Stan/Eval Newsletter
CIVIL AIR PATROL
UNITED STATES AIR FORCE AUXILIARY
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Mystical Secrets of Nexrad Revealed

More and more of our fleet have Nexrad weather as part of the avionics suite (notably G1000 equipped aircraft) which has proven to be very useful as well as an important risk management tool. It is useful to review the basics so we can better understand and interpret what we are looking at. A very good article by Mac McClellan appeared in Flying magazine which does a good job summarizing what Nexrad tells you and what it doesn't. You can find it here.

Nexrad is a network of 160 high resolution S band doppler radars. Doppler means not only that it measures the strength of the return but also the frequency shift of the pulse which makes it such a good weather detector.

Nexrad provides radar returns and displays them on our display in a color format. It integrates several scans together to better estimate the return. So, what you see on the screen is not a single scan result but a smoothed picture. The color goes from nothing to green, to yellow, to red. Red is the strongest return. Nexrad detects moisture. No moisture, no returns in general. There is such thing as anomalous propagation (AP) which provides a return but it's not moisture. So, there is a chance that what you are seeing is not moisture. But for the most part, it does well only depicting moisture.

In addition, Nexrad can also depict lightning which helps to confirm the intensity of the weather.

The characteristic that we need to keep in mind (Max Trescott has written a lot about this) is that Nexrad is not real-time. Whatever you see on the screen is "old" data. Typically, the data displayed is 10 minutes or so old but it's not unusual for it to lag by more than 20 minutes. Nexrad will display the age of the data, so you have some idea of how old it is. For slow moving weather, that's not so bad. For fast moving or developing weather it can be misleading. So misleading in some cases that the NTSB has opined that it was a contributing cause to someone flying into weather they had no business being in. So, it's better to describe Nexrad as near real time as possible. If you are VFR, you should always compare what you see on the screen to what you see out the window. Believe the window over the display. Thus, the admonition that Nexrad should be used strategically not tactically. That's a fancy way of saying take into account it's not real time.

For real-time weather you need a storm scope, onboard weather radar or a windscreen you can see out of.

Another characteristic of Nexrad (in the cockpit) is that what we see is not only horizontally scanned but vertically scanned as well. We call this a composite. If you see weather ahead, you have no idea of its vertical placement. You just know it's there. On the ground you can access both the composite and the lower tilts so you can get a better feeling for where in the vertical the weather is.

Given the returns seen on Nexrad, most pilots will happily fly through green and maybe even yellow returns but avoid the red. The logic is that green is most likely light rain or maybe not even falling precipitation but just a lot of moisture. Red is heavy precipitation that may presage a thunderstorm. Yellow is something in between. Nothing wrong with this logic if common sense prevails. If you head for green or yellow and you encounter turbulence, you probably want to turn around. Any lightning should be avoided no matter what color surrounds it. But you can glean more from the Nexrad weather display than just the color.

A key characteristic to look for is the gradient from green to yellow to red. The greater the gradient, the more chance of convection. When you see yellow and red surrounded by only a narrow band of green, there is a good chance of convective weather. If there is a lot of green on one side of the yellow/red but narrow on the other side, that can tell you which way the storm is travelling. Although I would be cautious about flying into red anytime, I have certainly done this when the red is surrounded by large patches of green. In this case, I encountered a lot of rain but no convection, but I was on high alert. I also supplemented what I was seeing on Nexrad with what ATC was telling me.

Which brings in another point. When weather looks iffy, ATC (especially approach radar) can warn you of weather ahead. Unlike Nexrad, approach radar is real time. Plus, the controller is talking to other pilots in the area who are reporting real time. They can help a lot figuring out what is to be avoided and what may be rain but not dangerous. If you are talking to Center, their radars are not as good at seeing weather.

There is an excellent weather radar discussion on weatherunderground. You can find it here.

Recognize unstabilized approach on final (Maj M. Banner)

After turning from base-to-final a pilot should be able to quickly and correctly determine whether to continue or discontinue the approach to landing by judging salient visual clues, (runway sight picture, glide path, descent rate, runway heading, airspeed, and altitude). Pilots need to be able to recognize these clues in real time to decide if the approach is stabilized or unstabilized. It is important to understand the stabilized approach to landing concept. A stabilized approach is one in which the pilot establishes and maintains a constant-angle glide path towards a predetermined point (aiming point) on the landing runway (Fig1)
(Airplane Flying Handbook, FAA – H – 8083 – 3C).

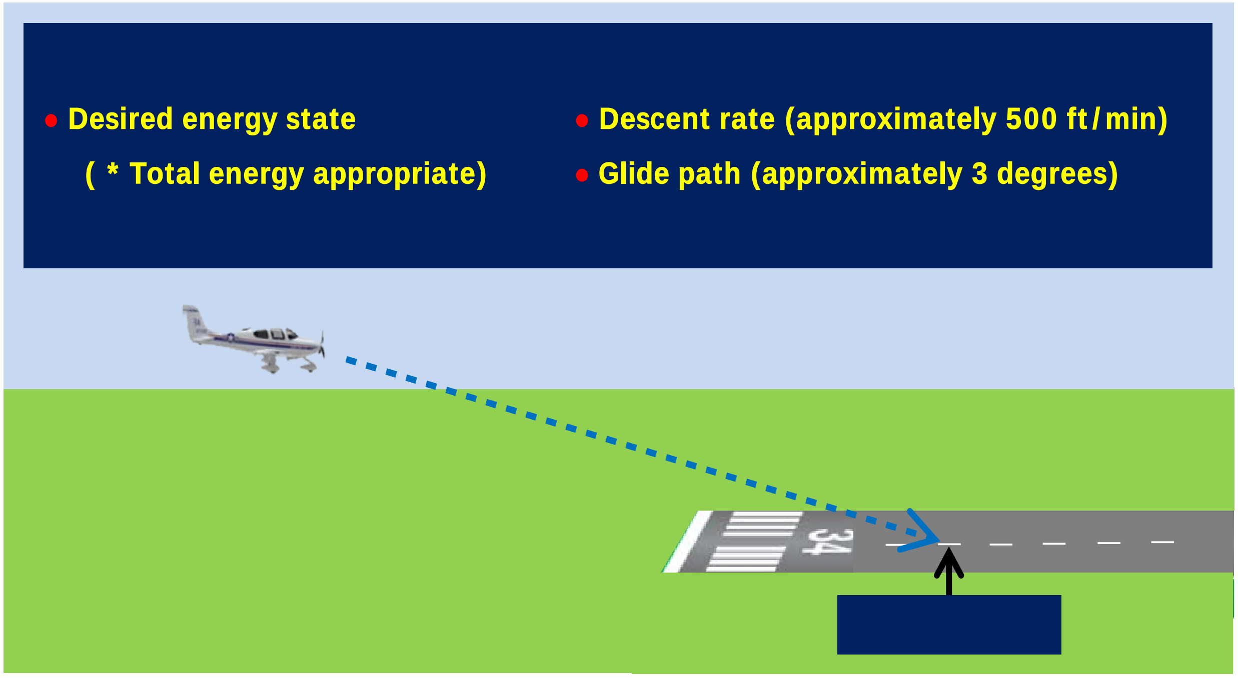


Fig. 1 * Total Energy = Kinetic energy (airspeed) + Potential energy (altitude)

Why is the stabilized approach to landing concept safety-critical? Risking inflight loss of control (LOC – I), controlled flight into terrain (CFIT) and possible fatal injuries can be avoided if we abstain from examples like these. A pilot who is unable to recognize the visual clues of an unstabilized approach and unwittingly continues toward the runway or another pilot with hazardous attitudes of anti-authority ("Don't tell me"), invulnerability ("It won't happen to me) and macho ("I can do it") for example who intentionally flies an unstabilized approach.

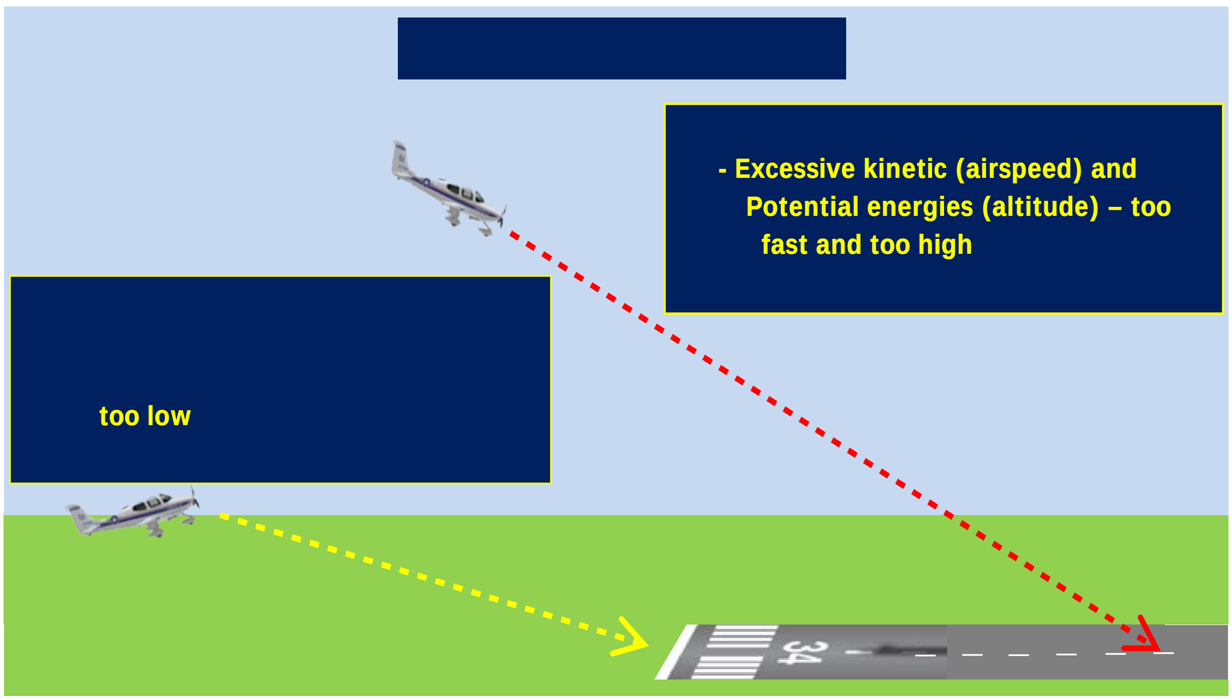
Flying a stabilized approach

As stated in FAA Advisory Circular 120 – 71B, prior to commencing the landing approach, all appropriate briefings and checklists should be accomplished before 1,000 feet height above touchdown (HAT) in instrument meteorological conditions (IMC) and at least before 500 feet HAT in visual meteorological conditions (VMC). A stabilized landing approach consists of the following attributes. Glide path: Typically, the aircraft should descend at 3 degrees from beginning the descent to the runway touchdown zone. Descent rate: This is proportional to angle of descent and ground speed. For example, to fly a 3-degree angle of descent glide path at a ground speed of 90 knots, the descent rate is approximately 500 feet per minute. Power setting: The pilot should employ power settings for approach to landing as specified in the aircraft's pilots operating handbook (POH). Runway heading: The aircraft should track on the extended runway centerline, while bank angle is limited to less than 15 degrees left and right once established on final to maintain centerline. Configuration: The aircraft should be properly configured for landing, i.e., landing flaps set, landing gear deployed (if applicable) and elevator trim set for descent. Aiming point: The aircraft should descend at a constant rate and airspeed in a straight line towards a spot on the runway referred to as the aiming point. The aiming point should remain stationary in the pilot's vision; it should not move under the nose of the aircraft and should not move forward away from the aircraft (Fig 1). To be clear, if the aircraft maintains a constant straight line glide path to the aiming point without rounding out for landing it will strike the runway. When immediately above the aiming point at about 10 to 20 feet altitude, the pilot should commence leveling off and rounding out to land.

<u>Unstabilized approach – Predisposing factors</u>

In 2000, the Flight Safety Foundation, an international organization concerned with aviation safety, determined that unstabilized approaches were a causal factor in 66% of 76 approaches and landing accidents and incidents worldwide between 1984 and 1997. The following predisposing factors for unstabilized approaches were identified. High-energy and low energy unstabilized approaches, characterized by excessive kinetic energy (airspeed) and potential energy (altitude) and insufficient kinetic energy potential energy respectively, were factors associated with landing mishaps (Fig. 2). Insufficient preparation time was a factor when the

Fig. 2 *Unstabilized* approaches are associated with ***energy mismanagement***.



flight crew conducted an approach without sufficient time to plan and prepare. Flight-handling difficulties (causal factor in 45% of unstabilized approaches) occurred in situations involving rushed approaches, attempts to comply with complex air traffic control (ATC) clearances and improper use of automation, for example, improperly using the autopilot. Adverse weather conditions such as wake turbulence, strong winds, low-level wind shear (LLWS), low visibility and heavy precipitation increased the chances of an unstabilized approach. Low proficiency, a low proficient pilot lacking experience and skills may be unable to quickly recognize essential visual clues of an unstabilized approach possibly resulting in a catastrophic landing accident. Distractions include anything that directs one's attention away from the immediate task, resulting in unstabilized approaches. For example, a powerful distractor is non-essential cockpit conversation leading to mistakes and loss of situational awareness. The sterile cockpit concept (prohibit non-essential conversation distractions during critical portions of flight, i. e., descent for landing, approach and landing, taxi, takeoff, climb out, and operation in high-density traffic areas) is a risk management (RM) control to mitigate distractions caused by talking.

Energy mismanagement – unstabilized approaches

In contrast to a stabilized approach where total energy is appropriate (Fig. 1), a low energy unstabilized approach to landing is characterized by very low kinetic energy/airspeed and potential energy/altitude (Fig. 2). It is associated with aerodynamic stalls, LOC – I, CFIT "land-short" mishaps due to inadequate vertical position awareness and tail strikes. The opposite situation, a high-energy unstabilized approach to landing is characterized by very high kinetic and potential energies (Fig. 2). This situation is associated with excessive airspeed while diving for the runway and at touch down, hard landings, loss of control on the ground (LOC – G), landing too far down the runway and runway excursion at the end, possibly leading to injuries and fatalities.

The following accident is an example of a pilot who failed to recognize a high-energy unstabilized approach until it was too late to fly a Go-around/Rejected landing.

Inability to recognize unstabilized approach

In 2010 in Caldwell, New Jersey, a relatively low-time private pilot (885 hours total flight time) flying a Cirrus SR – 22 did not appear to recognize an unstabilized approach that resulted in three fatalities. Weather conditions were clear skies and relatively calm winds. A flight instructor witness at the approach end of the runway observing the airplane stated that when it was on short final it was "a bit high and a bit fast" (excessive potential and kinetic energy) and that the “airplane was not stabilized”. Altitude was estimated to be much too high. It was a high-energy, unstabilized approach (Fig. 2). Despite the unrecognized “red flags” of the unstabilized approach, the pilot pitched down and dove for the runway which exacerbated the situation by further increasing the already increased kinetic energy state (airspeed). Consequently, the airplane landed long, 3,000 feet down the runway, toward the runway’s end and was abeam the tower when it finally touched down. Witnesses stated it was "rocking or bouncing," "porpoising hard" and traveling too fast on the runway. It then initiated an abrupt climb at a relatively high, nose-up attitude and at about 200 feet altitude; it did a stall-spin dive and impacted the ground. It is unclear if full power was applied. Examination of the wreckage revealed the wing flaps were fully extended at the 100 percent (32 degrees) position. The NTSB determined the probable cause of the accident was the pilot’s attempt to salvage an unstabilized visual approach that resulted in an aerodynamic stall at low altitude. Contributing to the accident was the pilot's continuance of an unstabilized final approach and the improper use of flaps during the Go-around/Rejected landing. A recently published FAASTeam fact sheet cautioned pilots on the importance of being proficient at recognizing high-energy states when close-in to airports or near a final approach fix. The pilot may have lacked this proficiency.

Recognize unstabilized approach

Regardless of aircraft type, pilot experience level, or whether the flight is conducted in VMC or IMC, a safety-critical pilot skill is to be proficient at recognizing the visual clues of low- and high-energy unstabilized approaches to landing. If unstabilized, pilots should train to withstand pressures from ATC and passengers to always land the aircraft because of the high risks involved. Pilots should also learn to ignore self-personality traits like continuation bias (tendency to continue with an original course of action that is no longer viable) and landing expectancy or set (anticipatory belief that conditions are not as threatening as they appear), forms of “get-there-itis”, which can delude a pilot into trying to salvage unstabilized approaches, rather than fly a Go-around/Rejected landing – a safer option.

REACT on Takeoff

IFR Magazine had an interesting article on the acronym REACT which is useful during takeoff. We all do a careful preflight and follow the before takeoff checklist prior to takeoff. But once on the runway and before liftoff, the REACT acronym provides a useful and practical way to monitor the takeoff and help in the decision for aborting the takeoff.

The R is for RPM and manifold pressure. When the throttle goes forward check for power output. For our C182 and GA8 aircraft, RPM should be 2400 (C182)/ 2700 (GA8) and MP should be close to the field barometric pressure. For our C172 aircraft, the RPM should be the static RPM (e.g., RPM when the aircraft is not moving or moving slowly). The static RPM is part of the TCDS but is around 2300 RPM for most C172’s. If RPM or manifold pressure is not where it should be, abort and figure out what’s wrong. Note that the published static RPM is for sea level, so in high density altitude conditions, expect less (and you know how to calculate less, right?).

The E is for engine instruments. Check to be sure they are all in the green. If not, abort and figure out why not.

The A is for airspeed. Airspeed should be alive and indicating properly. If not, abort and figure out why not.

C is for centerline. Keep the aircraft on the centerline. If you are unable, you have a problem with directional control either due to an excessive cross wind or some mechanical issue. Either way, abort and figure out what’s wrong.

T is for takeoff. As part of the pre takeoff briefing, you have a predetermined point on the runway by which time you should be flying. If you reach this point and you are not flying, abort and figure out what’s wrong. For most runways that we use, determining a takeoff point where we will abort if not flying is straight forward. We simply take the calculated takeoff distance with some margin (multiplying it by two is a good conservative estimate). However, for very short runways, the chosen takeoff point may not allow an abort without running off the runway (multi- engine pilots – think accelerate/stop distances). It takes discipline to abort a takeoff knowing you are going to bend metal. So, choose your takeoff point carefully on short runways. But aborting a bad takeoff is usually better than trying to get airborne when there is a serious problem.

For CAP, the acronym REACTT might be better where the second T is for transponder. Especially in the SFRA, we need to check to see that we are squawking altitude once in the air.

Lessons from AF447

On 1 June 2009, the pilots stalled an Airbus A330 serving the flight and then failed to recover, eventually crashing it into the Atlantic Ocean. There were no survivors. Many of us have read with horror the events in the cockpit of AF447 resulting in all crew and passengers losing their life in the Atlantic. Although flying a highly automated Airbus 330 is quite different from our CAP aircraft, there are still a few lessons that are worth noting.

- The aircraft was destroyed by a highly skilled and trained crew. There was nothing wrong with the aircraft, and except for a momentary loss of a few of the flight instruments, the aircraft flew into a cold ocean performing exactly as it was designed to do. This is unfortunately consistent with general aviation where pilot judgment is the number one cause of accidents.
- The crew was unable to think their way through a scenario that they had not encountered in training. Although what happened was not what they had been trained for, if the crew had exercised the most basic airmanship the flight would have continued quite uneventfully. In CAP, we train for the "usual" emergencies such as in-flight fire, low fuel, and so forth. But every flight is different, and we will face emergencies that we have not specifically trained for. That's when going back to basics is so critical. Aviate, navigate, communicate. And how about the three "P's" when faced with an emergency?
- Crew resources were mismanaged. Although they had been trained in crew resource management, neither the captain, nor the left seat pilot understood what the right seat pilot was really doing. We preach CRM in CAP, but let's be sure we understand what each of us is doing. Who is flying the airplane? Who is the PIC? Did you really tune the right frequency? Is the autopilot doing what you think it is doing? Did your observer really load the RNAV 24 approach or was it the ILS 24 approach? Check, crosscheck, confirm.
- And finally, let's not be too smug and fall into "It couldn't happen to me."

Articles for the National Stan Eval Newsletter:

These articles have been written to present ideas, techniques, and concepts of interest to CAP aircrews rather than provide any direction. The articles in this newsletter in no way should be considered CAP policy. We are always looking for brief articles of interest to CAP aircrews to include in this newsletter. CAP has many very experienced pilots and aircrew who have useful techniques, experiences, and tips to share. Please send your contribution to stephen.hertz@vawg.cap.gov

You can view past issues here.