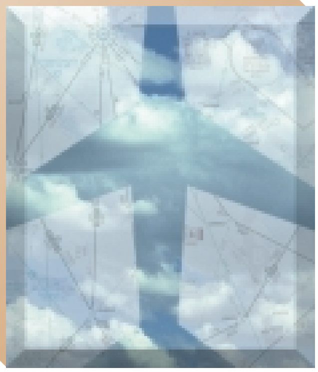


The Chart Clinic – Database Series

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

At one time while teaching a student to fly the pattern and landings, he was working, working, working to get the airplane exactly on the right path - both laterally and vertically. It seems the harder he worked, the more the airplane was all over the sky. Swing to the left, swing to the right, and then he'd over correct and then the turns back and forth became more and more - well, we've all been there at one time. At this rate, solo was a long way off.

The next time around, we did a two-mile final and I gave him a temporary new "rule" - he wasn't allowed to touch the control wheel. He had to have the airplane in trim and he could only move the rudder pedals with his heals firmly anchored on the floor. It turned out to be the best approach and landing he'd ever made - and he soloed only a few lessons later.

The same applies to IFR approaches. The fewer dials that are moving, and the better the trim, the easier it is to shoot an instrument approach down to minimums and then a landing. When the only instrument that is changing is the altimeter (and radar altimeter), small differences that typically happen on an approach because of turbulence, wind gusts, etc. are easily corrected. When power changes, airspeed changes, vertical speed changes, and trim changes all happen on the approach, even the most current instrument pilot has to be absolutely on top of everything to hope the outcome of the approach is as expected.

Stabilized Approach

The Flight Safety Foundation, the Air Transport Association, NBAA, the FAA, and others have all endorsed the concept of a stabilized approach. The leading cause of accidents resulting in CFIT (controlled flight into terrain) has been while flying non-precision approaches. An interesting observation is that most of the approach and landing accidents happen during the last 10 miles while on final approach. Most of the non-precision approach accidents happen on the extended centerline of the landing runway. This means that the lateral navigation has been very good - but what happened with the vertical navigation?

There are several reasons for the wrong vertical navigation. A common problem has been with crews that have mis-identified their location and believed they were one fix further along the path than they really were. This meant they descended to the altitude for a fix before they actually arrived there. This can happen when there is mental overload. This can happen from fatigue.

This all results in the belief that if stabilized approaches were the normal operation, there would be more time to scan the instruments and avionics to know precisely where you are.

Dive and Drive

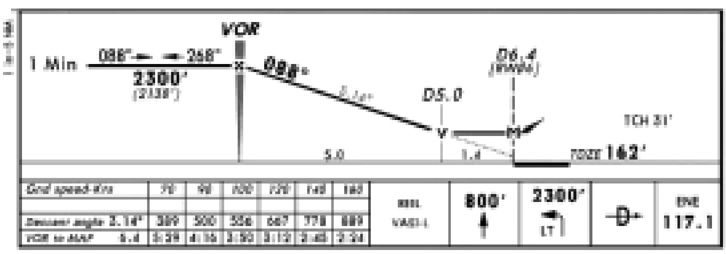
This "less than complimentary" term has been used to describe operations in which the airplane descends as rapidly as possible after crossing each fix and then levels off until arriving at the next fix. There are two good rationales for why this is considered valid. First, you get down earlier and have a better chance of getting below the clouds to get into visual conditions. Second, if there are icing conditions, you can descend faster to get below the freezing level.

This is also why there are so many CFIT accidents on non-precision approaches. If there are icing conditions, it may be better to get below the icing and work harder on shooting the approach. But is 500 feet going to make the difference to get below the icing?

FAA Initiative

The United States Standard for Terminal Instrument Procedures (TERPs) document was significantly revised in revision 17 to include descent angles on non-precision approaches. The FAA recognized the safety improvements for stabilized approaches and began adding descent angles to all non-precision approach procedures such as VOR, NDB, GPS, and RNAV. The new RNAV (GPS) precision approaches now include VNAV (vertical navigation) angles and minimums that use a decision altitude (DA) instead of the minimum descent altitude (MDA).

The first non-precision approach issued by the FAA with a descent angle was the Biddeford, Maine VOR Rwy 6 approach. It was issued in August 1998 and was the first of many that have been published by the FAA. The profile for Biddeford is illustrated.



In the profile view, a number of pieces of information have been added. The descent angle of 3.14° has been added above the descent line. A dotted line has been added below the MDA which indicates the path of the descent if continuing below the MDA in visual conditions. For the first time, a TCH has been added to a non-precision approach. The TCH of 31 feet indicates the path where the constant descent angle crosses the threshold.

In the conversion table below the profile view, the descent angle of 3.14° has been added with the rate of descent in feet per minute at various ground speeds. As an example, an approach flown at a ground speed of 100 knots could use a descent rate of 556 feet per minute from the 2,300-foot altitude over the FAF down to crossing the runway threshold at 31 feet.

Several things to remember are that the descent still takes you down to an MDA and not a DA. So you will need to stop your descent just before reaching the MDA so that you don't go below it (unless of course you are visual). Also, if you don't have VNAV equipment in your airplane and your ground speed is a bit high, your descent path will take you to a point farther down the runway than you want. Therefore, it is safe to have your descent rate slightly higher than charted so you don't land long.

Since this is still a non-precision approach, the MAP is still at the runway threshold. At Biddeford, there are two ways of identifying the MAP. The first (and most difficult) is timing. The conversion table gives various times based on ground speeds. The second is GPS. There are two ways to use your GPS to identify the MAP. One way is to keep your GPS set to the VOR and read the output just like a DME. The easier way is to fly to the RW06 waypoint in the database. Of course, to use the GPS as a substitute, it must be panel mounted and certified according to the FAA TSO-C129 as an IFR certified system to fly GPS approaches.

When flying the VOR approach, can you use the VDP (visual descent point) as your MAP? Many professional pilots and airline pilots treat the VDP as an MAP. If you were to level off at the MDA (which happens at the VDP) and fly after the VDP, any descent you would make to the runway after that would be considerably steeper than the approach from the VOR. Because of the high descent rates after reaching the VDP (assuming leveling at the MDA because of the airport not in sight), many pilots believe it is better to begin executing the missed approach if the airport is not in sight at the VDP.

But - remember there are two parts of a missed approach - one is the track and the other is the altitude. This means, if you begin your missed approach at the VDP, you can *only initiate the climb* before the MAP. You can't begin to execute the missed approach procedure track until *after* passing the MAP.

The design criteria for the installation of visual guidance systems such as VASI and PAPI are to align them with the glide slope on runways equipped with an ILS. There are no design criteria for aligning the visual systems with non-precision approach procedures. As a result, you will occasionally find that a perfectly executed, stabilized, non-precision approach will cause you to be above or below the VASI or PAPI when you break out under the clouds. When the FAA creates the descent angle, they will include a note that states "VGSI and descent angles not coincident." VGSI means visual guidance slope indicator.

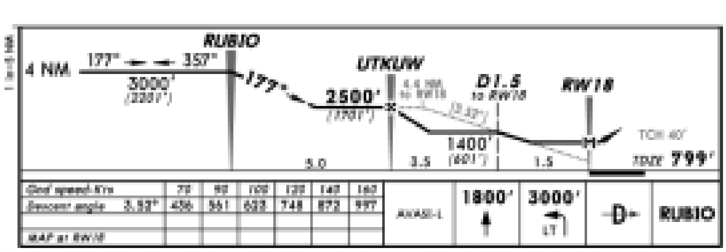
Database Angles

In Jeppesen's database, virtually every non-precision approach includes a descent angle. All the GPS and FMS systems that provide VNAV capability can use the VNAV angle and fly the approach virtually the same as an ILS approach. Systems with VNAV give displays the same as glide slope displays and provide "up and down" indications to show deviations away from the VNAV path.

All the angles in the database for non-precision approaches are created according to the specifications included in the ARINC 424 document, *Standards for Aeronautical Databases.* The ARINC specs contain a very important rule which we consider to be RULE NUMBER 1 - whatever is provided by the government authorities is what is included in the database. From that point, since most governments do not provide descent angles, there are 13 different examples of how a descent angle is to be calculated for the database.

All descent angles in the database that are calculated are essentially nothing more than "connecting the dots." And the "dots" are the FAF altitude and the TCH altitude. By connecting these two points, most descent angles are easily computed. These angles are then the angles in the database. There are a number of complex problems to make it work, but fortunately these are in the minority of locations.

One major exception to the "connect the dots" philosophy is when the straight line from the FAF to the TCH results in an altitude that will be lower than the altitude at a stepdown fix. In the example from Fairfield, Iowa, the stepdown fix on the RNAV (GPS) Rwy 18 approach is above the straight line from the FAF to TCH. To accommodate this, there is a slight delay after passing the FAF to ensure a stabilized approach down to the TCH. Since the FAF to threshold is 5.0 miles, there is a 0.6 mile delay after UTKUW to follow the 3.52° descent path. The descent angle of 3.52° is in the database.



In the next article, we will conclude the database series with a discussion of what is **not included** in the database.

James E. Terpstra is senior corporate vice president, aviation affairs at Jeppesen. His ratings include ATP, single and multi-engine, airplane and instrument flight instructor. His 6,000+ hours include 3,200 instructing.
For comments, please Email: JimTerps@jeppesen.com