FOUR-COURSE RADIO RANGES

In navigation, the good old days weren't

BY BARRY SCHIFF

TO those who have been flying long enough, the GPS revolution of the 1990s is reminiscent of the VOR revolution of the 1950s. This is when "omniranges" began to replace obsolescent four-course radio ranges, which had been the backbone of the federal airway system since the late 1920s. Like the VOR, the four-course range provided courses that led directly to or from a station. But that is where the similarity ends. VOR provides guidance along 360 radials, while the radio range offered only four beams (or legs). Another major advantage of VOR is that it provides guidance visually; pilots observe and make heading changes according to the silent dictates of a course-deviation indicator. Pilots of the radio-range era, however, were continually assaulted by loud, static-filled signals, and to remain on course they had to interpret what they heard through their earphones. It was a fatiguing process. ● An advantage of range flying was that it required only an inexpensive, low/medium-frequency receiver with a 200- to 400-kHz band. Although L/MF navigation was not subject to line-of-sight restrictions, reception range was limited by station power. ● It is said that to understand where we are going, we should know where we have been. So, "Return with us now to those thrilling days of yesteryear. From out of the past…" come those ear-splitting, nostalgic

Mint Canyon
LANG
Saugus
Newhall
NEWHALL
209 EHA
No voice
SANTA SUSANA MTS
TWIN LAKES
Twin Lakes Park
San Fernando Res
San Fernando
SAN FERNANDO
1168 L H 36
Sanatorium
Hospital
Reservoirs
WHITEMAN
1033 - H 39
Granada
Chatsworth
Northridge
BURBANK RADIO
248 BUR
Plant
VALLEY
Four stacks
Gravel pits
LOCKHEED AIR TERMINAL
775 L H 58
260 ILS DF
118.7 126.2 257.8 122.7G
GLENDALE
341 GCE
No voice
Sunland
Tujunga
La Crescenta
34°15′
BERRY
Golf course
Canoga Park
Reseda
School
Van Nuys
BS KMPC 710
VAN NUYS
800 L H 80
281 120.1 126.2 257.8 DF
Calabasas
Woodland Hills
Tarzana
Los Angeles R
BURBANK
GLENDALE
Studios
Golf course
Planetarium
Hollywood Bowl
HOLLYWOOD HILLS
Topanga
MOUNTAINS
Fernwood
Control zone eff. 0700-2300
Houses
Topanga Beach
Open-air theater
LOS ANGELES
City Hall
Tall bldg area
SANTA MONICA
University
Hospital
Studios
BS KABC 790
BALDWIN
STADIUM
Ball park
34°00′
BAY
Gas tank
SANTA MONICA
175 L H 50
201 120.3
126.2 257.8
122.6G
LOS ANGELES RADIO
332 LAX
TEMPORARY
LOS ANGELES RADIO
115.1 XLS
HUGHES (Pvt)
22 - H 88
126.2 259.2
Playa del Rey
El Segundo
Stacks
Hawthorne
Derrick 301′
LOS ANGELES INTNL
126 L H 120
GCA ILS DF
278 118.9
379.1 122.7G
HAWTHORNE
64 L H 45
400 121.3 257.8
COMPTON
Compton
V 299 W
V 27
272°
242°
076°
046°
008°
188°
318°
321°
340°
010°
042°

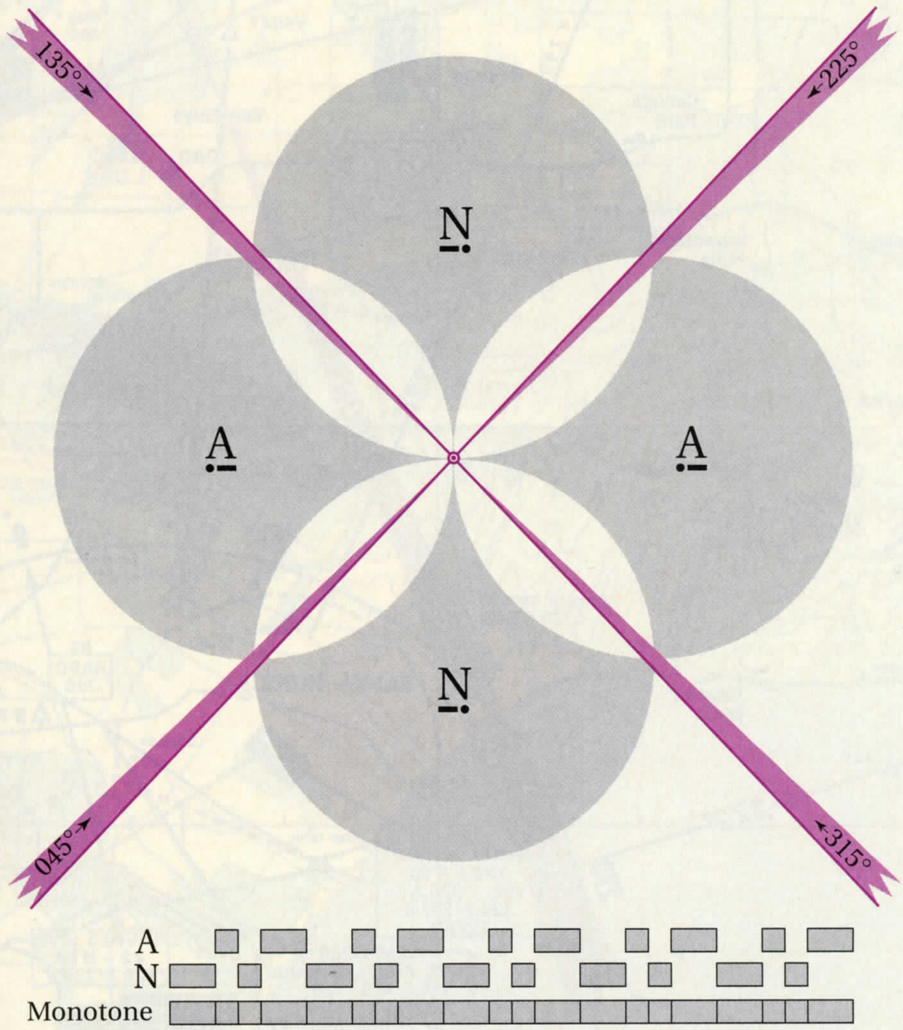
sounds that help us to appreciate what pilots of another era had to endure. You will never again complain about VOR navigation and its limitations, despite how archaic it might appear when compared with GPS.

In 1927, the Ford Motor Company used the first of its Tri-Motors to fly auto parts between Chicago and Dearborn, Michigan. That is when a young Ford engineer, Eugene S. Donovan, developed and patented the "four-course, loop-type, low-frequency radio range." The first two ranges were installed at Chicago's Lansing Airport and the Ford Airport at Dearborn. Both proved successful in guiding pilots during inclement weather and improving the reliability of cargo operations.

After extensive testing, the Bureau of Air Commerce (FAA's original predecessor) installed the first of more than 400 radio ranges that were to crisscross the country and form the civil airways (known then as radio-beam highways). In a manner similar to the procedure for VOR, pilots flew inbound to a radio range along one of its four courses, passed over the station, proceeded outbound along another beam until receiving the next range station along the airway, and so on.

Pilots who understand the radio range will never complain about the VOR or its limitations.

These low/medium-frequency airways were named by using four colors, a scheme still used elsewhere in the



The four-course range station included a pair of loop antennas. One transmitted a figure-eight pattern of the Morse code letter A (dot-dash), while the other transmitted a pattern of Ns (dash-dot). The patterns of As and Ns overlapped to form four legs (or beams) that were used to track to or from a station.

world. East-west airways were designated as Green or Red, while north-south airways were Amber or Blue. Airways also were numbered (Amber 1, Green 4, and so forth). Victor airways are so named because they are based on VHF radio aids.

The original radio range consisted of a pair of loop antennas set above the ground at right angles to one another. One antenna transmitted the Morse-code letter N (dash-dot) in a figure-eight propagation pattern (as shown in the figure), while the other radiated the letter A (dot-dash) in a figure-eight pattern that was similar and perpendicular to the first. In other words, if a pilot flew within either the north or south loop in the figure and had the receiver tuned to the proper frequency, he would hear an N repeated over and over again in Morse code. If he were within the east or west loop, he would hear an A. This is why four-course ranges were also called A-N ranges.

Note, however, that the four loops of the two figure eights overlapped in four areas to form the four beams (or legs) of the range. When flying along such a leg, the dots and dashes of an A loop are interwoven with the dashes and dots of an N loop so as to form a steady tone. In other words, the pilot knew that he was *on the beam* when he heard only a monotone signal; if he were not on a leg, he would hear an A or an N, depending on the loop, or quadrant, in which he was flying.

The Burbank range shown on page 63 typifies the way the four legs of a range station were displayed. The Burbank range transmitted on a frequency of 248 kHz. To receive this station, the pilot would turn on his "low-freq" receiver, wait for what seemed like an eternity for the tubes to warm up, turn the coffee-grinder-style dial to the proper frequency, and continue fine-tuning until he heard the Burbank range. The station identifier, BUR, was transmitted in Morse code every 30 seconds, first to the N quadrants and then to the A quadrants.

Notice that the A and N quadrants are not identified on the chart. The pilot had to know that an imaginary line drawn from the station toward true north always passed through an N quadrant. Going clockwise, the remaining quadrants were A, N, and A, respectively. (If a leg were aligned with true north, the northwest quadrant was designated as an N quadrant.) The dark magenta line charted on one side of each leg also enclosed and designated the N quadrants.

Although the legs of the Burbank range formed right angles, the legs of many other ranges were not laid out quite so neatly—because it was desirable to align the range legs with bends in the airways. Consequently, the legs of some range stations were laid out in a crow's-foot or scissors-shaped configuration.

Assume that a pilot was somewhere to the north of the Burbank range and wanted to intercept and follow the north leg to the station. He would first tune to 248 kHz and listen. If he heard an N, he would know that he was west of the north leg and needed to turn east for the intercept; similarly, if he heard an A, he would turn toward the west. Upon intercepting the north leg, the pilot would hear a steady tone and turn to a magnetic heading of 188 degrees

Charts did not identify the quadrants; pilots had to know their orientation relative to north.

(the charted inbound direction of the north leg). He remained on course by altering heading as necessary to avoid drifting into the N quadrant to his right or the A quadrant to his left.

Progress toward the station was confirmed by an increase in signal strength as the pilot got closer. To detect this increasing volume, he had to turn off the receiver's automatic volume control. (The AVC was used when listening for pleasure to AM broadcast stations.)

As the pilot proceeded inbound, signal strength continued to build, which necessitated turning down the volume with increasing frequency. As he approached the station, the 3-degree-wide leg became narrower and more difficult to track. Finally, as he passed over the station, the volume would suddenly die. This represented passage through the cone of silence, which was directly over the station. After the pilot passed through the cone, signal volume would return. The pilot confirmed station passage—there were false cones of silence—by noting a gradual decrease in volume as he flew away from the station. He also would note a reversal of the A and N quadrants. (South of the station, the A quadrant would be on his right, and the N quadrant would be on his left.)

Although a pilot would know the leg on which he was navigating, he had no way to determine his precise position along that leg. Because necessity is the mother of invention, marker beacons were developed and placed at strategic points along certain legs. These airway markers required that the aircraft be equipped with a 75-MHz receiver and functioned exactly like the markers associated with current instrument landing systems (ILSs). When passing

Of quadrants and bisectors

There were six orientation procedures that pilots could use to establish position with respect to a four-course range. Each was relatively complex, time-consuming, and selected according to the signal heard from a given station.

As an example of one such procedure, assume that a pilot tuned to a nearby station and heard an A signal. He knew, therefore, that he was in either the east or west quadrant shown in the figure. He then calculated average bisectors, lines that crossed at right angles and bisected each of the four quadrants. To obtain the bisectors, the directions of all legs were added (760 degrees, in this case) and the sum divided by 4. This resulted in the bisector of one quadrant (190 degrees). The remaining bisectors were obtained by adding and subtracting 90 degrees to and from the 190-degree bisector.

The pilot then turned parallel to the bisector of one of the two quadrants in which he was located (100 or 280 degrees). If he turned to 280 degrees, he would maintain that heading until determining whether signal volume faded or increased. A fade meant that he was headed away from the station and therefore was in the west quadrant. He then reversed course and confirmed that he was inbound to the station by listening for volume to increase.

The pilot eventually intercepted

Not all ranges were laid out at right angles. Some had scissor or crow's-foot configurations.

over a marker, the pilot heard a 3,000-cycle tone and saw the illumination of a white marker-beacon light on his instrument panel, the same tone and light used today to signal passage of an inner marker.

An airway marker transmitted a recurring sequence of dots and dashes according to the leg on which it was located and its position along that leg. For example, two dots and three dashes identified the second marker on the third leg (counted clockwise from true north). There are a number of airway markers still operating in the United States. The identifier of each indicates its previous position with respect to a range station long gone.

Most range stations also incorporated a Z marker that transmitted a steady 3,000-cycle tone and illuminated the white marker-beacon light as the

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either the northwest or southwest leg, but which one? The dilemma was resolved by turning 90 degrees in either direction. If this resulted in a return to the A quadrant, the pilot knew that he had intercepted the southwest leg; if the turn caused him to enter an N quadrant, he knew that he had intercepted the northwest leg. The pilot then maneuvered to re-intercept the identified leg and follow it to the station. Phew!

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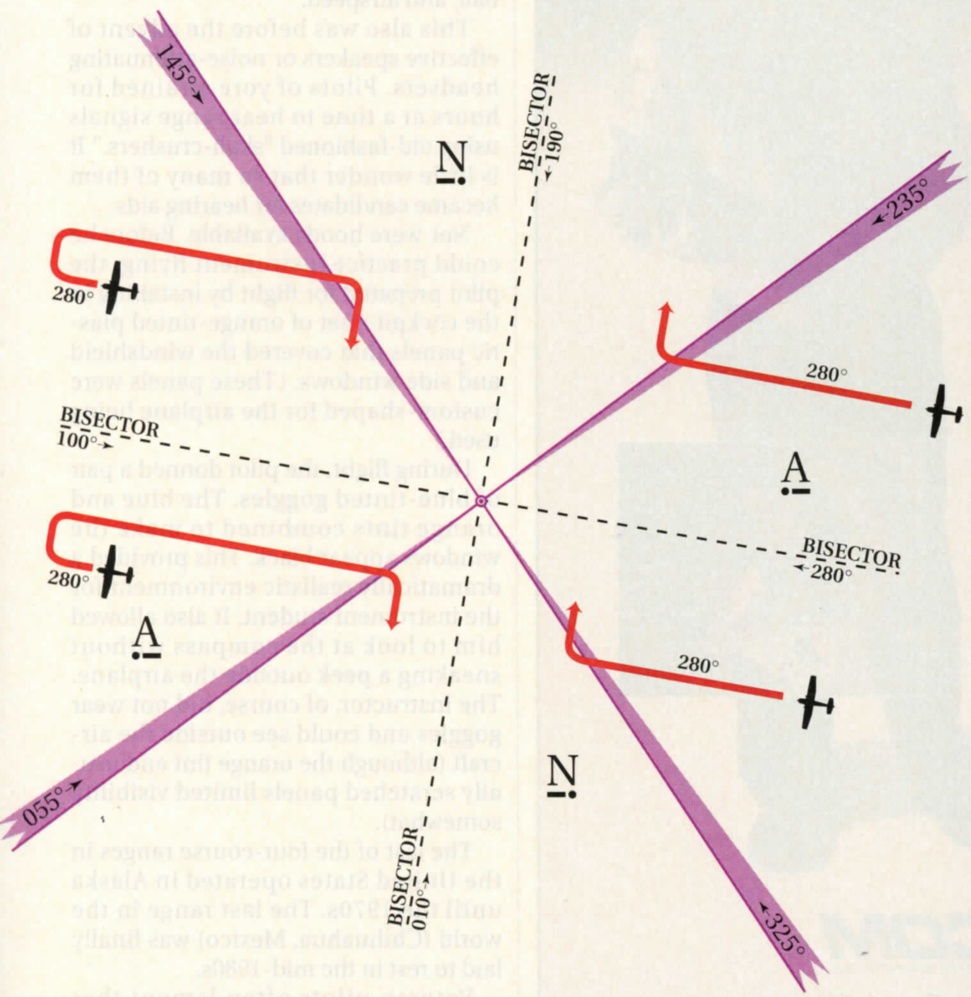

This is one of six relatively complex and time-consuming orientation procedures that a pilot could use to establish his position with respect to a four-course range station.

aircraft passed over the station and through the cone of silence. Both the cone of silence and the reception area of the Z marker increased with altitude in the form of an inverted cone.

There were other complications involved in using a four-course range. These included having to recognize and interpret the meanings of *twilight, bi-signal,* and *clear zones,* terms that might make old-timers a bit misty-eyed. And there were legs that would not behave according to the rule. Under certain conditions, they would split, multiply, bend, shift, or completely fade for agonizingly long periods. And only a masochist would attempt range flying in the vicinity of an electrical storm.

But it was the problem of orientation that drove pilots crazy. This consisted of various procedures devised (by a sadist, no doubt) to help a lost pilot locate a leg and track it to the station. Once there, he hopefully would not have to execute an instrument approach by using one of the range legs (as was required of applicants during a flight test for an instrument rating).

Only a masochist would attempt to fly a radio range in the vicinity of an electrical storm.

The fade-out, 90-degree, parallel, on-course, relative-tuning, and close-in procedures were names of the established methods of orientation.

Making matters worse for early pilots was that they usually had neither an attitude indicator nor a gyroscopic heading indicator. These were not required in general aviation airplanes for IFR flight until the late 1950s. Instead, pilots remained on an even keel by using only a primary instrument panel: "[turn] needle, [slip-skid] ball, and airspeed."

This also was before the advent of effective speakers or noise-attenuating headsets. Pilots of yore strained for hours at a time to hear range signals using old-fashioned "skull-crushers." It is little wonder that so many of them became candidates for hearing aids.

Nor were hoods available. Before he could practice instrument flying, the pilot prepared for flight by installing in the cockpit a set of orange-tinted plastic panels that covered the windshield and side windows. (These panels were custom-shaped for the airplane being used.)

During flight, the pilot donned a pair of blue-tinted goggles. The blue and orange tints combined to make the windows appear black. This provided a dramatically realistic environment for the instrument student. It also allowed him to look at the compass without sneaking a peek outside the airplane. The instructor, of course, did not wear goggles and could see outside the aircraft (although the orange tint and usually scratched panels limited visibility somewhat).

The last of the four-course ranges in the United States operated in Alaska until the 1970s. The last range in the world (Chihuahua, Mexico) was finally laid to rest in the mid-1980s.

Veteran pilots often lament that things were better in the good old days. You can be certain, however, that when they do, they are not referring to four-course radio ranges. □