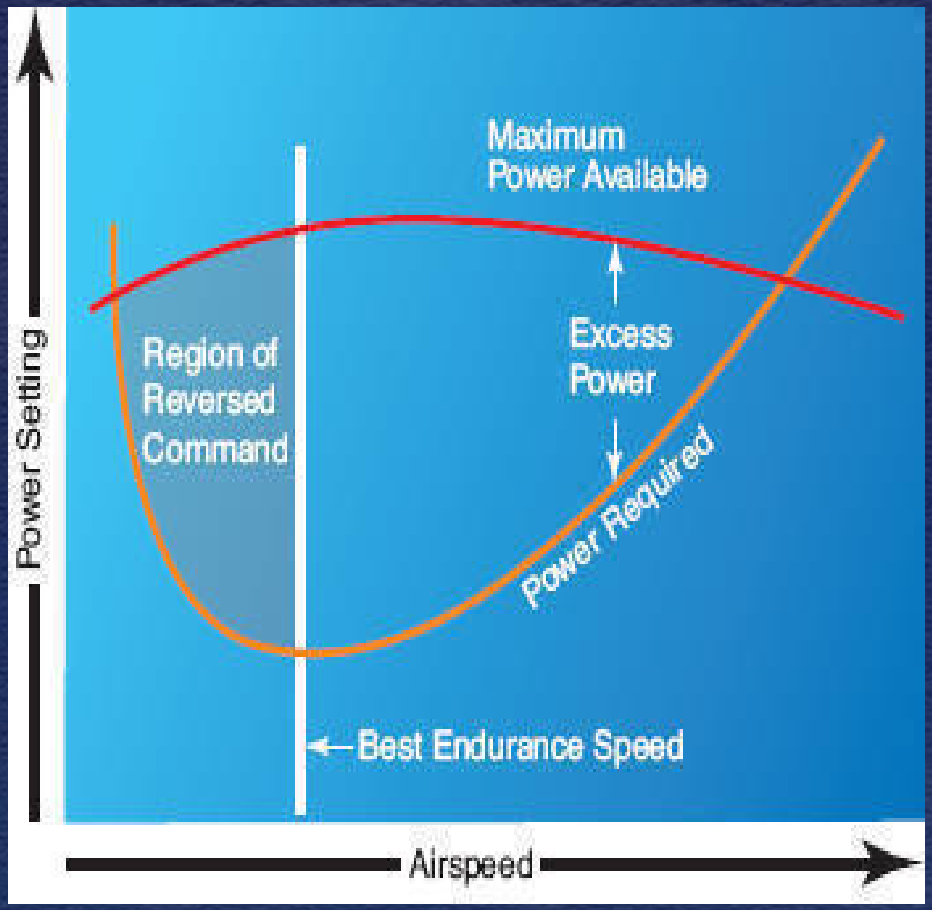
Takeoff/Climb Stalls

- Back Side of the Power Curve



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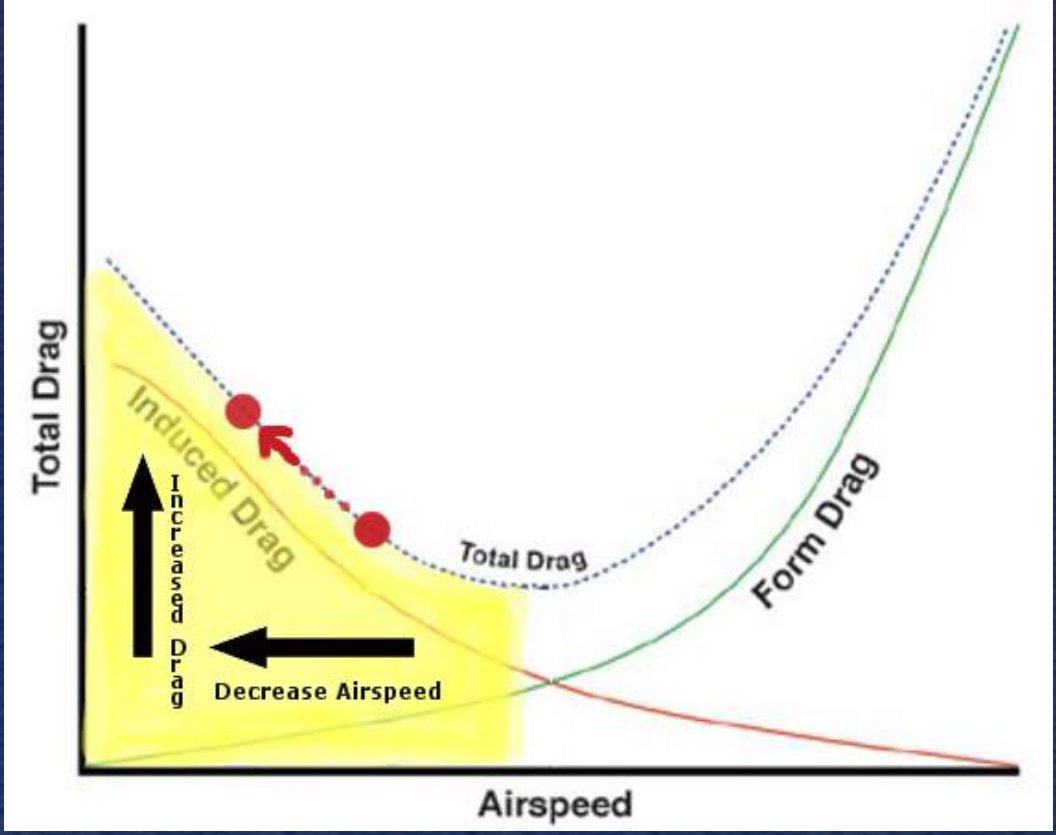
Extreme nose up effects

- Would be adding significant increase in induced drag with an increase in AOA.



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ERA12FA319 Honesdale, PA

- Cessna 177B
- May 5, 2012
- 1 Fatal
- PC: The pilot pitching the airplane to an excessive nose-up attitude during an aborted landing, which resulted in increased induced drag, diminished airspeed, and an aerodynamic stall/spin. Contributing to the accident was the pilot's use of a sedating antihistamine, which resulted in impaired mental and motor skills.

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Photo 2 - Additional Wreckage Overview

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Spins

- Critical AOA exceeded, with yaw.
- One wing “more stalled” than the other.

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Spinning Airplane Wreckage Diagram

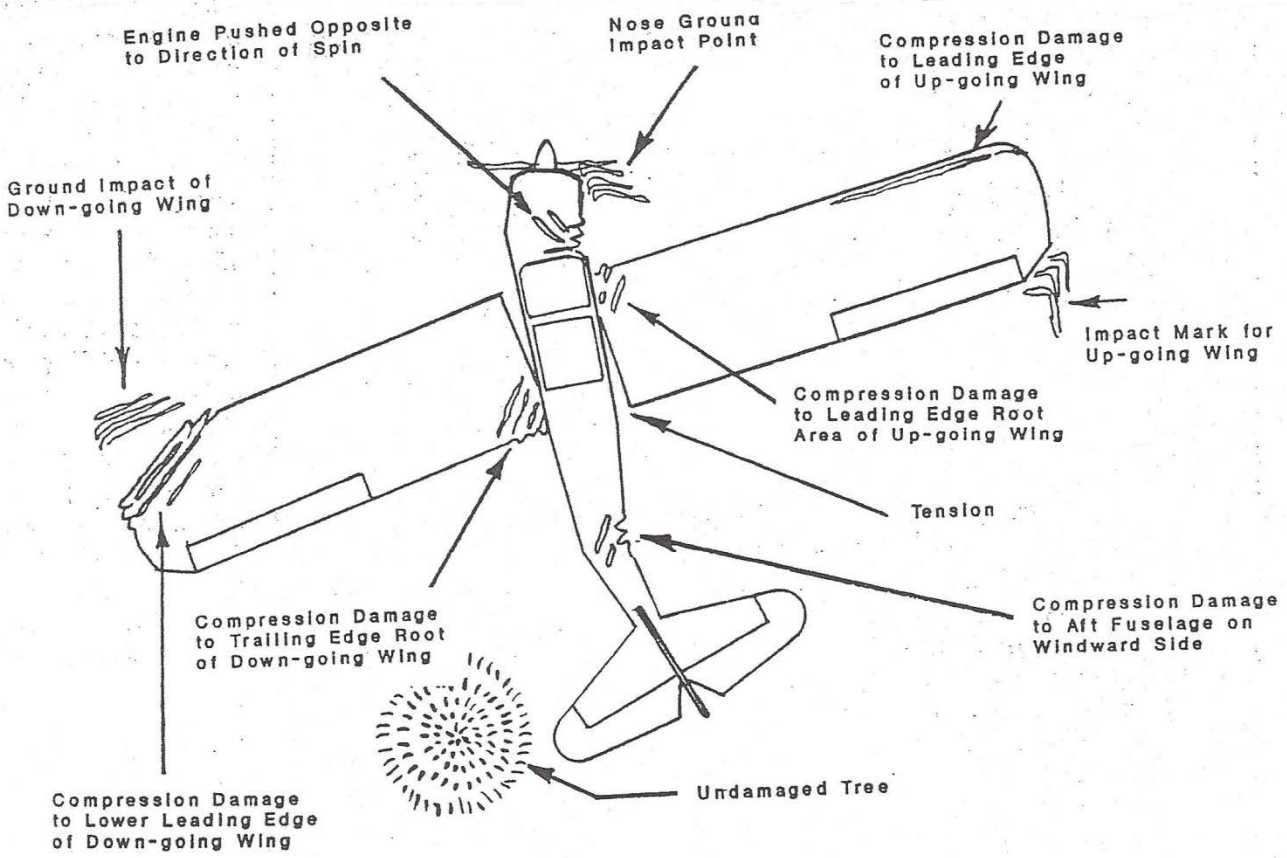

Figure 27-17. Wreckage Pattern of a Spinning Airplane

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ERA12FA120 Nashville, PA

- Cessna 441
- December 22, 2012
- 1 Fatal
- The pilot's failure to maintain minimum control airspeed after a loss of power to the right engine, which resulted in an uncontrollable roll into an inadvertent stall/spin. Contributing to the accident was the failure of the airplane's right engine for undetermined reasons, and the pilot's subsequent turn toward that inoperative engine while maintaining altitude.

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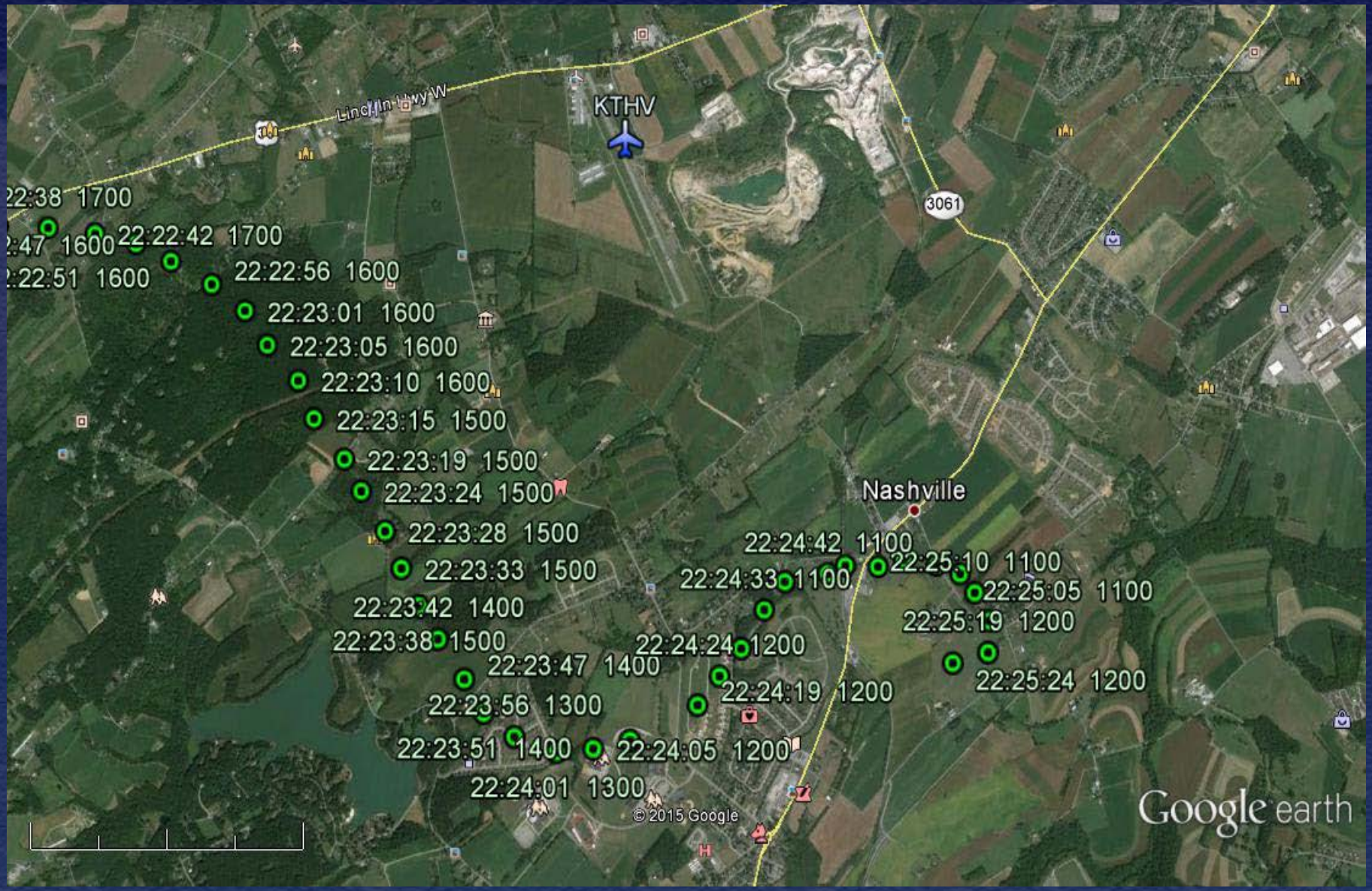
KTHV
Lincoln Hwy W
3061
Nashville
22:38 1700
:47 1600
22:22:42 1700
:22:51 1600
22:22:56 1600
22:23:01 1600
22:23:05 1600
22:23:10 1600
22:23:15 1500
22:23:19 1500
22:23:24 1500
22:23:28 1500
22:23:33 1500
22:23:42 1400
22:23:38 1500
22:23:47 1400
22:23:56 1300
22:23:51 1400
22:24:01 1300
22:24:05 1200
22:24:19 1200
22:24:24 1200
22:24:33 1100
22:24:42 1100
22:25:10 1100
22:25:05 1100
22:25:19 1200
22:25:24 1200
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Evidence of Spin to the Right

Photo 1 - Left Side of Airplane; Tail Broken to the Left and Left Wing Broken Forward

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Vmc Roll – Swanzey, NH

Photo - Wreckage Overview 2

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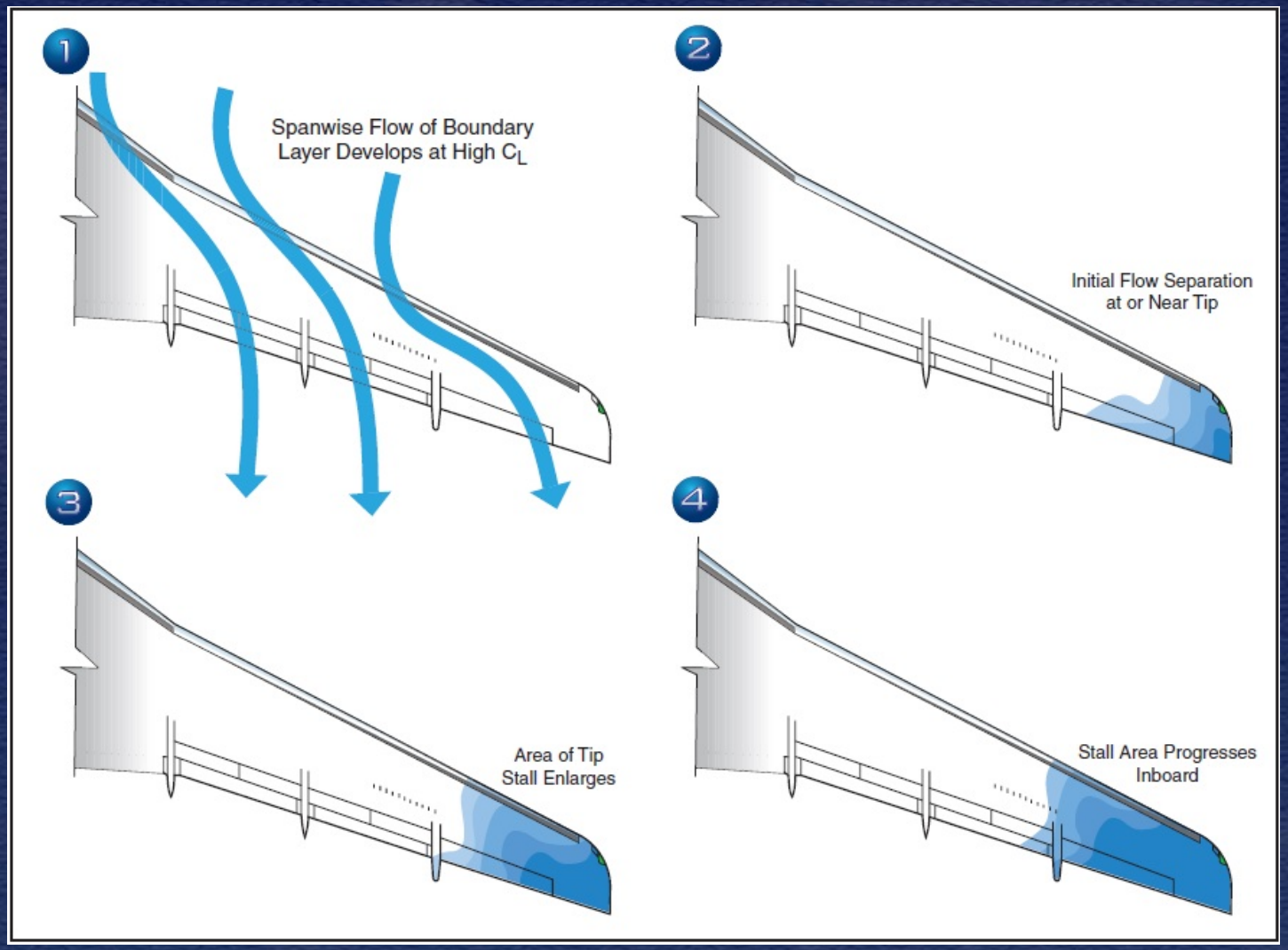
Photo - Right Engine Propeller Runway Marks

Swept Wing Stall



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Cross-Controlled Stalls

- Typically, rudder moves the airplane in one direction and ailerons in another.
- Results in rotation in the direction of rudder being applied, regardless of which wingtip is raised.

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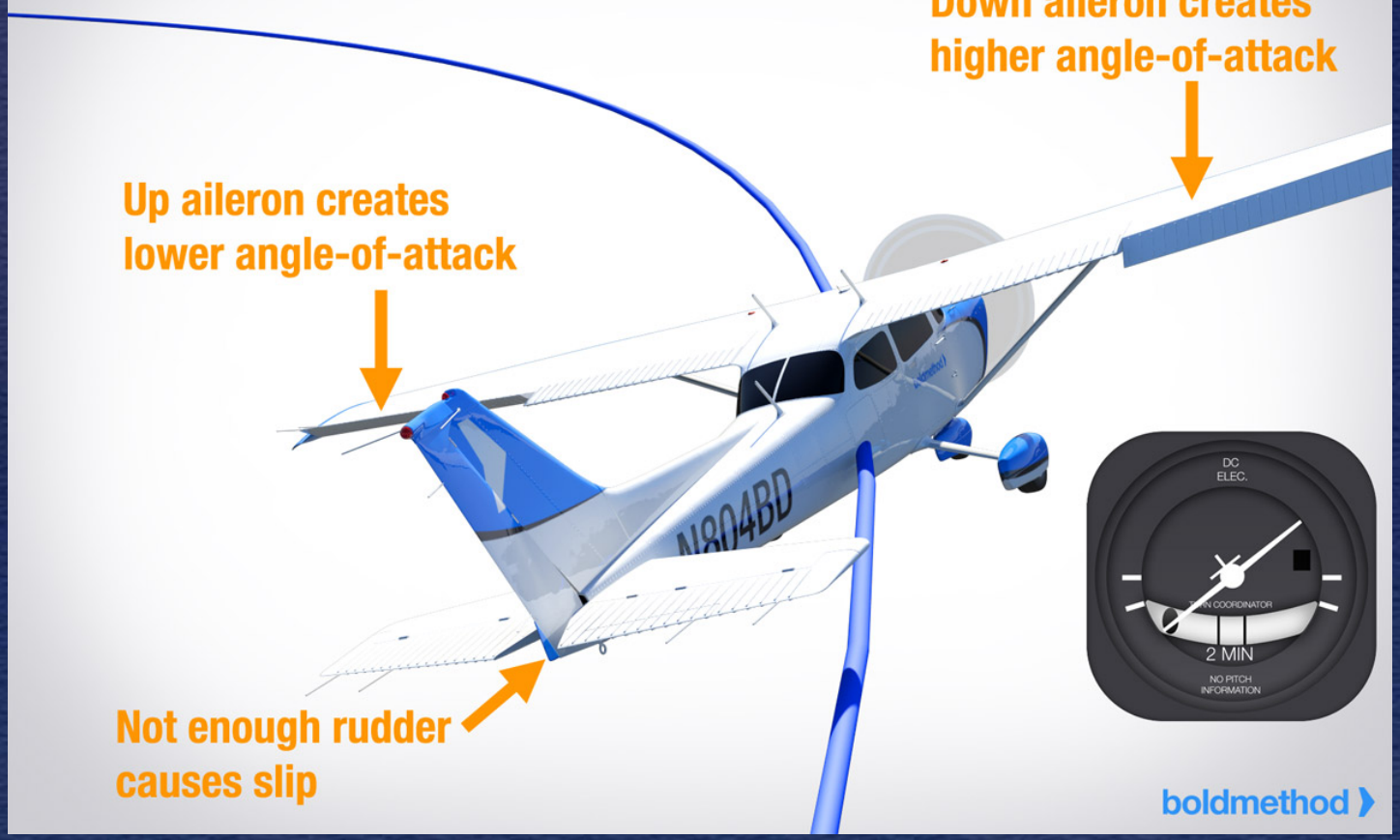
Slipping Turn

Ailerons counter underbanking tendency



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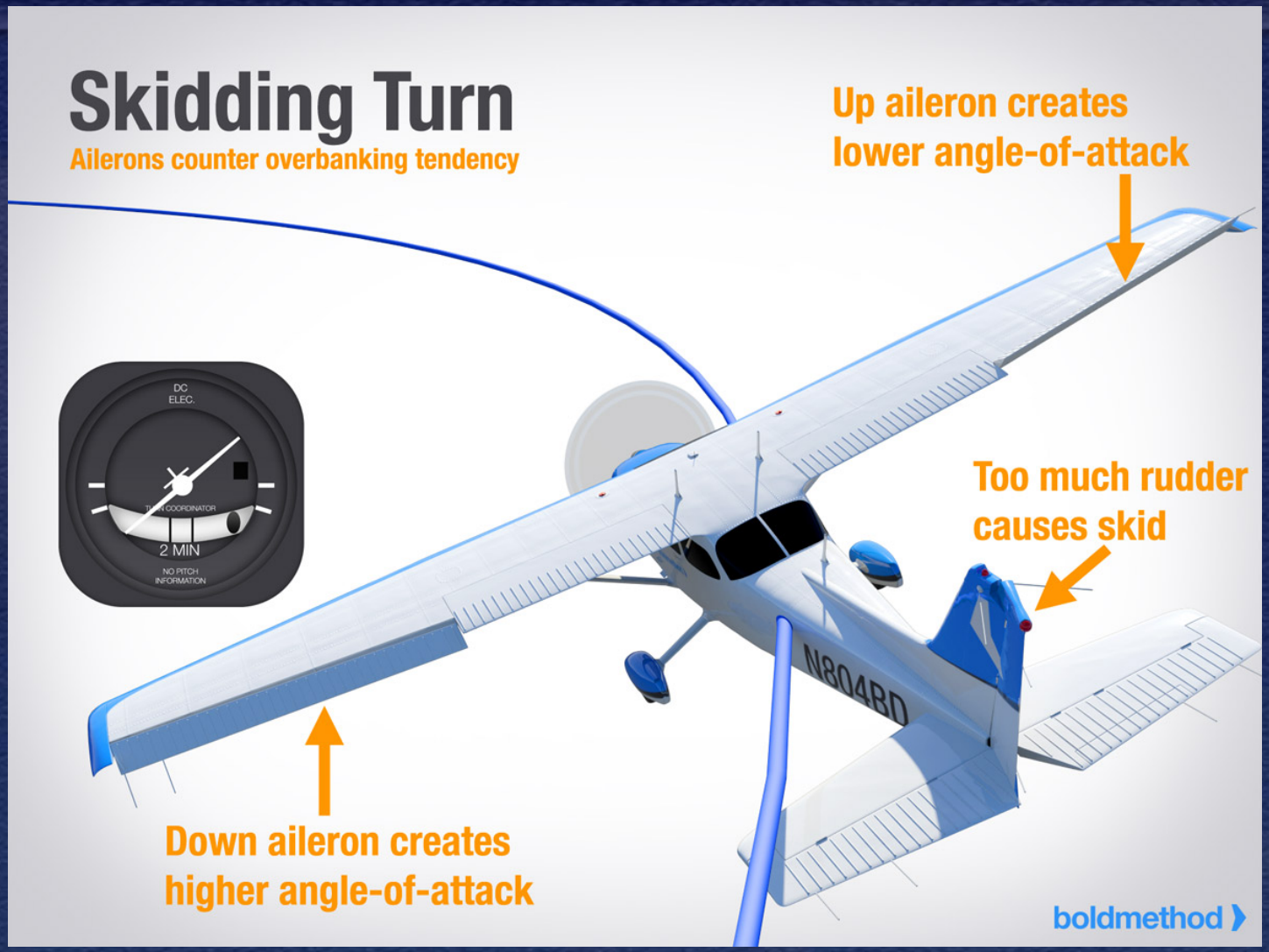
Skidding Turn
Ailerons counter overbanking tendency
Up aileron creates
lower angle-of-attack
DC
ELEC.
2 MIN
NO PITCH
INFORMATION
Too much rudder
causes skid
N804BD
Down aileron creates
higher angle-of-attack
boldmethod

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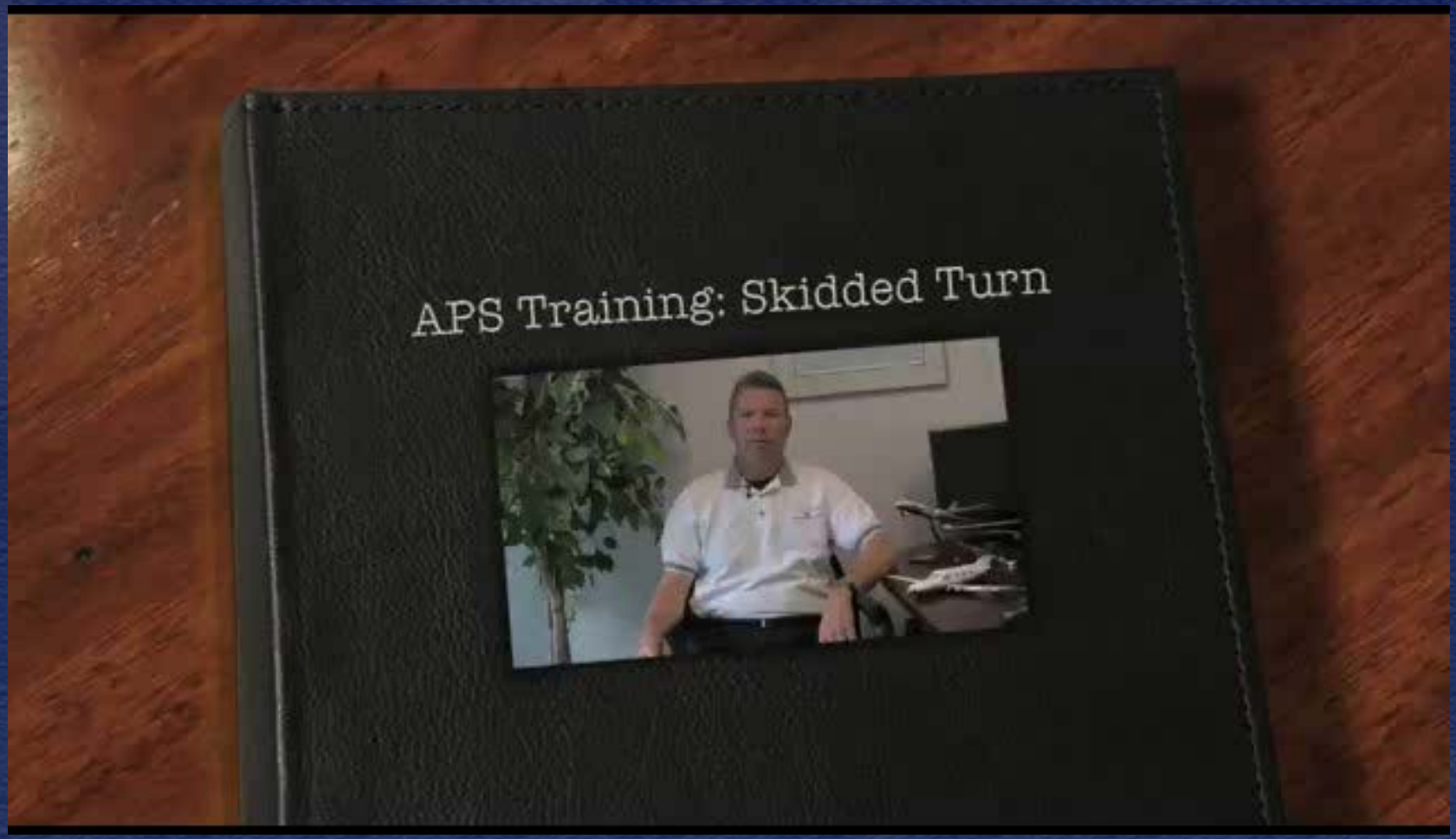
APS Training



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Skidding Left Turn Stall

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ERA13FA209 Williamsburg, VA

- April 19, 2013
- 2 Fatal
- PC: The pilot's failure to maintain airplane control during a base-to-final turn with a gusting wind and potential turbulence/wind shear, which resulted in an aerodynamic stall and collision with terrain.

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Photograph #1: Aft starboard view of wreckage (Courtesy of Williamsburg FD)

Photograph #2: Front starboard view of wreckage (Courtesy of FAA)

DFW08FA060 Lindsay, OK

- February 2, 2008
- 2 Fatal
- The [pilots'] failure to maintain control of the airplane, which resulted in an inadvertent stall while maneuvering.

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AvWeb

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Human Factors

- Multitasking myth
- Distractions
  - Visual, manual, cognitive
- Pilot reactions – 4 secs?
  - Startle effect

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Reaction Influencers

- Pilot demographics (experience, culture)
- Training/Scenario-based training (Upset training!)
- Anticipating things going wrong
- Systems complexity
- Mission
- Pilot workload
- Go-no-go/aeronautical decision-making concepts
- Medications
- Situational Awareness
  - Distraction
  - Complacency
  - Tunneling
  - Aids such as AOA

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Mitigating Human Factors

Be honest with yourself about your knowledge of stalls, and your ability to anticipate and react to them.

Understand and maintain currency in the equipment and airplanes you operate.

Maximize training opportunities.

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Thoroughly prepare for the environments in which you'll be flying.

Anticipate, manage and minimize distractions.

Increase situational awareness, including through devices such as angle-of-attack indicators.

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And finally…

Be an advocate.

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NTSB LOC Forum – Oct 14, 2015

- Search You Tube:

"NTSB Forum: Humans and Hardware: Preventing General Aviation Inflight Loss of Control."

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Four Panels - Roundtable

- What's the Problem? (Where are we and what have we done thus far?)
- Human Factors Issues
- Human Solutions
- Hardware Solutions

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Takeaways

- We’re just in the beginning of a long process.
- Technology will help.
  - Cost
  - Simplicity to install/use
  - Simulators to train to surprise
- Practical standards/flight reviews inadequate.

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- Consider the circling approach for stability and to reduce overshoot.

- As a community, we need to change the culture regarding LOC attitudes with fellow pilots (similar to seat belts, drink/drive campaigns.)

Some Initiatives

- EAA Founder's Innovation Award
- ASTM F44
- University of North Dakota
- Professor Dehais Eye Tracking

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