



**Stan/Eval Newsletter
CIVIL AIR PATROL
UNITED STATES AIR FORCE AUXILIARY
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Forget About the Topographic Overlay

(Capt R. Dlugash):

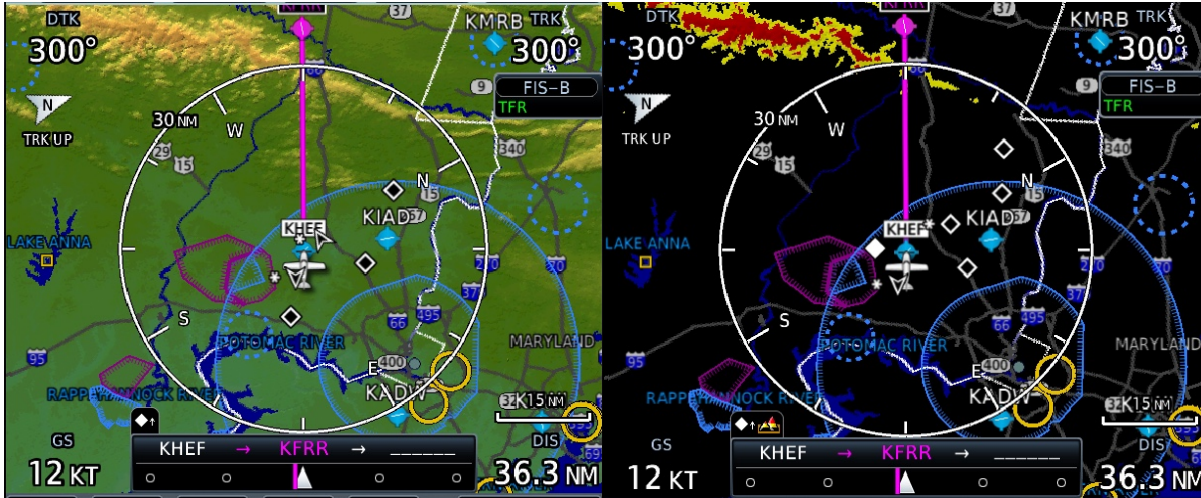
The map displays of Garmin avionics have changed the way we think about aviation. With highly customizable settings for what is displayed and at what range we want them displayed, there are thousands of configurations, and every pilot seems to have their unique preferences that tend to be the exact opposite of the next pilot who powers up the system. In many cases, the settings themselves make very little difference to us, whether we see a VOR radial ring at 10nm instead of 5nm, for example. However, one configuration that should be considered concerns the background topographic map.



My firm position is that pilots should leave this overlay off during routine flights. Here's why:

You can achieve better terrain awareness with the terrain overlay.

We know that the topographic overlay provides relative elevation information; a differently colored block indicates an elevation difference. The terrain overlay uses your aircraft's current altitude and compares it to ground elevation to depict terrain within 1,000 feet (yellow) or 100 feet (red). If your goal while flying is conformance monitoring (i.e., ensuring your planned flight matches your expectations), the terrain overlay is far superior.



Left: Topographic Overlay | Right: Terrain Overlay

Let's say you plan to clear the top of a peak by 1,200 feet during your preflight planning, and along your route of flight, you see some yellow depicted with the terrain overlay. The display is working for you by alerting you to a potentially risky situation. If you had the topographic overlay enabled in that exact scenario, the avionics would be doing nothing for you in terms of monitoring.



My method of operating the terrain overlay with G1000 is to always enable it on the inset map, which I leave decluttered to show traffic, my planned route, and airspace. I generally set up the main MFD map with weather depiction on, unless the flight route hinges on terrain avoidance for example, flying to an airport nestled in a valley, where heightened awareness would be beneficial. I use the terrain overlay for GTN750/650 type displays once airborne.

The topographic overlay interferes with important map object colors and violates many interface design principles.

Human Factors Engineering is the study of how humans interact with systems. An oft-cited and credible resource on the subject is *An Introduction to Human Factors Engineering*: Wickens, Christopher D., John D. Lee, Yili Liu, and Sallie E. Gordon Becker. *An Introduction to Human Factors Engineering*. Second ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2004.

Wickens et al. outline 13 design principles for display systems, some of which we violate when enabling the topographic map.

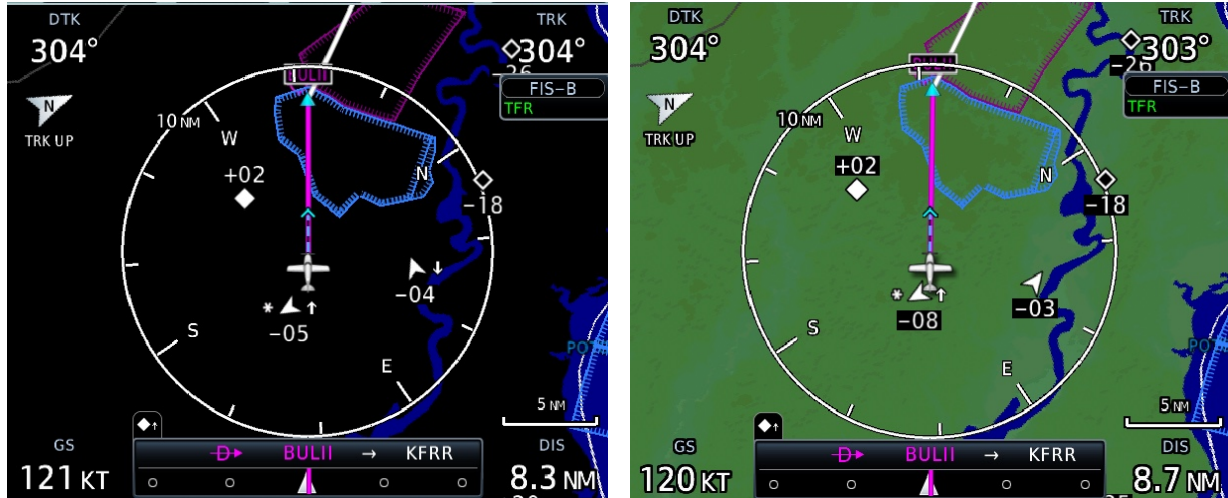
1. *Make displays legible (or audible)*. A display's legibility is critical and necessary for designing a usable display. If the characters or objects being displayed cannot be discernible, then the operator cannot effectively make use of them.

When the topographic map is enabled, the green (or yellow/brown) color interrupts the sharp contrast of white text on the ordinarily black background and reduces legibility. As the pilot increases zoom range, map complexity increases, and text legibility decays even further.

Here is my most compelling argument: if you want to avoid flying into restricted airspace, or a collision with nearby traffic (depicted as a yellow circle), having a green and yellow background is a sure-fire way to increase the mental resource required to detect that threat on your map.



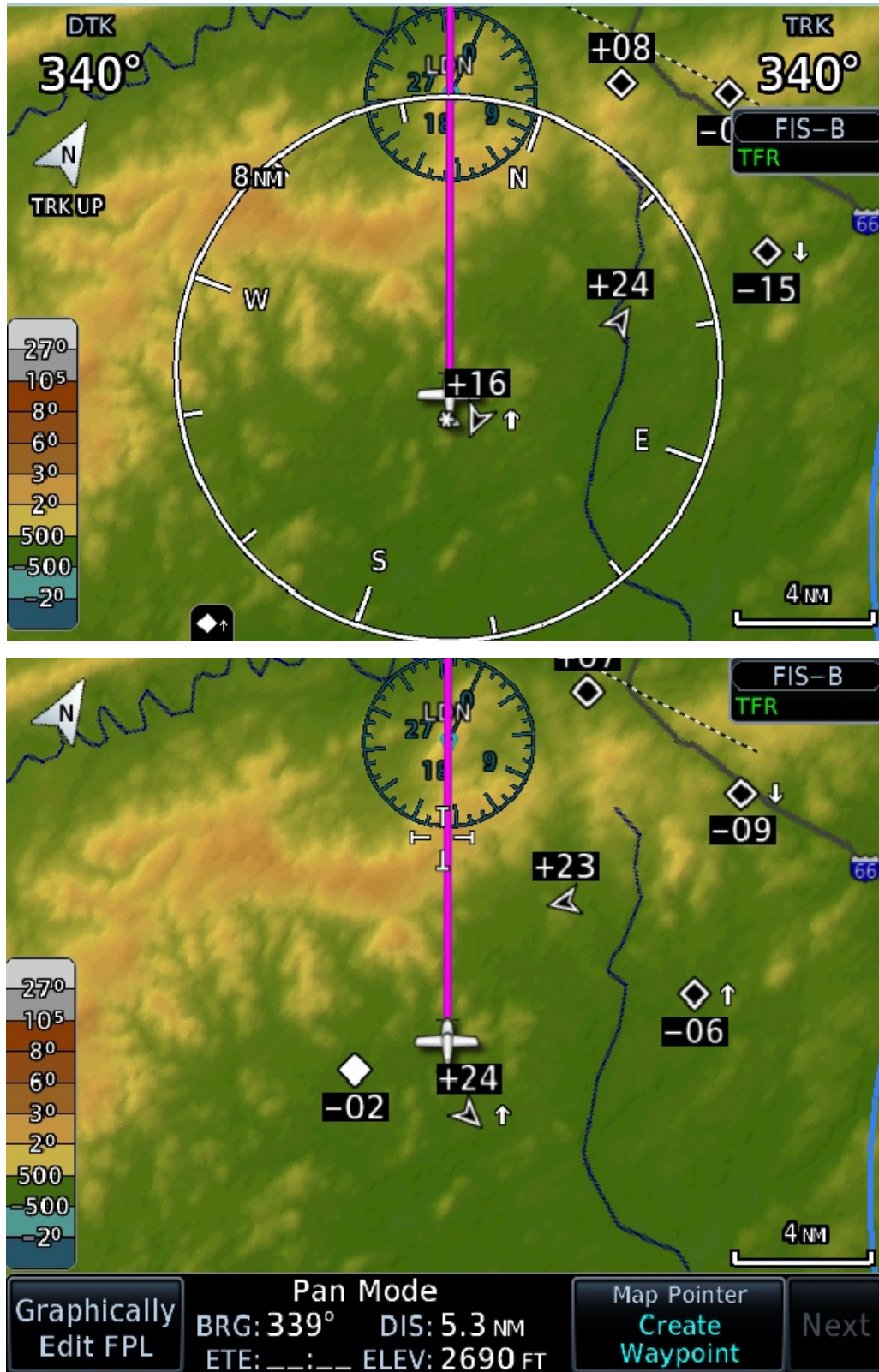
The yellow traffic symbology is easier to detect against a black background vs. a yellow one.



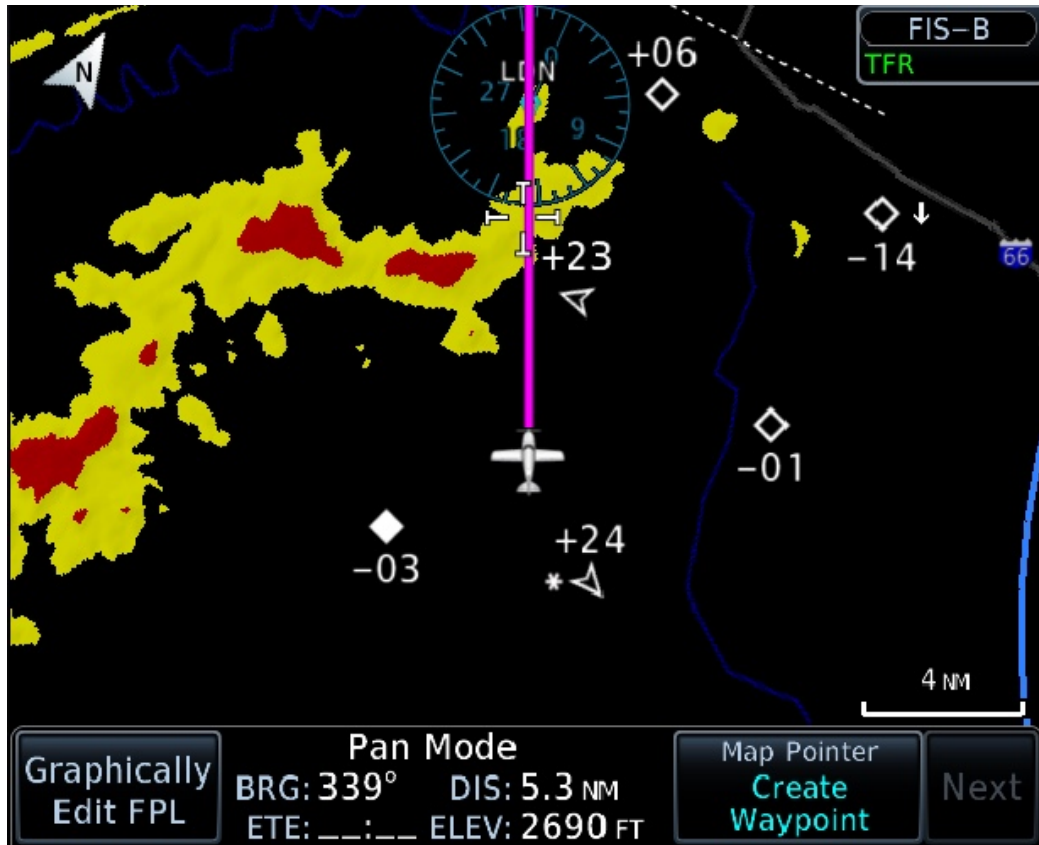
Restricted airspace is easier to see against a black background vs. a green one.

2. *Avoid absolute judgment limits.* Do not ask the user to determine the level of a variable on the basis of a single sensory variable (e.g. color, size, loudness). These sensory variables can contain many possible levels.

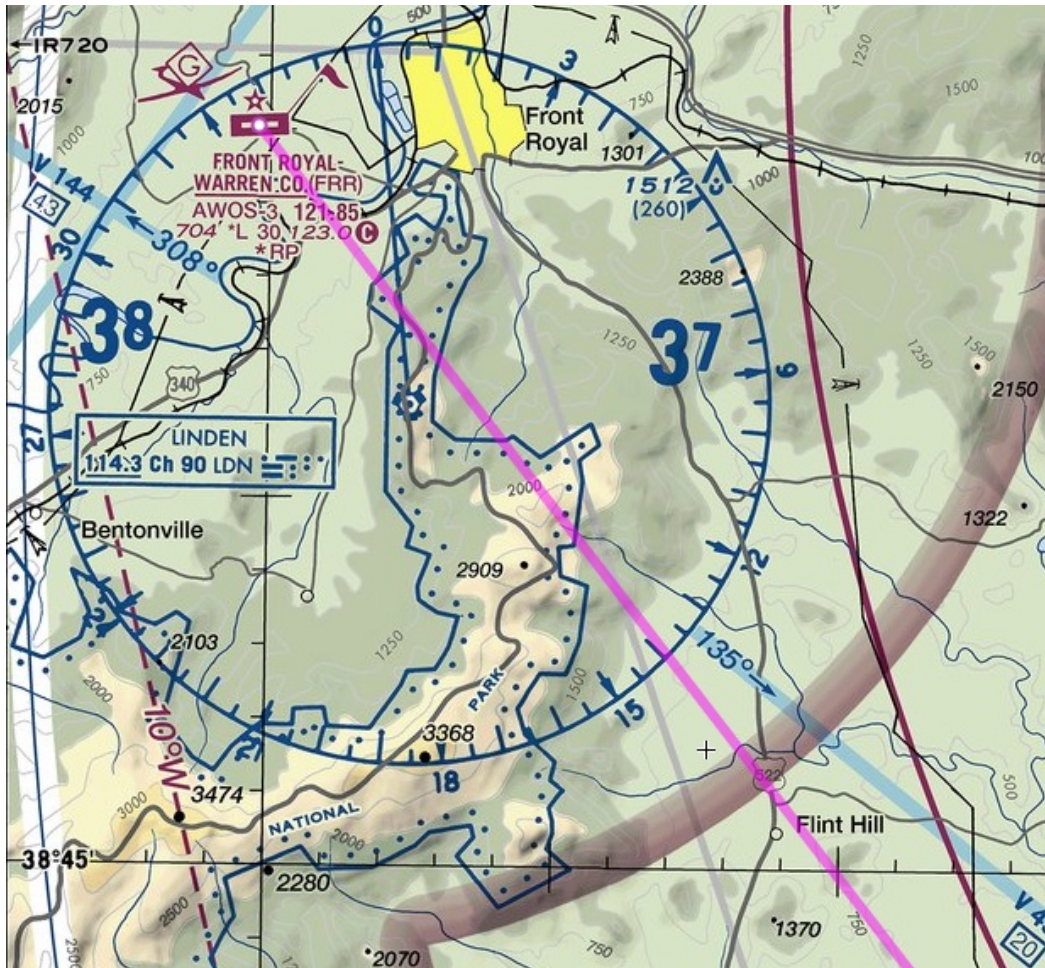
The topographic map promises to provide details about the ground elevation of an area you're flying over (or plan to fly over). However, the only method of coding this information on the overlay is color. If you want to determine the specific ground elevation for an area, you'll need to reference the legend or use the map cursor to read the spot elevation (a technique you can use without the topographic map enabled). Detailed contour lines and spot elevations make it easier to determine ground elevation when using printed sectional charts.



To determine the precise height of the upcoming peak, the pilot can place the cursor over the point of interest.



Pilots can use the same technique without the topographic overlay enabled.



Sectional charts contain detailed elevation information such as spot elevations and contour heights.

5. *Similarity causes confusion: Use distinguishable elements.* Signals that appear to be similar will likely be confused. The ratio of similar features to different features causes signals to be similar. For example, A423B9 is more similar to A423B8 than 92 is to 93. Unnecessarily similar features should be removed, and dissimilar features should be highlighted.

In many areas of the country, terrain is largely flat and there are very few peaks and valleys. In these areas, the topographic map displays essentially one color with some very minor differences displayed. Since (as we would expect) the legend doesn't update to accentuate these minor differences, the system presents pilots with a mostly mono-colored map with very subtle color differences in some areas. These "blocks" of subtle differences may likely confuse when glancing at them - is that block higher or lower? It would be much easier to observe a small peak on a sectional chart where the contour line and spot elevation indicate the ground elevation.



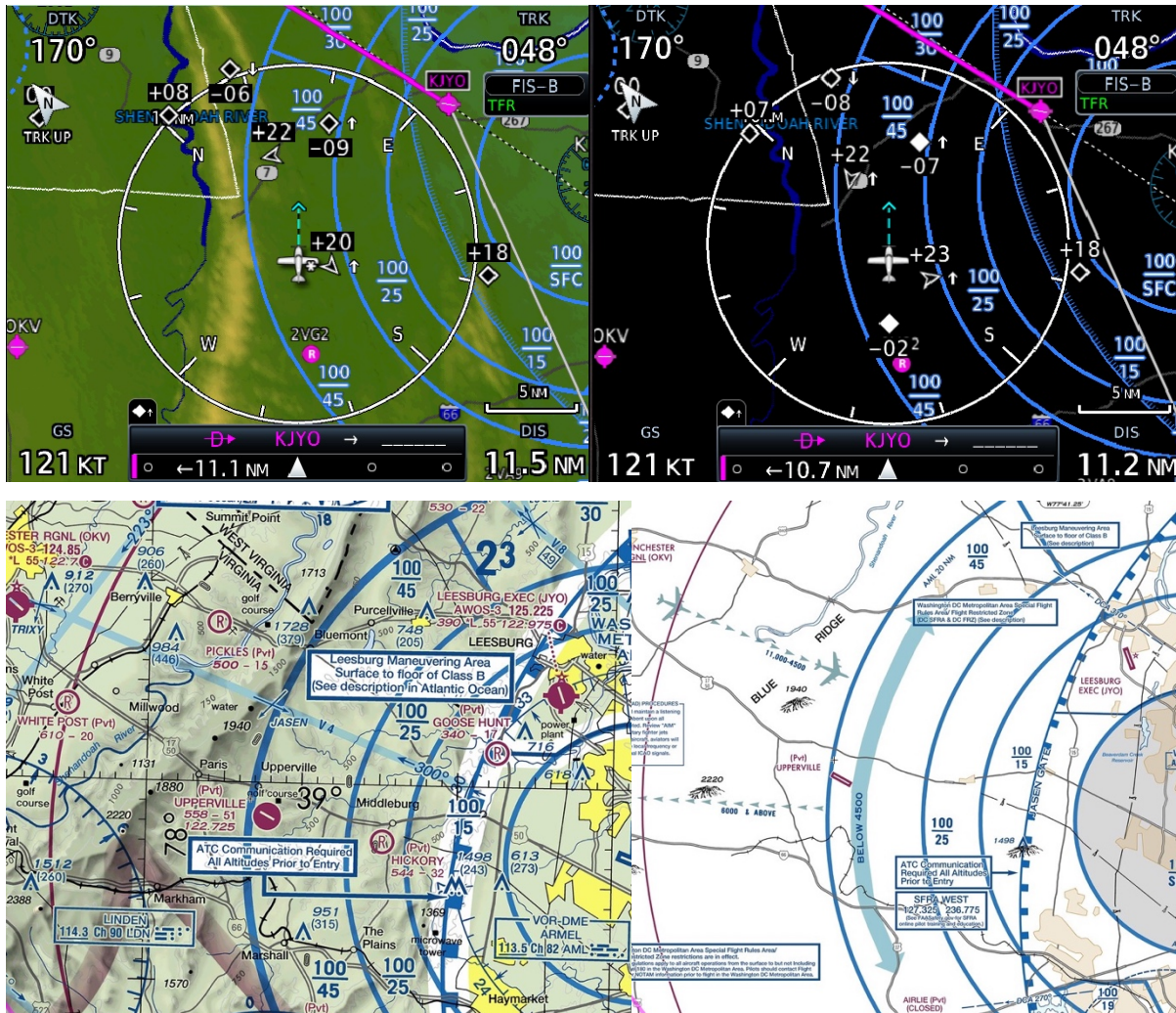
Is the lighter green color ground elevation higher or lower?

8. *Minimizing information access cost* or interaction cost. When the user's attention is diverted from one location to another to access necessary information, there is an associated cost in time or effort. A display design should minimize this cost by allowing for frequently accessed sources to be located at the nearest possible position. However, adequate legibility should not be sacrificed to reduce this cost.

If a pilot were referencing the topographic chart to determine the difference in elevation information, they can observe the color change in the map and, assuming they interpret the legend correctly, intuit the elevation variation without reference elsewhere. However, if the pilot intends to determine elevation using the overlay color, they must reference the legend elsewhere as there are no contour lines or spot elevations depicted on the overlay. An alternative would be to use the map pointer and elevation readout, as I mentioned, a tool that works without the topographic overlay enabled.

9. *Proximity compatibility principle*. Divided attention between two information sources may be necessary for the completion of one task. These sources must be mentally integrated and are defined to have close mental proximity. Information access costs should be low, which can be achieved in many ways (e.g. proximity, linkage by common colors, patterns, shapes, etc.). However, **close display proximity can be harmful by causing too much clutter.**

Why does the topographic map use green, yellow, and red to indicate terrain elevation? The designer correctly selected colors that replicated the FAA VFR chart elevation colors. The FAA recognized the proximity of **topographic colors** and **Class B airspace overlays**, so in areas where Class B airports exist, they publish FLY charts that preclude the use of terrain color. You can replicate the ease of detection gained by referencing a FLY chart by merely turning off the topographic overlay.



12. *Principle of predictive aiding.* Proactive actions are usually more effective than reactive actions. A display should attempt to eliminate resource-demanding cognitive tasks and replace them with simpler perceptual tasks to reduce the use of the user's mental resources. This will allow the user to focus on current conditions, and to consider possible future conditions. An example of a predictive aid is a road sign displaying the distance to a certain destination.

If we agree with the FAA's requirement that the primary means of obstacle and terrain avoidance will be visual scanning during VMC flight, then the most supportive display technology would only need to alert us if we were seemingly unaware of a threat to that objective. It is much more resource-demanding for a pilot to be continually scanning a display for a specific color relative to their current or planned altitude vs. observing an alert should they fail to prepare adequately.

If the “TERRAIN” overlay is selected on either the G1000 inset map or MFD/Display map while airborne, the pilot can focus on scanning visually out the window for obstacles and terrain, and if they observe yellow or red on the map, that proactive aid can direct their mental resources to mitigate the threat.

The information is useless compared to the detail of a VFR sectional chart.

To reiterate and summarize some of the points I've made about the differences between published VFR chart products and the Garmin terrain overlay, the lack of spot elevations and contour lines render the overlay useless in my view. The only information you get from the overlay is whether some terrain is higher or lower than the terrain near it. This information can quickly be learned either by:

1. Using the map pointer to move your cursor over a spot to determine its elevation
2. Enabling the topographic overlay to assess the difference in terrain then turning it back off

I can think of no case where, given its downsides, the overlay should be left enabled.

Using the map for navigation is forbidden by AFM anyway.

Here is a quick reminder of what the limitations section of many G1000 equipped airplane AFMs say:

Use of the NAVIGATION MAP page for pilotage navigation is prohibited. The Navigation Map is intended only to enhance situational awareness. Navigation is to be conducted using only current charts, data and authorized navigation facilities.

Use of the TERRAIN PROXIMITY information for primary terrain avoidance is prohibited. The Terrain Proximity map is intended only to enhance situational awareness. It is the pilot's responsibility to provide terrain clearance at all times.

You should confirm the language in the limitations section of the specific airplane you're flying.

Given we're required to take on the responsibility for terrain clearance using our eyes out the windows, what purpose does flying around with the topographic overlay enabled serve? Pilots should conduct adequate obstacle clearance planning well before they're staring at the moving map.

The information is useless when flying IFR.

It should go without saying; whatever path we're flying on while in instrument conditions should guarantee terrain and obstacle clearance. If your last line of defense from a collision with a mountaintop is the topographic overlay, I need to write a different article.

Lucky for us, the engineers at Garmin decided that when a weather overlay is enabled, the topographic overlay is disabled automatically. Indeed XM / ADS-B weather is a far more useful depiction while flying in IMC.

IMSAFE

We all realize that safety of flight depends as much on the pilot (or more) as the aircraft. So, we always preflight the pilot and crew using the IMSAFE acronym. Let's step through that to review what each item means.

Illness: The question is are we in good health. Hopefully, most of the time we are feeling fine and have no concerns. Other times we are down hard with a fever and other unpleasant symptoms making the decision easy. But there can be some grey areas. Suppose you are feeling a bit “off” but no fever or any other symptoms. Do you cancel your flight when a lot of folks are depending on you? Will you feel ok after that cup of coffee and the drive to the airport? Or is this just a precursor to a more serious condition? Are you also risking infecting your crew members? What if you are feeling fine but your back is pretty sore after rigorous workout the day before? You're not sick but are you fit to fly? Just like pre flying an aircraft, things are not always black or white. The best advice is to err on the side of caution.

Medication: There are two questions here in reality. The first is (1) are you taking a medication which would adversely affect safety of flight, and (2), are you NOT taking a medication which you are required to take for safety of flight. For many, the answer is pretty easy as most folks don't medicate on a regular basis. However, if you take an over the counter medication look at the label. If it has a warning about not operating machinery while using, that's a no go. The FAA recommends waiting at least five times the dosage interval before resuming flight. For some however, medication is required before flight. For example, many pilots are on blood pressure medicine which is required to keep their blood pressure under control. If you forgot to take your blood pressure medicine, you may want to defer flight till you do. Medication can be a tricky subject. The FAA website [here](#) has some useful advice but if in doubt, call your AME.

Stress: This is the most difficult to assess. If you are not under stress you are most likely dead or at least in a coma. Do you have a job? You are under stress. Do you fly for CAP? You are experiencing stress. And so on and so forth. A little stress is a good thing and can actually help performance. The question is whether the stress has reached a level that starts hurting performance vice enhancing it. Sometimes when you are over stressed it is obvious, but stress can build gradually and be difficult to assess. Unfortunately, CAP has not issued to its members a stress-o-meter as helpful as that would be. One of the best indicators however are those around you. They often can see stress in you before you do. Listen to them.

Alcohol: Finally, an easy one. Drinking and flying don't mix. Period. Eight hours bottle to throttle is a good rule of thumb. But even after eight hours if you are feeling any effects (read “hangover”) you are prohibited from flying. Many Part 135/121 operators use a 24-hour bottle to throttle rule and strictly enforce it. Of course, if you habitually have hangovers, you may have some more serious problems (like you are 18 years old) so go seek some help.

Fatigue: Back to the hard ones. This is especially difficult for mission pilots who may work all day and then be asked to fly a mission late at night (or early in the morning). The NTSB has a lot of accident reports that list fatigue as a factor. Yet, if you fly for FEDEX or fly internationally through multiple time zones, fatigue is always there. Unlike stress, a little fatigue does not help performance. But how many of us don't show up for work because we are a little tired? So, it's a tough call sometimes. A useful question to ask yourself is how long has it been since you got some sleep or better yet, a good night's sleep? Fatigue can be cumulative. You might get away with not much sleep for a short period but sooner or later it will catch up with you. But some sure signs that we need to cancel would be any difficulty driving to the airport because of fatigue or dozing off while waiting for the aircraft to be refueled. For some who know they are too fatigued

to fly, a couple of hours of sleep can do the trick. But in the long run that doesn't substitute for a good night's sleep.

Eating: OK this is a bit easier. Don't fly on an empty stomach. If you are expecting a bumpy flight, eat light but eat. Some folks use Emotion for this E but I consider that part of the Stress item.

CAPF 60-86

(LtCol M. Wormington)

Instructor pilots who are instructing cadets must complete the required information and obtain required signatures (cadet, parents, unit CC, group CC, Wing CC) on CAPF60-86 prior to beginning cadet flight instruction. This form must also be completed for cadets who have already begun and are currently receiving CAP flight instruction.

Giving a Proper Form 91 is Critical:

Unlike a Form 5 check ride, a Form 91 check ride is not testing the aeronautical skill of the mission pilot although aeronautical skills beyond the Form 5 are required. The purpose of a Form 91 is to ensure the mission pilot can safely and effectively execute CAP air missions. This of course includes ensuring that the pilot is a competent and safe pilot, but the emphasis should be on evaluating mission specific skills including:

- Mission planning skills
- Crew resource management to include the tasking associated with various missions
- ELT searches
- Visual searches
- Photographic missions
- Mountain operations (if applicable)
- Performance considerations
- Base operations
- Operational Risk Management
- Air/ground coordination (e.g. working with a ground team from the air)
- Mission specific equipment
- Weather considerations

Performing check rides is a sacred duty of every check pilot and must be taken very seriously as it is a critical part of our aviation safety. It is the single most important part of our quality assurance for CAP aviation. Signing off a mission pilot who really doesn't meet the standards is not in the best interest of anyone and could cause irreparable harm to CAP. Fortunately, check pilots get a lot of help in doing check rides correctly from very specific directions associated with the Form 91, to check pilots having to take an annual check ride. Although the check ride is a test, it should be approached as a learning experience both by the check pilot and the pilot being checked. Properly done, both pilots will be better mission pilots by the end of the ride.



As a check pilot you must demonstrate professionalism. This includes common courtesy such as being on time, being prepared, and all the other behaviors any CFI should exhibit. Be sensitive to the fact that a check ride is like going to the dentist for many pilots. Don't make it any more painful than necessary.

Prior to the Form 91 check ride, the check pilot should assign a mock mission to the pilot. The mission assigned should be designed to provide realistic scenarios for the pilot to demonstrate mission pilot skills. For example, looking for a particular landmark lays the groundwork for a visual search. One check pilot used an old overturned school bus to set up a scenario where the mission pilot had to fly a visual search for a crashed school bus with a last known position. Practice ELTs can be used to simulate crashed airplanes. The check pilot should note how well the pilot has prepared. Sloppy or incomplete preparation is not a good sign. Check rides have been terminated in the past simply because it became apparent the pilot wasn't ready (sometimes this is because the pilot did not understand how seriously CAP takes these rides). Check rides must be done in VFR conditions and preferably during the day. The check pilot should allow the pilot to make any go/no go decision unless the pilot is making an unsafe decision. Of course, in the case of a clearly bad decision, the check pilot should question the pilot's judgment and reconsider whether the individual is ready to be a mission pilot.

While it's important for the pilot to be examined to be properly prepared and ready, it is also important that the check pilot be prepared and ready. A poorly organized check pilot is a frustration to the pilot taking the check ride and reflects badly on CAP.

All check rides begin with an oral portion on the ground. The pilot should have done some homework including preparing a weight and balance, a plan for accomplishing the assigned

mission (this should include a partially completed e104), a thorough weather brief, an operational risk review, and a review of aircraft performance. A thorough review of aircraft performance is especially important if this is a Mountain Mission Pilot check ride.

Experience has shown that the many mission pilots and mission pilot candidates have little experience or knowledge about working with ground crews. This is a good topic for discussion.

A review of CAPR 60-3 must also be done. For a first-time mission pilot applicant, this should be very thorough while a long-time mission pilot may just need to review the latest changes.



The oral should include discussion of things the pilot might not ordinarily think about but can be a learning experience. Here are some questions to precipitate good discussions:

- “Can missions be flown at night or in IFR?” usually precipitates a good discussion.
- “Can you fly a mission solo (e.g. no scanner or observer)?”
- “How many horsepower will the airplane we are flying today produce at altitude?”
- “What’s your plan for dealing with an airsick crew member?”
- “What are the three biggest risks on today’s flight and what are you going to do about them?”
- “How much room do you need in the mountains to do a 180?”

At the end of the oral, the check pilot needs to be confident that the pilot is ready for the flight portion. If the pilot has convinced you that they do not grasp the fundamentals of missions, there is no point in wasting time and money on a flight to confirm what you already know. This is rare but does happen. Do your job and stop the Form 91 at that point. Give some honest feedback and offer some remedial training.



Although not on the F91 Form, reviewing some emergencies is a good thing to do. The purpose here is not to repeat the emergencies we are required to do on a Form 5. Instead, focus on emergencies that we often face in actual missions. Situations like an airsick crew member, worsening weather in the mountains, and other situations are good for discussion.

The rest of the check ride is done to accomplish the remaining tasks on the Form 91. During the check ride the check pilot should act as either an observer or a scanner to test the pilot's CRM. But make some mistakes to see if the pilot catches them – e.g. you should be a marginal scanner or observer. I usually plan to have a medical emergency sometime in the flight to see how it gets handled.

Often pilots come equipped with all sorts of electronic wizardry for a check flight from a handheld GPS to an iPad. It's ok to let them use these but it's also important to take them away for portions of the flight to ensure they can fly without them. Especially important is an evaluation of operating without a GPS. At some point in the flight, get them to demonstrate their pilotage, dead reckoning, and low tech (e.g. just a lowly VOR) navigation skills. It's amazing to me how many pilots fumble with a VOR. Emphasize to them that in a real national emergency, there will be no GPS, but we will be expected to maintain our level of effectiveness.

No check flight is complete without a thorough post flight debrief. What was done well and not so well? It's important to also ask for feedback on the check ride as well. Some of these pilots are themselves check pilots for the airlines and the military and may have some very useful insights and advice.

Take advantage of their knowledge. You should also ensure that the pilot understands how to enter their achievements into ops qual assuming they pass the check ride.

Finally, one of the fundamental items to evaluate and usually the hardest is judgment. Does this person exhibit good judgment? Are we comfortable letting this person fly missions in less than desirable weather with a crew onboard? Even if the pilot meets all the standards, it may be necessary to judge them unfit for CAP mission flying because of judgment. Tough call to make.

Articles for the National Stan Eval Newsletter:

The articles in this newsletter in no way should be considered CAP policy. These articles have been written to present ideas, techniques, and concepts of interest to CAP rather than provide any direction. We are always looking for brief articles of interest to CAP pilots 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

