NTSB National Transportation Safety Board

Office of Aviation Safety

Orlando FSDO CFI Refresher

August 12, 2015

Paul Cox
Senior Air Safety Investigator

About the NTSB

- Very small federal agency
- About 400 people total, 100 in Aviation

- Various modes
  - Aviation
  - Highway
  - Marine
  - Rail/Pipeline/Hazmat

NTSB

- About 1,500 accidents per year.
- 95%+ investigated by 45+ regional investigators.
- Congress mandates that all aviation accidents are investigated while other modes are selective.

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NTSB Investigation Purpose

- “To determine the facts, conditions, and circumstances relating to an accident or incident and the probable cause(s) thereof.

- These results are then used to ascertain measures that would best tend to prevent similar accidents or incidents in the future.”

- No enforcement or regulatory powers, so...

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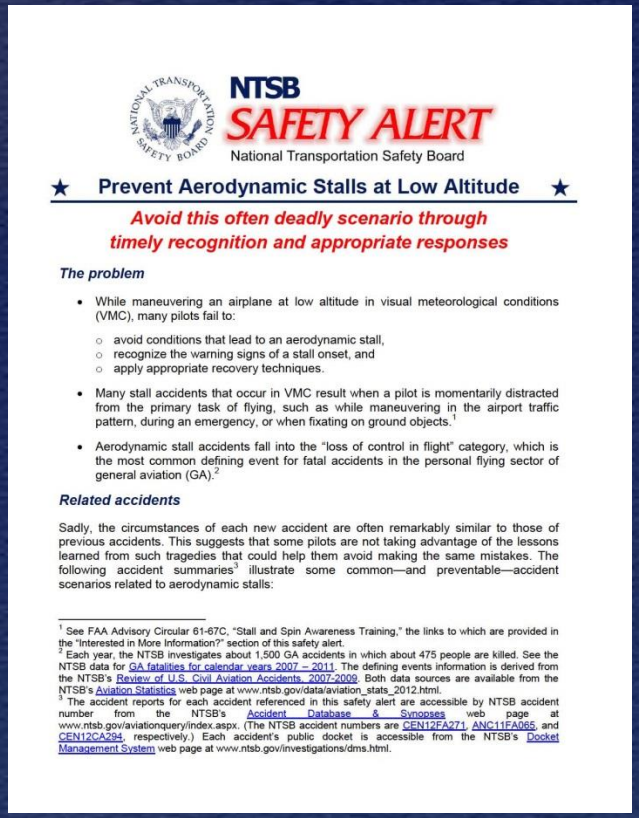
NTSB Facilitates Change Through….

- Accident reports
- Data base maintenance
- Some work w/other orgs

- Advocate safety through
  - Recommendations
  - Accomplishments
  - Results
  - Alerts
  - Forums, and….



NTSB
SAFETY ALERT
National Transportation Safety Board

★ Prevent Aerodynamic Stalls at Low Altitude ★

Avoid this often deadly scenario through timely recognition and appropriate responses

The problem

- While maneuvering an airplane at low altitude in visual meteorological conditions (VMC), many pilots fail to:
  - avoid conditions that lead to an aerodynamic stall,
  - recognize the warning signs of a stall onset, and
  - apply appropriate recovery techniques.
- Many stall accidents that occur in VMC result when a pilot is momentarily distracted from the primary task of flying, such as while maneuvering in the airport traffic pattern, during an emergency, or when fixating on ground objects.[1]
- Aerodynamic stall accidents fall into the "loss of control in flight" category, which is the most common defining event for fatal accidents in the personal flying sector of general aviation (GA).[2]

Related accidents

Sadly, the circumstances of each new accident are often remarkably similar to those of previous accidents. This suggests that some pilots are not taking advantage of the lessons learned from such tragedies that could help them avoid making the same mistakes. The following accident summaries[3] illustrate some common—and preventable—accident scenarios related to aerodynamic stalls:

[1] See FAA Advisory Circular 61-67C, "Stall and Spin Awareness Training," the links to which are provided in the "Interested in More Information?" section of this safety alert.
[2] Each year, the NTSB investigates about 1,500 GA accidents in which about 475 people are killed. See the NTSB data for GA fatalities for calendar years 2007 – 2011. The defining events information is derived from the NTSB's Review of U.S. Civil Aviation Accidents, 2007-2009. Both data sources are available from the NTSB's Aviation Statistics web page at www.ntsb.gov/data/aviation_stats_2012.html.
[3] The accident reports for each accident referenced in this safety alert are accessible by NTSB accident number from the NTSB's Accident Database & Synopses web page at www.ntsb.gov/aviationquery/index.aspx. (The NTSB accident numbers are CEN12FA271, ANC11FA065, and CEN12CA294, respectively.) Each accident's public docket is accessible from the NTSB's Docket Management System web page at www.ntsb.gov/investigations/dms.html.

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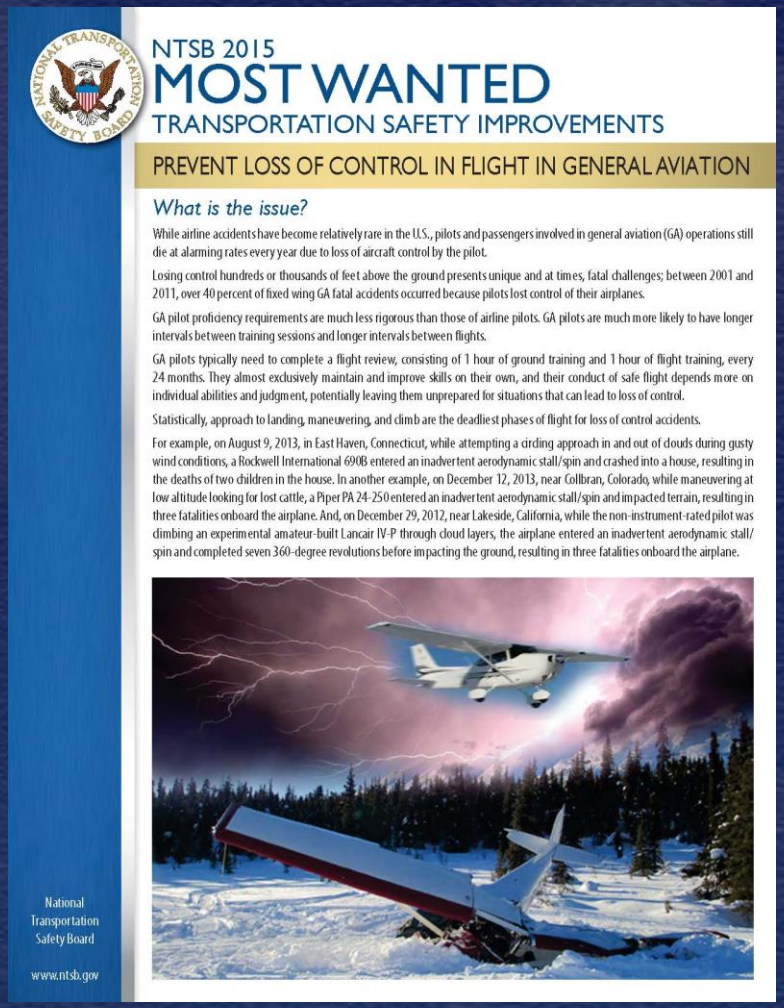
NTSB "Most Wanted" List (2015)



NTSB 2015

MOST WANTED

TRANSPORTATION SAFETY IMPROVEMENTS

PREVENT LOSS OF CONTROL IN FLIGHT IN GENERAL AVIATION

What is the issue?

While airline accidents have become relatively rare in the U.S., pilots and passengers involved in general aviation (GA) operations still die at alarming rates every year due to loss of aircraft control by the pilot.

Losing control hundreds or thousands of feet above the ground presents unique and at times, fatal challenges; between 2001 and 2011, over 40 percent of fixed wing GA fatal accidents occurred because pilots lost control of their airplanes.

GA pilot proficiency requirements are much less rigorous than those of airline pilots. GA pilots are much more likely to have longer intervals between training sessions and longer intervals between flights.

GA pilots typically need to complete a flight review, consisting of 1 hour of ground training and 1 hour of flight training, every 24 months. They almost exclusively maintain and improve skills on their own, and their conduct of safe flight depends more on individual abilities and judgment, potentially leaving them unprepared for situations that can lead to loss of control.

Statistically, approach to landing, maneuvering, and climb are the deadliest phases of flight for loss of control accidents.

For example, on August 9, 2013, in East Haven, Connecticut, while attempting a circling approach in and out of clouds during gusty wind conditions, a Rockwell International 690B entered an inadvertent aerodynamic stall/spin and crashed into a house, resulting in the deaths of two children in the house. In another example, on December 12, 2013, near Collbran, Colorado, while maneuvering at low altitude looking for lost cattle, a Piper PA 24-250 entered an inadvertent aerodynamic stall/spin and impacted terrain, resulting in three fatalities onboard the airplane. And, on December 29, 2012, near Lakeside, California, while the non-instrument-rated pilot was climbing an experimental amateur-built Lancair IV-P through cloud layers, the airplane entered an inadvertent aerodynamic stall/spin and completed seven 360-degree revolutions before impacting the ground, resulting in three fatalities onboard the airplane.

National Transportation Safety Board

www.ntsb.gov

For 2015….

- LOC in FW GA
- Public Helicopter Safety
- Procedural Compliance
- Medical Fitness for Duty
- Mass Transit Safety
- Commercial Trucking
- Positive Train Control
- Substance Impairment
- Rail Tank Car Safety
- Deadly Distractions

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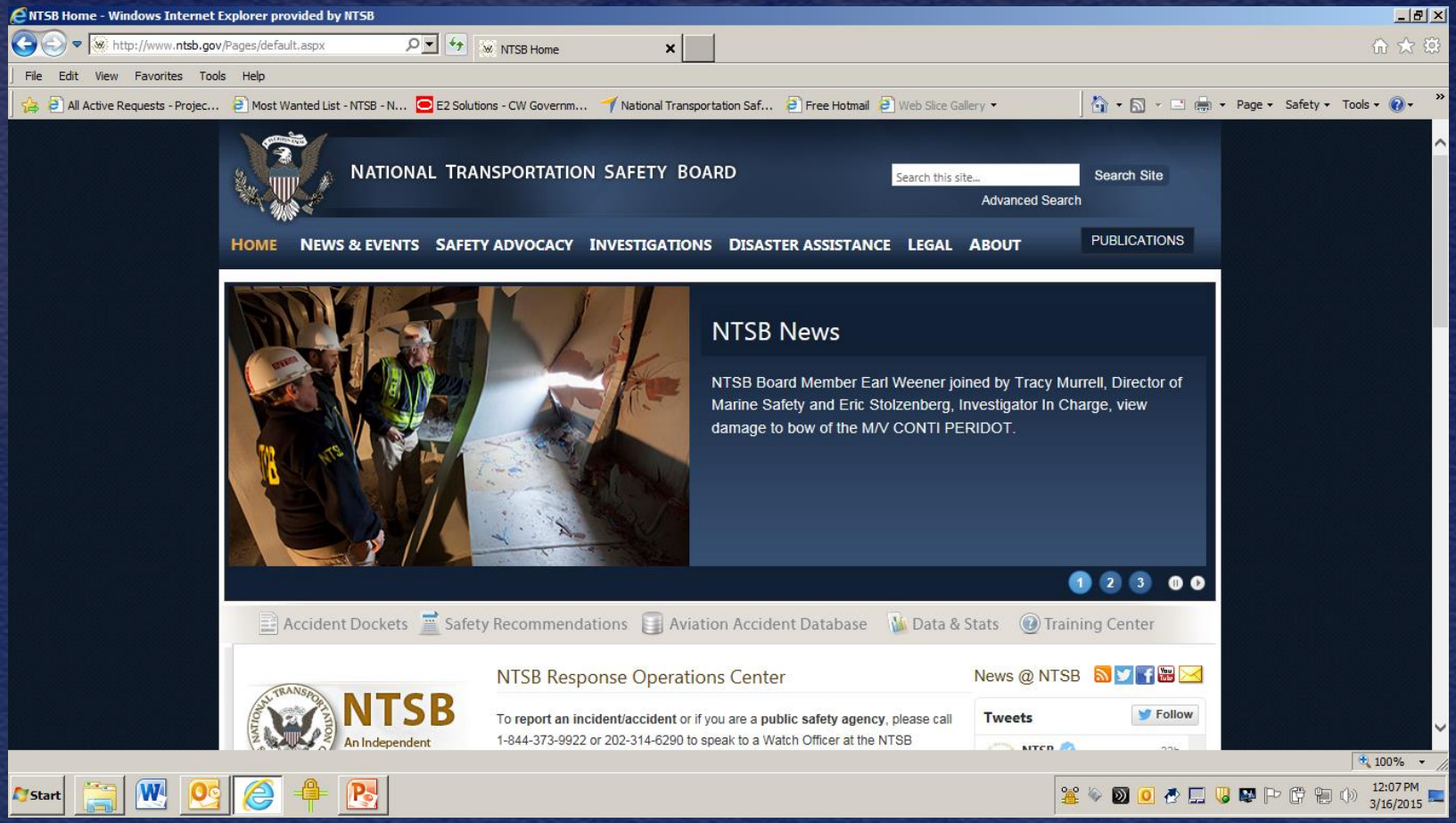
Where to Find These…



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Solving a problem involves:

- Education
- Realization
- Activation

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MWL Item – 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 do we fix this?

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How do we define LOC?

- CAST/ICAO Common Taxonomy Team (CICTT)
  - Common global descriptors of aviation safety events and standards for aviation safety data/information systems.
  - To remove constraints on aviation safety analysis and sharing.

CICTT Definition

- **Loss of Control – Inflight**

  "Loss of aircraft control while inflight."

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Others?

- FAR/AIM: Not defined.

- Pilot's Handbook Aero Knowledge:
- Not defined.

- Me: Airplane won't go where you want it to go, or does go where you don't want it to go.

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Anyone Can Have a Bad Day

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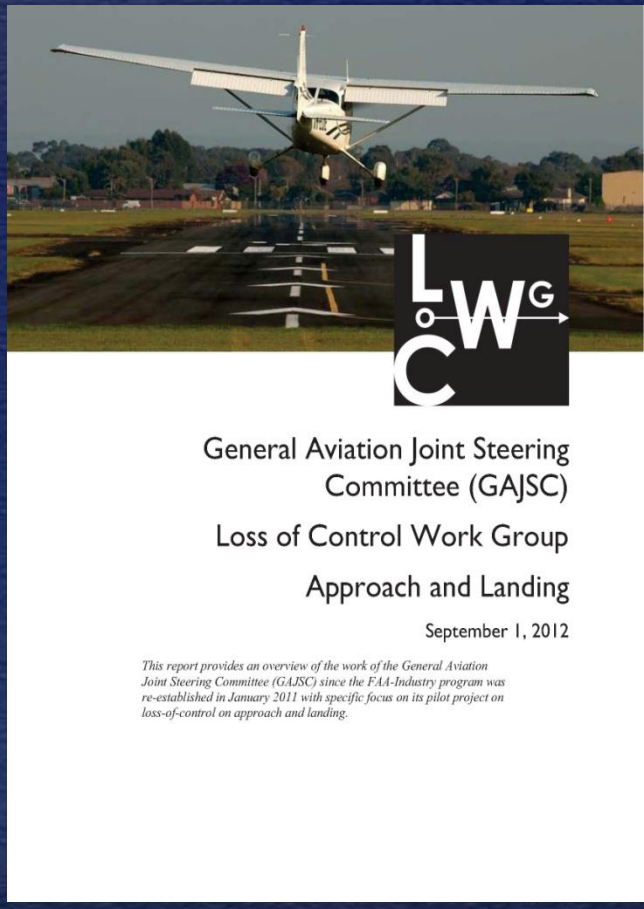
LOC Initiative – FAA/Industry

- General Aviation Joint Steering Committee (GAJSC) Loss of Control Work Group Approach and Landing

- 40.2% or 1,259 of fatal accidents 2001-2010 were “Loss of Control”

- 279 Accidents were approach and landing

- Took 60 accidents, and used the first 30 that were well documented.
- Then developed a methodology to prioritize problems and interventions.
- Stressed the use of AOA systems.



NTSB Data 2008-2014 (In-flight)

- Total FW accidents: 8,402
- LOC FW accidents: (1,465) (17.4%)

(LOC/stall is the “defining event.”)

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NTSB Data 2008-2014 (In-flight)

- Total fatal FW accidents: 1,570
- LOC fatal FW fatal accidents: 697 (44.4%)

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NTSB Data 2008-2014 (In-flight)

- **Total FW fatalities: 2,678**
- **LOC FW fatalities: 1,192 (44.5%)**

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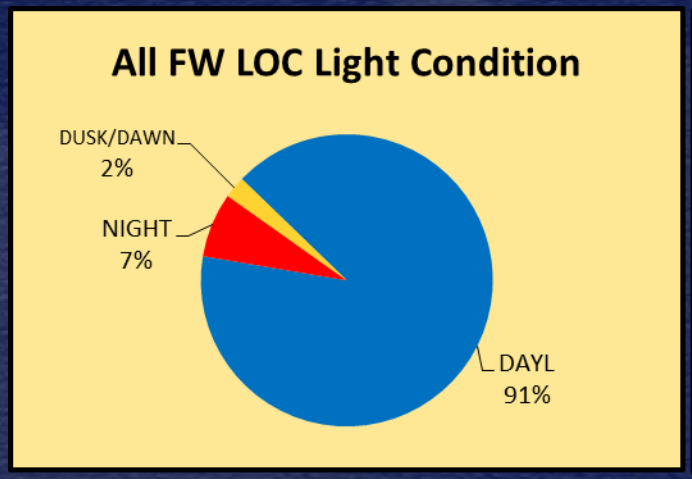
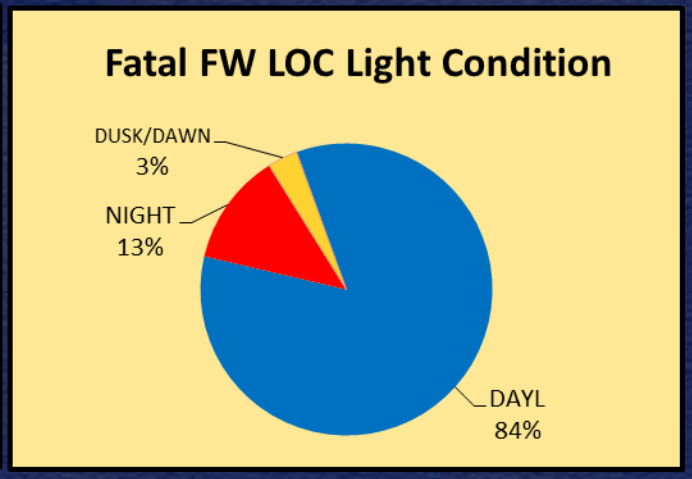
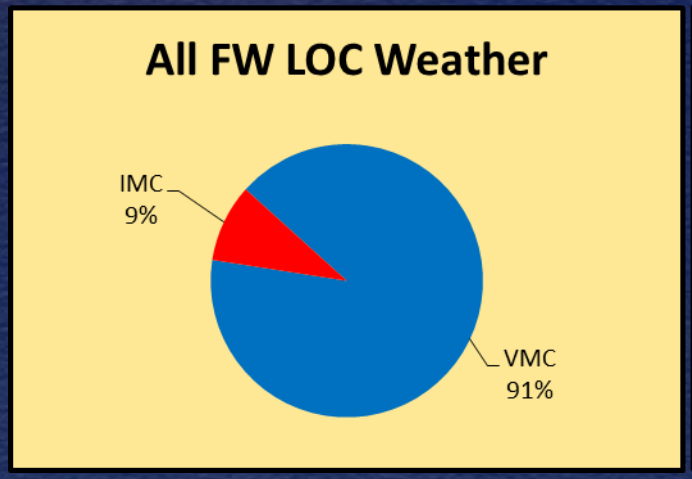
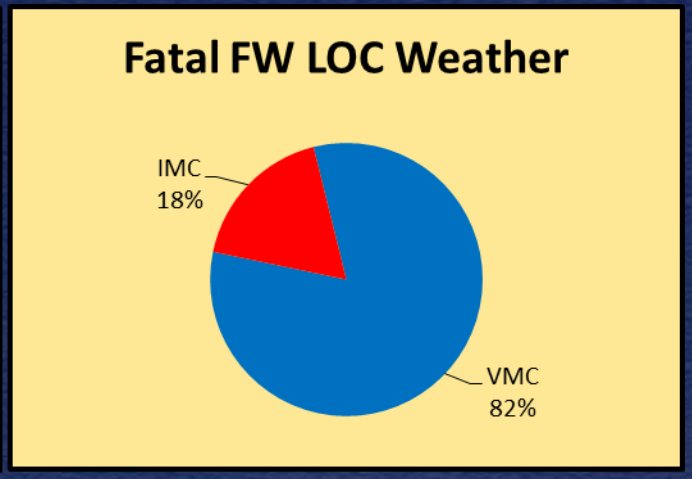
When do LOC accidents occur?









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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)

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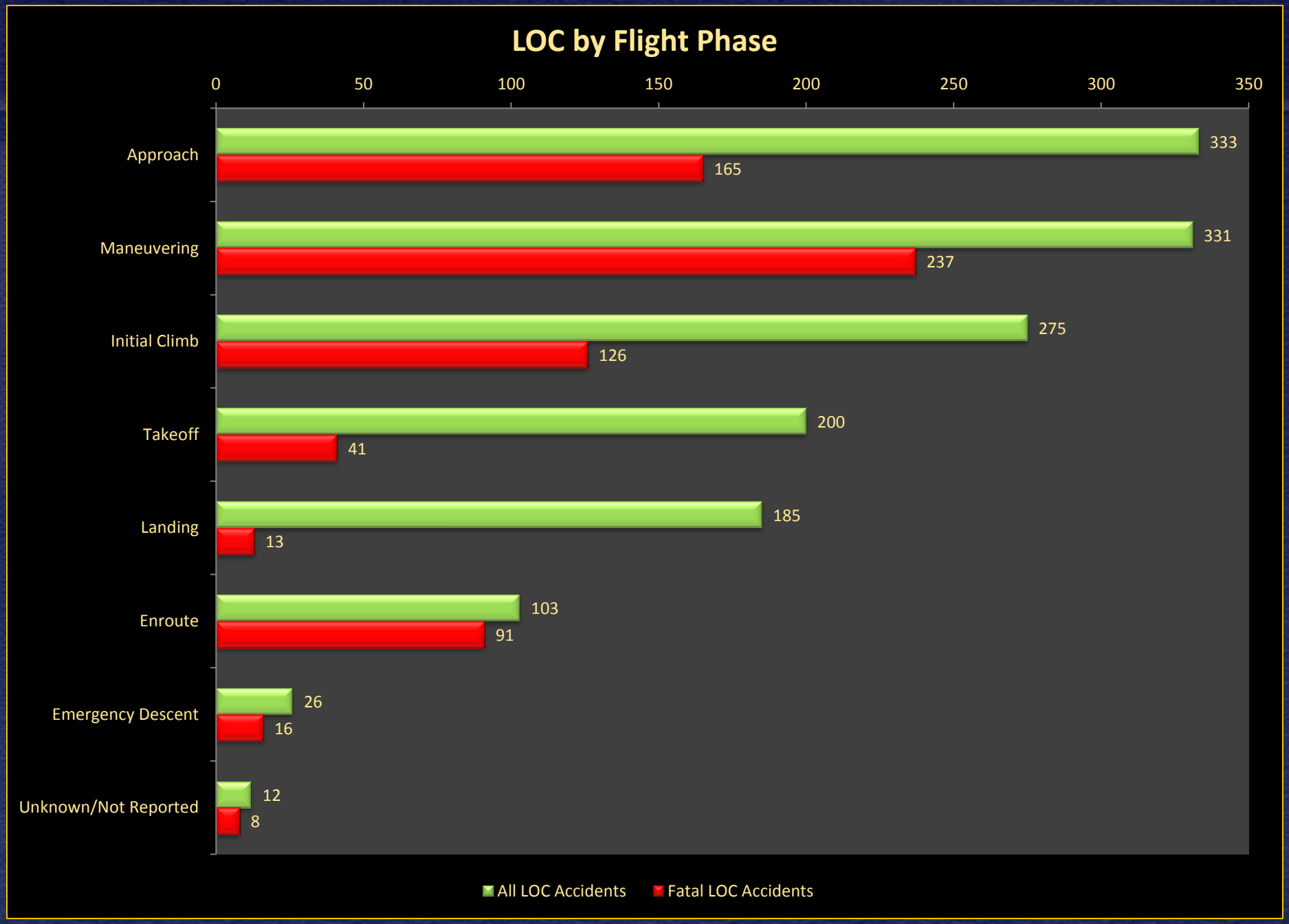
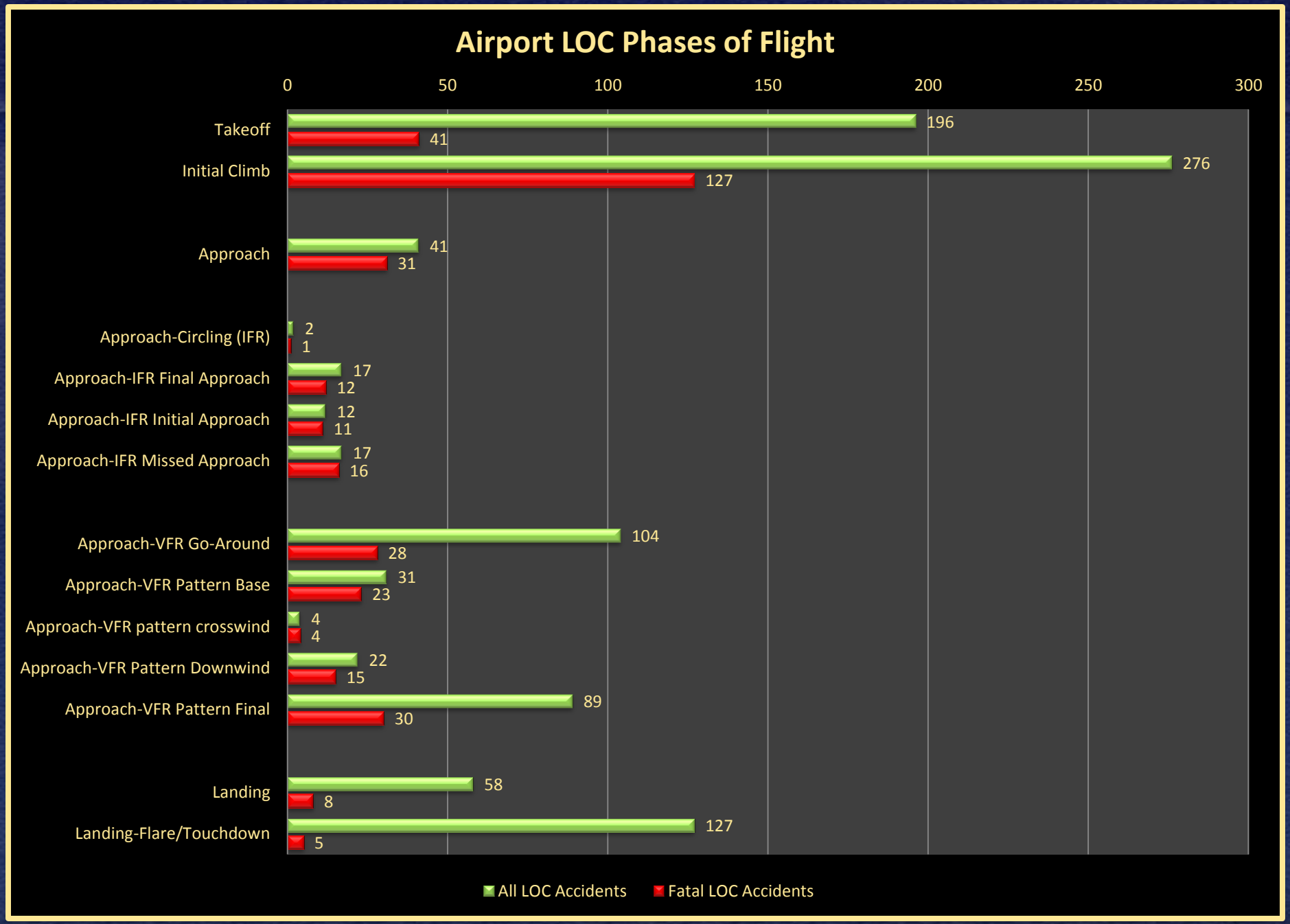
- **Maneuvering -** Low altitude/aerobatic flight operations.

- **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.)


LOC by Flight Phase
0
50
100
150
200
250
300
350
Approach
333
165
Maneuvering
331
237
Initial Climb
275
126
Takeoff
200
41
Landing
185
13
Enroute
103
91
Emergency Descent
26
16
Unknown/Not Reported
12
8
All LOC Accidents
Fatal LOC Accidents


Airport LOC Phases of Flight
0
50
100
150
200
250
300
Takeoff
196
41
Initial Climb
276
127
Approach
41
31
Approach-Circling (IFR)
2
1
Approach-IFR Final Approach
17
12
Approach-IFR Initial Approach
12
11
Approach-IFR Missed Approach
17
16
Approach-VFR Go-Around
104
28
Approach-VFR Pattern Base
31
23
Approach-VFR pattern crosswind
4
4
Approach-VFR Pattern Downwind
22
15
Approach-VFR Pattern Final
89
30
Landing
58
8
Landing-Flare/Touchdown
127
5
All LOC Accidents
Fatal LOC Accidents

Fatal Airport LOC 2008-2014

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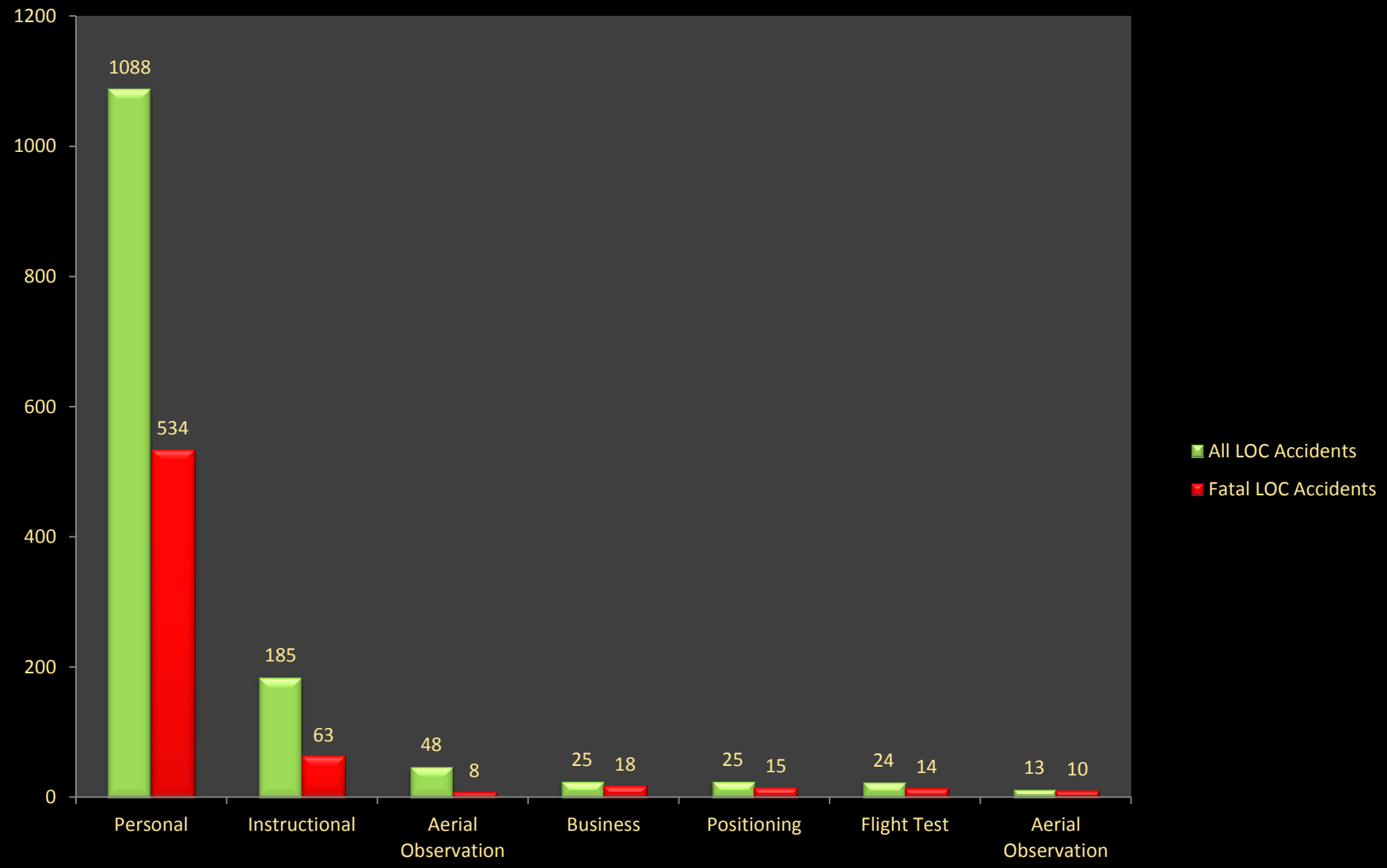
Flight Purpose



Instructional Accidents 2008-2014

	Minor/None	Serious	Fatal
Total	100	22	63
VMC	100	22	60
Day	97	21	55
Night	2	1	4
Dawn/Dusk	1		1
Solo	16	9	11

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	Minor/None	Serious	Fatal
Takeoff	23	2	2
Initial Climb	8	5	14
En Route Climb	1		1
En Route Hold			1
Maneuvering	2	3	21
Maneuvering Low Alt	2	1	4
Maneuvering Aero			2
Emergency Descent	1		1
Approach	1		
Downwind	1	3	
Pattern Base		1	3
VFR Pattern Final	6	2	3
IFR Final		1	
Landing	13		1
Flare/Touchdown	21	3	1
VFR Go-Around	22	4	4
Unknown		1	
Sum	100	22	63

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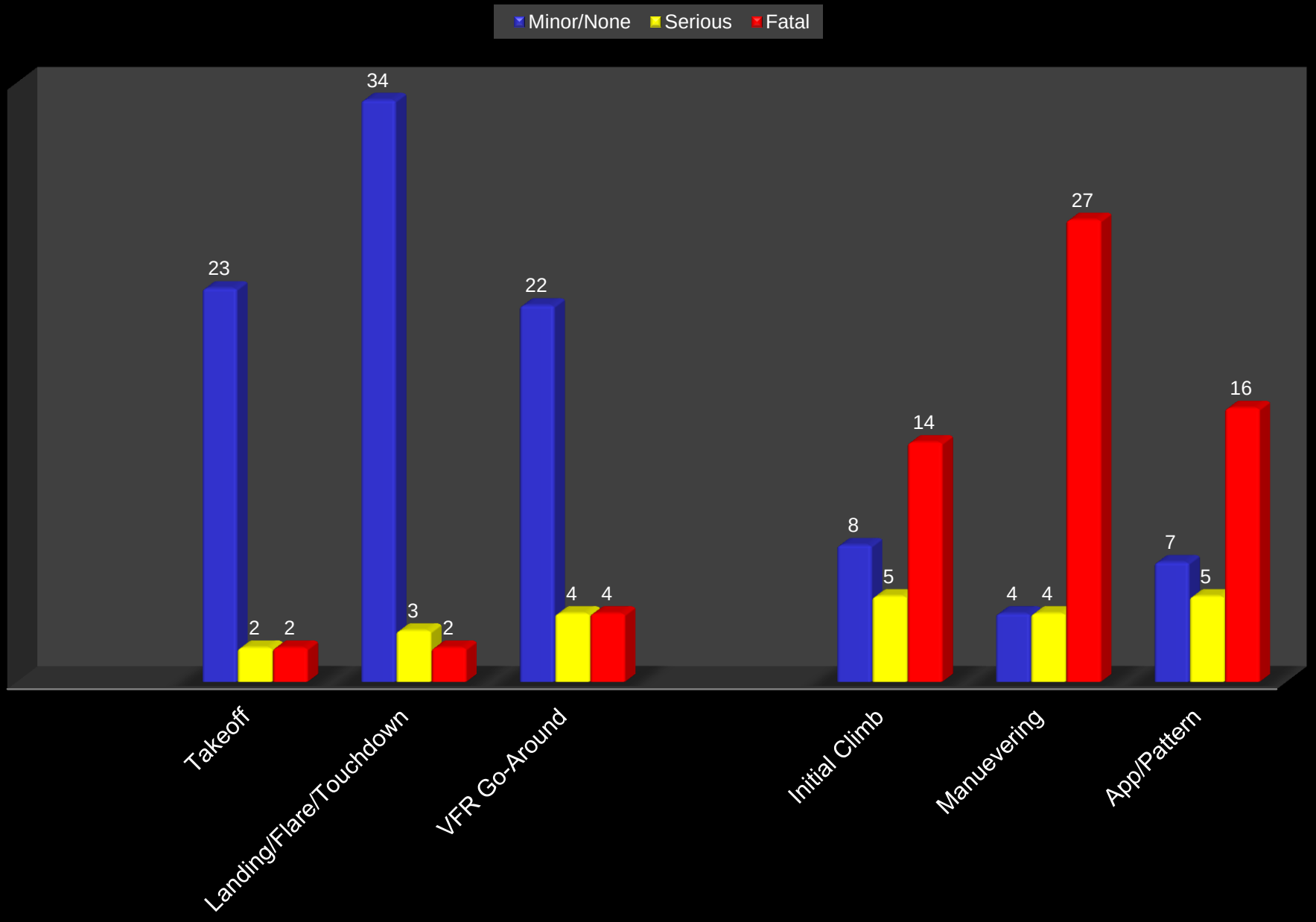
Instructional Flights 2008-2014



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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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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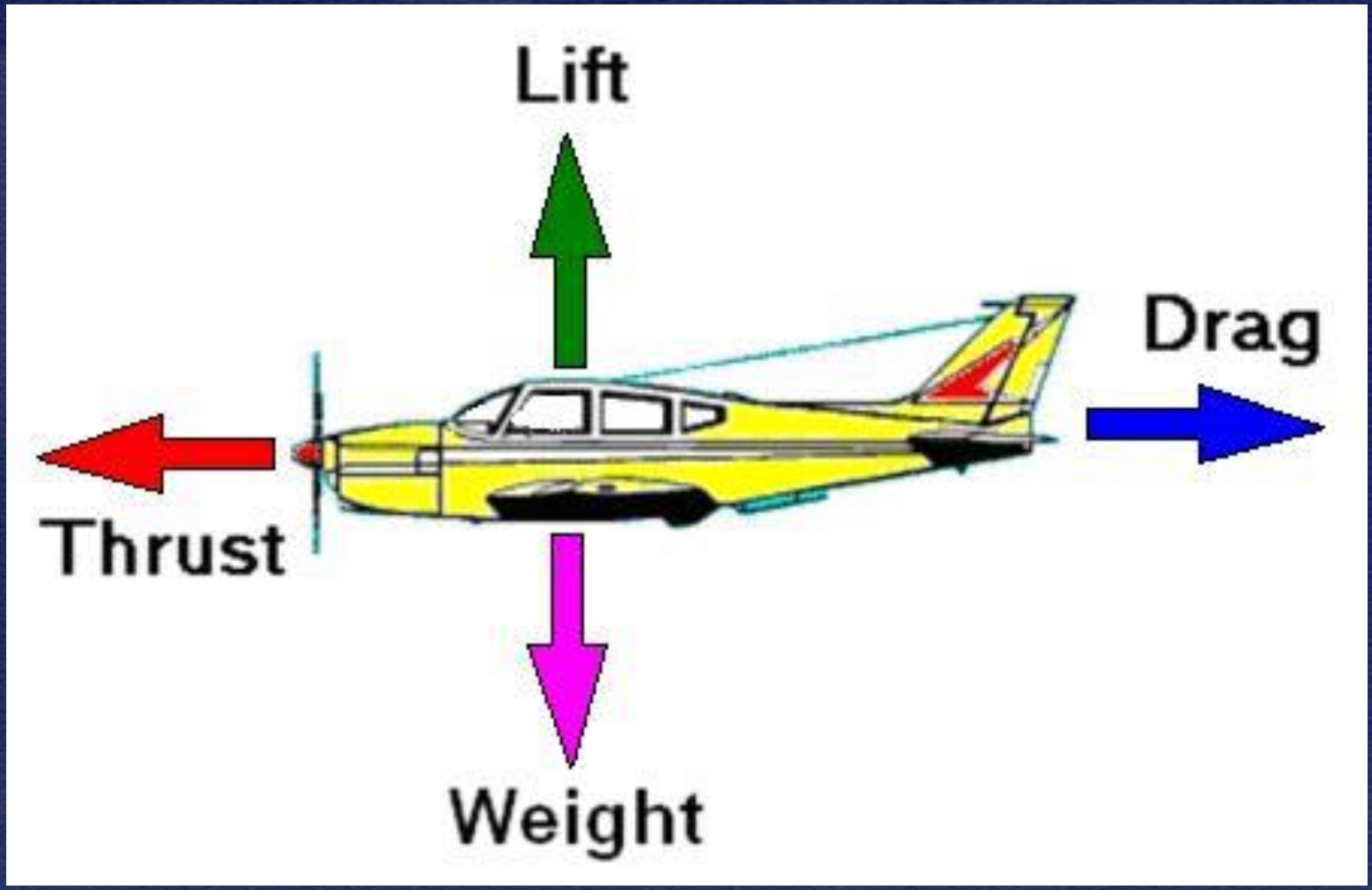
What Forces act on an Airplane?



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How is lift created?

- Push theory v. Equal Time Distance

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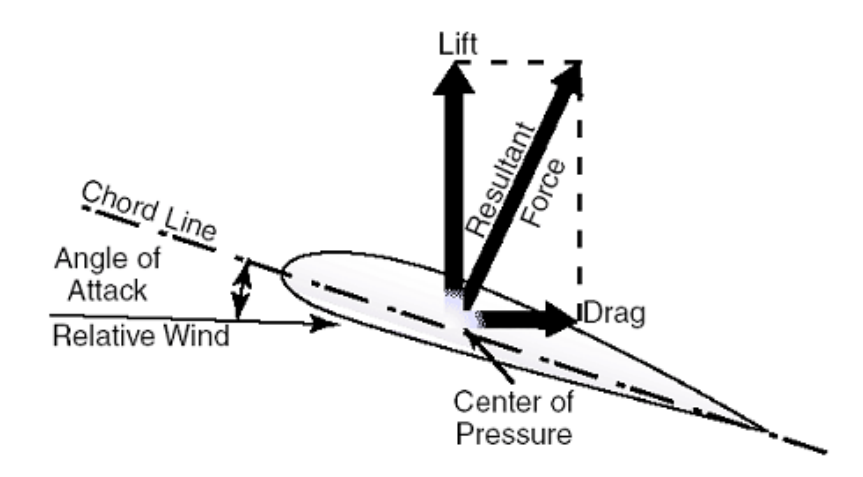
What is Angle of Attack?

- 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

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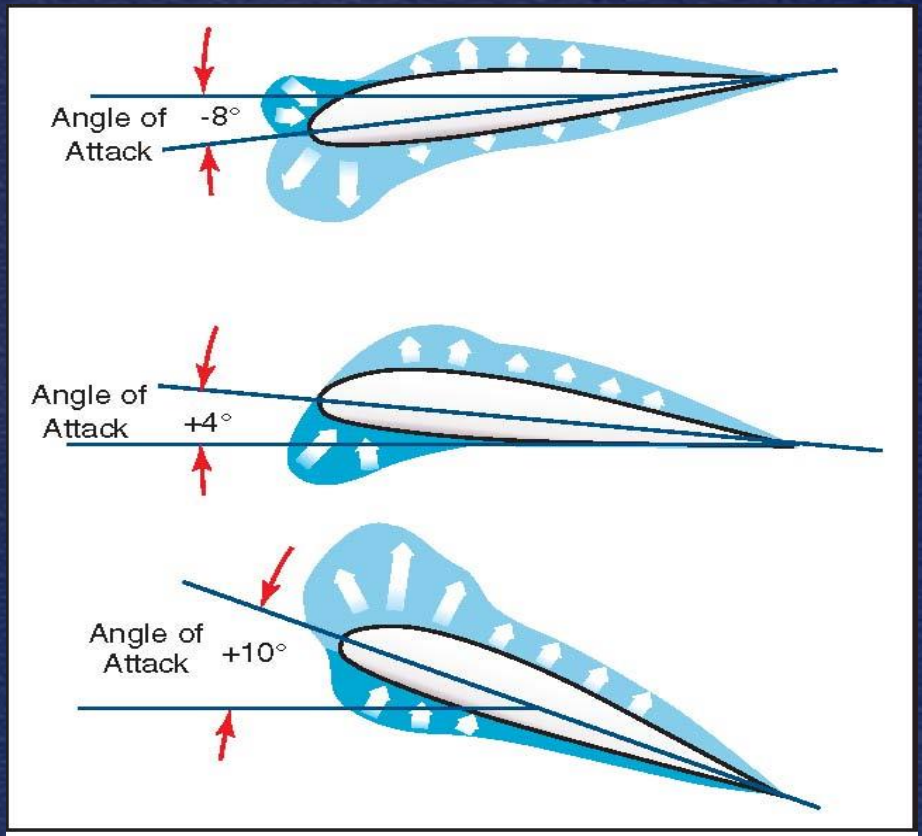

Figure 2-8. Pressure distribution on an airfoil.

How does AOA translate to airspeeds?

- The stall speed occurs at a particular angle of attack.
- Best glide speed occurs at a particular angle of attack.
- Best rate of climb speed occurs at a particular angle of attack.
- Best climb angle speed occurs at a particular angle of attack.
- Recommended approach speed is actually a recommended angle of attack.

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And airspeed?

- Controlled by power at a given configuration and AOA.
- If airspeed too low, AOA required for level flight will be so large that air cannot follow upper curvature of wing.
- Stall is from excessive AOA, not insufficient airspeed.

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How does Center of Gravity affect us?

- As CG moves aft, the amount of elevator deflection needed to stall is less. An increased AOA can be achieved with less elevator force.

- A forward CG can cause critical AOA to be reached at a higher airspeed.

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Configuration effects?

- Flaps, landing gear, other devices can affect stall speed.
- Device extension increases drag.
- Flap extension generally increases wing lift (white v. green arc.)

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LOC accident investigations

- Typically involve some type of stall
  - Straight Stall
  - Accelerated Stall
  - Takeoff/Climb Stall
    - Back Side of the Power Curve
  - Yaw 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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What's a stall?

- Critical angle of attack is exceeded.
- Smooth airflow over the wing is disrupted.
- Can occur at any airspeed, any attitude, and power setting.
- Gross weight affects the airspeed at which it can occur.

NTSB

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.

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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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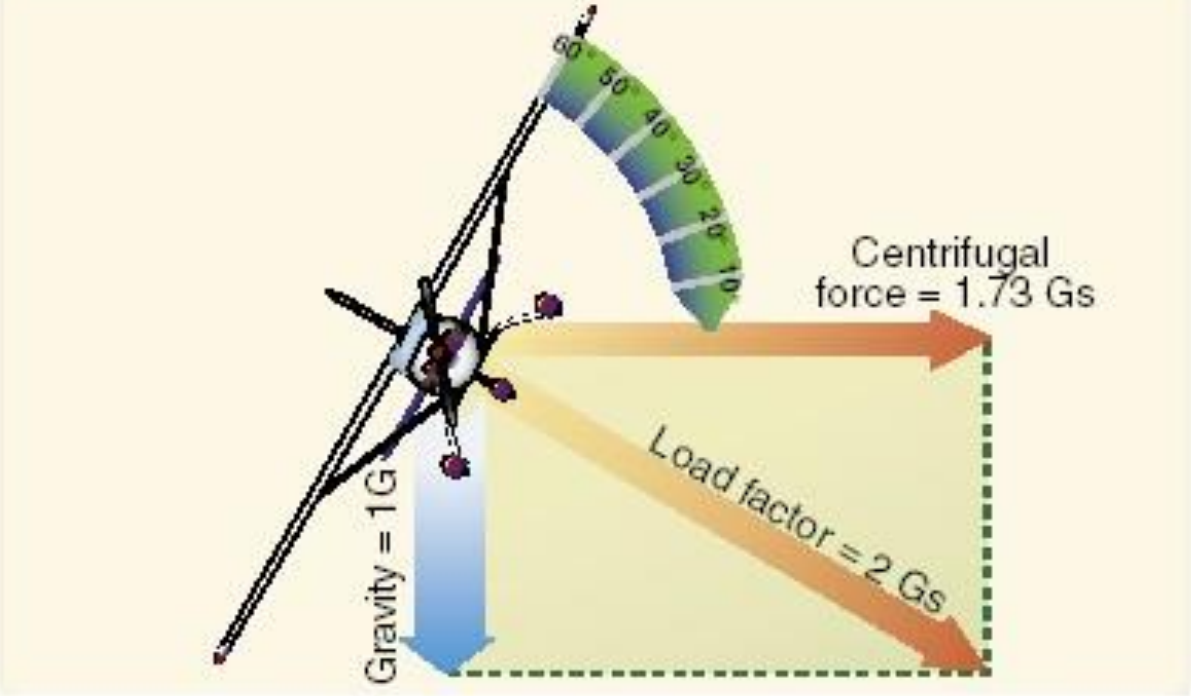
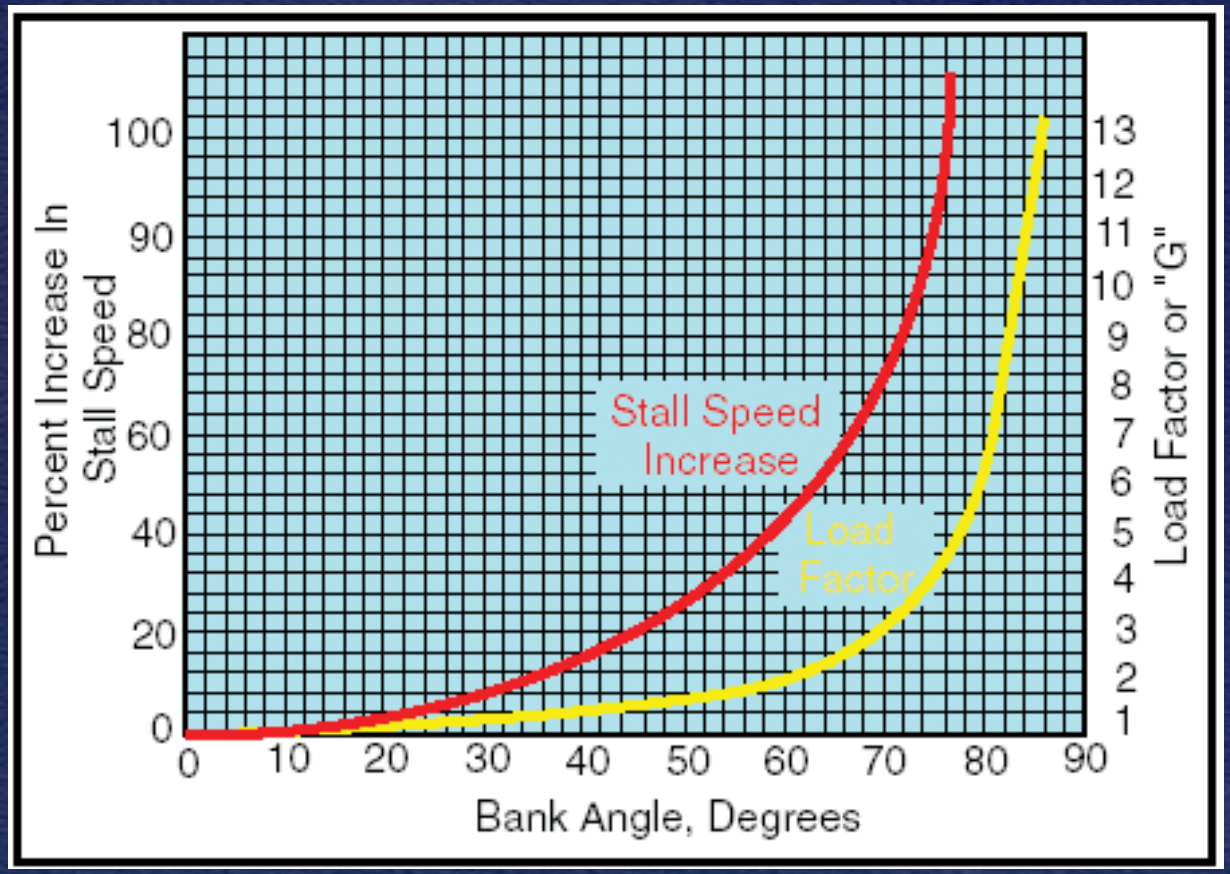


Figure 4-44. *Two forces cause load factor during turns.*

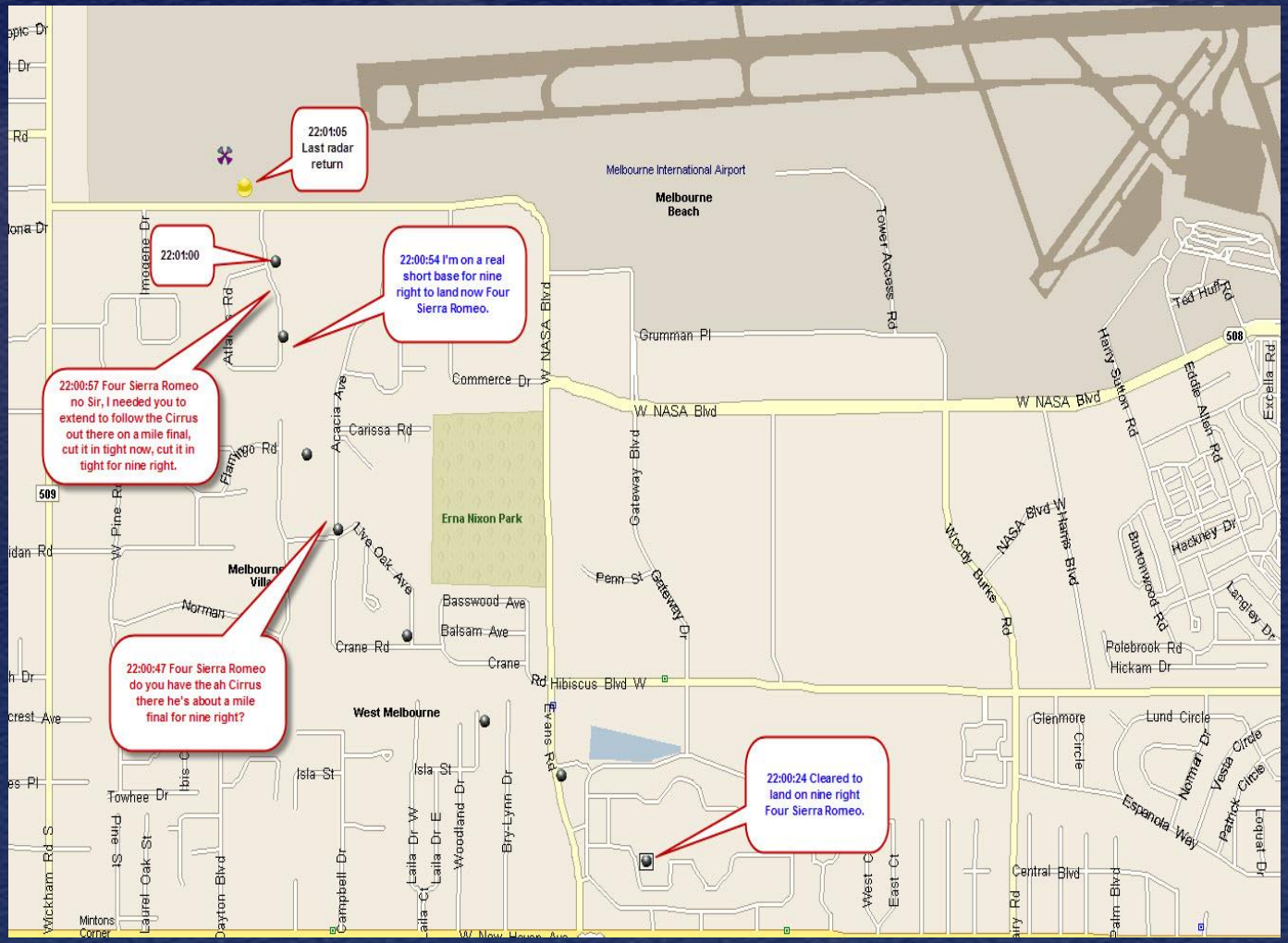

Percent Increase In Stall Speed
100
90
80
60
40
20
0
Stall Speed Increase
Load Factor
13
12
11
10
9
8
7
6
5
4
3
2
1
Load Factor or "G"
0
10
20
30
40
50
60
70
80
90
Bank Angle, Degrees

NTSB

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.

NTSB


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
West Melbourne
Erna Nixon Park
Grumman Pl
Commerce Dr
W NASA Blvd
Gateway Blvd
Penn St
Tower Access Rd
Ted Huff Rd
Harry Stilton Rd
Eddie Allen Rd
Excella Rd
Hackney Dr
Buttonwood Rd
Langley Dr
Polebrook Rd
Hickam Dr
Woody Burke Rd
Harris Blvd
Hibiscus Blvd W
Crane Rd
Basswood Ave
Balsam Ave
Live Oak Ave
Acacia Ave
Carissa Rd
Flamingo Rd
Pine St
Imogene Dr
Evans Rd
Isla St
Towhee Dr
Laurel Oak St
Dayton Blvd
Campbell Dr
Laila Dr W
Laila Dr E
Laila Ct
Woodland Dr
Bry-Lynn Dr
Glenmore Circle
Lund Circle
Norman Dr
Vesta Circle
Patrick Circle
Espanola Way
Central Blvd
Palm Blvd
West Ct
East Ct
Wickham Rd S
Mintons Corner
509
508

NTSB

Photo 1: View of Main Wreckage As Found

NTSB

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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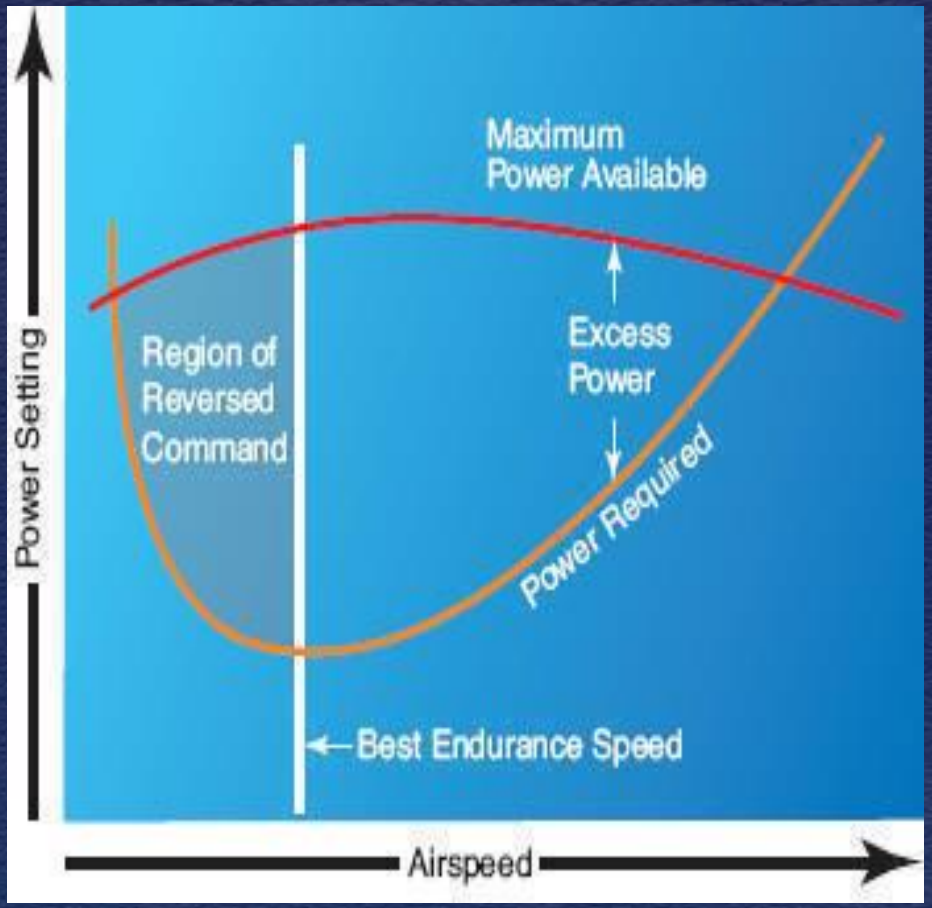
Takeoff/Climb Stalls

- Back Side of the Power Curve



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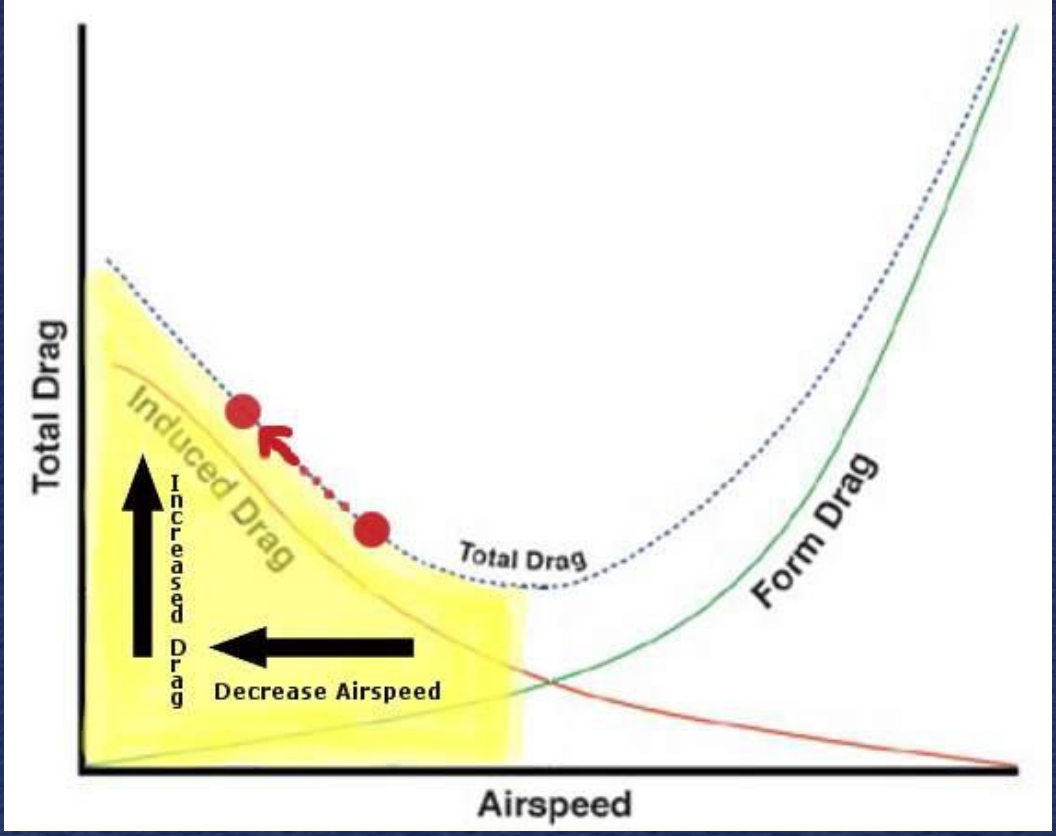
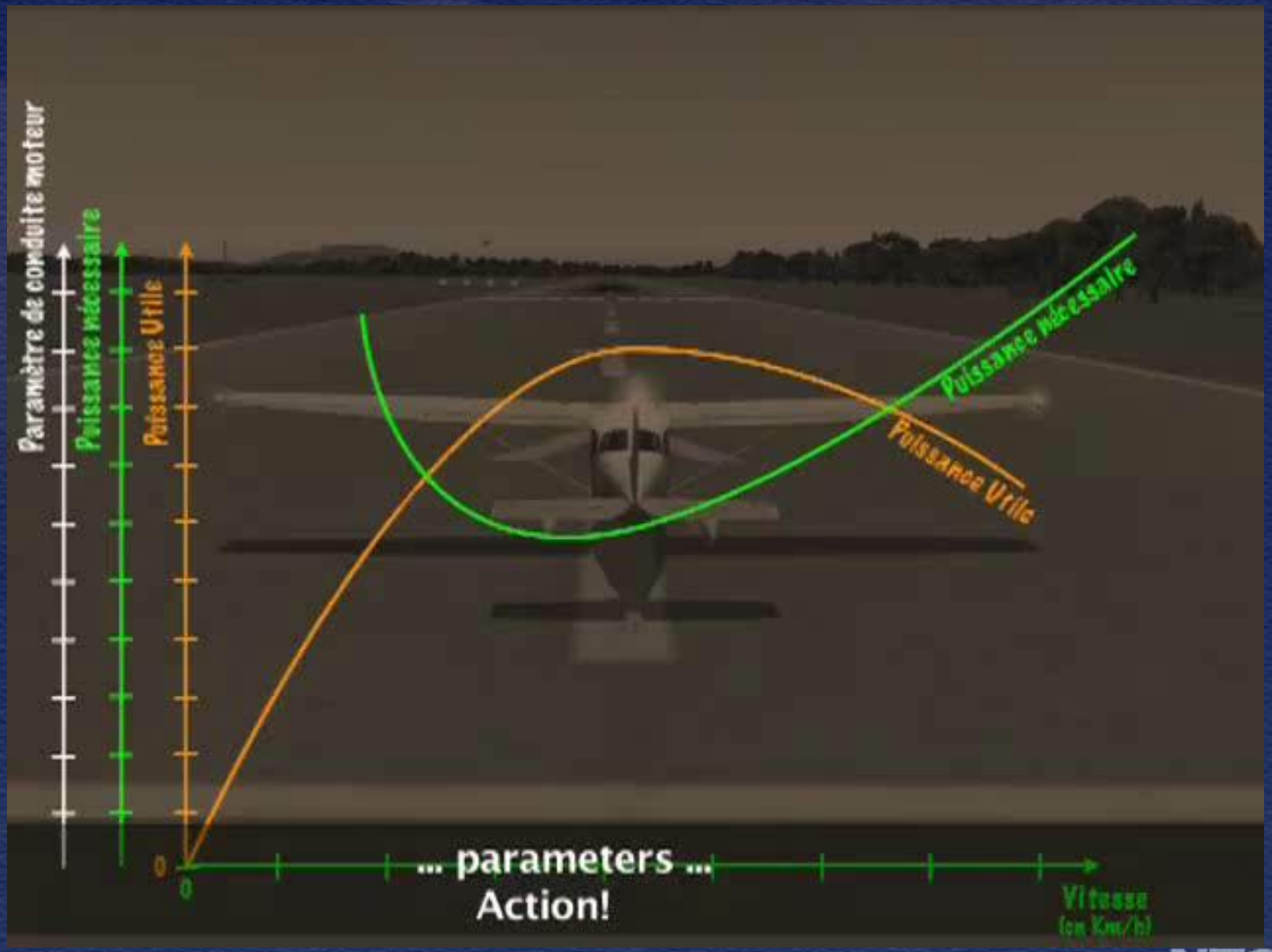
Extreme nose up effects

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



NTSB

IASA-France



NTSB

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

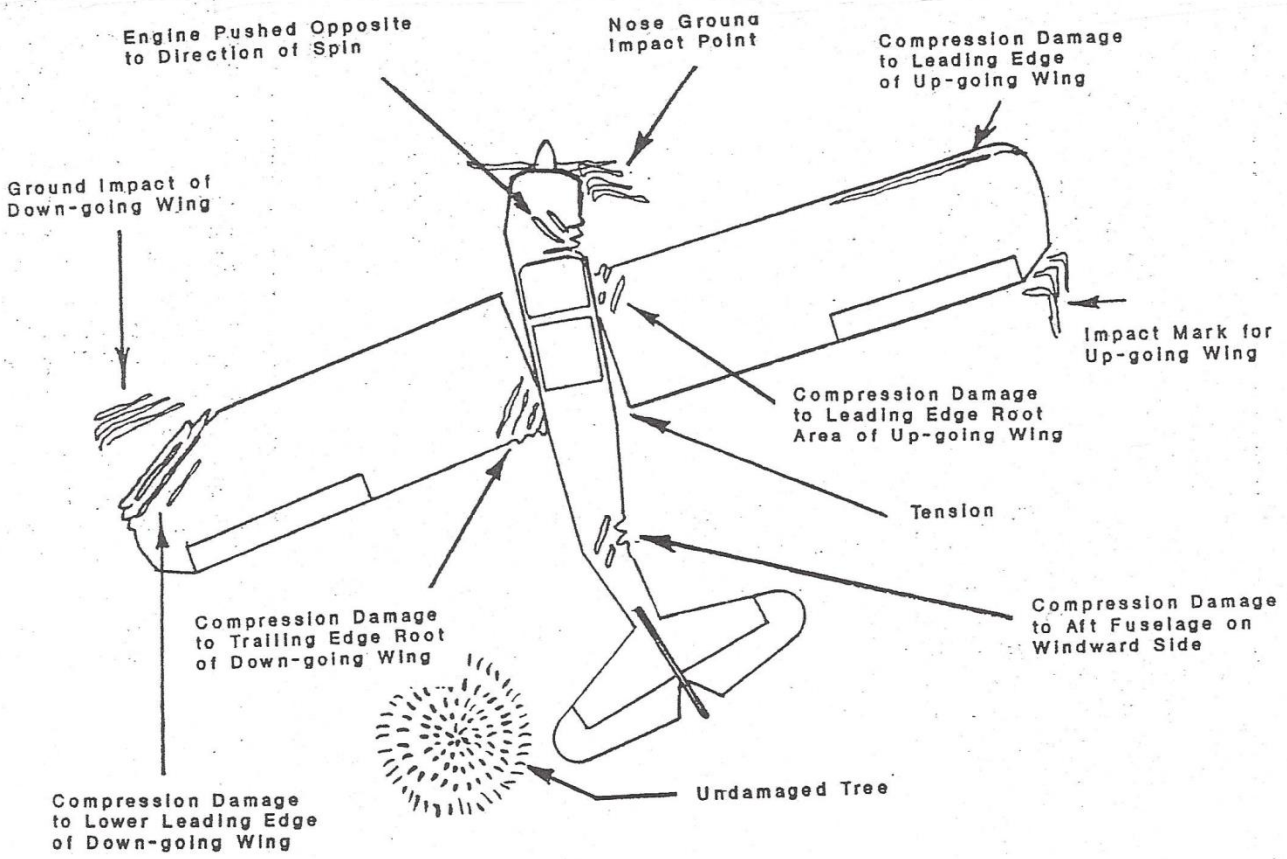


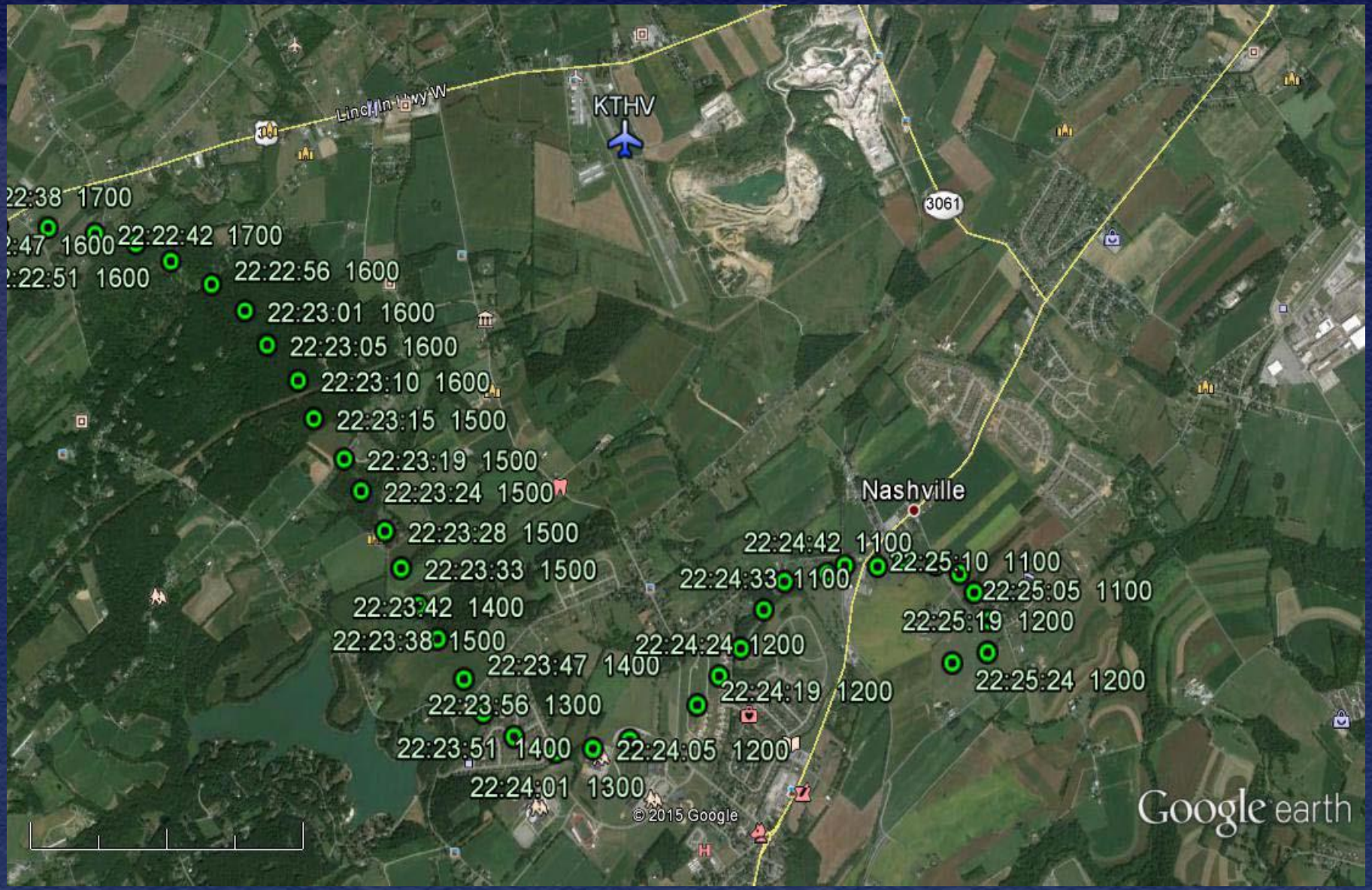
Figure 27-17. Wreckage Pattern of a Spinning Airplane

NTSB

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.

NTSB


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
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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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Google earth

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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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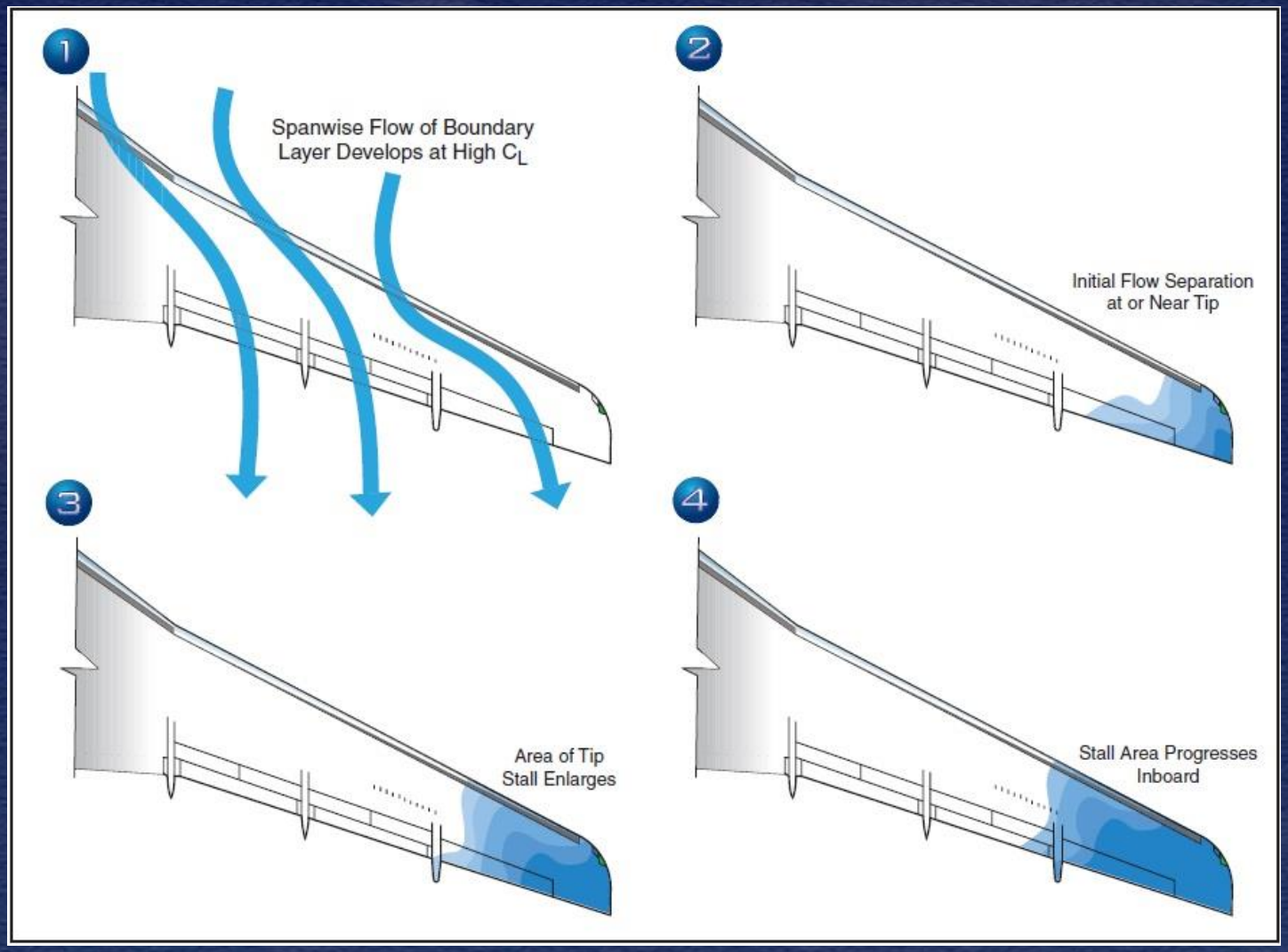
Photo - Right Engine PropellerHub

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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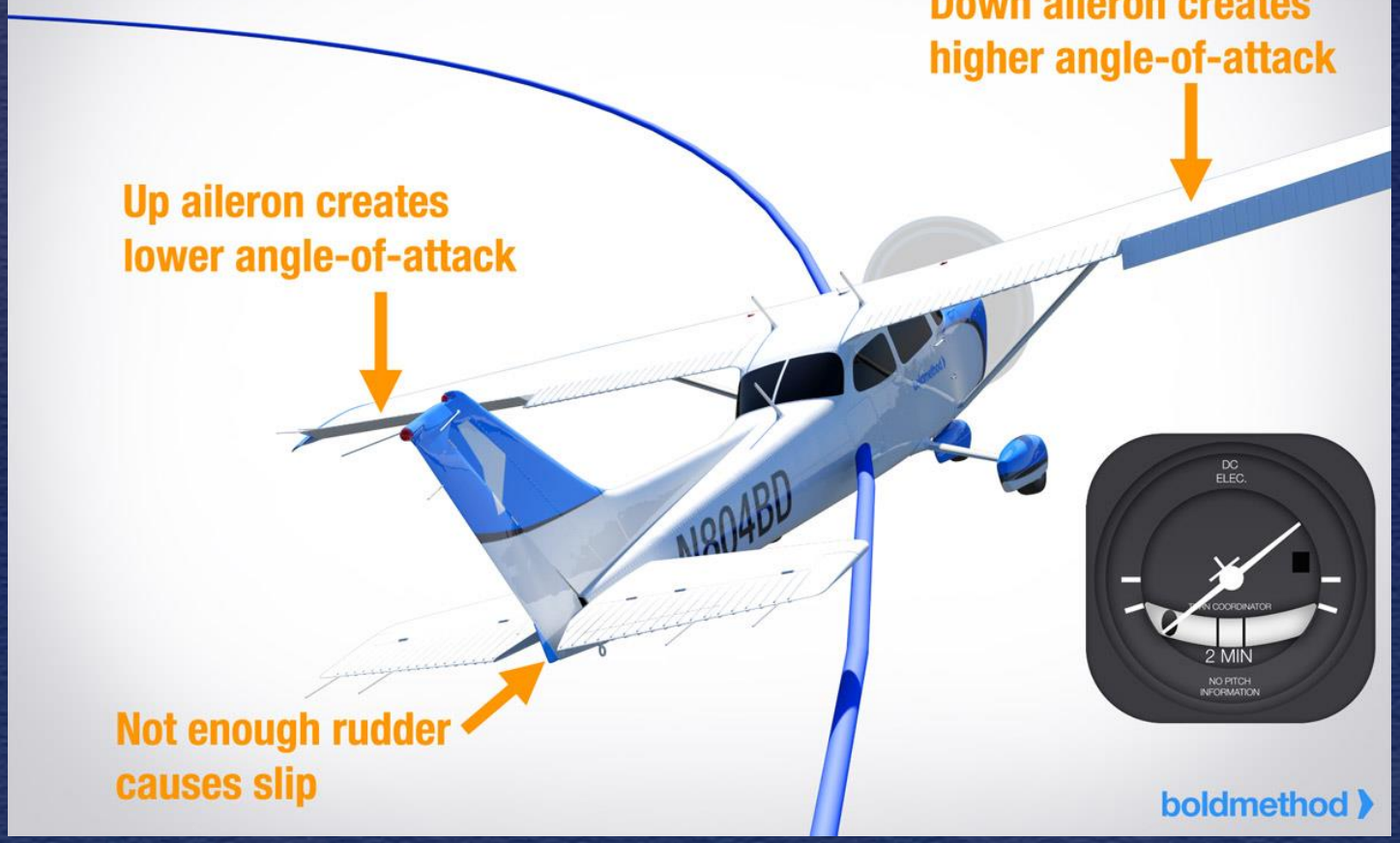
Slipping Turn

Ailerons counter underbanking tendency



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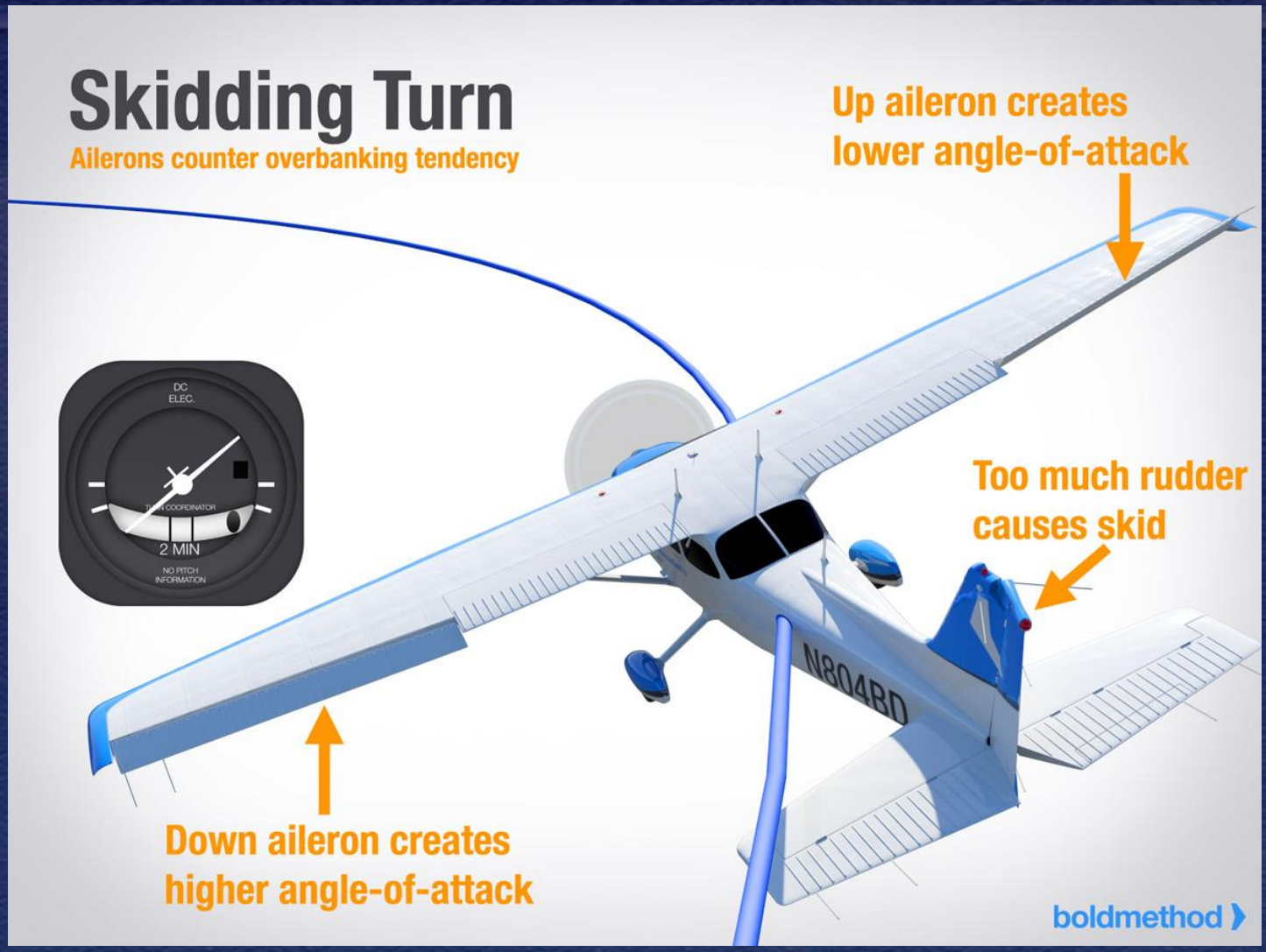
Skidding Turn
Ailerons counter overbanking tendency
Up aileron creates
lower angle-of-attack
DC
ELEC.
2 MIN
NO PITCH
INFORMATION
Too much rudder
causes skid
N804BD
Down aileron creates
higher angle-of-attack
boldmethod

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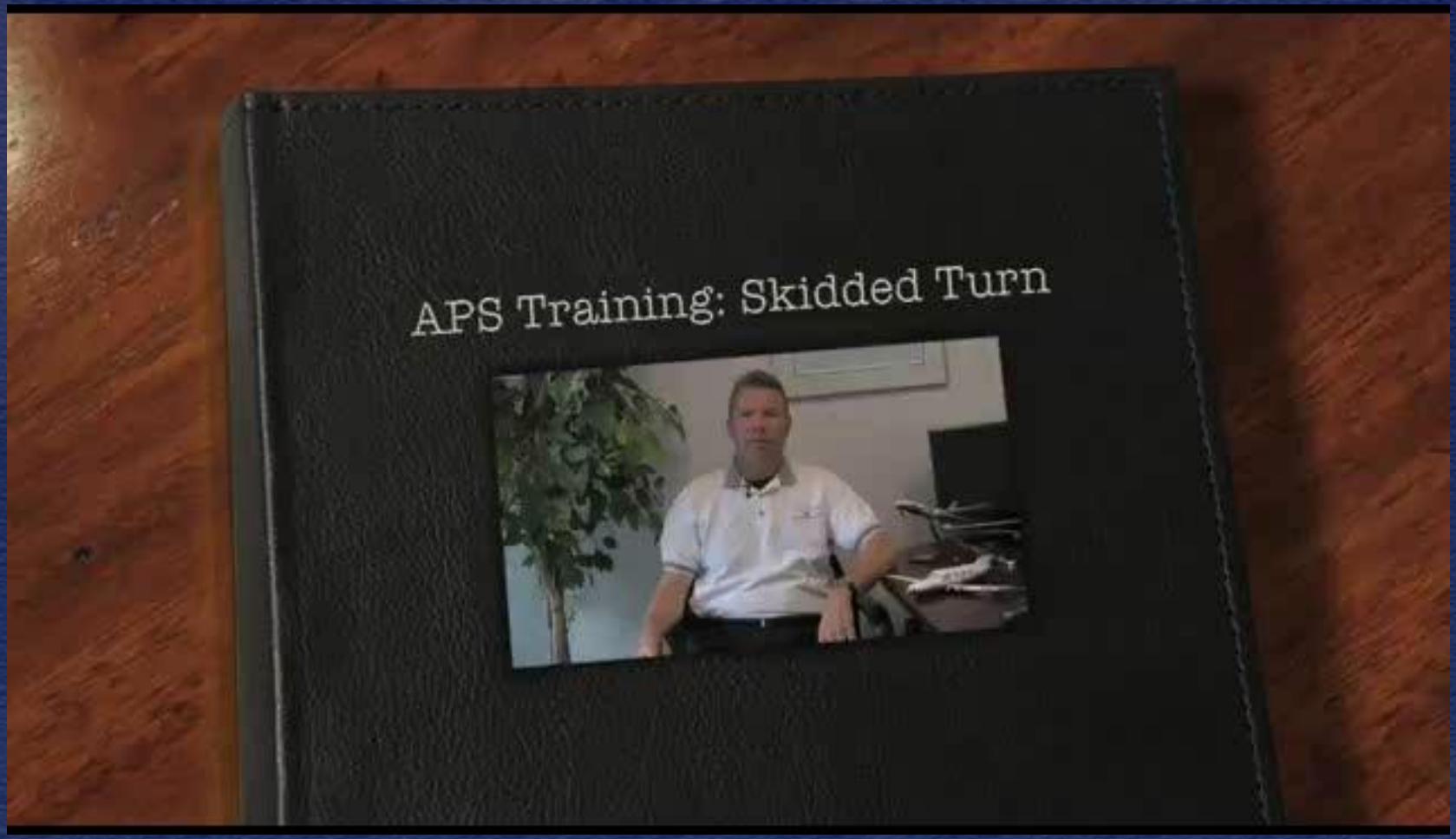
APS Training



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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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Human Factors

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

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Reaction Influencers

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

- Check ntsb.gov web site
- 4 Panels
  - 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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