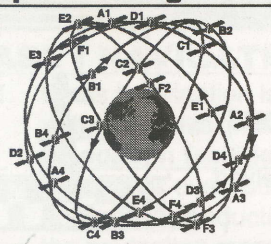


Certain **communications frequencies** have been known to cause **harmonic interference**, which may have an adverse effect on the reception of a **GPS** signal. These frequencies include **121.15**, **121.175**, **121.200**, **131.250**, **131.275** and **131.300** MHz. (AC 20-138)

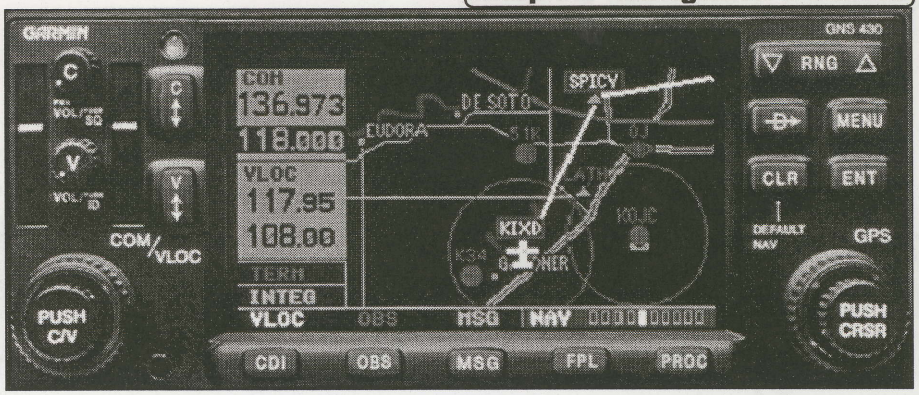
GPS — Global Positioning System: (AIM 1-1-21, 1-1-22, AIM table 1-1-8, AC 20-138, TSO C129)

1. A GPS receiver automatically selects signals from the satellites in view. Based on continuous knowledge of the position of each satellite — with respect to precise time and distance from each satellite — the receiver translates this information into three-dimensional position, velocity and time. As an example of how accurate the timing is — if the measurement were **1/1000th of a second off** — there would be a **186-mile error** in your location, or approximately **one foot error per billionth of a second**. Location is calculated by comparing the known time that the signal is broadcast by the **atomic clocks** in the satellites, with the actual time of reception, aka **T**ime **O**f **A**rrival (**TOA**) ranging.
2. The main GPS system is made up of **24 satellites** (plus a few spares) — **4 of which must be received** by your unit to yield a three-dimensional position and time solution. They orbit the earth twice a day at an altitude of **11,000 miles**. At least 5 satellites are in view at all times from virtually any point on earth.
3. Each satellite transmits its own "pseudo-random code". The receiver is programmed to recognize the code and match it to the specific satellite. The receiver does this with at least 4 different satellites as it simultaneously updates its own internal clock bias. The receiver then converts the time lapse of each satellite's signal into a precise distance measurement. Simple eh!
4. GPS is a **VERY high maintenance** system. The satellites require regular clock upkeep, orbit position adjustments, and data uploads. If the ground support team (the U.S. Air Force) went on strike, the system would degrade and become completely **unusable** within a couple of **weeks**.
5. **R**eceiver **A**utonomous **I**ntegrity **M**onitoring (**RAIM**) continuously monitors the (IFR certified) unit in your aircraft for ***integrity***. A **RAIM** error message is a way of warning the user that there is loss of accuracy, whether due to solar interference or intentional signal jamming. If a **RAIM** error message appears on your GPS, it's time to go to "Plan B" for a while. Contingent on the **T**echnical **S**tandard **O**rder (**TSO**) that the unit was certified under, some GPSs can still be used in the RAIM error mode if the waypoints are manually verified.
6. GPS provides **"Great Circle Track"** navigation.
7. Units with "**P**recise **P**ositioning **S**ervice" (**PPS**) capability can expect **accuracy** to **16 meters** (**52 feet**). With "**S**tandard **P**ositioning **S**ervice" (**SPS**) turned on, only a **100-meter** (**328 feet**) accuracy can be expected. PPS was originally intended only for the military but is now available to all users.
8. A study commissioned by the DOT has shown that GPS is susceptible to **occasional disruption** from **atmospheric effects**, **signal blockage** from **buildings** or **mountains** as well as deliberate GPS interference caused by cheap, pocket-sized **"JAMMERS"**. Long-term outages could be caused by hostile actions far less overt than full-scale war. Another danger is **"SPOOFING"** of the signal. False GPS signals could be transmitted, which could slowly divert an aircraft off course unbeknownst to the pilot. For these reasons the DOT "Volpe study" has recommended a continued backup system including VOR/DME, ILS, LORAN-C and Inertial Navigation Systems.
9. The most **critical** GPS **deficiency** is its extremely **low-powered signal** and its **single civil frequency** (1575.42 MHz). These deficiencies would be corrected when GPS III is commissioned sometime between 2012 and 2015. **GPS III** will transmit at much **higher power** over **two** dedicated civil **frequencies**, which will virtually **eliminate** natural **interference** and overcome cheap jammers.
10. A **"worm hole"** is an FAA term for a point where the GPS unit is coincidentally equidistant from four satellites, and for a short period of time the unit may not be operational.
11. An IFR-certified **GPS** (with a current database) may be used as a **substitute** for **DME** and **ADF** in all operations except NDB approaches that do not have a GPS overlay. [AIM 1-1-21f.5.]
12. An IFR certified GPS is required to have a separate **C**ourse **D**eviation **I**ndicator (**CDI**) located in the pilot's primary field of vision. (AC 20-138)
13. IFR certification requires a **FLIGHT MANUAL SUPPLEMENT** that must be on board the aircraft.

When flying an aircraft with an approach certified GPS — **if** an **alternate** is **required** — the alternate **must have** available a **non-GPS approach** and the aircraft must be equipped so as to be capable of executing that approach.

ADF / GPS: [AIM 1-1-21f.5.(a), 1-1-22, AIM table 1-1-8] An IFR-certified **GPS** (with a current database) may be used as a **substitute for DME and ADF** in all operations except NDB approaches that do not have a GPS overlay.

An **IFR certified GPS** with an **EXPIRED database** can **still be used** for **IFR enroute** and **terminal** operations, **but not approaches**.
Requires verification of data from current enroute and/or terminal charts.
(AIM Table 1-1-8)



GPS — IFR Direct with a VFR GPS: [91.205(d)(2), AIM 5-1-7]

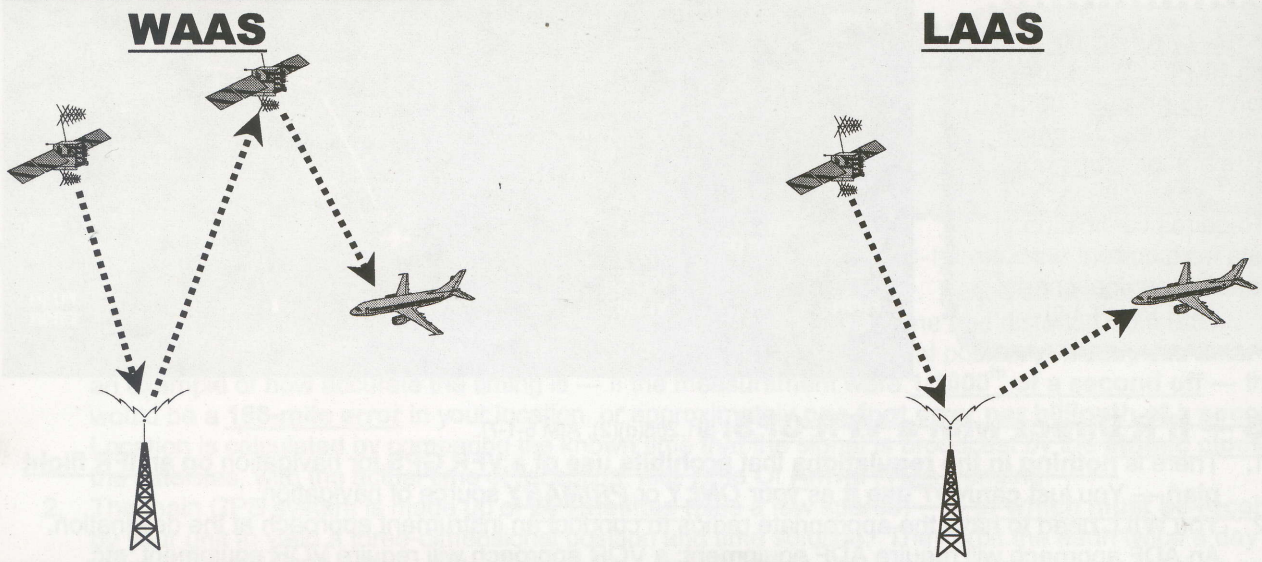
1. There is **nothing in the regulations** that **prohibits use of a VFR GPS** for navigation **on an IFR flight plan** — You just **can*NOT* use it** as your ***ONLY*** or ***PRIMARY*** source of navigation.
2. You WILL need to have the appropriate radios to conduct an instrument approach at the destination. An ADF approach will require ADF equipment; a VOR approach will require VOR equipment, etc.
3. **ENROUTE** — **As long as you're in** a ***RADAR*** environment, **you can legally file direct** to the destination. It is legal to use dead reckoning for portions of any IFR flight. There are still many airliners out there—without area navigation—that ask for and receive direct headings on a daily basis, staring at VOR flags for long periods of time. Think of the GPS as a form of **super-accurate dead reckoning**. It's a good idea to have the **maps** out and **cross-radial** off the passing **VORs** just to keep things honest. This is especially helpful if the GPS decides to go to lunch and doesn't invite you.
4. **APPROACH** — You **canNOT use** the VFR **GPS** (or an IFR certified GPS that does not have a current database) as the **PRIMARY source of navigation** for an **instrument approach**. But it certainly makes a great backup for situational awareness.
5. **FILING** the **FLIGHT PLAN** — Unless the GPS is IFR certified **do *NOT* file as /G**. **/G tells them** you have an **IFR certified GPS** with **Enroute** and **Terminal** (approach) capabilities (AIM 5-1-7). Always file the correct Equipment Suffix for your aircraft, usually **/U** or **/A**. If you want, in the remarks section, you can mention the fact that you have a GPS on board. **File direct** to your destination, but be ready with the **latitude** and **longitude**, FSS personnel will appreciate you having that information handy.
6. If you are navigating with VORs, you have to be within the standard service volumes (AIM 1-1-8). The exception is, if you are in **RADAR CONTACT** (which you would have to be so as to fly off-airway routing anyway), **standard service volumes don't apply**.
7. If you hear the question, **"HOW ARE YOU NAVIGATING DIRECT, WE SHOW YOU AS A SLANT UNIFORM?"** Simply state **"WE HAVE GPS ON BOARD."** You didn't lie. You didn't say you were slant Golf. You just said you had GPS. The controller doesn't care if you spent the extra $8,000 to get it "IFR certified", he just wants to know if you're gonna make his life simple or complicated. Keep it simple! The controller couldn't care less about your legal status other than how it affects his operation.

REMEMBER:
A handheld or "VFR" GPS can*NOT* be used as your "PRIMARY" source of navigation, but it certainly can be used for — and is acceptable to provide — "situational awareness."

So... keep those VOR & ADF radios on and keep reminding yourself that they are your "PRIMARY" source of navigation.

1. If your GPS is **hardwired** into the system, a FAA **337 (Major Repair & Alteration) form** is **required**. If it's plugged into the **cigarette lighter**, the 337 form is **not required**.
2. If a **tool** is used to mount the GPS, a **337 form** is **required**. If it's just simply **clamped** to the yoke or attached with **Velcro**, the 337 form is **not required**.

Also comes in handy for the drive to the motel.



Wide Area Augmentation System — WAAS:

1. A satellite navigation system consisting of **ground equipment** and software, which **augments** the **GPS** **S**tandard **P**ositioning **S**ervice (**SPS**). The WAAS provides enhanced integrity, accuracy, availability, and continuity over and above GPS SPS. WAAS **improves** the **accuracy** of the navigation system by **determining** position **error** from the GPS satellites by use of **G**round **R**eference **S**tations, then **transmitting corrective factors** to a geostationary **satellite**, then on to your **airborne GPS** receiver.
2. WAAS will **allow GPS** to be **used**, from **takeoff** through **Category I precision approach**.
3. Unlike traditional ground-based navigation aids, the WAAS will cover a more extensive service area. **W**ide-area ground **R**eference **S**tations (**WRS**) will be **linked** to form a **US WAAS network**. These precisely surveyed **GROUND REFERENCE STATIONS** (about 25 in the US) **receive signals from GPS satellites** and any **errors** in the signals are then **determined**. **Each station** in the network **relays** the **data** to a **W**ide-area **M**aster **S**tation (**WMS**) where **correction information** for specific geographical areas is **computed**. A **correction message** is prepared and **uplinked** to a **geostationary satellite** (**GEO**) via a **G**round **U**plink **S**tation (**GUS**). The **message** is then **broadcast** on the same frequency as GPS (L1, 1575.42 MHz) to **WAAS receivers** within the broadcast coverage area of the WAAS.
4. The **WAAS** broadcast message **improves** the GPS **signal accuracy** from 100 meters (328 feet) to approximately **7 meters** (**23 feet**) 95% of the time (it's the other 5% they're a little concerned about).
5. Planned **expansion** of the U.S. ground-station network will eventually include other countries such as **Canada**, **Iceland**, **Mexico**, **Panama**, and beyond. Additionally, **Japan** and **Europe** are building similar systems that are planned to be interoperable with the U.S. WAAS. The merging of these systems will create a worldwide seamless navigation capability similar to GPS, but with greater accuracy, availability and integrity.

Local Area Augmentation System — LAAS:

1. A **D**ifferential **G**lobal **P**ositioning **S**ystem (**DGPS**) that improves the accuracy of the system to *sub-meter levels* by **determining** position **error** from the GPS satellites at a **fixed**, **local ground station** on the **airport**, then **transmitting** the error, or **corrective factors**, to the **airborne GPS** receiver.
2. When a LAAS unit is installed at an airport, it will serve all runways at that airport with the **potential** of **CAT III**, **autoland** minimums in **any visibility** to **each runway**. The short-term goal is not to replace ILS but to provide precision approaches at airports where local terrain makes ILS equipment unsuitable.
3. LAAS can be used to create **curved approaches** involving numerous approach paths within 30 miles of the airport. The promised but long forgotten dream of the MLS system.
4. The LAAS **ground based monitor** can be installed at an airport for about the **price** of a **single ILS**, but can potentially **provide precision approaches** to virtually **all** of the airport's **runways**.
5. The **signal** can also **be used at reliever airports** close by to develop **non-precision approaches** without the cost of expensive ground equipment.
6. In addition, a **P**osition **V**elocity **T**ime (**PVT**) profile shared by controllers, aircraft and ground vehicles should keep runway incursions to an absolute minimum (you can never totally remove human error).
7. The objective of the FAA is to install approximately 143 LAAS units throughout the country at locations served by the airlines.