FS ACADEMY

ON INSTRUMENTS

CONTENTS

WELCOME

Welcome to FS Academy – On Instruments for FSX.

The course is comprised of the Video Series, 8 Missions in FSX & this Manual.

The manual is laid out in the order suggested for completing the course. It will take you through the video series and in-game missions in the optimal order.

The Video Series can be found under FS Academy within your main FSX folder.

The missions have varying levels of difficulty. Briefings are contained within this manual and provided at the beginning of each mission. You can favourite the missions with the star button to make them easier to find later.

The skills you will learn from FS Academy – On Instruments are transferable to almost any aircraft, from a Cherokee to a Jumbo Jet, the instrument scan and techniques are the same.

Each mission begins with an aircraft assigned to you, but you can select whichever aircraft you wish from within FSX. Although be aware that not all aircraft in your library will be appropriate for mission use.

Let's get started...

VIDEO 1 - INTRODUCTION

Watch this video before proceeding. The Video Series can be found under FS Academy within your main FSX folder.

Before we get started on learning how to fly on instruments, let's discuss why we might need to do this.

On a day with clear weather, flying an aeroplane by looking out of the window is simple. You can depart, fly down the coast, turn overhead your friend's house and stop off somewhere for a burger, all by looking outside.

An instrument rating might seem pretty irrelevant, until you see the clouds rolling in.

It doesn't take much for the weather to be below the regulatory limits for visual flying. A cloudy day can keep you grounded very easily. You either sit on the ground hoping for improvement, or you fly under Instrument Flight Rules (IFR). To fly IFR, you need an instrument rating.

Airlines will file their flights as IFR as a bit of rain shouldn't keep a jet full of passengers grounded. If you're aiming for the airline world, an Instrument Rating will be essential. This course is intended to help you on your way.

VIDEO 2 – HUMAN FACTORS

It only takes a quick look at some optical illusions to remind you that our human brains can easily be misled. There are a whole range of physical sensations and visual illusions that can lead you towards danger, so let's have a look at some of them that can give you trouble when flying.

The illusions we have just seen can be very convincing. They have caused many accidents over the years, so we study them so we are prepared to defend against them.

Illusions can come and go as your flying career progresses. For example, a new pilot may not have the idea of a 'standard' runway yet, so might not get misled by a narrow runway, whereas a grey-haired experienced captain might get caught out late at night on the fourth flight of the day.

Our balance sensors are located in the depths of our inner ears. They usually serve us well, but can be led astray without notice. As we saw when discussing 'The Leans', the fluid in our ears initially sense the turn as the motion induces a current in the fluid. But eventually the fluid has accelerated to full speed, and accelerates no more, meaning there is nothing to detect by the tiny hairs that lay in the stream. Once the turn finishes, the fluid is decelerated back the other way, again inducing a current in the fluid. So now you have stopped turning, but your ear senses a strong turn, confusing you into a dangerous predicament.

VIDEO 3 - RULES OF THUMB

Flying can get complicated. To help you ease the load, there are a range of helpful quick calculations to help you out. Let's have a look at the ones you can use on a daily basis.

DISTANCE TO HEIGHT DISTANCE x3

This is probably our most used rule of thumb. It works for long ranges, such as when to begin a descent from cruise altitude, or to check your progress as you near the beacon.

In light aircraft then this rule is basically all you need. For larger aircraft with higher inertia, you also have to account for the distance it will take to reduce speed. In most practical terms, this means 'adding a bit', such as 5-10nm, to your distance.

3 DEGREE DESCENT GROUNDSPEED x5

Easily worked out and highly useful, the Groundspeed x5 rule also works at long or short ranges. If we had a strong tailwind on approach and did not adjust for it, we would be covering ground more quickly, so our rate of descent would still take us down the glideslope in the same amount of TIME, but as we have travelled further in that time, we might have overshot the airport! Basing our rule on groundspeed solves this problem and takes account of any head or tailwind.

RATE 1 TURN 10% AIRSPEED +7

With a small aircraft like the C172, you will be flying pretty much everywhere at almost the same speed, typically 100 knots or so. Once you work out that 17 degrees of bank gives a rate 1 turn, you will use this number over and over. Also, you are assisted by the turn co-ordinator, which indicates rate 1 turns when a wing is touching a ‘block’ on the dial.

For larger aircraft, which have no turn co-ordinators and go through significant speed changes throughout a flight, you will be calculating for a few different speeds. If your answer comes up at more than 25 degrees of bank, disregard your calculation and just use 25 degrees, as this is considered the maximum bank angle for flying procedures. In the cruise, rate 1 turns are a little excessive for passenger comfort, so make your turns earlier and with more like 10 degrees bank when cruising in an airliner.

TURN ANTICIPATION 1% GROUNDSPEED

Most useful when a large turn is required, using 1% of your groundspeed is best suited with medium-large aircraft. Throughout the missions you will fly, try to calculate when to turn, but remember that this will be very conservative in the little C172 unless a very large change of direction is required.

LEVEL OFF 10% VERTICAL SPEED

Mostly of assistance in smaller aircraft, using 10% of your vertical speed can give you a smooth, controlled and comfortable level off. Airliners typically use Flight Directors on their instruments to guide you even more gently, but this feature is usually not found on smaller aircraft.

Be aware that ICAO stipulate some restrictions on vertical speed. In European airspace, if there is traffic nearby as you reach your desired altitude, they impose a limit of 1500fpm for the last 1000ft of climb. The UK have slightly different rules, where you are to reduce your vertical speed to 1500fpm earlier, for the last 1500ft of climb. They also impose a minimum rate of 500fpm in controlled airspace. The FAA impose different rules again, so for maximum realism, look into the restrictions in place for where you intend to fly.

There are more of these quick calculations out there, but we are covering the important ones for our purposes. They all get easier with practice.

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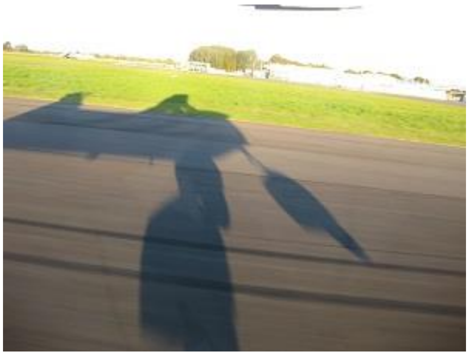
MISSION 1 – BASIC IMC



Duration: 10 minutes

Aircraft: Cessna 172

Location: EGHH – Bournemouth, UK

Objectives: Basic Instrument Flying

Welcome to your first practical flying assignment of FS Academy – On Instruments.

The Manual and Video Series can be found in the FS Academy folder in your main FSX folder.

Lesson Plan:

- Takeoff from RWY 26
- Climb to 2000ft
- Level turn to the Right
- Climb on HDG to 3000ft
- Speed changes
- Descending turn
- Rate 1 turn

The first FSX Mission of the course, open FSX, navigate to the missions section and in the "**FS Academy – On Instruments**" category, open the "**FS Academy 1 – Basic IMC**" Mission. Read the pre-flight briefing before you start the flight.

You will depart Bournemouth from Runway 26 and climb straight ahead to 2000ft. Then we will begin by making a level turn to a heading.

This lesson is designed to ensure your basic flying are up to standard, before we progress further into the course and start to introduce more complicated actions. If you are out of practice, it is worth spending the time now to ensure you have spare capacity to take on new information as we start to look at Radials, VOR tracking and Holding in later lessons.

VIDEO 4 - NAVIGATION AIDS

The highways in the sky are marked out by radio beacons. Understanding the basics of how they work and learning how to use them will be an important step forward.

As you can see, the Navaids themselves are not particularly complex. We have the benefit of decades of development and improvement of instrumentation and reliability.

It is important to remember the sequence of events to Tune, Identify and Display your navigation aids, as a mistake here will send you off the rails and into a very confusing and dangerous situation.

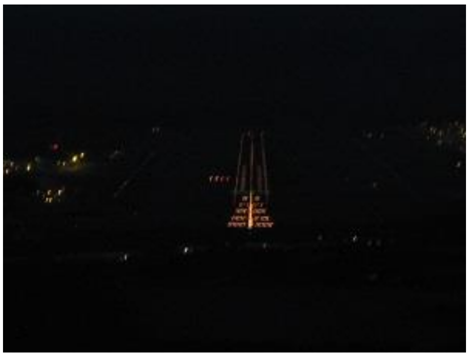
Now we know what there are and how they work, we need to learn what to do with them.

VIDEO 5 – RADIO NAVIGATION

Our instrument flying will usually take us to, from and overhead Navaids. Let’s learn how to do this easily, accurately and reliably.

As with any step in the course, if something does not ‘click’ then you should try to work it out clearly in your mind before we progress. Using Navaids is often a sticking point with new students, so there are many resources available to assist with this crucial step.

MISSION 2 – RADIO NAVIGATION



Duration: 15 minutes

Aircraft: Cessna 172

Location: EGCC – Manchester, UK

Objectives: Navigate with NDB & VOR

Lesson Plan:

- Takeoff
- NDB: Find your radial, track to station and leave on radial 090
- VOR: Find your radial, track to station and leave on radial 180

In this mission you will put what you have learned about Radio Navigation into practice.

We will depart Manchester and see how we can use Navaids to find our way. We'll be flying at night, but as you will notice, it makes no difference to techniques we use for instrument flying.

You should be beginning to get comfortable with instrument flying, as you need spare capacity to watch extra instruments such as DME read-outs and VOR needles, in addition to the regular operation of the aircraft.

In our video on Radio Navigation, we looked at how to Tune and Identify Navaids. The process for this is: TUNE – IDENTIFY – DISPLAY

In this mission, the Navaids have been tuned for you. They are:

MCH NDB: 428.0

MCT VOR: 113.55

Listen to the Ident for each Navaid as you use them:

MCH NDB -- / -.-. / ....

MCT VOR -- / -.-. / -

A .-	J .---	S ...
B -...	K -.-	T -
C -.-.	L .-..	U ..-
D -..	M --	V ...-
E .	N -.	W .--
F ..-.	O ---	X -..-
G --.	P .--.	Y -.--
H	Q --.-	Z --..
I ..	R .-.	

NDB TRACKING

Let's review how to track to or from an NDB.

To find your current RADIAL (Your location FROM the NDB), TURN the ADF compass card to match your current HEADING. The TAIL of the needle will be sitting on your current radial. After takeoff, we will turn the ADF so it matches our HDG of 240. The needle will be sat on 240, which makes sense as we have just flown AWAY from the beacon on its 240 radial.

The needle points directly to the NDB, so to fly TO the beacon, follow the needle.

To LEAVE the NDB on a particular radial (090 in this mission), as you are about to pass OVERHEAD the NDB, turn to the radial you want to fly. For us, we will turn to heading 090. We will pass overhead the NDB and will be flying away from it on the 090 radial.

We have left the NDB (MCH) on radial 090. We fly away from the airport for a short while, to give us some distance to set up for the VOR section of the mission.

VOR TRACKING

Next we try a similar exercise with a VOR (MCT).

To navigate TO the VOR, we turn the HSI Course dial so that we CENTRE the needle with a TO arrow.
After having done this, by turning to the heading shown at the TOP of the HSI dial, we will fly TO the VOR.

As the VOR and NDB are located close together, and because we have left the NDB on radial 090, we find ourselves on roughly the 090 radial from the VOR. Turning the OBS to centre the needle with a TO arrow puts heading 270 at the top of the dial. If we fly 270, we will track TO the station.

However, our position changes slightly while we are turning, so as we begin to head back towards the VOR, we should then RE-CENTRE the needle, still with a TO flag, to give us an updated direction to fly.

To leave a VOR on a particular radial (180 in this mission) we do the same as for an NDB.
As we are nearly OVERHEAD the VOR, we turn smoothly to our desired radial (180). This should put us in roughly the right place, from which we can make some fine adjustments.

Once tracking FROM the VOR, we can turn the HSI to put our 180 radial at the TOP with a FROM flag.

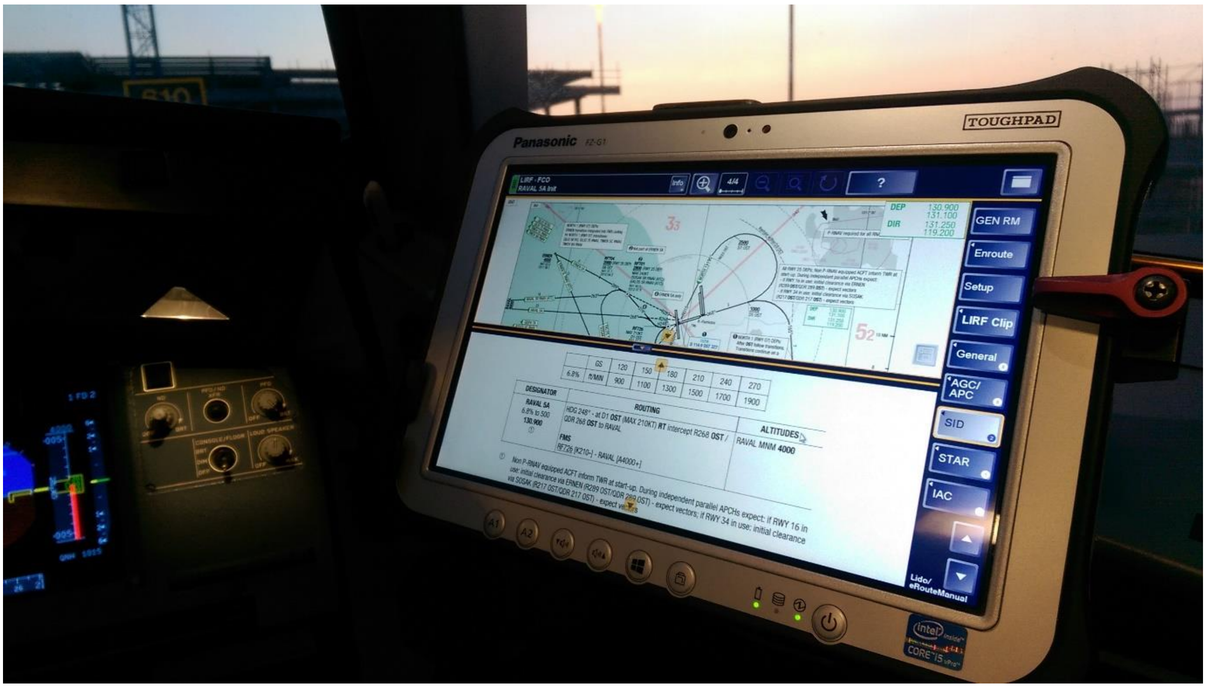
Leaving on the 180 radial to about 3 DME will complete the mission.

VIDEO 6 – DEPARTURE

Now we know how to get to where we need to go, let's get airborne.

Any IFR flight will, of course, begin with a departure. These procedures are standardised so that everyone follows a route from a set number of agreed routings. This has many benefits such as reliable noise reduction for the surrounding areas and greatly simplifying ATC instructions. Instead of ATC requesting that you "Maintain runway HDG until 2 DME, then turn right track 268, crossing DME 10 at 3000ft or above….." and so on, they can say "Pole Hill 2X" and we all know what it means.

Our charts are in basically the same format as any other. They all follow roughly the same layout, as they are all communicating the same information. Whether printed on paper or displayed on a tablet computer, charts are always to be kept close to hand for quick reference while flying.



The charts used in this course are included in the 'Charts Pack' for printing, but remember you can access them in-flight by using the FSX Kneeboard.

MISSION 3 - DEPARTURE

Duration: 15 minutes

Aircraft: Cessna 172

Location: EGNM – Leeds, UK

Objectives: Instrument Departure

Lesson Plan:

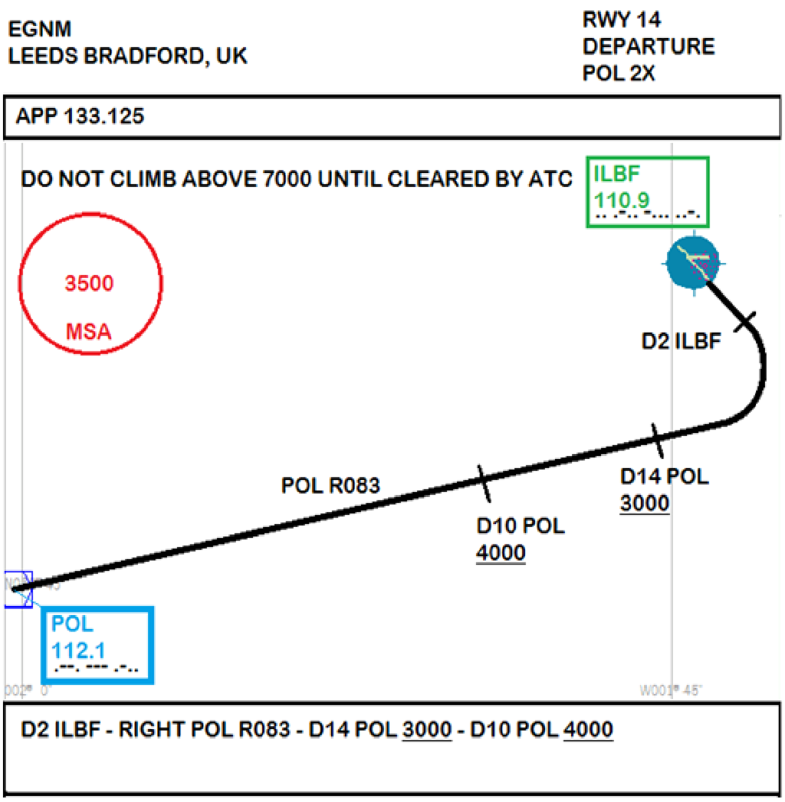
- Depart RWY 14
- Fly the POL 2X SID

In this mission you will fly a full Standard Instrument Departure (SID).

In our lesson on Departures, we looked at the POL 2X from Leeds Runway 14. We will now apply what we learned and fly the full departure.

You should be getting comfortable with instrument flying, as you need spare capacity to watch extra instruments such as DME read-outs and VOR needles, in addition to the regular operation of the aircraft.

Be aware that flying a slow aircraft such as our C172, instrument flying can seem to be happening in slow motion. This is good for training, but it is to be remembered, as you don’t want to be taken by surprise when you try something faster.



Remember you can check your charts (and briefing) at any time in the mission using the FSX menu.

We'll fly the SID until we reach 10 DME from POL, where the mission will end.

After takeoff, continue tracking straight ahead, adjusting for the light wind from the left. Begin a climb up towards 5000ft, which you should maintain once reaching.

We continue on the runway track until we hit 2 DME from the ILBF station, which is tuned and displayed on NAV2 on the DME box.

More sophisticated aircraft will display multiple DME readings at once, but in the C172, you can only see one at a time.

So, once we pass 2 DME, we have no use for the ILBF DME anymore, so we select R1 (NAV Radio 1) on the DME receiver, to display our distance to POL, which we use for the remainder of the SID.

As most SIDs are designed for larger commercial aircraft, the 2 DME turning point is slightly too early for us in our C172. Turn at 2 DME anyway, to comply with the SID, but beware that turning here won't put us on the inbound track. We'll have to make an intercept, so you can make your initial turn slowly and track to POL VOR on the 263 INBOUND, by centring the HSI needle.

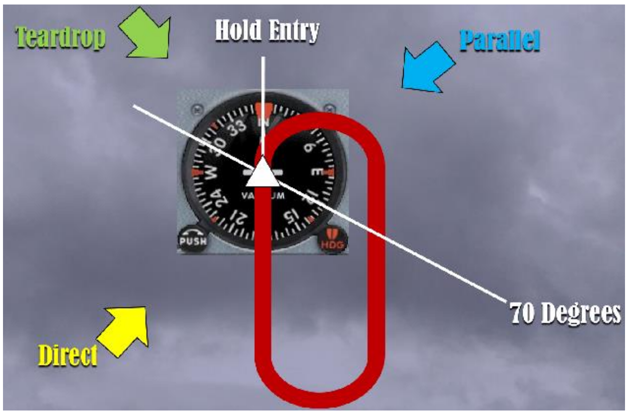
VIDEO 7 - HOLDING

ATC issue 'Slots' which are assigned take-off times to help to reduce delays inflight. However, they cannot be avoided completely and there are many reasons why we may encounter delays while already in the air.

Few concepts cause as much confusion for students undertaking their Instrument Rating as hold entries. But it does not need to be so.

There are a handful of 'Magic' techniques for visualising a hold in order to see which direction you are approaching it. The technique suggested in this course is the preferred method of many, but of course if it does not 'click' with you, then there are alternatives, which can be found online almost instantly.

Once you have the hang of it, it can become strangely satisfying to have conquered this essential skill.



Most holds have right turns. If you encounter one that is to the left, simply mirror the whole picture. Again, this is a crucial step and needs to be understood before progressing further into the course.

MISSION 4 - HOLDING

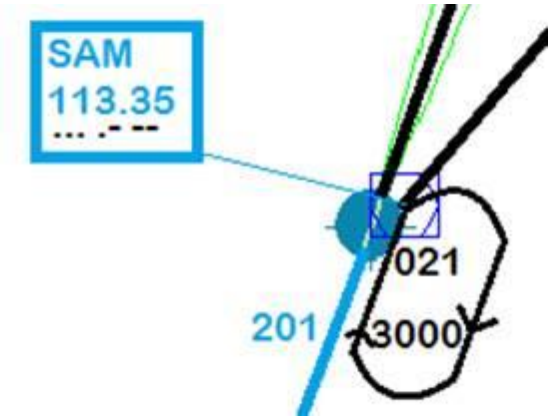
Duration: 40 minutes

Aircraft: Cessna 172

Location: EGHI – Southampton, UK

Objectives: Holding Entries

We will now introduce holding pattern entries. It is not uncommon for students to take a while to get to grips with this, so if you start to struggle, you are not the first and won't be the last. We are nearby Southampton (EGHI) in the UK and are using the ILS chart to read the information about our hold.



It shows that the hold is based on SAM VOR, with RIGHT turns and has an inbound leg of 021 degrees. The minimum holding altitude is 3000ft.

The mission begins with the Autopilot maintaining 3000ft and flying us towards Southampton VOR, SAM, which is tuned to your NAV1 radio. At first the Autopilot will keep your hands free, to make imagining the hold a little easier.

Between each type of entry, we will leave the SAM VOR on a heading and track out for a couple of minutes. This will give us enough space to turn around again and set up for the next entry.

We will cover the 3 holding pattern entry techniques in this mission. To assess which entry we require from the direction we are approaching, we use the following method:

When tracking TO the station, Imagine the HOLDING FIX is at the CENTRE of your HSI.

Now imagine your INBOUND COURSE (021), stretching out from the centre to 021. This gives us the basic orientation of the hold.

From this we can imagine the hold, with its right hand turns and as we ALWAYS approach from the BOTTOM of the dial, which entry we will need to make. In this case, we are in the DIRECT entry sector, so will make a direct entry.

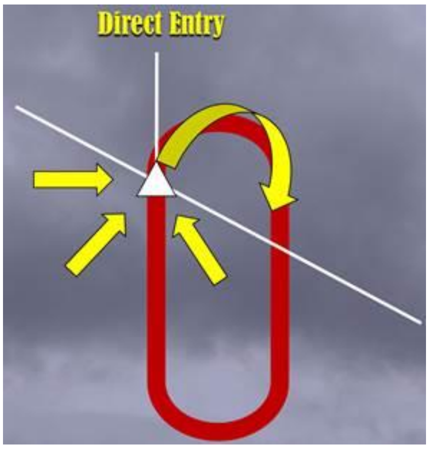
Of course, use another method that you find one that is easier to work with.

Remember you can refer to this briefing at any time during the mission by using the FSX menu:

AIRCRAFT-> KNEEBOARD-> BRIEFING

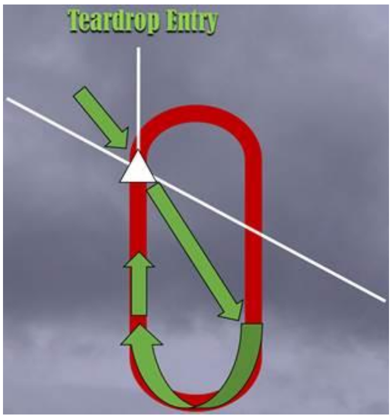
DIRECT

- Fly OVERHEAD the SAM VOR
- TURN to OUTBOUND LEG
- 1min – INTERCEPT INBOUND



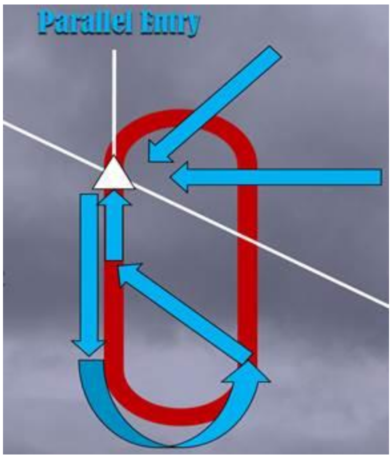
TEARDROP

- Fly OVERHEAD the VOR
- Track to 30 DEGREES away from OUTBOUND LEG
- 1 Minute – INTERCEPT INBOUND LEG



PARALLEL

- Fly OVERHEAD VOR
- Fly PARALLEL and OPPOSITE to INBOUND LEG
- 1 minute – INTERCEPT INBOUND LEG



Remember that unlike the other entries, a parallel entry will NOT put you on the inbound leg, you have to continue turning and INTERCEPT the inbound course.

VIDEO 8 – DME ARCS

Much like holding, a DME arc can be tricky to grasp at first, but once you have your eureka moment, it becomes simple forever after.

One of the risks to you while you concentrate on maintaining your arc is to lose track of how far you have progressed and keep going around for too long. Remember you are at the tail of the needle.

DME arcs are unlikely to be seen without also being accompanied by a beacon. It is the needle towards this beacon that provides our needle and therefore our guidance around the arc and our bearing.

MISSION 5 – DME ARCS

Duration: 15 minutes

Aircraft: Cessna 172

Location: EGNM – Leeds, UK

Objectives: Fly a DME Arc

Lesson Plan:

- Join a 4 DME Arc Clockwise
- Easy Checkpoints
- Medium Checkpoints
- Complete Arc

Now we'll try flying a full DME Arc.

We begin with the Autopilot flying the aircraft towards Leeds Airport NDB. The NDB and DME are already tuned for you.

DME ARC with RIGHT turns: Point the needle RIGHT

DMC ARC with LEFT turns: Point the needle LEFT

Use the 1% Ground Speed rule to find when to begin your turn. At roughly 90kts ground speed, you should begin your left rate 1 turn at 4.9 DME.

JOINING

We want to join a 4 DME arc with RIGHT turns. As we are joining from the OUTSIDE, your first turn will be to the LEFT.

When you reach your estimated turning point (4.9 DME), start a rate 1 turn to the LEFT. While turning, judge how close you are getting to your target DME (4.0 DME) to see if your turn was too early or too late.

Keep turning until you have 'Flattened' the needle to point the needle in the direction you will be turning WHEN ON the arc.

MAINTAINING

As you fly straight ahead, you will see the needle start to drop. Allow it to drop to slightly BELOW horizontal:

To maintain your CURRENT DME, make a SMALL turn TOWARDS the needle head to raise the needle back up to slightly ABOVE horizontal.

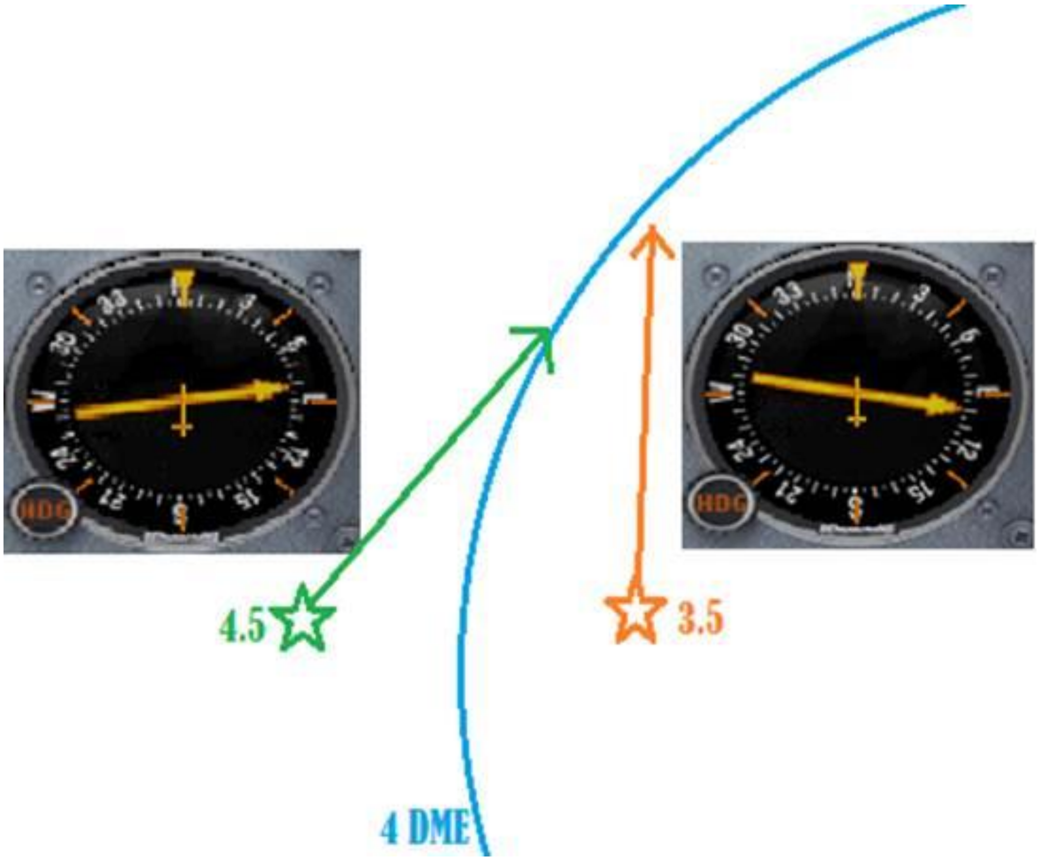
It will soon drop down again. Repeating this process will keep you on a DME arc at your CURRENT distance.

ADJUSTING

If you fly with the needle raised up, your DME distance will DECREASE. If you fly with the needle down, your DME will INCREASE. Therefore, to correct errors in your distance or to move in/out to a new arc at a DIFFERENT DME:

If your DME is too LOW, keep the needle LOW.

If your DME is too HIGH, keep the needle HIGH.



In this mission, you will start by joining the arc. Then you will have the assistant from the Mission Compass and Pointer to guide you to the "Easy" checkpoints. These are spaced every 10 degrees.

After Checkpoint 11 you need to make your way through the "Medium" checkpoints. You are still guided but now checkpoints occur only every 30 degrees around the arc.

After Checkpoint 15, you are on your own. No guidance will be given. You must continue to apply the Arc procedure without assistance. Pass through Checkpoints 16 and 17 unaided and you pass the mission.

VIDEO 9 - NON-PRECISION APPROACH

So now that we are well versed in departing, navigating, arcing and holding, it is time to descend and land.

Flying an instrument procedure is essentially the combination of everything we have learned so far. You'll need your spare capacity to read and the approach charts to understand what is required of you.

It may be helpful to remeber that if you can fly the aeroplane on instruments, then all you need to do is the right thing at the right time. They are the combination of speed, altitude and track changes. No NDB approach will require a barrel roll. As you near the runway, you will need to begin configuring your flaps and landing gear in order to perform the landing itself. This varies massively between aircraft and is not the focus of this course. Do remember that as you configure and decelerate, this will have an effect on your glidepath and drift. As you slow, you need to recalculate your rate of descent, which will have reduced slightly. Also your drift will have increased at your new, lower speed, so your wind adjustment will need to be increased as you reduce your pace towards touchdown.

MISSION 6 – NDB APPROACH

Duration: 20 minutes

Aircraft: Cessna 172

Location: EGHI – Southampton, UK

Objectives: Procedural NDB Approach

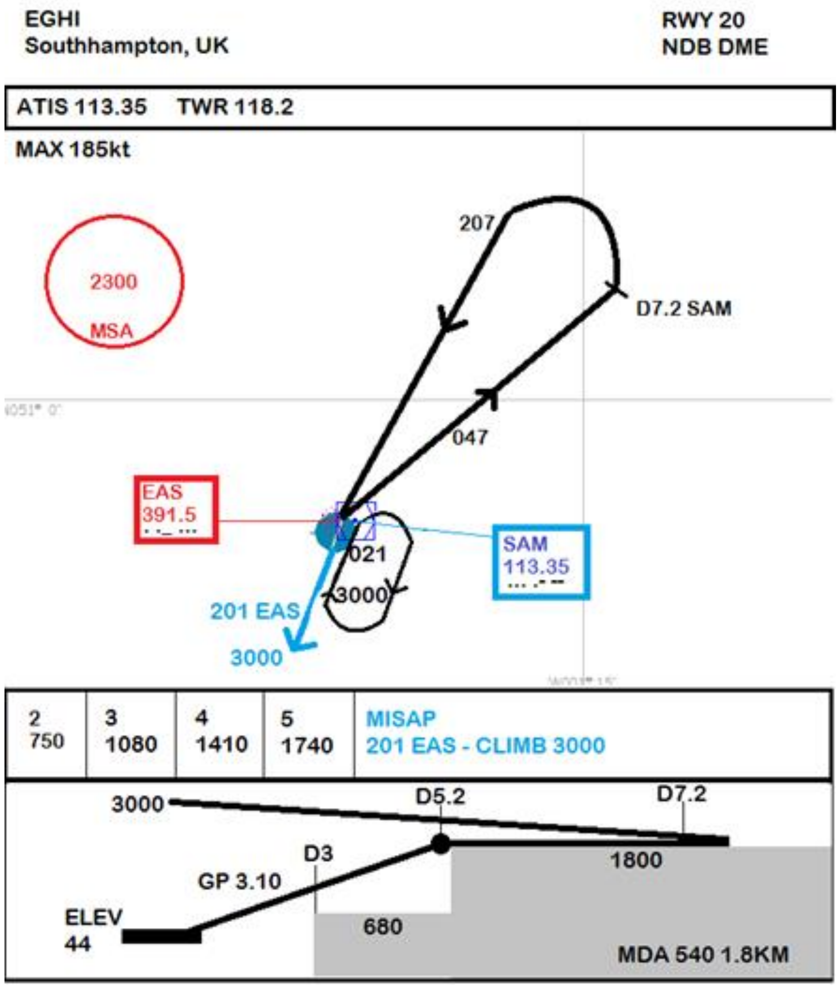
Lesson Plan:

- Join EAS Holding Pattern
- Make one lap of the hold
- Leave hold and fly procedure
- Missed Approach

Let's bring it all together.

By this stage you have flown basic instrument flying, radio navigation, IFR departure and approach charts, SIDs, and holding patterns and the missed approach. Now it's time to bring what you've learned together and fly a complete procedural NDB approach.

We begin in-flight at 3000ft with the autopilot guiding you roughly towards Southampton NDB with around 10 miles to go. You will judge which holding entry we require and then perform it. After joining, we will make one full lap of the hold to get you in the swing of things.



THE HOLD ENTRY

Use the same method as before to determine your hold entry.

THE PROCEDURE

Let’s run through the approach chart to see how to make an approach.

We have the correct chart, the NDB DME Runway 20 for Southampton.

The MSA is 2300ft. If you get lost, staying at or above 2300ft will keep you safe within 25 DME.

We have the ADF tuned to the EAS NDB on 391.5. The DME is from the SAM VOR and is tuned to VOR 2. Identify your Navaids.

We see that there is a speed restriction of 185kts for this procedure. Almost all procedures in the UK have this 185kt speed limit. Our Baron 58 will have no trouble keeping below that.

Our Minima is an MDA of 540ft and a visibility of 1.8KM. The weather is reported as marginally better than this, so we satisfy the “Approach Ban” and may continue below 1000ft.

The procedure itself starts at EAS and runs along the 047 radial until 7.2 DME. We then make a left base turn to intercept the 207 to EAS.

Making our turn to the final approach, we should note that we are in a slow aircraft, so we may be making much tighter turns than the procedure intended. Be prepared to make an INTERCEPT of the final approach course and do not expect to be presented in the right spot at the end of your base turn. Try turning to just HDG 270 initially and see how you are progressing.

We have a “Hard Altitude” of 1800ft. which stretches until our Final Approach Fix (FAF) at 5.2 DME. We must not get any lower than 1800ft until we reach the FAF. Going any lower might get us dangerously close to any obstacles lurking below the approach path.

The final approach descent begins at 5.2DME. This is where we begin our 3.1 degree descent towards the runway. The 5x Ground Speed rule for a 3.0 degree approach still works, but add a tiny extra, such as 50ft, in pursuit of accuracy.

Use the Check Altitudes on the above the vertical profile to check your progress down the approach. At D4 we want to be at 1410ft. If you’re not, you must do something about it.

MISSED APPROACH

If we were shooting this approach to land, we must be visual with any ONE of the following BEFORE we reach our minima, otherwise we MUST go-around:

- Approach Lights
- Threshold Markings or Lights
- Runway Edge Lights
- Touchdown Zone Markings or Lights
- Visual glide path indicator

With reduced visibilities such as we have today, at minima there not be much to see. Are you visual on this approach?...

Note that in this case, the final approach (207) and the runway (201) are not aligned. This means that as we get visual at the end of the procedure, the runway will appear in the window at an angle. Keep this in mind when flying in weather close to the approach minima, as you are looking for just a few lights.

The weather is good enough for this flight so we will likely become visual before we reach our MDA of 540ft, but for training we will make a Missed Approach.

When you are given the instruction “Go-Around”, you are to promptly apply full power and smoothly pitch the nose up to climb away. You must NOT descend below MDA. The missed approach for this procedure has us tracking 201 degrees and climbing to 3000ft. We track 201, which is the RUNWAY heading, so we need to make a small turn to ensure this. As you approach 3000ft the mission will be complete.

VIDEO 10 – ILS APPROACH

Now we can enter a hold, leave on the procedure and fly down to our minima, let's change over to an ILS approach. These are used at almost all of the world's busy airports.

An ILS approach is probably seen as 'easier' than an NPA by most students, as it gives clearer indications of how you are doing, without looking into check altitudes etc. The accuracy is also higher when following a Localiser, but care must be taken as the scale displayed on the instrument is much smaller than for a VOR. This means that when intercepting the final approach, a VOR will start to swing into play gradually, giving you a good chance to smoothly turn and intercept. A localiser on the other hand will not start to move the needle until you are very close to the centreline, giving you less time when intercepting. In an airliner this is one of the only times you might use 30 degrees of bank, as a sharper turn is required. To aid in this, if there is another beacon, such as an NDB, at the airport, you can tune it and it will display a rough guide to your intercept, giving you a little more warning.

MISSION 7 – ILS APPROACH

Duration: 10 minutes

Aircraft: Cessna 172

Location: EGHI – Southampton, UK

Objectives: Procedural ILS Approach

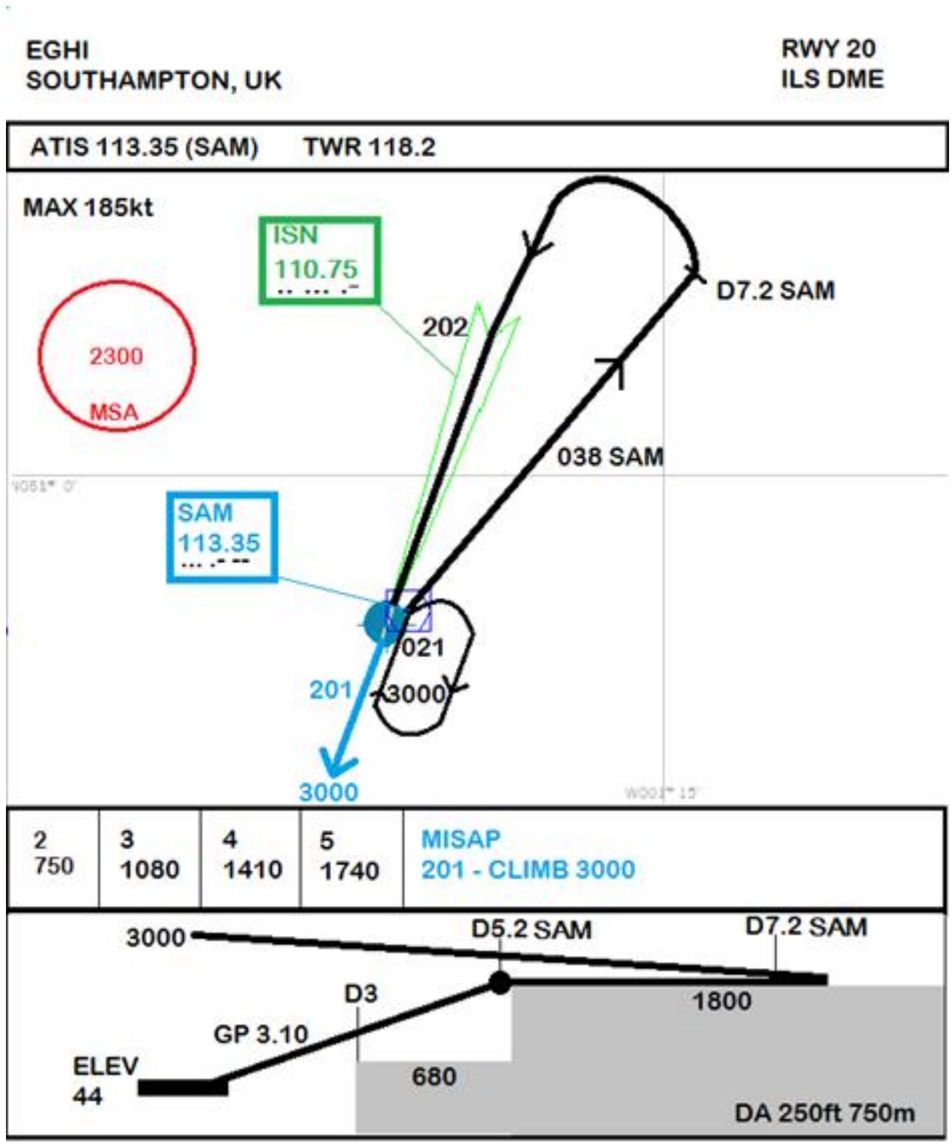
Lesson Plan:

- Depart Runway 02
- Climb out and intercept the procedural approach
- Complete the ILS approach and land on runway 20

Your next step towards the airlines.

Now you've got to grips with the NDB approach, the next step is to try your hand at an ILS. Almost every major airport in the world uses an ILS, so if you fly commercially, this will be an important skill to master. Helpfully, as you get used to it, you will likely find it the easiest type of approach.

We start on the ground at Southampton. Up until now you've had the radios tuned for you, but this time it's down to you. Look at the ILS Approach chart and set your radios up.



TUNE – IDENTIFY - DISPLAY

You'll need the ILS on NAV1, as this is displayed on HIS as this is the only instrument with a Glideslope display.

SAM VOR should be tuned for the outbound radial and DME, we recommend tuning SAM into NAV2. Remember from our Departure mission that you can select which NAV radio the DME will display. Make sure to set the switch on the DME to the radio you have used to tune SAM.

THE PROCEDURE

Let's run through the approach chart to see how to make this approach.

We have the correct chart, the ILS DME Runway 20 for Southampton.

The MSA is 2300ft. If you get lost, staying at or above 2300ft will keep you safe within 25 DME.

You will set up the radios however you like, but it is recommended to have the ILS on NAV1 (110.75) and the VOR (113.35) on NAV2, with the DME for NAV2 displayed.

We see that there is a speed restriction of 185kts for this procedure. Our Beech Baron will have no trouble keeping below that.

Our Minima is a DA of 250ft and an RVR of 750m. The weather is reported as better than this, so we satisfy the "Approach Ban" and may continue below 1000ft.

The procedure itself starts at SAM and runs along the 038 radial until 7.2 DME. We will be departing runway 02 and then turn right to intercept the outbound. At DME 7.2 we then make a left base turn to intercept the ILS.

Making our turn to the final approach, we should note that we are in a relatively slow aircraft, so we may be making much tighter turns than the procedure intended. Be prepared to make an INTERCEPT of the localiser and do not expect to be presented in the right spot at the end of your base turn.

Try turning to just HDG 250 initially and see how you are progressing. Remember that the scale of an ILS indication is smaller than a VOR, so you will get less notice when intercepting as the needle will only begin to move as you are close to the localiser course, be ready for it.

When intercepting, the HSI will look much like this. The first thing to move should be the localiser, the vertical needle. As it starts to swing towards centre, make a smooth turn towards it, to the final approach course of 202.

We have a “Hard Altitude” of 1800ft. which stretches until our Final Approach Point (FAP) at 5.2 DME. Once we climb to and reach 1800ft, we must not go any lower until we reach the FAP. To descend on a glideslope, you MUST be established on the localiser already, so try to intercept the LOC as soon as possible. A Final Approach POINT is slightly different to a Final Approach FIX, but only in that it is simply where we will intercept a glideslope. It has the same meaning and are practically interchangeable.

At 1800ft, we will intercept the 3.1 degree glideslope at 5.2DME. The 5x Ground Speed rule for a 3.0 degree approach still works, but add a tiny extra, such as 50fpm. The descent is easier with an ILS as you have real-time indications of your glidepath. But we still use the Check Altitudes on the above the vertical profile to check we are not following a ‘False’ glideslope. At D4 we want to be at 1410ft. If you’re not, you must do something about it.

DECISION TIME

Remember that an ILS uses a Decision Altitude rather than an MDA. You must NEVER descend below an MDA without being visual, whereas with a DA, you must have INITIATED your missed approach by then, which might take you just below the DA. They are otherwise used in the same way, if you are not visual by your MDA or DA, go-around.

Our visual references to continue are to be visual with ANY of these:

- Approach Lights
- Threshold Markings or Lights
- Runway Edge Lights
- Touchdown Zone Markings or Lights
- Visual glide path indicator

We expect to become visual and to continue for a full stop landing on runway 20, which will complete the mission.

MISSION 8 – A TO B

Duration: 30 minutes

Aircraft: Cessna 172

Location: EGHH – Bournemouth, UK

Objectives: Full IFR Flight

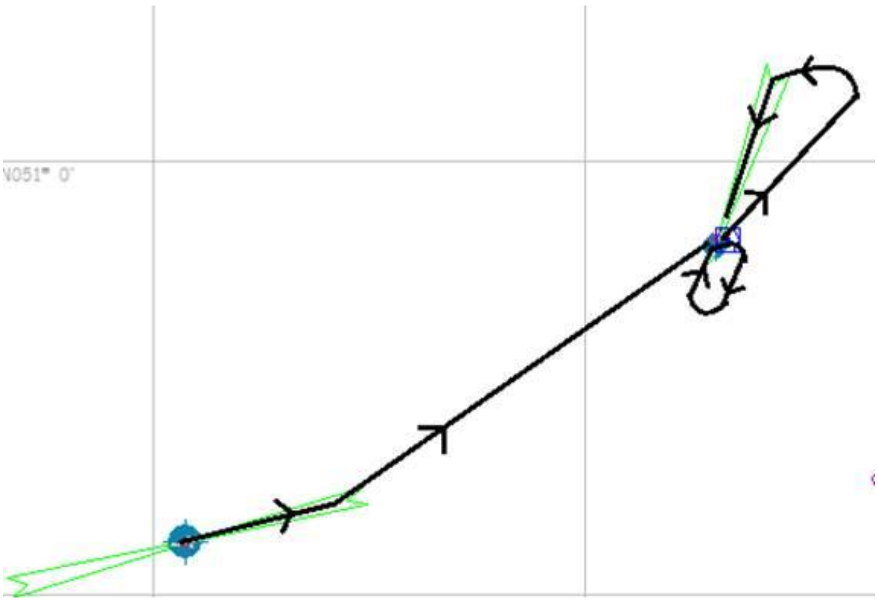
Lesson Plan:

- Depart Bournemouth runway 08
- Climb out and track to Southampton NDB (EAS)
- Enter the hold at EAS
- Leave the hold and complete the NDB DME approach to runway 20
- Land in Southampton

Apply what you've learned and make your first full IFR flight.

The time has come to put your skills to use. Instrument flying is to get you from A to B safely, so now the time has come for you to demonstrate a full flight.

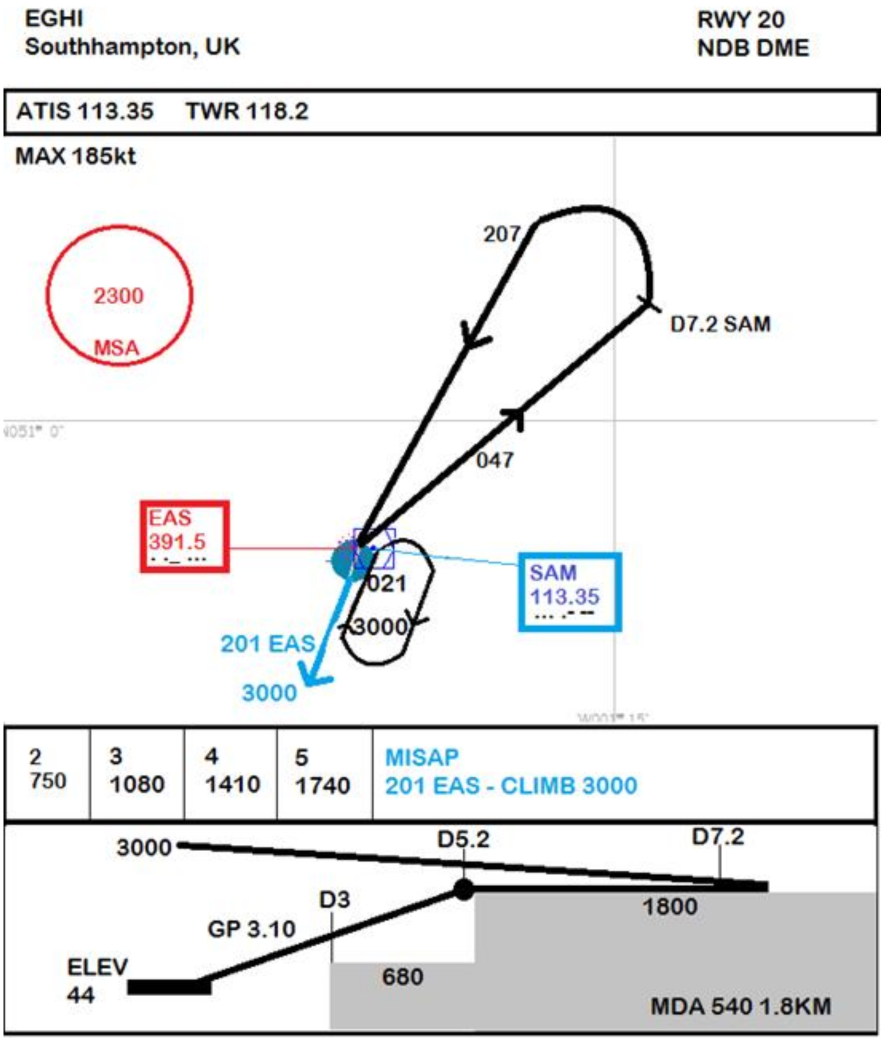
We start on the ground in Bournemouth. It is the middle of a cold British winter and the snow is coming down. We need to fly to Southampton.



We will leave Bournemouth, climbing to 3000ft and track to the Southampton NDB. Join the hold at EAS, using the correct entry procedure.

THE PROCEDURE

Let's run through the approach chart to see how to make this approach.



We have the correct chart, the NDB DME Runway 20 for Southampton.

The MSA is 2300ft. We will be arriving at 3000ft.

You will set up the radios however you like, but as we'll be tracking to EAS (391.5) you will need to have this tuned in the ADF. Our DME for the procedure comes from SAM VOR (113.35) so make sure to have this ready.

Our Minima is an MDA of 540ft and a visibility of 1.8KM. The weather is reported as better than this, so we satisfy the "Approach Ban" and may continue below 1000ft.

The procedure itself starts at EAS and runs along the 047 radial until 7.2 DME. At DME 7.2 we then make a left base turn to intercept the final approach of 207 towards the NDB.

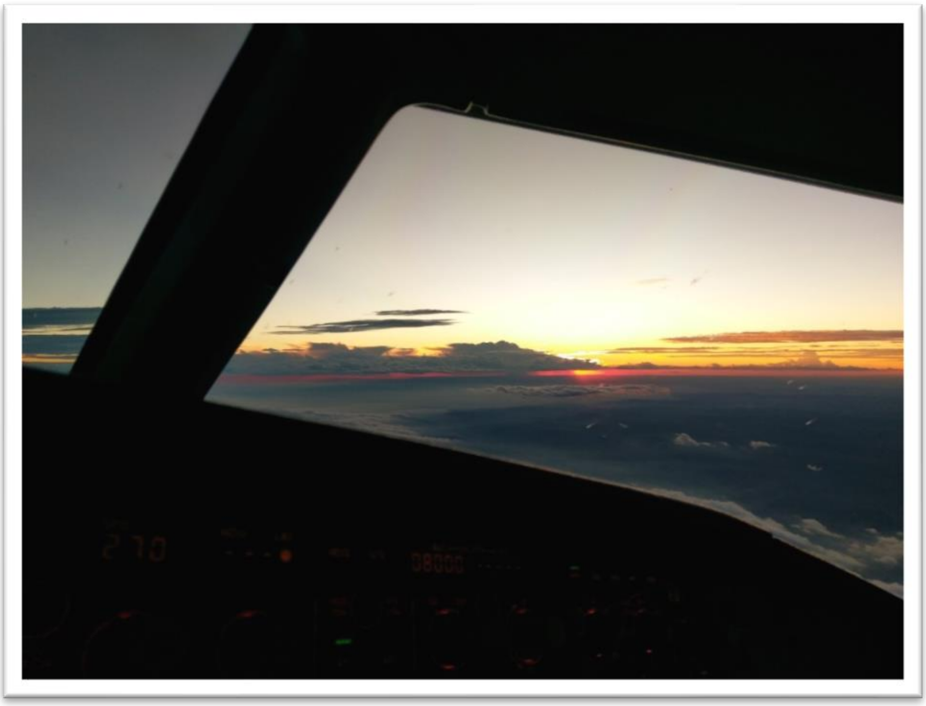
Making our turn to the final approach, we should again remember that we are in a slow aircraft, so we may be making much tighter turns than the procedure intended. Be prepared to make an INTERCEPT of the localiser and do not expect to be presented in the right spot at the end of your base turn.

Try turning to around HDG 250 initially and see how you are progressing. Remember that we need to track to within an accuracy of 5 degrees.

We have a "Hard Altitude" of 1800ft. which stretches until our Final Approach Fix (FAF) at 5.2 DME.

If you are visual at your MDA, continue the approach and make a full stop landing at Southampton, completing a fully IFR flight and concluding our Missions.

MISSION ACCOMPLISHED



…or is it?

Learning to fly on instruments is just the beginning. Now you have the skills, you can fly in almost any weather to almost anywhere. The intention of this course has been to get you flying on instruments like the pros. You know the basics, but only with practice will your flights go more and more smoothly.

Smoothness is key. Procedures are designed to be gentle and as easy as possible. If you find yourself becoming rough with the controls, it is likely that you aren't thinking far enough ahead. Spare time in the cruise should be used to thoroughly review the charts for what's coming up next.

Many approaches are tricky, but difficult to notice the sticking points. For example, in a crosswind the aeroplane will be turned into wind slightly, so you may get yourself all the way down the approach to minima, look straight ahead and see nothing, causing a go around. The runway was there to the side, but not where you were looking.

As you progress into faster aircraft, all that you have learned remains true. From our little Beech 58 to the 747, you will still be using the same rules of thumb and techniques. All that changes are the increased pace and inertia, meaning smoothness is critical in a large aircraft.

I very much hope you have enjoyed this course and that you now feel the door has been opened to an entirely new kind of flying.

Good luck and happy landings.

ICAO vs FAA

This course was built to be as realistic as possible. The regulations we will introduce to you are those as established by The International Civil Aviation Organisation (ICAO), but pilots should note that aviation regulations vary from country to country.

When flying in the United States, the local authority, called the Federal Aviation Authority (FAA) enforces many differences from the standard ICAO regulations.

Some of the main differences are listed below, mainly for use by pilots flying within the USA, to assist with maximum authenticity. A sample of these differences are shown below. They won't be a factor for our course, but are included as some pilots may find them useful:

	ICAO	FAA
Hold Timing	Outbound Leg	Inbound Leg (used in Honeywell FMCs)
Holding Speed Limit	At/Below FL140: 230. >FL140: 240	At/Below FL140: 230. >FL140: 265
Line Up Distance	Considered for Takeoff Distance	Not considered
Vertical Speed	1000fpm if traffic above/below	Minimum 1000fpm
VOR Check	Covered by maintenance	Required every 30 days
Holding Fuel Burn	At holding speed	At cruise speed
Taxi Across Runway	Must be clearly stated by ATC	Implied

MINIMUM FLIGHT ALTITUDES

It is the responsibility of the Captain that the aircraft is not allowed to be flown below any particular MFA except for the purposes of Takeoff and Landing. The purpose of most minimum altitudes is to avoid conflicts with terrain and obstacles, but can be put in place for airspace requirements or navaid reception limitations, amongst others.

These altitudes are absolute minimums and are to be increased depending on factors such as temperature changes, air pressure and wind speed. ATC will not necessarily include such adjustments in their clearances, so knowledge of these MFAs is important.

There are a few different ways of determining the MFA for a particular moment, so we'll touch on each of them in turn.

MSA

Minimum Sector Altitude
Within a 25nm radius of an airport or navigational aid, 1000ft clearance is given above the highest terrain or obstacle in that area, giving the MSA.

This 25nm area can be divided into sectors with each sector allocated its of MSA, to account for high terrain in one particular zone nearby the airfield.

MORA

Minimum Off-Route Altitude
For a particular route, an area 10nm each side of the route centreline is considered for terrain and obstacles. 1000ft margin is given above surrounding terrain that is no taller than 5000ft. For higher terrain, a 2000ft margin is applied.

MGA

Minimum Grid Altitude
An enroute chart is divided up into a grid pattern, with each grid square defined by lines of latitude and longitude. The highest terrain or obstacle within each grid square is taken and has a safety margin applied to it to define a minimum safe altitude. The margin varies slightly depending on the chart producer, but is generally 1000ft for terrain up to 6000ft, and 2000ft margin above terrain exceeding 6000ft. In some regions, including parts of France, airspace and danger areas are also considered as obstacles for this calculation.

SPEEDS

Every aircraft has its own set of limitations, which are essential knowledge. Many of these are in the form of speed limitations, so we'll run through some of the more relevant terms you will come across.

Speeds are usually shortened with a system of “V speeds”, V standing for velocity.

VFE

Each aircraft with high lift devices, such as flaps and slats, have speed limitations for their use. VFE is the maximum airspeed for that configuration. An exceedance would have to be reported to engineers, so they can inspect for damage, before the next flight.

VMO

This is the maximum airspeed for normal operations in the clean configuration, such as in the cruise. Considered a limit, there is a safety margin built into the design, so structural damage is unlikely, but again an exceedance would need reporting and inspecting.

VNE

Treated much the same as VMO, VNE is the Never Exceed speed and is different to VMO in that damage is likely to occur. An airliner would use VMO as its limit, whereas a small single engine aircraft would typically refer to VNE.

VMCA

The minimum speed for multi-engine aircraft at which directional control can be maintained with one engine failed with the live engine at full power and 5 degrees of bank towards the live engine.

For multi engine aircraft, an engine failure will cause a strong yawing motion, as the total thrust will no longer be symmetrical.
To counteract this yaw, the rudder is used to keep the aircraft flying straight ahead.

As the rudder is a control surface, it requires an airflow over it to be effective. With full power on the live engine, the rudder needs a certain amount of airflow over it to provide enough power to keep the aircraft straight.

The minimum airspeed at which the rudder has sufficient power is called the minimum airborne control speed (VMCA).

If the speed was allowed to drop below this minimum, the rudder would not have enough aerodynamic force to counter the asymmetrical thrust, and the pilot would begin to lose control. This is a very important limitation for handling an engine failure, so VMCA is marked on most airspeed indicators with a blue line.

If airspeed drops below VMCA, the recovery is slightly counter intuitive. In most cases you would increase thrust to increase airspeed, but as we are below VMCA, the thrust is causing a control problem, so unlike other cases, thrust should be slightly reduced and the nose lowered to regain airspeed. Speed is to be prioritised, so if at your current weight and altitude you are finding speed impossible to maintain, begin a descent to stay above the blue line. Making a small bank of 5 degrees towards the live engine will also offload some of the demand from the rudder, assisting handling.

Aircraft have a whole range of other limitations, such as maximum altitudes, weight limitations and brake temperatures, to name a few. These are the things that a captain would need to know and would be covered in a type rating course.

AIRPORT FACILITIES

PAPI

Runways come in all shapes and sizes. With some experience, you will become used to judging your approach angle to the runway, based largely on how the runway appears in the window. However, there are many factors that can cause some visual illusions, making it difficult to assess your approach.

A long runway can make you look high, whereas a wide runway can make you appear low. Terrain, runway slope and other features cause these kind of confusions, which is a known problem for pilots.

To make your approaches easier, approach path guidance lights have been developed, which use a colour coded set of lights to easily guide you down the approach. The most common of these is the Precision approach path indicator, or PAPI.

PAPIs normally have 4 lights, set out in a row side by side. The lights are colour coded in the following way:

All White	Too High
3 White	Slightly High
2 Red & 2 White	Correct
3 Red	Slightly Low
4 Red	Too Low

You want to keep 2 reds and 2 whites, all the way down the approach. If you see 3 reds, for example, you are slightly low and need to reduce your rate of descent. PAPIs lose their accuracy just before touchdown, so once reaching roughly 100ft, shift your focus to the aiming point markings on the runway, which we will look at next.

VASIS

Another variation on approach path indicators are Visual Approach Slope Indicator Systems (VASIS). They follow a similar red/white logic as a PAPI, but are configured differently.

VASI systems are arranged into two or three bars of lights. When two bars are installed, you are looking for one bar to be white and the other red, indicating you are on the correct glidepath.

All white or all red have the same too high/too low logic as a PAPI.

When three bars are used, you only use two of the three. Which of the three bars you ignore depends on your aircraft type. Most aircraft will use the lower two bars, disregarding the top bar of lights. If flying a wide body, long haul airliner, the top two bars are utilised, and the bottom bar is disregarded. This would apply if flying a 747, 757, 767, 777, A380 etc.

RUNWAY MARKINGS

Runways have a system of painted markings, which are mostly standardised internationally, for making the runway easy to see and use. Not all runways have a full set of markings, as smaller airfields don't require them, but large airports will typically have a fully lit and marked runway.

The centreline of most runways is marked, making it easier to stay central when taking off and landing, especially in the case of a crosswind, or an engine failure in a multi engine aircraft.

To help you touch down in the correct spot on the runway, there is an aiming point marked out, within a touchdown zone. The zone will be marked by repeating double lines. You should not touchdown and further down the runway than the last of these lines. If it looks like you won't land within the touchdown zone, you should go-around, as otherwise you might not have enough runway to stop. The aiming point is the centre of the touchdown zone and is marked with large, wide markings.

For landing, the aiming point should be kept in a constant position in the cockpit, and is literally aimed at until you start the landing flare.

Runways will have numbers, defined by their magnetic direction. For example, a runway that points directly West, which is 270 degrees, will be numbered runway 27. If an airport has parallel runways, they will also be designated with Left and Right.

The stripes at the ends of the runway, commonly called the piano keys, make the runway ends easier to see and also are an indication of the runway width. A standard 45m wide runway will have 12 piano keys, whereas a 60m wide runway would have 16.

Typically, the whole runway length can be used for taking off, although Depending on what terrain and obstacles are on the approach to a runway, the full length may not be usable for landing. This unused length is called a displaced threshold and is shown by arrows. You can begin your takeoff here, but you must not touch down within this threshold. If the threshold has yellow chevrons, they are not to be used takeoff or landing and are simply there as extra runway for emergencies.

If a runway has a large painted “X”, it is closed and must not be used.

RUNWAY LIGHTING

Runways are of course used night and day, so a system of lighting is usually put in place. The green bar shows the beginning of the runway, the red shows the end. As you near the end of the runway, the centreline lights will become alternating white and red, showing 900m remain. Towards the very end, the centreline turns all red as you reach the last 300m.

The painted aiming point can’t be seen at night, so this too has a lighting system on large runways. Many rows of light bars stretch from the runway start until up to 900m down the runway. This indicates the touchdown zone, as we discussed earlier, with the aiming point in the middle.

Only the largest runways have the full system of lighting and marking, and there are many variations, but now you know the basics and can apply this knowledge when needed.

TAXIWAY MARKINGS

Large airports can be a maze of taxiways and aprons. Finding your way can be easier said than done. A system of taxiway lights and markings has been developed to help guide you.

The most basic taxiway marking is its centreline. Painted yellow to differentiate itself from runway markings, a taxiway is marked by its centreline. By keeping the aircraft on the centreline, you can be sure that you will be clear of buildings and obstacles and that the surface is strong enough to support your aircraft.

At night, major taxiways have a centreline lit with green lights, with the edges often lit blue. Taxiways are named by letters of the alphabet. They are intended to follow a logical pattern, such as Taxiway A (Alpha) being the first taxiway onto a runway, followed by B (Bravo) and so on. However, at older airfields this pattern can be disrupted, as years of re-organising and building of new aprons and terminals begin to increase the complexity of the taxiway system. Careful navigation is needed to avoid wrong turns, which at a busy international airport can quickly cause massive disruption.

You can easily determine which taxiway you are on by the signage. A black sign with yellow letters tell you which taxiway you are on right now. Remember: Black Square, You're There.

The opposite of this, a Yellow sign with black lettering, show upcoming taxiways. An arrow is often included at busy intersections to aid orientation.

Many taxiways will have restrictions, such as a maximum wingspan. A wingspan restriction allows you to be confident that while using that taxiway your wings will not strike other aircraft or hazards. Such restrictions will be written in the airport charts for that airfield, with the most significant restrictions often painted on the ground itself.

To help indicate when you are entering a runway and to assist ATC with sequencing the flow of traffic, many taxiways have holding points. These take two forms:

Type A

These holding points are important to spot, as they indicate the last holding point before entering a runway. These should never be crossed without clearance from ATC. Type A holds are directional and can be crossed freely from one direction but must not be crossed without clearance from the other direction. These are usually arranged so that you must await clearance before entering a runway, but you may cross them freely when vacating a runway, to help keep the runway clear.

Type B

These are intermediate holding points and can be used by ATC to help sequence aircraft into the optimal order for takeoff. These holding positions can be crossed unless told otherwise and can be crossed in either direction.

Holding positions are named to match the taxiway on which they are located. For example, taxiway A may have holding positions named A1 or A2.

At airports with the capability for Low Visibility Procedures (LVPs) there will usually be a red stop bar that spans across the holding point, acting in the same way as a red traffic light on the road. Even with ATC clearance, a red stop bar must not be crossed until it is switched off to indicate you may proceed.

An airport can appear as a confusing web of aprons, taxiways, holding points and runways, but there is method in the madness. These markings and lighting are standardised across the globe, with only occasional variations. For example, some runways in Scandinavia have yellow markings, to make them more easily visible in snowy conditions, which occur regularly. Many runways in the UK have a slightly different touchdown zone marking, again to aid visibility, helping it to stand out on a heavily used runway with thick rubber deposits.

APPROACH LIGHTING

As with runways and taxiways, providing lighting to the approach path will greatly improve visibility and allow far easier visual guidance towards a safe and accurate landing.

Often influenced by the local terrain and landing capabilities available, approach lights take many forms. although they are largely standardised, a great variation of lighting patterns can be found worldwide. Approach lighting is there to help you visually acquire the runway and its surroundings. This is most apparent at night, where they provide great assistance with judging distance to go, approach slope and even offers an equivalent horizon to aid keeping wings level. In addition to night lighting, approach lights come into their own in low visibility, where thick fog can mean the runway would otherwise not be sighted until just a second or two before touchdown. This would not give enough time for the captain to successfully verify that the approach has correctly led the aircraft to the landing zone.

To give the pilot much more time, approach lights stretch out from the runway and will be the very first indication that the pilot can receive to judge the progress of their approach. Having this increased safety margin allows for landings in thicker fog than would otherwise be possible.

ALTIMETRY

Indicated Altitude & QNH

The air pressure is reported in a METAR as it gives indications of many factors. Knowing the local air pressure at your departure and destination is important, as it is used to define your altitude above sea level. To explain this, we will briefly discuss how an altimeter functions.

An altimeter works much like a pressure gauge that indicates in reverse. It contains a sealed chamber, which maintains a constant pressure. As an aircraft climbs, the air pressure outside reduces, causing the chamber to expand. The higher you fly, the lower the air pressure and the more the chamber expands. The exact expansion of the sealed chamber is precisely calibrated, allowing the expansion to drive a needle, accurately indicating aircraft altitude.

There is an important distinction to be made between height and altitude. Height is the distance above the ground below, whereas altitude is the distance above the worldwide average (mean) sea level, MSL.

It would be difficult to use height above ground level (AGL) as a reference for aircraft, as the elevation of the terrain below changes massively from place to place. To fly a constant height above ever-changing terrain would mean continually climbing and diving to keep the ground at a fixed distance as you traverse valleys and mountain ranges, which is clearly not ideal. Using an airfield elevation as your reference is not much use either, as airports can be located at very different elevations. Anything from sea level (or even slightly below MSL in the case of Amsterdam) to thousands of feet up a mountain range is possible. Also, another aircraft would be using another airfield as their reference, giving very inconsistent results.

The mean sea level is a good reference for aircraft as it provides a reliable and consistent datum around the world. Therefore all aircraft can use MSL as their altitude reference, allowing far greater consistency and safety.

So, while the sea level remains constant, what does change from day to day is the air pressure. As an altimeter is a pressure gauge that indicates in reverse, if the pressure drops overnight, the altimeter would show an increase in altitude, even while the aeroplane is parked in the hangar. To compensate for these changes, the local air pressure is reported on METARs, in units of hectopascals (hPa) or inches of mercury (in Hg) and is known as the QNH.

The QNH is dialled into the altimeter before takeoff or landing and will correct for any localised variations in pressure. Each 1hPa of pressure equates to around 30ft. When QNH is set correctly, the altimeter will display altitude Above Mean Sea Level (AMSL). This means that when on the ground, rather than indicating zero feet, the altimeter will display the aerodrome elevation. If you wind the setting so that zero feet is displayed, you are now indicating your height Above Airfield Level (AAL). The pressure setting required to indicate zero is known as the QFE, but this is rarely used and generally not included in weather reports.

In the USA, the convention is to use units of Inches of Mercury, which is reported as A2992 to represent 29.92 inches, the standard setting and is equivalent to the standard QNH of 1013 hPa. Most altimeters allow use of either unit.

Radio Altimeter

When closer to the ground, most larger aircraft have a separate method for measuring the current height over the ground (AGL). This is done with the use of a Radio Altimeter or RADALT. This system sends a radio beam directly downwards from the aircraft and measures how long it takes to be reflected back. As the radio beam travels at the constant speed of light, by measuring the round-trip time the RADALT computer can very accurately determine the aircraft's height over the ground at that moment.

Only effective at relatively short ranges, a RADALT can provide a very clear and accurate height up to roughly 2500ft, where most systems will automatically remove the needle or display from view.

These systems are most effective for the late stages of landing, where completing a landing in marginal weather requires the most exacting figures available.

Flight Levels

We have discussed altitudes based on height above ground (AGL) and height above sea level (AMSL). Using these as a reference for measuring altitude works very well at lower levels and for short range flights. Problems can begin to appear however when longer distance travel is desired. If using the local QNH to give Altitude AMSL, your altimeter will only read correctly if you stay nearby to the airport the QNH is based on or if you continually obtain and set each local QNH as you pass by. This would be quite tedious, time consuming and open to error.
A factor to also account for is that other aircraft flying from other places will have other QNH settings dialled in. We can see a mess beginning to emerge, especially in today's busy skies.
A solution is needed and it comes in the form of Flight Levels.
A Flight Level is an altitude based on an internationally standardised QNH of 1013. It is agreed that all aircraft flying at or above a certain altitude will use Flight Levels as this ensures that all aircraft enroute throughout the globe are all using the same QNH setting of 1013, thereby ensuring safe clearance between aeroplanes.

The altitude at which you transition to using Flight Levels is called the Transition Altitude (TA) and this varies from airport to airport, depending on local airspace and topography.
The minimum available Flight Level is called the Transition Level (TL). The gap between these two is referred to as the Transition Layer.

To clearly distinguish between an Altitude and a Flight Level, there is a difference in terminology and presentation. A Flight Level is presented with a preceding “FL” and three figures for that altitude in hundreds.

For example; 15,000ft is equivalent to FL150.
To set a Flight Level, you simply set the QNH on your altimeter to 1013. Some aircraft have an ability to easily toggle between the local QNH and 1013 which is often labelled “Standard” or “STD”.

METAR REPORTS

Rain or shine, a pilot needs to know the weather of the departure airfield, enroute and at the destination. The exact details of temperature, cloud base, wind speeds etc need to be communicated quickly and clearly in a standardised way. This is done by the use of METARs and TAFs.

The definition of METAR varies slightly between countries, but is generally referring to a Meteorological aerodrome report. A METAR provides a snapshot of the current weather at an airport and is published at regular intervals, generally hourly. They are generated either manually or automatically, depending on the equipment in use at a particular airfield. Automatically compiled METARs begin with “AUTO”.

It is within a METAR that the detailed weather information can be found. Information contained within the message can include:

- Airport
- Date and Time
- Wind direction and speed
- Visibility
- Temperature and dew point
- Cloud type and height
- Precipitation type and intensity
- Air pressure
- Trend of weather changes

That is a lot of information to communicate. Looking at an example METAR will show us how we get so many details into a short message.

EGCC 300520Z AUTO 19004KT 150V230 9999 FEW040CB -SHRA 12/11 Q1001 NOSIG

To understand what information we are seeing, we can break this message down into its components, which we'll run through one by one.

Airport Code

EGCC
ICAO airport code for Manchester, UK.

IATA Codes

Each airport has its name converted into two types of code. IATA and ICAO. IATA is a 3-letter code that many frequent fliers will already be accustomed to.

Here are some well-known examples:

LAX	Los Angles
LHR	London Heathrow
JFK	New York John F. Kennedy
SFO	San Francisco

ICAO Codes

Less familiar to the travelling public, ICAO codes are the type used almost exclusively by pilots and ATC.
As a 4-letter code, it contains information about the airport location. The first 1-2 letters help to locate the airfield. Conventions vary by location, but in Europe the airports are divided by upper (E) and lower (L) areas within Europe, followed by the country. The remainder of the code defines the individual airport, occasionally using letters from the airport name, but usually are simply allocated.

A few examples will show the most common conventions:

LFPG	Lower Europe, France, Paris Charles de Gaulle
EGPH	Upper Europe, Great Britain, Edinburgh.
NZHN	New Zealand, Hamilton
EHAM	Upper Europe, Holland (The Netherlands), Amsterdam.

Date & Time

300520Z

Day of the month (30) and the time in UTC (0520Z).

A METAR is published typically every hour or half hour, giving regular updates to provide a snapshot of the current weather conditions.

UTC Time

As the earth is a rotating sphere, local time of day at the same instant varies around the globe. To manage this, the earth is generally divided into 25 time zones, named A-Z (Skipping J). Each zone represents an hour difference from UTC (Universal Coordinated Time).

For example, GMT +1 is time zone A, GMT +2 is B, etc. GMT itself is time zone Z or "Zulu" in the phonetic alphabet, giving rise to the convention of Zulu Time or UTC.

J was not used to avoid confusion with letter I, as this was the convention around the 1800s when this system was devised. Occasionally J is used to represent the observer's own local time, but this is almost always represented as L for Local.

Previously referred to as Greenwich Mean Time (GMT), Universal Co-ordinated Time (UTC) is used throughout the world to avoid confusion and is in regular use in aviation.

Observation Type

AUTO

AUTO indicates that this METAR has been compiled automatically by software, as opposed to by a human observer.

Wind Direction & Speed

19004KT

This represents the average (mean) wind direction in degrees true (190) and wind speed in knots (04).

Wind direction is rounded to the nearest 10 degrees and indicates to the pilot which direction the wind is coming from. In our case, it is blowing from 190 degrees, which is roughly from the south.

As runways are numbered in degrees magnetic, while METARs give wind in degrees true, care should be taken when working out if you are to expect a headwind or tailwind, or if the crosswind is within your aircraft's limits.

Some airports can be highly disrupted by even moderate winds if they are coming from an inconvenient direction. For example, if an airfield only allows landings in one direction, possibly due to terrain, a tailwind can easily prevent landing. As the commander, you would need to be very aware of this possibility, as it may increase the chance of a diversion dramatically, which needs careful planning.

In other cases, terrain or buildings may cause turbulence when landing, if the wind has to pass by those obstacles before reaching the runway. An example of this could be the hangars just to the south of London Gatwick 26L, where a relatively moderate wind speed, as little as 10-15 knots, can cause considerable turbulence and rolling to an airliner just moments before touchdown. Look upwind to see if any obstacles are near the runway, as this can help you predict these disturbances.

Wind speed in aviation is almost always measured in knots (KTS) meaning nautical miles per hour. Some reports may use Meters per Seconds (MPS), which can be roughly converted into Knots by doubling the figure.
For example, 10 MPS = Approx. 20 KTS.

Degrees True vs Magnetic

To understand what is meant by degrees True, we need to take a quick look at how positions on the earth are described. A location can be described by coordinates, which give a position on the globe as a Latitude and Longitude. Lines of longitude run north south between the poles. This 'Geographic' North pole is different to the Magnetic North pole, which moves from year to year and is where a magnetic compass would lead you to. given in degrees true, meaning degrees from a North which is aligned with the earth's lines of Longitude. The difference between True North and Magnetic North is known as Magnetic Variation. This variation changes from year to year and place to place and can be quite considerable. In the UK, variation is as little as about 2 degrees, whereas in New Zealand it can be as high as 20 degrees.

150V230

Wind direction and speed are not always smooth and constant. Wind direction can vary minute by minute and strong gusts can come and go by the second. This presents increased difficulty in aircraft handling and so are reported. To show that the direction is variable, a V or VRB is used. A V is surrounded by the extremes in direction. So 150V230, as in our example, represents a variable wind between directions of 150 and 230 degrees true.

Often very light winds are described as VRB as they are not strong enough to determine their direction. Speed is reported as an average over a short period, usually the last few minutes.

Gusty conditions can make handling more difficult, as your airspeed, vertical speed and sideways drift can all vary second by second. To indicate the presence and severity of gusts, G can be included in the wind speed.
For example, if the wind was from the south at 15 knots gusting up to 25 knots it could be represented as 18015G25.

Visibility

9999

These numbers represent the visibility from the airport in metres. A figure of 5000 would represent 5km visibility. In clear conditions, of visibility of over 10km, the numbers 9999 are used, sometimes referred to by pilots as “all the nines”.

With relatively good visibility, distances can be estimated by an observer, such as reporting the distance to the furthest visible object.

Visibility can be reduced by many factors, such as rain, mist or smoke. When the visibility is reduced, the cause is often included. For example, if visibility is 5km on a hazy day, this might be reported as 5000 HZ.

Visibility can occasionally be very different in one particular direction. This is reported in the METAR as the visibility in metres followed by the direction, such as “3500NW” representing 3500m to the North West.

Here are some of the causes of reduced visibility, their associated METAR code and what the implications can be.

Mist **BR**

Visibility below 5km. Visibility somewhat reduced. Usually unable to depart for a VFR flight as 5km visibility is usually required for VFR. IFR flights generally unaffected.

Fog **FG**

Visibility Below 1000m. Greatly impaired visibility. Extra caution and reduced speeds when taxiing. Traffic flow restricted, causing holding and delays. Tends to form or worsen in the early hours, as the rising sun causes heating and mixing. Often dissipates to reveal a clear day, but can linger for many hours, not helped by the characteristically low wind speeds that accompany fog.

Smoke FU

From the French "Fumer", smoke can cause localised reductions in visibility. Ingested smoke can enter the aircraft cabin via vents or air conditioning, potentially causing alarm amongst passengers or triggering smoke warnings from the aircraft systems. Thick smoke is usually highly visible and avoidable in the daytime, but can be unexpected and invisible at night. Blows downwind and can change direction repeatedly. Usually very localised and of short duration.

Volcanic Ash VA

A very serious threat. Ash will clog ports and engine intakes, while causing serious abrasion on the paint and windscreens. A jet aircraft can experience loss of thrust or failure of all engines.

Abrasion and clogging are likely to persist, but a jet engine can recover. The ash comes into contact with the red-hot turbine blades at the rear of the engine, effectively being heated and turned into a glass-like material. These deposits can significantly affect airflow and ruin engine performance. Once cooled, this material has been known to break away and clear, so attempts to restart should continue for as long as possible.

Ash deposits can also fall to the ground and fill the runways and taxiways, closing an airport and taking many hours or days to clear.

Sand SA

Masses of airborne sand can cause very severe reductions in visibility and will easily close an airport. In a similar manner to VA, Sand can clog vents, intakes and ports. Use reduced engine power when taxiing and be considerate as to where your thrust will blow the sand.

While the visibility is reduced due to some phenomena such as Smoke or Fog, there is often good reason to include a little extra data to describe how it is distributed at the airfield. Here are some of the codes you may come across:

Partial	PR
Patches	BC
Shallow	MI
Drifting	DR
Blowing	BL

Cloud

FEW040CB

The density, height and type of cloud is an important factor when considering airfield weather. Density is conventionally described in units called Octas, which generally represent how much of the sky is obscured. Obscuration is rated as a number out of 8 Octas, described in a METAR with the following system:

1-2	Few	FEW
3-4	Scattered	SCT
5-7	Broken	BKN
8	Overcast	OVC

The height of the cloud bottoms is given in hundreds of feet above the airport elevation. Our example gives 040, meaning a height of 4000ft. The height of the cloud is measured as height above the airfield, as opposed to altitude. So if an airport has an elevation above sea level of 500ft, a reported BKN020 will be encountered at 2500ft indicated altitude.

NCD If the skies appear to be clear to an automatic observing system, NCD (No Cloud Detected) may be included in an AUTO METAR.

Some scattered clouds at 3000ft are unlikely to cause much distress. Conversely, a storm cloud can cause great challenges. Significant cloud is reported as such using the following coding.

Towering Cumulus TCU

A cumulous cloud with great vertical development. Strong air currents are contained within but tend to affect only at very short range. Can be avoided at close distances. Less severe than a CB, but still attempt to avoid. Can cause delays if found on the approach path.

Cumulonimbus CB

A more developed cloud, posing a serious threat to anyone straying too close. A CB contains far harsher conditions than a TCU, and are usually far larger. Air currents are fierce and further reaching, so a wider margin is needed for avoidance. If approaching an airfield with a CB nearby, proceed with great caution and be prepared for windshear.

CAVOK

Stands for Cloud and Visibility OK. This does not necessarily mean clear skies, as it is used if the following conditions are met:

- Visibility 10km or more
- No cloud below 5000ft or the MSA
- No CB or TCU at any height
- No precipitation

Precipitation

-SHRA

Next in our METAR code we'll find any significant conditions, such as precipitation. Its type, frequency and intensity are all coded with a simple system.

Many variations of precipitation can be found all around the world. From hail stones to drizzle, a code is in place to identify the prevailing conditions.

When it comes to rain, everyday experience reminds us that it can take various forms. A shower (SH) means the rain passes quickly, usually followed by more shortly after. Drizzle (DZ) on the other hand can linger for what seems like hours or even days.

The frequency is implied by the type of precipitation. Rain (RA) may be long lasting but Rain Showers (SHRA) may be short lived.

The intensity is assumed to be moderate unless accompanied by - (Light) or + (Heavy). Heavy precipitation of any kind will be worth your attention.

Here is a selection of some of the most common forms that precipitation and weather conditions can take and what it means to you as a pilot.

Showers SH
Can be heavy, but temporary. Usually more showers are coming but are small and seen easily, making them easier to avoid. Look upwind to see what is coming.

Drizzle DZ
Rarely heavy, fine rain droplets reduce visibility and is unlikely to cease in the immediate future. Can thoroughly drench grass runways and painted markings, making them very slippery. Usually widespread.

Hail GR
Hail stones can cause significant damage, as passing through them at speed can severely harm propellers, nose cones and windscreens. Often of short duration and located nearby or within Cumulonimbus (CB) Cloud. To be avoided when at all possible.

Freezing Rain FZRA
Rain that freezes to your aircraft on contact, building up rapidly and dangerously. Can clog intakes, disrupt wing airflow and increase aircraft weight at dramatic speed. A rare but severe occurrence.

Heavy Rain +RA
Larger rain droplets in vast quantities. Causes such a great reduction in visibility that windshield wipers are of little help. Runway may be unable to drain water quicker than it falls so standing water or flooding can appear rapidly. Water ingested into engine may reduce performance or cause failure in extreme cases. Aircraft may lose momentum against the wall of water and have reduced thrust. Usually isolated.

Snow SN
Usually light but in continued cold conditions will build up and has potential for huge disruption. Can take hours to clear runways and taxiways, especially if not forecast.

Slippery on the ground, taxi with care. Can be widespread, with alternate airports filling up with diversions quickly.
Cleared snow will be formed into banks near the taxiway, ensure your wings or engines will clear them. A runway does not always need to be cleared completely, so the visible tarmac may be misleading as to the runways real proportions, causing confusing visual illusions when landing.

If a period of significant weather has ended, but is still worth mentioning, a Recent (RE) code can be incorporated. You may come across codes such as RETS or RERA, indicating that these weather phenomena have ceased, but may have lasting after-effects such as disruption or water patches.

Air Temperature

12/10

The air temperature and dew point are presented together, to give the outside temperature and humidity. Measured in Centigrade, the temperature can have profound effects on the aircraft performance and operation. On hot days with strong sunshine, dark surfaces such as roads and car parks will heat up quickly and will conduct much of that heat into the air directly above, causing an updraft of warm rising air. These narrow columns are called thermals and can be quite destabilising on the approach and landing.

When entering the thermal, the aircraft be carried upwards with the rising air, putting you slightly high and suggesting reduced thrust to descend. Shortly after, when leaving the thermal, you will begin to fall back down as you lose your updraft. As you may have reduced power to regain the glidepath, you will find yourself pulling the nose up to arrest your sink rate and require a boost of thrust to maintain speed. This process may repeat itself several times on a single approach and makes a stable approach more difficult to achieve.

The first figure is the temperature, followed by the dew point. The dew point is a useful figure to consider, as it represents the temperature at which the air will reach 100% humidity. When such a condition exists, the air cannot carry any extra moisture, causing mist or fog.

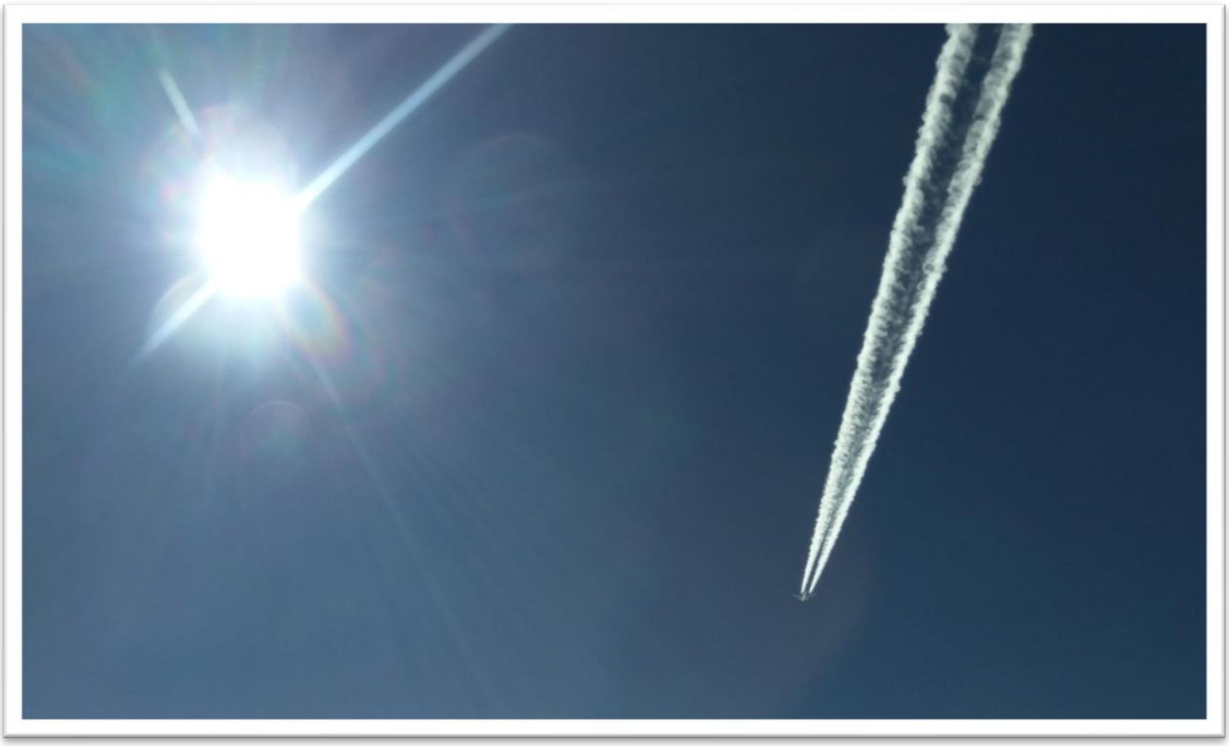
On hot days, aircraft tend to have decreased performance, as the warm air is less dense, reducing engine power output. This also occurs in humid conditions, which can be deciphered in a METAR message as the relationship between the temperature and dew point. For instance, if 10/10 is reported, the air is fully saturated, indicating high humidity, the possibility of fog and reduced performance.

Air Pressure

Q1020

The local reported QNH is listed with 4 digits and a leading Q. An Altimeter setting, as used in the USA, has a leading A. EG A2992 signifies 29.92 InHg.

Refer to the section on Altimetry for more information about QNH and altimeters.



Trend

NOSIG

If No Significant change in weather for the next 2 hours is forecast, the code NOSIG may be included at the end of the METAR. If there are changes on the way, there are the following codes to indicate this to the pilot.

Becoming **BECMG**

This code is used for a relatively long-term trend in the weather, generally lasting no more than 2 hours, but can on occasion apply up to 4 hours.

Temporary **TEMPO**

For a more fleeting change, TEMPO is used, indicating a short-term variation in the prevailing conditions, but only for short periods of up to 1 hour.

When more detail is known about the weather in question, more information can be included, such as the times from (FM) or time until (TL) the change will be commencing and ceasing.

TAF REPORTS

A METAR message shows a current snapshot of the conditions at an airfield. But this only reveals part of the story. A forecast is needed to build a more complete picture. In aviation, this is achieved through Terminal Aerodrome Forecasts, known as TAFs.

The coding is very similar to a METAR, but offers a little less detail in exchange for a far wider time range. Here is an example:

TAF LFRB 261100Z
2612/2712 20004KT 9999 SCT030 TX25/2615Z TN14/2706Z
PROB30
TEMPO 2703/2708 0600 FG

We can already find many of the coding conventions already discussed, but we see a slightly different layout for a TAF. We'll decode this TAF and discover the useful information contained within.

Airport Code *LFRB*
A forecast is identified as such by beginning with TAF and the aerodrome to which it applies. In this case, Brest in Northern France (LFRB).

Date & Time *261100Z*
Our example was published on the 26th day of the month at 1100Z.

A forecast is published at intervals which are determined in accordance with its validity period. A TAF that forecasts a period between of 12 hours or less (to a minimum of 6 hours) will be published every 3 hours. Whereas a TAF with a longer validity period, up to 30 hours, will be published every 6 hours.

Weather *20004KT 9999 SCT030*
As with our METAR, we can decode this as a wind of 200/4, visibility of 10KM or more and Scattered clouds at 3000ft AAL.

Forecast Period

2612/2712

A forecast is designed to cover a specified period of time. This XXXX/XXXX format includes the beginning (26th Day at 1200Z) and the end of this period (27th Day at 1200Z), separated by a "/".

Temperature Range

TX25/2615Z TN14/2706Z

A system unique to a TAF message is the maximum and minimum temperatures for a period.

Here we see that the highest temperature (TX) of 25C will be reached at 1500Z on the 26th, followed by the lowest temperature (TN) of 14C the following day at 0600Z.

This can be a useful early indication of temperature extremes in summer and winter, where very high or very low temperatures require special handling and care.

Probability

PROB30

Accurately forecasting the weather for a particular location can be a massive undertaking. With the use of highly sophisticated weather theories and running computer algorithms, we can obtain a very good indication of the likely conditions to come. However, in the real world, things don't always go as expected. There is still an element of guesswork and estimation, with even a tiny misforecast in wind speed, temperature or any number of variables giving rise to a very different result. To help cope with such circumstances, a PROB code can be used to indicate the Probability that a particular set of conditions will occur.

Usually published as either PROB30 or PROB40, this code gives an indication of the probability percentage for a particular condition. In our Brest TAF we see that there is a 30% chance of the following TEMPO condition occurring.

Temporary Conditions

TEMPO 2703/2708 0600 FG

Rated as a 30% chance by the preceding PROB30, This TEMPO indicates that for a time of less than an hour the visibility is forecast to be 600m in Fog.

Weather Report Examples

KJFK 161751Z 33009KT 10SM FEW050 26/06 A3025
New York JFK, 26th day at 1751Z, Wind 330/9 knots, 10 Statute Miles visibility (USA often uses Miles rather than KM) Few clouds at 5000ft, temperature 26C dew point 6C, indicating low humidity. Altimeter setting 30.25 in Hg.

NZSP 030912Z 12010KT 4800 IC BR FEW120 M70/ A2767
The South Pole, 3rd day at 0912Z. Wind 120/10 knots, visibility 4800m with Ice Crystals and Mist. Few clouds at 12000 feet, temperature Minus 70C, dew point not reported. Altimeter 27.67 in Hg.

GCXO 021800 30009KT 4500 2000NW PRFG FEW000 SCT007 19/18 Q1018 NOSIG
Tenerife North, 2nd day at 1800Z. Wind 300/9 knots, visibility 4500m except to the North West where it is only 2000m. Partial Fog. Clouds just over the ground, QNH 1018, not expected to change within the next 2hrs.

KLAX 021513Z 0215/0318 VRB03KT P6SM
SCT030
FM022000 26012KT P6SM SKC
Los Angles, 2nd day at 1513Z.
Between 1500Z on the 2nd and 1800Z on the 3rd, wind light and variable. Visibility 6 statute miles. Cloud scattered 3000ft. From 2000Z on the 2nd, wind 260/12, sky clear.

EGLL 081051Z 0812/0818 27014KT 9999
SCT035 PROB40 TEMPO
0812/0814 28018G28KT 7000 RA
London Heathrow, 8th day published at 1051Z. Between 1200-1800Z, westerly wind at 14kts, visibility 10km or more, scattered cloud. 40% chance of temporary gusts up to 28kts between 1200-1400Z with moderate rain and 7km visibility.

OMDB 021343Z 0213/0218 30012KT
PROB30 0223/0301 1500 BR
PROB30 0301/0305 0150 FG VV///
Dubai, 2nd day, published 1343Z.
30% chance of 1500m in mist, possibly worsening at 0100Z to 150m in fog. Vertical visibility not reported.

ABBREVIATIONS

Aviation is absolutely awash with Abbreviated terms. This list will help you navigate a selection of the most common and useful to know abbreviations that will come up from time to time.

AAL	Above Airfield Level
ACARS	Aircraft Communications and Reporting System
ADF	Automatic Direction Finding
ADI	Attitude Direction Indicator
AER	Approach End Runway
ADS	Automatic Dependent Surveillance
AFB	Air Force Base
AFM	Aircraft Flight Manual
AGL	Above Ground Level
AGNIS	Azimuth Guidance Nose in Stand
AIAA	Area of Intense Aerial Activity
ALS	Approach Lighting System
AMM	Aircraft Maintenance Manual
AMSL	Above Mean Sea Level
APU	Auxiliary Power Unit
ASDA	Accelerate Stop Distance Available
ASI	Airspeed indicator
ASU	Air Start Unit
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilots Licence (UK)
ATR	Airline Transport Rating (USA & Canada)
BALS	Basic Approach Light System
BC	Patches
BR	Mist
C/S	Callsign
CAA	Civil Aviation Authority
CAS	Calibrated Airspeed
CAT	Clear Air Turbulence/Category
CAVOK	Cloud and Visibility OK
CB	Cumulonimbus
CDA	Continuous Descent Arrival
CDI	Course Deviation Indicator
CDL	Configuration Deviation List

CG	Centre of Gravity
CGL	Circling Guidance Lights
CLL	Centreline Lights
CPDLC	Controller-Pilot Datalink Communications
CPL	Commercial Pilots Licence
CRM	Crew Resource Management
CTR	Control Zone
CVR	Cockpit Voice Recorder
CWY	Clearway
DA	Decision Altitude
DCL	Departure Clearance
DER	Departure End of Runway
DFDR	Digital Flight Data Recorder
DH	Decision Height
DME	Distance Measuring Equipment
DST	Daylight Savings Time (Summer)
DU	Dust
DZ	Drizzle
EAS	Equivalent Airspeed
EASA	European Aviation Safety Agency
EAT	Expected Approach Time
ECAM	Electronic Centralised Aircraft Monitoring
EFB	Electronic Flight Bag
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indicating and Crew Alerting System
ELT	Emergency Locator Transmitter
EMDB	Embedded
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETOPS	Extended Range Twin Operations
ETP	Equal Time Point
EVS	Enhanced Vision System
EWH	Eye to Wheel Height
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FALS	Full Approach Lighting System
FANS	Future Air Navigation System
FAP	Final Approach Point
FAR	Federal Aviation Regulation
FBL	Feeble/Light
FC	Funnel Cloud/TAF with validity <12hrs

FD	Flight Director
FG	Fog
FL	Flight Level
FMC	Flight Management Computer
FMS	Flight Management System
FT	TAF with validity >12hrs
FU	Smoke
FZ	Freezing
GA	Go-Around/General Aviation
GMT	Greenwich Mean Time
GNSS	Global Navigation Satellite System
GP	Glidepath
GPU	Ground Power Unit
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GR	Hail
GS	Glideslope/Ground Speed
GS	Small Hail
H24	Applies 24hours
HDG	Heading
HG	Mercury
HIALS	High Intensity Approach Light System
HJ	Applies only in Daytime
HN	Applies only at Night
HP/hP	Holding Pattern/Hectopascals
HOT	Holdover Time
HSI	Horizontal Situation Indicator
HUD	Head Up Display
HURCN	Hurricane
HZ	Haze/Hertz
IAF	Initial Approach Fix
IAS	Indicated Airspeed
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IF	Intermediate Fix
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IM	Inner Marker
IMC	Instrument Meteorological Conditions
INOP	Inoperative
INS	Inertial Navigation System
IR	Instrument Rating
IRS	Inertial Reference System
ISA	International Standard Atmosphere

ITCZ	Inter Tropical Convergence Zone
JAA	Joint Aviation Authorities
KM	Kilometres
KT	Knots
LCTR	Locator
LDA	Landing Distance Available
LIAL	Low Intensity Approach Lighting
LMT	Local Mean Time
LNAV	Lateral Navigation
LOC	Localiser
LT	Local Time
LTNG	Lightning
LTS	Lower Than Standard
LVO	Low Visibility Operations
LVP	Low Visibility Procedures
MA	Missed Approach
MAPt	Missed Approach Point
MATZ	Military Air Traffic Zone
mb	Millibar
MBST	Microburst
MCDU	Multifunction Control and Display Unit
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MEA	Minimum Enroute Altitude
MEHT	Minimum Eye Height
MEL	Minimum Equipment List
MMEL	Master MEL
METAR	Meteorological Aerodrome Report
MFA	Minimum Flight Altitude
MGA	Minimum Grid Altitude
MHA	Minimum Holding Altitude
MI	Shallow
MIALS	Medium Intensity Approach Light Sys
MISAP	Missed Approach Procedure
MLW	Maximum Landing Weight
MLS	Microwave Landing System
MNPS	Minimum Navigation Performance Specifications
MOC	Minimum Obstacle Clearance
MORA	Minimum Off Route Altitude
MPS	Meters Per Second
MRA	Minimum Reception Altitude
MROT	Minimum Runway Occupancy Time
MSA	Minimum Safe Altitude

MSL	Mean Sea Level
MTCA	Minimum Terrain Clearance Altitude
MTOW	Maximum Takeoff Weight
MVFR	Marginal VFR
MZFW	Maximum Zero Fuel Weight
NADP	Noise Abatement Departure Procedure
NALS	No Approach Light System
NAVAID	Navigational Aid
NCD	No Cloud Detected
NDB	Non-Directional Beacon
NM	Nautical Mile
NOSIG	No Significant Change
NOTAM	Notice to Airmen
NPA	Non-Precision Approach
NSC	Nil Significant Cloud
NSW	Nil Significant Weather
NTZ	No Transgression Zone
OAT	Outside Air Temperature
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OCNL	Occasional
OEI	One Engine Inoperative
OFP	Operational Flight Plan
OM	Outer Marker
OTS	Other Than Standard
OVC	Overcast
PALS	Precision Approach Lighting System
PANS	Procedures for Air Navigation Services
PAPI	Precision Approach Path Indicator
PAX	Passengers
PBN	Performance Based Navigation
PCL	Pilot Controlled Lighting
PCN	Pavement Classification Number
PDC	Pre-Departure Clearance
PDG	Procedure Design Gradient
PFD	Primary Flight Display
PIC	Pilot in Command
PL	Ice Pellets
PN	Prior Notice Required
PO	Dust/Sand Whirls
POB	Persons on Board
PRFG	Partial Fog
PRNAV	Precision Area Navigation
PROB	Probability

QDM	Magnetic Heading to Station
QDR	Magnetic Bearing from Station
QFE	Air Pressure at Airfield Level
QFU	Magnetic Orientation of Runway
QNH	Air Pressure at Sea Level
QRH	Quick Reference Handbook

RA	Rain
RAIL	Runway Alignment Indicator Lights
RAIM	Receiver Autonomous Integrity Monitoring
RASN	Rain and Snow
RCLL	Runway Centreline Lights
RCLM	Runway Centerline Markings
REDL	Runway Edge Lights
REIL	Runway End Indicator Rights
RENL	Runway End Lights
RET	Rapid Exit Taxiway
RFFS	Rescue and Fire Fighting Services
RIL	Runway Identification Lights
RMI	Remote Magnetic Indicator
RMK	Remark
RNAV	Area Navigation
ROC	Rate of Climb
ROD	Rate of Descent
RSC	Runway Surface Condition
RTIL	Runway Threshold Identification Lights
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minima

SA	Sand
SAR	Search and Rescue
SCT	Scattered
SEV	Severe
SELCAL	Selective Calling
SFC	Surface
SG	Snow Grains
SH	Showers
SI	International System of Units
SID	Standard Instrument Departure
SIGMET	Significant Meteorological Information
SIGWX	Significant Weather
SKC	Sky Clear
SLP	Speed Limiting Point
SM	Statute Miles
SMC	Surface Movement Control
SNOCLO	Airport Closed due to Snow

SQ	Squall
SRA	Surveillance Radar Approach
SS	Sandstorm
STAR	Standard Terminal Arrival Route
SWY	Stop way
TA	Transition Altitude
TAF	Terminal Area Forecast
TAS	True Airspeed
TCAS	Traffic Alert and Collision Avoidance System
TCH	Threshold Crossing Height
TCU	Towering Cumulus
TDO	Tornado
TDZ	Touchdown Zone
TECR	Technical Reason
TEMPO	Temporary
TL	Transition Level
TS	Thunderstorm
U/S	Unserviceable
UAV	Unmanned Aerial Vehicle
UNREL	Unreliable
UTC	Coordinated Universal Time
VA	Volcanic Ash
VASI	Visual Approach Slope Indicator
VC	Vicinity
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VMCA	Minimum Control Speed (Airborne)
VOLMET	Weather reports for aircraft inflight
VOR VHF	Omnidirectional Range
VPT	Visual Manoeuvre with Prescribed Track
VRB	Variable
VV	Vertical Visibility
WEE	Whichever is Earlier
WEL	Whichever is Later
WGS-84	World Geodetic System 1984
WIP	Work in Progress
WKN	Weakening
WS	Windshear
WTH	Wheel to Threshold Height
WX	Weather
WXR	Weather Radar
XPDR	Transponder