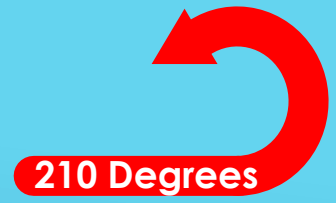
210 Degrees

Free Calculator

an educational tool for

Engine Failure and Return to Airport



Presented by Dr. George Bolon

With Corps Members

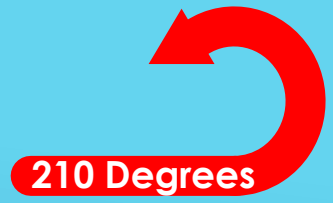
Reed Niederkorn Scott Sloan Nigel Smith

Special Thanks to:

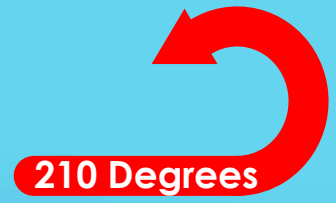
210 Degrees

Minneapolis FAAST Team

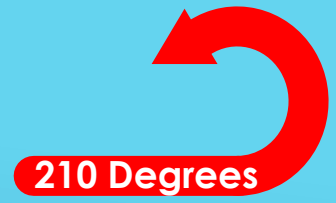
Nick Halatsis **Troy Siekas**



WHY DEVELOP A CALCULATOR TO SUMULATE A RETURN TO THE RUNWAY AFTER POWER FAILURE?



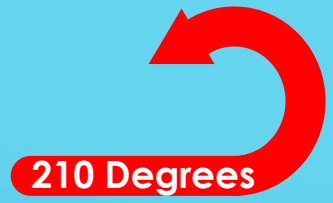
> SAFETY <



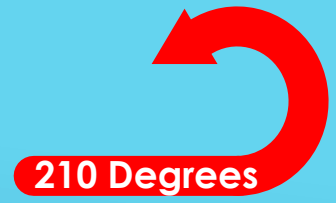
Our Flight Goals Are:

1. No individual is injured

2. We accomplish the purpose of the flight



… By Increasing the Pilot's Knowledge, Understanding, Skills and Decision Making for Single Engine Failure on Take Off



PERSONAL THOUGHTS…

THREE CRITICAL SUCCESS FACTORS for PILOTS

I. An Intimate Knowledge of your Business

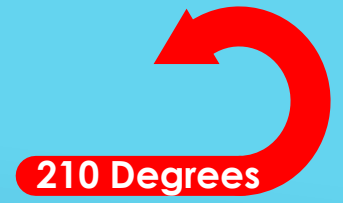
II. An Attitude of:

   a. Continual Skepticism;

   b. Situational/Positional Awareness;

   c. Choosing the Most Conservative Approach

III. The Development and Use of Effective Standard Operating Procedures; THE COMPANY MANUAL



Author's Note

I. Remember you as Pilot in command must:

1. Know what you want or are asked to do
2. Have a Plan or Series of Steps on how to Accomplish #1
3. And, KNOW you can do it - if you have a doubt, DON'T TRY TO DO IT.

II. Cross Country Flights are made on the Ground Prior to Takeoff.

III. The Best Safety Component of an Aircraft is a PROFESSIONALLY TRAINED PILOT

IN OUR VIEW, THE BEST SAFETY COMPONENTS OF AN AIRCRAFT ARE:

210 Degrees

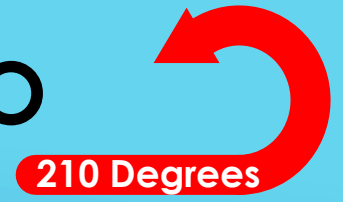
I. A Professionally Trained Pilot

II. Harnesses for the Occupants

4 point Harness

3 point harness w/ Airbag

STEPS FOR GO/ NO-GO DECISION FOR A RETURN TO THE RUNWAY

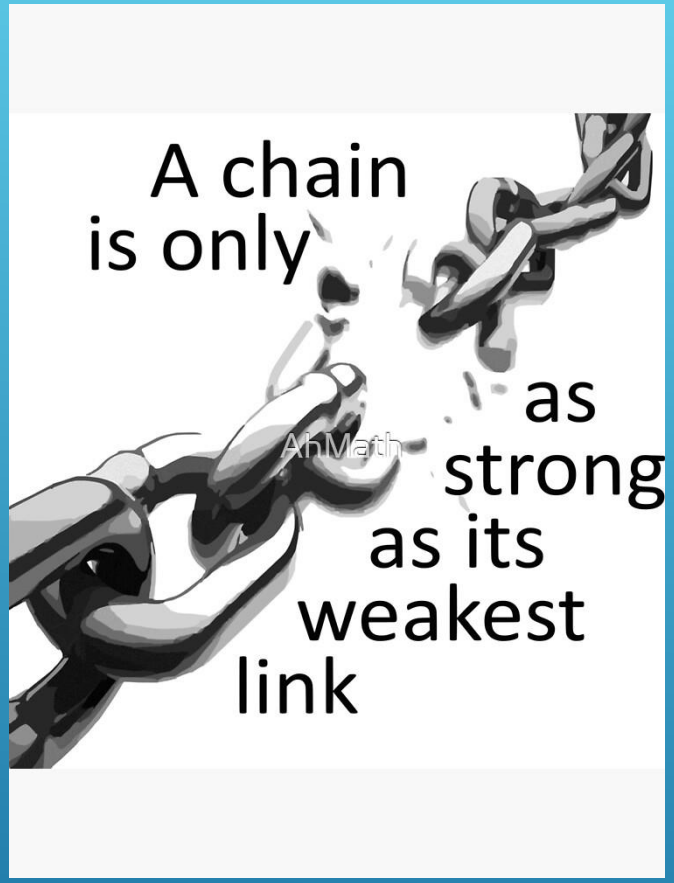


I. Use of the Calculator to determine minimum and maximum critical altitudes

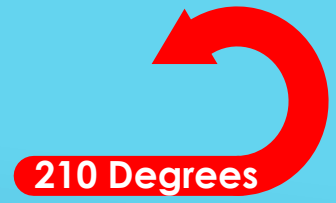
II. Compliance with pre-takeoff **PILOT BRIEF**

III. Ground and Simulator Training to increase Pilot's knowledge and skills

IV. You may wish to do validation testing at a "safe altitude" (We utilize 3,000' AGL)



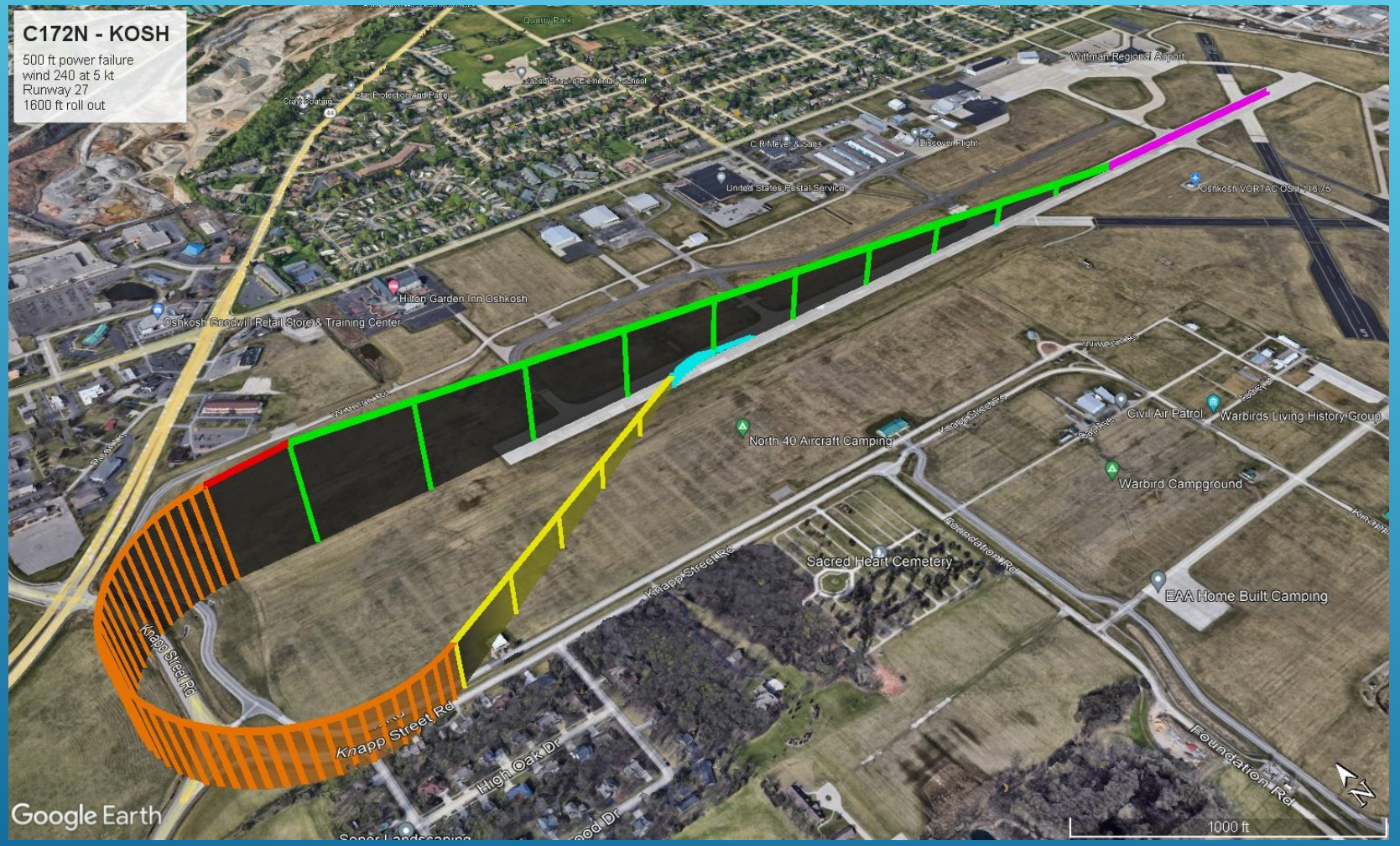
What causes power plants to fail?

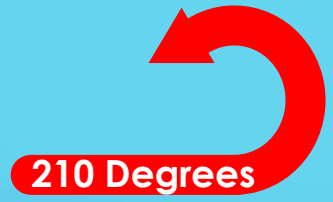


Lack of:

- Air
- Fuel
- Ignition

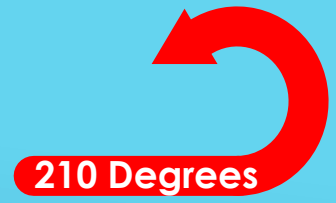
WHY 210° OF TURN?





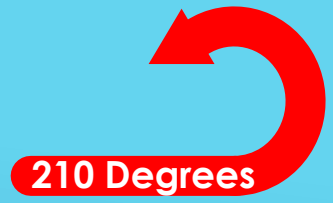
SEGMENTS OF A RETURN TO THE RUNWAY

1) Pilot Brief
2) Takeoff Roll
3) Climb Out
4) Time Delay after Power Failure
5) Primary Turn
6) Glide Back
7) Align with Runway and Land



CALCULATOR DEMONSTRATIONS

CALCULATOR TAKEAWAYS: TAKE OFF ROLL AND CLIMB OUT



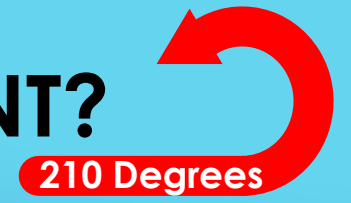
I. Start roll as close to beginning of runway as possible

II. Accelerate Smoothly

III. Climb Out between Vx and Vy

IV. Climb at V best glide if that speed is between Vx and Vy to reduce load on Pilot if engine loss occurs

CLIMB OUT- WHY IS CLIMB SPEED SO IMPORTANT?



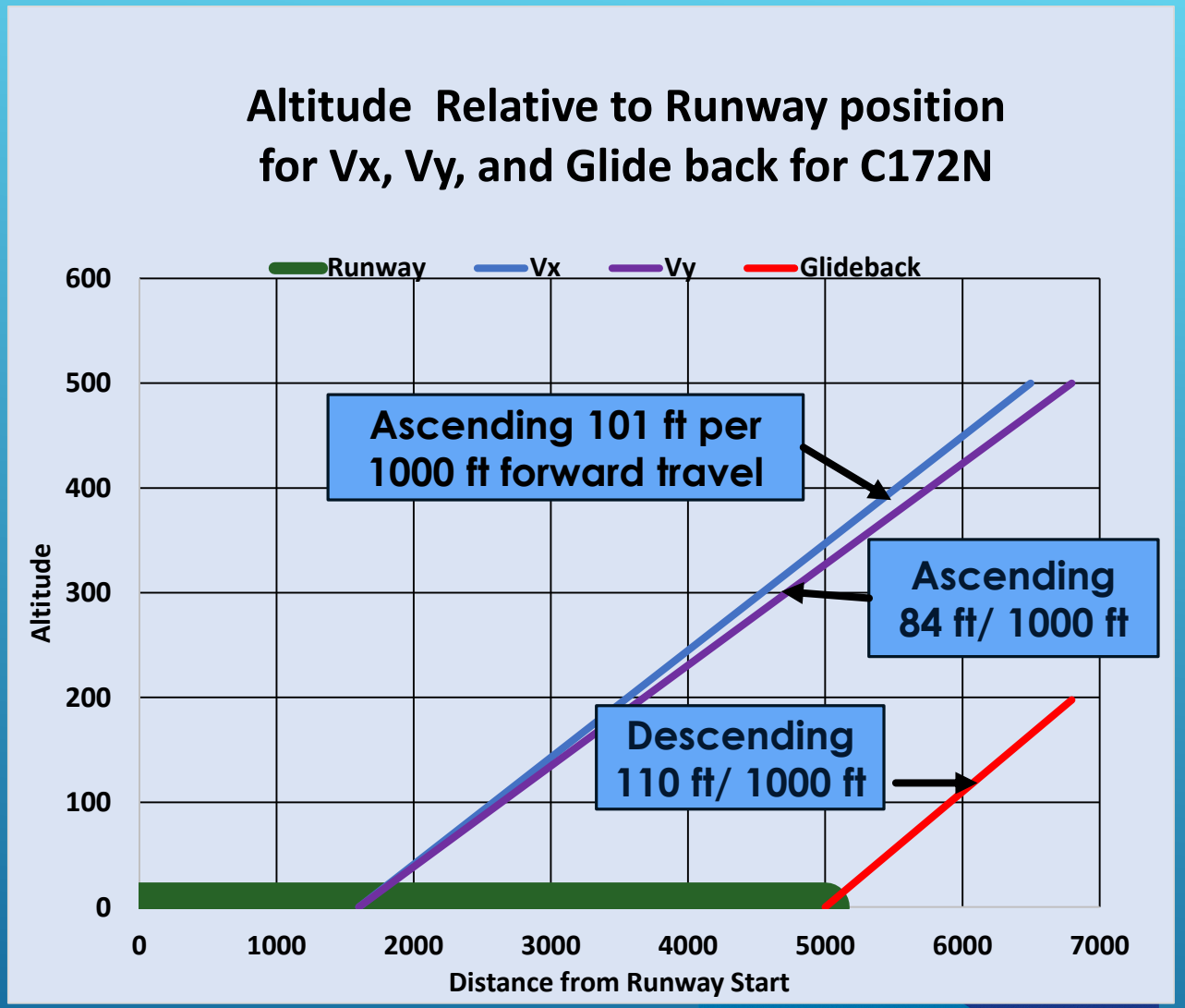
I. Objective is to gain as much altitude as possible while staying as close to runway end as possible.

II. Best angle of climb (Vx) is usually the best target.

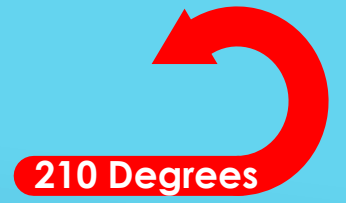
III. Glide back flight deck pitch angle is generally greater than Vx or Vy for aircraft with fixed landing gear.

IV. Note: In most cases, a longer climb time results in lower chance to return to runway due to distance.

V. And for many aircraft, above some maximum altitude, you can no longer make it back to the runway due to distance.



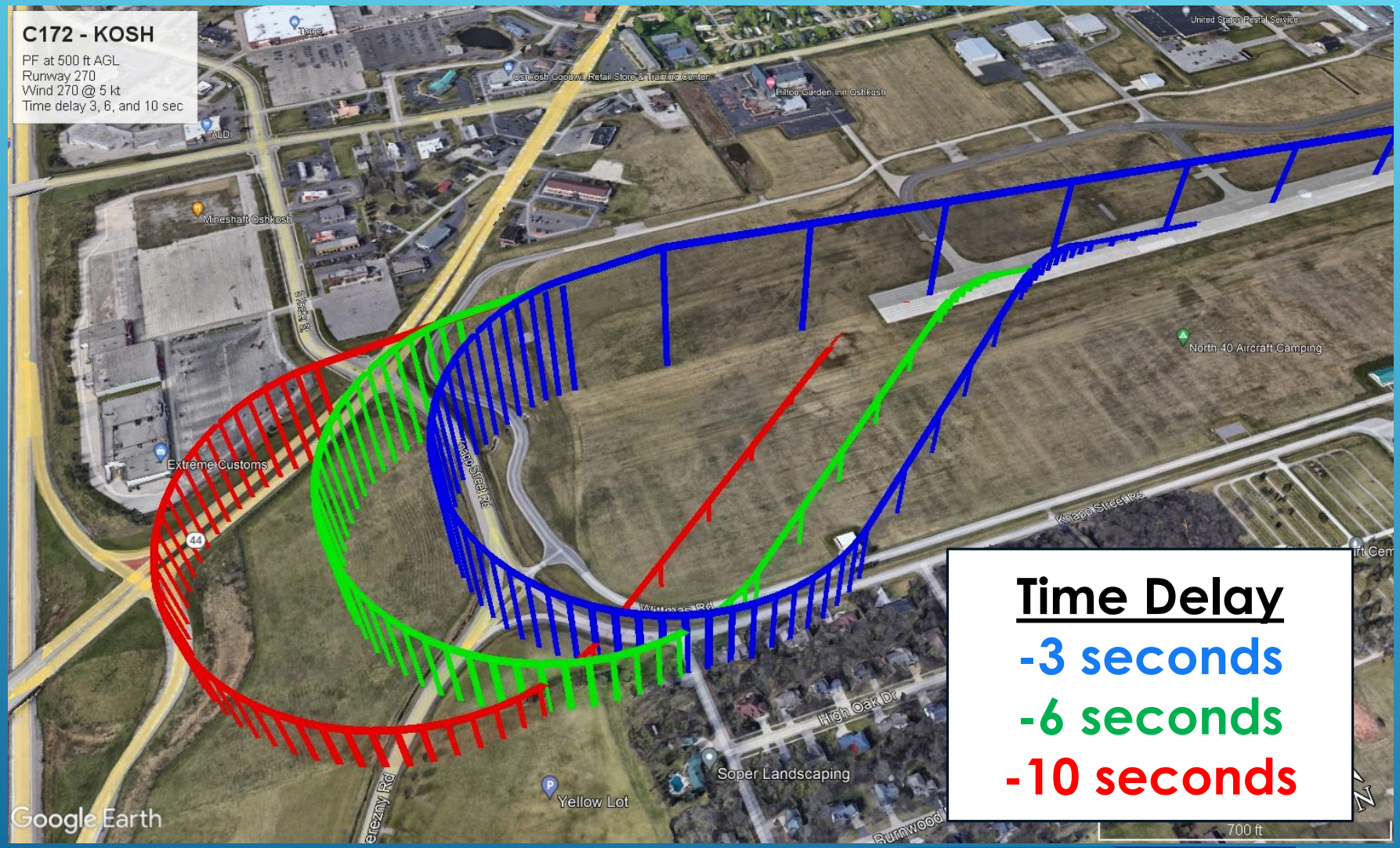
TIME DELAY AFTER POWER FAILURE (PF) AND ITS SIGNIFICANCE TO MAKING IT BACK



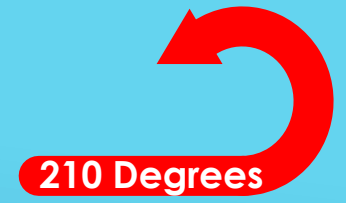
I. For every second the pilot waits to turn back to the runway, the aircraft is more than 100 ft farther away from the runway and loses more altitude.

II. For this case, more than a 7 second delay results in the pilot not being able to return to the runway surface.

III. How long should a pilot nurse a failing engine before making the decision to turn back, or go straight ahead and look for a place to land? IN MY OPINION, NEVER.



What should the bank angle be in the turn?

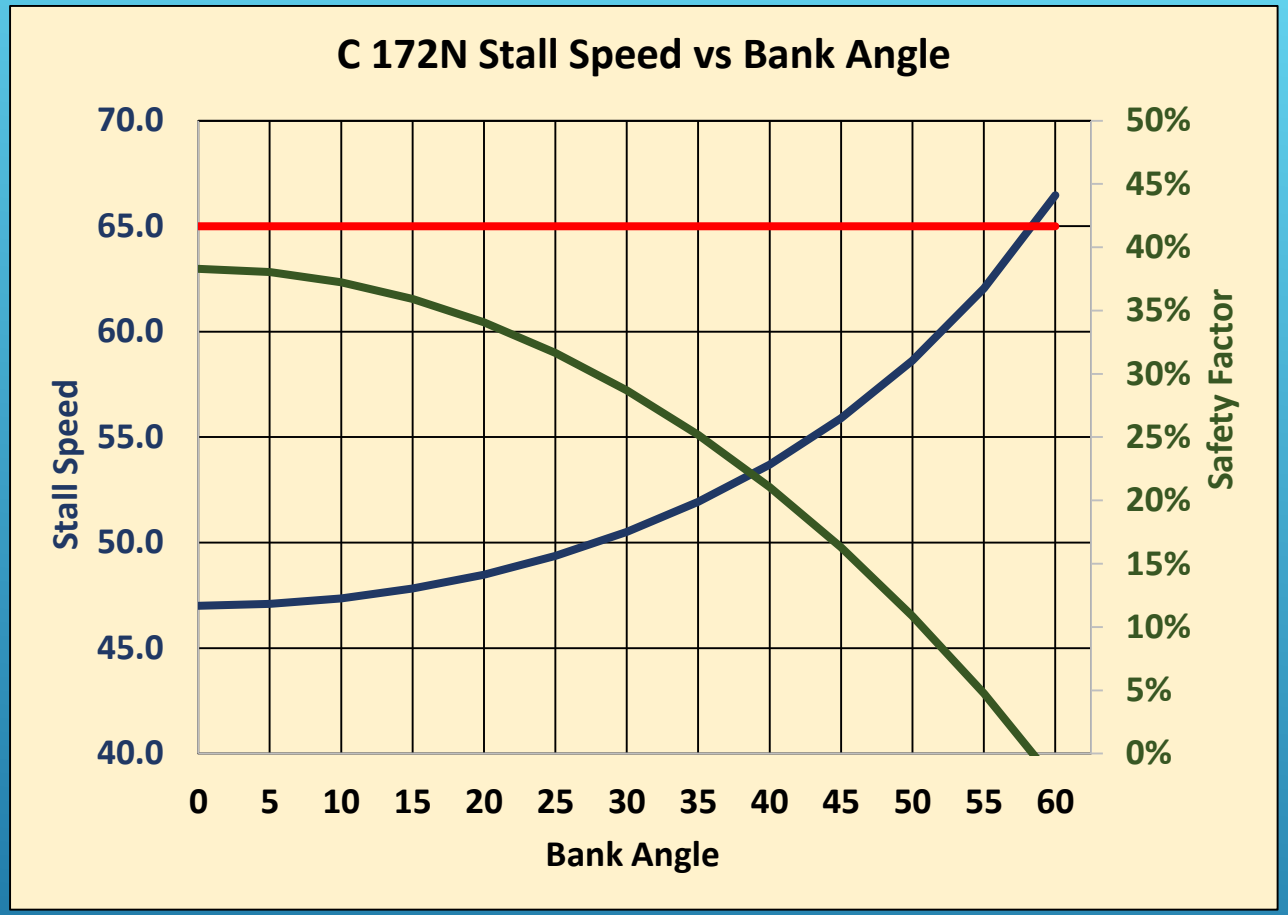


I. Stall speed increases with bank angle (G Loading) so we must choose carefully to avoid the possibility of an accelerated stall/spin.

II. Goal is to maintain "Best Glide" speed all the way to the ground fighting one's natural tendency to pull back when we see the ground coming up at us.

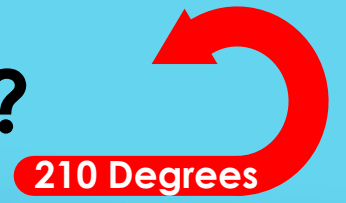
III. In this case of a 35 degree bank we have a 25% stall safety factor.

IV. If we would increase the bank to 55 degrees, now safety factor of only 6%!



Best Glide Angle of Bank Stall Speed

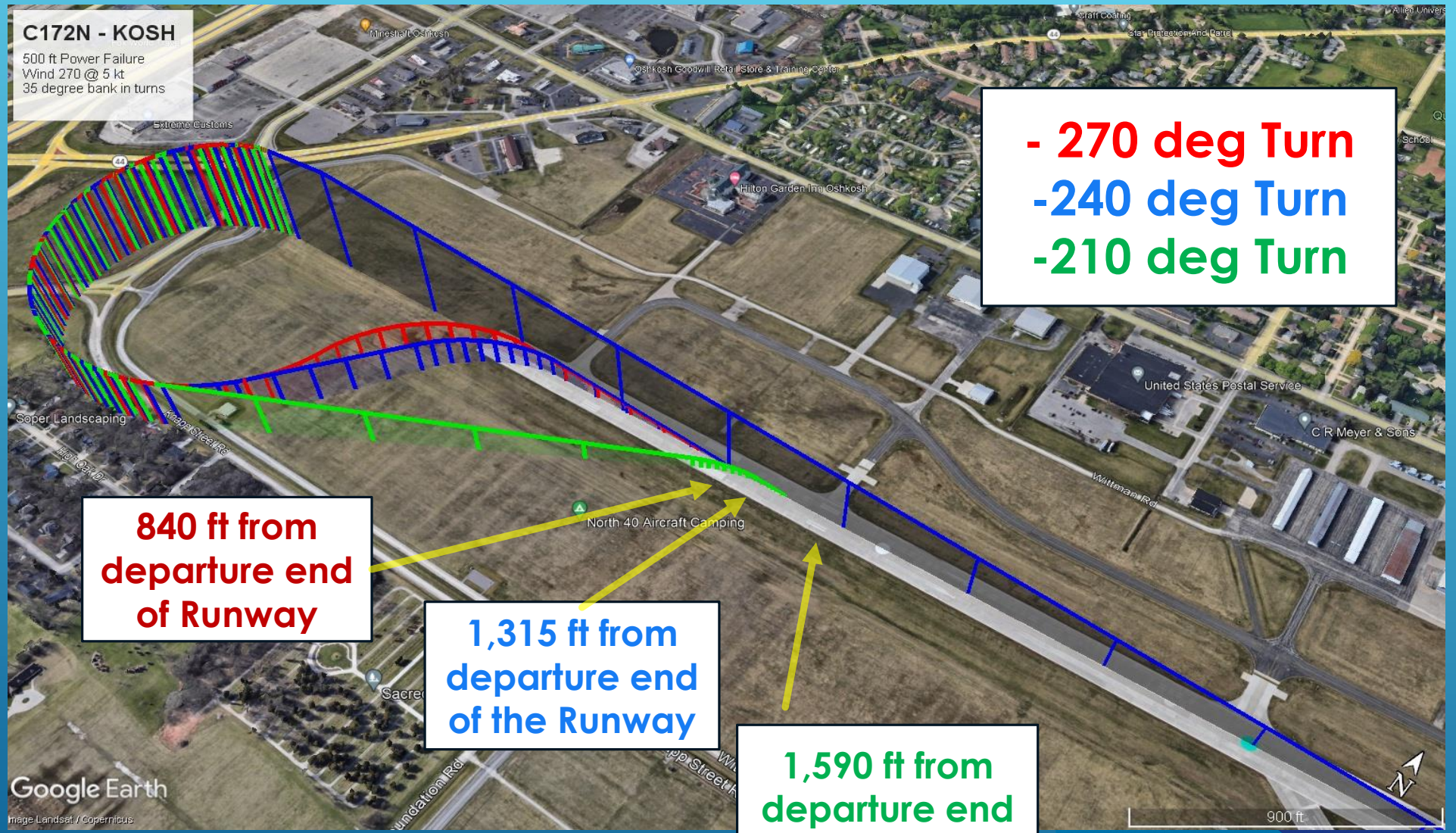
WHAT SHOULD THE PRIMARY TURN ANGLE BE?



I. Since 240 and 270 degree turns are nearly identical in glide path length and altitude loss, there is no good reason to ever turn beyond 240 degrees

II. Minimum runway length for return to runway is less for 210 degree turn

III. Return path length and altitude loss are substantially greater for turns less than 210 degrees

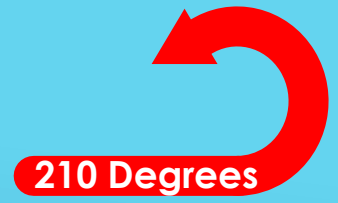


HOW TURN ANGLE AFFECTS ALTITUDE LOSS AND TOUCHDOWN POINT

- **Turn Angle has two primary effects:**
  1) **Altitude loss during glide back to runway;**
  2) **Distance gliding back toward runway.**
- **For shorter runway lengths smaller turn angles are important:**
  - **However, you need enough turn angle to get back to runway center line.**
- **Balancing altitude loss and distance back toward runway, turn angles less than 210 deg and greater than 240 deg. are very questionable.**

Turn Angle (deg)	Altitude Loss after PF (ft)	Distance Flown Back toward Runway (ft)
190	908	5273
200	574	2132
210	472	1108
220	428	616
230	406	338
240	396	171
250	392	71
260	391	17
270	391	0

FOCUS AREAS FOR GLIDE BACK AND LANDING



I. As soon as the Primary Turn is completed on Instruments, now look outside and visually assess whether you require up to 30 additional degrees.

II. Maintain Airspeed (Vbg) and Heading.

III. Resist temptation to pull back on the yolk as the ground is coming up at you.

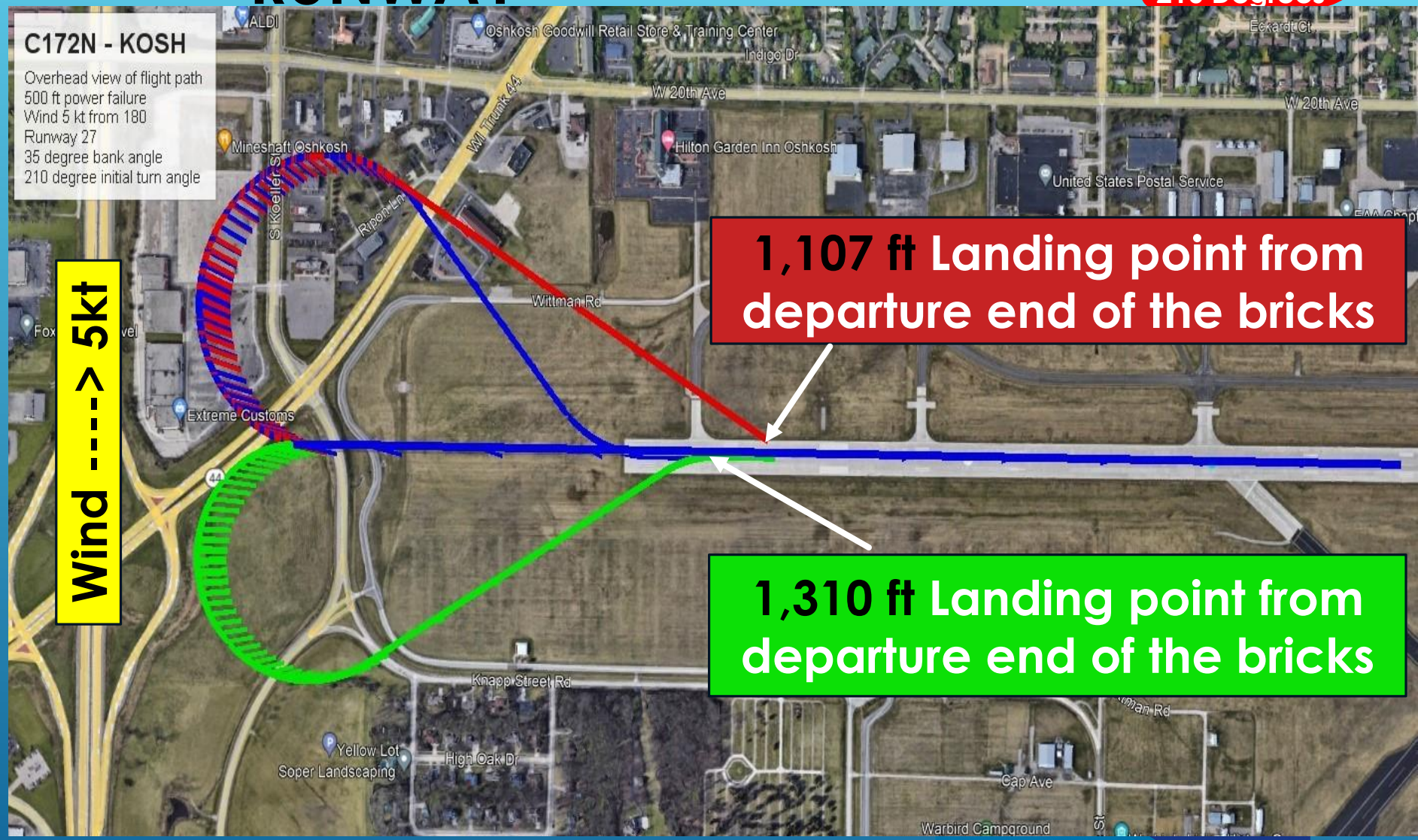
IV. Maintain Best Glide until the Wheels/Skin SQUEAK.

Pilots view after a 210 degree primary turn is complete

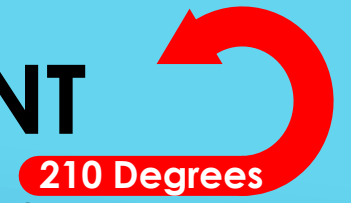
EFFECT OF CROSS-WIND ON RETURN PATH TO RUNWAY

If you make your turn <u>with the wind</u> as in the case in RED, you could find it difficult to get back to the runway centerline

Turning <u>into the wind</u> (GREEN case) makes it a bit easier to get back to the runway

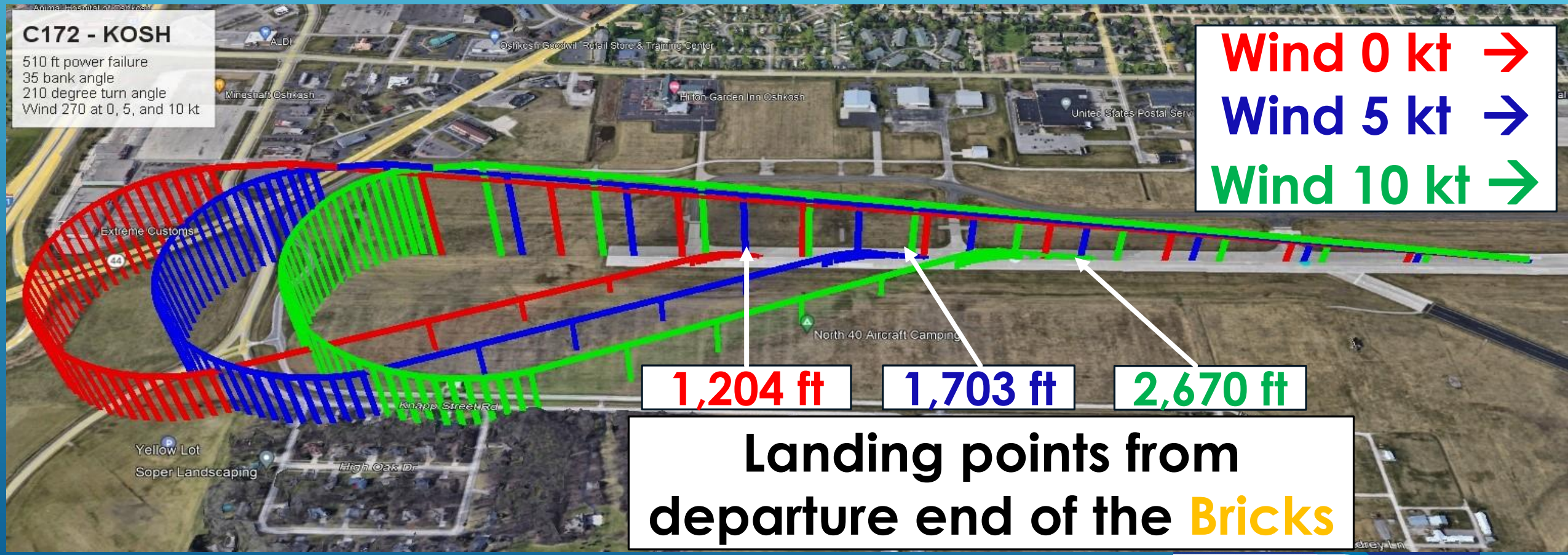


EFFECT OF HEADWIND VELOCITY COMPONENT

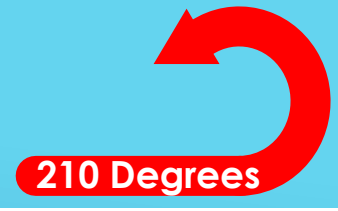


- Wind increases climb angle before PF
- Wind decreases glide angle after PF

- Short runways may make runway return impossible without headwind
- Do not overestimate wind at BRIEF



PILOT BRIEF FOR CESSNA 172N



Note:
If the Pilot Brief is omitted and you experience a Power Failure on take off; … Go Straight Ahead +/- 30 degrees at best glide and find a landing site.

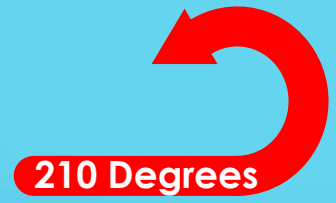
More on why later.

* **Example of a Captain's VFR Brief:**

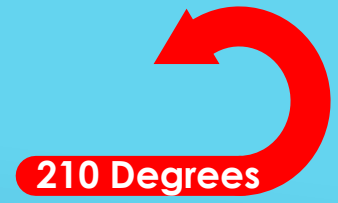
"This shall be a Standard Company Max Power VFR Brake Release (On the Roll) Takeoff from Runway ____ at _____ above all Landing Minimums. If we have any Un-Briefed Anomalies Prior to Liftoff (V1) We Shall Reject the Takeoff. For An Engine Failure, Catastrophic Loss of Directional Control or a Wildlife Strike that results in a Catastrophic Loss of Directional Control; below 500 ft. (AGL); _____ MSL; We Shall Land Straight Ahead +/- Thirty (30) Degrees Maintaining Best Glide Speed of **65** KIAS until the Wheels Squeak. If we are VFR and above 500 ft (AGL); _____ (MSL) and Any of the Preceding Occurs or We have a **FIRE**; We shall make a 210 Degree Turn to the (left or right) into the wind at a Thirty Five (35) Degrees Angle of Bank, maintaining Best Glide Speed of **65** KIAS, for a Return to Runway _____, or Anywhere on the Airport Environment. If we have no issues our Clearance is Runway Heading in the Heading Mode to 400 ft (AGL); _____ (MSL) complete the 400 ft Checklist; engage the A/P (if applicable) and proceed via our Clearance/Flight Plan Route to _____ and Climb as Cleared /Instructed To _____. Do you have any questions or suggestions"

NOTE: 65 KIAS until the WHEELS SQUEAK

"BOLON METHOD" FOR CAPABILITY OF A TURN BACK TO THE RUNWAY

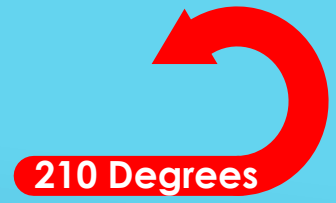


I. **Application of Calculator** to find the minimum and maximum critical altitudes;
II. **Incorporating Calculator** information into **"PILOT BRIEF;"**
III. **Ground and Simulator Training** to increase Pilot's skills and competency;
IV. **"At altitude" flight exercises** for real world Validation Testing;
V. **Maintaining Focus** and **Best Glide (Vbg)** on all maneuvers necessary to return to the runway until the **wheels (or skin) squeak.**



▶DO ME A FAVOR◀

A SUMMARY OF HIGH POINTS:



Density Altitude;

Reaction Time;

Runway Length;

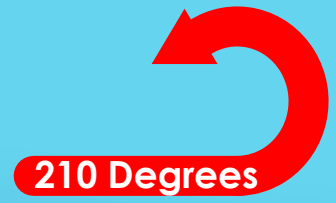
Flying the Instruments through 210˚;

High Performance Aircraft.

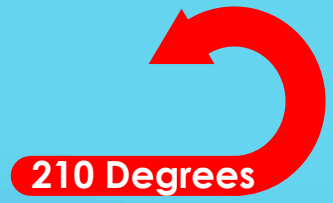
FREE AVAILABLE RESOURCES

210 Degrees

I. 3 Critical Success Factors
II. Go No-Go Decision
III. Calculator User Manual
IV. Calculator Program
V. Before Take Off BRIEF
VI. Reference Sources
VII. Where to go to tell us how you thought we did

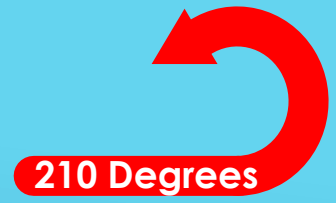


ATTENDEES QUESTIONS AND COMMENTS



Where to get the FREE Calculator and Resources?

https://www.twotendegrees.com



THANK YOU FOR JOINING US ALONG THE YELLOW-BRICK RUNWAY

Production