JEFF SKILES

The Nondirectional Beacon

Your grandfather's navigational aid

BY JEFF SKILES

IN RECENT MONTHS I have written about several different navigational aids now long relegated to the annals of aviation history. I really hadn't intended to do a series on the subject, but one thing led to another and I ended up writing columns about the lighted airway system, the four course range, and the visual aural range. All of these are long gone today, of course, but one pioneering navigational means is still very much among us: the nondirectional beacon (NDB).

The nondirectional beacon is a simple enough device, and its entire operational function is represented in its name. It broadcasts a signal, and unlike most other navigational aids there is no directional component whatsoever. NDBs use the low-frequency range of the radio wave spectrum typically broadcasting on 190-435 kilohertz. This is just below the AM radio band thus allowing innumerable pilots of yesteryear to tune in airborne entertainment in the days before XM radio.

The reception range of a particular station is dependent on a variety of factors, not the least of which is the power that is brought to bear. A low-power station might be useful as a localizer beacon to identify the outer marker of an ILS. High-power NDBs are more suitable for long-distance navigation. Across the largely empty plains of Canada a combined VOR/NDB airway can extend for hundreds of miles. The NDB, and VOR are co-located at either end of the airway. The very-high-frequency VOR will set you on course for the first 40 miles or so and pick you up on the other end, but it is useless in the middle reaches of the airway. The intervening miles are flown by tracking to or from an NDB.

RADIO DIRECTION FINDER

While the NDB itself hasn't changed much over the years, the onboard equipment to receive the signal and interpret its meaning has evolved greatly. The early receiver was called a radio direction finder (RDF). The RDF used a mechanically operated loop antenna that would project from above or below the cockpit. Looking like a vertical basketball hoop it could be cranked around until a null was detected (minimum aural signal); the azimuth position of the antenna could then be read as a bearing to the station. Two such bearings or better yet three could be plotted on a chart and fix the position of the airplane. The actual plotting of the azimuth bearings must have been problematic in an airline cockpit, though. The DC-3 hardly boasted a steamship-sized chart table.

AUTOMATIC DIRECTION FINDER

The introduction of the automatic direction finder (ADF) significantly improved conditions by displaying a continuous bearing to the station with reference to the nose of the aircraft. This real-time information allowed the NDB to be useful for instrument approaches.

Because both NDB transmitters and ADF receivers are fairly cheap to buy and maintain, NDB approaches consequently proliferated. The NDB approach falls into the category of nonprecision approaches, although many would argue that the word precision, non or otherwise, belongs nowhere in the name. However, with appropriately high minimum descent altitudes and limited distance between the fix and the field, the NDB brought all-weather capability to many small airports. Even today NDBs are liberally strewn across the sectional chart in some areas of the country.

Automatic direction finder and control panel

THE NDB APPROACH

Without going into extensive detail, an NDB approach is conducted by comparing the aircraft's heading with the bearing to the fix displayed on the ADF card. Instrument students learn that one must "track" to the station in the same manner as we crab into the wind on final approach to a runway. For instance, if the course to the station is 270 degrees, and the wind is from the south, one might fly 265 degrees crabbing into the wind and expect to see the ADF needle pointed 5 degrees to the right of the nose. After station passage one would conversely expect the needle to point 5 degrees to the left of the tail. If the stars are in alignment, the appropriate wind correction should place the aircraft on the prescribed approach course.

RADIO MAGNETIC INDICATOR

Since all this was done by comparing the heading on the directional gyro with the bearing on the ADF card, further improvement was envisioned by combining both into one instrument. This was called a radio magnetic indicator (RMI), and the RMI alleviated much of the mental gymnastics required to successfully hold a course.

NDBS ON THE AIRLINE

When I first began flying at the airline 30 years ago we still had ADFs installed in the jet, albeit the fancy ones with an RMI readout. Because NDB approaches were still listed in our airline's ops specs, we needed to demonstrate them on checkrides, too. A full procedure turn was part of the drill as well, and being "nonprecision" there was no glide slope, calculated or otherwise. We would "dive" the three-holer (Boeing 727) to the minimum descent altitude and "drive" to the missed approach point. All very old school. If the sim instructor was feeling particularly Machiavellian, the approach might be conducted with an engine out as well.

I would generally throw in a few degrees of left correction to account for a crosswind and hope for the best. The crosswind in these early sims always seemed to be 10 knots from the left. At 140 knots or so you arrived at the missed approach point too fast to get significantly off course. But, we still used to joke that the acceptance of an NDB approach on the line really needed to be accompanied by the declaration of an emergency given how rarely we conducted them.

NDB AT CLEVELAND

Every six months we would accomplish our requisite NDB approach in the simulator with no further exposure on the line. But, even for an airline pilot, a steady diet of ILS approaches can't always be guaranteed. There was a period of time about 25 years ago when the ILS wasn't in operation for the northeast runways in Cleveland. If memory serves it had something to do with runway construction or resurfacing. This unfortunate occurrence coincided with a month of trips for me to the city by the lake. It always seemed to be my leg to Cleveland; I think the captain carefully planned it this way. For the first three weeks of my Cleveland assignment Indian summer weather placed the field in clear view from minimum vectoring altitude leading to uneventful arrivals. The fourth week however, my luck ran out!

The ATIS advertised low clouds and poor visibility. The disembodied controller's voice cheerfully proclaimed that we should expect the NDB. Grrrr. At least the approach radar worked and we could get radar vectors onto final. The wind wasn't particularly strong, and I configured early. Approaching the fix my eyes rarely left the RMI as I watched expectantly for the needles to flip from intently pointing off the nose to somewhere behind the tail. My plan was to descend rapidly to the MDA and hopefully get the runway in sight for a visual before this all got too far out of hand. The needles flipped. I started the clock to time the segment to missed approach and focused like a laser on the 060 heading on the RMI. At our airspeed we would need a 700 fpm descent rate to get down to MDA before the missed approach. I opted for 1,000 to get down early and hopefully have a little more time to look around. Fortunately, just as I was bringing up the power to level out at minimums, we popped out of the deck with the runway in sight over the nose, thus successfully ending my first and only "for real" NDB approach in a transport category airplane.

I believe others with considerably higher standing on the airline's organizational chart may have held a similar antipathy for NDB approaches because shortly after this experience, they were mysteriously removed from our ops specs negating the need for testing or practical application. I haven't shot an NDB approach since.

Certainly within the coming years GPS will render the lowly NDB obsolete. In fact, other than CAT II and III precision approaches, possibly all instrument procedures will be defined solely within the digital memory of our onboard GPS receivers. But, the NDB has served proudly for the better part of a century safely guiding aircraft to their eventual destinations and deserves a place of honor as certainly the longest lived navigational aid extant. EAA

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