Types of Instrument Procedures

With navigation aids and the procedure design process, the various types of procedures that are available will be described in this article. Relatively little emphasis will be placed on conventional navigation aids as the aviation industry is rapidly shifting to a satellite-based environment. For this reason, satellite-based procedures will be described in detail.

Aircraft can depart using a variety of procedures. For those airports without sophisticated runway lighting and weather reporting (RVR), the best-case scenario is a take-off visibility of ½ statute mile visibility.

A diverse departure is one where an aircraft can climb to 400 ft above the airport then turn in any direction and continue to climb at a minimum climb rate of 200 ft vertically for every nautical mile of forward travel and still meet the required obstacle clearance requirements. Other departure procedures provide a route based upon a conventional navigation aid to provide guidance to avoid obstacles.

A GPS-based departure procedure is now available. Known as an RNAV (Area Navigation) Departure, this type of procedure uses a series of GPS waypoints to describe a route to avoid terrain or noise-sensitive areas. And since it is based upon GPS, there is no ground infrastructure investment required. With ground-based navigation aids, there are often issues regarding the ability to receive the navigation signal, depending on terrain and altitude. With GPS, this is not an issue as signal coverage with GPS is available everywhere, anytime.

RNAV Departures are particularly useful in a terrain-rich environment such as mountainous areas. RNAV Departures are also useful in busy airport environments or areas of noise sensitivity to ensure that aircraft consistently avoid these areas.

The types of instrument approach procedures involve a wide array of possibilities that depend upon the navigation aid that is used and the nature of the procedure. It is useful to provide a few definitions to help clarify the choices that are available. Conventional approaches use traditional (ground-based) navigation aids compared to satellite-based procedures that use GPS or WAAS. Approaches can also be divided between precision and non-precision approaches. Precision approaches are highly precise procedures that provide the pilot with both lateral and vertical navigation guidance. Non-precision procedures are not as accurate as precision approaches nor do they provide the pilot with vertical guidance (lateral guidance only).

Conventional, non-precision approaches are named by the navigation aid used for the procedure. These include NDB, VOR and VOR/DME approaches. The lateral navigation source of an ILS, the Localizer, also provides a non-precision approach. The venerable ILS is the source of the sole case of a precision navigation approach.
Satellite based navigation offers a wide variety of approaches with its own set of terminology. The basic satellite-based non-precision approach is known as Lateral Navigation (LNAV). This approach procedure uses unaided GPS to provide a two-dimensional approach with no vertical guidance. A vertical path to this type of approach can be added; this is based upon barometric altimetry as the vertical reference and is known as Barometric Vertical (Baro VNAV). A Baro VNAV approach offers both lateral and vertical guidance however it is not by any means an ILS replacement. The aircraft equipment to fly an LNAV approach is a basic, aircraft grade GPS receiver; Baro VNAV requires a more sophisticated receiver however many new receivers, even the basic panel mounts, have a Baro VNAV capability.

An instrument approach that uses the WAAS is known as a Lateral Procedure with Vertical Guidance (LPV). For all intents and purposes an LPV approach is an ILS approach – it has the same qualities as an ILS and the design criteria is identical to ILS. LPV fails to meet the technical definition of a precision approach; however, the differences are minor.

LPV approaches require a WAAS receiver – these devices are becoming more and more common. It is expected that LPV approaches will eventually become the de facto standard at every airport North America and eventually the world. These approaches provide both a lateral and vertical guidance identical to an ILS.

Recently, another type of satellite-based approach has been developed. Required Navigation Performance (RNP) has two subsets – basic and advanced. The concept of RNP is that if the avionics receiver satisfies a certain, required navigation performance an approach will be permitted to certain approach minimums. The onus is upon the navigation receiver to determine if it has the required navigation performance and if it doesn’t it alerts the pilot. This concept provides an entirely new set of design tools for a procedure designer to find an optimal solution. This includes things such as curved approaches.

Basic RNP can be flown by most GPS receivers with a Baro VNAV and with no specialized aircraft equipment or pilot training. Advanced RNP requires not only these avionics but also special aircraft equipage and crew training. The use of Advanced RNP is best suited to an airport/air carrier combination where specialized and customized procedures can be leveraged to achieve better results.

While every airport offers its own unique challenges, as a general rule WAAS/LPV is the approach of choice – all of the benefits of an ILS without the costs. It just doesn’t get any better than that. The next best choices are Basic RNP followed by Advanced RNP. Both LNAV and Baro VNAV are early implementations of GPS (circa 1996) and have not been updated to reflect over a decade of GPS experience. The newer design criteria – WAAS and RNP – more accurately reflect state-of-the-art of satellite navigation and are rapidly becoming the best alternatives for instrument approaches to airports. For departures, the first choice is diverse departures owing to their simplicity however RNAV Departures are effective when a diverse departure does not provide a workable solution.