ADF: FOLLOW THE NEEDLE

The ancient art of NDB navigation is as familiar to most pilots as plotting a course using the stars and a sextant. Here's what you really should know.

by Fred Simonds

In a simpler time, demonstrating an NDB approach was a fixture on an instrument check ride. In preparing for my own test I came to love NDBs for their intuitive simplicity, for the speck of brainwork needed, and for the opportunity to show mastery of something new, yet old.

ADFs have all but vanished in newer airplanes, and if you find one in an older plane there's a good chance it will have an "INOP" sticker pasted to it. GPS is the standard today, so it's no surprise that instrument students wonder why they even need to know anything about NDBs. Yet these seemingly ancient beacons persist in small numbers, guiding pilots from cloud to ground just as they have for 70 years.

History

Introduced around 1937, NDBs followed Jimmy Doolittle's historic first instrument flight in 1929 by only eight years—remarkable progress in so little time. The venerable ILS, still the gold standard of instrument approaches, emerged in 1941.

The NDB revolutionized the nascent airline industry because for the first time airlines could offer reliable service into airports with less than VFR weather. Even today, an airport with an NDB approach offers something like 600-1 minimums, which is a lot better than 1000-3 for basic VFR. The NDB at least offers you a shot at making it into the airport.

In the early days, there was no "automatic" adjective preceding the words "direction finder." The airplane had a loop antenna turned by hand until a null, or weakest signal point was heard. Reading the azimuth, the pilot then had to figure out which heading would lead to the station.

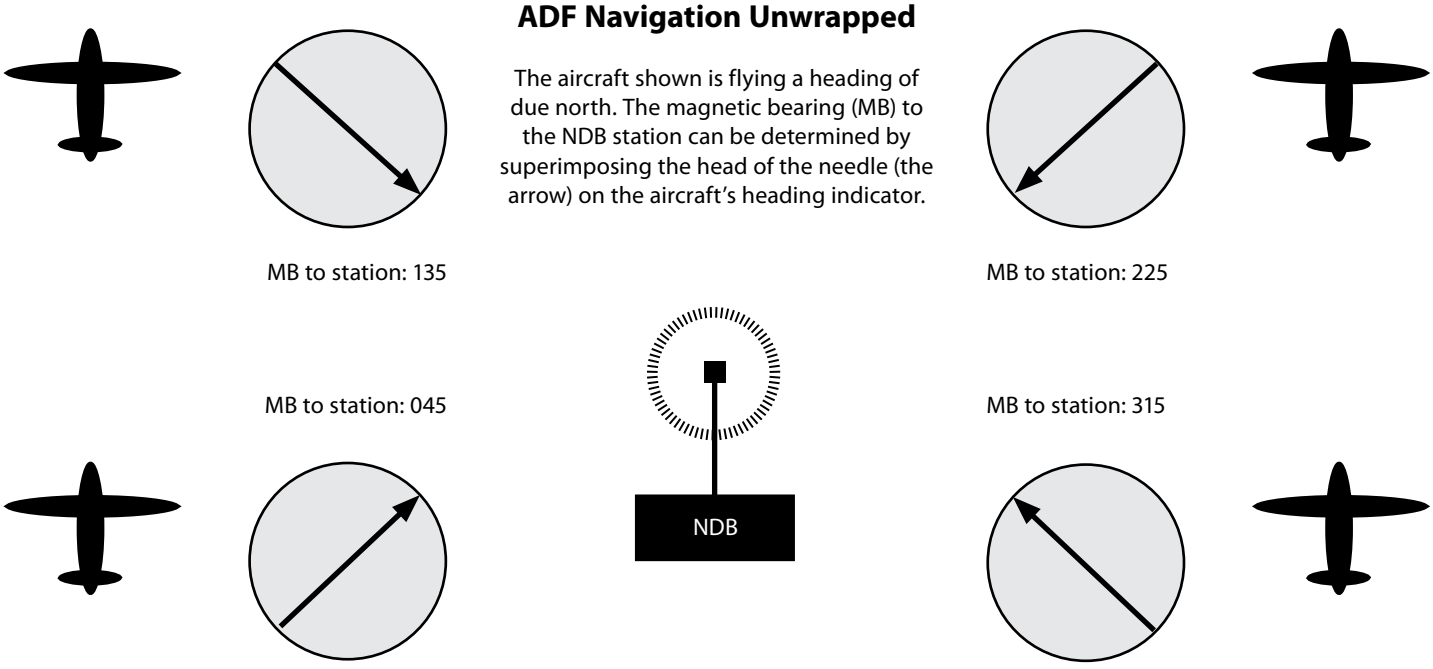
Orientation procedures were standard fare then, and their remnants remain with us in today's NDB work. This particular orientation called for the pilot to turn the airplane to a heading perpendicular to the null. Analyzing the geometry, this means that the airplane must be heading away from the station. The null was then continually checked until the bearing changed about 10 degrees. A bearing that shifted toward the tail was the bearing to the station; if it shifted toward the nose it was the reciprocal.

This method had the secondary advantage of easy calculation of time to station. Simply divide the time in

(Continued on page 12)

ADF Navigation Unwrapped

The aircraft shown is flying a heading of due north. The magnetic bearing (MB) to the NDB station can be determined by superimposing the head of the needle (the arrow) on the aircraft's heading indicator.



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seconds it takes to fly 10 degrees of bearing change by 10 and you have time in minutes to the station.

Inefficient as it was, this orientation allowed pilots to fly toward or away from an NDB or intercept a given track much as we find a VOR intersection today. Some orientation methods were even worse, requiring a full 180-degree turn away from the station.

Extolling the Humble ADF

VORs make ADFs look simple, and they are. There are no radials or reciprocals. Neither is there a TO/FROM indicator. With ADF, reverse sensing is not possible. Except for setting the frequency, you never have to touch it. There is no "twist" and hence no way to set an OBS incorrectly.

To get magnetic bearing to or from the station, mentally superimpose the ADF needle tip (or tail) atop your DG. You'll instantly be able to figure out the magnetic bearing to the station (MBTS) or from the station with no need for the unwieldy MH (magnetic heading) + RB (relative bearing) = MBTS calculation.

ADFs are intuitive. You always know where you are because the needle tip always points toward the station. Tune in the compass locator on an ILS if it has one. Even if ATC vectors you like a pretzel toward the localizer, you will always know which way it is to the FAF. ADF is great for situational awareness and requires no work on your part.

Unfortunately, there is no direct way to accurately know distance from an NDB station without maneuvering. But how much can you ask from 1930's technology?

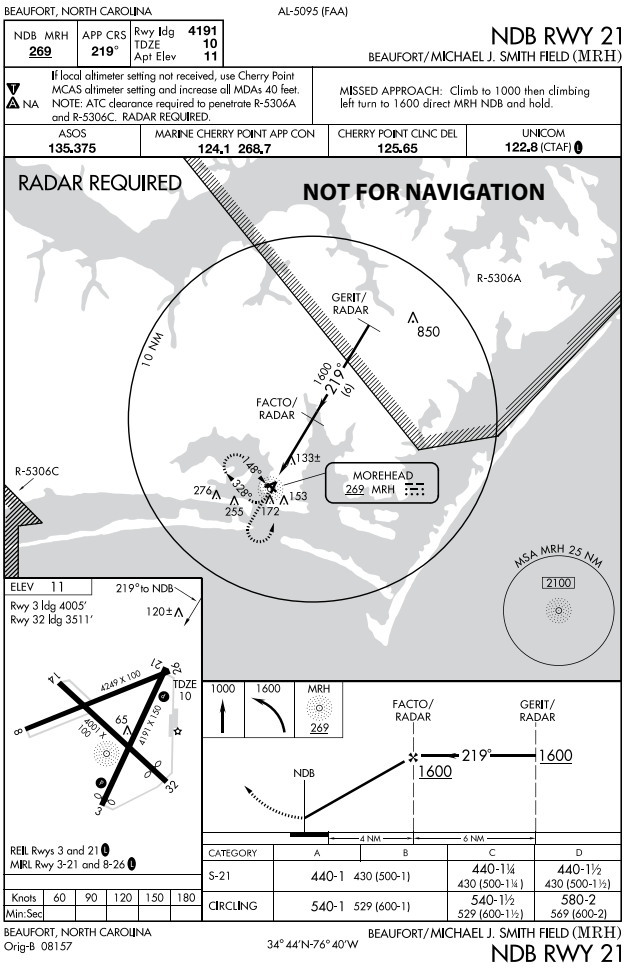
Do You Really Need To Know This Stuff?

Yes, if you're still working on your instrument ticket. ADF procedures are still included in the Practical Test Standard (PTS) for the instrument rating. Instructors are obliged to train students to meet the requirements outlined in the PTS. It doesn't matter whether there is an ADF in the airplane, or whether it works. NDB principles and skills can be taught using a desktop training device or even Microsoft Flight Simulator (though you can't log the hours doing so).

The instrument rating knowledge test is peppered with ADF/NDB questions, and the subject is fair game for the examiner during the ground portion of the practical test, regardless of whether it will be possible for the student to demonstrate ADF procedures during the flight test.

NDB Is Sometimes the Best Option

In 2005, the FAA proposed eliminating 479 NDB approaches that it considered redundant. The Aircraft Owners and Pilots Association investigated and concluded, based in part on AOPA member comments, that 25 of these NDB approaches actually represented the best approach available at those airports for non-GPS equipped aircraft. One of these approaches, the NDB Rwy 21 approach at the Michael J. Smith Field Airport in Beaufort, North Carolina (below), is the only straight-in, non-GPS approach available to Runway 21. The straight-in minima on this approach are 440-1 whereas the circling minima for the LOC Rwy 26 approach are 540-1.



ADFs In Practice

NDB approaches are still around and will linger for some time. That in itself is sufficient to justify staying current on NDBs. An instrument-rated pilot is expected to be able to fly any departure, approach or arrival procedure except for those approaches calling for additional certification. Though rare in real world instrument flying, what with the plethora of GPS approaches available throughout the country, an NDB approach might be the only way to get into the airport you desire.

Approaches are by no means the only place NDBs are used. An NDB can also be the holding fix after an approach even if the approach itself is not an NDB. Those of you who operate in a non-radar environment especially know that an NDB is sometimes used as a compass locator to help find your way to an ILS. The FAA expects

these locators to remain in use until the ILS system is phased out, for which they have set no date.

While no longer common, the venerable NDB will continue to serve as an en route navigational aid as in Alaska and in the Gulf of Mexico. Being low frequency, NDB signals follow the curvature of the earth and so offer much greater range than VHF VORs, which are line-of-sight.

Internationally, thousands of NDB stations remain on line. In this hemisphere alone they abound in Canada (especially northern Canada), Mexico and the Caribbean.

AIM 1-1-19(d)(1)(b) requires aircraft using GPS under IFR to be equipped with an appropriate, approved and alternate means of navigation, unless the GPS is WAAS-capable (see AIM 1-1-20(c)(7)). Most of us take that to mean VOR, but if you fly sufficiently far off the beaten path without WAAS, the humble NDB may become your only legal alternative.

Decommission By Attrition

The word on the street is that aging NDB stations will be decommissioned as they fail or are damaged. Internationally, the International Civil Aviation Organization is being asked to rapidly decommission NDBs worldwide to save money.

There are exceptions. The FAA's 2005 Federal Radionavigation Plan (the latest FRP available) says: "Most NDBs will be phased out with the exception of those that serve International Gateways, and within Alaska. Certain offshore areas like the Gulf of Mexico will be retained. Some NDBs may also be retained where required to provide guidance for missed approach procedures."

At the time of the 2005 FRP, the National Airspace System included more than 1,300 NDBs, of which the FAA owned only 225. The majority were owned by state and municipal authorities, which, logically enough, own the airports upon which many of these stations sit. Some municipalities have begun to discourage use of their NDBs by publishing NOTAMs warning that a beacon is unmonitored. It may be working when you get there, and it may not.

For the FAA's part, the FRP says, "Expenditures for beacons are planned to be limited to the replacement of deteriorated components, modernization of selected facilities, and an occasional establishment or relocation of an NDB used for ILS transition."

Historically, the aviation industry is hesitant to let go of old but trusted technology. The NDB might be a dying breed of navigation aid, but it's not dead just yet.

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