The Peculiarities of Holding

Although the idea of holding is widely known, the finer points are relegated to mystery manuals.

By Wally Roberts

AROUND AND AROUND WE GO. That aspect of holding patterns is understood by everyone, even the airline flying public. In fact, holding patterns are in the layman's aviation lore more than any other instrument flight procedure, for obvious reasons.

As instrument pilots and instructors, we spend a lot of time perfecting holding pattern entries and techniques. We even speak in terms of remaining within "protected" airspace. But beyond that, the finer points about holding patterns are relegated to various mystery manuals, more so than most of the TERPs stuff. This article will provide some insights into holding pattern protected airspace. Also, I'll provide some guidelines about what ATC can and cannot do with non-published patterns, and what the pilot should be watching out for in this regard.

Requisite history

The historical holding pattern had two-minute legs, and was known as either the "racetrack" or "shuttle" pattern. Unlike airways and approach procedure criteria, which have always belonged to the flight standards gurus at the FAA (previously CAA), holding pattern criteria historically belonged to the designers of ATC procedures.

In 1961, a particularly astute ATC procedures fellow took a hard look at whether the then-existing holding pattern criteria were up to the task of assuring non-radar separation from IFR aircraft in busy airspace. The advent of civil jet transports and the early 1960s travel boom provided considerable impetus for this review. The result was to completely revamp the holding criteria and procedures and, for the first time, establish different, "canned" holding speed limits for a broad range of aircraft types.

Thirty-one sizes fit all

The consensus of the military, industry, and FAA folks resulted in the speeds most of us are familiar with, plus 265, 280, and 310 knots for some of the more exotic military aircraft of the early 1960s. It was further agreed that turbo-props, although using piston-prop speeds for level flight would use jet level holding speeds for climbing in hold, and all jets could use 310 knots for the climb. 280-knot patterns were to be provided for jets during level holds in turbulent air at high altitudes. Finally, provision was made for 100-knot holding for STOL aircraft.

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All these speed categories had to be protected for holding from 2,000 feet to 50,000 feet msl, with assumptions of increasing true airspeed and winds at 2,000-foot intervals. Further, the basic timed pattern would be one minute from 2,000 through 14,000 feet, and 1-1/2 minutes above 14,000. The result was several-hundred possible patterns, without even considering longer patterns using DME. But through careful analysis, the designer came up with only 31 holding pattern templates to cover all timed pattern possibilities.

Figure 1 (below) is the generic pattern, which can be constructed by the procedures designer using only a protractor and drawing compass. Figure 2 (page 6) provides the dimensions of a selection of the 31 different pattern sizes, from the smallest (No. 1), the typical used for instrument approach procedure (IAP) course reversals (No. 4), the largest used for course-reversals (No. 8), and the largest used for any application (No. 31). This generic template protects for entries from any direction.

As a further example, Pattern No. 12 (not shown) is used for holding at an accurate fix as follows: 175 knots at 28,000 feet, 230 knots at 16,000, 265 knots at 12,000, 280 knots at 8,000, and 310 knots at 4,000. (Less accurate fixes require larger pattern sizes for a given speed and altitude.) Pattern No. 31, the largest, protects for 265 knots at 48,000 feet, and 310 knots at 38,000 feet.

Figure 3 (page 6) shows optional areas that can be excluded by ATC from protection once an aircraft is established in the holding pattern. Figure 4 (page 7) shows

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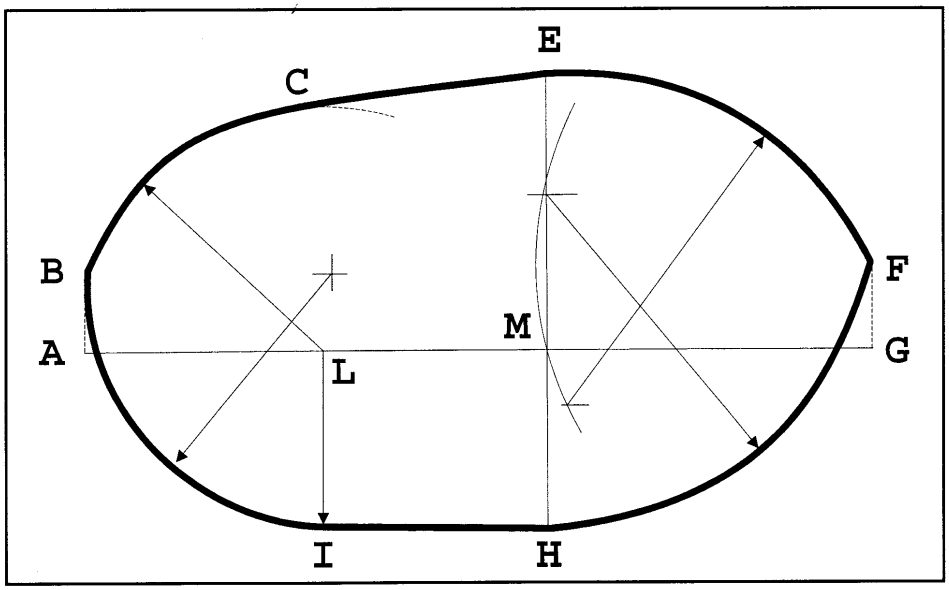

Figure 1. *Holding pattern template. When used in conjunction with the "Holding Area Airspace Dimensions" (Figure 2), any type holding pattern can be designed.*

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end-areas that can be excluded by ATC provided entry is made within specified limits (not shown). These are known as "on entry" pattern reductions. ATC uses these operational advantages in busy airspace, where freeing up those small pieces of airspace can make the difference in freeing up an adjacent airway.

Templates for charted procedures

Holding patterns used in TERPs-developed IAPs, missed approach, and instrument departure procedures can never have "on entry" pattern reductions. Further, the smallest pattern size permitted for such procedures is Pattern No. 4. Also, TERPs holding patterns have a two-mile secondary area, with reduced vertical clearance, surrounding the entire template. These additional constraints are to insure protection from higher terrain.

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Missed approach and departure holding patterns are protected for 310-knot jet climb-in-hold, but only where jet aircraft are likely to use the procedures, and only where terrain penetrates the missed approach or climb obstacle clearance surfaces. The guidelines used by the procedures designers for climb-in-hold are very convoluted today, because of years of inadequate review of criteria implementation guidelines in this regard. So, the conservative word to the wise for jet drivers is to limit low-altitude climb-in-hold during non-radar operations to 230 knots, even if some departure flaps are needed.

Plastic templates for sectionals

The early-1960s plan included making plastic reproductions of the 31 templates for distribution to all ATC controllers. This actually happened for awhile. These templates were similar to Figure 5 (page 7) and were made to a scale of 1:500,000. The idea was for the controller to drop this gadget onto a sectional chart's non-published holding fix to see whether holding would work for a particular aircraft at that fix. Obviously, all of the nuances required were simply too complex for effective implementation of this concept.

Nonetheless, the ATC handbook still makes a vague reference to such a procedure to this very day:

ATC Handbook 7110.67J, 95-7- 3: Do not hold aircraft at unpublished fixes below the lowest assignable altitude dictated by terrain clearance for the appropriate holding pattern airspace area (template) regardless of the MEA for the route being flown.

Published holding patterns

Published holding patterns that appear on today's IAP, departure, and en route charts are developed by the same procedures specialists who develop other TERPs procedures. The official form (Form 8260-2, Radio Fix and Holding Data Record) is prepared after a detailed topographical map study is made by applying the proper combination of the 31 templates. The 8260-2 tells the controller whether holding at the subject fix is restricted or unrestricted. If it is unrestricted, then the controller can use the specified holding fix or facility in any useable direction, without regard to the minimum instrument altitude (MIA) for the area. More often than not, in mountainous areas, holding will be restricted to the published pattern where the authorized minimum holding altitude (MHA) is less than the area's MIA.

A published holding pattern is one that is

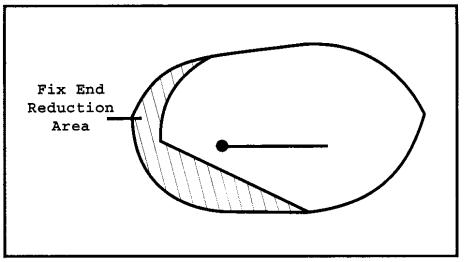

Figure 3. *An entry area that can be excluded by ATC for traffic separation once an airccraft is established in holding.*

documented by the FAA on the Form 8260-2. Not all "published" patterns appear on en route or terminal charts, though. For the sake of charting clarity, only those patterns that are expected to be used frequently are charted on en route or terminal charts. Holding patterns for course reversals (in-lieu-of procedure turn) and missed approach procedures are always charted.

Unpublished holding

The controller is free to hold you anywhere at anytime, provided he or she holds you at, or above, the MIA (center) or MVA (approach control minimum vectoring altitude). Further, the center controller can hold you using the MIA without seeing you on radar. Without radar, the controller is taking on a lot where there are mountains around, unless the MIA being used is usable for many miles around the holding fix.

What about that occasional unplanned hold, where you must hold because you've either reached a clearance limit, and can't get a word in edgewise, or because of lost com procedures? If there are mountains

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HOLDING AREA AIRSPACE DIMENSIONS (Nautical miles)

Pattern/ Template No.	A-L	L-M	M-G	L-I M-H	M-E	A-B G-F (J-K)	(J-L)	Total Length	Total Width
1	3.5	3.7	4.4	2.6	4.1	1.2	2.5	11.6	6.7
4	4.5	4.3	5.6	3.5	5.3	1.5	3.3	14.4	8.8
8	6.5	6.8	9.3	4.9	7.7	2.3	4.7	22.6	12.6
31	30.9	17.0	37.0	22.5	34.5	11.0	21.9	84.9	57.0

Figure 2. *Four of the 31 pattern dimensions used to construct holding pattern templates.*

nearby, and there's no published hold, there might or might not be adequate airspace for holding. It might be that only the four-mile width of the airway has been evaluated at that fix. So, if you have to hold in such circumstances, it's best to do it at the lowest feasible airspeed, just to cover your bets until you can communicate and ascertain with the controller that holding is protected at the limit fix.

Pilot requested variations

Controllers are encouraged to approve pilot requests for higher holding speeds and longer holding legs. Controllers are inclined to approve such requests based on the lack of conflicting traffic. However, if

More often than not, in mountainous areas, holding will be restricted to the published pattern where the authorized minimum holding altitude (MHA) is less than the area's MIA.

the controller either cannot see you on radar, or is too busy to monitor the pattern, you might very well leave the airspace protected for holding. If you're at 8,000 feet over Illinois, who cares? But, if there are mountains nearby, you might want to think twice about requesting a clearance to modify the published pattern.

"Recommended" holding entries

Are the three entry methods set forth in AIM Section 5-3-7 mandatory, recommended, or just plain optional? Well, the FAA waxes and wanes on this, primarily because of lack of corporate memory. The fellow who designed all of this, circa 1961, considered those three entries to be the only acceptable means of entering the hold (with a five-degree ambiguity cushion). So, at a fuzzy fix (some intersections where the facility is a great distance away or forms a small angle) and at maximum permitted speed, the entry could be critical.

Further, he designed the turning criteria with either a standard rate turn, or 30-degree banked turn, whichever is less. The 30-degree banked turn is considered to be 25 degrees "achieved." Some of today's jet autoflight systems do lazy 10- or 15-degree turns in the hold. Such bank angles at jet holding speeds are simply inadequate.

Speeds for jets

A few years ago, because of a lot of user complaints from the jet set, the FAA decided to change jet level-flight holding to 265 knots above 14,000 feet, and to 230 below 14,000. The 265 knot decision was fine, because there was already a 265-knot selection table in the book. Alas, because of lack of corporate memory, the folks in 1989 thought that the "200-230" selection table in the book meant that any speed within that range was okay.

However, the fellow who wrote the book thought everyone would understand in context that "200-230" meant 200 knots, 6,000 feet and below, 210 above 6,000 through 14,000, and 230 above 14,000. (He assumed too much). Until my committee brought this to the attention of the FAA in

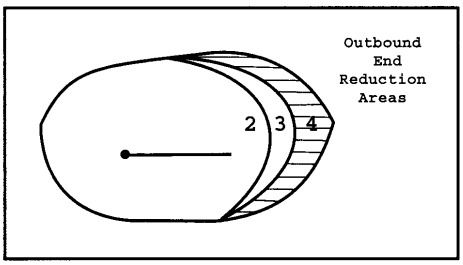

Figure 4. *End areas of a holding pattern that can be excluded by ATC for traffic separation, provided entry is made within limits not illustrated in this article.*

1993, jets were routinely busting protected airspace by holding at 230 knots in patterns designed for either 200 or 210 knots.

Subsequent reviews in some tight center airspace (notably New York City and Washington, D.C.) have revealed that 200 or 210 knots will be the maximum jet hold-

Wind studies subsequent to the early 1960s have shown that the wind assumptions contained in the present holding pattern criteria are inadequate for some conditions.

ing speed at some fixes forever. At most other places, 230 knots will become the norm for en route jet holding at 14,000 feet, or below; but with one permanent exception: IAP course-reversal holds will always be limited to 200 knots in order to preserve minimums in existing "canyon" IAPs.

The future

Wind studies subsequent to the early 1960s have shown that the wind assumptions contained in the present holding pattern criteria are inadequate for some conditions. The criteria are under general, but very slow, review. The future will probably see smaller patterns for autoflight aircraft that can fly closed-loop patterns, and larger patterns for some other operations. Perhaps, also, we will see specific maximum speeds charted for each pattern, or at least for each pattern that is an exception to the norm.

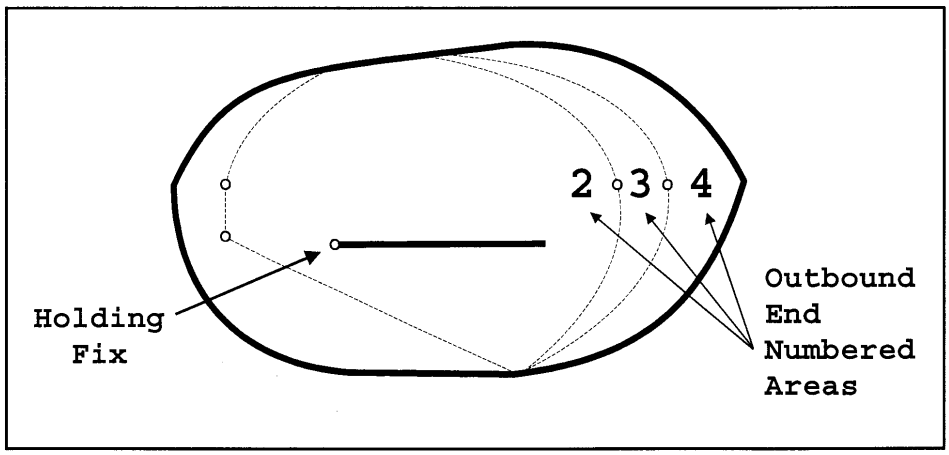

Figure 5. *Thirty-one different plastic templates like this one were intended for use by controllers on sectional charts. The small circles are holes for a controller's pencil. This concept never went very far.*

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