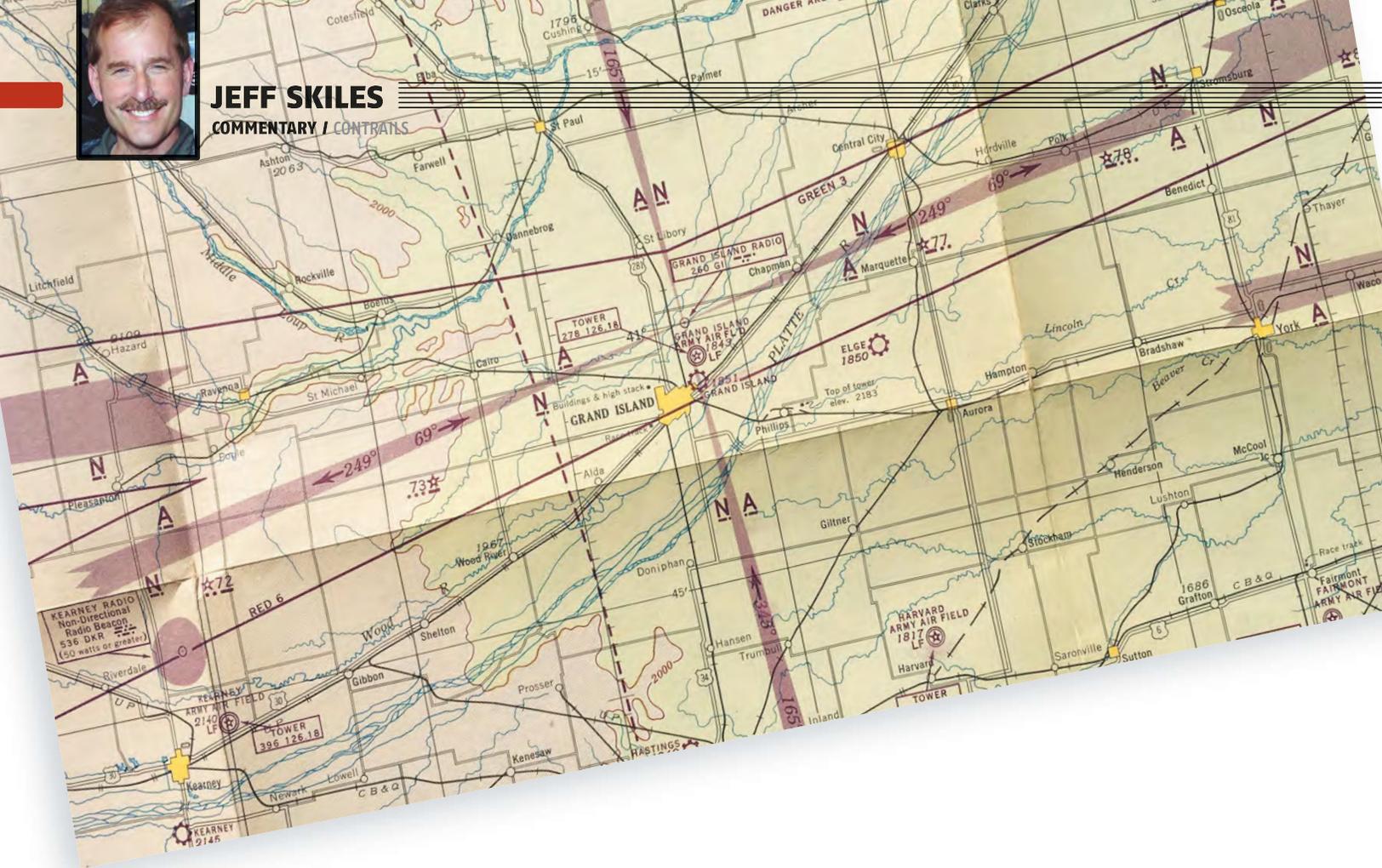




JEFF SKILES
COMMENTARY / CONTRAILS



The Four Course Range

An all but forgotten means of navigating the country

BY JEFF SKILES

LONG BEFORE ANYONE HAD even heard of GPS, and even before the existence of the VOR, pilots flew from coast to coast and even accomplished low approaches to their destinations using an all but forgotten radio system called the four course range.

The earliest of aviators had no recourse but to navigate using the crudest of aeronautical methods — pilotage or, even worse, dead reckoning. Automobile road maps were the only form of assistance to help guide the way. In the 1920s the lighted airway system and associated ground markings began to crisscross the land, but such aids to navigation were only of help when the weather was good enough to see them. Navigating in or above the clouds was still an impossibility with the methods of the time.

RADIO TECHNOLOGY

In the late 1920s radio technology had improved enough to pose a solution to the problem of long-distance navigation. Early efforts harbored little more than what we today call a nondirectional beacon (NDB), a station that merely radiates a signal in all directions. Aircraft with radio direction finding (RDF) equipment could home in on this beacon, but RDF was not the automatic direction finder

(ADF) we know today. An RDF radio employed an overly large directional loop antenna, think of those 1-foot diameter hoop antennas you may have seen on a DC-3. These loop antennas would have to be hand cranked to change their azimuth while the operator listened intently on the frequency for either a crescendo of noise from the Morse code station identifier or the absence of same — called a null. Either could be used to determine the bearing of the station off the aircraft's nose or tail. Two, or better yet three, such bearings could be plotted on a chart to fix an aircraft's position, kind of like celestial navigation, but it wasn't much good for on-course navigation since it could only show you where you had been but not where you were going. Certainly such imprecise plotting was of no use for an instrument approach.

Note: This image is from a 1945 sectional chart; notice the lighted airway beacon symbols co-located along the Red 6/Green 3 airway (Contrails, July 2016, "The Lighted Airway System"). Also, I have some charts of the western states that depict the east and west legs of four course ranges using the Morse code symbols for B and Y rather than A and N. I can find no reference for this in my research. Should anyone have an explanation for this and for how four Morse code signals might be propagated, please feel free to contact me.

THE FOUR COURSE RANGE

Then the four course range revolutionized instrument flying. The four course range was also called a low frequency range, Adcock, or AN range. It consisted of two crossed loop directional antennas that would emit a signal in a figure-eight pattern. This signal would be either the Morse code signal for the letter N (dash dot) or the Morse code signal for the letter A (dot dash). Both were broadcast on the same frequency and could be listened to intently by a pilot in the cockpit. Where the two figure-eight directional signals overlapped the pilot would hear only a steady hum as the dash dot and dot dash merged into a continuous tone. With this the pilot knew he was on one of the four courses of the station, and this was often called "flying the beam" or "on the beam."

The course created by the overlapping signals was commonly 3 degrees wide yielding a 5.2-mile-wide airway 100 miles distant from the station. It was common practice to fly on the right side of the beam, in "twilight" where the faint A or N signal could be heard through the steady tone, for the purpose of traffic separation. Every 30 seconds or so the signal would be interrupted to broadcast the three-letter Morse code identifier for the station in question.

Later designs employed four 134-foot tall ground-based vertical directional antennas at the corners of a square to transmit the signal. These four antennas would often be augmented by a fifth antenna mast in the center of the square that would broadcast weather information on a recurring schedule, or act as a homing signal (NDB).

As you can see in the picture, the Grand Island range had four quadrants. Two N quadrants and two A quadrants. If you weren't on the beam and were only hearing an N, you could only determine that you were

either northeast or southwest of the station, and conversely for the A identifier you'd only know you were southeast or northwest. Therefore, the four course range was great for on-course navigation but somewhat less useful for determining your position if unknown. Extensive and time-consuming procedures were developed to allow pilots to bracket the range signal and orient themselves. The best way to determine whether you were flying to or from the station was simply by listening for the increasing or diminishing volume of the signal.

The four courses themselves did not have to be symmetrical. Ranges with significantly asymmetrical courses were known as "crow foot" ranges, although practical considerations required the four courses to be at least 20 degrees apart.

HATS AND HEADPHONES

Relatively rudimentary onboard equipment could open up the world of navigation for aviators with only a simple AM radio receiver required to capture the signal. Pilots heard their navigation signal rather than seeing it on a gauge as we are used to today. This must be why you always see those cockpit photos of early airline pilots with headphones clamped over their hats. It explains the headphones anyway if not the hats.

NOT PERFECT, BUT ...

The four course range suffered from all the maladies affecting low frequency radio transmissions, like static disruption due to thunderstorms, "night effect" in which radio signals would "skip" off the ionosphere resulting in receiving signals from two different locations sharing a common frequency, and the bending of the beam due to shore effect or mountainous terrain.

Still, it was a vast improvement over what aviators had before, and quickly more than 400 stations were constructed throughout the United States. Some of these radio ranges defined transcontinental airways. East/west airways were labeled either green or red. North/south were blue or amber. The depicted airway shows where Green 3 and Red 6 merge over Grand Island, Nebraska.

THE FIRST INSTRUMENT APPROACHES

Radio ranges were often located next to or on major airports so they could be used for

an instrument approach as well. The pilots would orient themselves by flying to the station and then passing through the cone of silence directly over the top of the station. This cone of silence was the only way to positively identify your position anywhere on a four course range much as we look for the flip-flop of a VOR needle today. At this point the pilot would fly outbound on a leg of the range, accomplish a procedure turn, and intercept the same leg inbound while descending to the published minimum descent altitude. If no airport was in sight when he would return through the cone of silence, a missed approach was warranted.

However, the range could also be quite some distance from an airport. In this case the pilot would fly inbound to the range station on initial approach until passing through the cone of silence, at this point the pilot would turn to a magnetic heading toward the airport, start the clock to time the final approach leg, and descend to minimum descent altitude. Keep in mind that all of this was done with no gyro instruments in the early years, only a turn and bank and magnetic compass. Amazingly crude by today's standards.

Minimum descent altitudes for four course range approaches were often as low as 300 feet, and most were circling approaches. A shockingly low altitude for something that seems even less defined than a non-precision approach today.

TIME MARCHES ON

The four course range was the pre-eminent means of navigation from the 1930s to the 1950s. The advent of the much more capable VOR, however, shrunk the number of four course ranges in half by the early 1960s.

Sometime around 1980 I recall a flight instructor and instrument student at the flight school where I worked making a long cross-country to British Columbia. It was their understanding that the last four course range in North America was still active there. They made this pilgrimage to shoot an approach and experience the trials of early aviators. That range was decommissioned shortly thereafter, ending an era that stretched for half a century. *EAA*

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