INSTRUMENT READINGS™

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Issue No. 1

RNAV APPROACHES

This article will not be as broad and general as its title suggests. I intend to use some new RNAV approaches at Huntsville International Airport to illustrate features of some newer types of GPS approaches and their associated charts.

RNAV is an abbreviated term meaning Area Navigation, which in turn means a navigation system that can determine aircraft position and accomplish a direct route between two arbitrary points. That definition is good enough for present purposes. Some types of RNAV systems are INS (inertial), LORAN, VOR/DME, DME/DME, and GPS. Our concern here will be GPS.

At the time of this writing (November 2004), GPS navigation for IFR is undergoing great change. The FAA's addition of its WAAS (Wide Area Augmentation System) satellites to the GPS constellation is finally beginning to realize its long-delayed promise. IFR-certified GPS receivers used in light aircraft are beginning to have the capability for precision vertical guidance and approaches to near-ILS minimums. In turn, this has the potential to improve the accessibility of multitudes of smaller airports without the initial and continuing expense of ILSs.

Prior to WAAS, GPS units to be used for navigation under IFR were certified to TSO-C129. These units use a scheme called RAIM, for Receiver Autonomous Integrity Monitoring, to detect any conditions under which navigation can not be provided to the accuracy required for the phase of flight. A TSO-C129 GPS cannot be used as the sole means of navigation under IFR. With the advent of WAAS, new standards emerged, TSO-C145A and TSO-C146A. Units certified to these standards have a faster 5/second update rate, make use of the WAAS satellites, and are certified for sole means of navigation. Furthermore, they provide improved vertical accuracy, sufficient to allow semi-precision approaches down to 250 feet and ½ mile visibility.

We will see some different naming conventions on these approaches. We have all learned that approach names ending in a letter, like VOR/DME-B, mean that the approach has circling minimums only. Further, we know that the suffix –A is the first circling-only approach associated with a city name, -B is the second one, -C the third, etc. These approaches can be of completely different types. Looking at the Instrument Approach Procedure (IAP) charts on the next page, you will notice that they are both RNAV (GPS) approaches to the same runway, and have the suffixes Y and Z. When there is more than one approach of the same type to the same runway, the suffixes begin at the other end of the alphabet. The first one is Z, the second Y, the third X, etc. Why would there be multiple approaches of the same type to the same runway? It is generally due to technicalities of rules. More on this later.

HUNTSVILLE, ALABAMA

AL-5488 (FAA)

RNAV (GPS) Y RWY 36R

HUNTSVILLE INTL-CARL T. JONES FIELD (HSV)

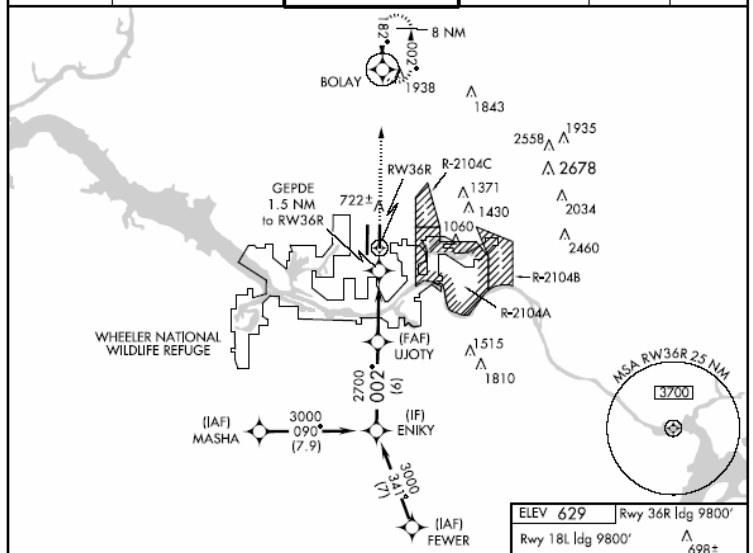
APP CRS	Rwy ldg	9800
002°	TDZE	595
	Apt Elev	629

Cat. E circling NA east of Rwy 18L-36R.
For inoperative MALSR, increase Cat. E visibility to RVR 6000.
GPS or RNP-0.3 Required. DME/DME RNP-0.3 NA.
Inoperative table does not apply to LNAV Cat. D.

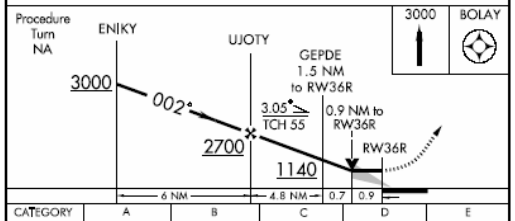
MALSR

MISSED APPROACH: Climb to 3000 direct BOLAY and hold.

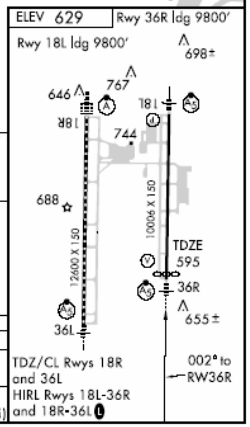
ATIS	HUNTSVILLE APP CON ★	HUNTSVILLE TOWER ★	GND CON	CLNC DEL	UNICOM
121.25	125.6 354.1	127.6 (CTAF) L 350.35	121.9 269.525	120.35	122.95



CAUTION: Numerous migratory bird flocks in area.
Wildlife Refuge Area south of airport.



CATEGORY	A	B	C	D	E
LNAV MDA	920/24	325 (400-½)		920/50	325 (400-1)
CIRCLING	1080-1	451 (500-1)	1080-1½ 451 (500-1½)	1240-2 611 (700-2)	1240-2¼ 611 (700-2¼)



HUNTSVILLE, ALABAMA
Orig 04274

HUNTSVILLE INTL-CARL T. JONES FIELD (HSV)
34° 38'N-86° 47'W **RNAV (GPS) Y RWY 36R**

SE-4,25 NOV 2004

SE-4,25 NOV 2004

HUNTSVILLE, ALABAMA

AL-5488 (FAA)

RNAV (GPS) Z RWY 36R

HUNTSVILLE INTL-CARL T. JONES FIELD (HSV)

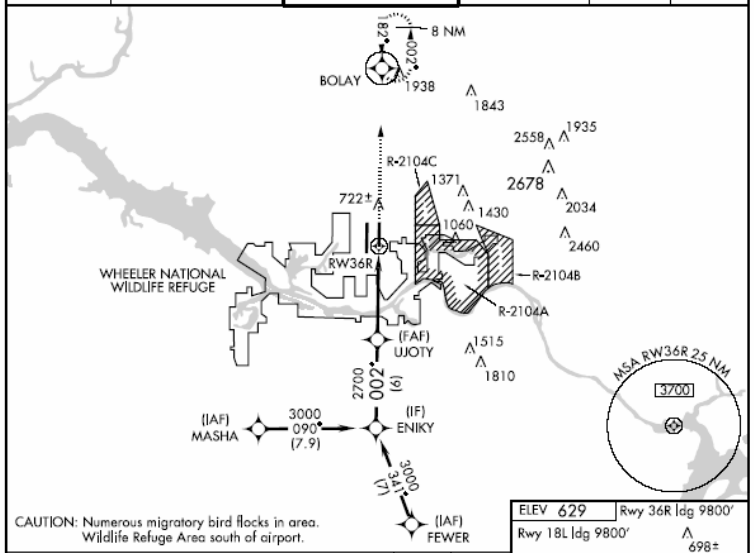
APP CRS	Rwy ldg	9800
002°	TDZE	595
	Apt Elev	629

For inoperative MALSR, increase LNAV/VNAV Cat. D visibility to RVR 5000, and Cat. E LNAV/VNAV and LNAV visibility ½ mile.
Baro-VNAV NA below -16° C (4° F). Cat. E circling NA east of Rwy 18L-36R.
GPS or RNP-0.3 Required. DME/DME RNP-0.3 NA.

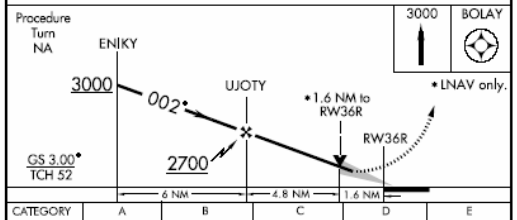
MALSR

MISSED APPROACH: Climb to 3000 direct BOLAY and hold.

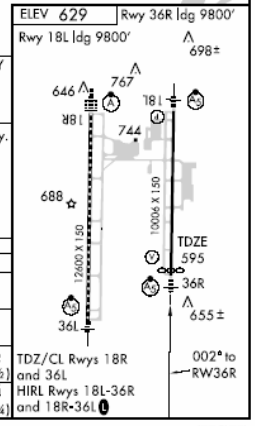
ATIS	HUNTSVILLE APP CON ★	HUNTSVILLE TOWER ★	GND CON	CLNC DEL	UNICOM
121.25	125.6 354.1	127.6 (CTAF) L 350.35	121.9 269.525	120.35	122.95



CAUTION: Numerous migratory bird flocks in area.
Wildlife Refuge Area south of airport.



CATEGORY	A	B	C	D	E
GLS DA	NA				
LNAV / VNAV DA	920/24	325 (300-½)		920/40	325 (300-⅜)
LNAV MDA	1140/24	545 (600-½)	1140/50 545 (600-1)	1140/60 545 (600-1¼)	1140-1½ 545 (600-1½)
CIRCLING	1140-1	511 (600-1)	1140-1½ 511 (600-1½)	1240-2 611 (700-2)	1240-2¼ 611 (700-2¼)



HUNTSVILLE, ALABAMA
Orig 04274

HUNTSVILLE INTL-CARL T. JONES FIELD (HSV)
34° 38'N-86° 47'W **RNAV (GPS) Z RWY 36R**

SE-4,25 NOV 2004

Since the Z approach is first, let's begin with it and dissect it. There is lots of new alphabet soup on this chart. So let's begin with the name of the approach, RNAV (GPS). It is an RNAV approach, but it is restricted to the GPS type of RNAV. It cannot be flown with, say, a VOR/DME type of RNAV navigation unit, like a KNS-80. There are some VOR/DME RNAV approaches at other airports, but not many. And, no, they are not named RNAV (VOR/DME).

Next, in the notes box in the upper left, we see other terms: LNAV, VNAV, Baro VNAV, and RNP. LNAV means Lateral Navigation, and it is what we get with an ordinary GPS. VNAV means Vertical Navigation, and it comes in two flavors. The first is Baro VNAV, which is not a GPS function at all, in terms of deriving vertical position from satellite signals. A pressure transducer in the aircraft is connected to the GPS unit, which then uses that barometric-derived altitude in computing vertical descent profiles. The second flavor is based on true GPS-derived vertical position. LNAV/VNAV always means that the procedure was designed based on the vertical data being provided by the barometric pressure sensor, although it can be flown with WAAS/GPS-derived elevation data. Another related term, one that does not show up on this chart, is LPV, meaning Lateral Precision Performance with Vertical Guidance. LPV minima are based on both lateral and vertical position data being derived from the WAAS-aided GPS signals, and LPV usually provides lower minima than LNAV/VNAV. Next, RNP means Required Navigational Performance. There is a trend toward basing navigation procedures, including IAPs, on the accuracy of the position-determining system, without regard to how to they actually accomplish it. RNP-0.3 means that the system must be able to fix the location of the aircraft to within 0.3 nautical miles (95%). This is equivalent to the 0.3 nm RAIM limit used in the final approach segment of GPS approaches. A GPS certified for approaches meets the RNP-0.3 requirement, whereas one certified for enroute and terminal only meets RNP-1.0. (Note: I don't think it is exactly right to say it is an accuracy limit, the units are more accurate than that. They talk about an "integrity limit", and I haven't delved into the exact meaning of that.)

Looking at the minima section of the Z approach, we see GLS DA, LNAV/VNAV DA, LNAV MDA, and Circling. LNAV is our plain old GPS approach, with lateral guidance only. Its minimum altitude is specified as a Minimum Descent Altitude, signifying that it is a nonprecision approach. LNAV/VNAV means that both lateral and vertical navigation are being used, and the fact that its minimum altitude is expressed as a Decision Altitude means that it is to be flown the same as a precision approach, with positive vertical guidance. Actually, the FAA considers only ILS, MLS (which not much other than the Space Shuttle uses), GLS and maybe PAR to be precision approaches. Other approaches with vertical guidance, including LDA/GS, LNAV/VNAV, and LPV are in another class called APV, for Approach With Vertical Guidance. TLS is considered precision, but is classified as a Special IAP. (Look, don't blame me, I don't name these things or make the acronyms, I just have to use them.)

What is the difference in how you fly the approach if the minimum altitude is a DA vs an MDA? Flying a nonprecision approach to an MDA, if you don't have the runway environment in sight by the time you reach MDA, you can level off at MDA and continue flying to the MAP, hoping to see the airport in time to descend as you get closer. Without the required visual sightings, you are not allowed to descend below the MDA at all, the tolerance is minus zero. Flying down a glide slope to a DA, you stay on the glide slope. The point at which you reach DA on the glide slope is your missed approach point. At DA, if you don't have the required visual sightings, you immediately initiate the missed approach: power, pitch attitude, flaps, etc. In the transition to the

missed, you will sink slightly below DA. That is recognized and accepted. So when you reach MDA, you should be level; when you reach DA, you should be descending.

We skipped a term, GLS. This means GNSS Landing System. GNSS is an ICAO term for Global Navigation Satellite System. ICAO, being an international body, doesn't care whether the satellite system is US GPS, Russian GLONASS, or the coming European Galileo system. GLS provides differential augmentation to GNSS, attempts to harmonize usage of the various international systems, and provides for country-specific local augmentation (such as LAAS). This one is still in the "maybe" category. The TPP says that "The GLS (NA) minima line will be removed from existing RNAV (GPS) approach charts when LPV minima is published." I think this means that WAAS/LPV is classified under GLS, but the whole GLS thing is about as clear as mud. More on LPV later.

To fly LPV, you have to have a WAAS-capable receiver certified for it. To my knowledge, the Garmin GNS-480 (CNX-80) is the only one currently certified. A unit certified for LPV will also fly LNAV/VNAV using satellite-derived vertical guidance. Note that not all WAAS-capable approach-certified receivers may be certified for LPV; some may not meet the update rate and other requirements for LPV and will be certified for LNAV/VNAV only.

Note that, for the Z procedure, the minima for LNAV/VNAV are 325 AGL and 2400 RVR (1/2 mile). That's pretty doggone good. The LNAV MDA is 545 AGL.

On the profile view, you will see a Vertical Descent Point (VDP), with a note specifying that it apples to LNAV only.

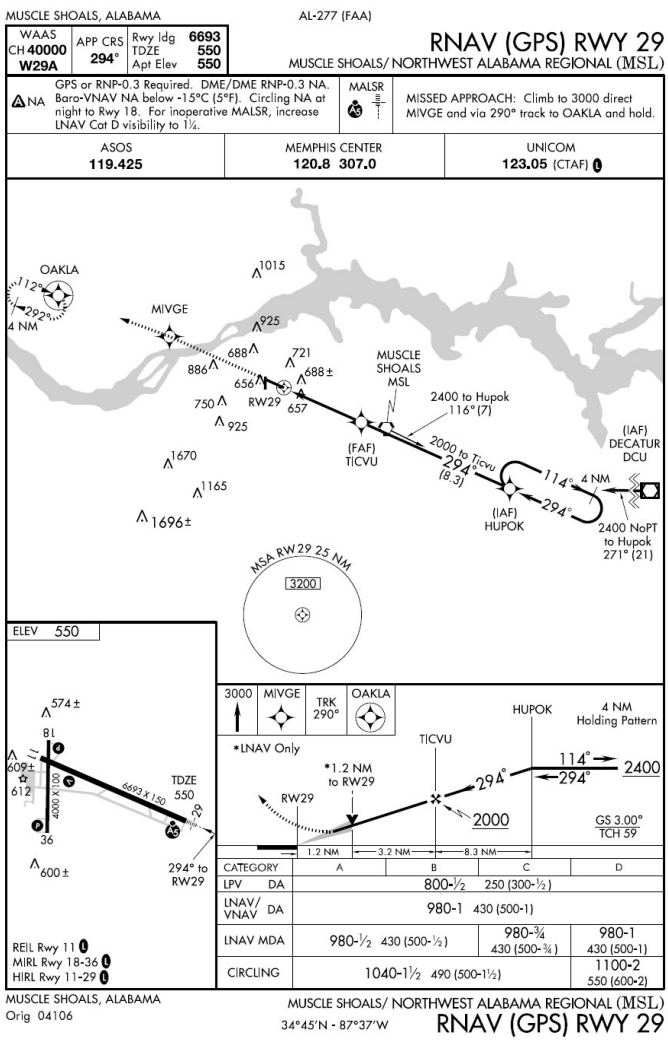
Now, look at the Y procedure. The plan view for each procedure is exactly the same. There are some differences in the notes box on the upper left. Minimum altitudes at the IAF and FAF are the same. The profile view shows a stepdown fix after the FAF that is not on the Z procedure. Minima are published only for LNAV and Circling. Here is the biggie: note the LNAV MDA: it is 325 AGL, exactly the same as the LNAV/VNAV DA on the Z procedure! We can deduce that there is an obstacle on the final approach segment that can be avoided two ways: one is to fly the glide path of the Z procedure, with positive vertical guidance from properly certified equipment, or to observe the step down fix on the Y procedure on a "dive-and-drive" basis.

The Y procedure can be flown with our regular TSO-C129 LNAV-only GPS units. An MDH of 325 ft is really good!

The question naturally arises as to why it took two procedures to do this, and why the stepdown fix could not have been included on the Z procedure with a note restricting it to LNAV. The answer seems to be that when development of these procedures was initiated, there was a rule, since rescinded, that a step-down fix could not be included on an RNAV approach with a glide slope.

We now have *seven* RNAV (GPS) approach procedures at KHSV. If you haven't looked recently, all the approaches there have been reworked. Even the VOR or GPS-A has been changed, replacing the procedure turn with a Hold-In-Lieu racetrack, and it is now a VOR-only approach. Also, the GPS overlay has been removed from the NDB 18R approach.

Back to a subject mentioned earlier, the LPV approach. A nearby example is at Muscle Shoals, AL (KMSL), the RNAV (GPS) RWY 29 procedure. Let's examine a few noteworthy aspects to this procedure. Notice that it has minima for LNAV, LNAV/VNAV, and LPV (250-1/2 !). The GLS N/A entry has been replaced by the LPV minima, as discussed earlier. Remember that LNAV is plain old GPS, LNAV/VNAV can be flown with either WAAS/GPS or GPS with Baro-VNAV, and LPV is flown entirely with WAAS/GPS.



Next, note that in the upper left corner of the chart, in the first field in the briefing strip where you normally find the magnetic course of the final segment or information on the navaid providing guidance on the final approach segment, that this field is dedicated to WAAS. Note the channel number and Approach ID. This has to do with an alternate method for calling up the procedure in the GPS unit. For more information, I refer you to the AIM, section 1-1-20(d)(6).

The next installment of *Instrument Readings* will begin a series of articles on Obstacle Departure Procedures and Takeoff Minima.

The author invites discussion and constructive comments. stan@sprevost.net