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GPS — From VFR to IFR

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by Larry Anglisano

You've purchased a new-to-you airplane with a panel-mount IFR GPS -- but the placard reads "VFR-only." As Larry Anglisano explained recently in Aviation Consumer, you can upgrade your unit to IFR (but you may want to sell it and start from scratch). Here's what it'll take to make it happen.

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With the world of avionics changing faster than you can cycle a master switch, even those of us who deal with this stuff every day have our hands full keeping track of it all. What's new? What's best? And, increasingly, what's legal?

Because of the massive influx of new technology, there's a long tail of radios, navigators and displays stretching back more than a decade, leading many owners to ask us if the old RNAV, Ioran or even first-gen GPS they still have in the panel is legal for IFR.

Surprisingly, the answer is often yes. On the other hand, some recent installations we've seen of supposedly IFR-approved navigators aren't legal at all. They don't have the right components, lack the switching networks and the required paperwork can't be found.

As more used GPS units find their way to market, expect to see more of these installations in an airplane you might consider for purchase. Does it matter if it's legal or not?

It depends on what you plan to do with the airplane. In most cases, the legal nits don't matter on day-to-day, practical basis. If you file /G with a VFR panel-mount, you're unlikely to get busted -- but it's still not legal. And if you think you're buying an IFR navigator, make sure that's what you're getting, not a "VFR-only" installation.

VFR-Only

The number of VFR-only GPS navigators in the fleet is relatively high. Some are even "IFR approvable" but not legally certified. It's not uncommon to see something like an older Garmin GPS 155 or even a Bendix/King KLN90B -- both IFR units -- installed on the cheap, with a "VFR-only" placard somewhere on the panel. That might lead you to conclude that the placard is an artifact, left over from a previous installation.

Chances are, however, the IFR navigator was put in by an owner who just got a good price on it and had no intention of using it for IFR. The shop complied -- which it can legally do -- and put the placard on the panel, thus avoiding the time and expense of an IFR flyoff and the additional paperwork.

Some owners, upon discovering this, assume that since they have an "IFR-approvable" GPS, getting it officially blessed for legal IFR is a piece of cake. Sometimes it is, but usually it's not. Nor is it cheap. Let's examine what's required.

Keep in mind that every airplane is unique and we see all kinds of strange scenarios that suggest that what works for one won't always work for another.

TSO Or No TSO?

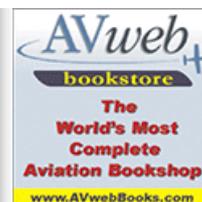
As with most other avionics equipment, GPS units and their components are built to a TSO specification and, in the world of GPS navigators, the two most important are TSO C129 (A1) and TSO C129 (A2) -- A1 being en route, terminal and non-precision approach-certified while the A2 versions allow en route and terminal navigation only, no approaches.

There are some en route only boxes out there, such as the UPSAT GX-55 and some versions of Garmin and Bendix/King navigators, that weren't signed off for approaches in the particular airplane they were installed in.



[Click any image for a larger version.]

At a quick glance, both of the Garmin navigators shown here appear to be identical. Yet the 150XL, top, is a VFR-only GPS while the GPS 155XL, lower, is IFR approved. However, that doesn't mean it was certified for IFR in the aircraft it was installed in. Check the logs and AFM to find out if it's legal.



What's the difference between en route and terminal operations? CDI scale, mainly. The terminal mode allows a 1-mile scale while en route is 3 miles.

The IFR TSO is quite specific about what an IFR navigator is supposed to do and how it must be installed. Some of the specifics include one-second position updates, fixes stored in a non-corruptible database, pilot selectable CDI sensitivity, RAIM integrity alarms and paths between fixes defined only by TO-TO navigation.

Now, if your TSO'd receiver has the official approved designation, it will do all this stuff and a lot more. But unless it's installed with all the required annunciators -- including the required coupling to a CDI-- it may not be IFR-legal.

Sometimes, a box that looks just like an IFR-approved navigator isn't. For example, you can put two physically identical GPS units-- the Garmin GPS150XL and the GPS155XL --side by side. The difference is that the GPS155XL is blessed with TSO C129 (A1) while the GPS150XL isn't, falling under AC 20-138 for VFR-only guidance.

Similarly, before it made the KLN89B and the KLN90B -- both IFR-approved navigators -- Bendix/King had VFR-only versions.

To qualify for installation approval, the GPS sensor or antenna must also meet the TSO. Some of the earlier Bendix/King KLN90 navigators, for example, had a non-TSO antenna system. After all, they weren't IFR boxes so they didn't need a TSO'd antenna. Don't assume that you can use the existing antenna with any IFR navigator. Have your shop check the part numbers before proceeding with an upgrade.

Transplant It

Our advice is that, if you're in the market for a quality used IFR system, find an entire system that was removed from the same aircraft and purchase all components as a package. For example, the aforementioned IFR KLN90A/B can be had on the used market quite reasonably, complete with the required annunciation control panels and appropriate antenna removed from the very airplane it was approved on before.

While on the subject of antennas, the shop may want to replace any cable you already have in place. Let them. Although the existing cable from a VFR installation will likely work for feeding signal to the receiver, low-loss coaxial cable is required and for good reason.

You're guaranteed top performance with the bonus and flexibility for longer cable runs with minimal signal loss. Most common is the expensive RG142 coax and, if you don't have it already, it should be added to meet the IFR criteria.

With some navigators and applications, an RF signal notch filter, appropriate for the 1.5GHz band, should be installed to provide uninterrupted GPS signal flow. These filters were imperative with many earlier GPS systems and your shop may recommend one.

As a side note: with panel and fuselage space often tight, optimum placement of components is an ever-increasing challenge. Major manufacturers are learning what works well and not so well with different airframes and/or when mixing equipment. You can only hang so many antennas on a airplane without conflict. Even with the best possible combination of placement, outside factors such as noisy strobes and beacon power supplies will make their presence known, even if they have previously caused no problems.



Two must-have items for most GPS IFR installations include a TSO'd antenna, top, and a remote annunciator / switching panel, such as the MD41, lower photo. Some navigators have self-contained annunciation.

The Baro Connection

It's a 50/50 deal whether that old beater VFR GPS currently in your panel talks to your altitude encoder -- but your new IFR GPS will have to.

Altitude information must be fed to all IFR installations from an encoding altimeter or blind encoder. Why? Because the altitude feed is necessary for RAIM computations and is also used in conjunction with navigators that have VNAV descent profile features.

Most common altitude encoders output "gray code" data format altitude information. However, some navigators -- the entire line of UPSAT/Apollo units, for example -- accept only serial data, a more precise data stream.

In these cases, either an appropriate serial encoder must be installed or a gray-code-to-serial "happy box" converter will be needed.

The point is, while better shops go the extra mile to provide the baro interface to even VFR boxes, some shops don't bother. Plan for it if you want an IFR-approved system.

Similarly, if the transponder/encoder system is getting tired, now's the time for upgrade because there's little room and tolerance for marginal equipment when interfacing IFR GPS. As we have reported, newer transponders such as the Garmin GTX327 and UPSAT SL70 output altitude data in either serial or gray code format for the purpose of feeding a navigator. It's nice to have the choice but it'll cost money to get there.

Remote Hardware

**En Route Only
or Approaches, Too?**

All IFR installations require varying degrees of remote annunciation, except the Garmin GNS530/430 and Bendix/King KLN94 in which annunciation is integral to the navigator. But when remote annunciation is required, it must be positioned within the pilot's normal instrument scan.

These mode annunciators and control switches advise the pilot of any messages transmitted from the navigator and appropriately arm and activate the approach, if the navigator is approach-capable.

Also required for both en route or approach certification is a course deviation indicator which displays GPS navigator left/right and nav flag information. This can be accomplished with most HSI systems and many options are possible for interfacing with rudimentary nav heads, as we reported in the March issue of Aviation Consumer.

In any case, if your existing VFR GPS doesn't display steering information on a remote head, this will be the most costly part of getting it approved for IFR, assuming it's a TSO'd box.

The Paper Chase

Now that IFR GPS has become relatively routine, most FAA FSDOs seem to know what's required to make these systems legal. We don't hear many horror stories about FSDOs requiring a \$10,000 contract to a DER to write a POH supplement. However, there's no question that some FAA regions are quicker at IFR approvals than others.

We polled several shops on both coasts and most report that the IFR GPS approval process and satisfying the expected criteria usually goes without a hitch. What's important is that approval paperwork is clearly drafted and all the details appropriate to the installation are noted.

System integrity has to be proven and all of the hardware and interfaces we've described here must be referenced.

Most shops that routinely turn out IFR GPS installs aren't running into snags with the FAA. Buyers should remember that until it's officially approved, the system is to be used for VFR navigation only and placarded accordingly. Consult with your shop beforehand and review the exact procedure for your region.

Generally, what FAA offices seem to want is proof of absolute system integrity. Most owners underestimate the amount of paperwork and testing required for an IFR GPS, whether approach or en route-certified. A Flight Manual Supplement is drafted and this booklet is specific for each installation. It describes all aspects of the GPS installation and includes general system information and specifications, emergency operating procedures in case of malfunction, system limitations, normal procedures, proof of flight testing and applicable FAA paperwork, such as FAA Form 337.

Most FSDOs are specific about flight test data. If the navigator is approach-approved, multiple GPS/overlay approaches must be flown to prove that the system will navigate the approach and the missed procedures. If the navigator is interfaced with an autopilot, it must also be proven that the autopilot will fly correctly. Other parameters include passing through fixes within a specified degree of accuracy and proper interface with existing on-board stuff, including a radio interference test.

Once the Flight Manual Supplement is approved by the FAA and the shop, it has to remain in the aircraft at all times, since it's part of the AFM.

We're not sure how interested the FAA is in enforcing these fine points in the regulations. Theoretically, if you fly an IFR approach and are ramp checked and found wanting in the paperwork department, it's no different than getting ramped without having required weight and balance aboard the aircraft. According to our polling there have been violations, but we don't know how often it has happened. We don't think it's a good idea to ignore these legalities, but it's your ticket.

If the navigator and/or installation are certified for only VFR, a placard must be installed on the instrument panel that says as much. We've even heard of folks failing an IFR ride because they filed a /G plan without having the GPS approval paperwork. We assume the examiner was paying back the applicant back for weaseling out of the ADF portion of the test.

Conclusion

Although system certification has become straightforward, we have seen many instances in which a customer has purchased an aircraft that was represented as being IFR GPS-equipped, only to find that the documentation was missing.

Either the seller had an IFR system slapped in to make the aircraft more attractive but never followed through with the certification paperwork or the

When making the switch to IFR from a VFR install or buying a new or used navigator, many owners struggle with the question of certifying for enroute only or enroute and approaches.

As always, the cost Delta comes into play and when it's all added up, it almost always makes sense to opt for full approach certification, if there's a choice.

As far as the legalities are concerned, if you have an (A2) box -- enroute/terminal only -- you can freely use it as a DME substitute, for off-route IFR navigation and to substitute for ADF on ADF-required approaches. DME substitution also applies to precision approaches.

The good thing about an (A2) box is that you needn't have a current database for legal IFR navigation. You're allowed to use current paper charts to check fix accuracy. (As if anyone actually does that.) For approaches, you'll need a full-up (A1) box, installed with all the remote hardware, flight checked and with an approved AFM supplement. We're quite certain there are owners out there flying approaches with properly installed IFR GPS that isn't legally approved. If you're picky about such things -- we are -- get the flyoff and paperwork done.

If your existing GPS is VFR-only, it's probably what we call standalone, meaning it doesn't drive a CDI and/or it isn't interfaced with the altitude encoding system.

To make it en route or (A2)-approved, a flight test will have to be done and a Flight Manual Supplement prepared and you'll still need mode annunciator lights. So the steps and equipment required to make it IFR-legal are similar whether you go C129 (A1) or (A2). Of course, if the navigator is only approved to C129 (A2), such as the UPSAT GX55, you'll have no choice other than another navigator entirely.

Some owners have suggested that an approach-approved navigator be interfaced for en route and terminal only, in hopes of saving some money. But that makes little sense. Get a quote for both options and you'll see why.

And last, if you're still on the fence about the IFR versus VFR issue, but want to install a GPS navigator, buy a box that's TSO C129 (A1) approved. You can always add the required accessories and interface later on. The cost difference between a basic VFR versus basic IFR navigator is surprisingly little. It's the interface and accessories that drive the cost up.

work was done and never filed properly. We have also worked on a few factory-new Mooneys, going back to the early 1990s, that were represented as IFR GPS-equipped but didn't have appropriate annunciation for the GPS system. Somehow, they slipped off the assembly line unfinished.

In any case, expect your shop to proceed through the installation with a fine-toothed comb because they're accepting responsibility for the integrity of the system.

In short, making an IFR system out of a VFR system can be relatively painless or a nightmare, or anything in between. In many cases, it may actually be cheaper and more practical to buy a used transplant system and keep the VFR GPS in the panel as back-up -- or sell it on the used market and apply the proceeds to the IFR installation.

About the author...

Larry Anglisano is the Aviation Consumer avionics editor. He works with EXXEL Avionics in Hartford, Connecticut, where he does GPS flyoffs, among other tasks.