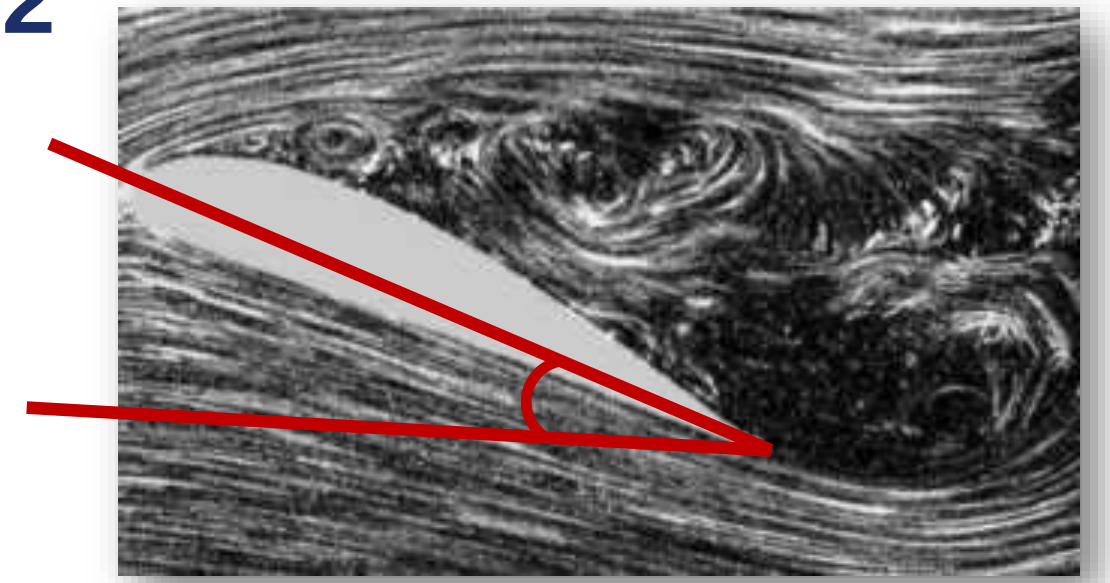
Federal Aviation Administration

Topic of the Month—April 2022



Angle of Attack

Presented to: WAFC and Friends

By: Stephen Bateman, CFI

Date: April 11th, 2022

Produced by AFS-850
The National FAA Safety Team (FAASTeam)

Welcome

- **Steve Bateman, CFI, AOPA Director of Flying Clubs**
  - Safety and Maintenance Officer, Westminster Aerobats Flying Club
  - FAASTeam lead representative, Baltimore FSDO

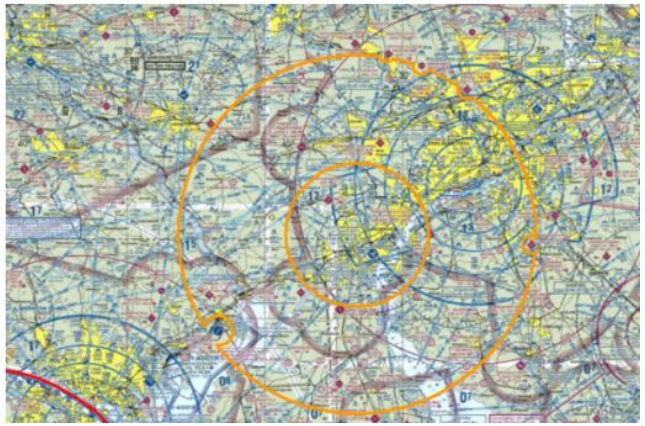
- **Our monthly in-and-out safety meeting using the FAASTeam Topic of the Month**

- **Sponsor Acknowledgment – WAFC, AOPA, FAASTeam, Baltimore FSDO**

- **WINGS Credit: Yes…but give me a day…**

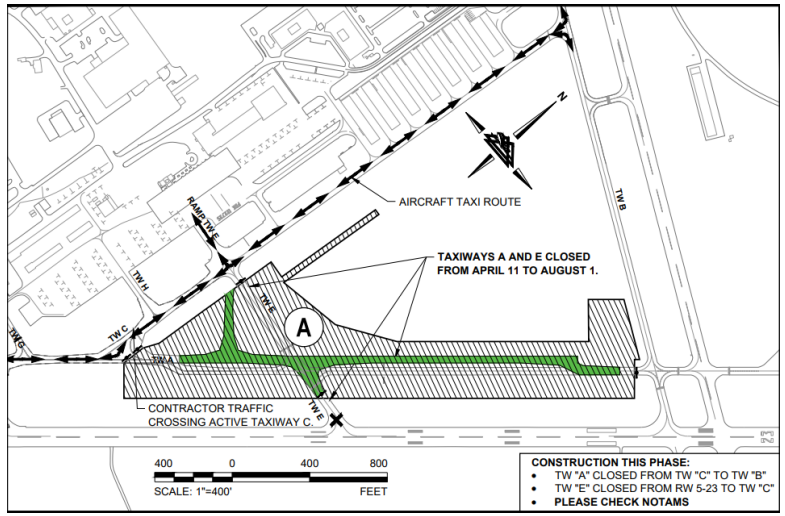
- **Probably no time for questions, but send email:**
  steve.bateman@aopa.org

Check NOTAMS!



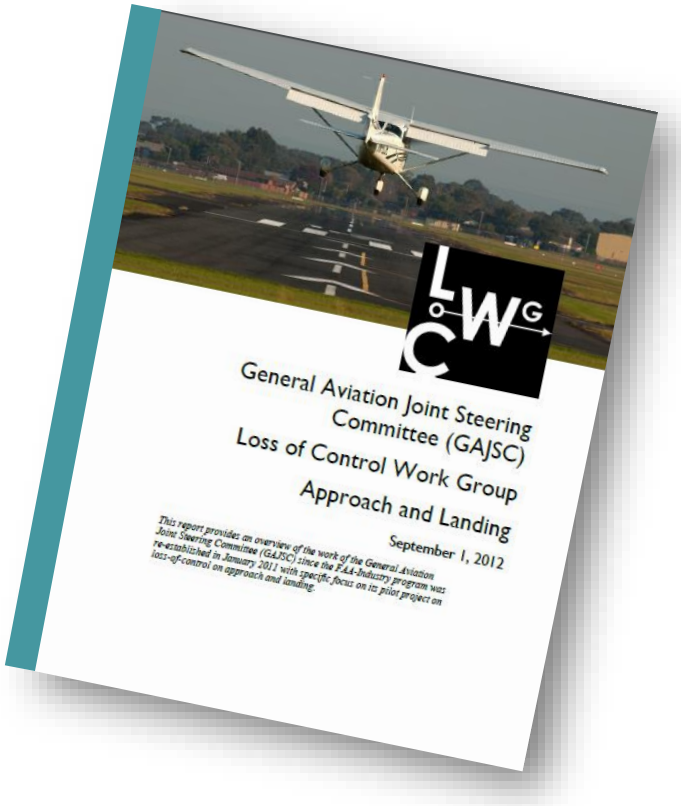
VIP TFR OVER HAGERSTOWN/THURMONT, MD
BEGINNING FRIDAY, APRIL 2, 2021
(((CHANGE IN DEPARTURE TIME)))

Heads-up: Taxiway A work at Frederick for the next 4 months.



Overview

- GAJSC * recommendations
- Aerodynamics of wing stalls, review
- Angle of attack (AOA) indicators
- Training recommendations



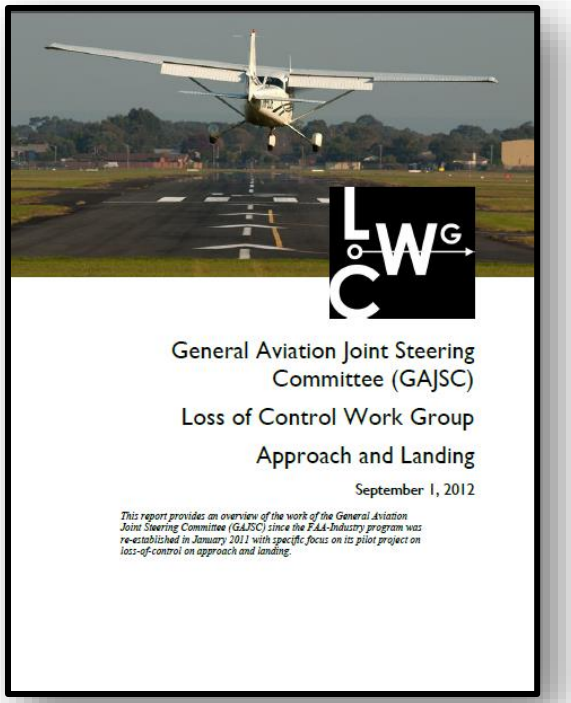
* General Aviation Joint Steering Committee

What the GAJSC's LOC Working Group discovered:

… pilot awareness of the overall (energy) state in flight was just not where it needed to be. AOA seemed a logical place to start with how to mitigate this risk….

…Awareness

…Indicators



Loss of Control – The result, not the cause…

- **The most lethal GA accident precursor**
  - Disorientation (Continued VFR into IMC)
    - >90% fatality rate. “178 Seconds to Live”
  - Distraction
  - Inappropriate response to emergent event
  - Lack of aircraft handling skills
  - Not understanding the situation/sensation
  - Inadequate risk management/mitigation

Loss of Control – The result, not the cause…

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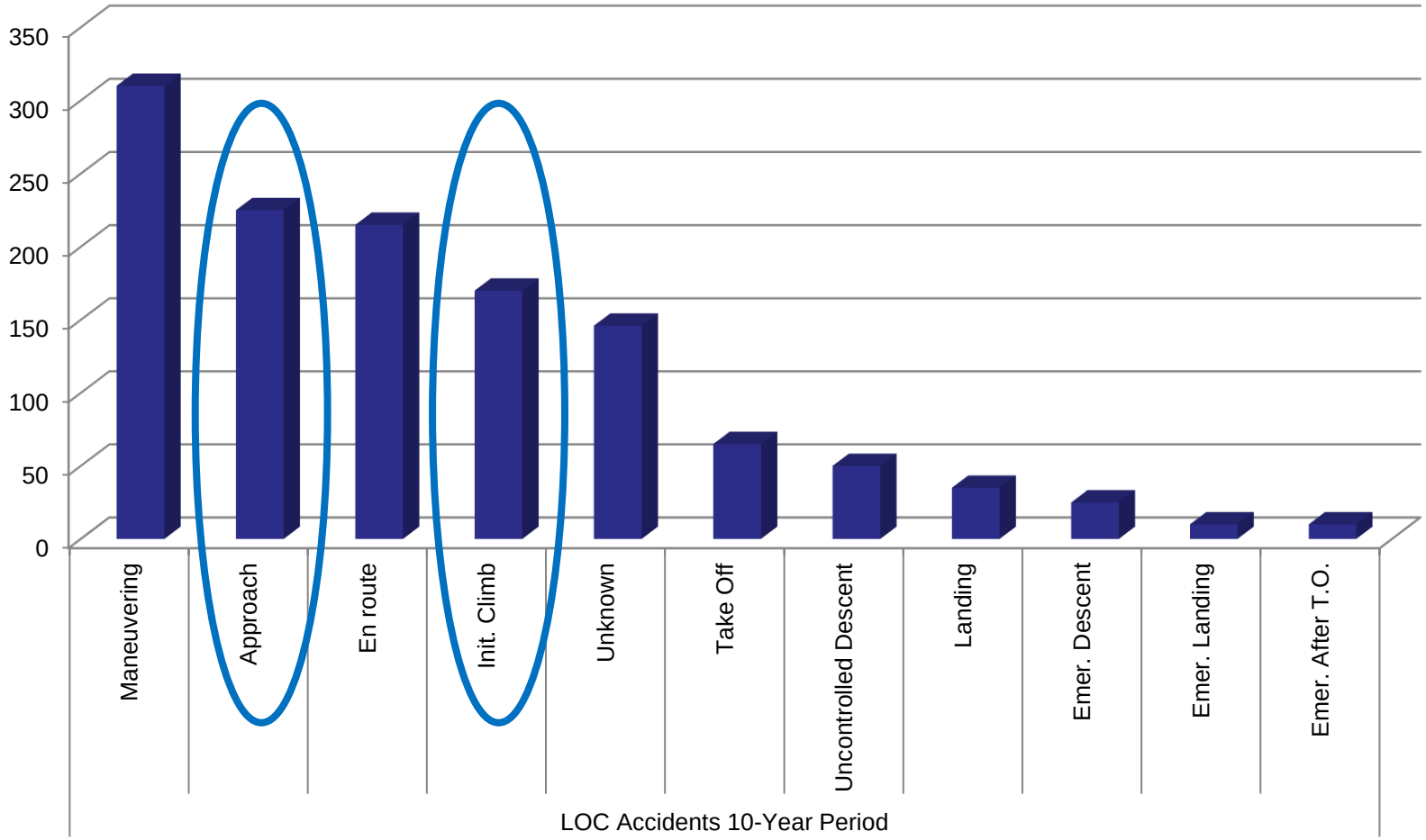
  - ***Inappropriate response to emergent event***
  - ***Lack of aircraft handling skills***
  - ***Not understanding the situation/sensation***
  - Inadequate risk management/mitigation

- **Proficiency Training addresses all of these**

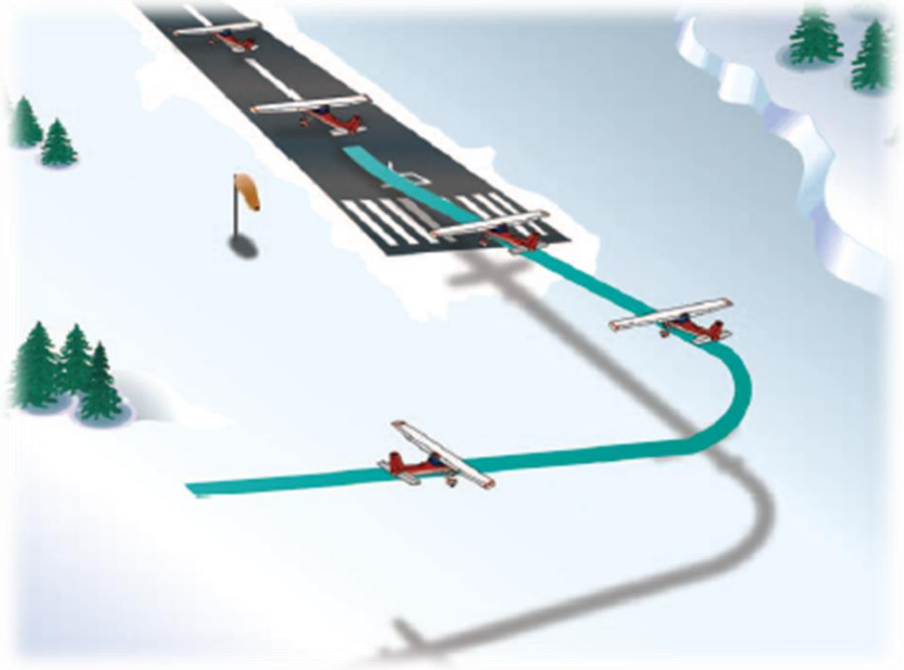
Looking at Fatal LOC Accidents

- **Initial climb out**
  - Gaining energy (PE)
- **Approach**
  - Losing PE and KE



Stall/Spin Accidents

- **In the traffic pattern**
  - Takeoff 28 %
  - Approach 18 %
  - Go Around 6 %

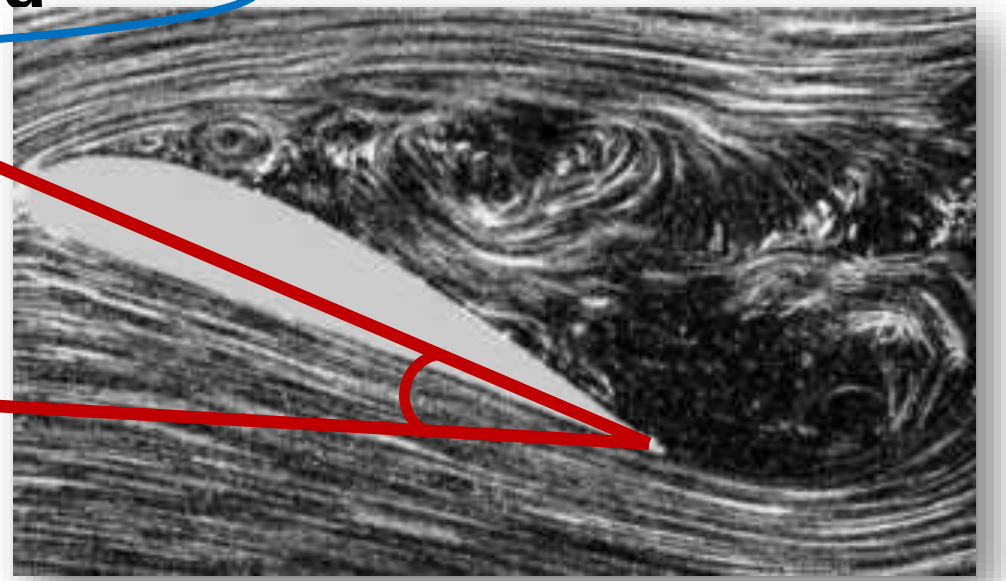


- **Maneuvering** 41%

One Fatal Accident ~ every 3 days

An aeroplane wing stalls because:

A. The wing ceases to produce lift
B. The pitch attitude is too high
C. The critical angle of attack is exceeded
D. The airspeed is too slow

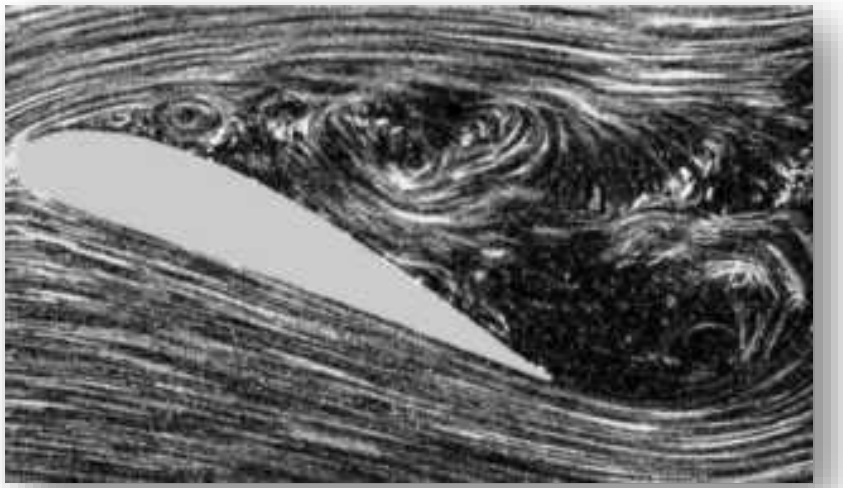


Why is this angle not necessarily the AoA?

Only if this is the direction of the relative wind…

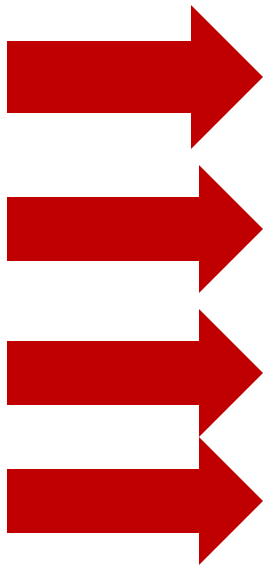
The critical AOA for a typical aerofoil is :

A. Always at 30°
B. Depends on weight
C. Around 16° relative to pitch axis
D. Anything over 45°



E. None of these—actually around 16° to the relative wind

Which is true with respect to stalls?



A. Can occur in any phase of flight

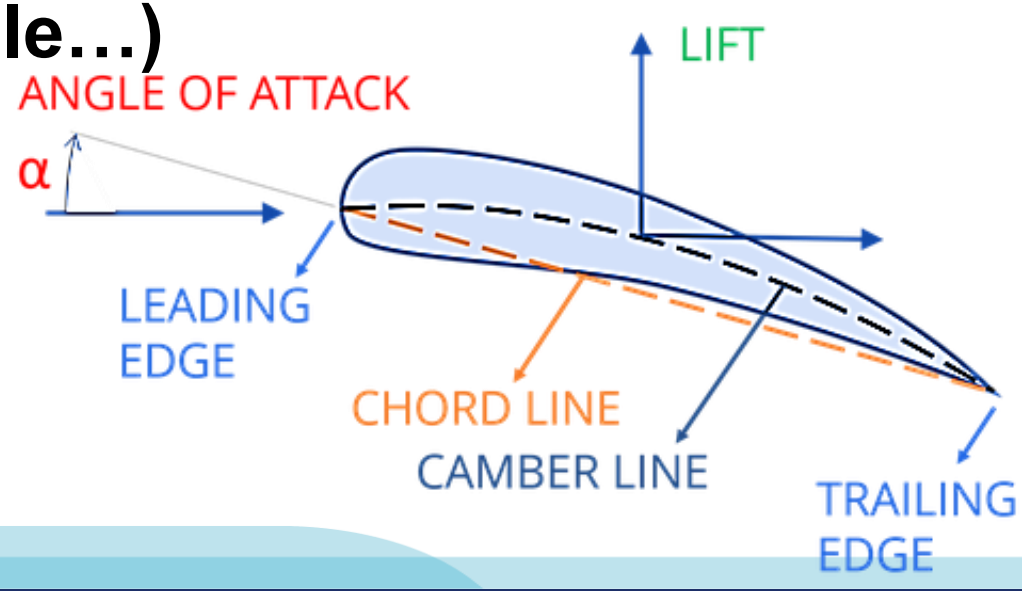
B. Are a factor in many fatal accidents

C. Usually involves low time pilots

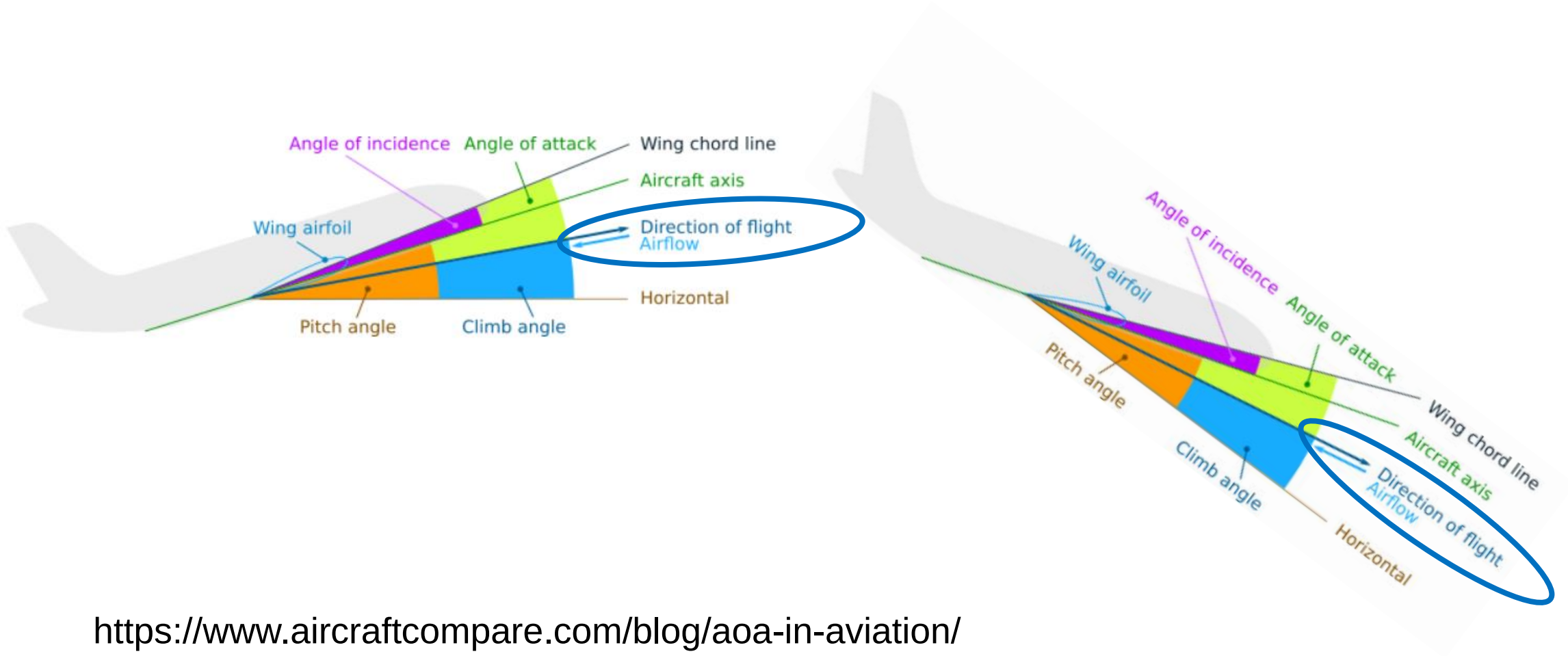
D. Can occur at any airspeed

Angle of Attack (AOA)

- **The angle at which the chord of an aircraft's wing meets the relative wind.**
- **The chord is the straight line from the leading edge to the trailing edge**
- **Relative wind is opposite the direction of travel (not the same as pitch angle, climb angle…)**



Everything has an angle



https://www.aircraftcompare.com/blog/aoa-in-aviation/

Angle of Attack: Visual Misperceptions

“If I have (insert), I won’t stall”

Sufficient airspeed

Low pitch attitude

Small bank angle

On the horizon

Sufficient power

A light airplane

Not so…sorry!

Angle of Attack: Visual + Performance

Pitch-power-performance data adds another dimension to understanding

- Practice S&L slow flight
- Also, ascending and descending slow flight, as on climb out and approach

Power-Pitch-Performance Tables

Level Flight		
RPM	Pitch Angle	IAS

Slow Flight. Level Full Flaps, Carb Heat On		
RPM	Pitch Angle	IAS
		70
		65
		60
		55
		50
		45

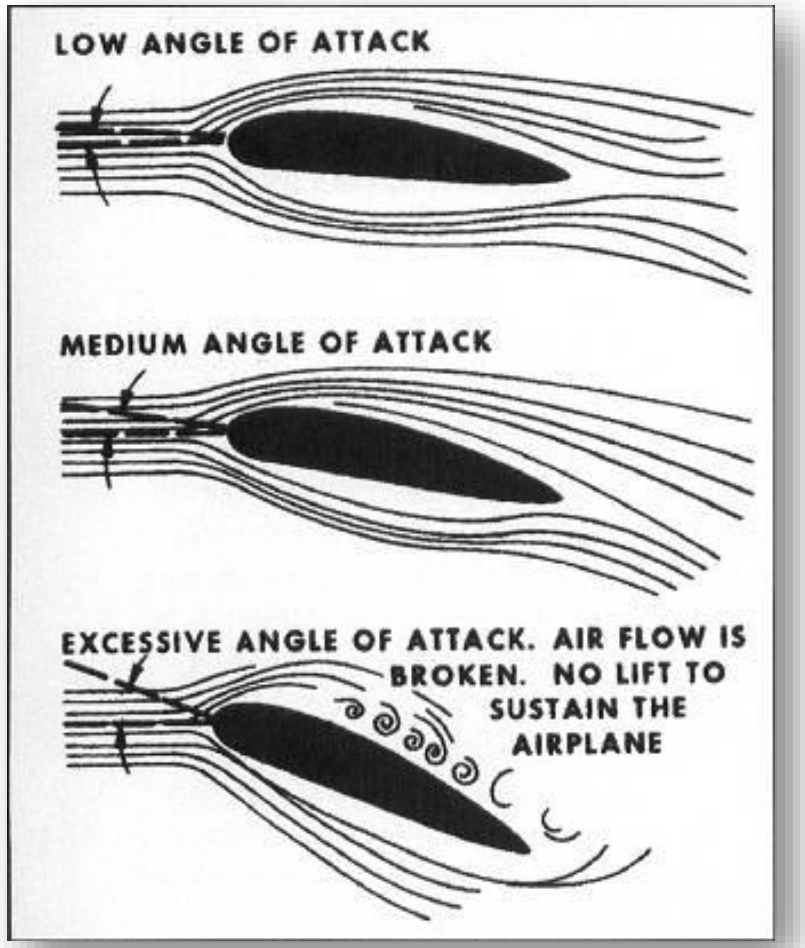
500FPM Descent First Flap, Carb Heat On		
RPM	Pitch Angle	IAS
		80
		70
		65

500FPM Descent Full Flaps, Carb Heat On		
RPM	Pitch Angle	IAS
		70
		65
		60

Altiude Lost in Impossible Turn		
Turn to:	Altitude	Alt Lost

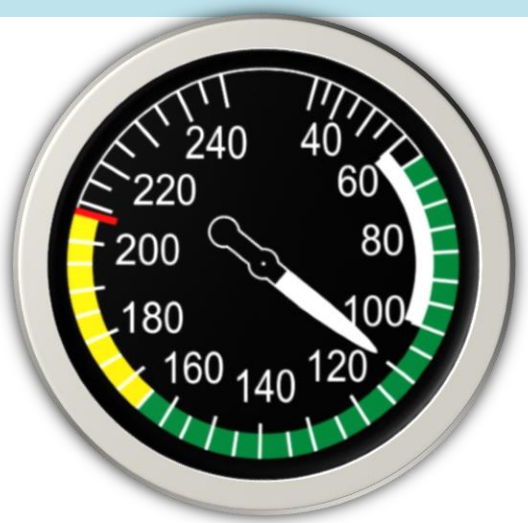
Altiude Loss Per Turn at Best Glide		
Turn #	Altitude	Alt Lost

Airspeed is a (Bad) Proxy for Stall Awareness



- Sort of works in known situations (e.g., level flight)
- A wing stalls at its critical angle of attack
- Can reach AOA_{Crit} at any airspeed
- So, can stall at any airspeed!

The Airspeed Problem

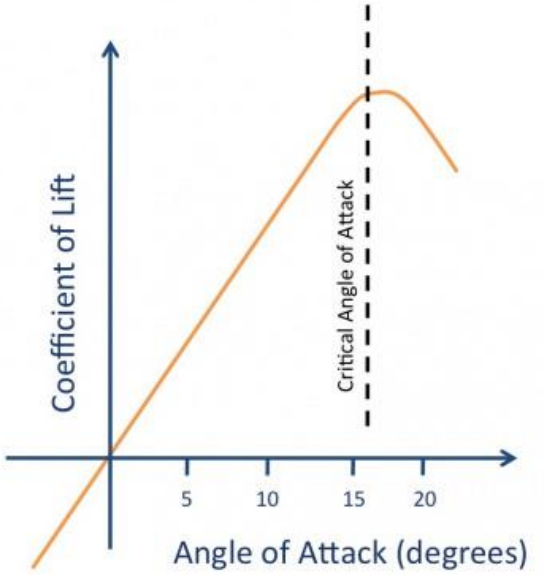


- **Lift equation:**

  Lift = C_L * ½ V^2 * ρ * A

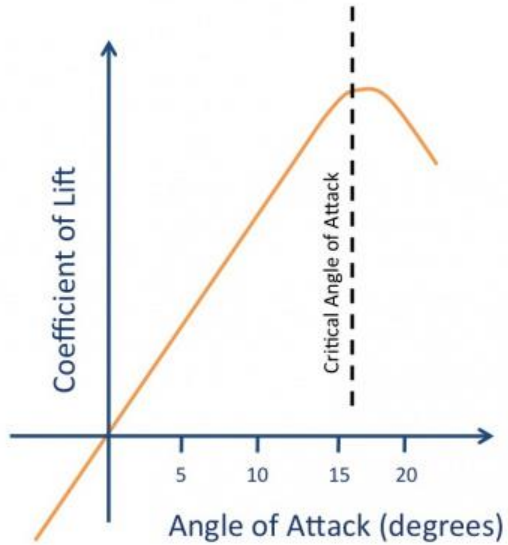
  For given plane and time: Lift α C_L and V^2

- **In level flight, L = W (1g)**
- **Now slow down to the "stall speed"**
- **<u>To stay level</u>, C_L must be increased**
- **This requires increasing AOA = pulling**
- **Get to AOA_{Crit} and off you go…**



The Airspeed Problem

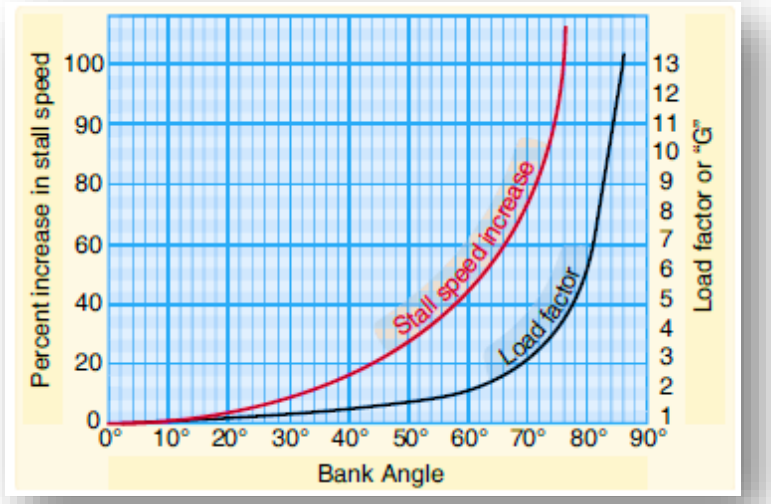
- So…what does “stall speed mean”?
- The speed at which the critical angle of attack is reached….**IN 1g LEVEL FLIGHT**
- Action…pulling



- Resolution?
- PUSH to reduce AOA!

The Airspeed Problem

- **Aircraft configuration**
  - V_S Cruise configuration
  - V_{SO} Landing configuration
  - **These are for 1g level flight!**
- **Load up the wing (level turn, gust…)**
  - If the wings is loaded up…no longer 1g
  - Higher effective weight…so…
  - Need more lift to stay level
  - Means greater C_L = increased AOA
  - Get to AOA_{CRIT} sooner!
  - "Stall speed is higher" (than at 1g)



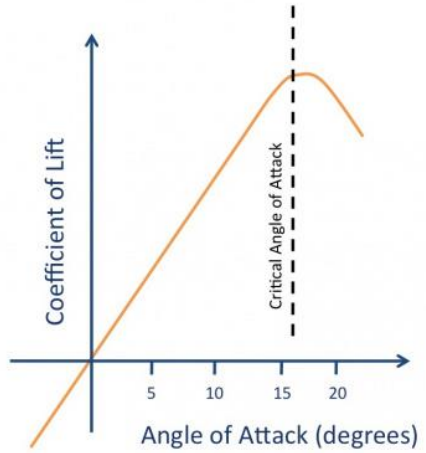
Be honest, now…

- **How many of you have gone out and practiced stall recovery in the last year?**
  - Last two years
  - Haven’t since I got my private certificate
  - My instructor didn't like stalls…so I don’t…
  - Are you insane?

How will this change things?

To stay “up”, L = W

Lift α C_L and V^2



More W requires more L from V and/or C_L

At given V, AOA will have to be higher = Closer to Critical

How will this change things?

Not just W, but B (W&B)

- Location of W affects CG
- Affects effectiveness of controls
- Loaded aft = more nose down than usual cruise
- Loaded fwd = more nose up than usual cruise
- “Consume” control range just to stay level

Get out there and practice!

Every aircraft is different…and special…!

- **Different wind size, shape and planform**
- **Conventional tail vs T-tail**
- **Small rudder vs. big rudder – e.g. C152 vs. A152**
- **Aircraft with or without vortex generators**
- **Flaps out vs. flaps in**
- **…**

Important: Always follow the PoH procedures

Practice stall recovery

- **CLEAR THE AREA!**
- **Altitude—maintain**
- **Trim—set**
- **S&L**

- **Power - off**
  - Go into the maneuver
  - Where are you looking?
  - Stall indication
  - Recover
- **Recovery procedure**
- **Clean up**

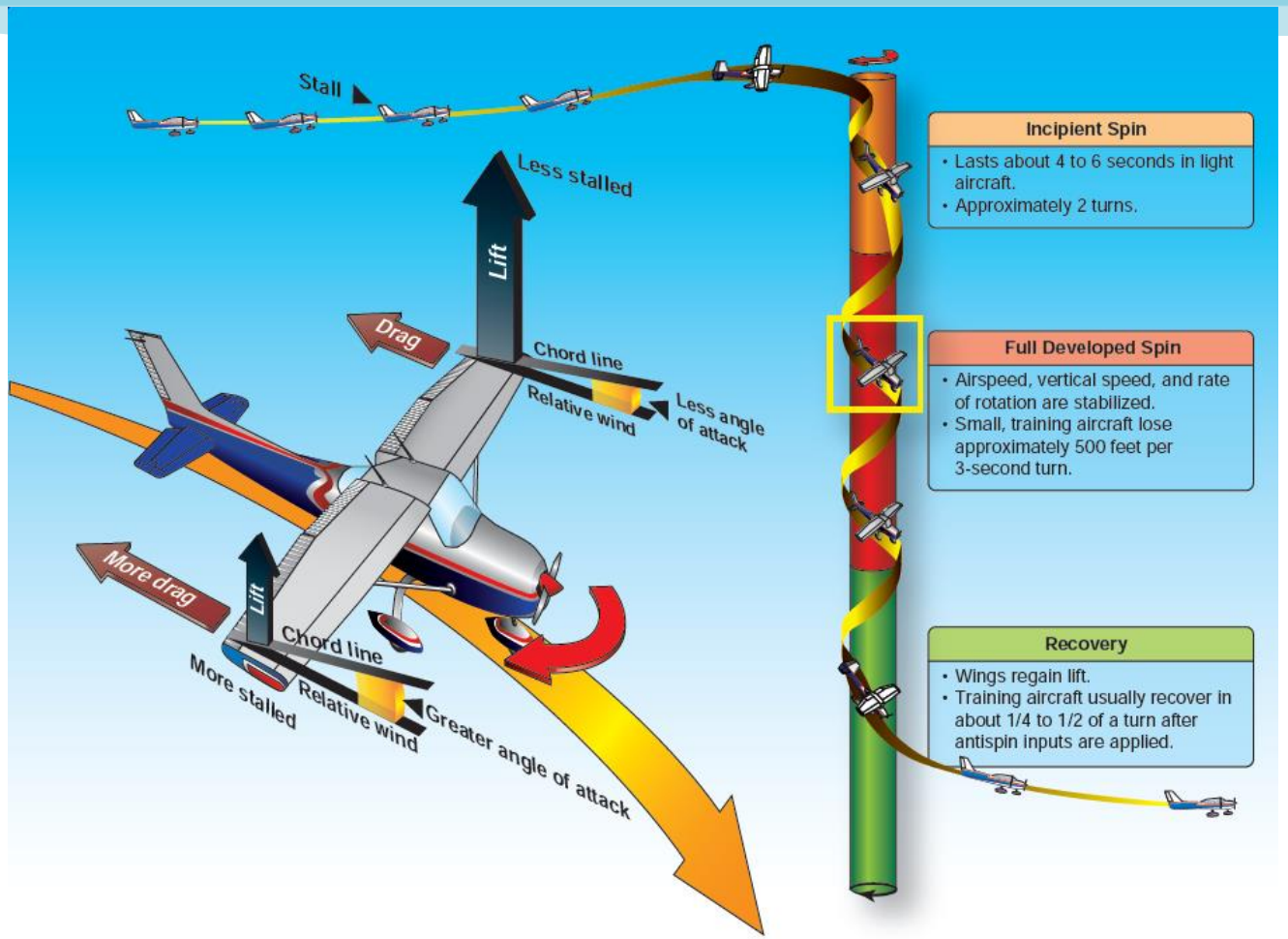
- **Practice these**
- **Really practice there, not just one-and-done**
- **Feel what is happening**
- **Recovery exercises:**
  - First indication
  - Second indication
  - At AOA_{Crit}
  - Now add in some turns

The look and feel of the stall:

- **Note lack of control effectiveness as the aircraft slows towards “stall speed”**
- **Note the view out the windows**
  - Forward
  - To the sides – angle of wings to horizon

Remember- these are just angle of attack *proxies*

Stall/Spin Awareness



It's all about being close to AOA_{Crit} and coordination
So, be aware of AOA and coordination!

When is an aeroplane upset?

1. **When it doesn't like the pilot, duh!**
2. **An aeroplane is upset when:**
   - Includes unusual attitudes
   - Pitch attitude >25º nose up, or >10º nose down
   - Bank angle >45º
   - Within above parameters but flying at inappropriate airspeeds for conditions

Spin Awareness and Upset Recovery

- **Prime situations for stall/spin:**
  - Slow, level flight (high AoA), uncoordinated
  - Any uncoordinated stall

  - Inducing yaw – e.g., “ruddering” the nose around in a skidding turn when trying the recover from runway overshoot. Base to final turn…
    - Beware the tailwind on base…
  - Uncoordinated while stretching the glide
  - Dragging it in on long windy final and getting distracted

Spin Awareness

- **Do I *have* to do spins…?**
  - No, but you should…

- **Get some spin awareness/recovery training:**
  - Practice “wing rocks” (interplay between aileron and rudder)
  - Feel the sloppy controls as the stall is approached
  - Witness aileron-rudder coupling in slow flight
  - Feel the “kick” when the “yawll” (yaw/stall) happens
  - Feel the ease, relief and joy of a spin recovery!
  - Do it again!

- **Recovery:**
  - Counter the yaw
  - Reduce angle of attack

Spin Awareness

- **Reactions:**
  - Recognize the difference between yawing and banking
  - Counter yaw with rudder, not aileron
  - Elevator to lower AoA (and pleasingly increases airspeed at the same time)
  - Don’t believe a mechanical gyro AI – it may have tumbled…
  - Do believe the TC
- **PARE:**
  - Power: IDLE
  - Ailerons: NEUTRAL
  - Rudder: OPPOSITE
  - Elevator: FORWARD

ACS Version

- **Take-off, Landings and Go-Arounds:**
  - Stall/Spin called-out on Risk Areas:
    - Maneuvering during slow flight
    - Power on and off stalls

- **Use the ACS as a checklist for stall/spin awareness on your flight review or *WINGS* flight activity**

VII. Slow Flight and Stalls

Task	*A. Maneuvering During Slow Flight*
References	FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with maneuvering during slow flight. ***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.*
Knowledge	The applicant demonstrates understanding of:
PA.VII.A.K1	Aerodynamics associated with slow flight in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:

VII. Slow Flight and Stalls

Task	*B. Power-Off Stalls*
References	FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power-off stalls. ***Note:*** *See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.*
Knowledge	The applicant demonstrates understanding of:
PA.VII.B.K1	Aerodynamics associated with stalls in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
PA.VII.B.K2	Stall characteristics (i.e., airplane design) and impending stall and full stall indications (i.e., how to recognize by sight, sound, or feel).
PA.VII.B.K3	Factors and situations that can lead to a power-off stall and actions that can be taken to prevent it.
PA.VII.B.K4	Fundamentals of stall recovery.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:

VII. Slow Flight and Stalls

Task	*C. Power-On Stalls*
References	FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power-on stalls. ***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.*
Knowledge	The applicant demonstrates understanding of:
PA.VII.C.K1	Aerodynamics associated with stalls in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
PA.VII.C.K2	Stall characteristics (i.e., airplane design) and impending stall and full stall indications (i.e., how to recognize by sight, sound, or feel).
PA.VII.C.K3	Factors and situations that can lead to a power-on stall and actions that can be taken to prevent it.
PA.VII.C.K4	Fundamentals of stall recovery.
Risk Management	

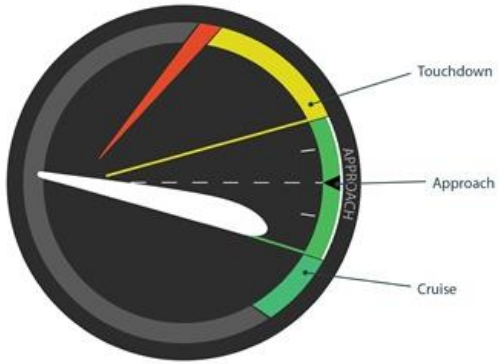
VII. Slow Flight and Stalls

Task	*D. Spin Awareness*
References	FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with spins, flight situations where unintentional spins may occur and procedures for recovery from unintentional spins.
Knowledge	The applicant demonstrates understanding of:
PA.VII.D.K1	Aerodynamics associated with spins in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
PA.VII.D.K2	What causes a spin and how to identify the entry, incipient, and developed phases of a spin.
PA.VII.D.K3	Spin recovery procedure.

Okay…airspeed is a (bad) proxy for AOA

- So, what do we do…?
- Enter the AOA sensor and indicator!
- Direct measure of AOA at any attitude, speed, etc. = how close the wing is to losing lift
- Great strides forward in indicator technology but also less burdensome certification requirements = faster and cheaper to market

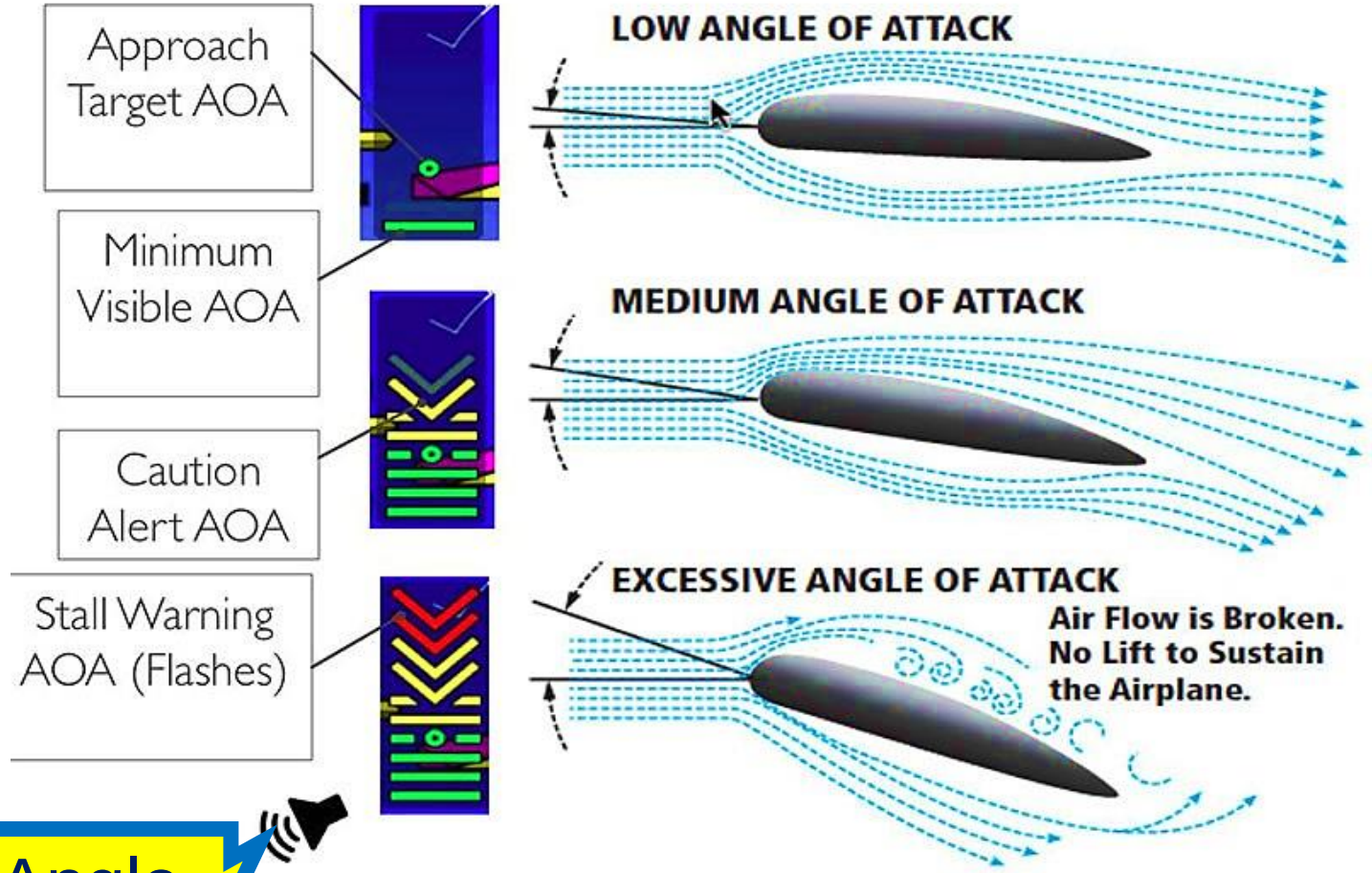
AOA Indicators



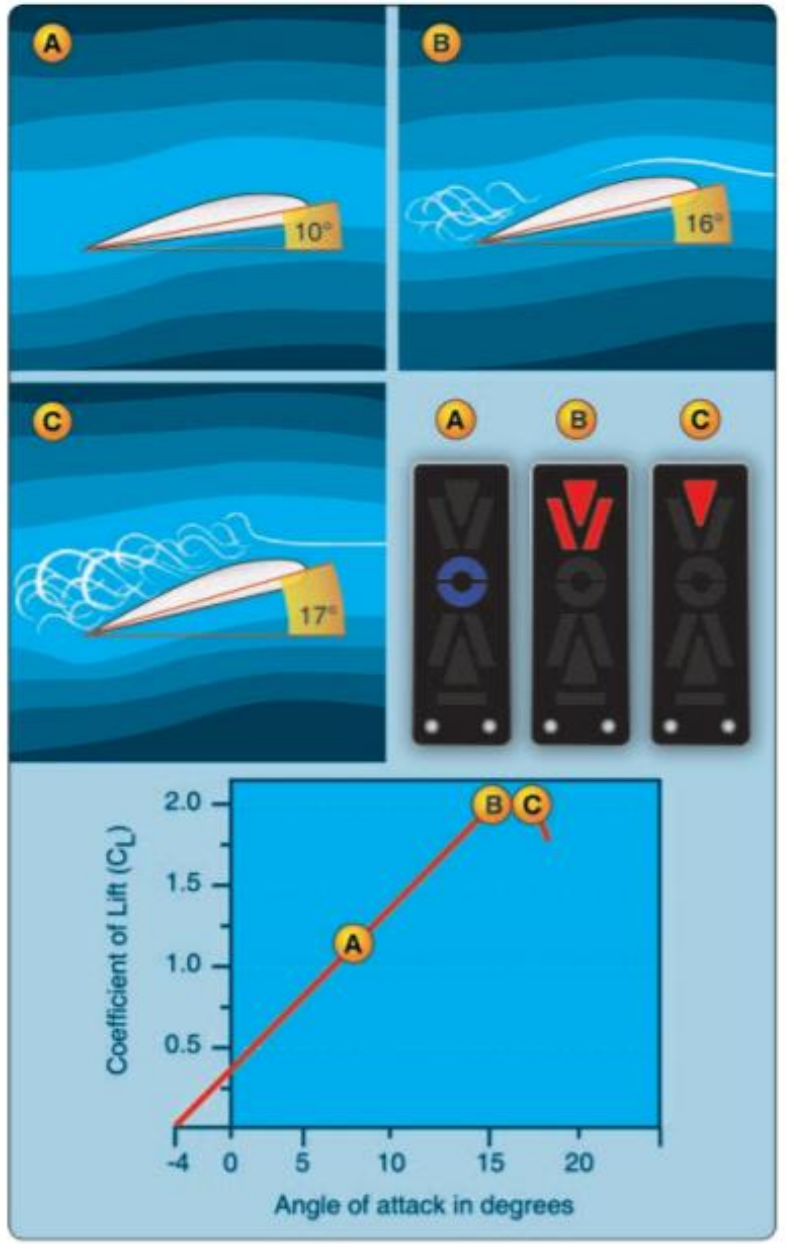
All require an AOA sensor

•Pushing the Envelope: A Plan of “Attack” for Loss of Control. FAA Safety Briefing May-June 2018

What's this thing trying to tell me?



Angle Push



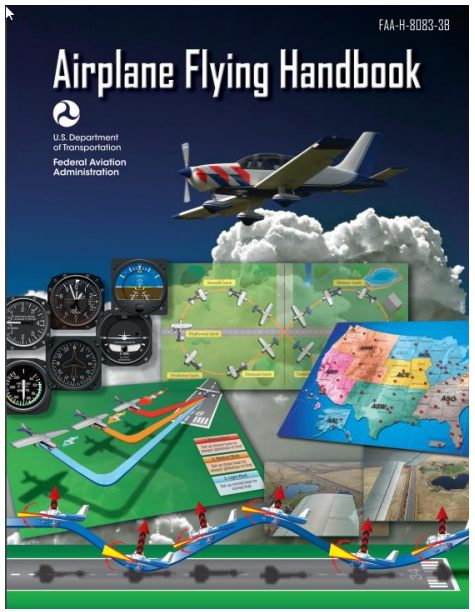
A conceptual representation of an AOA indicator. It is important to become familiar with the equipment installed in a specific airplane.

Can’t control it if you can’t measure it…

Resources

- **Airplane Flying Handbook**
  - http://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/airplane_handbook/

Read the book!



•Homework

- Investigate AOA Systems
- Practice
  - Stalls & slow flight
  - Patterns under different situations
    - Extended downwind…slow down?
    - Beware the tailwind on base
- Don’t just “wing it”, fly with a CFI doing *WINGS* activities

Proficiency and Peace of Mind

- **Fly regularly with your CFI**
- **Practice, practice…**
- **Document in *WINGS***

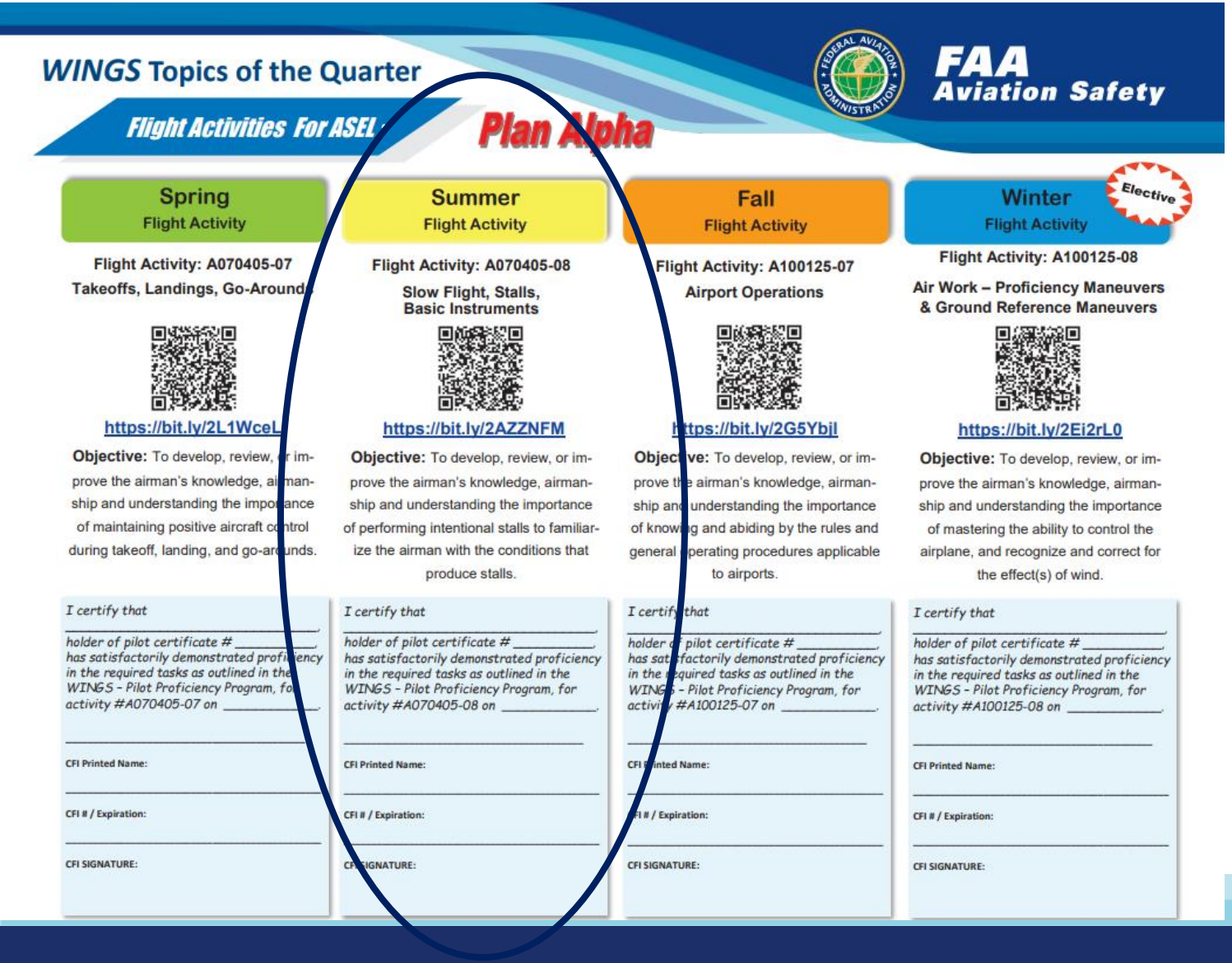
WINGS Topic of the Quarter

- **Easiest way to work with *WINGS***
- **Three knowledge activities and three flight activities chosen for you**
- **Do one per quarter – gets you a phase of *WINGS* with all the rewards**

- **CFIs: Give WINGS credit after every instructional flight**

- **NEW for 2022! Two ToQ plans to choose from: Alpha and Bravo**

WINGS Topic of the Quarter – Alpha Flights



- **Easy to do these rewarding light activities**
  - With your CFI
  - At least 3 times a year!
  - Go on…do the bonus 4th!

Summer Training (Flights)

Summer
Flight Activity

Flight Activity: A070405-08

Slow Flight, Stalls, Basic Instruments

https://bit.ly/2AZZNFM

Objective: To develop, review, or improve the airman's knowledge, airmanship and understanding the importance of performing intentional stalls to familiarize the airman with the conditions that produce stalls.

I certify that
_____,
holder of pilot certificate # _____,
has satisfactorily demonstrated proficiency in the required tasks as outlined in the WINGS – Pilot Proficiency Program, for activity #A070405-08 on _____.

_____
CFI Printed Name:

_____
CFI # / Expiration:

_____
CFI SIGNATURE:

Federal Aviation Administration

Activities, Courses, Seminars &

Activities | Courses | Seminars & Webinars | Topic

Accredited Activity Infor

Name: ASEL-Slow Flight
friendly)
Credits:
1 Credit for B
Activity Number: A070405-08
Syllabus: S-BF2-W1.00-0801
Slow Flight, Stalls,
Request Credit

Name: ASEL – Slow Flight, Stalls, Basic

– (Pvt, Comm'l, ATP)

Activity Number: A070405-08

Credits: 1 Credit for Basic Flight Topic 2

Revision: June 2019

Syllabus: S-BF1-W1.00-080124-02-01

1. BACKGROUND – Loss of control, particul
Aviation fatal accidents. This and other ***WING***
airmanship, proficiency, flight discipline and ri

In this WINGS Flight Activity the airman a
recommended procedures for the safe op

Slow Flight and Stalls. It is essential that
its aerodynamic buffet or stall-warning, ar
airplane feels and looks. It is important to
develop proficiency in stall recognition and recovery

WINGS Flight Activity # A070405-08 Worksheet
ASEL – Slow Flight, Stalls, Basic Instruments

			DATE:	
			LOCATION:	
AIRMAN:	**AIRMAN CERTIFICATE #:**	**AIRMAN EMAIL:**	**TYPE AIRCRAFT/SIMULATOR USED**	**BLOCK TIME**
CFI:	**CFI CERTIFICATE #:**	**CFI EMAIL:**	***WINGS* Flight Activity Completed:** ☐ **YES** ☐ **NO**	

NOTE: The Flight Instructor will ensure the airman possesses the knowledge, ability to manage risks, and skills consistent in the performance of flight maneuvers specifically listed in the Areas of Operation for Takeoffs, Landings and Go-Arounds; Emergency Operations, and Night Operations (as applicable) to the ACS completion standards. While this ***WINGS*** Flight Activity targets specifically the Takeoff, Landing, and Go-Around Area of Operation, Airmen should satisfactorily demonstrate all pertinent parts of the ACS in their Preflight, Flight, and Post Flight activities consistent with their certificate or rating. For ***WINGS*** credit, the airman will satisfactorily demonstrate the maneuvers and procedures listed in bold text below, using both outside visual references and cross checked with the flight instruments, for the privileges of the certificate or rating being exercised in order to act as Pilot-in-Command (PIC).

Principal ACS Areas of Operations for this *WINGS* Flight Activity (Bold Items Required):

AREA OF OPERATION	GRADE FM	GRADE SRM	AREA OF OPERATION	GRADE FM	GRADE SRM
I. PREFLIGHT PREPARATION			**VIII. BASIC INSTRUMENT MANEUVERS**		
II. PREFLIGHT PROCEDURES			• **STRAIGHT-AND-LEVEL FLIGHT**		
			• **CONSTANT AIRSPEED CLIMBS**		
III. AIRPORT AND SEAPLANE BASE OPERATIONS			• **CONSTANT AIRSPEED DESCENTS**		
			• **TURNS TO HEADINGS**		
IV. TAKEOFFS, LANDINGS, AND GO-AROUNDS			• **RECOVERY FROM UNUSUAL FLIGHT ATTITUDES**		
			• **RADIO COMMUNICATIONS, NAVIGATION SYSTEMS/FACILITIES, AND RADAR SERVICES**		
V. PERFORMANCE AND GROUND REFERENCE					
			IX. EMERGENCY OPERATIONS		
VI. NAVIGATION					
			X. MULTIENGINE OPERATIONS		
VII. SLOW FLIGHT AND STALLS					
			XI. NIGHT OPERATIONS (AS APPLICABLE)		
1. **MANEUVERING DURING SLOW FLIGHT**			1. NIGHT PREPARATION		
2. **POWER-OFF STALLS**					
3. **POWER-ON STALLS**			XII. POSTFLIGHT PROCEDURES		
4. **SPIN AWARENESS**					
5. **MANEUVERING DURING SLOW FLIGHT**					

COMMENTS: (Use back for additional notes)

Need help with *WINGS*?

Talk with your local *WINGSPro*

WINGS for Flying Clubs

- **Work with your (and other) flying clubs to promote *WINGS***
- **Include all *WINGS* transcripts with insurance renewal**

- **My club *saved 27%* over previous year's premium…**

- **Info on AOPA Flying Clubs Radio and *Club Connector* newsletter**

- **We provide links to these ToM presentations in the *Club Connector* safety article**
  - Search for AOPA Club Connector and sign-up

Next Month's ToM:

~~May~~ - I'll be at the Great Alaska Gathering!

June:

The National FAA Safety Team Presents

Topic of the Month – June
After-market Safety Equipment

Presented to: WAFC and Friends
By: Stephen Bateman, CFI
Date: June 13th, 2022

Produced by AFS-850
The FAA Safety Team (FAASTeam)

Thank you for attending!

You are vital members of our GA safety community!

•Homework

- Investigate AOA Systems
- Practice
  - Stalls & slow flight
  - Patterns under different situations
    - Extended downwind…slow down?
    - Beware the tailwind on base
- Don’t just “wing it”, fly with a CFI doing *WINGS* activities