
OBLIGATORY DISCLAIMER

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NOT FOR USE IN REAL WORLD AVIATION.*

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Introduction

Chapter 1 - Introduction

Why Learn Missed Approach Procedures?

In a perfect (MSFS) world, you will never need to know how to fly a missed approach procedure. Why should you? Maybe you feel pretty good about your ability to hand fly an ILS or RNAV approach on multiple aircraft. If you miss the landing approach because of crosswinds, too fast, too high, pilot inattention or a myriad of other reasons, you can always press the ESC key and stop or restart the session.

This is true.

Understanding and knowing how to fly a missed approach procedure is a key learning to take your MSFS 2020 experience and skills to the next level. While there are many flight sim pilots who just want to jump in and cruise around sightseeing through London or scream through the Grand Canyon, others strive for maximum realism; starting 'cold and dark', equipment failures, weight and balance, fuel consumption and many other factors that real pilots deal with on a daily basis. It's up to you on how realistic you want your sim experience to be.

For me, while I enjoy the visual sightseeing aspects of the sim, my favorite flights are landing approaches at airports of all sizes and challenges throughout the world. I've gotten pretty good at hand flying ILS and RNAV approaches. While knowing how to set up and manage the autopilot through an instrument approach is an essential skill, especially as you move up into higher performance aircraft, hand flying these approaches is particularly satisfying to me. Throw in a crosswind or some heavy weather and the approach can quickly become tense.

And yes, sometimes I hit the ESC key.

While testing scenarios for my [Navigation & Flight Planning eBook](#), I was on an ILS approach when ATC told me to go around. This has only happened one time. Of course, not being prepared for a missed approach, I hit the ESC key and had some choice words for the AI pilot who pulled onto the runway when I was under 2 nm from the threshold. Really?

I understood the missed approach section and diagrams on Instrument Approach Procedures (IAP), but never gave them a second thought until that moment. I realized this was a gap in my knowledge and started working to fix it.

Before we go any further, let's get the standard disclaimers out of the way. I am not a licensed pilot, just an experienced MSFS flight simmer from the earliest days of the sim. I'm sharing with you what I've learned about flight simulation in MSFS 2020.

Repeated Obligatory Disclaimer

The contents of this eBook are intended for use in flight simulation only.

Not for use in real world aviation

Introduction

Now that we have that out of the way, let's continue. In this eBook, I'll share with you what I've learned about missed approach procedures in MSFS. If you follow along and put some work into it, you will soon not only understand how to fly a missed approach, but just as importantly, you will understand when and how to recover and set up a new approach to the runway. What we won't cover in this eBook is how to plan or fly instrument approach procedures, but we've got you covered:

Shameless Self Promotion

You can learn how to navigate and plan flights with my eBook,

[Navigation & Flight Planning in MSFS 2020.](#)

We also cover autopilot basics, and how to fly using VOR and GPS navigation.

To get back to the ground safely, we cover VOR, RNAV and ILS approaches.

<https://flightsimnav.com>

Get your copy now!

Missed Approach vs Going Around

A missed approach is part of a published instrument approach procedure: various flavors of VOR, RNAV and ILS. We will get into these next.

If you are flying VFR on a visual approach and for some reason need to try again, this is known as *going around*, not a missed approach. You are expected to radio your intentions, re-enter the traffic pattern and fly a normal visual approach, all while keeping the airport in sight.

In general, you will need to:

- Increase power to initiate a climb back to the pattern altitude
- "Clean up" the aircraft: set flaps to take-off position while flying the runway heading
- Once a positive rate-of-climb has been established, retract the flaps fully and radio your intentions to re-enter the traffic pattern.

While we're not going to do an example of this, it is a good idea to practice this maneuver on a regular basis so you can do it automatically next time you are too high or off track on final. You know, like real pilots do...

Introduction

The Process

As an engineer, I'm fairly obsessed on the process for problem solving. Learning missed approach procedures is no different. To take you through the learning process, we will follow this path:

- Background Knowledge

To start, we'll examine the missed approach section and diagrams on IAP charts for VOR, RNAV and ILS approaches. Yes, in the real world, there are other types of approach charts, but we live in the MSFS world. As we approach the one year anniversary of the release of MSFS 2020, we will stick to only what can be done in the sim.

- Preparation

Before flying an instrument approach, you need to brief properly. This includes understanding the missed approach procedure and setting up your NAV radio or GPS *before* you begin the approach. Fumbling around, looking at charts or procedures when you get to minimums and realize you can't land safely is not a recipe for success.

- Flying a Missed Approach Procedure

If you are properly prepared, executing a missed approach procedure is not complicated. In this section we will understand how to fly the procedure, whether it is VOR or GPS based. We will include plenty of examples for you to set up and fly.

- Holds

Holds are an essential part of a missed approach procedure. They are also used by ATC to ensure safe spacing as multiple aircraft approach a busy airport. While I don't believe the current state of ATC in the sim includes holds, we'll still learn how to enter and fly a holding pattern.

- Recovering from a Missed Approach

You executed a Missed Approach properly and are now on your way to a holding pattern or have been cleared by ATC to fly the approach again. How do we get back to the Initial Approach Fix (IAF)? This is the area I struggled most with, particularly dealing with the stock G1000 used on the Cessna 172 and other General Aviation aircraft. I'll be generous and say that this is an area that *<ahem>* needs some work.

But fear not! We will examine the procedures and set up examples using VOR NAV radios and the G1000.

As in the [Navigation & Flight Planning eBook](#), we will be mostly flying the C172. I'm a firm believer in learning aircraft in MSFS the same way that real pilots learn and move up to increased performance aircraft. Nobody in the real world learns how to fly in an A320. Learn and master the slower GA aircraft first.

Let's get started...

Introduction

Missed Approach Procedures

In this section, we will review how a missed approach is defined in an instrument approach procedure (IAP). Depending on your source for charts, there may be some layout/visual differences, but the content will be the same.

Every Instrument Approach Procedure (IAP) has a corresponding Missed Approach

For this first example, here is a section of the RNAV approach for RWY 06R at CYYZ in Toronto.

Figure 1 - Missed Approach Sections on an IAP

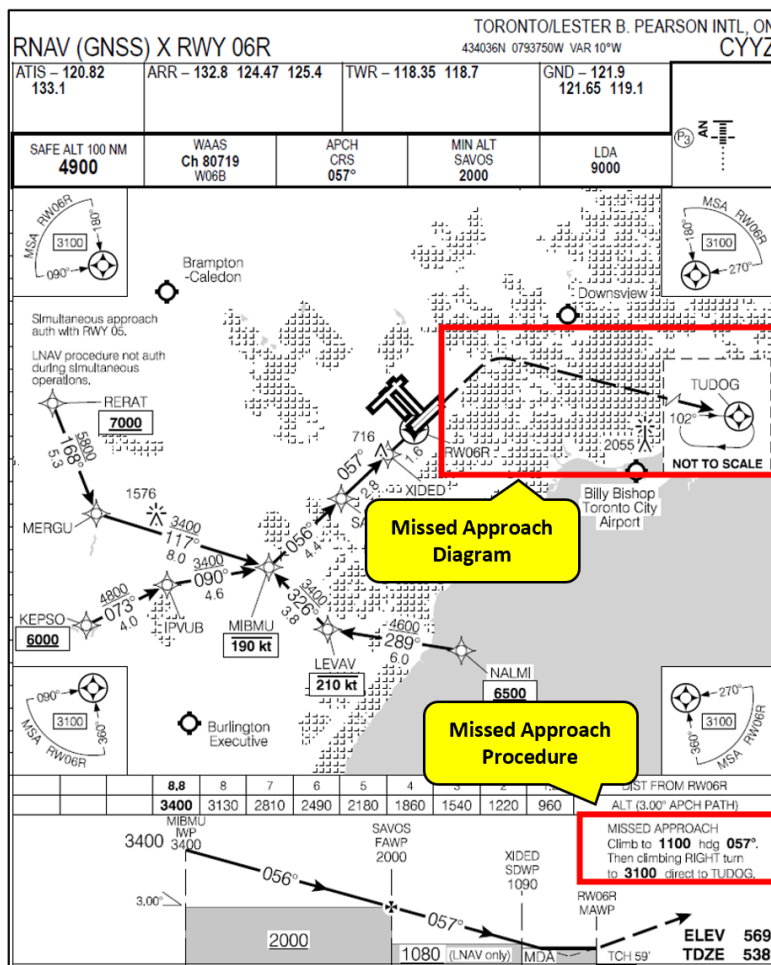


Image Source: VATSIM/ChartFox

This is about as simple of a missed approach as you will find. Since you are flying an ILS approach, it only makes sense that the missed approach procedure utilizes a GPS waypoint as the hold point. Punch in (or activate) the TUDOG waypoint as you are climbing out and the autopilot will take you directly there. Even the entry to the holding pattern is direct and simple, no teardrop needed. Don't worry, we will cover holds later when we start flying some examples.

As you can see on this chart, the missed approach procedure is shown in two places.

The procedure instructions are shown in the profile view.

- Climb to 1,100' on a heading of 57° (RWY HDG)
- Make a climbing right turn to 3,100' and fly directly to TUDOG waypoint (and hold)

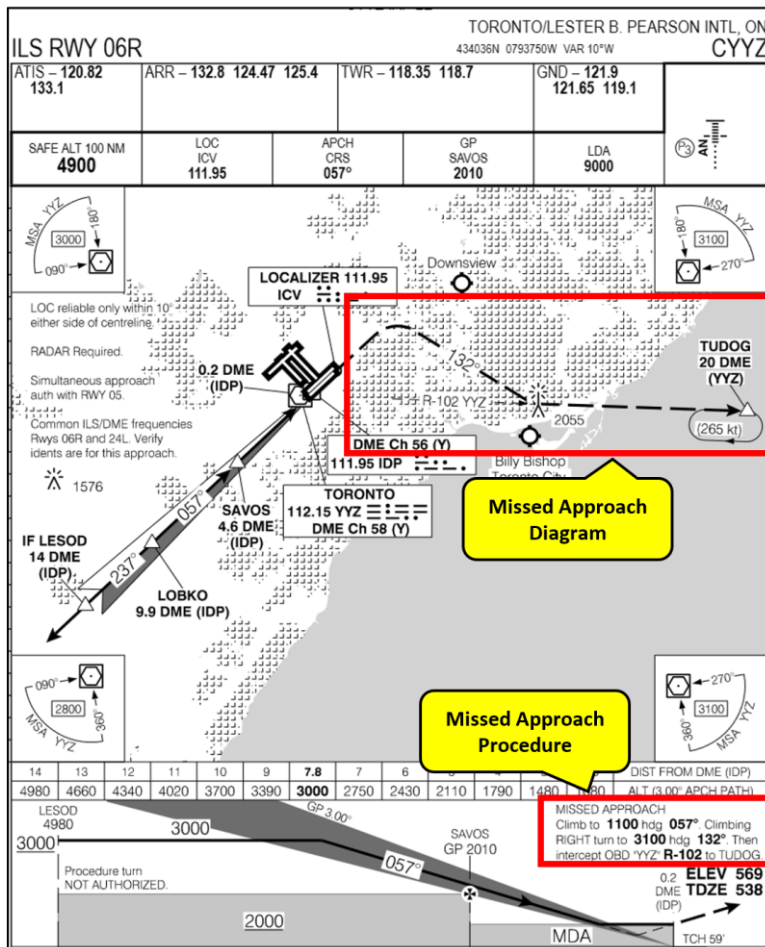
On the plan view of the approach, the missed approach course is shown with a dashed line.

Introduction

It's important to note that the missed approach fix/hold point does not automatically correspond with the type of approach. This first example did, but not all are like this.

To illustrate, let's look at the ILS approach on the same runway at Toronto Pearson:

Figure 2 - VOR to the Hold Point



At first glance it looks the same, using the TUDOG fix as the hold point. But notice that how you get there is different, using a VOR radial instead of direct using a GPS.

- Climb to 1,100' on a heading of 57° (RWY HDG)
- Make a climbing right turn to 3,100' on a heading of 132°
- When you intercept the R-102 radial from the YYZ VOR, follow it until you reach 20.0 nm DME from YYZ and hold.

Image Source: VATSIM/ChartFox

A bit more complicated.

Since you are coming in on an ILS approach, in this example you will have to deal with two NAV sources: one for the localizer (ICV 111.95 MHz) and the YYZ VOR (112.15). A bit more work, but entirely manageable, even if you are in an airplane with only one NAV radio, like a C152. And yes, you can fly an ILS approach in the C152, even without <gasp> an autopilot.

We will come back to this one later and detail out how to fly it. We still have some learning and preparation to do first.

At a larger airport like Toronto Pearson, you won't find a VOR approach listed, another example of how RNAV is superseding VORs. However, there are still plenty of VOR approaches in use.

Introduction

Here is the VOR approach to RWY 25 at LIRF Rome Fiumicino.

Figure 3 - Missed Approach on a VOR Approach

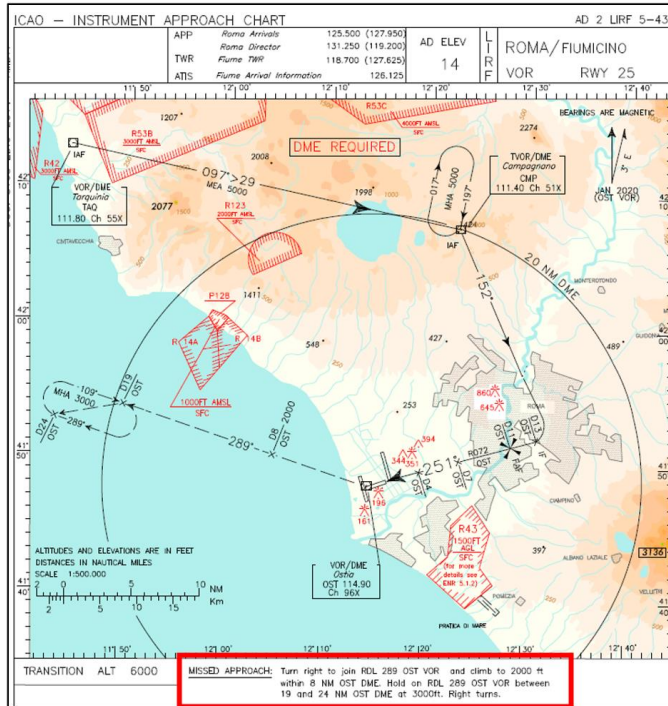


Image Source: AIP Italia

By now, it should be easier to read and understand these procedures.

At LIRF, the OST VOR is located at the airport.

On a missed approach, make a climbing right turn to 2,000' intercepting and tracking OST R-289 outbound while continuing to climb to 3,000'.

At DME 19.0, enter the holding pattern.

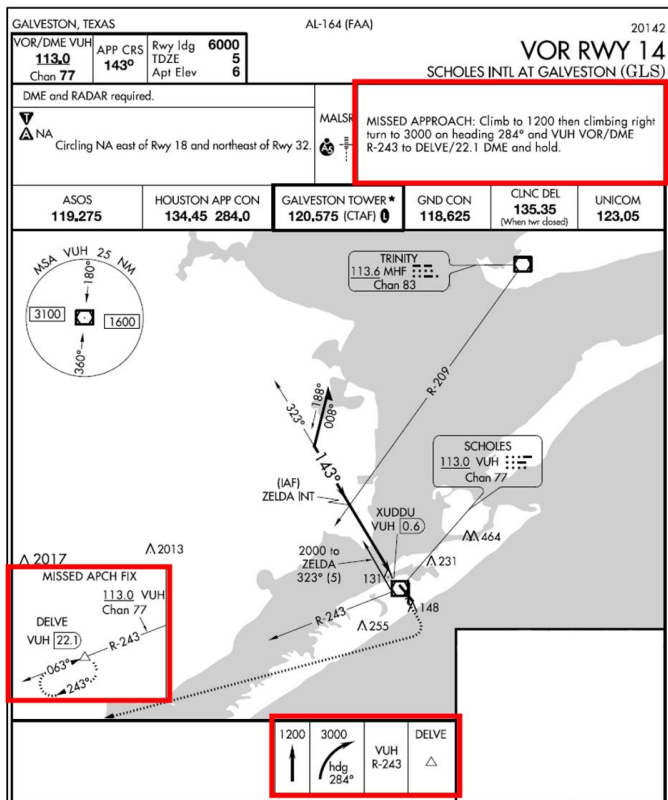


Image Source: FAA IFR Chart Database

Here's another VOR approach, this time on the Texas coast at KGLS Galveston Scholes RWY 14.

Again, a VOR is located at the airport, VUH.

On a missed approach, we climb to 1,200', at which point we turn right to a heading of 284° while continuing to climb to 3,000'. When we intercept VUH R-243, we track it outbound until the DELVE intersection at DME 22.1, where we enter the hold.

Notice that on this FAA chart, an additional graphic for the missed approach procedure is shown at the bottom of the image.

Introduction

Summary

As you can see by these examples, missed approach procedures shown on IAP charts are straightforward and easy to understand once you know what to look for. While each missed approach is different, they share common characteristics:

- Fly the runway heading to a specified safe altitude. This gives you time to clean up the aircraft from a landing approach configuration to one more amenable to level flight.
- Fly to a specified location/altitude and enter a holding pattern to await further instruction from ATC. We will have a bit more to say about ATC interaction in a later section.

Of course, it is your choice whether to fly the missed approach procedure by hand, or by managing the autopilot. My suggestion is to start out using the autopilot, so you gain experience with the maneuver and build confidence, then transition to flying the procedure by hand. As readers of my [Navigation & Flight Planning in MSFS 2020](#) eBook know, I'm a strong advocate for learning and practicing flying procedures by hand. Yes, it's relatively easy to manage an autopilot, but you gain so much by leaving the autopilot off.

Preparation

Chapter 2 – Preparation

To successfully fly a missed approach procedure, you must be prepared. Realizing you can't safely land when you hit minimums is not the time to think about how to go missed approach.

Preparation takes many forms:

- Understand the IAP procedure you are flying to the runway.
- Understand your aircraft's capabilities
- Study the missed approach procedure
- Know Your Avionics

We will expand on these one at a time.

IAP Procedure

At the one year anniversary for MSFS, we are limited in the types of IAP procedures:

- VOR
- RNAV
- ILS/LOC

Yes, there are still NDB approaches, especially in Europe, but we made an executive decision to let those go. I'm sure there are some enthusiasts out there, but I'm not one of them. If you love flying a NDB approach, take what you learn from this eBook and apply it to those types of approaches.

To fly a missed approach to a given airport/runway, you will need the chart for the approach. Flight planning in the World Map remains limited and in need of improvement; integration of missed approach procedures is lacking in both the flight planner and the stock avionics.

Get into the habit of studying the IAP and have a copy of the chart available before you start your flight. Be clear about the relevant navigation aids, both on the landing and missed approaches. Circle or highlight them on the chart, write them down, whatever works for you.

Preparation

Aircraft Capabilities

Understanding your aircraft capabilities is vital to being able to control it. Here's a starting point: what is the normal rate-of-climb and what are the power settings that give you that performance? As an example, the best rate-of-climb in a C172 is 78 kts.

While this type of info is not available within the sim, it generally can be found on the net.

Do you have one or two NAV radios? Are you flying using an autopilot or by hand? Does your aircraft have a GPS installed? What type and do you know how to operate it effectively?

Some of this may seem superfluous but knowing the details will make your actions nearly automatic when pilot workload increases.

Study the Missed Approach Procedure

Every missed approach procedure is different; some are simple, some are very complex. Before you climb into the sim cockpit, make sure you think through and plan the steps you would need to take to successfully fly the missed approach. Don't wait until the moment you decide to go missed to understand what to do next. [Chapter 3 – Flying a Missed Approach](#) will help you fly the procedure, no matter if it is based on VORs or GPS routes.

For most missed approach procedures, they finish with a holding procedure. While many holding procedures are “standard”, there are plenty that are not. How do you safely enter a holding pattern? We'll cover this and much more in [Chapter 4 – Holds](#).

Know Your Avionics

It doesn't matter whether your aircraft has a modern glass cockpit with a fancy Flight Management System (FMS) or a single VOR gauge, it's important you understand how to setup and adjust your avionics during the flight. On the G1000, do you know how to set a DIRECT-TO or manually change the active leg in your flight plan?

To start the learning process, we'll detail two features on the G1000 you might not be familiar with, but we'll be using throughout the rest of the eBook:

- OBS mode
- DIRECT-TO mode

Preparation

OBS Mode

When you create a flight plan, whether using the World Map or directly on the G1000, the flight management system (FMS) will provide course guidance between the waypoints in the flight plan. It doesn't matter whether those waypoints are GPS, VOR, NDB or a custom fix, the system treats them the same.

Figure 4 - G1000 Flight Plan Example



ACTIVE FLIGHT PLAN			
JUDEP/KPFN			
	DTK	DIS	ALT
JUDEP	0°	0Nm	9500FT
PKZ	71°	24Nm	9500FT
HRT	94°	25Nm	9500FT
GINTY	107°	24Nm	5950FT
KPFN	107°	30Nm	----FT

To illustrate, here is a flight plan along the Florida Panhandle region.

- PKZ is an NDB (326.0 kHz)
- HRT is a VOR (110.8 MHz)
- GINTY is an RNAV waypoint

The G1000 treats all of these as waypoints. You can set your CDI source to GPS and fly merrily along the route without turning an ADF or VOR. As you fly, the system will sequence automatically from waypoint to waypoint through the flight plan. Pretty cool...

When navigating using GPS as the source, the course and the deviation to course is shown on the CDI and cannot be adjusted while the flight plan is active unless you use OBS mode.

So, what is OBS mode?

To start, let's refresh with a VOR. OBS is the acronym for "Omni Bearing Select", which means to select a given radial on a VOR using an OBS knob (steam gauge) or CRS knob (G1000).

Figure 5 - G1000 HSI with VOR Source



When we track a VOR signal on a G1000, we select VOR as the CDI source. This shows as a green arrow. The CRS knob functions as the OBS on an old steam gauge, setting the course, which is the VOR radial we want to track or intercept.

In this example, the course (radial) is R-001, and it is right of our current position.

With VOR as the HSI source, the course can be changed or adjusted at any time.

In OBS mode, the FMS treats any waypoint as a VOR, allowing you to select any "radial" to or from the fix. Just as importantly, OBS mode stops any automatic sequencing in the flight plan. This will become very important later as we learn to fly a holding pattern using a GPS, especially if we are going direct to a waypoint.

Preparation

DIRECT-TO Mode

DIRECT-TO is a useful feature of the G1000, giving you the ability to get a direct track (DTK) from where you are to any other point in the G1000 database: an airport, VOR, NDB, waypoint.

We'll use this later, both to navigate to a missed approach holding fix, and to give us a course back to an IAF/IF on a instrument approach procedure (IAP).

Both the PFD and the MFD have DIRECT-TO functions. I prefer the MFD, but that's just me.

Figure 6 - Configuring DIRECT-TO



In the lower right of both displays are a series of keys used for FMS management.

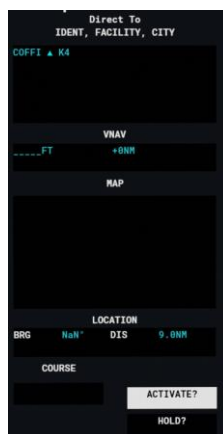
The key highlighted in red is the DIRECT-TO key.



When you press the DIRECT-TO key, a window appears with the cursor positioned on the cyan entry field.

Use the small FMS knob to enter the characters for the desired point. Again, this can be anything in the G1000 database: Airport, VOR, NDB or GPS waypoint/fix.

When you finish entering the characters, press the ENT key.



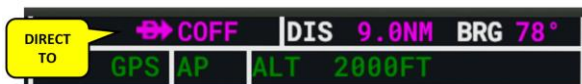
Here I've entered the waypoint COFFI. Notice that the cursor has moved to the ACTIVATE field.

Press the ENT key again to activate.

Preparation

When you activate a DIRECT-TO, a couple of things happen:

Figure 7 - DIRECT-TO on the PFD & Nav Map



In the AFCS box on the PFD, the lateral guidance shows the waypoint, distance and bearing.



On the MFD navigation map, you now have a direct track (DTK) from the location where you activated the DIRECT-TO entry to the destination waypoint.

ACTIVE FLIGHT PLAN			
USER/COFFI	DTK	DIS	ALT
USER	0°	0Nm	----FT
→ COFFI	78°	13Nm	----FT

This is the flight plan after DIRECT-TO entry.

In NAV mode, the autopilot will fly us to our entered waypoint. Then what? When you reach the waypoint – typically within 2nm – the waypoint disappears from the AFCS & Flight Plan!

Unless you are in OBS mode.

If you are in OBS mode, the waypoint remains. You'll have distance and bearing to it. If you use one of the BRG pointers, you'll also have a blue arrow pointing directly to the waypoint. When you pass over the waypoint, the arrow will flip 180°, indicating that the waypoint is now behind you. When we start flying GPS waypoint holding patterns, we'll use this to our advantage.

OBS Bonus!

Here's a good way to combine OBS & DIRECT-TO

Figure 8 - Using OBS & DIRECT-TO For Runway Alignment



Use OBS mode to line up your approach to a runway.

- DIRECT-TO the airport and turn on OBS mode
- Set CRS to the runway heading. XTK shows distance to intercept. Turn to final on intercept.

This is not RNAV or ILS exact, but it will get you close. The blue BRG1 arrow will point to the airport. As the CDI centers, turn to final and fly it on down!

Missed Approach Procedures

Chapter 3 – Flying A Missed Approach

The Missed Approach Procedure

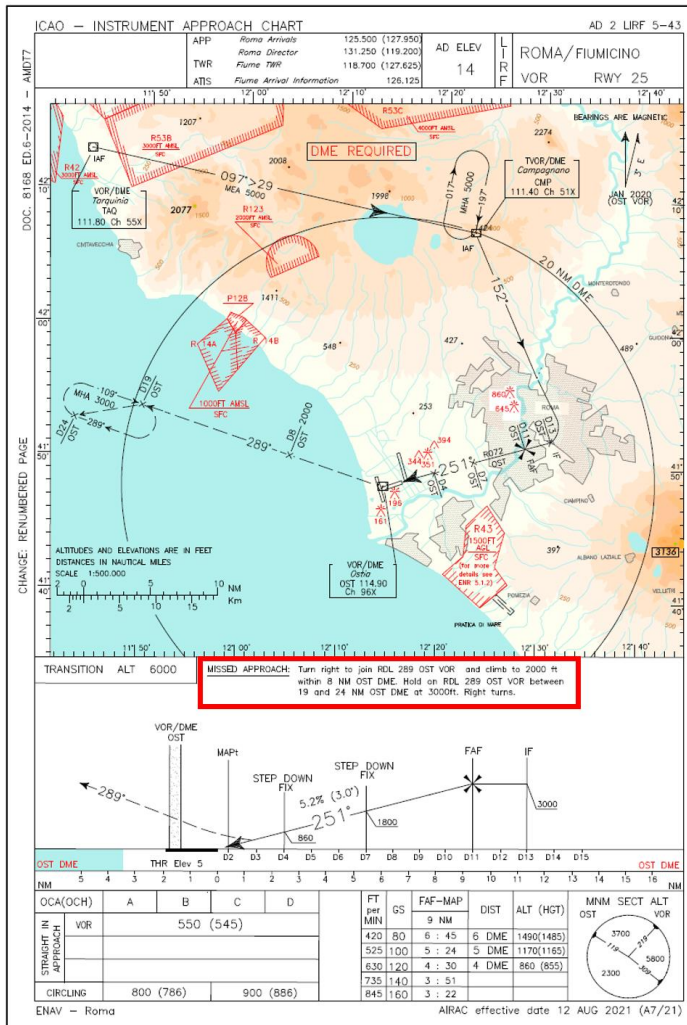
Now that we understand missed approach procedures and the necessity of being prepared beforehand, it's time to look at different procedures and how to fly them. [Chapter 4](#) will then give you in-depth instruction on holding patterns once you get out to the holding fix.

As mentioned earlier, we are going to focus on two types of navigating and flying missed approaches: VOR and GPS. While these examples will utilize autopilot control, make sure you also can fly them by hand. We will be using the Cessna 172 with G1000 avionics for these examples.

VOR Approach

We will start with the VOR approach we saw earlier, RWY 25 at LIRF, Rome Fiumicino

Figure 9 - VOR approach – LIRF RWY 25



As a non-precision approach, we will have to manage our altitudes.

When we intersect OST R-251, our final approach heading, the altitudes listed are DME from the OST VOR.

Distance	Altitude
11.0	3,000'
7.0	1,800'
4.0	860'
2.0 (MA)	550'

At the 2.0 OST DME point, if we don't have the runway in sight or any of the other reasons indicating we can't safely land the aircraft, we need to initiate a missed approach.

Missed Approach Procedure:

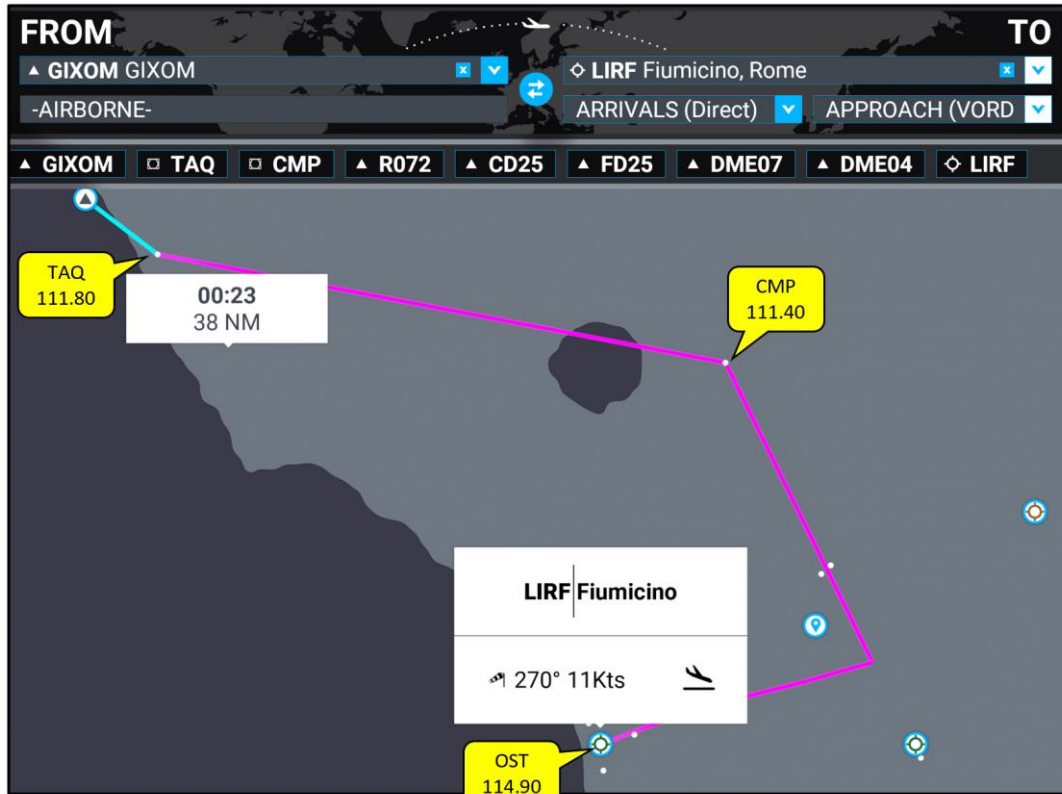
Climbing right turn to 2,000, intersecting OST R-289. Follow this radial outbound to OST 19.0 DME and hold.

Image Source: AIP Italia

Missed Approach Procedures

Time to get into MSFS! Open the World Map and set up a flight as shown below. The flight must be set up as IFR (Low-altitude airways). While you can fly an IAP in VFR, you won't have the option to call a missed approach with ATC. Why? Only instrument approaches have corresponding missed approaches. In order to call a missed approach, fly the procedure and receive ATC clearance to try the approach again, you *must* be on an IFR flight plan.

Figure 10 - VOR Approach Example in MSFS



The route to RWY 25 from GIXOM should look like this, complete with ugly, unnecessary white boxes that can't be turned off. As a VOR approach, we only need and will use the VORs. The flight planner generously provides us with five waypoints that we will ignore: R072, CD25, FD25, DME07, DME04. Also note that OST, our approach navaid, is nowhere to be found in the flight plan. Since you can't add a waypoint or navaid to an approach course (magenta line), we will dial it in manually. Maybe someday...

In the NAV LOG, set your cruise altitude to 5,000'. I suggest printing out or have the IAP easily available, so you have the approach altitudes and the missed approach procedure readily at hand.

From the chart above, we will be at 5,000' between TAQ and CMP. Between CMP and turn to final, we will be descending to 3,000'. ATC may squawk at you for being below your assigned altitude; ignore them until they get it right by the chart. On final, we will use VS mode to manage our descent to the DH (Decision Height).

Missed Approach Procedures

In this scenario, we will use NAV2 to navigate the first part of the approach from GIXOM → TAQ → CMP. On final and in the missed approach, we will use NAV1. Plan ahead!

Let's fly...

When the scenario starts, immediately put it in ACTIVE PAUSE so you can set up the following:

- Press the HDG dial to set the heading bug to your present heading, then turn on HDG mode on the autopilot.
- Dial in 5,000' on the altitude preset and turn on ALT mode on the autopilot.
- Adjust NAV2 to CMP (111.40) and press the double arrow key to make 111.40 your active NAV2 frequency.
- Press the CDI softkey to select VOR2 (NAV2) as your HSI source
- Press the CRS button. This will show you the radial to CMP - 102°. Note that this is also shown in the top status bar.

Figure 11 - VOR Example: G1000 Initial Settings



At this point, you can put the autopilot into NAV mode. The airplane will turn to the left and track the 102° radial to CMP, which is currently 33.5 nm from the present location.

It's a lot to get started; maybe someday we will be able to set up the avionics prior to starting the scenario.

Notice that the current leg in the AFCS status box center top shows our leg to be GIXOM → CMP. What happened to TAQ? It doesn't show up in the flight plan either. On to CMP...

Missed Approach Procedures

Figure 12 - HSI Tracking a VOR

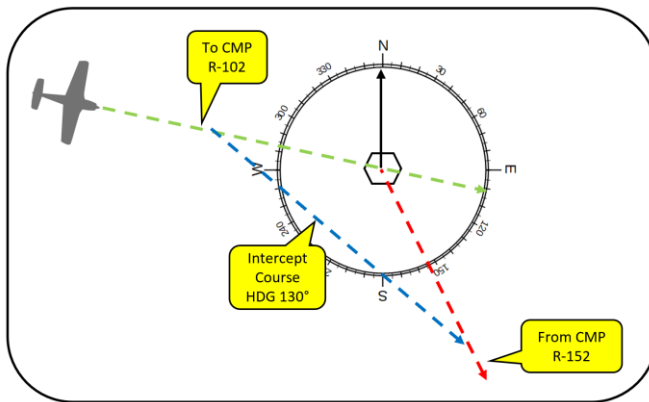


In NAV mode with a VOR as the HSI source, the autopilot will track the radial shown in the CRS setting. In this example, we're tracking CMP R-102. This will take us directly to the CMP VOR, making automatic adjustments for the wind.

DME will show us the distance to the VOR. We know from the IAP chart that we will turn right at the CMP VOR to a new heading of 152° outbound from CMP until we intercept the R-251 inbound to OST.

It's good practice to keep your heading bug set to your current course. This allows you to maintain course while adjusting the VOR course. Why? Glad you asked...

Figure 13 - Intercepting Outbound Course



As we approach the CMP VOR, we will switch to heading mode and intercept the R-152 radial from CMP.

Cutting the corner avoids the "Cone of Confusion" directly over the VOR where the NAV radio loses the ability to know whether you are coming or going.

We will start this maneuver 2 nm from CMP.

Here's how:

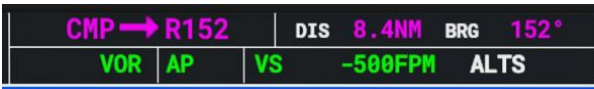
- Rotate the heading knob to 130°
- At 2 nm from CMP, change the autopilot from NAV to HDG. The aircraft will turn right to the new heading.
- Change the CRS setting on NAV2 to the new heading of 152°
- When the CDI needle centers – showing you have intercepted the radial – switch back to NAV mode.

Once we get established on the outbound CMP R-152, we can begin our descent to 3,000' as shown on the IAP chart. We want to be at this altitude when we make our turn to final.

ATC may complain; ignore their repeated pleas to return to your assigned altitude.

Missed Approach Procedures

Figure 14 – AFCS Showing Descent to 3000



- Dial in 3,000' on the altitude preset.
- Press the autopilot VS button and press the NOSE DN button to set up a -500 fpm descent
- The white ALTS means Altitude Capture is armed and you will level off at your preset.

As soon as you are level at 3,000' in ALT mode, dial in your next step-down altitude: 1,800. If you have not yet done so, tune NAV1 to OST (114.9) as the standby frequency. The IAP chart shows our present course will intercept OST R-251 at OST DME 13.0 nm.

We will make the turn to final when we cross the inbound OST R-251 radial. The turn will be 99° (251-152) to the right. While we don't have to worry about the Cone of Confusion directly over a VOR, we also want a nice clean turn without zig zagging around the sky as the autopilot hunts for the radial.

To accomplish this, we will once again make a temporary switch to HDG mode, this time to switch the HSI source from NAV2 to NAV1 and set the course. Since we only have one HSI on the G1000, you can switch the navigation source from VOR2 to VOR1 using the CDI softkey to watch for movement of the CDI needle, but I strongly recommend you **always** temporarily switch to HDG mode before changing CDI source so that your autopilot doesn't make any unexpected turns.

Figure 15 - Nearing Turn to Final



As we near the OST R-251, we can see on our HSI the CDI needle has moved off of full scale deflection.

Since we are in HDG mode, begin a turn to the right by turning the HDG knob. Just before the CDI centers, press the NAV button and the autopilot will track the inbound final approach course.

When tuned to a NAV radio, the single blue arrow on the HSI shows the bearing to NAV1 source (OST) and the double blue arrow shows the bearing to the NAV2 source (CMP).

Missed Approach Procedures

Once we turn to final, we are mostly managing altitudes. To refresh:

Distance	Altitude
11.0	3,000'
7.0	1,800'
4.0	860'
2.0 (MA)	550'

All distances are DME from the OST VOR.

As before, use VS mode to descend at fixed rates. Referring back to the IAP, Navigraph/Jeppesen charts have a nice table showing descent rates for different approach speeds. In the C172, we will be managing power settings for an approach speed of approximately 80 kts.

As on any approach, pay attention to pitch, power settings/speed, flaps etc. On the C172, we don't need to worry about landing gear.

When we get to our DH of 550', it's time for us to decide to go missed approach. I might have flown a perfect approach, but we're here to practice missed approaches. Make the call.

Since we had already prepared for a missed approach, it's not difficult to fly the procedure. More than likely, you had already transitioned from autopilot to hand flying the final segment. After all, a C172 does not have Autoland capability, even though I tried it once, setting the final altitude setting to the TDZE. Predictably, I crashed.

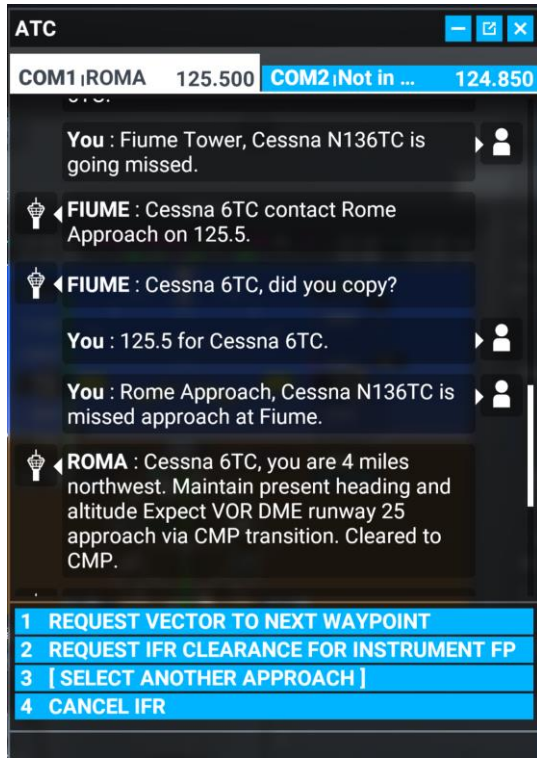
Here we go missed approach:

- Increase power and raise the flaps to TO position, while flying the runway heading. I'm sure your heading bug is already set to the runway heading of 251°.
- Once you have established a positive rate of climb, it's easiest to turn on the autopilot. It will default to ROL (wings level) and PIT mode (capturing your current pitch). It's possible you may need to turn off ALT mode since you may still be within the \pm capture window of approximately 120'. The important thing is to be climbing.
- Turn on HDG mode to continue flying the runway heading.
- Turn the CRS knob to our missed approach course of OST R-289. Since NAV1 is still your CDI source, you only need to turn the CRS knob.
- Dial in 2000' on the altitude preset and turn on FLC mode, with a speed setting of 78 kts. Why? Best-rate-of-climb in the C172. When you are comfortable the climb out is under control, fully retract flaps.
- Turn on NAV mode and the aircraft will turn right to intercept and track OST R-289, our missed approach course.

Make sure you contact ATC and declare your missed approach, but FIRST establish control of the airplane. Head towards your missed approach course and climb to the first altitude in the procedure. Speaking of ATC, here is a capture of the ATC comms after declaring the missed approach.

Missed Approach Procedures

Figure 16 - ATC Interaction on Missed Approach



Notice that once we left the airport, we were handed back off to Rome Approach. Makes sense since they're responsible for inbound traffic to the airport.

For some reason, my AI co-pilot did not respond to the hand-off instruction. It could be he was laughing at my approach.

Here's the important part of this: we were almost immediately cleared back to CMP. As soon as you receive clearance, you are good to go direct to CMP and fly the approach again. Once you have clearance, you are not required to fly out to the hold point.

We'll spend all [Chapter 5 – Recovery](#) on how to get back to the landing approach course.

In this first example, we went into a lot of detail on both the landing approach and the missed approach. This example was pretty basic, a single turn to intercept a VOR radial out to a holding fix.

Missed Approach Procedures

RNAV Approach

On this RNAV approach, we will fly the RNP approach into RWY 08L at EDDM Munich. Here is the full IAP chart:

Figure 17 - RNAV Approach Example

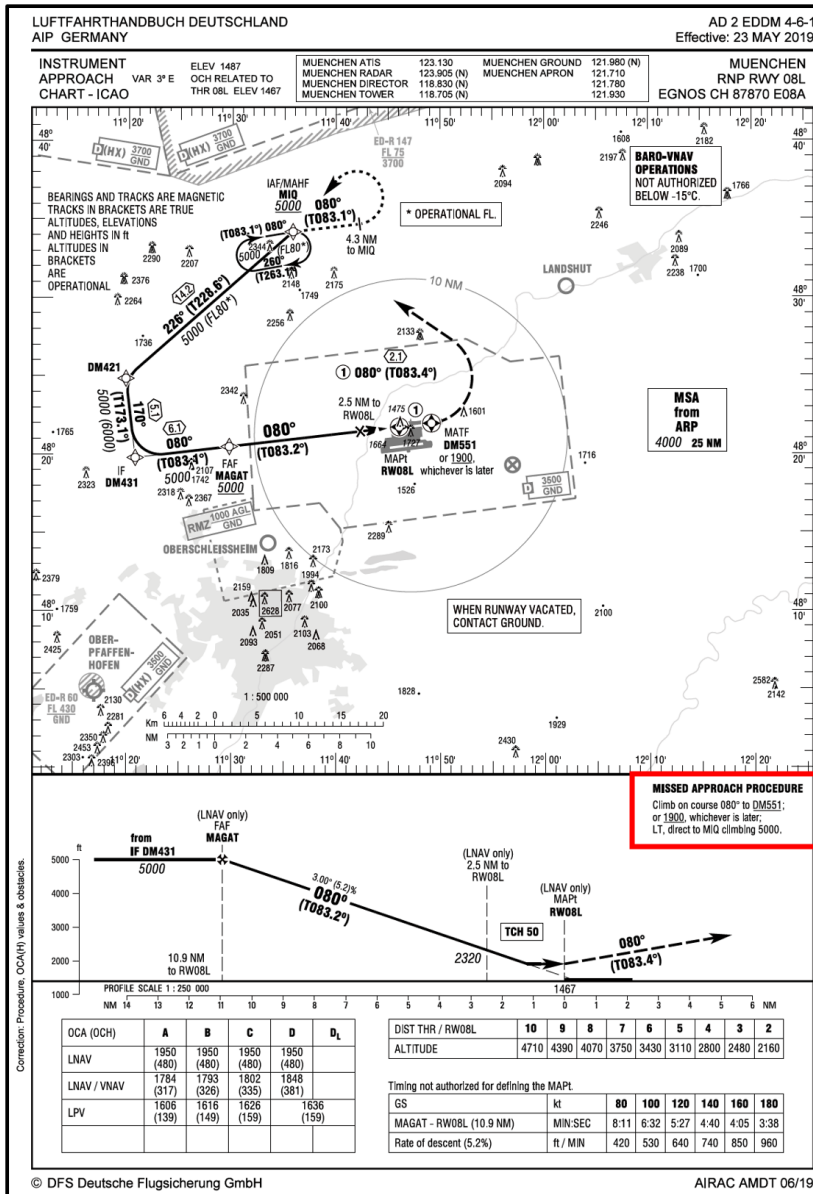


Image Source: AIP Germany

We will be coming into the approach from the north, using MIQ as the IAF.

The missed approach procedure:

- Fly runway heading 80° and climb to 1,900' or DM552, whichever is later.
- Turn left on a direct course to MIQ, continuing to climb to 5,000'
- Hold at MIQ

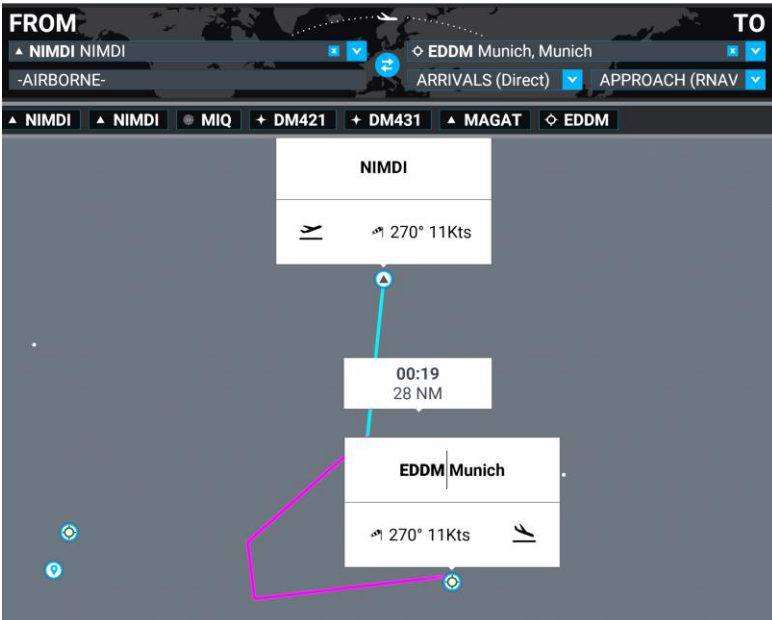
Since the G1000 in the C172 is capable of flying RNAV LPV approaches, we should be able to ride the glidepath down to the Decision Height (DH) of 1,667'

As always, have the chart with you so in the event the autopilot does not capture the glidepath, you can manually step down to the required altitudes. RNAV approaches are still a bit inconsistent, so it's good to be prepared.

Missed Approach Procedures

Here's the flight plan in MSFS. Note that we are starting airborne at NIMDI, heading towards our approach IAF at MIQ.

Figure 18 - RNAV Approach Example



Remember, the flight plan must be set up as IFR so we can call missed approach.

In the NAV LOG, set your cruise altitude to 6,000'

It's interesting to note MIQ is actually an NDB, but the FMS will treat it as a GPS waypoint.

See, I don't totally hate NDBs!

When started, for some unknown reason we were heading north instead of south. Set your altitude hold for 6,000' and use either HDG or NAV mode to get on course.

Figure 19 - Direct-To on the MFD



During these early segments of the flight, you have time to call up our waypoint on the missed approach: MIQ

This is a section of the MFD showing the Direct-To page. Use the FMS knob in the lower right to enter MIQ and press the ENT key.

Do not activate (yet). We will come back to this when we start our missed approach procedure. Presetting this first waypoint in the procedure will be one less thing you will need to do in the busy first moments of starting the missed approach procedure.

Once called up, you can close the Direct To window by pressing the Direct To button.

Missed Approach Procedures

Figure 20 - PFD on RNAV Final



When we got to MAGAT, the magenta diamond on the altitude tape showing GS deviation was centered, so we switched to APR mode. Note that GS shows green in the AFCS status box, indicating the glidepath is captured.

Adjust the power settings so we don't go into a screaming dive towards the runway.

Make sure the heading bug is set to the runway heading of 80°

We're going to need it soon...

Once you are on the glidepath, you can change your altitude preset from 5,000' to 1,900', our first altitude setting for the missed approach procedure.

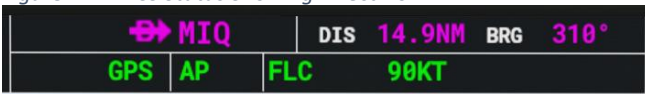
Despite the tailwind on approach (??) we got to our Decision Height and decided to go missed approach. Same as before:

- Increase throttle and bring the flaps to TO position
- Establish a positive rate-of-climb
- Engage the autopilot on HDG mode and then FLC at 78 kts to our first preset, 1,900'

Now that we have the aircraft under control, we next need to:

- Make the missed approach call to ATC
- Shift our attention over to the MFD and activate the Direct To function to MIQ. The AFCS Status box should look like this:

Figure 21 - AFCS Status Showing Direct-To



ATC responded by telling us to climb to 5,000 and cleared us to MIQ. We switched to NAV mode and flew the leg to MIQ.

Another relatively simple procedure, this time using GPS guidance to head direct to MIQ.

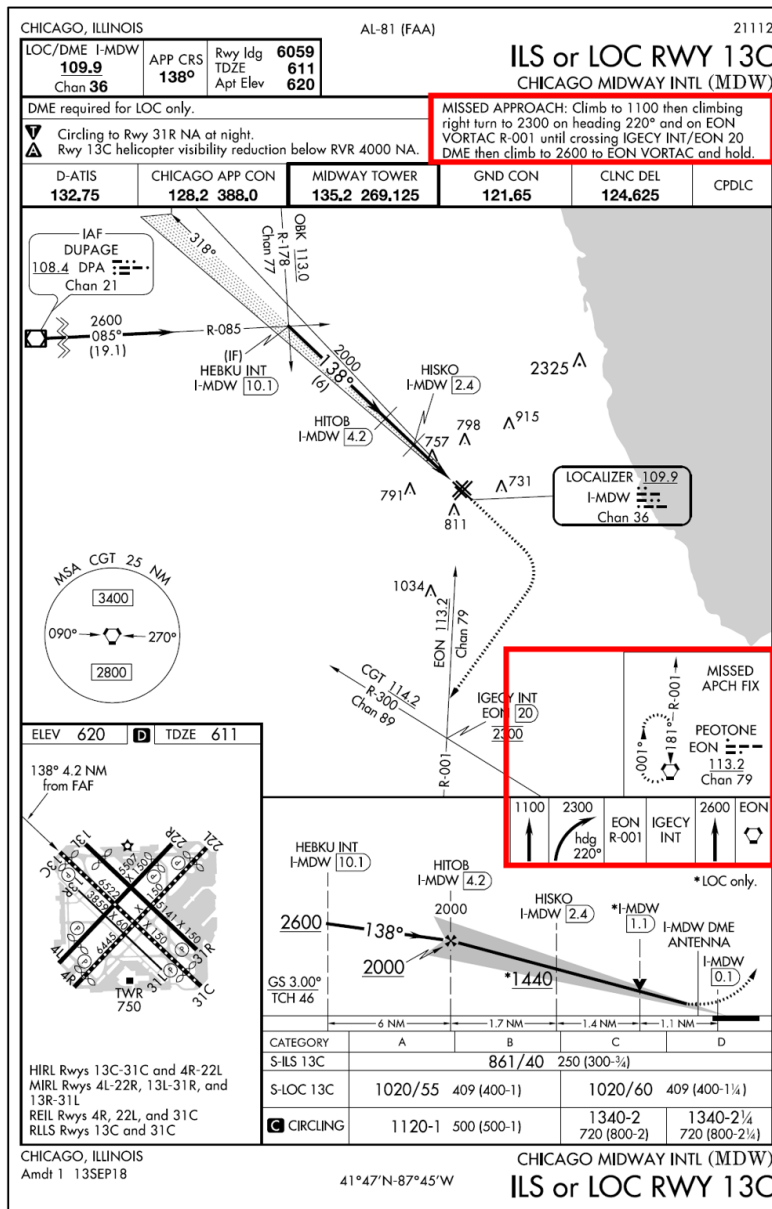
Missed Approach Procedures

ILS Approach

In these two examples, we've flown missed approaches to holding points using VOR and GPS. These two methods of navigation will cover the majority of missed approach procedures. Yes, there remain many NDB fixes used in missed approach, but in many cases, these navaids are considered waypoints, as we saw in the previous example at Munich.

We will do one more type of approach, an ILS into RYW13C at KMDW Chicago Midway. As you can see from the chart, we will be navigating to a VOR on the missed approach procedure.

Figure 22 - ILS Approach Example



As we look over the missed approach procedure, at this point you should be able to interpret the procedure.

For this approach:

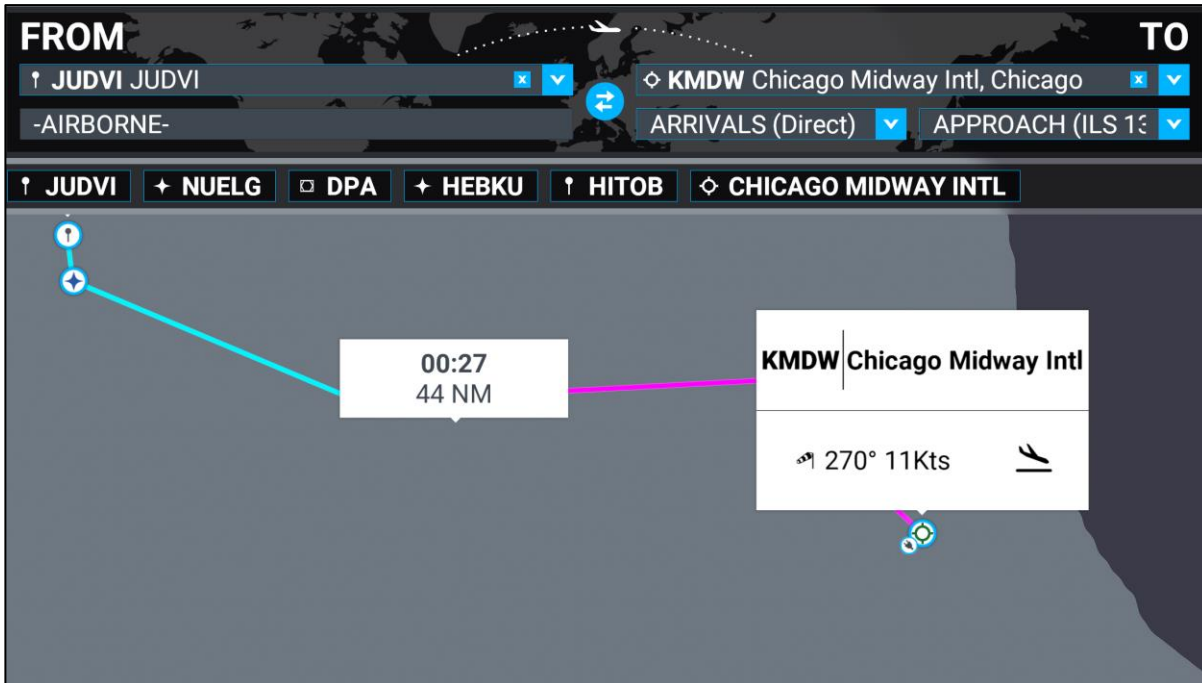
- Climb to 1,100' on the runway heading of 138°
- At 1,100', make a climbing right turn to 2,300' on a heading of 220°
- Intercept and track the EON R-001 inbound. When you pass the EON DME 20.0 (IGECY fix), you are then cleared to 2,600.
- Hold at EON

Image Source: FAA IFR Chart Database

Missed Approach Procedures

In the sim, set up the World Map IFR flight plan as shown below. In the NAV LOG, set cruise altitude to 7,000'.

Figure 23 - ILS Approach Example - Flight Plan



When the scenario starts:

- Put the autopilot into NAV mode with GPS as the CDI source, ALT hold at 7,000'
- Set NAV1 active to the localizer frequency: 109.9 MHz
- Set NAV1 standby to EOM: 113.2 MHz
- Set NAV2 active to DPA: 108.40 MHz

Using both the active and standby frequencies on NAV1 will simplify our switch from the localizer approach to the missed approach; we will only have to press the double arrow key.

Once you turn to the final approach course of 138° at HEBKU, set the heading but to 138° and switch to HDG mode. Change your CDI source to NAV1 and the autopilot back to NAV.

It is good practice to switch to HDG mode before changing CDI source!

As we follow the LOC/GS down towards RWY13C in APR mode, make sure your heading bug is set to 138°. After capturing the GS at HITOB, set the altitude preset to 2,300', which we will maintain on the missed approach procedure until we reach EON DME 20.0, when we can climb to our holding altitude of 2,600'.

Missed Approach Procedures

Once we started the missed approach procedure, we followed the altitude/course guidance and intercept EON R-001. Here we are tracking inbound to EON at 2,600'.

Figure 24 - ILS Example - Tracking VOR



Notice that I've set the CRS to be the reciprocal of R-001, the R-181. While the autopilot is capable of tracking either to or from a VOR, for the holding pattern, we want to reference the inbound course, which is R-181.

Summary

In these examples we've looked at a variety of approaches – VOR, RNAV, ILS – as well as the different missed approach procedures you will encounter as you fly anywhere in the world.

The key takeaway in this chapter is to fly the airplane first as you initiate a missed approach. You'll have to reconfigure your aircraft from a landing configuration (speed, flaps, gear etc.) to one that allows you to climb to the assigned altitude and heading and navigate to the holding pattern.

Next, as you approach the holding pattern, how do you enter it safely/correctly? Chapter 4 is all about holds.

Holds

Chapter 4 – Holds

A holding pattern is an essential part of every missed approach procedure. Holding patterns are “racetracks” utilizing one or more navigation aids: VOR, GPS fix/waypoint and yes, NDBs.

Here’s how we’ll cover holds:

- Elements of a Holding Pattern
- Holding Pattern Entry
- Flying a Holding Pattern

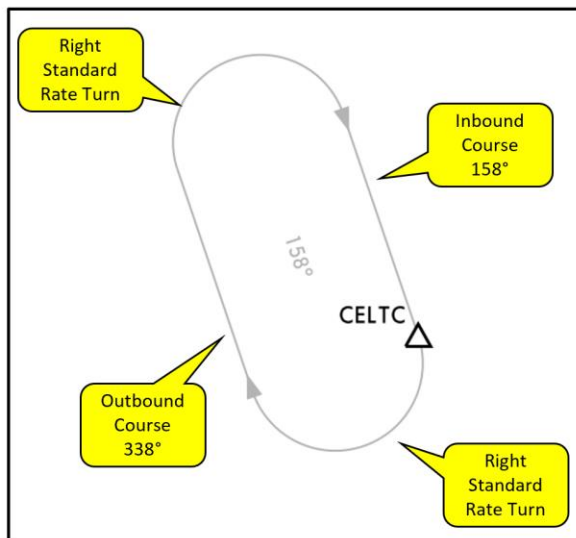
As always, we’ll set up examples for you to fly.

To our experience and knowledge, sim ATC does not (currently) instruct you to hold, either enroute or on approach. As we’ve seen in our missed approaches examples, ATC will usually clear you to fly the landing approach again prior to your arrival at the hold fix. As we said earlier, once you receive the clearance – usually to an IAF – you do not need to continue flying the missed approach procedure.

Elements of a Holding Pattern

Let’s start by examining a typical holding pattern. Here is one using the CELTC fix.

Figure 25 - Typical Holding Pattern – GPS Fix



The holding pattern is defined by the fix, whether it is a VOR, GPS waypoint or NDB.

The fix is always at the end of the inbound leg.

In this example, CELTC is the fix, and the inbound course is 158°. This makes the reciprocal outbound course 338°.

This pattern uses right hand turns. Unless otherwise specified, each of the legs is 1 minute long.

Holds

Let's go back to our previous missed approach example at Galveston Scholes.

Figure 26 - Missed Approach Holding Pattern - KGLS RWY 14

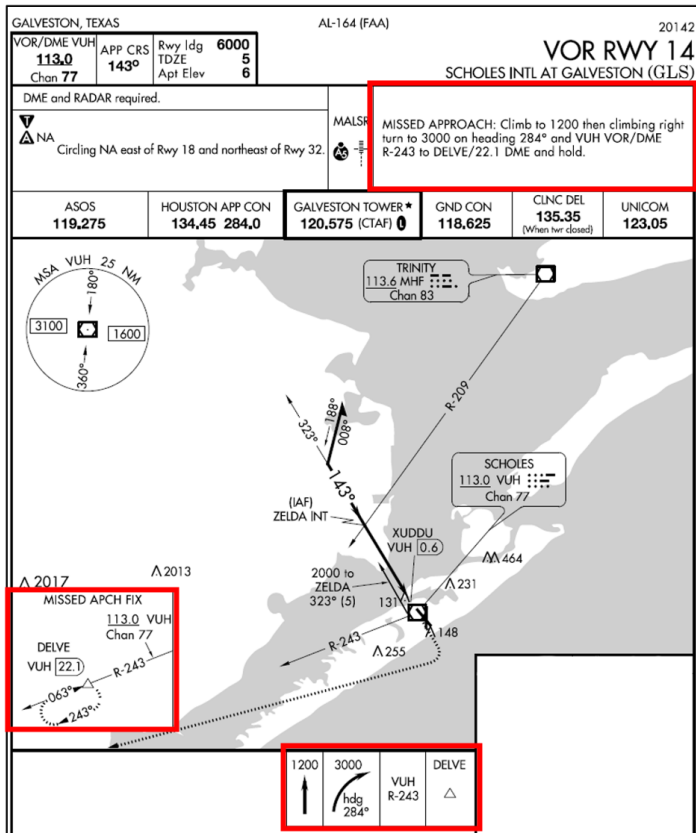
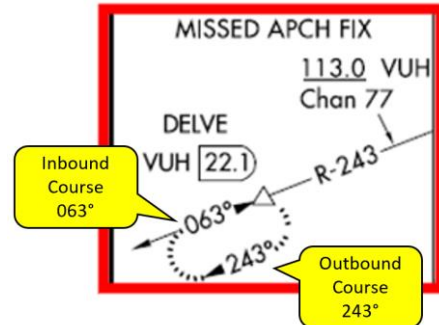


Image Source: FAA IFR Chart Database

The missed approach procedure provides altitude and course guidance to a holding pattern at DELVE, with a graphic showing the needed pattern information.

Zooming in on the Hold Pattern:



Not a lot of information (but enough)

- DELVE is 22.1 nm from the VUH VOR. It is also a RNAV fix.
- Inbound course is 063°
- Outbound course is 243°

While we were assigned an altitude for the missed approach procedure, there's no apparent information on how long or how far for each of the inbound/outbound legs. It also appears that our course to DELVE and the inbound course in the pattern meet at DELVE!

Now what?

All holds have an assigned altitude, either shown on a chart (IAP, Enroute, STAR, SID, Terminal etc.) or are specified by ATC. In our DELVE example, the hold altitude was 3,000', defined in the missed approach narrative in the IAP briefing strip.

MISSED APCH: Climb to 1200' then climbing RIGHT turn to 3000' on heading 284° and outbound on VUH VOR R-243 to DELVE INT/D22.1 and hold.

Holds

Let's look at how holding patterns are defined. Holding patterns fall into two main categories:

1. A "standard" hold
2. Deviation from a standard hold

Standard Hold

Standard holds have turns to the right. Unless *specifically instructed* by the chart or ATC to use left turns in the holding pattern, you must use right turns.

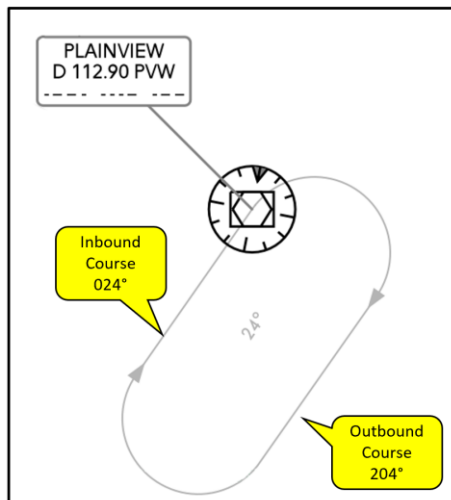
Standard holds have either:

- 1 minute legs
- Specific leg lengths (usually by DME)

In the example above, we would fly 1 minute on both the inbound and outbound legs. While DELVE is a RNAV fix, you can also fly this holding pattern using VOR. DELVE is defined as 22.1nm from VUH on R-243.

Here's additional examples, one using a VOR as the hold fix, the other an NDB as the hold fix.

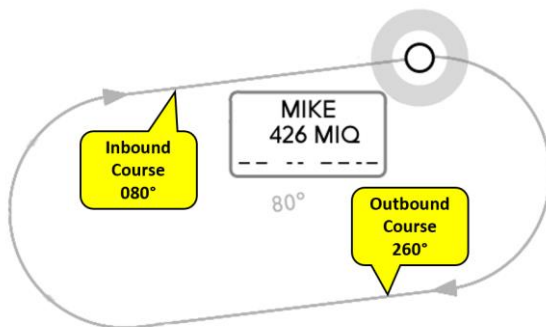
Figure 27 - Typical Holding Pattern – VOR Fix & NDB Fix



This hold uses the PVW VOR as the hold fix.

The inbound course is 24°, and the outbound course is 204°

Since not specified otherwise, these are 1 minute legs.



This hold uses the MIQ NDB as the hold fix.

The inbound course is 80°, and the outbound course is 260°

Since not specified otherwise, these are 1 minute legs.

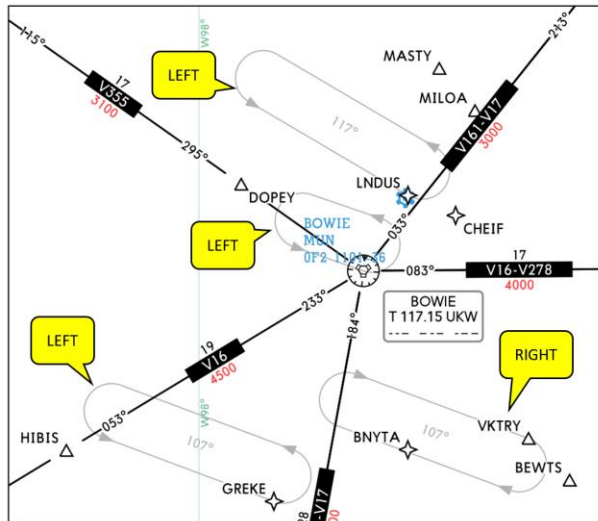
We'll fly this NDB example shortly, but we have some more learning first.

Holds

Deviations from a Standard Hold

There are times when the hold pattern varies from “standard”, either on a chart or as specified by ATC. You’ll see this most frequently using left hand turns. Even with left hand turns, the fix is always at the end of the inbound leg.

Figure 28 - Left Turn Holding Pattern Example



Here are some holding patterns near the UKW VOR northwest of Fort Worth.

LINDUS, BOWIE and GREKE holds all use left turns.

VKTRY uses standard right turns.

Turn Rate, Speed and Distance

On all holds, the turns are “standard rate”, which is defined as 3° per second. If you were doing a full circle in the sky, a 360° turn at 3°/sec mean it would take 120 seconds to do the full 360°.

On a hold “racetrack”, we’re doing a course reversal of 180°, so that should take 1 minute. You mean there’s a method to the madness?

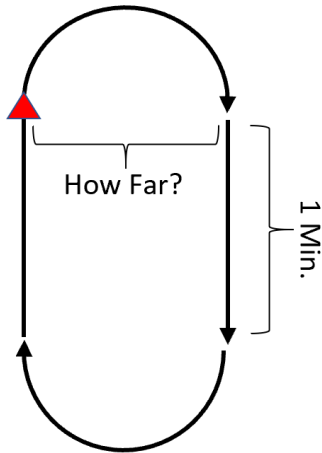
It’s important to note that holds defined and shown on a chart are NOT to scale. If you’re using the “live” feature on Navigraph charts inside the sim, you’ll notice that your turn and outbound leg do not track what is shown on the map.

What does matter is your airspeed. Standard turn rate is the same 3°/sec whether you’re flying a C172 or a 787. However, the distance you’ll travel during the turn is drastically different.

Understanding the relationships between turn rate, speed and distance is crucial to flying an accurate hold pattern.

Holds

Figure 29 - Distances in a hold



We'll start by considering a typical hold pattern.

When you roll out level after making a 180° turn to the outbound leg, how far from the fix are you?

How far do you travel on a 1 minute leg?

To answer these questions, we need to do some basic math.

Let's do the easy one first: how far do you travel in 1 minute?

We measure speed in nm/hr, so we can simply divide our speed by 60 to get distance/minute or nm/min.

Here's a reference chart for you:

As you can see, if you're flying at 100 KIAS, you're traveling 1.7 nm/minute, whether you're turning or flying a straight line.

In the CJ4, you may be at 180 KIAS, covering 3 nm/minute. On a standard 1 minute holding pattern, the inbound and outbound legs will be different distances depending on your airspeed.

The same holds true (pun intended) on the turns. Turn at 100 KIAS and the *distance* you travel is much less than if you did the turn at 180 KIAS.

I'm going to show you two ways to calculate this: one using math and one using approximation.

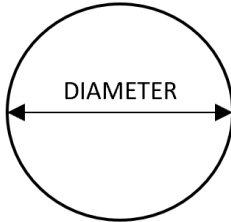
Note: Speeds highlighted in green are good ones to memorize.

Airspeed	NM/Min
70	1.2
80	1.3
90	1.5
100	1.7
110	1.8
120	2.0
130	2.2
140	2.3
150	2.5
160	2.7
170	2.8
180	3.0
190	3.2
200	3.3

Hold

The distance traveled in a full (360°) 2 min standard turn rate is the circumference of a circle. The answer to the question of how far are you from when you started your reversal turn in the hold, is the diameter of the circle.

Figure 30 - Circle Math



But first, let's figure out the distance. From the 1 minute table above, we know distance is speed/time. On a standard rate turn it will take 2 minutes to complete the circle, so we need to double the time.

$$\text{Distance}=\text{Speed}/\text{time}$$

Speed is in kts (nm/hr), so we divide kts by 60 to get speed/min. Our time is 2 minutes to do the full circle (circumference)

$$\text{Distance}=(\text{Speed}/60)/2$$

Simplifying: $\text{Distance}=\text{Speed}/30$

So now we have how far we travel in a 2 min standard rate turn, which is the circumference of a circle. R is the radius, and the diameter is $2 \cdot R$

Putting the numbers into the circumference formula and solving for R

$$C= 2\pi R$$

$$\text{Speed}/30 = 2\pi \cdot R$$

$$R= (\text{Speed}/30)/6.28$$

$$\text{Diameter} =2 \cdot R$$

$$\text{Diameter}=(\text{Speed}/30)/\pi$$

You gotta love π . I know if the steps in the math incorrect, astute readers are will gladly correct me.

All this is fine if you have the time. When you're setting up a holding pattern, you may not have the luxury of time, so there's another method: approximation.

The distance separating your inbound and outbound tracks is approximately:

1% of your airspeed.

That's **too easy**; even I can do this math in my head.

I took you through the whole exercise so you would understand the math behind the maneuver. The 1% rule is fine for what we're doing.

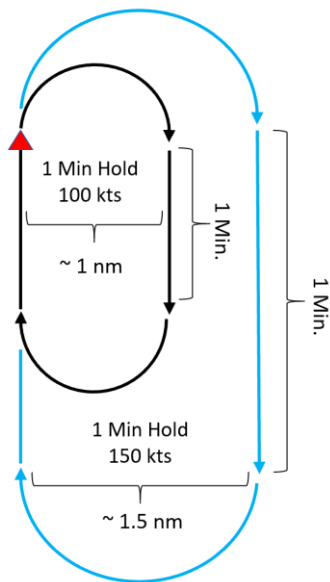
Holds

Here's the whole table:

Airspeed	Distance	Standard Rate Turn	
		Diameter	1% Rule
70	1.2	0.74	0.70
80	1.3	0.85	0.80
90	1.5	0.96	0.90
100	1.7	1.06	1.00
110	1.8	1.17	1.10
120	2.0	1.27	1.20
130	2.2	1.38	1.30
140	2.3	1.49	1.40
150	2.5	1.59	1.50
160	2.7	1.70	1.60
170	2.8	1.80	1.70
180	3.0	1.91	1.80
190	3.2	2.02	1.90
200	3.3	2.12	2.00

From the table, we can see that the 1% rule is a very close approximation. Given that few of us can maintain speed or turn rate exactly, it makes the 1% approximation look even better.

Figure 31 - Holding Pattern Distances



This illustrates the fact that your aircraft's path in a "standard" 1 minute holding pattern looks different depending on your airspeed.

If you're flying a C172 (black lines), your distances from the fix and the length of the 1 min legs are different that if you were flying the same pattern in a C208 at 150 kts (blue lines).

Next, we'll work through what is generally the hardest part of understanding holds: pattern entries.

Holds

Holding Pattern Entry

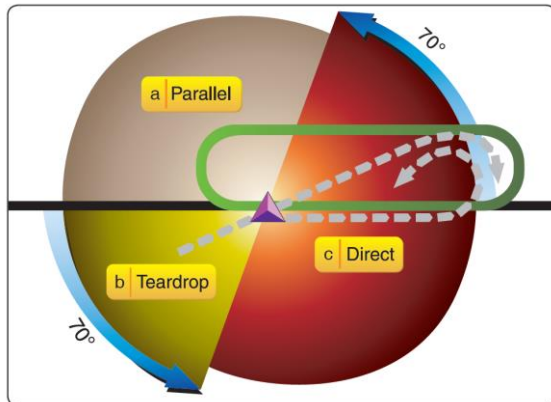
Browse any aviation or flight sim forum and you'll see that holding pattern entry is a topic that many people struggle with. Our goal is to try to simplify this for you.

On any given holding pattern, there are two factors that determines which of the three methods you'll use to enter the hold.

- The inbound leg course
- Your present position

This is the graphic from the FAA Instrument Flying Handbook:

Figure 32 - Holding Pattern Entry (FAA)



Source: FAA Instrument Flying Handbook FAA-H-8083-15B

Yikes: immediate confusion!

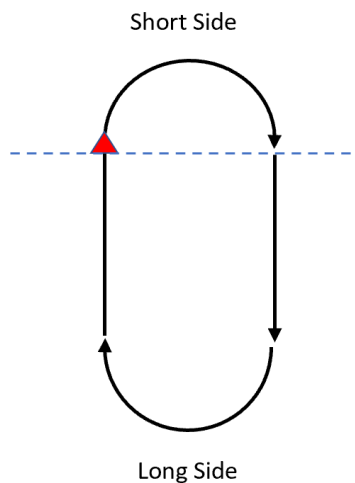
Fear not, brave sim aviator, it's not as bad as it appears.

From this graphic, we see there are three entries:

1. Parallel
2. Teardrop
3. Direct

How do we determine which one to use? In the continuing spirit of simplification, we'll dispense with the 70° offset from the inbound course. As you deepen your knowledge and skills, feel free to use the 70° standard method if you feel so inclined.

Figure 33 - Holding Pattern Entry - Long/Short Side



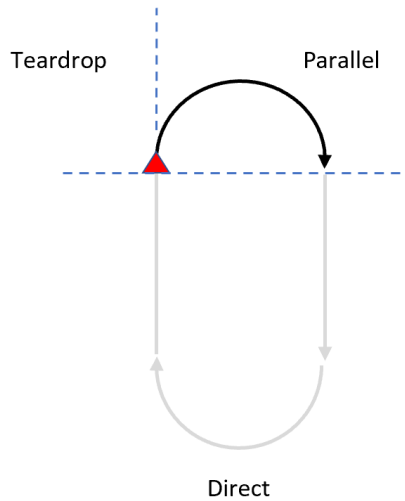
To make this easier, imagine a line perpendicular to the inbound course at the fix. We'll divide the circuit into two parts: short side and long side.

If you are approaching the hold from anywhere on the LONG side, you will make a DIRECT entry.

If you are approaching from anywhere on the SHORT side, go on to the next graphic.

Holds

Figure 34 - Holding Pattern Entry - Short Side



If you are approaching from the short side, visualize a line extending outward from the inbound course.

If your present position is opposite of the holding pattern direction, use the TEARDROP entry.

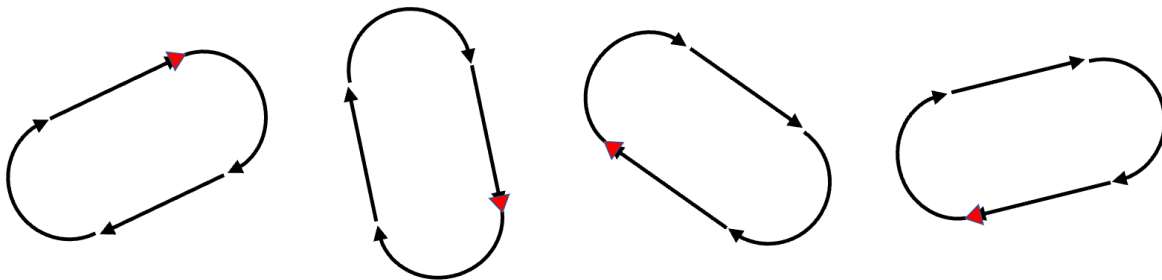
If your present position is on the *same side* as the holding pattern direction, use the PARALLEL entry.

To summarize:

1. Are you approaching from the long or short side? If the long side, use the DIRECT entry. If from the short side, go to the next step
2. Are you approaching from the same side as the holding pattern? If yes, use the PARALLEL entry. If no, use the TEARDROP entry.

This makes it relatively simple, but keep in mind the inbound course in holding patterns varies:

Figure 35 - Holding Pattern Alignments



You need to be able to make a quick and accurate judgement on your entry maneuver, no matter the inbound course alignment or your position.

There's only one solution: *practice*.

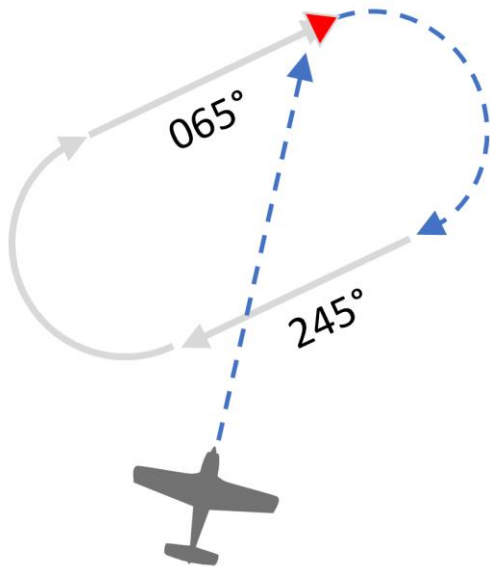
Draw out a variety of pattern alignments and place yourself at different locations. Work at it until you can tell at a glance what your entry maneuver should be.

There is an important common element between the three holding pattern entries: on all of them, you fly direct to the fix before starting the entry maneuver. No matter if the fix is a VOR, NDB or GPS waypoint, *always start at the fix*.

Holds

Direct Entry

Figure 36 - DIRECT Entry

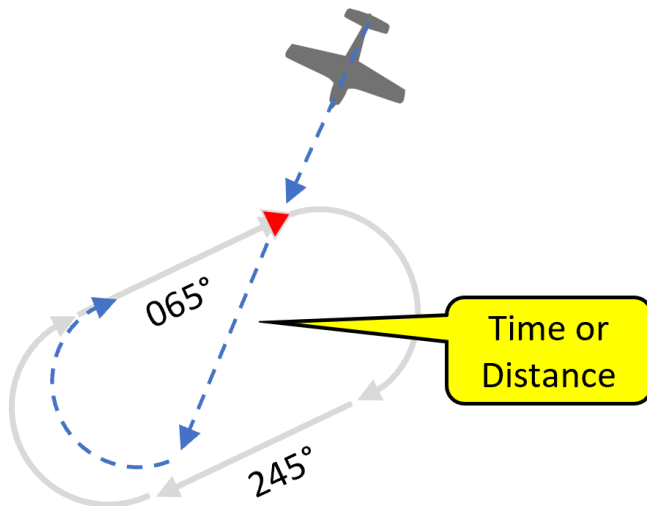


Direct pattern entries are straightforward:

- Fly directly to the fix
- Turn at standard rate in the specified direction
- Roll out at the outbound course heading
- Fly the hold as published (or directed by ATC)

Teardrop Entry

Figure 37 - TEARDROP Entry



Teardrop pattern entries are *slightly* more complicated:

- Fly to the fix
- Continue outbound for the length of the leg, either time (1 min) or distance
- Turn at standard rate towards the inbound leg
- Roll out on the inbound course heading
- Fly the hold as published (or directed by ATC)

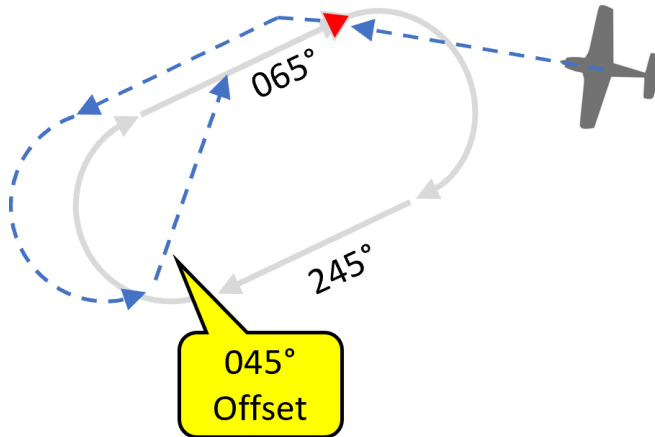
Note: many sources will specify a 30° course offset – I've seen this referenced to both the inbound and outbound courses. At this point, I wouldn't worry about it unless your approach angle is too shallow or too steep. Adjust if you must.

Keep it simple for now...

Holds

Parallel Entry

Figure 38 - PARALLEL Entry



We saved the best for last: Parallel Entry

- Fly to the fix
- Once past the fix, turn to the outbound heading
- At the completion of the initial turn, continue outbound for the length of the leg, either time (1 min) or specified distance
- Turn at standard rate towards the outbound leg. This will be opposite of the holding pattern turn.
- Roll out on a heading that is approximately 45° to the inbound course
- When you intercept the inbound course, roll out on the inbound course heading
- Fly the hold as published (or directed by ATC)

This one is a little harder to understand; after all, we are flying opposite to the direction of the holding pattern legs and turns.

In the example above, we initially turn to the outbound heading of 245° for the length of the leg, either time or distance. Next, we turn to the left at a standard rate turn. We roll out of the turn at a heading that is approximately 45° offset from the inbound course. In this example, we would turn left to a heading of 20° until we intercept the inbound course.

Again, the best advice I can give you to master holds is to practice, practice, practice.

Holds

Flying a Holding Pattern

Let's put it all together: holding patterns are defined by:

- A fix – either VOR, NDB or a GPS waypoint
- An inbound heading. The outbound heading is 180° or reciprocal from the inbound
- A specified altitude, published as part of a procedure or assigned by ATC
- A direction and rate of turns – right turns unless specified, standard rate (3°/sec)
- Leg lengths – either time (1 minute) or distance

A lot of variables!

For the rest of this chapter, we're going to set up multiple examples:

- Direct entry on a VOR
- Direct entry on a GPS waypoint
- Teardrop entry on a VOR
- Parallel entry on a GPS waypoint
- Holding Patterns using NDB/ADF
- Understanding wind drift

Let's fly!

Direct entry on a VOR

Figure 39 - Direct Entry Example

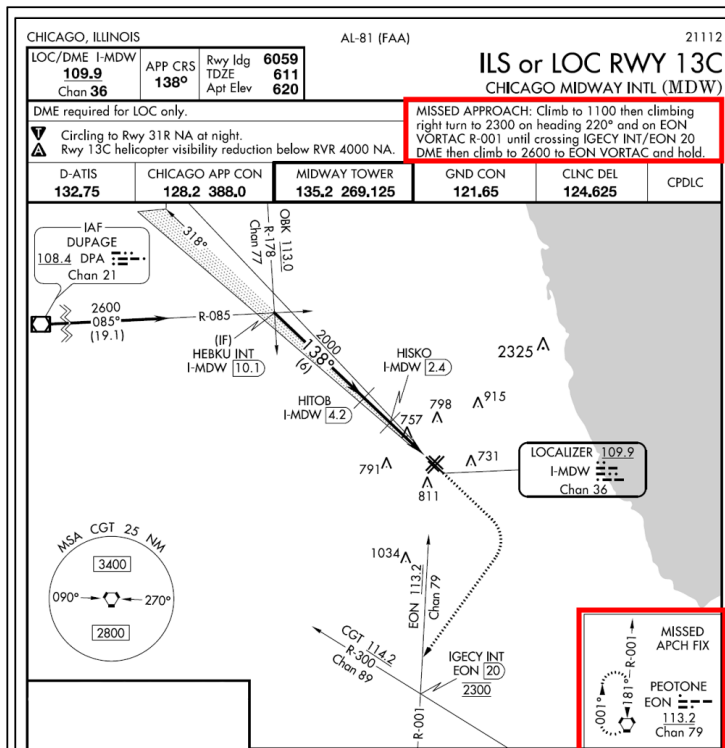


Image Source: FAA IFR Chart Database

Going back to our earlier missed approach example at Chicago Midway KMDW, we see the procedure has us holding at EON.

Because we're coming into EON on the long side, this would be a direct entry.

Instead of flying the missed approach, we'll take off on KMDW RWY 13C and fly to EON using the missed approach narrative.

To start, set the Departure airport to KMDW RWY 13C. Don't worry about an arrival airport unless you want to land after flying the hold example.

Holds

When the scenario starts,

- Set NAV1 to 113.20 (EON) and the CDI to VOR1 (green needle).
- The missed approach instructions say to climb to 1,100' (implied: runway heading), then turn right to a heading of 220°, while continuing to climb to 2,300'.
- Intercept and follow EON R-001. We're actually going to intercept the EON R-181, since it's our inbound leg heading on the hold pattern. As you know, R-001 and R-181 are the same, only one is TO the VOR (R-181) and the other is FROM the VOR (R-001).
- When we get to 20.0 nm from EON, we can climb to 2,600', our hold altitude.

We'll hand fly until we roll out on 220°, going to HDG and FLC modes on the autopilot. When we cross EON R-181, change to NAV mode.

Figure 40 - Direct Entry Example - PFD Enroute



On our way to EON

VOR tracking R-181
Altitude at 2,300'

Timer window
open and ready.

When we get to
DME 20 nm, we'll
climb to 2,300.

As with all holding pattern entries, we'll fly directly to the fix (VOR). As we approach the VOR, we'll switch to HDG mode, approximately 3 nm out. We do this because the CDI sensitivity increases as we approach the VOR.

We'll use HDG mode to control our aircraft in the holding pattern. Using the autopilot through this maneuver is an easy way to not have to worry about maintaining altitude. As your skills improve, hand fly the hold.

Holds

Figure 41 - Holding Pattern - HSI



When we get over the VOR, the center of the CDI needle will disappear and the TO/FROM flag flips. Also note that the bearing indication in the bottom left of the graphic shows “NO DATA”, indicating we’re over the VOR.

Use the HDG knob to turn right to our outbound course setting of 001°. Since it was not specified, the inbound/outbound legs are 1 minute.



As we level off from our turn, we are now on the outbound leg on a heading of 001°

I’ve started the timer, counting up. When it gets to 1 minute, we’ll make our next right turn to turn back towards the inbound leg heading of 181°.

Note how the VOR needle shows the R-181 off to the right of us, as it should be.



After 1 minute, we turn back to the inbound course.

Note how I’ve set the heading bug to about 30° from the inbound course setting. This is because our turn did not put us directly on the radial, as shown by the CDI deflection. As the CDI moves toward the center, keep turning the HDG knob until you finish right on the radial/course.

Through practice, you’ll improve the consistency of your turn rate, and will soon turn out exactly on the radial.

As you fly multiple circuits, you’ll notice that you may need to adjust the outbound course timing a bit to ensure that our inbound course is exactly 1 minute. This is generally due to the influence of the wind. We’ll get to that a bit later.

For now, keep practicing until exhaustion sets in...

Holds

Direct Entry on a GPS Waypoint

Next step is an example on how to fly a holding pattern using the GPS. For this example, we'll go back to Toronto Pearson CYYZ RWY 06R.

Figure 42 - Direct Entry Example

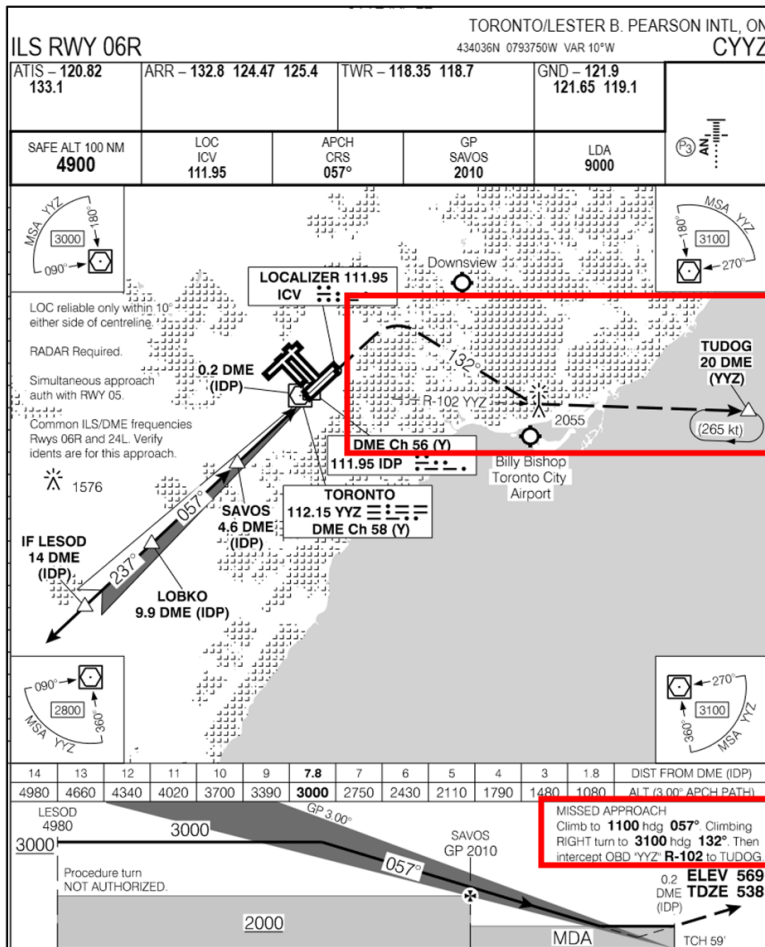


Image Source: VATSIM/ChartFox

Similar to the previous example at Chicago Midway, we'll start at the runway and fly the missed approach course, this time to TUDOG.

Per the instructions:

- Climb to 1,100' heading 057°
- Turn right to 132°, continuing to climb to 3,100'
- Intercept the YYZ R-102 and follow to TUDOG

TUDOG is 20 nm from the airport VOR YYZ, so we'll have plenty of time to dial in a DIRECT-TO function to TUDOG on our GPS.

When we start:

- Set NAV1 to YYZ 112.15, heading bug to 57°, course to R-102, CDI to VOR1
- We'll hand fly the initial climb-out using the missed approach procedure. Once we're established on the 132° heading, we'll turn on the autopilot in HDG and FLC mode and set up to intercept YYZ R-102 towards TUDOG.

Holds

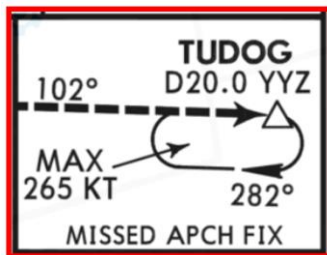
Figure 43 - Direct Entry GPS Example - PFD



We're intercepted and are tracking YYZ R-102 and have reached our missed approach hold altitude of 3,100'.

- Set your heading bug to 102°, select HDG mode
- Change the CDI to GPS
- Activate OBS mode
- For DME readout, set BRG1 to GPS

Figure 44 - Holding Pattern at TUDOG



Like we did with the VOR holding pattern fix, we're going to use HDG mode throughout the maneuver. The CDI will be a reference only.

The inbound course is 102°, which makes the outbound course 282°. These will be the numbers you'll dial in with the HDG knobs after you pass the fix and enter the hold.

Your GPS course may be slightly different than 102°, depending on when you made the turn towards TUDOG. In most of the times I ran the scenario, my GPS course showed about 107°. Remember: the holding pattern does not start until you reach the waypoint.

When you get to approximately 2 nm from TUDOG, switch to HDG mode, if you have not yet done so.

Holds

Since we are in OBS mode, the DIRECT-TO TUDOG waypoint will remain active during the holding pattern, giving you both distance and bearing to the fix.

When we cross the TUDOG fix, spin the heading knob for a right turn, ending up on your outbound course setting of 282°. When you are abeam the fix or wings level, start a 1 minute timer.

After 1 minute, spin the heading knob again for a right turn, ending up on your inbound course setting of 102°. When you are abeam the fix or wings level, start a 1 minute timer. If all is well, you should reach TUDOG at the 1 minute mark. If not, adjust your outbound course time. If you get to the fix 10 sec late, add 10 sec to the outbound.

Continue flying this holding pattern until you are comfortable using a GPS waypoint as the holding pattern fix.

A couple of comments on the flight:

Figure 45 - GPS Hold Pattern HSI



- Note the blue arrow on the HSI and on the BRG1 indicator lower left. This arrow points to the waypoint and can be used to tell when you are abeam (across from) the waypoint. When it is 90° (as shown), you are direct across or abeam from the waypoint.
- While this example had us approaching on the inbound course, many missed approach/holding patterns are not. By using OBS mode, you can use the CDI to help visualize your inbound and outbound course.

Holds

Teardrop entry on a VOR

To fly a holding pattern using a [Teardrop entry](#), we're back to Rome Fiumicino LIRF RWY 25.

Figure 46 - Teardrop Entry Example

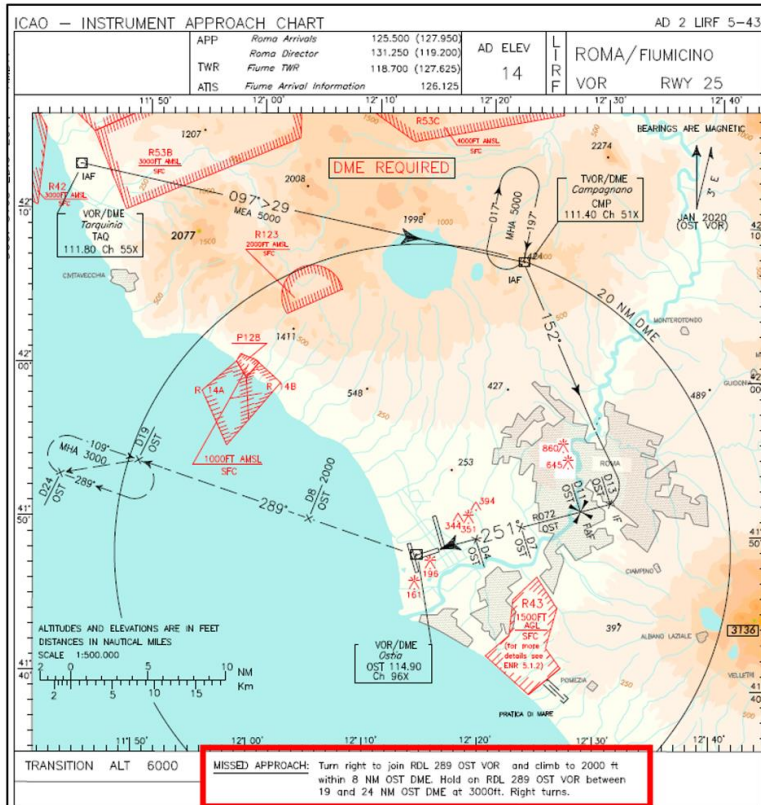


Image Source: AIP Italia

We'll start at RWY 25 in VFR, no destination airport needed.

The holding fix D19.0 is defined as 19.0 nm on the OST radial R-289.

- Our inbound course is 109°.
- Our outbound course is 289°.

Note: at the end of the outbound leg, we start our turn at D24.0 OST. This makes our holding pattern distance based instead of time.

Set NAV1 to OST 114.9 MHz, course to 289°

After establishing a positive rate of climb, turn right and intercept R-289, climbing to 2,000'. At OST 8.0, we can begin our climb to 3,000', our holding altitude.

Holds

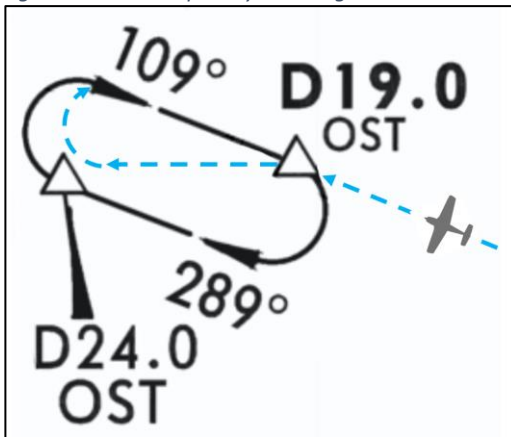
Figure 47 - Teardrop Entry Example - PFD



We've intercepted and are tracking OST R-289 and have reached our first altitude in the procedure.

On the way to the holding pattern, let's review our entry into the pattern.

Figure 48 - Teardrop Entry Planning



Since the Teardrop entry is not as obvious as the direct, let's make sure we have a plan for when we begin our maneuver.

At OST 19.0, we're going to make a turn to the left into the protected area of the holding pattern. We want to be coming in towards the outbound course at approximately 45° angle to the outbound. In this example, that will be a heading of 244°.

The other planning aspect is using the VOR inbound radial to ensure we are on course. We're approaching the pattern on OST R-289, which is the reciprocal to our inbound course. When we get to about 17 nm from OST – 2 nm from our holding pattern fix – we'll switch to HDG mode throughout the holding pattern maneuver.

Spin the course knob to the inbound course setting of 109°.

Now we're ready for pattern entry.

Holds

Figure 49 - Teardrop Entry - HSI



At the holding pattern fix, we spin the heading knob for a left turn to a heading of 244°.

Proceed on this course until the DME reads approximately 23 nm OST. We're going to turn right towards our inbound course. The reason we turned earlier than the outbound end of leg of 24.0 OST is because we are not yet in the pattern: we are entering the pattern but want to remain inside the protected area.



As we turn right back towards the inbound course of 109°, we want to roll out exactly on the inbound course. Notice how I've stopped the heading bug approximately 30° short of our inbound course of 109°. As the CDI needle centers, we'll continue our right turn so that we finish our turn exactly on the inbound course.



When we reach our fix of 19.0 nm, we are now in the pattern and begin our turn towards the outbound.

When we get to OST 24.0 nm on the outbound course, we turn right back to the inbound. If our turns are correct, we should start the inbound course on the R-109 radial at approximately 24.0 nm.

Despite the slightly more complex entry maneuver, this holding pattern using a specific distance for the legs is fairly easy to fly.

Fly the racetrack pattern until you're comfortable. Bonus points for flying it by hand.

Holds

Parallel entry on a GPS

Next entry example is the parallel entry. Refer to [Figure 32](#) to review the Parallel entry maneuver. For this example, back to Munich EDDM RWY 08L.

Figure 50 - Parallel Entry Example

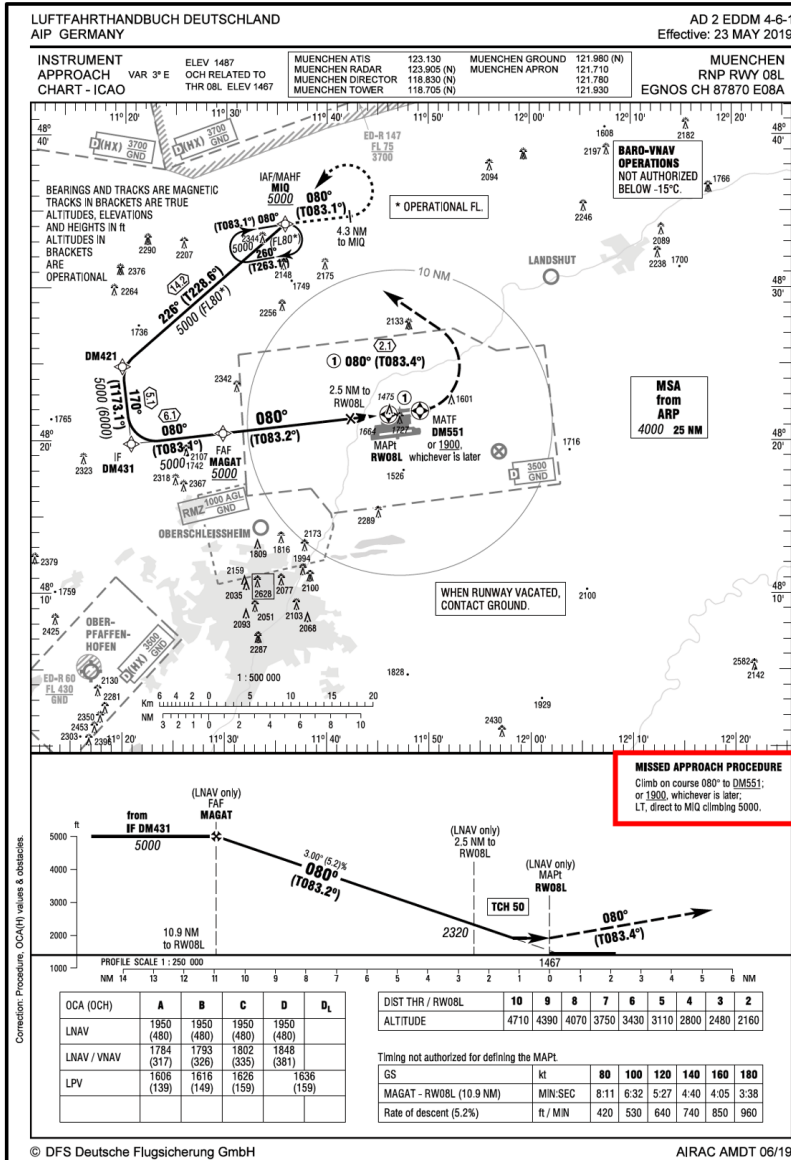


Image Source: AIP Germany

As you can guess, we'll take-off on RWY 08L and fly the missed approach procedure to the MIQ waypoint.

- Fly the runway heading until 1,900'
- Turn left to direct heading to MIQ and continue to climb to 5,000'

Note that our waypoint is MIQ, which is actually an NDB. Remember that in air navigation, VORs and NDBs have three letter names; waypoints always have five letter names.

So, what gives?

As an RNAV approach, your FMS is using the lat/long of the MIQ NDB as a waypoint, making your life a bit easier.

We have a few more items to set up prior to takeoff:

- Altitude preset to 5,000'
- Set up BRG1 indicator to the GPS
- Set up a DIRECT-TO to MIQ

Holds

Figure 51 - DIRECT-TO MIQ

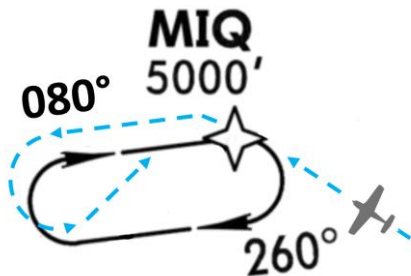


To set a DIRECT-TO to MIQ:

- Press the DIRECT-TO button on either the MFD or PFD
- Push the FMS knob to display the cursor and use the two FMS knobs to enter MIQ in the entry field
- Press the ENT key – the cursor should highlight ACTIVATE?
- Press the ENT key again to activate the DIRECT-TO to MIQ

To be fully prepared for this maneuver, let's think through the Parallel entry for this pattern.

Figure 52 - Parallel Entry Example - Holding Pattern



Once we make our initial climb, we'll use NAV mode to take us to MIQ. Shortly before (~2 nm) reaching MIQ, switch to HDG mode.

After passing MIQ, stay on your heading for approximately 0.2 nm to offset you from the inbound course, then turn to parallel the inbound course. This heading is the same as your outbound course or 260°.

When the turn to the parallel course is completed, start a timer. After 1 minute, begin a standard rate turn to the left, rolling out on a heading approximately 45° to the inbound course. In this example, the heading would be 35°.

Once we intercept the inbound course and pass over MIQ, we begin the 1 minute holding pattern with right turns to our course settings of 080° inbound and 260° outbound.

Let's fly...

Holds

Figure 53 - Parallel Entry Example - HSI



Here we are approaching MIQ.

When we are 2 nm from MIQ, switch to HDG mode and turn on OBS mode. OBS mode prevents the FMS from sequencing to the next waypoint and allows you to manually set the course.

After turning on OBS mode, turn the CRS knob so your new course setting is at the inbound heading of 80°.

Now we have a reference for our heading bug. When inbound, the heading bug will be set to the pointer on CDI. When outbound, the heading bug will be on the tail of the CDI needle.

As you pass over the waypoint, observe the behavior of the blue arrow on the HSI. It will soon be your new best friend. The blue arrow from BRG1 will always point to the waypoint.

At .2nm past MIQ, spin the HDG knob to initiate a left turn to our parallel course of 260°. When we get wings level, start a timer. At 1 minute, we begin our left turn to bring us around to an intercept heading of 35°. As you approach the inbound on the intercept heading of 35°, watch the blue arrow. When it points to 80°, turn right onto the inbound course. The same information is shown on the AFCS at the top of the PFD. Note the BRG field; when it shows 80°, make your turn.

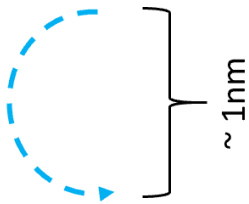
Once you've made your entry, flying the pattern is easy using the HDG function on the autopilot.

Parallel entry is not easy or intuitive the first few times you attempt it. To understand why, let's examine our flight path in a bit more detail.

Take a moment and go back to the earlier section in this chapter: [Turn Rate, Speed and Distance](#).

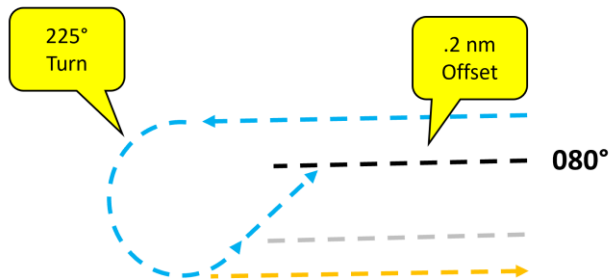
Holds

Figure 54 - Parallel Entry Turn Radius



From that discussion, we learned that a 180° standard rate turn at 100 KIAS will put us approximately 1 nm from where we started the turn. (1% Approximation)

On the parallel entry, our turn back towards the inbound course is not 180°, but 225°. The additional 45° of turn will not only take longer ($45/3=15$ sec) but will shorten the turn diameter even more!



To illustrate:

- The blue line is your parallel entry
- The black line is the inbound course
- The orange line is your track if you did a standard rate 180° turn
- The gray line shows the additional offset with a 225° turn.

What you'll (likely) find the first few times you fly a parallel entry is that you will spend almost no time on the intercept heading. For example, if your initial turn to the parallel course was more than .2 nm from MIQ, your time on the intercept heading will be even less. If you turn at a steeper (faster) rate than 3°/sec, your turn diameter will be less.

To summarize this, there are some key points to consider:

- Understanding the relationship between turn rate, speed and distance is critical
- Understanding the details of the maneuver is critical
- Understanding the information available to you is critical
- Maintaining a given turn rate is critical

Figure 55 - Parallel Entry - Practice



This is a great scenario to practice until you fully understand and get it right. At any time, you can return to your flight plan course to MIQ and try fly it again.

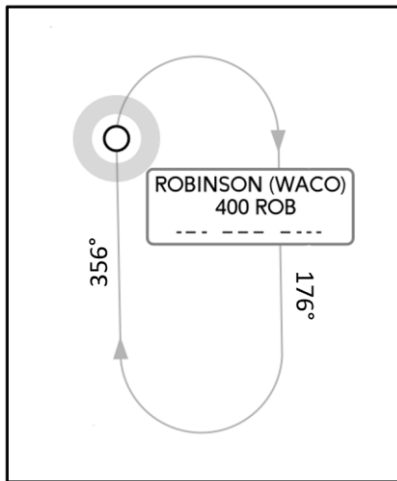
Holds

Holding Pattern Using an NDB

And you thought I was going to ignore NDBs. My beta readers said that was a bad idea, so here we go.

Let's face it: NDBs are not very precise but are still in use throughout the world. Yes, you can fly a holding pattern using an NDB/ADF and I'm going to show you how.

Figure 56 - NDB Holding Pattern



Near my home is the ROB NDB, complete with a standard holding pattern. Since we'll be approaching from the SW, this will be a direct entry.

Set your departure airport to KPWG RWY 17. It's a nice day, so we'll fly VFR for this example.

Set your ALT preset to 2,700', the published holding altitude.

Holds

Figure 57 - NDB Example - Tuning an NDB



Before takeoff, call up the ADF/DME TUNING window by pressing the ADF/DME softkey on the PFD.

Adjust the standby frequency (cyan box) to the frequency for ROB – 400 kHz – and press ENT to transfer to the active frequency on the left.

Press the ADF/DME softkey again to close the tuning window.



Next, select NAV1 as your CDI source. You won't have a signal since we're not tuned to a VOR. We will be using the CDI as a reference for the holding pattern courses.

Turn on OBS mode with the softkey so the key shows in white.

With the CRS knob, set the CDI to your inbound course of 356°.

Let's fly...

Figure 58 - Tracking to the NDB



We're heading SE, climbing to 2,700'. The NDB is now being received, shown in the BRG1 indicator lower left from the HSI and the blue arrow.

The arrow points to the NDB, so we'll need to turn left. I'm using HDG mode on the autopilot, so I can keep my altitude steady at 2,700'. Rotate the HDG bug until it matches the direction shown by the blue arrow.

Note that there is no DME function with the NDB, so we'll start our turn to the outbound course as soon as the blue arrow flips, indicating we've passed over the NDB station.

As you approach the NDB, you'll need to adjust your heading, especially if there is any wind. Remember that all holding pattern entries start with flying direct to the fix.

Hold

Figure 59 - NDB Example - Turning to the Outbound Course



As soon as the blue arrow begins to swing around, begin the right turn to the outbound course by rotating the HDG knob until it lines up with our reference, the tail of the VOR course arrow.

Note how the blue arrow pointing to the NDB is pointing to the west at almost a 90° angle. This indicates that we are abeam (across) from the NDB.

Start a 1 minute time for the outbound leg.

After 1 minute, turn right again towards the inbound course by rotating the HDG knob until the heading bug lines up with the point of the VOR arrow. If everything is correct, you should roll out on the inbound course with the blue arrow lining up with the VOR arrow, indicating you are on the 356° heading to the NDB.

Fly several circuits to practice your timing and turn rate accuracy. You knew that was coming...

Wind Adjustment

The wind is a constant influence on airborne maneuvering. Sure, we can turn it off in the weather settings, but what fun is that?

Wind correction mainly comes into play when you are manually flying the aircraft, and I include using autopilot HDG mode as manual. In NAV mode, the FMS will make the necessary heading corrections to accommodate wind drift, but this is not true in HDG mode.

In a holding pattern, wind can make itself known in any of the four phases: inbound and outbound legs, and the two course reversal turns. It could be pushing you off course or affecting distance traveled during timed legs.

Be aware of the wind speed and direction and take it into consideration as you plan your holding pattern. You may have to lengthen/shorten times slightly. For example, if you reached the fix on the inbound leg in 53 seconds, you would need to increase the time on the outbound leg so your inbound stays at 1 min.

You may need to change your heading slightly on crosswinds. If you make a good standard rate turn and find yourself too long or too short on rolling out on the leg heading, you may need a few degrees into the wind to compensate.

Again, the best way to learn is to practice. Use the holding pattern example at ROB and play with the wind to see how it affects your flight and learn to compensate.

Recovery

Chapter 5 – Recovery

Great progress! Not only do you understand missed approach procedures and how to prepare for them, but you also know how to accurately fly the procedure and associated hold patterns using VOR, GPS and NDB navigation.

Well done!

All missed approach procedures involve flying to a predetermined fix (VOR, NDB or waypoint) and entering a holding pattern until cleared by ATC to the IAF of the landing approach.

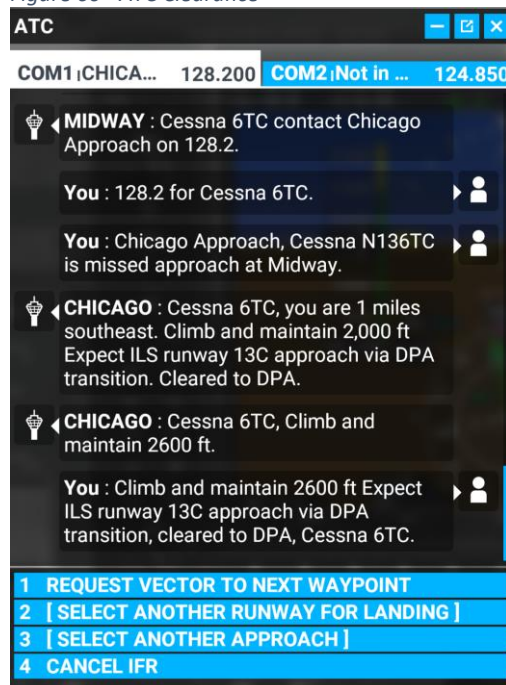
Within the MSFS world, you will find that shortly after calling a missed approach, you will be cleared to fly the landing again. This has happened in 100% of the missed approaches I have flown in the sim.

It's no secret that ATC in the sim needs work; like many aspects of the sim, the developers have gotten ATC interaction to a reasonable, working levels, even if not entirely realistic.

Improvements to follow...

Here's an example from the last flight:

Figure 60 - ATC Clearance



The missed approach was called in as soon as we reached our initial altitude and heading.

We were handed off to Chicago Approach, who immediately cleared us back to DPA to fly the landing approach again.

Once you are cleared to a fix, you do not need to continue to fly the missed approach and hold.

Based on multiple flights of this scenario, this behavior does not seem dependent on either live or AI traffic. With KORD (Chicago O'Hare) a few miles from our turn to final, there is always a lot of live traffic in the vicinity.

Recovering from a missed approach involves navigating from your current position to an IAF on the landing approach. This could be a simple matter or more complex than you are not familiar with changing or editing the flight plan inflight. This type of exercise is great practice to help you improve your navigation and flight management skills.

Recovery

The goal of this chapter is to help you understand how to go from your current position to the IAF and make sure your avionics are set up for another landing attempt. We will go it this in the next topics:

- VOR Navigation – Flying Direct to a VOR
- GPS Navigation – Flying Direct to a Waypoint/Fix
- Loading & Activating an Approach Using the G1000

Since we're on an instrument flight plan, it has been "filed" with ATC, setting up ATC interaction and the flight plan in the G1000. This greatly simplifies ATC interaction until you are ready to take on that function from the AI co-pilot. When I try this on a flight, I get an even higher level of respect for the real world pilots who get us safely to our destination.

Adoration aside, let's get to the first part.

VOR Navigation – Flying Direct to a VOR

On many approaches, your IAF is a VOR station. A necessary skill is to track to the VOR, either on a specific radial, but other times directly to the station from your present position. Let's take the previous example and follow it back around.

Figure 61 - Recovery to VOR

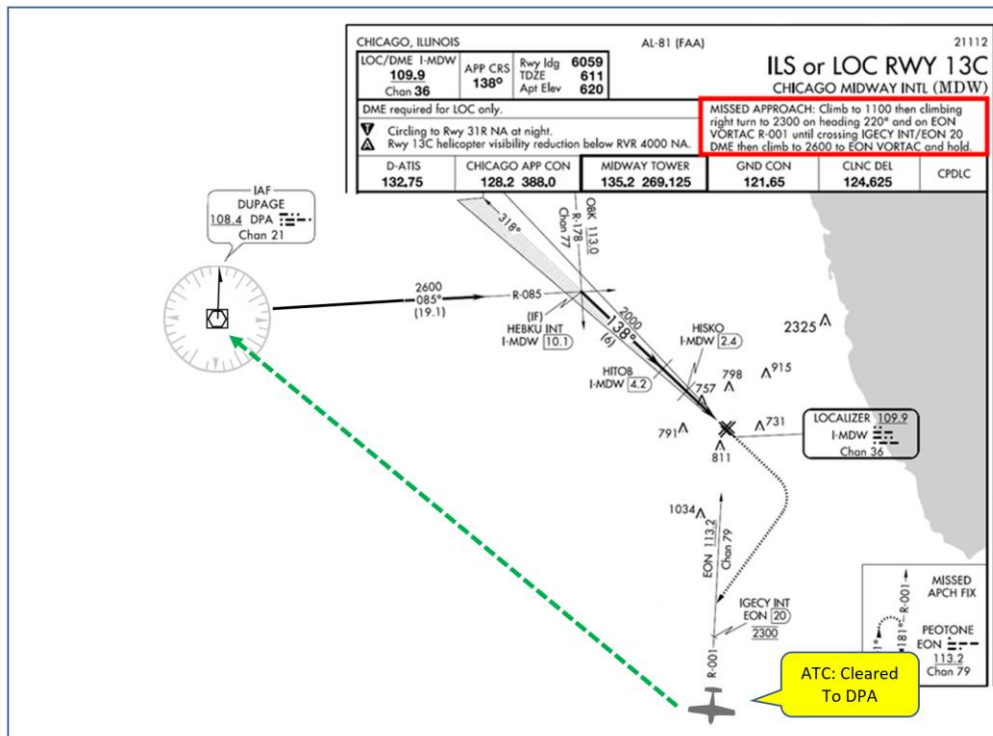


Image Source: FAA IFR Chart Database

After making the call and flying the initial climb towards EON, we were cleared back to DPA to give RWY13C ILS another try.

Recovery

It doesn't matter where we are on the R-181 to EON, or even somewhere close by, the instructions are the same: *Cleared to DPA*.

How do we get back to DPA?

For this example, we will track the VOR signal to DPA. Since DPA was part of our original flight plan (JUDVI NUELG **DPA** HEBKU HITOB RW13C), we know it is at 108.4 Mhz. Perhaps (hopefully) it is programmed as one of the four channels on NAV1/NAV2. There it is: NAV2 active. Good planning!

To start:

- Set ALT hold to your assigned altitude
- Make sure you are in HDG mode. Turn to the NW towards the VOR.
- Using the G1000 CDI softkey, cycle the CDI source to NAV2. You should see a double green CDI needle.
- Press the CRS button on the right panel of the PFD This will set your course to the radial to the VOR you are currently on.
- Change to NAV mode on the autopilot and you will track this radial inbound to the VOR

Figure 62 - Tracking VOR Inbound



Recovery

As we look at the chart, the turn at DPA to the GPS course to HEBKU is a very sharp angle, so we're going to do a simple procedure turn to make it a nice transition at DPA.

Figure 63 - Procedure Turn at DPA

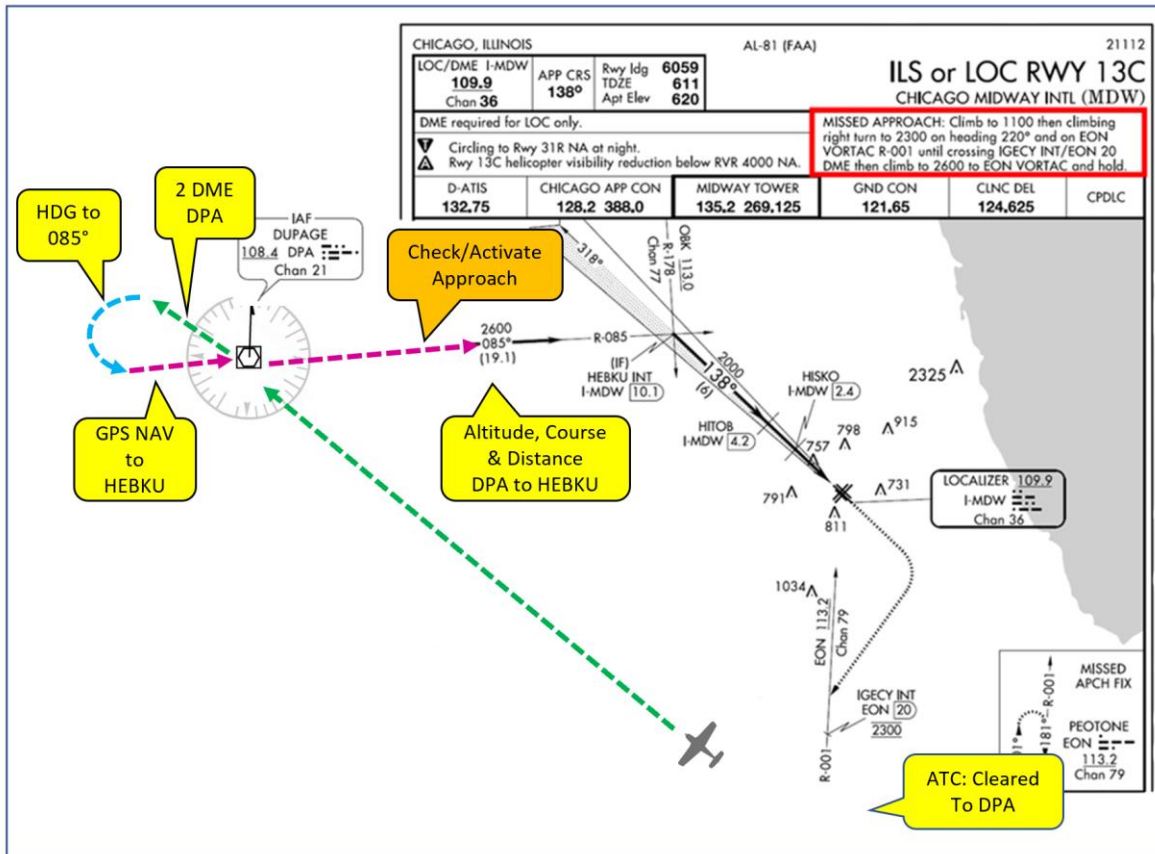


Image Source: FAA IFR Chart Database

This maneuver will be good practice at using HDG mode as a transition between navigation sources. Some FMS systems – like Working Title’s fantastic work on the CJ4’s Collins FMS – have the capability to fly these transitions automatically. Unfortunately, the G1000 does not, so we will have to do it manually.

Since this is probably your first procedure turn, we will keep it wide and simple.

1. (Green Segment) Fly direct to DPA and continue on the reciprocal course until the DME reads 2 nm past the station. The heading bug should be set to your current course. Recommend you switch to HDG mode 2 nm prior to DPA to ensure course stability over the VOR.
2. (Blue Segment) Turn the HDG knob so your plane makes a left turn from your current course. Continue rotating the HDG knob until you reach a new heading of 85°
3. (Magenta Segment) As you come back to wings level, change your CDI source from NAV2 to GPS. The CDI needle should be magenta (GPS) and close to centered.

Recovery

4. Change to NAV mode for the leg to HEBKU.

As you passed over DPA, the G1000 flight plan should have automatically changed to the DPA→HEBKU leg. If not, you may need to update the ACTIVE LEG on the flight plan in the MFD.

The chart shows it is 19.1 nm from DPA→HEBKU, adequate time to ensure you are set up for the ILS approach to RWY13C.

Our first check is making sure the active frequency on NAV1 is set to 109.9 MHz, the localizer frequency for this approach.

Next, let's look at the MFD.

Figure 64 - MFD/Flight Plan Display



Press the FPL button to view the current flight plan. Between DPA → HEBKU, it should look like the screenshot above:

- The approach to ILS 13 is loaded and part of the flight plan. So far, so good!
- The magenta arrow connects DPA and HEBKU, showing this is the active leg.

Won't it be great when VNAV and weather shows up on the flight plan page?

From here, fly the landing approach as planned.

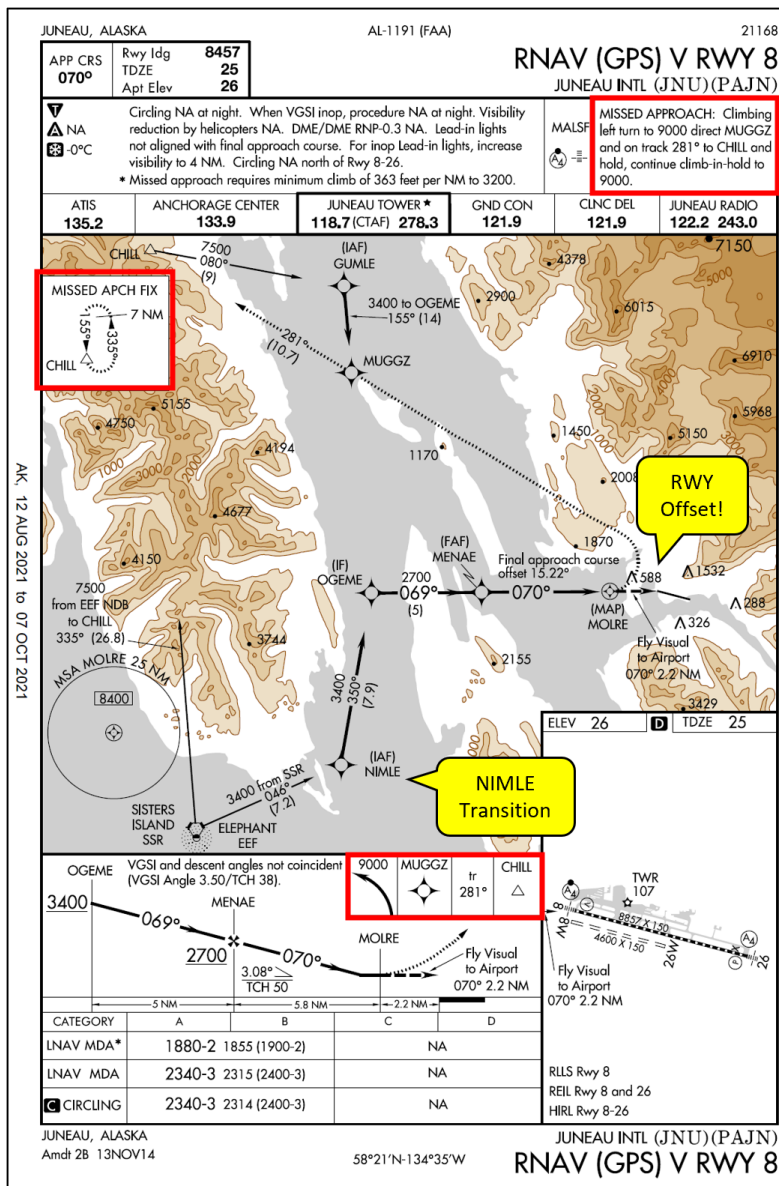
Recovery

RNAV Navigation – Flying Direct to a Waypoint/Fix

Next up, we will examine how to fly RNAV to set up a different landing approach.

This will be a fun one to fly!

Figure 65 - RNAV Approach to Juneau RWY 8



Before we set up a flight plan in MSFS, several notes on this approach.

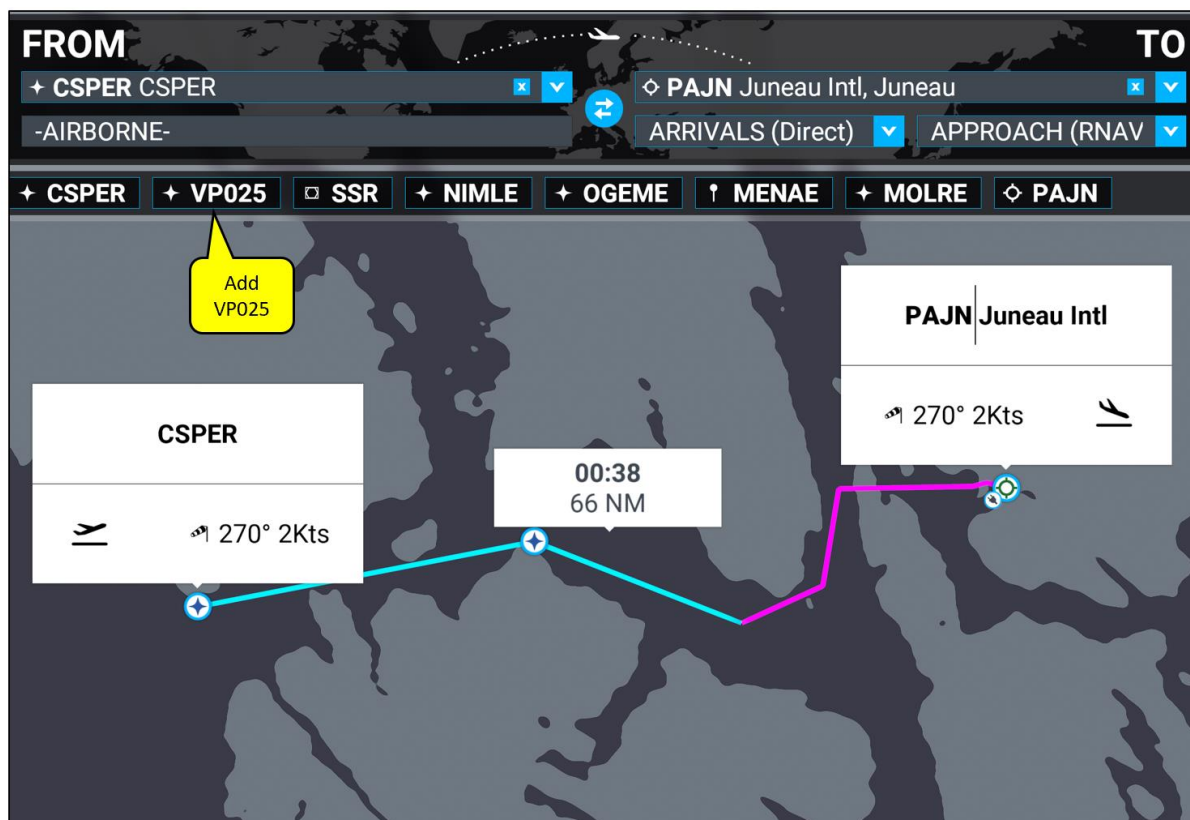
- We'll come in from the SW, using the NIMLE transition.
- This is a LNAV approach, no vertical guidance provided. We will need to manage our descent altitudes.
- Note the 15° offset to the runway. Our final approach course is 70°, and the runway heading is 85°
- Note the requirement to climb at a minimum of 363' per minute to 9,000' on missed approach.

Image Source: FAA IFR Chart Database

We're taking the missed approach all the way out to CHILL. You'll see why in a minute...

Recovery

Figure 66 - PAJN RNAV 8 V Approach in MSFS



Here's the IFR RNAV flight plan into PAJN RWY 8 V. It should be a scenic ride in to the airport.

- We'll start out at CPER; this is the only reasonably close waypoint where the flight planner would give us the desired NIMLE transition.
- Add the VP025 fix to keep your flight path from getting too close to the mountains.
- Set your cruise altitude to 5,000'.

As we look at this and think/prepare for a missed approach, we can see from the IAP chart above that the missed approach takes us NW to MUGGZ and then on to CHILL, climbing to 9,000'.

How do we get back to the RNAV approach?

Referring again to the IAP chart, we can see an alternate IAF at GUMLE for routes from the north. Since the missed approach procedure puts us NW of the airport, we'll be changing our approach to a GUMLE transition.

Recovery

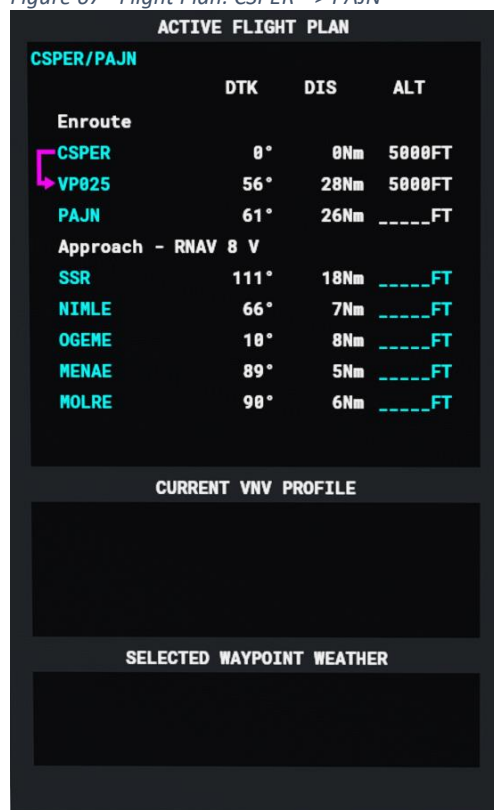
Before flying, let's review our missed approach procedure:

- Immediate left turn to a heading of 281°
- Climb to 9,000' – we'll definitely want best-rate-of-climb on this one (90kts)
- Direct to MUGGZ
- Direct to CHILL

On the way to CHILL, we'll be changing the approach to the airport from a NIMLE transition to a GUMLE transition. We'll see how the sim ATC handles this one...

Let's fly...

Figure 67 - Flight Plan: CSPER --> PAJN



To start:

- Autopilot to NAV mode, ALT hold at 5,000'

From the Flight Plan, we can see:

- Our current leg is CSPER → VP025
- The approach course begins with SSR and sequences NIMLE OGEME MENAE MOLRE RWY8

After we pass VP025, set your altitude to 3,400'.

From the IAP, we can see we want to be at 3,400' no later than OGEME.

We got the call to descend just prior to SSR.

After you level off at 3,400', preset your next altitude to 2,700', which is our altitude at MANAE.

Just prior to OGEME, ATC cleared to the airport. Begin your descent to 2,700 at OGEME.

At soon as you level off at 2,700', preset your final descent altitude of 1,800', which you need to be at by MOLRE. From the IAP chart, this would be a descent rate of approx. 600'/min.

At MENAE, set up your airplane for final: flaps, pitch and power for a 600'/min descent to the runway.

Missed approach!

I hope you are prepared, because there are mountains dead ahead and to the left of the runway. Full throttle, flaps to TO position and left turn to 281°. I tried to ignore the scenery and the warning voice calling out 500' as I climbed over the ridge just north of the airport.

That was crazy in a C172; can't wait to fly an airliner.

Recovery

Figure 68 - DIRECT TO MUGGZ



Now that we're established on a FLC 90kt climb to 9,000' and a heading of 281°, time to start breathing again.

It's also time to use the DIRECT TO function on the MFD to set our next waypoint to MUGGZ. Use the FMS knobs to enter the characters. Press the ENT key when finished.

The cursor should automatically move to the ACTIVATE? field. Press the ENT again and you should now have a single active leg to MUGGZ.

As you approach MUGGZ, repeat the procedure for the next waypoint: CHILL. Activate the waypoint when you get to MUGGZ.

If all goes according to plan, your PFD should look something like this:

Figure 69 - PFD Enroute to MUGGZ



Recovery

It is 10.7 nm between MUGGZ and CHILL. At our present speed, we have about 7 minutes until we reach CHILL.

Now comes the interesting part: changing our return approach to PAJN.

Figure 70 - New Approach in PROC & FLP Windows



Press the PROC key on the MFD. You'll get a window that looks like this, but you'll <probably> have a transition of SSR – our original flight plan/approach.

We're still planning on RNAV 8 V as our approach, but we need to change the transition to EEF. Press the FMS knob button to bring us the cyan cursor, use the large knob to highlight the transition field, and then the small FMS knob to select EEF. Press ENT and you should see the sequence as shown here.

VERY IMPORTANT: Do not Load or Activate unless you are in HDG mode, on course to CHILL. If you don't go to heading mode first, you may find yourself turning south to EEF, as I did the first time I ran the scenario.



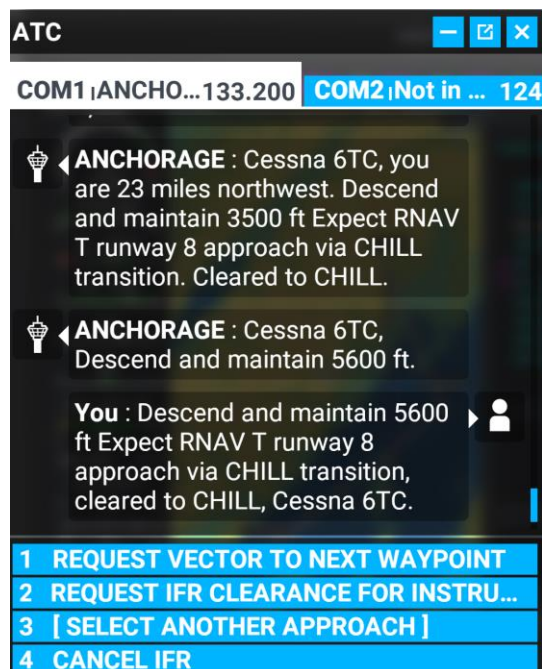
To make this work smoothly, bring up the FPL window. Use the FMS knobs to highlight the EFF → CHILL leg. Then, use the ACT LEG softkey to make EFF → CHILL the active leg.

Once it looks like this, you can switch to NAV mode. From here on in, the FMS should step through the approach legs as normal.

Knowing how to manipulate the flight plan and approach procedure is a key skill to learn, practice and master.

Recovery

Figure 71 - ATC Comms on RNAV Approach



Problems:

- My AI co-pilot stopped working during the missed approach. Don't know why, but I had to handle ATC interactions, even though the auto radio tuning still worked Not a huge deal, but annoying anyway...
- ATC cleared me on the RNAV approach via CHILL and the rest of the approach was normal.
- ATC couldn't make up their minds about altitude assignments: down then back up.
- On one of the times I flew this scenario, ATC directed me to use the RNAV T approach instead of RNAV V. Another mad scramble on the MFD...

This was a complicated scenario, but I choose it to give you some guidance on how to deal with changes in the air. It's easy to get confused, but these harder scenarios will give you ample ability to practice and hone your skills.

Summary

In these two scenarios, we learned how to navigate a missed approach procedure using VOR and GPS (RNAV).

As we said earlier, missed approach procedures will be different routes and different altitudes, including mixing VOR, NBD and GPS waypoints as the holding pattern fix.

Knowing how to plan and manipulate your flight plan from the holding pattern or enroute to the holding pattern is important. Know your avionics! Missed approach procedures can be times of high pilot stress and workload but can be made easier by proper preparation.

Final Approach

Chapter 6 – Final Approach

All the pieces are now in place:

- We understand the need to properly brief/prepare for a missed approach any we fly an Instrument Approach Procedure.
- We understand how to initiate and fly a missed approach procedure to a holding pattern fix.
- We understand how to identify the proper entry into a holding pattern and how to fly both time and distance patterns.
- We understand how to set up and fly from the holding pattern and reenter the IAP.

One more piece: we need to put it all together. This will be an extensive flight example.

Figure 72 - Final Example - KAPC ILS 1L

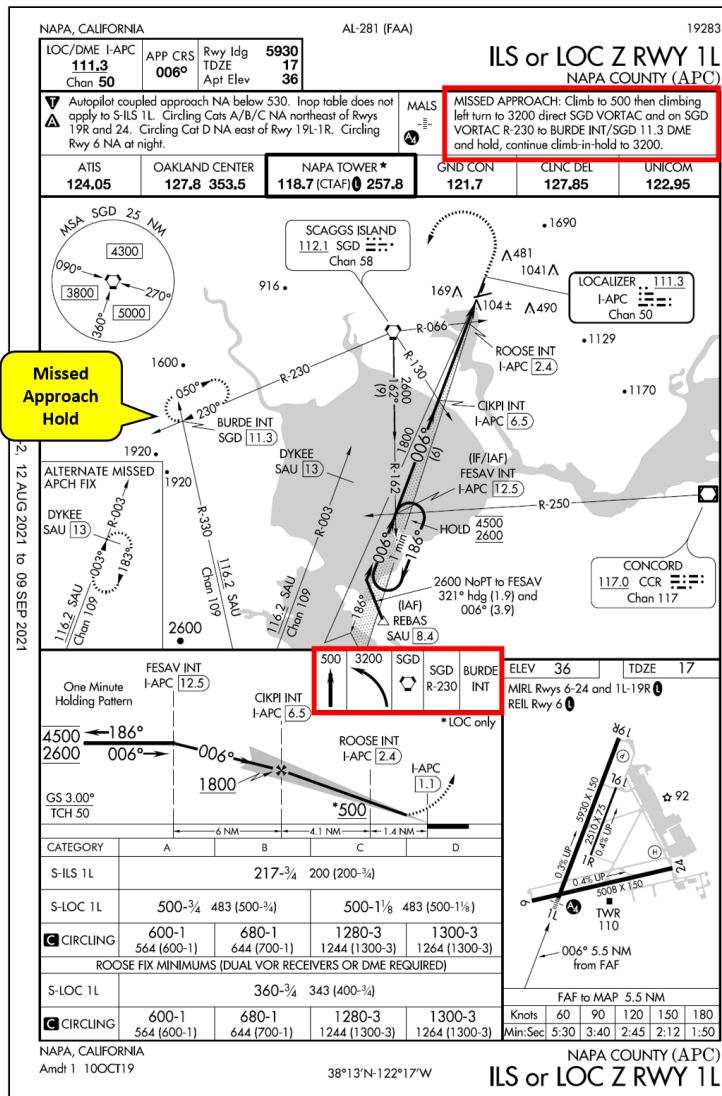


Image Source: FAA IFR Chart Database

Our final example flight will be from Half Moon Bay KHAF to Napa County KAPC RWY 1L. There's a cold glass of Chardonnay waiting for when you finish.

We'll do a bit of sightseeing up the coast and turn inland over the Golden Gate bridge. We'll turn NNE at Alcatraz Island and begin our ILS approach at REBAS, intercepting the glideslope at CIKPI.

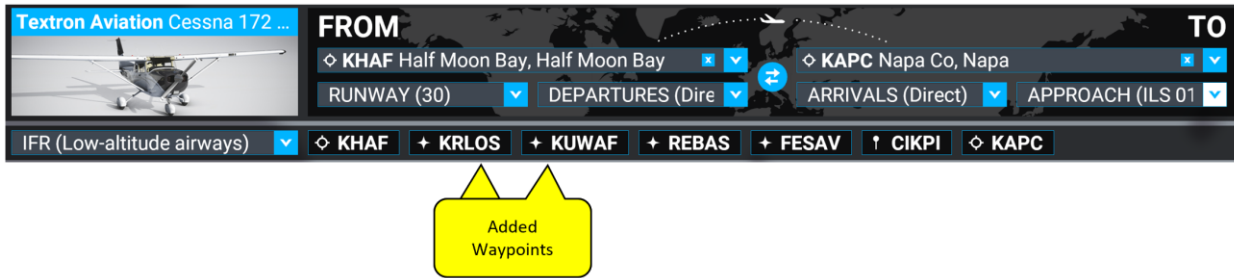
Of course, we're going to go missed approach as shown on the chart.

BURDE is on the SGD R-230 at a distance of 11.3 nm. As you can see, we'll be making a direct approach into the pattern at BURDE and make standard right turns with 1 minute legs.

From BURDE, we expect to get clearance to the IAF at FESAV for another approach.

Final Approach

Figure 73 - Final Example - Flight Plan



Set up the flight plan as shown above. The default path has you flying direct to the SFO VOR. Remove SFO and add the two waypoints as shown above. If you are unsure how to do this, there's a very detailed explanation in my [Navigation and Flight Planning in MSFS](#) eBook.

Before you take-off from KAHF, set up a few things:

- NAV1 Active to the KAPC localizer IAPC 111.3
- NAV1 Stand-By to the SGD VOR 112.1
- Altitude preset to 4,000' or whatever you set in the NAV LOG.

Let's fly...

Figure 74 - Final Example - Inflight



It's a beautiful day in the Bay Area as we turn to fly over the Golden Gate Bridge. The flight into the REBAS IAF was uneventful. We never expect to go missed approach, but we're always prepared to do so.

Final Approach

Figure 75 - Final Example - ILS Approach PFD

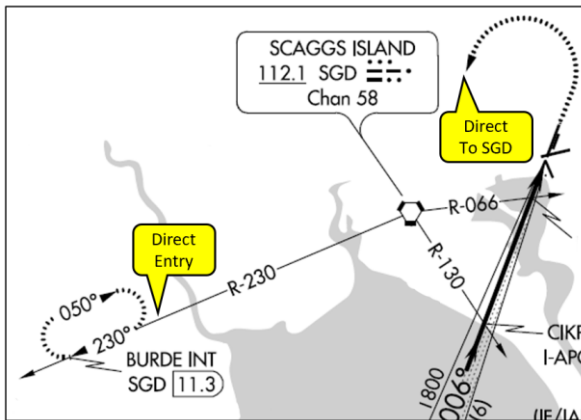


We've picked up the glideslope at CIKPI and are descending to RWY 01L.

Everything looks good.

It's time for a quick review of the Missed Approach Procedure.

Figure 76 - Final Example - Missed Approach Procedure



From the missed approach narrative, we turn left once we reach 500' and take a direct route to SGD, while climbing to 3,200'.

At SGD, we track the outbound SGD R-230.

We make a direct entry at BURDE (11.3 nm SGD) and begin our standard right turn pattern with 1 minute legs.

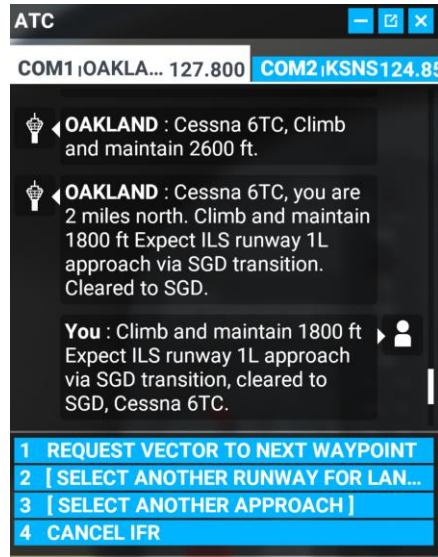
Nothing too complex, nothing we haven't done in earlier examples.

As we start the missed approach procedure, we'll clean up the aircraft so that we can climb to our assigned altitude. Once you make the left hand turn, change the CDI from GPS to VOR1, and swap the active and standby frequencies on NAV1 so that SGD is now the active frequency.

As we approach SGD, change the autopilot to HDG mode to maintain course over the VOR. Turn the CRS knob so that it reads 230°

Final Approach

Figure 77 - Final Example - ATC Clearance to SGD



This is the communications with ATC after we called in the missed approach.

We were cleared to SGD, but the altitude was nothing as shown on the chart. First to 2,600', then to 1,800'.

Both times I flew this, I didn't hear anything else from ATC after passing SGD. I proceeded on to the holding fix and flew several orbits, just to practice and see if ATC cleared us to try again.

Note: the IAP for this approach does not identify SGD as a transition to the approach procedure.

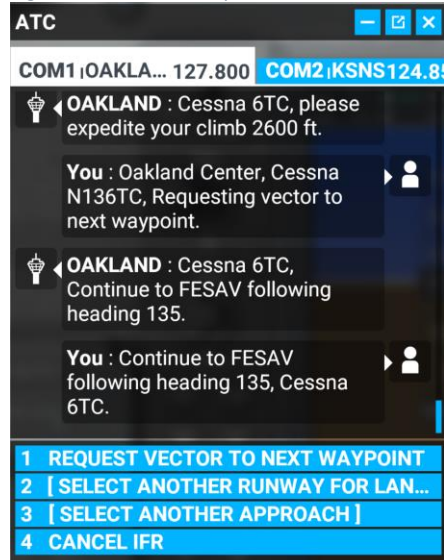
Figure 78 - Final Example - Tracking Outbound from SGD



Here is the HSI as we track outbound from SGD. Monitor the BRG indicator to the lower right of the HSI for your distance from SGD

Once you're past the VOR, make the necessary adjustments to track R-230 outbound; you can go to NAV mode if you wish, but just make sure you are back in HDG mode prior to reaching BURDE at 11.3 nm SGD.

Figure 79 - Final Example - ATC Vector to FESAV



After not hearing from ATC while I flew the holding pattern, I requested a vector to the next waypoint.

This is helpful to give you a direct course back to the approach course.

Use the HDG knob to adjust your course.

Final Approach

So now we're in what I've referred to as the recovery phase: we've finished the hold and are now heading back to the approach to try again.

For this, we need to adjust the flight plan. My preference is to make these adjustments on the MFD.

Figure 80 - Final Example - Flight Plan on the MFD



Call up the flight plan. It should look like this.

Press the FMS button to bring up the cursor. Using the large FMS knob, highlight the field for FESAV and press the ACT LEG softkey. This segment should now be magenta as shown.

The course guidance on the CDI with GPS as the source will show the track USR → FESAV.

Figure 81 - Final Example -HSI & AFCS



Here is the AFCS and HSI as we approach the USR → FESAV course in HDG mode.

The CDI shows the course. As the example shows, we're not quite there yet.

The single blue arrow and the BRG indicator on the AFCS show the bearing to FESAV.

The double blue arrow shows the direction to SGD, which is still the active NAV1 frequency.

As the CDI needle centers, we'll switch to NAV mode, and we'll be back on the landing approach course.

Final Approach

After you pass FESAV, the flight plan should automatically sequence to the next waypoint, CIKPI. Don't ever expect the FMS to work perfectly 100% of the time and make sure you know how to fix sequential errors.

Figure 82 - Final Example - Tracking the Localizer



Now that we're back on the landing approach, change NAV1 back to the localizer. Once you are receiving the localizer signal, switch the CDI to NAV and you should see this.

You'll pick up the glideslope at CIKPI. Follow it down and land on the numbers.

Figure 83 - Final Example - Waiting for the Limousine



Time for wine!

Summary

And that's it for this MSFS: Next Level topic. I hope you found this instruction to be useful and a means towards increasing your MSFS knowledge and skills.

If you found this type of instruction useful and would like to influence me on the next topic, drop me an email at fnav.tc@gmail.com

The same email works if you have questions/comments or would like to report an error.

Thanks, and happy flying...Tc

FINAL Shameless Self Promotion

*You can learn how to navigate and plan flights with my eBook,
[Navigation & Flight Planning in MSFS 2020.](#)*

*We also cover autopilot basics, and how to fly using VOR and GPS navigation.
To get back to the ground safely, we cover VOR, RNAV and ILS approaches.*

<https://flightsimnav.com>

Get your copy now!



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Must-Have Free Materials

General Aviation Information
FAA Handbooks (Excellent free instructional material): https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/
FAA Instrument Flying Handbook https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/media/FAA-H-8083-15B.pdf
FAA Instrument Flight Procedures Information Gateway: https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/
The European AIS Database https://www.ead.eurocontrol.int/cms-eadbasic/opencms/en/home/
Listing of Aeronautical Information Services around the World https://www.eurocontrol.int/articles/ais-online

Acronyms & Abbreviations

A basic glossary of the acronyms and abbreviations used throughout the book.

Acronym	Full Name	Description
ADF	Automatic Direction Finder	Old School directional gauge, normally using a NDB as a signal source
AFCS	Automatic Flight Control Status	Autopilot information
AGL	Above Ground Level	Distance to the ground
ALT	Altitude Hold	An autopilot mode used to maintain a specific altitude
AP	Autopilot	Flight computer used to automatically control the aircraft
APR	Approach Mode	Autopilot mode for ILS precision landings or RNAV approaches
ATC	Air Traffic Control	FAA personnel who manage the National Airspace System (NAS)
ATIS	Automatic Terminal Information Service	Pre-recorded information broadcast from an airport terminal

Reference

Acronym	Full Name	Description
CDI	Course Deviation Indicator	An indication showing both course and deviation from course
COM	Communications	Radios used to voice communications
CUG	Chart Users Guide	FAA publication explaining navigation chart symbols
DA	Decision Altitude	Altitude where the pilot must decide to either land or fly a Missed Approach
D-ATIS	Digital ATIS	Modern version of ATIS, can be downloaded to an app or text message
DG	Directional Gyro	An instrument used to determine an airplane's attitude in 3 dimensions (X,Y,Z)
DH	Decision Height	Altitude where the pilot must decide to either land or fly a Missed Approach
DME	Distance Measuring Equipment	A signal co-transmitted with VOR to establish distance from the ground transmitter to aircraft receiver
DP	Departure Procedure	A standard route used to depart from busy airports or for terrain clearance
DTK	Desired Track (GPS)	The course to your next waypoint
FAF	Final Approach Fix	Final location on a landing approach, usually where the GS or GP intersects
FD	Flight Director	Airplane attitude guidance from the autopilot
FIX		A geographical position
FLC	Flight Level Change	Speed limited altitude change by autopilot
FMS	Flight Management System	A computer used for flight planning and control
FPM	Feet Per Minute	Used as a measure of change in altitude
GP	Glide Path	Non-precision vertical guidance
GPS	Global Positioning System	Satellite based navigation
GS	Glide Slope	A precision vertical guidance signal
HIRL	High Intensity Runway Lights	A high visibility type of runway lighting
HSI	Horizontal Situation Indicator	An instrument used to show course and course deviation, usually coupled to a GPS or VOR receiver
IAF	Initial Approach Fix	Beginning fix for an instrument approach
ICAO	International Civil Aviation Organization	https://www.icao.int/Pages/default.aspx

Reference

Acronym	Full Name	Description
IF	Intermediate Fix	Intermediate position used in landing approaches
ILS	Instrument Landing System	Ground based radio beacons for final approach guidance
IM	Inner Marker	A radio signal identifying proximity to the runway
LNAV	Lateral navigation	Control of the aircraft's position
LOC	Localizer	Precision horizontal guidance on a landing approach
LP	Localizer Performance without vertical guidance	RNAV approach without GP guidance
LPV	Localizer Performance with Vertical Guidance	RNAV approach with GP guidance
MAP	Missed Approach Point	Decision point to either land the aircraft or fly a Missed Approach procedure
MDA	Minimum Decision Altitude	Altitude on approach to either land the aircraft or fly a Missed Approach procedure
MEA	Minimum Enroute Altitude	Minimum altitude to maintain terrain clearance
MFD	Multi-Function Display	On the G1000, navigation map and engine monitoring gauges, flight planning & procedures
MOCA	Minimum Obstruction Clearance Altitude	Minimum altitude to maintain obstruction clearance
MSA	Minimum Safe Altitude	Minimum altitude to maintain terrain clearance on approach to an airport
MSL	Mean Sea Level	Altitude of the ground above Sea Level
NAS	National Airspace System	FAA's Scope of Responsibility
NAV	Navigation Mode	Autopilot lateral navigation mode following a VOR or GPS path
NDB	Non-Directional Beacon	A radio beacon without any directional guidance
OAT	Outside Air Temperature	
OBI	Omni-Bearing Indicator	A flight instrument for lateral navigation, usually coupled with a NAV radio
OBS	Omni-Bearing Selector	A dial on an OBI used to set a course
OM	Outer Marker	A radio signal on an approach path providing an intermediate fix

Reference

Acronym	Full Name	Description
PFD	Primary Flight Display	A computer display focused on flight instrumentation
POI	Point of Interest	A custom location in MSFS
REIL	Runway End Identifier Lights	A type of runway lighting showing end of runway
RNAV	Area Navigation	Point-to-point navigation, usually with GPS
RNP	Required Navigation Performance	A performance based standard of RNAV equipment with high level of accuracy
RVR	Runway Visual Range	Distance a pilot should be able to see the runway.
SID	Standard Instrument Departure	A set route from an airport, usually for jet aircraft. Also known as a Departure Procedure
STAR	Standard Terminal Arrival Route	A set route to an airport, usually for jet aircraft
TAS	True Airspeed	Airspeed adjusted for wind
TDZE	Touch Down Zone Elevation	The runway elevation
VFR	Visual Flight Rules	Meteorological conditions that allow for visual flight
VNAV	Vertical Navigation	Autopilot control of altitude changes
VOR	Very high frequency Omnidirectional Range	A ground based radio beacon that provides directional radials to aircraft avionics
VORTAC	VOR with TAC	VOR coupled with a military navigation channel
VS	Vertical Speed	An autopilot mode used to change altitudes based on a rate in FPM
WAAS	Wide Area Augmentation System	A ground based navigation aid used to improve the accuracy of GPS receivers
Waypoint		A designated geographical location used for route definition or progress-reporting purposes and is defined in terms of latitude/longitude coordinates.
XPDR	Transponder	A signal transmitted from an aircraft to ATC to identify the aircraft on radar.

Reference

About: Tom Carroll

A flight sim enthusiast from the earliest days of MSFS, Tom still has a 360K floppy disk for the PC Jr. version. The BASIC flight simulator he wrote for his Sinclair ZX-81 is long lost, but it was fun while it lasted.

Always fascinated by the technical aspects of flying, he started planning and writing [Navigation and Flight Planning in MSFS 2020](#) soon after the release of the software.

Now happily retired, Tom wore many hats during his technical career: Engineer, Programmer, Project Manager and Engineering Manager.

Retirement has given him the gift of time to pursue his passion for writing. His 2020 novel, *Simple Sarah – A Spiritual Adventure* is available [here](#) on Amazon.

All profits from the sale of *Simple Sarah* are donated to [Feeding America](#).

Tom lives near Waco, Texas with his incredibly supportive wife LeAnn and a Velcro [Vizsla](#) named Lenny. In his spare time, he enjoys spending time with his awesome grandsons, playing guitar, golf and dabbling in hydroponics. Never bored...

