Next (now) Gen Navigation/Approaches

By John Morris

You think you know what's out there, but there's always something new, unknown or not enough information, as in this case with the ongoing evolution of Next Generation navigation/approaches.

I recently was training with clients in a PC12 NG when we encountered an RNAV (GPS) LP minima approach, which neither of us had seen before or heard of. Also discussed during the training was the ability to fly an RNP approach, which can be done using any PC12 but with restrictions. Some investigating was in order to increase my knowledge and understanding regarding these subjects and share my findings.

I will start with a short, nostalgic look back at the evolution of post VOR-only enroute navigation to the present and future.

Enroute Navigation	Year Civil approved	Year Ended
Omega	1978	
RNAV*	1975	Evolved
Loran-C	1988	2010
GPS	1994	
RNAV-WAAS / GNSS	2003	

GNSS: Global Navigation Satellite System

* AREA NAV (RNAV) definition (current-modified): A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground - [or space based] navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Since 2006 the FAA has implemented RNAV 1 protocol (1 NM maximum error for 95% of total flight time) for published RNAV standard instrument departures [SID's] or departure procedures [DP's] that included obstacle avoidance, and RNAV standard terminal arrivals [STAR's]. For RNAV routes that are ground-sensor limited e.g., "Q", "T" and Alaska, the RNAV 2 protocol (2 NM maximum error for 95% of total flight time) is used. These procedures basically require a minimum ability of the pilot to have (ABAS) Aircraft-Based Augmentation System [RAIM] information available for position accuracy along with the navigation equipment meeting the required standards for RNAV enroute. Or with WAAS RNAV, confirmation before flight only (not required while enroute) that no area of the flight will be out of coverage. Beats the RNAV (VOR) version of the 70's!

Approaches have made significant advancements since the first GPS/Overlay approaches in 1994.

Below is a table showing current RNAV (GPS or RNP)-based approaches:

Facility	Type of approach	Vertical Guidance
Ground Navaid or GPS	Overlay	NO
RNAV (GPS) - A, B, C	Circling only	NO
RNAV (GPS) - X, Y, Z	Straight-in	
RNAV (GPS) …LNAV With/With out WAAS/GNSS	Straight-in	NO
RNAV (GPS) ...LNAV/VNAV WAAS/GNSS	Straight-in	YES
RNAV (GPS) …LPV WAAS/GNSS	Straight-in	YES
RNAV (GPS) …LP WAAS/GNSS	Straight-in	NO
RNAV (GPS) …Circling WAAS/GNSS	Straight-in	If Applicable
RNAV (RNP) - X, Y, Z WAAS/GNSS [0.10 to 0.30]	Straight-in	YES

Note: All of the above Instrument Approach Procedures are Non-Precision

What's the difference between and LNAV and the original GPS approach? The answer is no difference, except that to simplify the approach terminology the FAA changed the names of/added lines of minima to the approach plates. Looking at the lines of minima at the bottom of any RNAV (GPS) approach plate will let you know what is available regarding approach type and minimums (minima).

The difference between an LNAV/VNAV and an LPV is that (at FAF) the maximum horizontal position error for an LNAV/VNAV is 0.3 nm (556 meters) while an LPV is 40 meters. Both have vertical guidance and maximum vertical position errors of 50 meters. Due to the horizontal difference the minima for an LPV is generally lower, near ILS minima. To signify the minima difference an LPV minimum altitude is called decision altitude (DA) [baro-based on highest point of 1st 3000 feet of runway] whereas an LNAV/VNAV minima is a minimum descent altitude (MDA).

What then is an LP? The 1st LP approach was published Jan. 2011. It uses the horizontal criteria of an LPV but without vertical guidance and an MDA (usually closer to the LPV minima than an LNAV minima) instead of a DA. This type approach is published based on the airport environment meeting standard approach requirements but having obstacles or other local issues not allowing an LPV.

What is RNP? Required Navigation Performance (RNP) - definition (modified for approach only): navigational performance required to maintain flight within the OEA (Obstacle Evaluation Area) associated with instrument procedure segments by use of RNAV with on-board navigation monitoring and alerting.

RNP approaches are more about precise lateral control than vertical. The descent from FAF uses Baro-VNAV information, which in most cases the associated DA is higher than an LPV. However, the precision tracking of the paths to the FAF, sometimes-sharp turns, curves or parallel runway approaches require the aircraft navigation equipment/displays and pilots to receive specialized training and FAA authorization, shown at the minima section of an RNP approach chart as "Authorization Required", in order to fly these approaches. The qualification process for pilots is very similar to CAT II/III ILS requirements.

What also makes a RNP approach different is the requirement for a total lateral/along track system error of ± 1 NM for at least 95% of the total

flight time. When on the final approach segment the total error is a maximum of ± 0.3 nm [down to 0.10 nm] for at least 95% of the total flight. The "error", call the estimate of position uncertainty (EPU) is from around the aircraft's estimated 95% position. The pilot's primary flight display must indicate the current RNP level and EPU in NM. The RNP approach value includes the calculation for the missed approach since the DA may be raised due to the OEA associated with the missed approach segment when the RNP resumes the ±1 nm error. Circling approaches are not planned since one premise of an RNP approach is close quarters to terrain throughout the approach, to the touchdown and/or missed approach.

So, can the PC12 perform all of the approaches listed in this article? Yes, all of the legacy PC12 aircraft can currently perform all of the listed approaches except the RNP's. This is based on the aircraft having the currently available/approved equipment installed. It would appear in the near future the approved displays and navigation equipment will be made available to also perform the RNP approaches. Currently the PC12 NG is approved for RNP 0.30 nm approaches. But as stated earlier in this article it probably would require additional FAA authorization depending on the RNP approach in order to execute one in any of the properly equipped PC12 aircraft.

FYI: As of 2/2012

- Number of US ILS approaches 2100-including military
- Number of US LPV approaches 2272
- Number of US RNP approaches 291 (airports)

" A safe pilot is always learning"

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