What's Below MDA and DH?

The published minimums reveal a lot about what's in the airspace from MDA/DH to the runway.

By Wally Roberts

THERE ARE OFFICIALLY TWO types of runways at the end of a straight-in instrument approach procedure: precision or non-precision. These runway classifications dovetail with the two fundamental types of instrument approach procedures: precision and non-precision.

It sounds simple enough, right? Well, it's anything but simple. What is glossed over in these two broad classifications of precision and non-precision runways is what it takes to avoid obstacles when descending in the "visual" segment below DH or MDA. I place "visual" in quotes, because the weather conditions that permit flight below the minimum instrument altitude are anything but visual in the traditional sense of being able to see-and-avoid prominent obstacles along the close-in final approach and landing path.

I touched on this subject briefly in "Establishing Visibility Minimums" (June, 1995 IFRR), and in "Where to Start the Missed Approach" (July, 1995 IFRR). Since these articles, the subject has heated up, especially in light of the near-tragic accident involving an American Airlines MD-88 at Bradley International Airport (BDL), CT, in November, 1995.

BDL incident

The MD-88 was on the VOR Runway 15 approach at BDL, and contacted trees on a ridgeline approximately 2.7 miles prior to the runway threshold. These trees were at approximately 780 feet msl, which is 610 feet above the touchdown zone elevation (TDZE) of 172 feet. The MDA for this approach is 1,080 feet msl (908 feet HAT), and the airplane was obviously below the MDA when it struck the trees.

One of the MD-88's engines failed from debris ingestion, and the other developed only partial power, but enough power for the aircraft to make a landing on the overrun before the approach end of Runway 15.

Why the aircraft was below MDA is still under investigation by the NTSB. What is germane to this article is that every pilot who intends to land out of an instrument approach must, at the appropriate time, descend below the MDA or continue an approach below DH on an ILS. What is also of interest with the BDL VOR approach is that a 3-degree slope, measured from 50 feet above the touchdown zone elevation and from the runway threshold, would have an elevation of about 1,065 feet msl at the ridgeline. (A 3-degree slope is the optimum, especially for runways used by large jet aircraft.[1] See footnote, page 7.)

In actuality, Runway 15 has a VASI, but its slope is 3.5 degrees. Why is the VASI at a 3.5-degree slope if a 3-degree slope crossing the ridgeline almost satisfies the non-precision MDA requirement?

Electronic glideslope safety target

The subtle answer (and one with many complex implications) is: a precision final approach slope (be it ILS or VASI) permits continuous descent over a downward sloping concrete mass. In order to assure a constant target level of safety, international obstacle clearance experts agreed many years ago that there must be a generous amount of electronic slope vertical clearance at the beginning of the final approach segment, decreasing to a minimum value near the runway. This minimum value is a factor in determining the minimum acceptable decision height. In the situation at BDL, the extra margin required for a VASI at 2.7 miles before touchdown is greater than the obstacle clearance required to clear the same obstacles on a non-precision approach.

Without going into the nuts-and-bolts of ILS glideslope obstacle clearance requirements, it's noteworthy to point out a couple of benchmarks and comparisons with non-precision final approach obstacle clearance requirements. Most non-precision final approach segments have a minimum required obstacle clearance (ROC) of 250 feet, whether the obstacle is just inside the FAF or just off the end of the runway. The ILS glideslope ROC (3-degree glideslope) varies, however, from 110 feet at the standard 200-foot DH to 660 feet at an outer marker that is 5 miles from the runway. At any point prior to about 1.5 miles from the runway, the ILS glideslope has obstacle clearance greater than the 250 feet minimum ROC required for most non-precision approaches.

Obstacle alligators

Note that the foregoing pertains to obstacle clearance on the ILS while in the "glue." What about obstacle clearance on the glideslope inside the DH point until the only remaining "obstacle" is the runway

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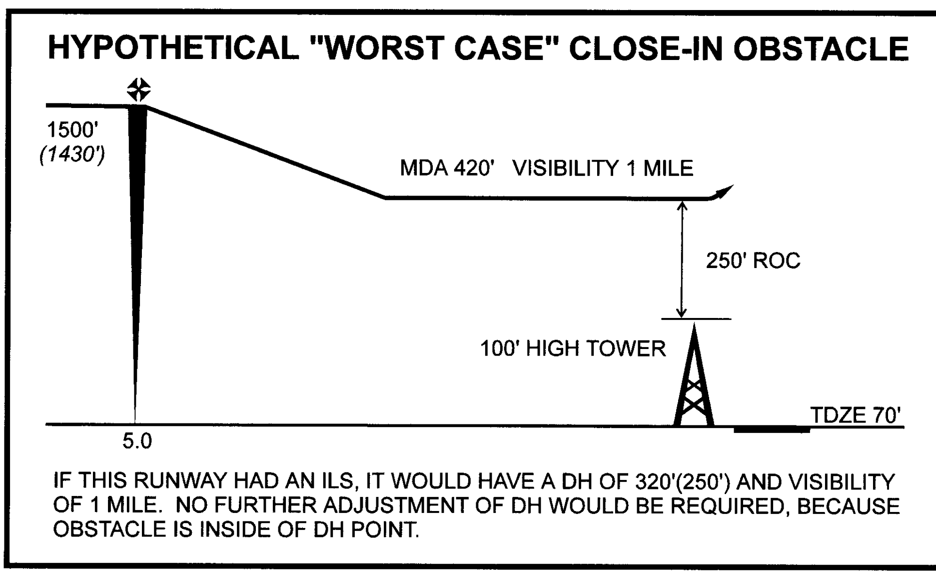

Figure 1*. Although this is a worst-case obstacle scenario, the FAA is ultimately powerless to prevent such interference with instrument approach procedures. In the final analysis, all the FAA can do is adjust the minimums.*

What's Below...

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surface passing under you during the flare? If the ILS has approach lights, a DH of 200 feet, and a minimum visibility of one-half mile, you're home free.

In order for any approach, precision or non-precision, to have a visibility minimum of less than three-quarters of a mile, there must be no obstacle penetrating a 34:1 slope from 200 feet prior to the threshold, out for 10,000 feet, with a lateral area the same as the primary protected areas for a localizer, and there must be approach lights. If this 34:1 slope is penetrated, but a 20:1 slope is clear, then a visibility of not less than 3/4 miles can be authorized. This 20:1 slope gets very close to a 3-degree glideslope, so inside DH on an ILS with three-quarter mile authorized minimums, there could be obstacles at almost the height of the glideslope.

With authorized straight-in minimums of one mile, or greater, there could be something higher than the glideslope inside the DH point. For a straight-in non-precision approach, the only requirement in this situation is that the ROC of 250-feet not be penetrated from the runway threshold to the FAF. In the extreme, it would be "legal" to have a tower or building on the runway centerline at virtually the runway threshold, and that is higher than the normal descent path for landing on that runway. Figure 1 (page 5) illustrates this possibility, with a 100-foot high antenna on runway centerline at the threshold.

In such an extreme case (or even not quite so extreme), the first order of business for the FAA would be to displace the landing threshold to get relief from our hypothetical tower. This is fine, provided there's sufficient runway to displace the threshold, yet provide enough remaining concrete for safe landings. San Diego Lindbergh Airport Runway 27 has such treatment for a parking structure that was built just off the approach end of the runway.

FAA can't fix high terrain

What about really high terrain further out from the runway? That stuff generally precludes the installation of an ILS, and causes non-precision straight-in minimums to become quite high in terms of height above the touchdown zone elevation. Where the obstacles get high enough, the FAF crossing altitude becomes too high to satisfy descent gradient requirements for a straight-in approach, even though the lateral electronic guidance is lined up for straight-in. In this situation, TERPs criteria require that the descent gradient only be computed from the FAF altitude to the circling MDA. This type of approach is perhaps the most dangerous of all, not only because of obstacle alligators below the required obstacle clearance surface, but because of the high, unspecified descent rates required to land straight-in.

When it comes to constructed obstacles, such as towers or buildings, that could interfere with both VFR and IFR procedures at an airport, the FAA requires that notice be given by construction proponents under FAR Part 77, "Objects Affecting Navigable Airspace."[2] The FAA region studies all such applications to determine whether the proposed construction would be hazardous to aircraft operations. If the proposal is determined to be hazardous, and the proponent decides to build anyway, the only recourse the FAA has is to threaten to withhold federal airport improvement money if the community doesn't stop construction.

In situations such as the San Diego parking structure, the FAA doesn't always do the required math correctly. In the 1970s, a

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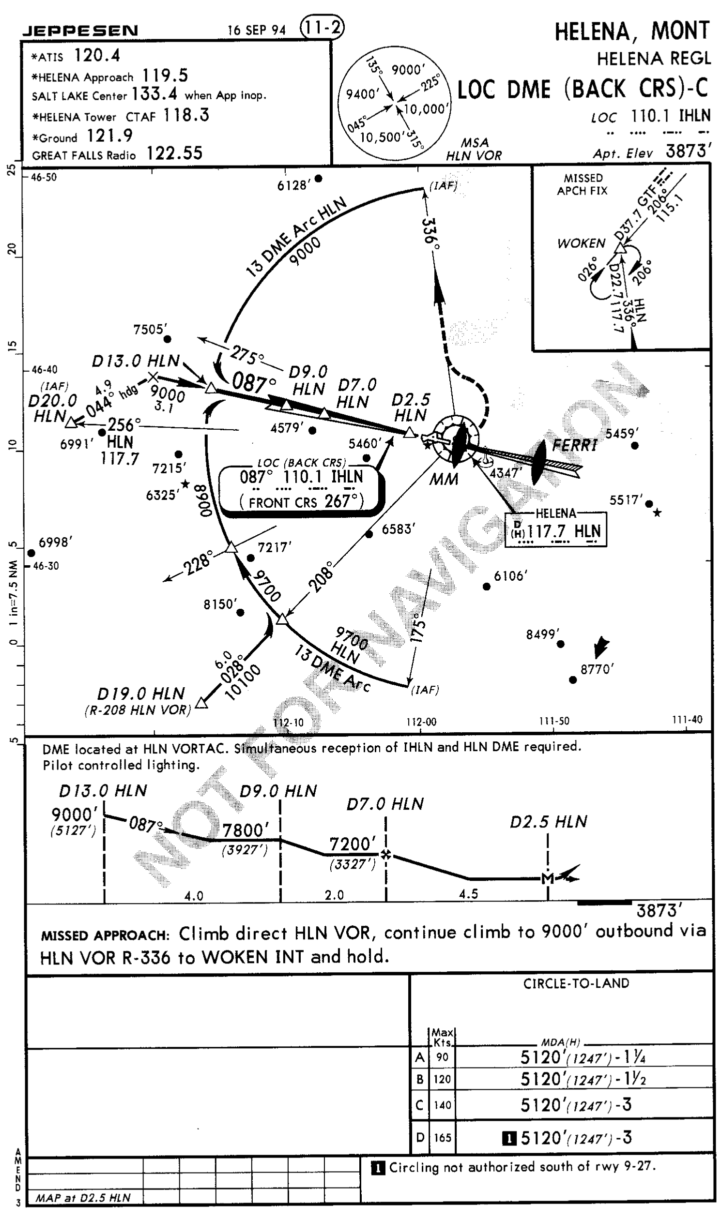

***Figure 2.** Although the localizer on this procedure is aligned for a straight-in approach, the runway is a "Super Number 4" because it lacks straight-in minimums.*

more spirited FAA tried to get local government to adopt airspace zoning laws that followed the imaginary evaluation surfaces set forth in FAR 77. Most communities chose to ignore the FAA, Oklahoma City being a notable exception.

Four types of runways

In reality, there are four classes of runways for purposes of a straight-in instrument approach and landing:

(1) Precision, without restriction.

(2) Precision, with restrictions and possible obstacle alligators inside DH point.

(3) Non-precision, with below-MDA obstacle alligators at bay.

(4) Non-precision, below-MDA obstacle alligators could be anyplace below the MDA required obstacle clearance baseline.

Number 1 is easy, and is the only sure bet when making an approach at an unfamiliar airport during poor visibility conditions, especially at night. It has a DH of 200 feet (HAT), approach lights, and a visibility minimum of one-half mile (or RVR 1800 to 2400 feet). A superior subset to this unrestricted Category I ILS is a Category II or III approach procedure, which assures that the glideslope will perform reliably until there's runway under you.

Number 2 usually has a DH of 250 feet, or higher, and a visibility of at least 1 mile, with or without an approach light system. Be especially leery of an oddball DH higher than 250 feet, which means there's something funny about obstacles inside the DH point. These obstacles can be either side of centerline, or even on the centerline.

Number 3 could have a visibility of as low as one-half mile with approach lights. If the visibility is one-half mile, it means the HAT of the MDA is fairly low, and that a normal descent for landing below MDA is 34:1 clear, provided you're pretty much on the runway centerline. Note that most non-precision approaches with approach lights are a secondary approach to a runway that has an ILS. Further, if the runway has a VASI and/or VDP, the below-MDA obstacle alligators can be kept at bay by rigorous adherence to the VASI slope or VDP. Also, any of the new non-precision GPS IAPs that have an FAA-published VNAV slope are 34:1 clear below the MDA required obstacle clearance baseline to touchdown. Consider the published GPS non-precision VNAV slope to be a VDP equivalent, not a precision descent path.

Number 4 is self-defining. It could be any non-precision approach with a straight-in visibility of one mile, or greater, and without either a VASI or VDP. Many such approaches have no obstacle alligators at all; others are loaded with below-MDA obstacles. The problem is, without airport familiarity, you have no way of separating the good from the bad.

Then, there's what I call **Super Number 4**. Figure 2 (page 6) is the LOC/DME Back Course-C at Helena, MT. This approach is lined up perfectly for straight-in, yet has no straight-in minimums. You can't even figure out the distance from the FAF to the runway by looking at the chart. Because it's a circling-only approach, the approach isn't "associated" with Runway 9, although that's where it goes, and (according to the AIM) that's where ATC usually expects you to land (AIM 5-4-18d[3]).

The profile baseline distances for this approach are to the MAP, which is prior to the runway. The DME information is from the Helena VOR, which is off-airport from the opposite side of the airport. The descent gradient required from the FAF for a straight-in landing is well over 600 feet per mile (twice that allowed for straight-in minimums).

Runway 9 has a VASI, so this provides good information that the final approach is free of alligators for at least four miles.[4] Where a similar approach has no VASI, though, there might or might not be any obstacle alligators below the MDA ROC baseline for the approach inside the point where descent below MDA would have to begin in order to make a normal descent to a straight-in landing. Without intimate local airport knowledge, you just don't have any way of figuring out what's up unless there's a VASI and/or VDP.

Your lines of defense

Your first line of defense on non-precision approaches is the published VDP. (The VDP fell out of favor in the FAA over the years since inception of the concept about 20 years ago. The FAA recently changed its policy once again, and is now supporting VDPs, where possible.) Basically, in order for an approach to meet the obstacle clearance requirements for a VDP, the final approach must meet VASI siting requirements from the VDP fix to the runway. (Also, other than the non-precision GPS approach procedures, DME must be available in order to have a published VDP.)

The best possible non-precision runway is that with both a VDP and a VASI or PAPI. Although the VASI/PAPI obstacle-clearance area isn't as stringent as that for the ILS glideslope, it's quite adequate provided you can see the VASI or PAPI, and don't use it beyond its certified limits.

We've said it before

For those unfamiliar airport non-precision approaches without either VASI/PAPI or a VDP, it might be a better idea to wait for a nice, sunny day for the first arrival. I probably sound like a broken record with this recommendation, but it's with good reason that I repeat this advice. If you lack good knowledge of the local terrain, especially along the final approach, limit night approaches at such airports to straight-in unrestricted Category I ILS approaches (published minimums of 200 - 1/2).

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[1] The BDL VOR Runway 15 originally had a published VDP, but the FAA incorrectly calculated it at a 3-degree angle, instead of the required 3.5 degree angle dictated by the runway's VASI angle. When this error was pointed out to the FAA in 1994, they removed the published VDP. Had they, instead, relocated the VDP to its correct 3.5 degree angle, the AAL crew would've had a published "heads up" about the requirement to make a steeper-than-normal descent below the MDA.

[2] Advisory Circulars related to FAR 77: AC 70/7460-2J - "Proposed Construction or Alteration of Objects that May Affect the Navigable Airspace" (1/1/96), AC 150/5190-4A - "A Model Zoning Ordinance to Limit Height of Objects Around Airports" (12/14/87).

[3] AIM 5-4-18d: "When either the normal rate of descent or the runway alignment factor of 30 degrees is exceeded, a straight-in minimum is not published and a circling minimum applies. The fact that a straight-in minimum is not published does not preclude pilots from landing straight-in if they have the active runway in sight and have sufficient time to make a normal approach for landing. Under such conditions and when ATC has cleared them for landing on that runway, pilots are not expected to circle even though only circling minimums are published. If they desire to circle, they should advise ATC."

[4] AIM 2-1-2 states that a VASI ensures obstacle clearance for 4 nautical miles. Note that nothing is said about obstacle clearance provided by a PAPI. Advisory Circular 150/5345-28D - "Precision Approach Path Indicator (PAPI) Systems" (5/23/85) advises airport operators to provide PAPI obstacle clearance for at least 4 **statute** miles.