# Runway approaching: How pilots find their way safely to the ground in all elements

thepointsguy.co.uk/news/pilots-find-way-to-ground-all-elements/

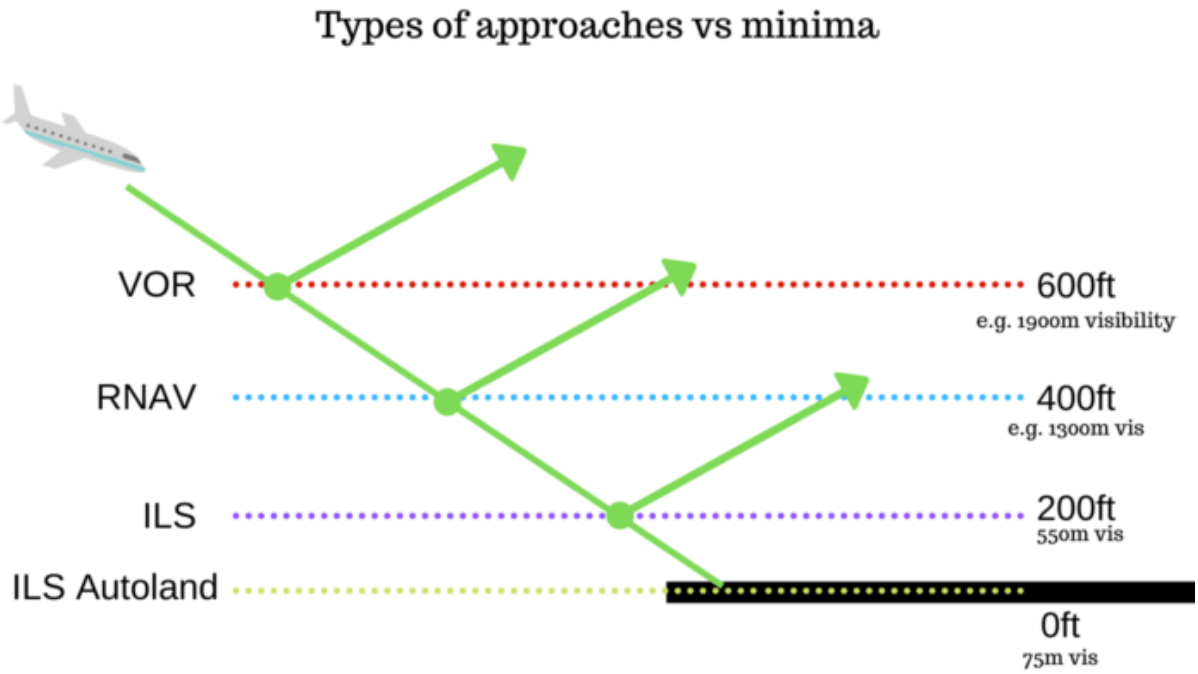
Charlie Page

Flying halfway around the world is great, but unless you can accurately find your for way those last few hundred feet to the runway, it's all a bit pointless. When the weather is good, pilots are able to see the airport from several miles away. However, what do we do when there is low cloud or snow reducing the visibility? Fortunately, most airfields have some sort of approach system in place which enables us to safely descend the aircraft towards the runway. This is how we do it.

## What stops pilots from making an approach?

For every approach to a runway, there is minimum weather criteria which pilots must legally abide by. This is to ensure the safety of the aircraft and to prevent pilots from "chancing it" in the hope that they might still be able to land.

This criteria varies from approach to approach, runway to runway and aircraft to aircraft. There are two elements to the approach: the visibility and the Minimum Descent Altitude (MDA)/ Decision Altitude (DA). These values are published at the bottom of the relevant approach chart which is available to the pilots.




The accuracy of the approach determines how close pilots can get to the runway. (Image courtesy of Charlie Page/The Points Guy)

The visibility is the defining factor, the legal limit dictating whether or not we can start the approach. If the visibility reported by the airfield is below the minimal on the chart, we are not allowed to start the approach. It's that black and white.

The MDA/DA is the altitude down to which we are allowed to fly the aircraft before having to make a decision. If at that point we can see the runway, we can continue to land. If not, we must perform a go-around and head back up into the sky.

If the reported visibility is good enough but the cloud base is lower than the MDA/DA, we can still start an approach. However, we will do so knowing that there is a very high chance of not seeing the runway at the decision point and having to turn round.

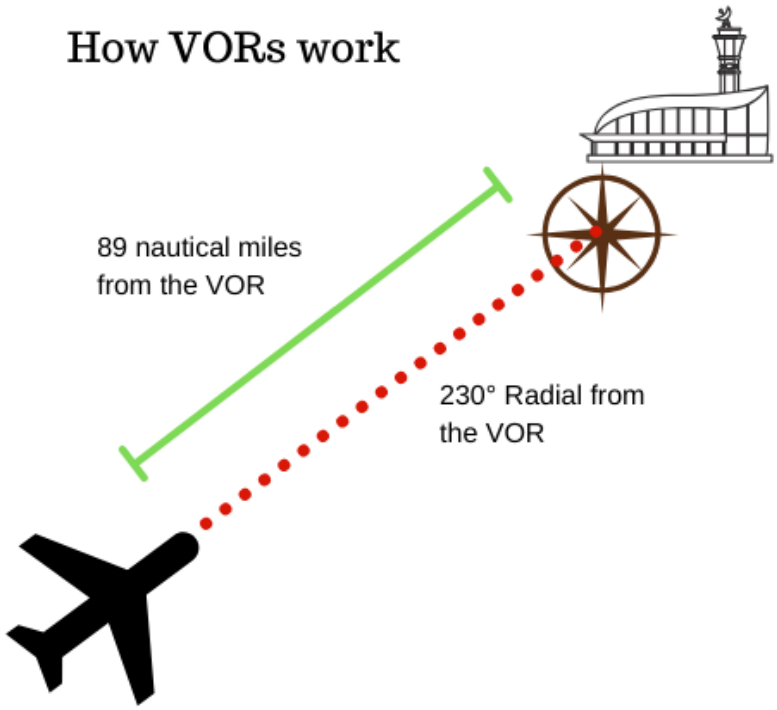
**Read more**: Behind the scenes: What goes on in the flight deck during a diversion?

## What was used in the past — VOR/NDB

A Very High Frequency Omni-Directional Range (VOR) is a type of short-range radio navigation beacon which emits a signal. Aircraft fitted with the right equipment are able to pick up this signal and not only determine where the beacon is, but also how far they are from it. The distance is quantified as Distance Measuring Equipment — DME.

VORs have been around for quite a while and were first developed in the 1930s, entering service in the mid 1940s. The best feature of VORs over older types of navigation beacons are that the signal is true and strong. Older types were subject to interference

from the atmosphere and would only provide direction, not distance.




VORs enable pilots to determine their bearing and distance from the beacon. (Image courtesy of Charlie Page/The Points Guy)

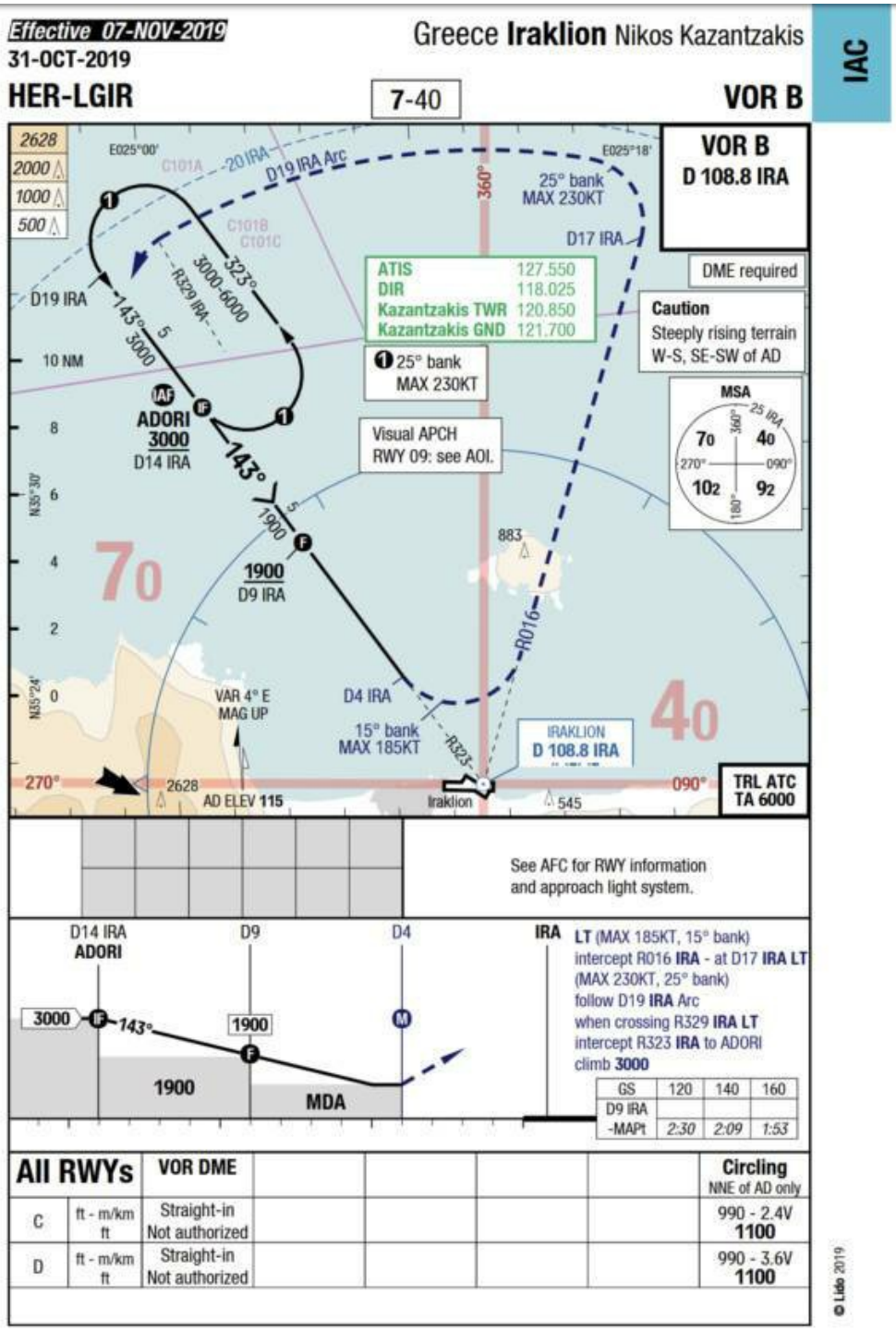
As the signal emitted by VORs are sent in a straight line, they are limited by the line of sight — they continue into space as the earth curves away beneath them. As a result, for an aircraft in the cruise, they are only useful within around 140 miles. However, this range is enough to enable aircraft to fly one from beacon to another as they zig-zag their way around the world.

Where VORs became very useful was in the final stages of approach when there is low cloud.

By placing a VOR at or near an airfield, pilots are able to fly towards the beacon from a certain direction and be fairly confident of their position. Then, using the DME to determine how far they are from the beacon, pilots can then start to descend towards the airfield.

A good advantage of a VOR is that the approach doesn't have to be straight towards the runway. At airfields where there are hills on the extended centre line of the runway, pilots can fly towards the airfield at an angle which keeps them clear of the terrain. Once out of the cloud and with the runway in sight, they can then turn the aircraft to line up with the runway.

VOR approaches tend to be found at smaller airports where the facilities are limited. They're quite common at the airports around the Greek islands.




A VOR approach into Heraklion, Greece. The angle of the approach is different to that of the runway, keeping the aircraft clear of the terrain. (Image courtesy of Charlie Page/The Points Guy)

There is, however, one main draw back to VOR approaches and that's the accuracy.

When flying around the earth at 36,000 feet, being a mile or two off track isn't a major issue. However, when you're trying to thread your way between hills on the approach to land, accuracy is everything. As a result, the minima on VOR approaches tends to be very conservative. It's not uncommon to require several thousand metres of visibility to start the approach and have an MDA of around 600 feet, or higher, above the ground.

This is fine when the weather is decent, but no good when proper winter weather sets in. What you need is something more robust which will allow pilots to fly lower in worse visibility.

## What's used now — ILS

Fly into any major international airport and I'd be confident in saying that you flew an ILS — Instrument Landing System — approach. Developed to give greater accuracy when approaching the runway, the best ILS approaches allow pilots to fly their aircraft all the way to runway, without even needing to see the ground outside.

The ILS consists of two radio beams which project up from the area around the runway up into the approach path. These signals are then picked up in the aircraft by the ILS receiver which displays them on the screens in the flight deck.

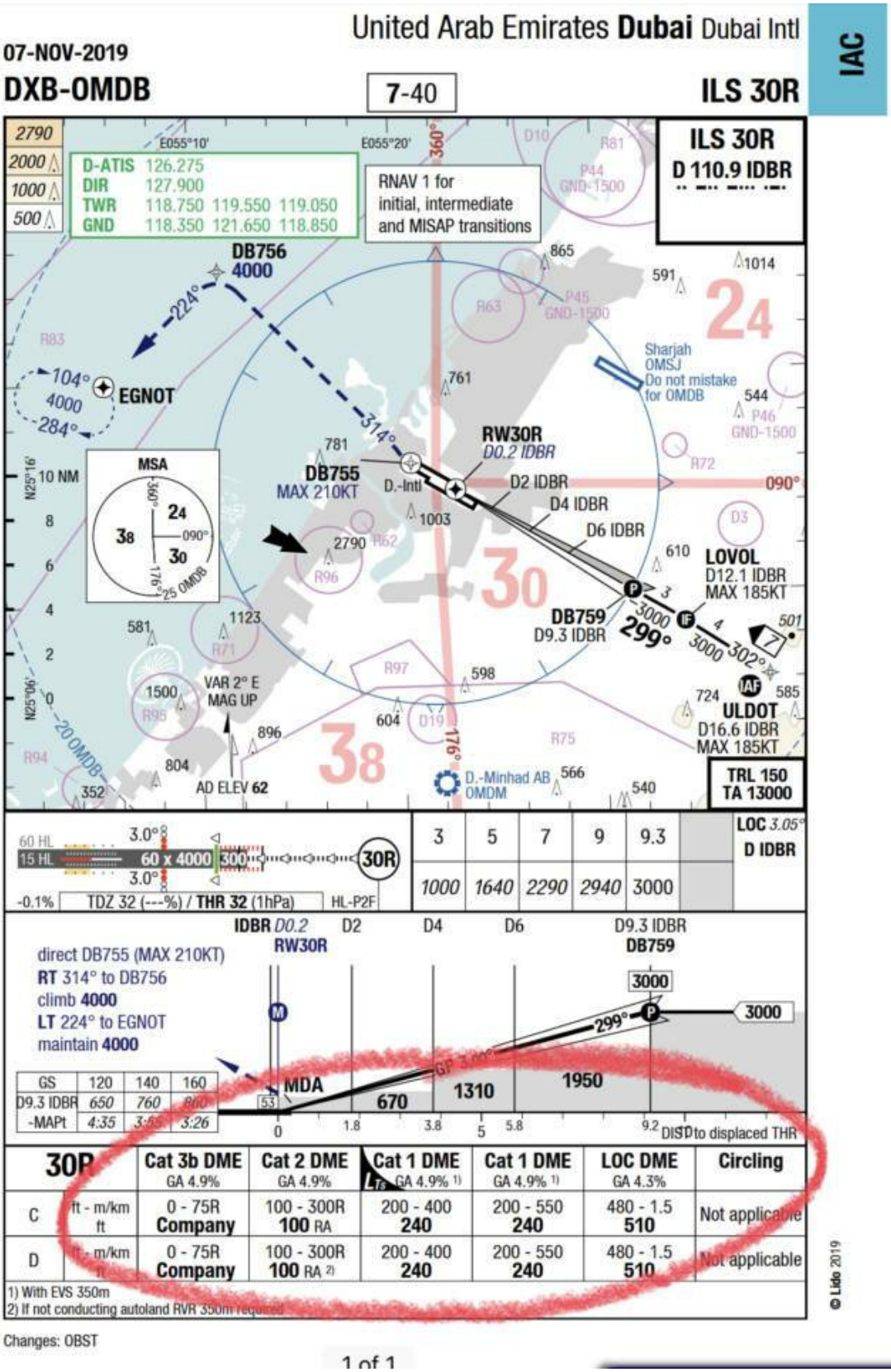
The first signal is the localiser, radiating from antennae which sit at the end of the runway. This shows the pilots where the aircraft is in relation to the centreline. The second signal comes from antennae to the side of the runway, around 1,000 feet in from the threshold abeam the touchdown zone. This is the glideslope and it sends another beam into the sky, normally at an angle of three degrees to guide the aircraft down vertically to the correct touchdown spot.

Most ILS approaches are flown with the autopilot doing the flying and the pilots monitoring the systems. When the required visual references are seen, the pilot flying will disconnect the autopilot and land the aircraft manually.

### Cat I ILS

In its most basic form, a Category One (CAT I) ILS allows aircraft to start an approach with just 550 metre reported visibility and a DA of 200 feet above the ground. This will normally suffice in 99% of weather conditions an airfield will experience in a year. As a result, CAT I ILS approaches are found at all major international airports and are the default type of used.

That said, some airports are so busy that should conditions be worse than 550 metre visibility, the whole flying operation would have to shut down. In order to deal with these situations, there are other kinds of ILS approaches available.




The various minima for the ILS approach to runway 30R at Dubai. (Image courtesy of Charlie Page/The Points Guy)

## CAT II ILS

When the weather really closes in, the standard method of reporting visibility isn't quite good enough. In order to give more accurate readings of the visibility, a special device called a transmissometer measures the Runway Visual Range — RVR.

In its simplest form, the transmissometer fires a light source between an emitter and a sensor. This interaction measures the “thickness” of moisture in the air and gives the RVR in metres.

A CAT II approach uses the same ILS signal from the localiser and glideslope, but there are added protections in place to preserve the integrity of the ILS beams. In addition with a CAT II approach, instead of using the pressure-based altimeter (fairly accurate) to descend to the DA, pilots use the Radio Altimeter (very accurate) to fly to a Decision Height (DH). The radio altimeter shoots a radar beam down beneath the aircraft to give an exact height the aircraft is above the ground.

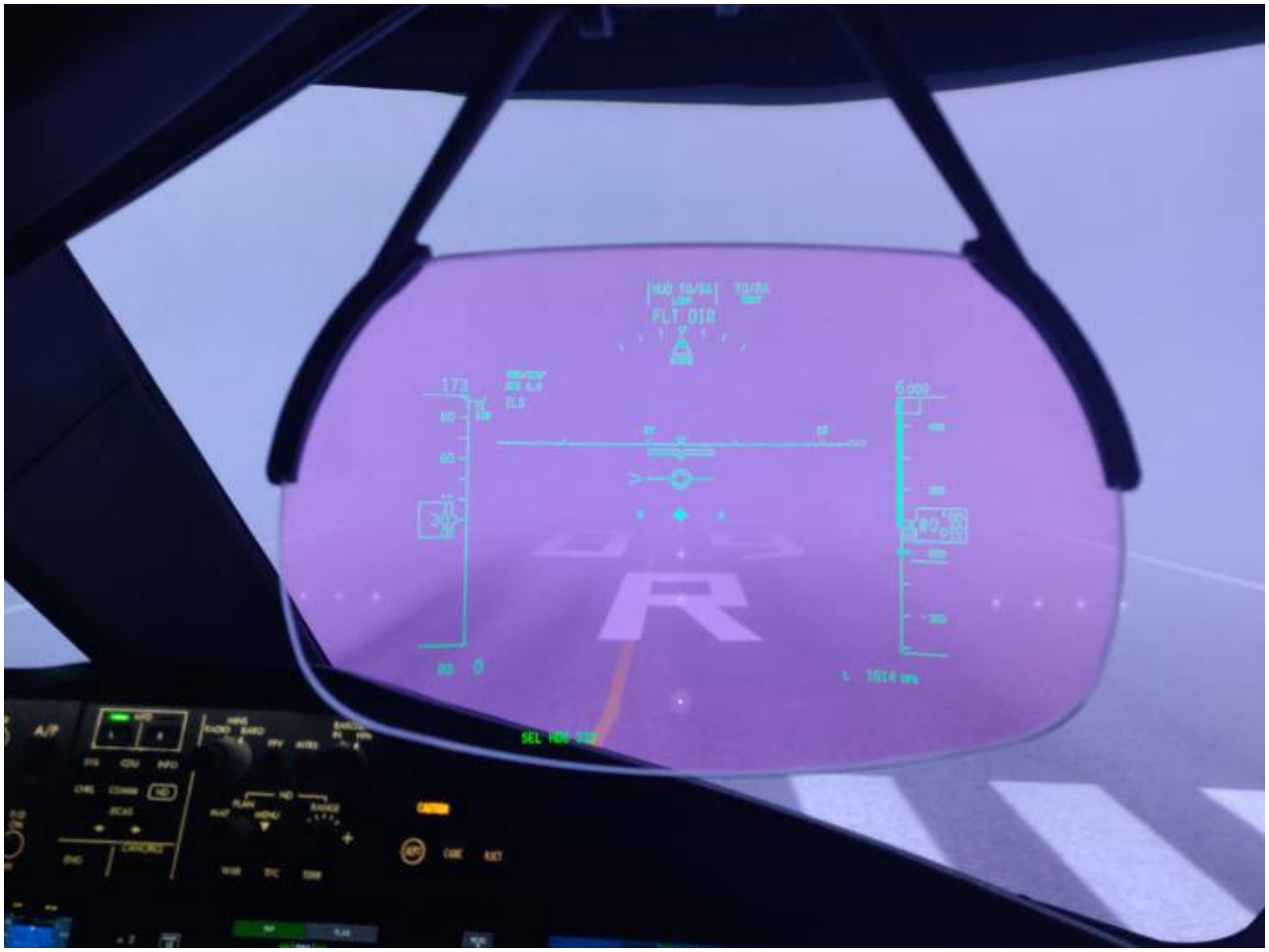
As a result of the increased accuracy, CAT II approaches have a lower minima, normally around 300 metre RVR with a DA of 100 feet above the ground. These reduced minima also mean that the pilots normally leave the autopilot engaged till touchdown and perform an autoland. That said, should there be a failure in either the ground or aircraft-based systems, there are enough visual references out of the window for the pilots to still land manually.

**Read more:** How pilots stay alert on ultra-long-range flights

## CAT IIIA and CAT IIIB ILS

When things get really foggy, the ultimate in navigational accuracy is required. With a CAT III approach, aircraft can land with a RVR of just 75 metre and with no DH — in effect having no need to see anything out of the window before landing. Needless to say that CAT III approaches are always autolands.

With a CAT IIIB approach, there are enough redundancies in the system to still land with a 75 metre RVR in the case of a system failure. In a CAT IIIB approach, certain failures would require the pilots to revert to using the CAT II minima. If this happened late on in the approach, it may well require a go-around. This is exactly why bad weather landings are carried out by the autopilot — it gives the pilots the spare capacity to notice system failures and take the appropriate actions when time is tight.




CAT III approaches allow aircraft to land in visibility of just 75 metres (Photo by Charlie Page/The Points Guy)

## The future — RNAV and GPS

ILS systems are great as they give unparalleled accuracy, but their major flaw is that the approach has to be directly lined up with the runway. This is fine for places like Dubai, where the area around the airport is flat, but not great for places surrounded by hills.

For these places, VOR approaches always used to be the only method of making approaches in cloud but with the advance of GPS technology, a whole new method of approaches has been born — RNAV approaches.

In its basic form, RNAV approaches allow aircraft to use the accuracy of their systems on board to make an approach into an airfield which has no physical antennae on the ground. This means that, in theory, an aircraft can make an approach into any airport in the world with the correct authorisation.

### RNAV approaches

RNAV approaches use a series of GPS waypoints to guide the pilots laterally towards the runway. So long as the systems on board the aircraft can maintain the required accuracy (normally 0.3 miles), the pilots can then also descend in accordance with the profile published on the approach charts.

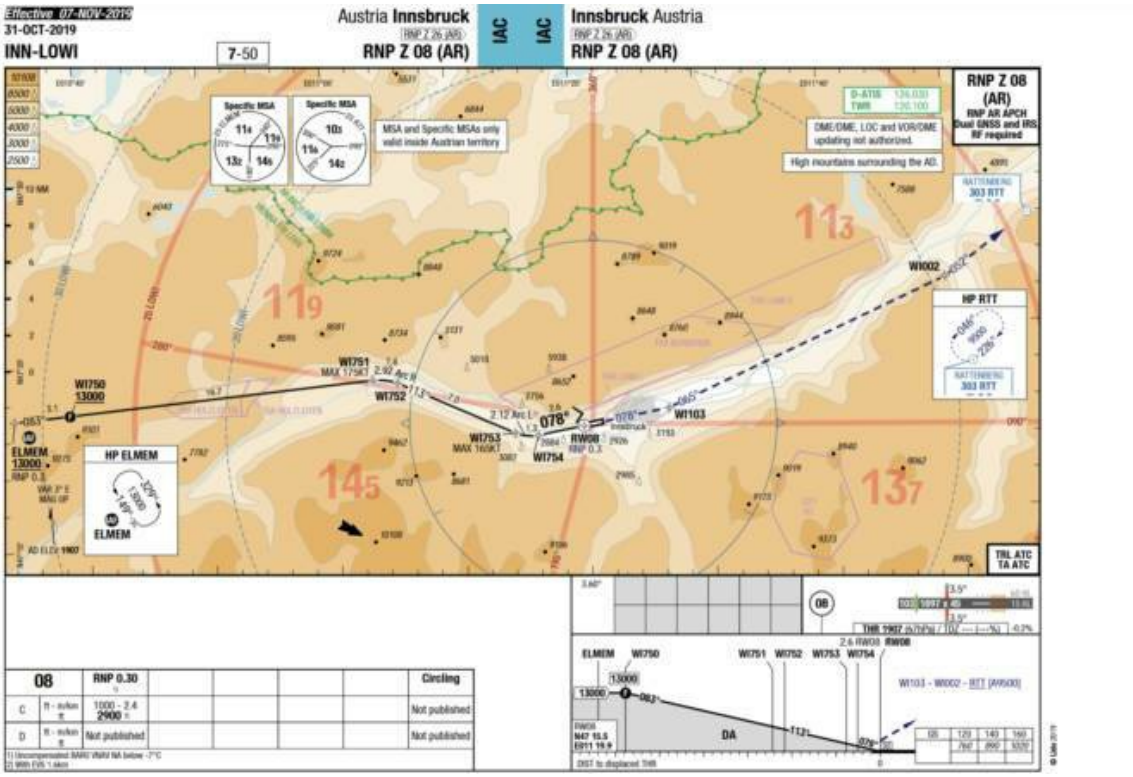
This is ideal for smaller airports as they don't have to pay for and continue to maintain expensive ILS systems on the ground. Once the approach has been created and authorised by the relevant authorities, pilots can just fly the published approach using their equipment on board.

However, when RNAV approaches really come into their own is when there is terrain around.

## AR (Authorisation Required) approaches

The creme de la creme of airfield approaches, RNAV AR approaches, allow pilots to fly their aircraft around the tightest of terrain and still line up with the runway. Whilst the approach is published for all to see, the AR aspect means that each airline must receive approval from the regulator in order to fly that specific approach. This will normally involve training in the simulator for all pilots before the approval is granted.

Whilst the minima isn't normally much better than a VOR or normal RNAV approach, the increased accuracy of an AR approach enables aircraft to land into places which they would normally be unable to do so. A great example of this is into Innsbruck (INN) in Austria, as seen in the chart below.




The RNAV AR approach into Innsbruck. (Photo courtesy of Charlie Page/The Points Guy)

With the approach starting at the western end of the valley, the pilots instruct the autopilot to fly the aircraft to fly via the prescribed waypoints, turning down the valley, descending as they go. Whilst the required visibility is 2,400 metres, the approach brings the aircraft safely down to just 1,000 feet above the airfield.

## Bottom line

Getting the aircraft safely onto the runway at the destination is the primary task of your pilots. In order to do so, there are a number of different approaches which we could be expected to fly, depending on the facilities available at the airfield.

VOR approaches were ground-breaking for their time, but as technology progressed, more accurate systems became available. ILS approaches are the norm for most major airports now, allowing aircraft to land in just 75 metre visibility. However, with increased accuracy and reliability of GPS, RNAV approaches are becoming more common. They allow aircraft to make approaches into airfields where previously they were unable, all without the added cost of ground based navigation systems.

*Featured image by Getty Images/Brigitte Blättler*