GPS Operations Under IFR

Terms
1. **DTK—** Desired Track; Desired magnetic course between waypoints.
2. **TRK—** Track; Current magnetic course of an aircraft relative to ground (ground track).
3. **BRG—** Bearing; Compass direction from present position of the aircraft to a waypoint.
4. **RNAV—** Area Navigation; Method of navigation which permits aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids.
5. **RAIM—** Receiver Autonomous Integrity Monitoring; A system used to verify usability of GPS signals and warns pilot of any malfunction. **Required for IFR-certified GPS units.**
6. **WAAS—** Wide Area Augmentation System; A system that improves the accuracy of GPS by determining position error from satellites, then transmits error/correction to airborne GPS receiver.
7. **VLOC—** VOR/Localizer Receiver Mode
8. **APV—** Approach with Vertical Guidance
9. **LP—** Localizer Performance (*no vertical guidance*)
10. **LPV—** Localizer Performance with vertical guidance
11. **LNAV/VNAV—** Lateral Navigation/Vertical Navigation
12. **Baro-Aiding—** Integrity monitoring that allows GPS to use non-satellite input source (aircraft static system) to provide vertical reference. Reduces RAIM requirement of 5 satellites to 4.
13. **FAWP—** Final Approach Waypoint
14. **MAWP—** Missed Approach Waypoint
15. **GNSS—** Global Navigation Satellite System
16. **FDE—** Fault Detection and Exclusion; ability for system to exclude a faulty satellite and maintain RAIM (requires 6 satellites)

General Requirements (AIM 1-1-18; 1-1-19)				
	Preflight	**Enroute**	**Approaches**	**Alternates**
RAIM	- Verify RAIM - Alternate must have non-GPS approach - GPS Database up-to-date: Every 28 days	Requires backup equipment for route of flight	LNAV, LNAV/VNAV (requires baro-VNAV, possible temperature restrictions)	- FDE only— Either primary destination or alternate may use GPS approach, but not both. - Non-FDE— if alternate required, must be planned off non-GPS IAP
WAAS	- GPS Database up-to-date: Every 28 days	None	LNAV/VNAV, LP, LPV	Must plan alternate based on LNAV minimums

Principle of Operation (AIM 1-1-18; 1-1-19; IFH 9-25)
● Satellite-based radio navigation; receiver tracks multiple satellites and triangulates position. ● Minimum of 4 satellites required for 3D position. ● RAIM verifies integrity (usability); 5 satellites required for RAIM (or 4 with baro-aiding). ● GPS Substitution— GPS may be used as a substitute for ADF and DME receivers for the following: 　○ Determining position over DME fix 　○ Flying a DME arc 　○ Navigating TO/FROM an NDB, determining position over an NDB, holding over an NDB

GPS Sensitivity		
Enroute	**Within 30 NM straight line distance of airport/heliport**	**Within 2 NM of FAWP**
±5 NM of centerline	±1 NM of centerline	Gradual change from ±1 NM to ±0.3 NM at the FAWP (WAAS approaches are normally scaled to 700 feet at runway threshold)

WAAS Basic Principles of Operation
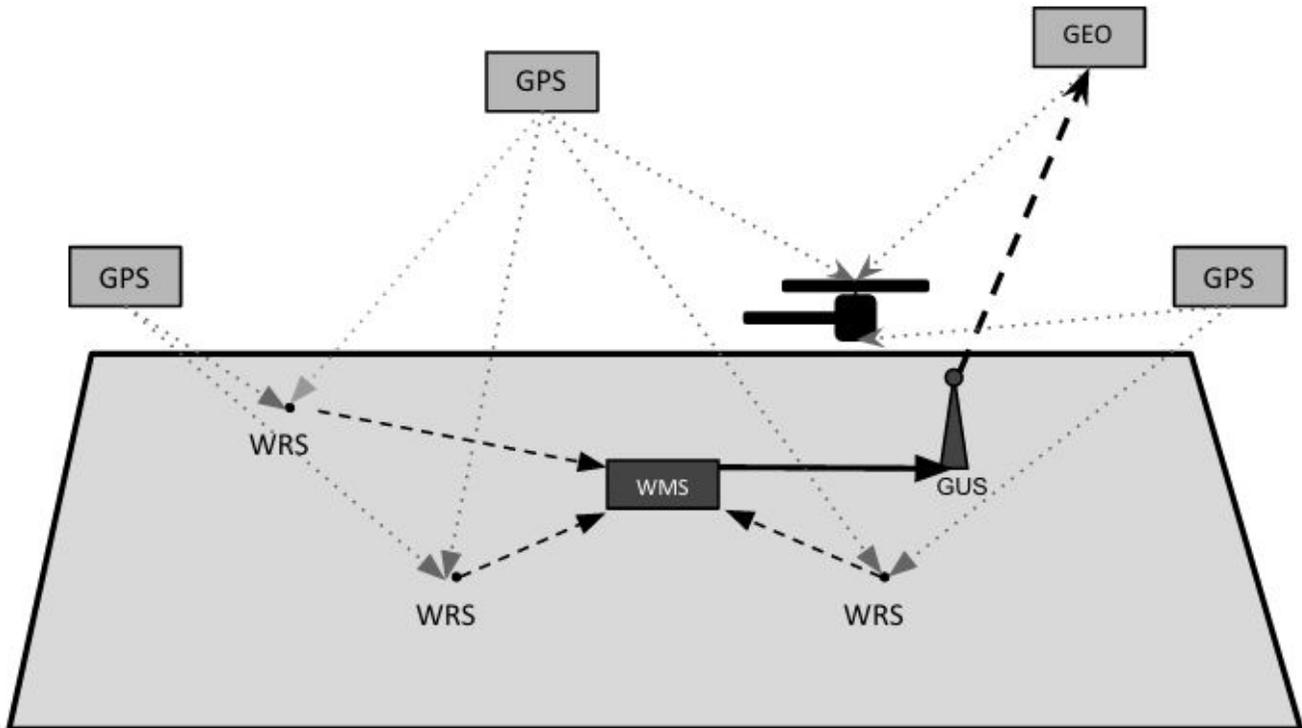
Legend
1. **GPS—** Normal satellites found in the GNSS; 24 satellites in orbit
2. **WRS—** Wide-Area Reference Station; 38 stations across United States
3. **WMS—** Wide-Area Master Station; 3 stations across United States
4. **GUS—** Ground Uplink Station; 6 stations across United States
5. **GEO—** Geostationary Satellite (satellite that matches the rotation of the earth, making it appear stationary) — 3 satellites in orbit

Basic Operation
Wide-area reference stations monitor signal of GPS, send information to wide-area master station. The wide-area master station corrects the errors in GPS signal and sends it to the ground uplink station. The ground uplink station sends the correction to the geostationary satellite, which then sends the correction to your aircraft, enhancing the accuracy.

Important Notes
WAAS UNRELIABLE in a NOTAM is an advisory, and you may still use your GPS and fly to LPV or LNAV/VNAV if GPS indicates. If GPS indicates LNAV, you must fly to LNAV minimum. With WAAS, pilot may plan to use IAP with WAAS at required alternate provided: ● Flight planning is based on LNAV minima line, or minima on a GPS (non-WAAS), or conventional IAP with "GPS" in the title. ● Upon arrival at an alternate, LNAV/VNAV or LPV may be used if available. If a "vertical" flag appears on approach, pilot may use LNAV minimums and continue approach.