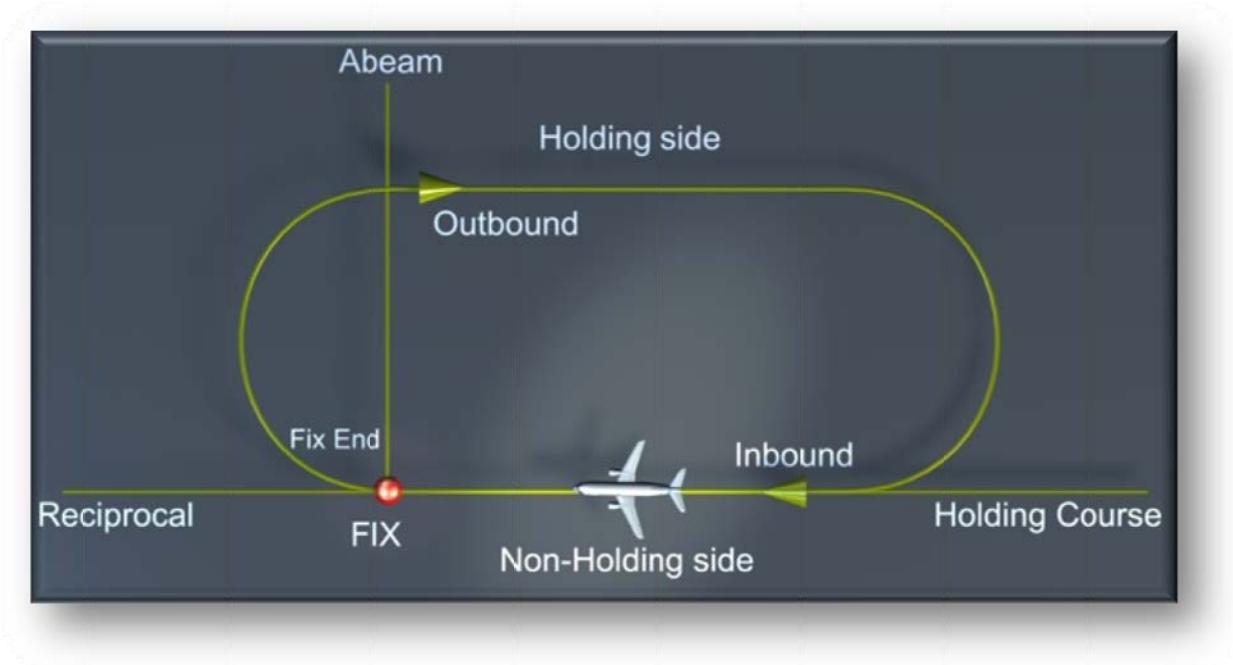
HOW TO “STOP” WHEN YOU ARE AIRBOURNE.

Holding Patterns are very important. In this lesson we will learn why they are so important and how to execute them.

Imagine you are nearing Schiphol and you are at HSD VOR. It is very busy at the airport, there are 40 planes waiting to land. Runway 36R is active and ready to accept traffic, but obviously not all 40 planes can land at once. In that case you would be made "stop" in the air. This "stop" would happen at a VOR, NDB or intersection. The stop consists of flying a circular circuit around that point till such a time that ATC tells you that you can continue your flight. This mid air "stop" is called a Holding Pattern.

Such a "Holding Pattern" is important as you can see, for only one thing, and that is to reduce the traffic flow to the runway.
What we need to know to perform a Holding Pattern is not that difficult, but you do have to know a number of rules.

First we will look at what a Holding looks like on the map.



Most turns in a Holding Pattern are to the right. This is the standard, but it could also be the other way around and you may have to make left turns. This would be shown on the charts.

On the picture you see at first glance, a red point, it is called the FIX. This FIX is based on an Intersection, VOR , NDB or VORTAC stations.
Let's briefly explain some terms:

FIX

- The "Hub" of the Holding Pattern. Everything is based on the so-called FIX time, distance and navigation.

FIX END

- The end of the racetrack pattern. Here you would start your turn for the outbound leg.

ABEAM

- The point at which the aircraft is at a 90 degree angle to the FIX.

HOLDING SIDE

- The outbound leg of a holding pattern

OUTBOUND END

- The end of the racetrack pattern which is also the furthest away point from the FIX.

HOLDING COURSE

- The course of the holding pattern, which runs in-line with the FIX, this line may be intercepted by a Localiser, an airway or a VOR / VORTAC radial.

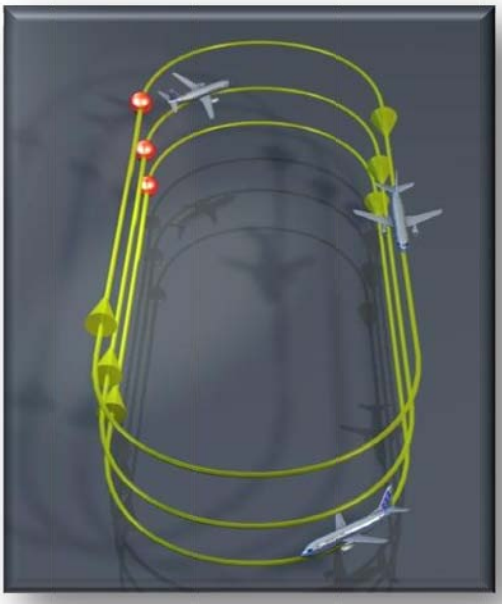
RECIPROCAL

- The opposite (180 degrees) of the Holding course. To give you an example if the Holding course was 270, then the reciprocal would be 270 - 180 = 90 degrees.

NON HOLDING SIDE

- The inbound leg of the Holding.

STACKED HOLDING



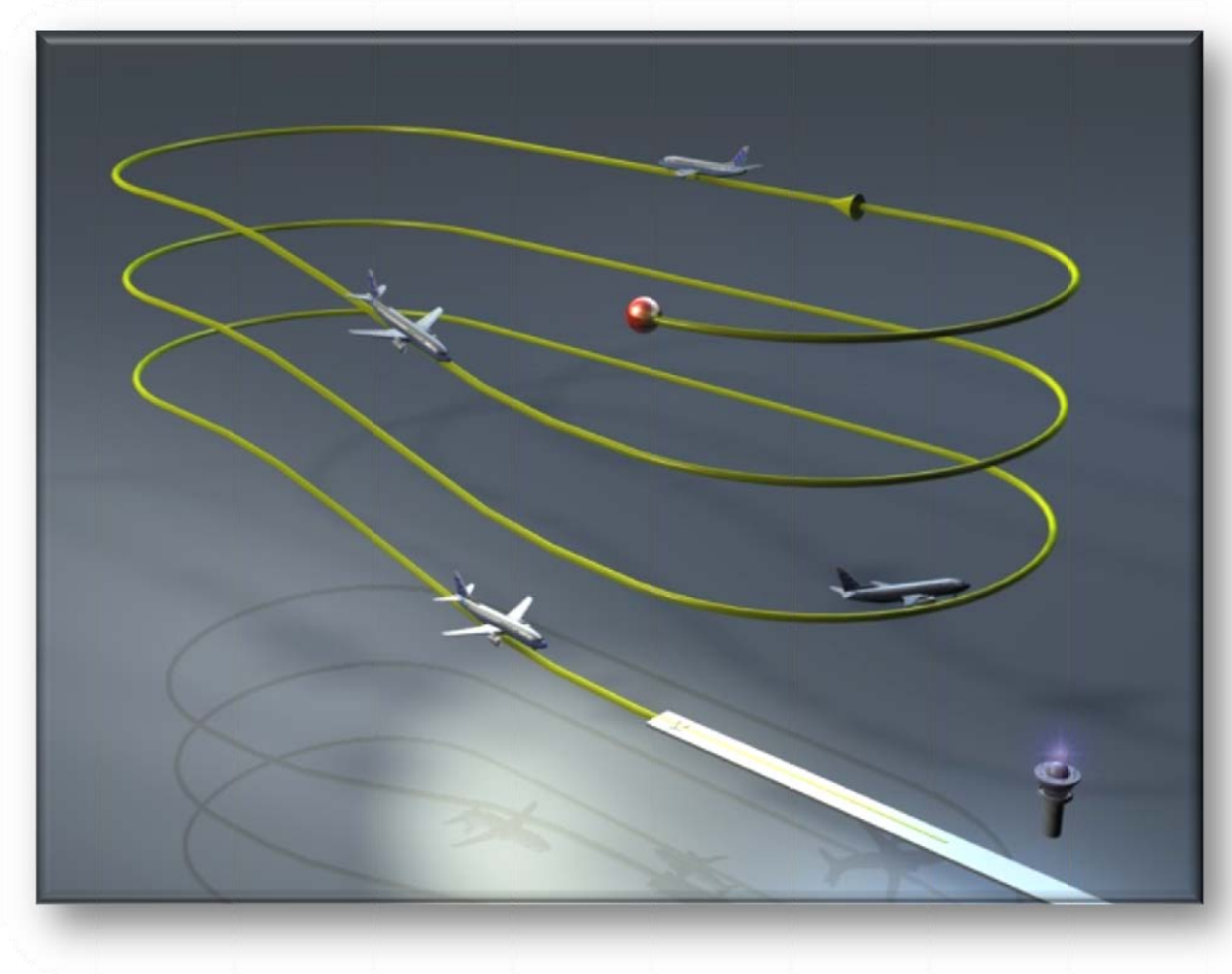
Several aircrafts may fly the same holding pattern at the same time, separated vertically by 1,000 feet or more. New arrivals will be added at the top and the aircraft at the bottom of the stack will be taken out of the holding to make the final approach.

ATC will control the whole process, in some cases using a dedicated controller (called a *stack controller*) for each individual pattern.

Shuttle procedure.

A shuttle procedure is a maneuver involving a descent or climb in a pattern similar to a holding pattern. It is used on instrument procedures located in mountainous areas, or for certain types of missed approaches, or when ATC clears a plane, located below in a stack, for the approach and instructs the planes holding in the same airspace to descend one step further.

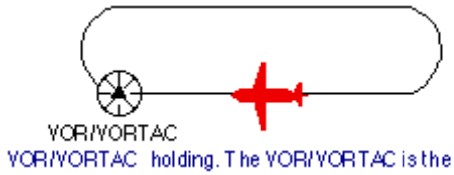
The maneuver is flown exactly the same as a holding pattern, except that descent will occur within the inbound or the outbound leg. In order to prevent the airplane from exiting the protected airspace, speed is restricted to 200kts IAS.



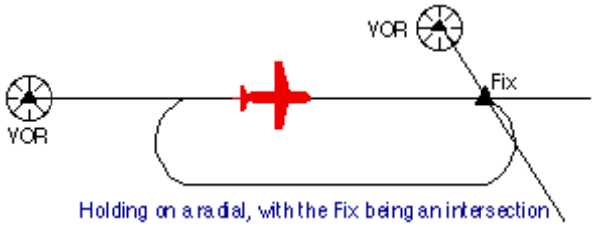
shuttle procedure

TYPES OF HOLDING PATTERN

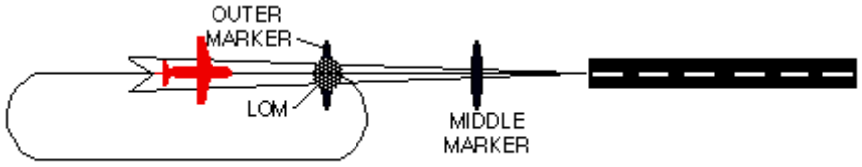
There are several types of holding patterns. They could be based on a NDB, VOR etc. But also holdings based on 2 VOR's or holdings at a LOM (outer marker). I'll show you a few examples:



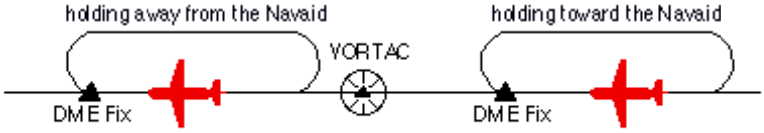
VOR/VORTAC holding. The VOR/VORTAC is the Fix.



Holding on a radial, with the Fix being an intersection



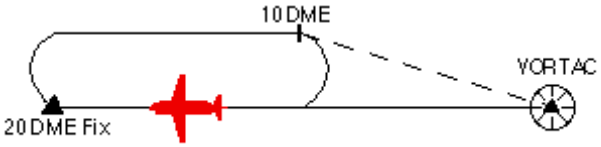
Holding on a localizer, with the Fix being the LOM



Holding on a radial, with the Fix's being DME distances from the VORTAC

DME HOLDING

DME HOLDING AWAY FROM THE NAVAID

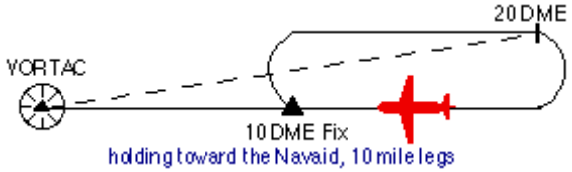


holding away from the Navaid, 10 mile legs

It may happen that you encounter a Holding without a VOR or VORTAC, in that case you would be dealing with distances.

In this type of DME Holding you can see a distance of 20NM between the VORTAC and the FIX. The point at which you start your 180 degree turn away from the inbound leg is 10NM. That means that you must fly a distance of 10NM before you start your turn.

DME HOLDING TOWARDS THE NAVAID



holding toward the Navaid, 10 mile legs

This is a Holding where you are lined up with a NAVAID. For this you need the course for the inbound course to correctly align you with said NAVAID. In this case you would use the DME (distance) from the VORTAC to identify the correct location where you would initiate your 180 degree turn.

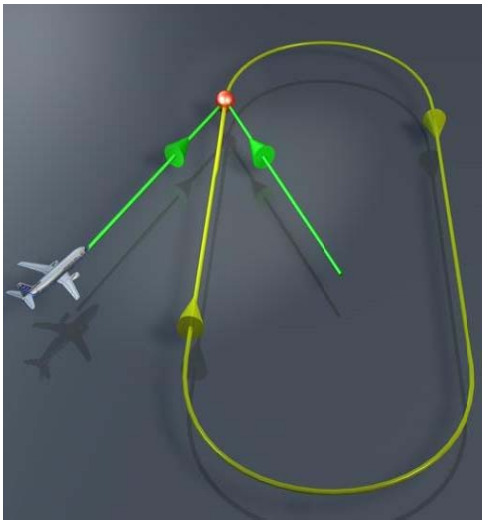
HOW DO I ENTER A HOLDING ?

The entry to a holding pattern is often the hardest part for a novice pilot to grasp, and determining and executing the proper entry while simultaneously controlling the aircraft, navigating and communicating with ATC requires practice.

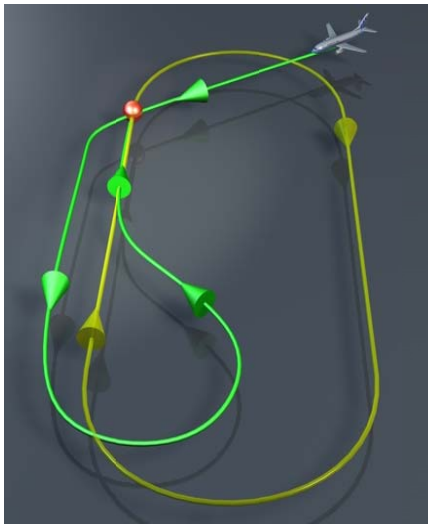
There are 3 ways to enter a Holding.

- **Parallel**
- **Teardrop Entry**
- **Direct Entry**

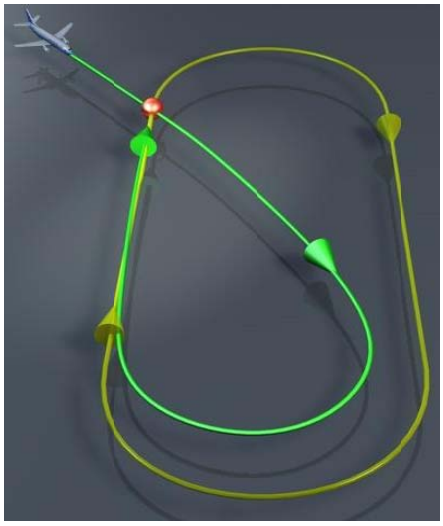
STANDARD HOLDING PATTERNS WITH RIGHT TURNS



Direct entry

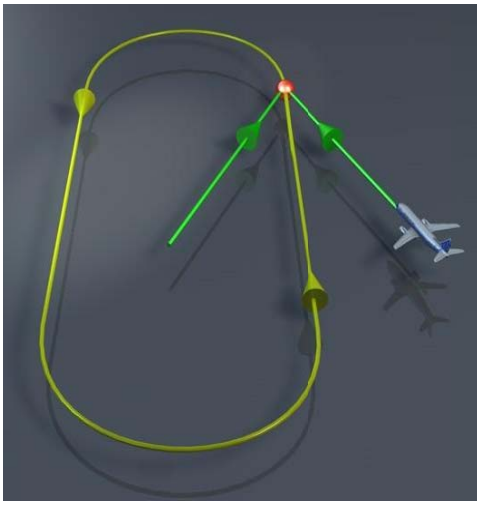


Parallel entry

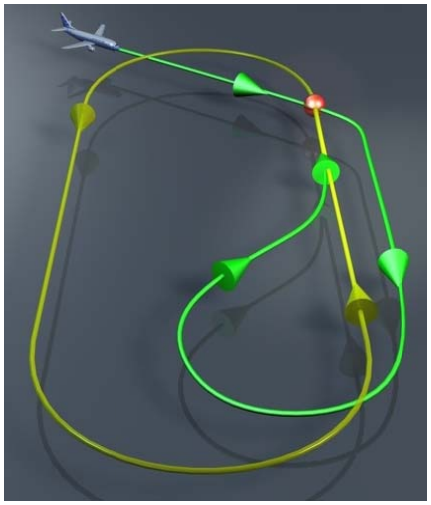


Teardrop entry
Offset entry

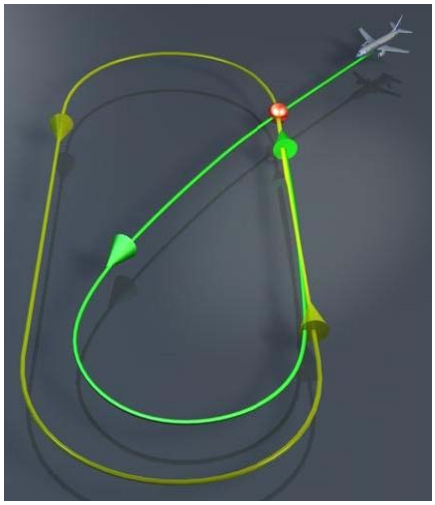
NON-STANDARD HOLDING PATTERNS WITH LEFT TURNS



Direct Entry

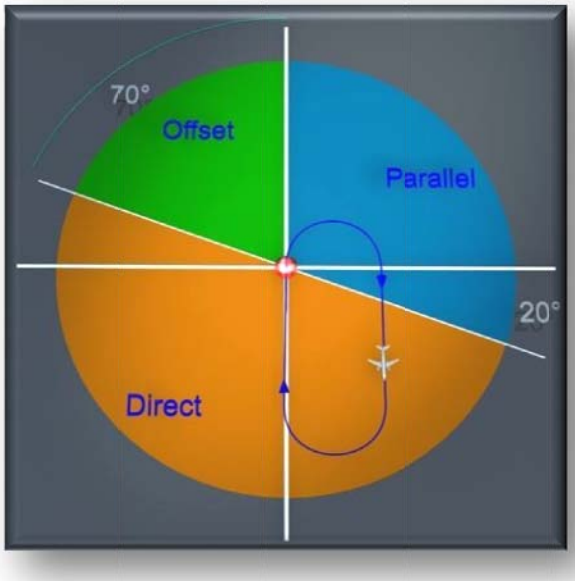


Parallel entry

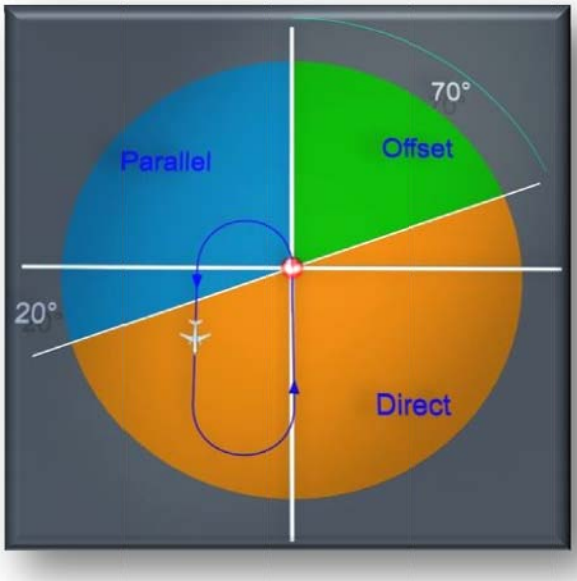


Teardrop entry
Offset entry

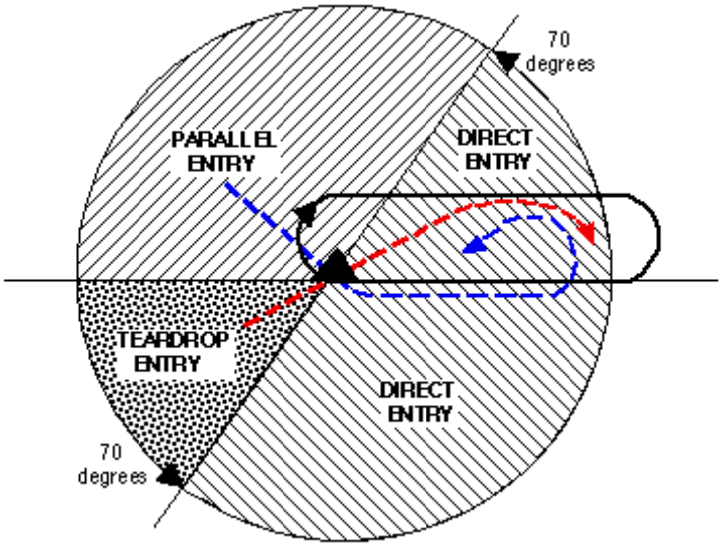
HOW DO I KNOW WHICH ENTRY TO USE ?



Standard Holding entries



Non- Standard Holding entries

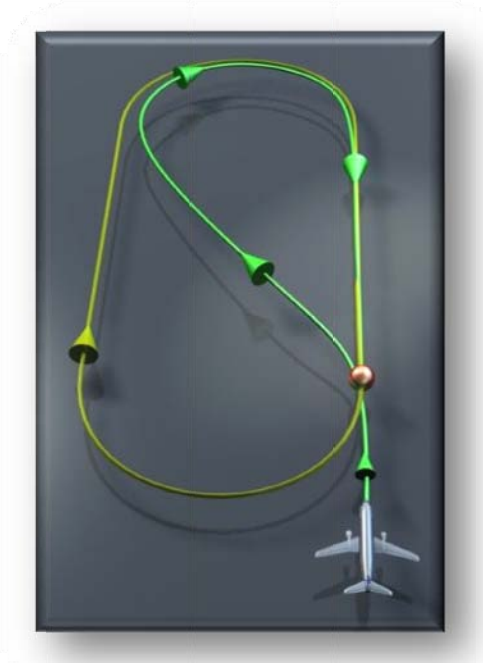


There are zones in the circle (see diagram) which divide it into three segments. This division centres around the FIX. If for example your inbound leg was 240 degrees, and we subtract 70 degrees from that, so 240-70=170 degrees. Then that would be the starting point of a Direct Entry. So on a heading of 160 then it would...
be impossible to make a Direct Entry, in this case it would be a Parallel Entry. So a Direct Entry starts between 170 and 350 degrees if the inbound course was 240. It is very important to know your current heading, so there can be no mistake in which type of entry you would use.

LIMIT DECISIONS:

When an aircraft is on the edge of 2 different zones for a Holding entry within a margin of +/- 5 degrees, it's up to the pilot to decide which entry will be performed. The decision shall be based on staying clear of the NON-holding side and heavy crosswinds.

Parallel entry



Teardrop entry

Example: Entering the Hold from the Reciprocal.

FLYING THE ENTRIES

PARALLEL ENTRY

- Fly in the zone marked Parallel Entry (see diagram), to the FIX. At the FIX execute a turn so that you are flying parallel to the inbound leg of the Holding. Start your timing as soon as you are flying parallel.
  After 1 minute execute a left hand turn to a heading of 30 degrees less than the inbound leg of the Holding so it will be easier to intercept the leg.
  On interception of the leg fly direct to the FIX.
  As an example we will again use our 240 degree inbound leg course.
  After the FIX fly on a heading of 060 (that is the opposite of the inbound course), after one minute turn start a left hand turn to a heading of 210, this would bring your aircraft to the inbound leg line. The 30 degree difference that we have applied makes it easier to intercept the inbound course line.

TEARDROP ENTRY

- Fly in the zone marked Teardrop Entry (see diagram), to the FIX.
  After the FIX fly directly on a 30 degrees course to the left of the outbound course. Fly this for 1 minute, after which you make a right hand turn to the FIX via the outbound course.
  Our example: The inbound course is 240, after the FIX fly on a heading of 210,(that is the inbound course minus the 30 degrees).
  After 1 minute turn the aircraft back towards the FIX, you are now on the inbound leg of the Holding.

DIRECT ENTRY

- This is without question the easiest of them all. Flying in the zone Direct Entry (see diagram), then fly directly to the FIX. After the FIX execute a 180 degree turn to fly the outbound leg. You are now in the Holding.

In the 3 options we have just learned you can see that is all depends on how you approach the FIX, and with that, it determines what type of entry you would use, and also the type of FIX determines the name of the Holding. These holdings have laws and we need to uphold these laws, if we want to become professionals.

HOLDING SPEED RESTRICTIONS

It is important to know that when flying a Holding that there are restrictions when it comes to the speed of an aircraft.
There are differences in speed limitations as stated in the FAA regulations (US) and the ICAO regulations (Non-US). We will look at the ICAO.

Up to an altitude of 14000ft then the speed would be a maximum of 220-230 KIAS.

If you are higher than 14000ft then the speed would be a maximum of 265 KIAS.

This may not always be the case, but if other restrictions apply it would tell you in the charts of the relevant airport. If no speed restrictions are found on a chart then you are required to use these speeds unless otherwise instructed by ATC.
A Holding pattern may sometimes take a long time, depending on levels of traffic, therefore clearly state to ATC, if you would like to fly slower in a Holding to conserve fuel.

HOLD SPEEDS (INDICATED) acc. ICAO

LEVELS (1)	NORMAL CONDITIONS	TURBULENCE CONDITIONS
Helicopters up to 6000FT (1830M) inclusive	100 KT (185KM/H)	
Up to 14 000 FT (4250 M) inclusive	230 KT (425 KM/H) (2) 170 Kt (315 KM/H) (4)	280 KT (520 KM/H) (3) 170 KT (315 KM/H) (4)
Above 14 000 FT (4 250 M) to 20 000 ft (6 100 M) inclusive	240 Kt (445 KM/H) (5)	280 KT (520 KM/H) or 0,8 Mach whichever is less (3)
Above 20 000 FT (6 100 M) to 34 000 FT (10 350 M) inclusive	265 Kt (490 KM/H) (5)	
Above 34000 FT (10 350 M)	0,83 Mach	0,83 Mach

(1) - Tabulated levels represent "altitude" or corresponding "flight levels" depending upon the altimeter setting in use.
(2) - When the holding procedure is followed by the initial segment of on instrument approach procedure promulgated at a higher speed than 230 KT (425 KM/H), the holding should also be promulgated at this higher speed wherever possible.
(3) - The speed of 280 KT (520 KM/H) (0.8 Mach) reserved for turbulence conditions shall be used for holding only after prior clearance with ATC, unless the relevant publications indicate that the holding area can accommodate aircraft flying at this high holding speeds.
(4) - For holding limited to CAT A and B aircraft only and CAT H above 6000FT (1830M).
(5) - Wherever possible, 280 KT (520 KM/H) should be used for holding procedures associated with airway route structures

TIMING

There are standards to follow when it comes to Leg-time, that is the length of time you fly an inbound leg, before you make a 180 degree turn.

Below 14000ft the inbound leg time would be 1 minute.
Above 14000ft the inbound leg time would be 1½ minutes.

timing begins *over/abeam* the fix, whichever occurs later. If the abeam position cannot be determined, start timing when turn to outbound is completed.
Now let's look at the total timing of a HOLDING below 14000ft.

1 minute for the outbound turn
1 minute for the outbound leg
1 minute for 180 degree turn to bring you back on the inbound leg.
1 minute for the inbound leg

This would be very easy to do if you don't have wind to deal with.But of course we almost always have wind to deal with, but I will explain more of that later.

STANDARD RATE TURN

Standard Rate Turn is the Angle of Bank (position between horizon and wings) that you turn. The standard is that you rotate 360 degrees in 2 minutes.
But doesn't the bank angle of different types of aircraft vary? I hear you ask, and yes you would be correct. A slower aircraft would need a lot less of an angle to make a turn than a faster one. So it all depends on what type of aircraft you are using.
That's all very well but how do we know what bank angle to use to make the correct turn?
Well that's why we have instruments in the cockpit !
In our panel we can see exactly the steepness of a turn and to correct it if necessary.

As you can see the instrument says 2 minutes. Therefore you can now bank your aircraft left or right to match your wings where it says L or R, and from that point on your aircraft would make a 360 degree turn in 2 minutes. Easy isn't it ??? What it comes down to is that you are making a standard 3 degrees per second turn, therefore taking 2 minutes to complete a 360 degree turn.

A pilot should make all turns during entry and while holding at:

1. 3° per second, or
2. 30° bank angle, or
3. 25 degree bank provided a flight director system is used.

Use whichever requires the least bank angle !

HOW TO REPORT IN THE HOLD ?

Pilots shall report the ATC that they entered the HOLD stating:

1: Call sign
2: “In the Hold over...(name the FIX)”
3: Altitude or Flight level
4: Speed

WHEN TO REPORT IN THE HOLD ?

1: on the Outbound leg after a DIRECT entry
2: on the Inbound leg after a Parallel entry
3: on the Inbound leg after a Teardrop (Offset) entry

HOW WILL ATC INSTRUCT YOU TO ENTER A HOLD ?

we will give you some examples:

ATC: " MSR606" enter the Hold over CVO VOR as published

ATC: " MSR606" hold over CVO VOR , inbound course 225, left turns, maintain 4500 feet, expect further clearance in 15 minutes.

ATC: " MSR606" hold North East of CVO VOR on the 045 degree radial, left turns, maintain 4500 feet, expect further clearance at 1730, time is 1715.

ATC: " MSR606" hold North East of CVO VOR on QDR 045, left turns, maintain 4500 feet, expect further clearance at 1730, time is 1715.

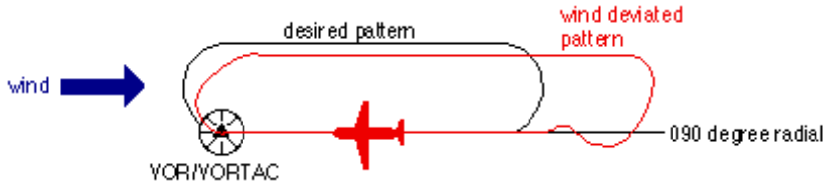
mmm....did I say we will give you some examples? You probably already noticed that the examples above are all four exactly the same Holds....but instructed differently.

So as you see....there are no strict rules. As long as you understand what is being said.

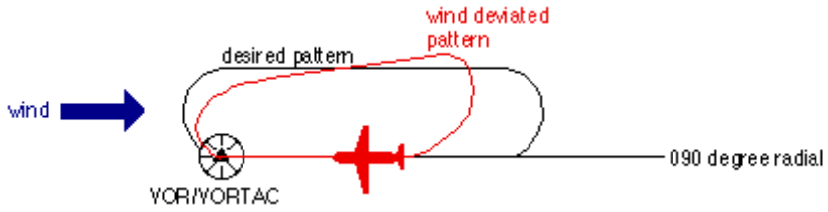
ATC issues **holding instructions** in the following form:

- *Geographical reference* of the Holding fix: the general location of the holding
- *Inbound leg*: the inbound leg is always the reference
- *Turn direction*: (right turns (standard) or left turns (non-standard)
- *Altitude*
- *Expected further clearance* time (**EFC**)
- *Current time* (optional)

FLYING A HOLDING PATTERN WITH WIND



Wind is always a difficult factor to deal with, because it can blow your aircraft off-course. If there was no wind you would be able to fly the perfect Holding Pattern, but as we all know wind is ever present. So how do we fly a Holding with wind? In the diagram above you see the wind, as soon as we would start our turn for the outbound leg the wind would take effect and blow us off-course which would really mess up our pattern. Also it is most probable that we would fly further distances, even if only flying 1 minute legs, because of the wind drift on the outbound leg. There is something we can do to minimise the effect of this drift. We could make a shallower turn, thus reducing our bank angle and taking the turn more slowly. Also we could shorten the outbound leg to 45 seconds instead of the full 1 minute.
The most important thing to remember is the Inbound leg, this must be in line with the FIX. If you keep your eye on that then the Holding should end up looking something like...



So while in the Holding, anticipate your positions, to get a better feel of what effect the wind is having, so that you can fly an acceptable Holding Pattern.

I hope that it has become clear to you, the different types of Holdings and how to execute them.

I have made a little checklist for you with all the points regarding a Holding Pattern.

- A pilot should make all turns during entry and while holding at:

  1. 3° per second, or
  2. 30° bank angle, or

3. 25 degree bank provided a flight director system is used.
Use whichever requires the least bank angle !

- There are speed restrictions in a Holding Pattern.
- Timing begins *over/abeam* the fix, whichever occurs later. If the abeam position cannot be determined, start timing when turn to outbound is completed.
- The inbound leg is the most important and should take 1 minute or 1½ minutes depending on altitude. The inbound leg could also be dependent on a certain DME which you will find on the relevant charts or advised by ATC.
- **Standard Holding Pattern (With Wind)**
  A standard symmetrical holding pattern cannot be flown when winds exist. In those situations, the pilot is expected to:

  1 Compensate for the effect of a known wind except when turning.
  2 Adjust outbound timing to achieve a 1-minute (1½ minutes above 14.000ft) inbound leg

PROCEDURE TURN

In some cases we MUST us a holding pattern to perform a procedure turn.

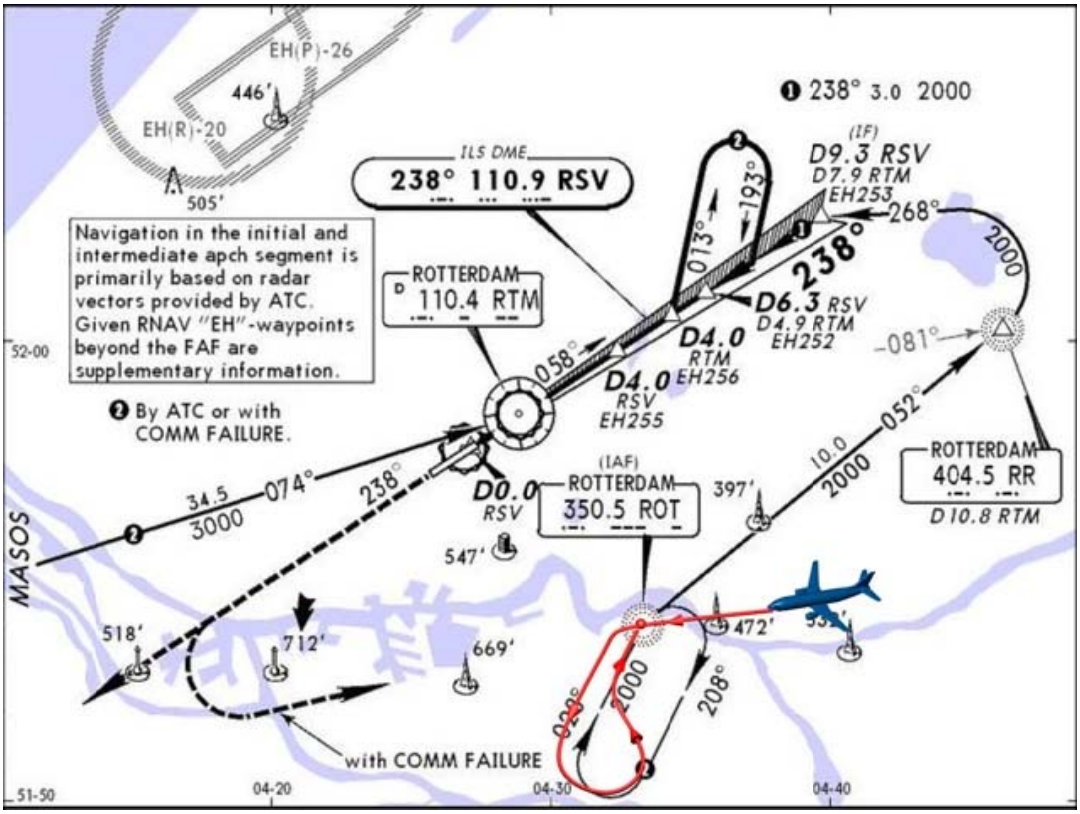
This means we are using the Hold to get better aligned before proceeding with the approach procedure.

Or....

We must use the Hold because our assigned altitude is above the published minimum holding altitude

To clarify this, an example:

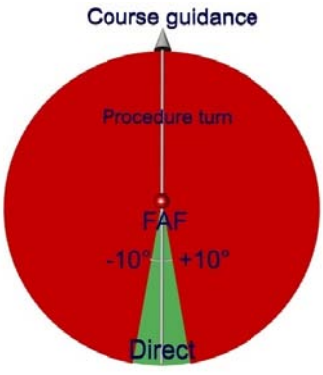
We are at an heading of 260° inbound ROT NDB (the IAF) and we are already cleared for the ILS DME approach rwy 24 at Rotterdam. The heading from ROT NDB towards RR NDB is 052°. This angle is way too sharp for us to just turn right from ROT NDB towards RR NDB. In this case we HAVE to make a procedure turn. We will perform a parallel entry and pretend we are going to enter the hold over ROT NDB. We DO NOT report we are in the hold because we are only using it to make the turn. If we reach ROT NDB for the second time we can now directly continue with the ILS DME approach rwy 24.



procedure turn decision criteria:

The angle between you current heading and the course guidance

Max 10° on a FAF
Max 90° on a IAF precision approach
Max 120° on a IAF non-precision approach



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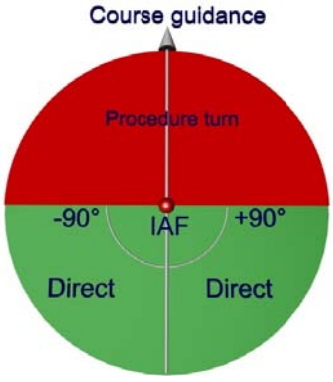
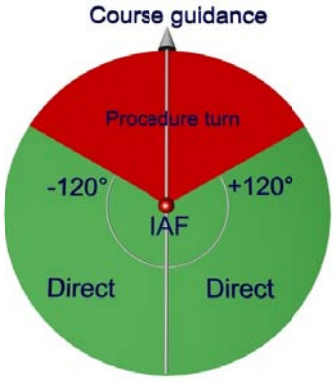


IAF



IAF

Our heading is 260 and the course guidance is 052°. The difference is greater than 90° nl: 208° so also here we have to perform a procedure turn.

WHEN SHOULD YOU ENTER A HOLD ?

The pilot is under no circumstance allowed to enter a hold prior to approval of the ATC…..UNLESS the HOLD is the end point of the previous instruction or arrival procedure and no further clearance is received.

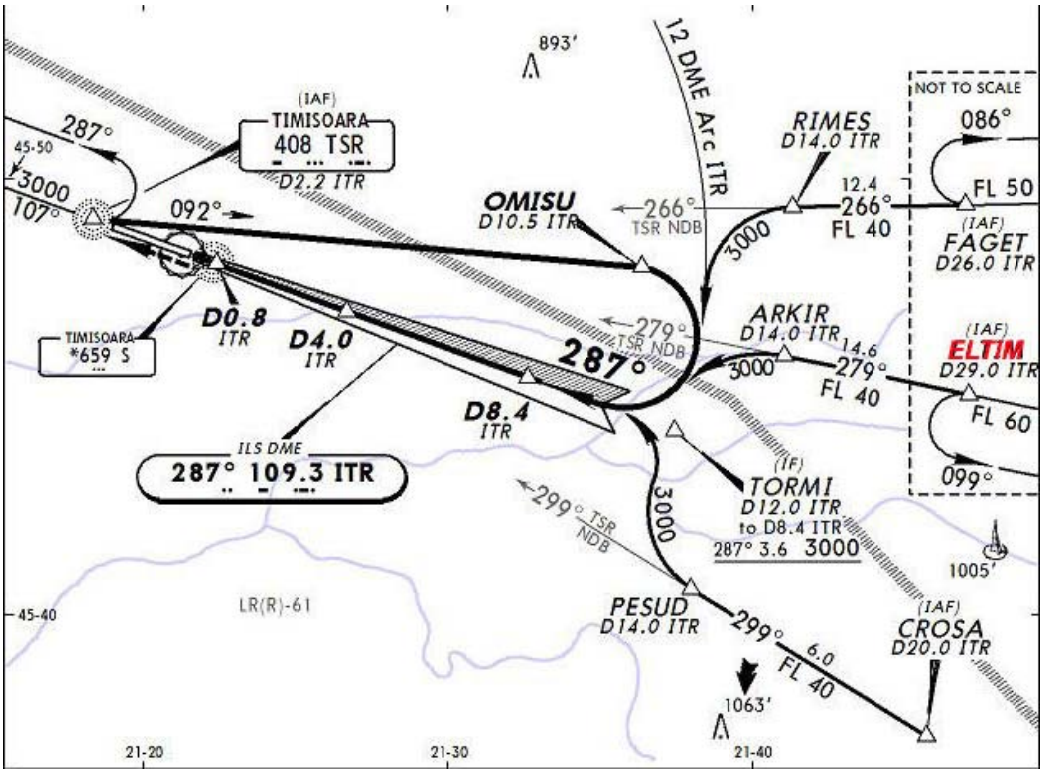
1: When ATC tells you to do so.
- He will instruct you to enter a hold as published (acc. to the chart)
- He will instruct you to enter a non published holding by providing inbound course (or , turn , speed restrictions if necessary and expected delay
- Direction of holding from the fix in terms of the eight cardinal compass points (i.e., N, NE, E, SE, etc.).

2: When you have not yet received clearance to continue with the final approach.

3: If an aircraft is at the published minimum holding altitude and subsequently cleared for the approach, the holding pattern would only be a segment of the IAP *if* it is published on the instrument procedure chart and is used in lieu of a procedure turn.

4: If an aircraft is established in a published holding pattern at an assigned altitude above the published minimum holding altitude and subsequently cleared for the approach, the pilot may descend to the published minimum holding altitude. The holding pattern would only be a segment of the IAP *if* it is published on the instrument procedure chart and is used in lieu of a procedure turn.

Let me clarify this with a couple of examples for this is very important.



Let's assume we do a flight from LROP (Bucharest) to LRTR (Timisoara). At Timisoara we can expect rwy 29 for landing. We arrive from the South-East and are inbound ELTIM as our last waypoint. The chart of the ILS DME rwy 29 shows us ELTIM as the IAF (initial approach fix) and the HOLD at FL060.

1- The pilot is at FL 160 and instructed to descend to FL060 overhead ELTIM.

The pilot will use the 3 to 1 rule (3 nm per 1000ft) to estimate the distance needed for the descend. In this case he will need 16-6 = 10 *3 = 30nm for the descend. When the pilot is unable to comply to the crossing restriction he has to convey this to the ATC like:

pilot: “KLM479 unable to make the crossing restriction”

Now a few things can happen in this situation:

A: The pilot can **request** to use the HOLD for further descent
B: The ATC will tell the pilot to use the HOLD for further descent
C: The ATC will give the pilot vectors and speed restrictions

So..under no circumstance the pilot will enter the HOLD for his own convenience since he will then turn in the opposite direction of his current heading and this might impose a dangerous situation on surrounding traffic. Only the ATC has a clear view on the situation!

2- The pilot is at FL 160 and instructed to descend to FL060 AND cleared for the ILS DME RWY 29

Again the pilot will us the 3 to 1 rule to estimate the distance needed for the descend. In case he reaches it in time at ELTIM there is no problem. In case he will reach ELTIM at FL 080 he is still allowed to continue with the procedure because he was already cleared for the ILS DME RWY 29.

So….also here, there are a few options.

A: the pilot decides to **request** to enter the HOLD for the descent to FL060 before he continues with the approach. This however is not very logical for he is wasting time and fuel for a descent of only 2000ft.

B: The pilot just continues with the approach as cleared because he knows that with the 3-1 rule he only needs 12 nm to get from FL080 at ELTIM to FL040 before reaching ARKIR. Its more than enough time get on track and catch the descent profile. (distance between ELTIM and ARKIR = 14.6nm) The only important thing here is that the pilot has to reach the altitude at the FAF to intercept the glide and that he is able to descend and manoeuvre in a reasonable fashion. So no kamikaze dives !

C: In case he concluded that he will reach ELTIM let say at FL100, then there is not enough distance left to comply with the rest of the procedure which he was already cleared for. It's the responsibility of the pilot to think ahead and he now has no other alternative to report this immediately to ATC and tell him he is unable to comply with the procedure. The ATC will solve the problem by giving him vectors or he will put him in the HOLD for further descent.

No let's assume we departed from another airport and our heading towards ELTIM is 170°

3- As we know when course guidance is given and a procedure turn is required to be performed to get on track, the same rules apply as discussed in items 1 and 2.

A: The pilot reaches ELTIM at FL 060 on a heading 170 and cleared for the ILS DME rwy 29

The pilot uses the HOLD in lieu of a procedure turn and continues with the approach procedure. He doesn't report in the hold!

B: The pilot reaches ELTIM at FL 080 on a heading 170 and cleared for the ILS DME rwy 29

*If **an aircraft is established in a published holding pattern** at an assigned altitude above the published minimum holding altitude and subsequently cleared for the approach, the pilot may descend to the published minimum holding altitude. The holding pattern would only be a segment of the IAP if it is published on the instrument procedure chart and is used in lieu of a procedure turn.*

So…in this case the pilot is allowed to descent to FL060 during the procedure turn

C: The pilot reaches ELTIM at FL 100 on a heading 170 and cleared for the ILS DME rwy 29

The pilot thinks ahead and understands that one procedure turn is not enough to descend to FL060. Which brings us back to the items as discussed in 1 and 2. Either the pilot will decide to continue with the approach because he has enough distance after ELTIM to descent and catch the profile…or he will tell ATC that he is unable to comply with the rest of the procedure.

4- Sometimes the ATC uses the term EXPECT ....

ATC: "KLM479, after ELTIM expect ILS DME rwy 29"

There is a lot of discussion about the legality of the term EXPECT and therefore not always very clear to the pilot.
For many pilots the word EXPECT in an instruction means that this will be the next logical step. So most of the pilots (also in real life) will NOT enter the hold at ELTIM and continue with the EXPECTED instruction although they were not CLEARED for the ILS DME rwy 29.

Other pilots just think the opposite. They didn't get any CLEARANCE to continue so they enter the HOLD.

In short: …there are no clear rules about this and therefore should be handled with care. If you are uncertain about what you can EXPECT....ask for confirmation from the ATC

Just remember that you as a pilot will follow instructions from the ATC...and when no further clearance is received...ask for it...and when there is no reply....you have no other option then to enter the HOLD.

<u>One final note on HOLDING altitudes.</u>

always look at the published holding altitudes on your chart. They may vary from airport to airport and country to country

altitudes can be published like:

1: 3000 above 3000

2: 3000 below 3000

3: 6000 below 6000 and above 3000
3000

4: or just plain text on the chart:
" DO NOT DESCEND BELOW THE DESCENT PROFILE. GIVEN ALTITUDES TO BE CONSIDERED AS MNM ALT "

Once again I hope that you have gotten a better insight about Holding patterns