The two types of VNAV paths that the FMS use is either a performance path or a geometric path. The performance path is computed using at idle or near idle power from the TOD to the first constrained waypoint. [Figure 3-3] The geometric path is computed from point to point between two constrained waypoints or when on an assigned vertical angle. The geometric path is shallower than the performance path and is typically a non-idle path. [Figure 3-4]

LNAV/VNAV Equipment

Lateral navigation/vertical navigation (LNAV/VNAV) equipment is similar to an instrument landing system (ILS) in that it provides both lateral and vertical approach course guidance. Since precise vertical position information is beyond the current capabilities of the GPS, approaches with LNAV/VNAV minimums make use of certified barometric VNAV (baro-VNAV) systems for vertical guidance and/or the wide area augmentation system (WAAS) to improve GPS accuracy for this purpose.

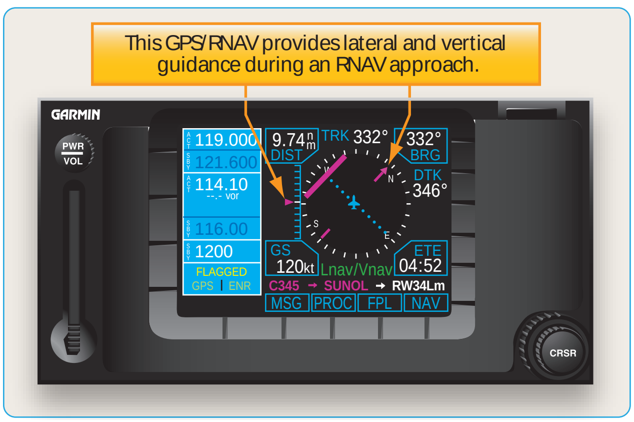

Figure 3-5. WAAS data provide lateral and vertical guidance.

Note: WAAS makes use of a collection of ground stations that are used to detect and correct inaccuracies in the position information derived from the GPS. Using WAAS, the accuracy of vertical position information is increased to within three meters.

To make use of WAAS; however, the aircraft must be equipped with an IFR-approved GPS receiver with WAAS signal reception that integrates WAAS error correction signals into its position determining processing. The WAAS enabled GPS receiver [Figure 3-5] allows the pilot to load an RNAV approach and receive guidance along the lateral and vertical profile shown on the approach chart. [Figure 3-6] It is very important to know what kind of equipment is installed in an aircraft, and what it is approved to do. It is also important to understand that the VNAV function of non-WAAS capable or non-WAAS equipped IFR-approved GPS receivers does not make the aircraft capable of flying approaches to LNAV/VNAV minimums.

FMS are the primary tool for most modern aircraft, air carriers, and any operators requiring performance based navigation. Most of the modern FMS are fully equipped with LNAV/VNAV and WAAS. The FMS provides flight control steering and thrust guidance along the VNAV path. Some less integrated systems may only advise the flight crew of the VNAV path but have no auto-throttle capability. These less integrated systems require an increase in pilot workload during the arrival/approach phase in order to maintain the descent path.

Descent Planning for High Performance Aircraft

The need to plan the IFR descent into the approach gate and airport environment during the preflight planning stage of flight is particularly important for turbojets. TOD from the en route phase of flight for high performance aircraft is often used in this process and is calculated manually or automatically through a FMS based upon the altitude of the approach gate. A general rule of thumb for initial IFR descent planning in jets is the 3 to 1 formula. This means that it takes 3 NM to descend 1,000 feet. If an airplane is at FL 310 and the approach gate or initial approach fix is at 6,000 feet, the initial descent requirement equals 25,000 feet (31,000–6,000). Multiplying 25 times 3 equals 75; therefore, begin descent 75 NM from the approach gate, based on a normal jet airplane, idle thrust, speed Mach 0.74 to 0.78, and vertical speed of 1,800–2,200 fpm. For a tailwind adjustment, add 2 NM for each 10 knots of tailwind. For a headwind adjustment, subtract 2 NM for each 10 knots of headwind. During the descent planning stage, try to determine which runway is in use at the destination airport, either by reading the latest aviation routine weather report (METAR) or checking the automatic terminal information service (ATIS) information. There can be big differences in distances depending on the active runway and STAR. The objective is to determine the most economical point for descent.

An example of a typical jet descent-planning chart is depicted in Figure 3-7. Item 1 is the pressure altitude from which the descent begins; item 2 is the time required for the descent in minutes; item 3 is the amount of fuel consumed in pounds during descent to sea level; and item 4 is the distance covered in NM. Item 5 shows that the chart is based on a Mach .80 airspeed until 280 knots indicated airspeed (KIAS) is obtained. The 250 knot airspeed limitation