FS ACADEMY

IFR

CONTENTS

WELCOME

In FS Academy – IFR, we coach you from the basic techniques of flying purely using the aircraft instruments to performing full IFR procedures including VOR, NDB, ILS Approaches, Holding Patterns and more.

IFR mirrors a real Instrument Rating course and will use all real techniques and procedures to learn how to fly IFR like the pros. You'll begin in the conventionally equipped Cessna 152 before moving forwards to the glass cockpit Cessna 172 and multi-engine Diamond DA62.

The skills you will learn are transferable to practically any aircraft, from a Cessna 152 to a 747 and everything in between.

Each mission has an associated chapter. Progress through this ground school manual to learn the theory behind IFR flight, as the briefing topics cover the details of what you need to know before you take to the skies and practice it for yourself with the help of your instructor.

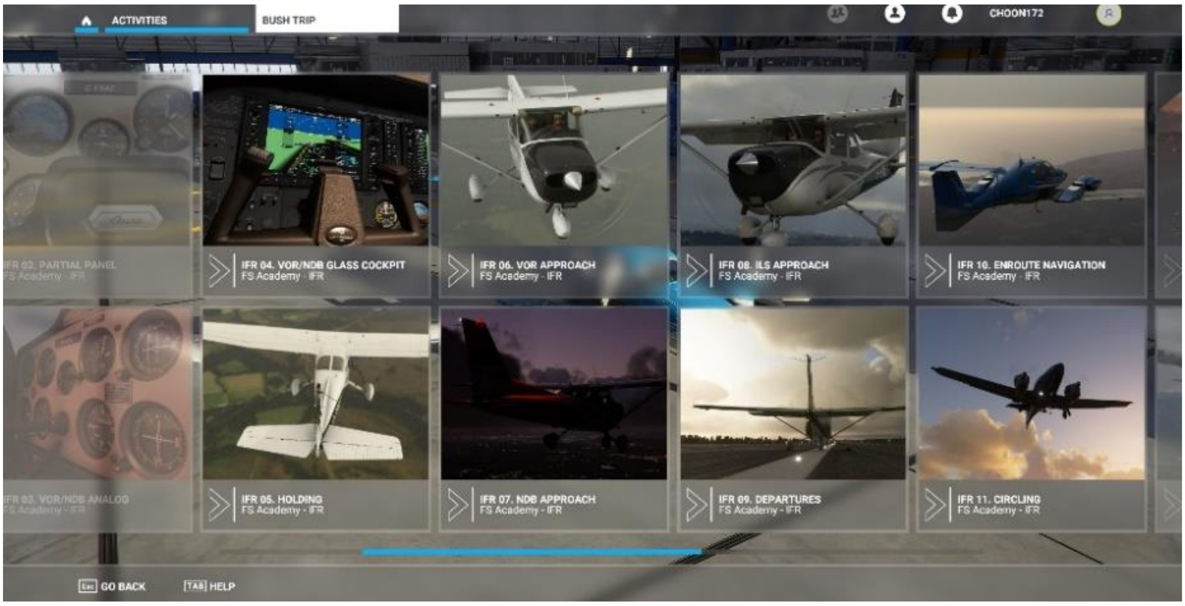
Once you are comfortable with your knowledge and abilities, take the IR Checkride and put your new skills to the test.

FOR THE BEST EXPERIENCE

BUSH TRIPS MENU

At time of development (Late 2020) mission categorisation is limited in its options for organising third-party content.

The missions are currently located under **Activities -> Bush Trips**.



Please disregard the “Legs” and “Duration” stats on the left side of the briefing pages, as they are not applicable to these missions.

AVOID PAUSING

There currently appears to be a glitch regarding the passage of time whilst a flight is paused. This can be observed in a mission by noting the time on your aircraft clock, pausing for an amount of time, then unpausing and seeing that the aircraft clock has continued in the background.

Some mission triggers are location activated, whilst others are time based. If the flight happens to be paused whilst awaiting a time activated trigger, dialog and instructions may be triggered silently in the background whilst the flight is paused, leading to missed instructions on your return.

Until this is addressed by the MSFS developers, **please avoid pausing** during a mission.

Let’s get started…

IFR 01. BASIC IFR

C152
Level Turns
Climb on HDG
Speed Changes
Descending Turns

This lesson is designed to focus on ensuring your basic flying skills are practiced and up to the level needed 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.

INSTRUMENT SCAN

Effective IFR flight requires a disciplined approach to how you look at your instruments for information.

A “Selective Radial Scan” is a common technique and is good to learn and practice.

Use the attitude indicator (AI) as your primary point of focus. Look from the attitude indicator to an instrument, such as the airspeed indicator (ASI), then return to the AI. Then look away from the AI to your next instrument, before returning ‘home’ again to the AI. Continue this flow throughout your flight. With practice you’ll do it without thinking.

WHY FLY IFR?

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 relatively simple. You can depart, fly down the coast, turn overhead your friend's house and stop off somewhere for a snack, all by looking out the window.

An instrument rating might seem niche, until you see the clouds rolling in…

It doesn't take much for the weather to be below limits for visual flying.

A cloudy day can keep you grounded very easily. You either sit on the ground hoping for improvement or, with the right knowledge and skills, you could fly under Instrument Flight Rules (IFR). To fly IFR, you need an Instrument Rating (IR).

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. Cloud is considered as "Cloudbase" when reported as Broken (BKN) or thicker.

EXAMPLE VFR AIRFIELD MINIMA

Cloudbase 1500ft AAL (Above Airfield Level)

Visibility 5KM

Note: The values and units for these parameters vary by location, but are typically very similar globally. New Zealand is the source for these figures.

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 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 an 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. A sensation known as 'The Leans' is where the fluid in our ears initially senses 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 further 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.

These sensations are not usually perceptible when flying a desktop simulation. But the take-away is the same: Trust Your Instruments

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 a 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.

Example: 15nm to landing. 15x3=45. Target altitude 4500ft.

3 DEGREE DESCENT GROUNDSPEED x5

Easily worked out and highly useful, the Groundspeed x5 rule 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 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.

Example: Speed 100kts 100x5= 500fpm.

RATE 1 TURN 10% AIRSPEED +7

All IFR turns are made at rate 1, which is 3 degrees per second. At Rate 1 you will turn 180 in 1min and a 360 in 2mins. By adding 7 to 10% of your airspeed, you roughly work out the bank angle needed to achieve rate 1. You are assisted by the turn co-ordinator, which indicates rate 1 turns when a wing is touching a 'block' on the dial.

Example: Speed 120kts. 12+7= 19 degrees bank.

For larger aircraft, which 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 scenarios you will fly, try to calculate when to turn, but remember that this will be very conservative unless a very large change of direction is required.

Example: Speed 200kts Begin turn with 2nm remaining

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.

Example: Climbing at 700fpm. Begin to lower the nose with 70ft remaining.

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.

IFR 02. PARTIAL PANEL

C152
Compass Turns
DG Failure
Vacuum Failure
Turn Coordinator + VSI

VACUUM SYSTEM

The vacuum system spins the gyroscopes that drive the Attitude indictor and Directional Gyro instruments, your primary attitude and heading indications. If there is a failure with the vacuum system, these instruments lose their drive, the gyros lose speed and begin to 'topple' which is where they are not spinning quickly enough to maintain gyroscopic rigidity.

When such a failure occurs, you need to know how to react in order to continue flying safely. The gyros lose speed progressively and topple slowly. This characteristic can be observed safely after engine shutdown. Sit and watch the attitude indicator for a minute or so after turning the engine off, and watch the attitude topple to the left and show a climb.

Flying in cloud and caught by surprise, the uninitiated may begin a tightening right-hand turn and descent, in an effort to keep the toppling attitude centred. This instrument failure is indicated by a red flag to appear on the affected instruments if a low vacuum condition is detected.

Instead, you are to use the turn coordinator to check for turns and wings level, which is also gyro driven, but is spun with an electric motor, remaining reliable. There is no pitch information on the turn indicator. Use your VSI and Altimeter for vertical guidance.

COMPASS TURNS

Another skill to keep you safe in the event of a vacuum failure is how to turn to a heading with reference to the compass alone.

Due to how the compass is encased and constructed, it is only fully reliable when flying straight and level. As the compass card is 'hanging' within the instrument, if you bank the aircraft whilst turning, the compass will also swing. This swing makes the heading indication through the instrument glass appear to change. The swing is predictable however, so allowances can be made to still operate reliably.

When turning to the East (090) or West (270), the compass performs perfectly and there are no corrections to make. You can simply rollout once you see your desired heading indicated on the compass card.

Turning to the North or South however, the swing error is at its maximum. When turning to South (180) you must wait to see your desired heading appear on the compass, but then continue turning beyond that heading by around 30 degrees. If you want to make a left-hand turn from H270 to H180 for example, you would keep turning until you see 30 degrees BEYOND 180, which would be H150 in this case. Once H150 is shown on the compass, roll wings left and the compass will un-swing and correct itself to your actual HDG of 180.

The opposite effect applies when turning North (360). Turning left from 090 to 360 requires you to stop your turn when reaching 30 degrees BEFORE 360. This would be H030 in this example.

Overshoot South – Undershoot North
"OSUN"

Please note, that OSUN applies to the Northern Hemisphere only. In the Southern Hemisphere you should apply the reverse, ONUS. Overshoot North, Undershoot South.

Speed changes can also cause the compass to swing and display an erroneous HDG. Accelerating causes the compass to swing North, whilst Decelerating causes a swing to the South.

ANDS – Accelerate North, Decelerate South.

Again, in the Southern Hemisphere, the effect is reversed.

Note: You can find the compass attached to the upper section of the windshield. If it appears dark and difficult to read, consider adjusting your monitor and display settings.

IFR 03. VOR/NDB ANALOG

C152
Pushing and Pulling the ADF Needle
Setting the OBS
Tracking to and from a VOR
Setting & Intercepting Radials
Tune, Identify & Display

NDB TRACKING

To determine the bearing you would need to fly in order to go directly to a Non-Directional Beacon, there are a few options. You could simply turn until the Automatic Direction Finding (ADF) needle points straight upwards on the dial, which is the quickest and simplest way. It should be noted that turning to align the needle upwards will only point your nose to the station, called Homing, but this does not account for wind.

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

Disregard the initially rapid needle movements and ensure an accurate and timely turn to your desired outbound HDG. The needle tail will pull to you very shortly after.

If there is any crosswind and you ensure only that the needle remains upright, you will follow a curved path to the station, as you would be continuously pushed off track, realign and repeat, until arriving. Therefore, you should turn to the needle and then apply a wind correction.

WIND CORRECTION

To determine your wind correction, you calculate your drift angle. This is the amount that you heading (direction the nose is pointed) and track (your path over the ground) differs.

At 60kts Groundspeed, your drift angle will match the crosswind.
A 15kt crosswind when travelling at 60 kts GS, will give a 15-degree drift angle. You would therefore fly a HDG of 15 degrees into wind, which would also deflect the ADF needle 15 degrees, to remain on a constant track to a the NDB.

You drift angle is affected by groundspeed. **If you double your GS, you halve the drift angle.**

So, flying at 120kts GS, the same 15kt crosswind would give 7.5 degrees drift, so a 7-8 degree wind correction would be applied.

This drift is always to be accounted for when flying IFR, whether on a SID track, an ILS or tracking to or from an NDB or VOR.

Remember to account for drift angle changes as you fly at different speeds, such as decelerating to land would cause you to turn more into wind to account for the increased drift angle.

VOR TRACKING

To navigate TO a VOR, we turn the OBS 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 OBS dial, we will fly TO the VOR.

For example, if turning the OBS to centre the needle with a TO arrow puts heading 270 at the top of the OBS dial. Flying H270, we will track TO the VOR station.

However, our position changes slightly while we are turning, so as we reach out target HDG towards the VOR, we should then RE-CENTRE the OBS needle to give us an updated course to fly, for best accuracy.

To leave a VOR on a particular radial (180 as an example) 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.

As we reach overhead a VOR, we enter a zone called the “Cone of Confusion”. This is where VOR indications become erratic or misleading when in extreme close proximity to the beacon. We ignore these indications for a short while and simply turn to the desired next radial. The indications will soon return. This phenomenon does not occur with an NDB.

MORSE CODE

Here we provide a table of morse code for your reference when identifying navaids.

Morse code was a very early version of digital communication, where rather than ones and zeros, there are dots and dashes, sometimes referred to as Dits and Dahs.

You will also see the morse code listed underneath a navaid frequency on your chart. Learning morse is not compulsory for IFR flight, but it may ease your workload slightly whilst identifying.

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 . - .	

IFR 04. VOR/NDB G1000

C172 G1000
Glass Cockpit Technology
Displaying BRG Needles
NDB Tracking
VOR Tracking

TRANSITIONING TO GLASS

In this lesson we will progress to more modern avionics equipment, as found in today's training aircraft the world over.

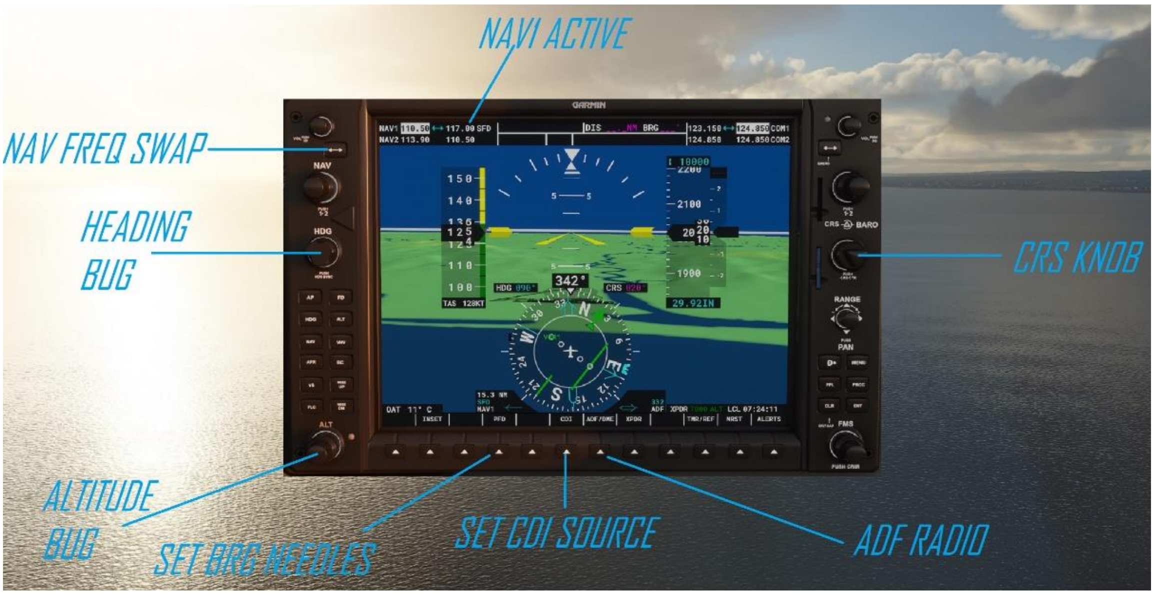
Advancements have been made to make the life of the IFR pilot easier, by combining the multiple dials of the old systems into a single screen, the Primary Flying Display (PFD.)

Set Course: Instead of turning the OBS, you can now set your CRS with the CRS BARO knob, on the right side of the PFD. This will turn the CDI to the course required.

Bearing Needles: To display a VOR or NDB Needle: Click PFD and cycle BRG1 and BRG2 to display the navaid to be used.

Set ADF Frequency: Click ADF/DME and use FMS Knob to set. Press ENT to make active.

Display NAV DME: Click PFD and DME.



IFR 05. HOLDING

C172 G1000
Holding Procedures
Direct Entry
Teardrop Entry
Parallel Entry
Wind Corrections

HOLDING PATTERNS

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.

ATC issue 'Slots' which are assigned take-off times to help to reduce delays inflight. However, delays cannot be avoided completely and there are many reasons why we may encounter delays while already in the air. Also, in order to commence an instrument procedure, you must arrive at the associated beacon already aligned within 30 degrees of the outbound leg. Otherwise, you must perform a hold entry to become properly aligned and then begin the procedure afterwards.

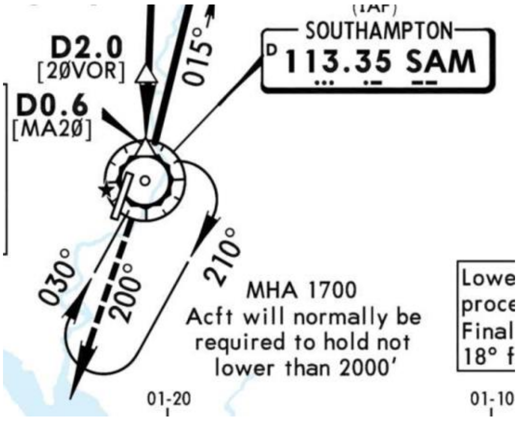
Few concepts cause as much confusion for students undertaking their Instrument Rating as hold entries. But it does not need to be so.

There are a handful of 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 with online resources

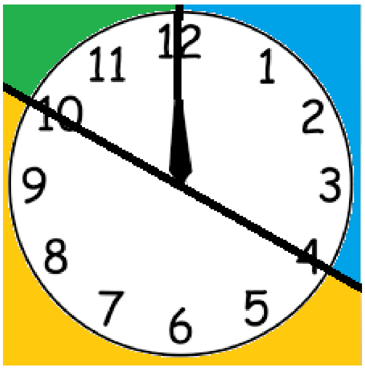
Once you have the hang of it, it can become strangely satisfying to have conquered this essential skill. Holding is a crucial step and needs to be understood before progressing further into the course.

HOLD ENTRY

Holding technique is based upon the direction of the inbound course. Look at the approach chart to find the inbound course. This is from the Southampton VOR 20 Approach, which is used for our holding lesson. In this case, the holding course pointing towards the SAM VOR is 030.



To discover which holding entry is required, try to visualise the hold like this:



Visualise your holding inbound course (030 for our example) is pointing straight upwards, like 12 o'clock on a clock face. Flying towards the holding fix, imagine where on the clock you are approaching from, whether from the bottom (near 6 o'clock), top left (11 o'clock) or top right (2 o'clock).

BOTTOM: If you are arriving FROM a direction of between 10 o'clock and 4 o'clock (the lower and bottom left portion of the clock face) then you are already aligned closely enough to the inbound leg to simply perform a DIRECT ENTRY.

TOP LEFT: If arriving from between 10 o'clock and 12 o'clock (including 12 o'clock itself), perform a TEARDROP ENTRY

TOP RIGHT: From anywhere between 12 o'clock and 4 o'clock, perform a PARALLEL ENTRY.

There are other ways to visualise the hold, such as imagining the holding fix is at the centre of your Horizontal Situation indicator, draw an imaginary line up the inbound course and figuring it out from there. Use whatever techniques work for you. As always with IFR flight, turns are to be made at rate 1.

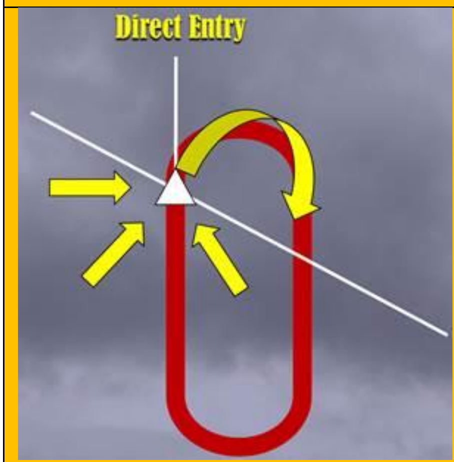
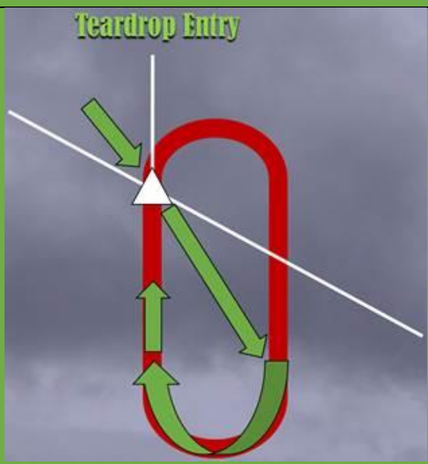
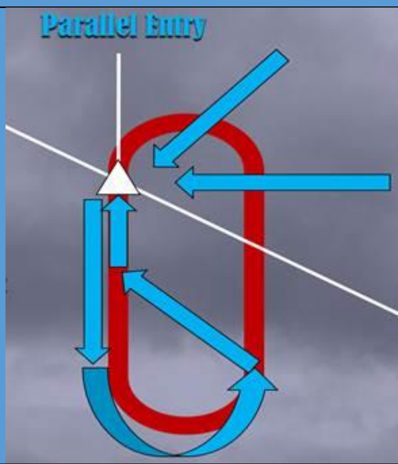
Most holds have right turns. To enter a hold with left hand turns, mirror the clock face.

Once you have decided on which entry you require, perform it as follows:

DIRECT ENTRY: Fly to the beacon and turn in the holding direction and begin holding.

TEARDROP: Leave the beacon on the outbound HDG -30 degrees. In our example the outbound is 210, so 210—30 is 180. We'd fly on H180, for 1 minute. Then turn right onto the inbound leg.

PARALLEL: Leave the beacon and turn in the NON holding direction (left turn for a right-hand hold) and fly the same HDG as the outbound leg (210). Time for 1 minute once wings are level and then make a long turn in the same direction as earlier (Left) to intercept the inbound course. As you flew parallel to the inbound, you will certainly overshoot the inbound course, so just continue your turn and complete your interception from the other side.

DIRECT	TEARDROP	PARALLEL
		
FLY TO BEACON TURN RIGHT ONTO OUTBOUND LEG	FLY TO BEACON FLY OUTBOUND HDG MINUS 30 DEGREES TIME 1 MIN TURN RIGHT ONTO INBOUND LEG	FLY TO BEACON TURN LEFT TO OUTBOUND HDG TIME 1 MIN TURN LEFT TO INTERCEPT INBOUND LEG

IN THE HOLD

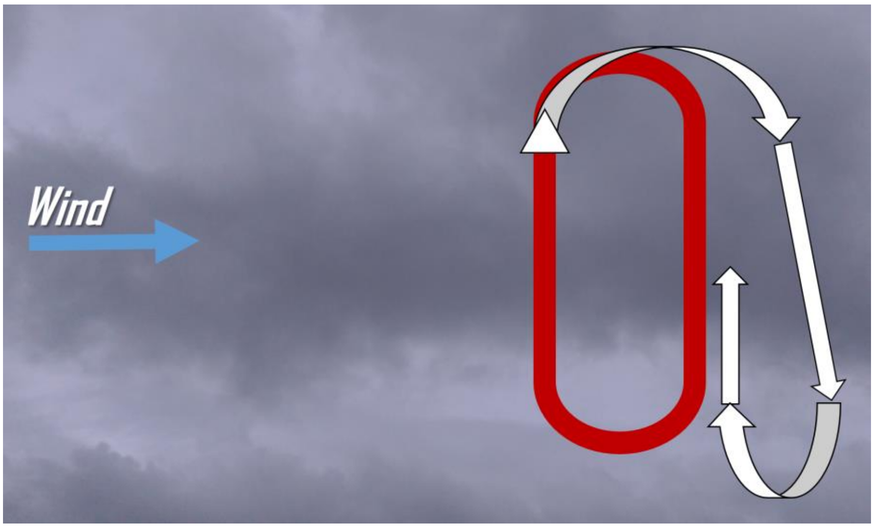
Once you have completed the required holding entry, you can now concentrate on performing an accurate and precise holding pattern.

A hold consists of 4 sections. An inbound leg, an outbound leg and two turns.

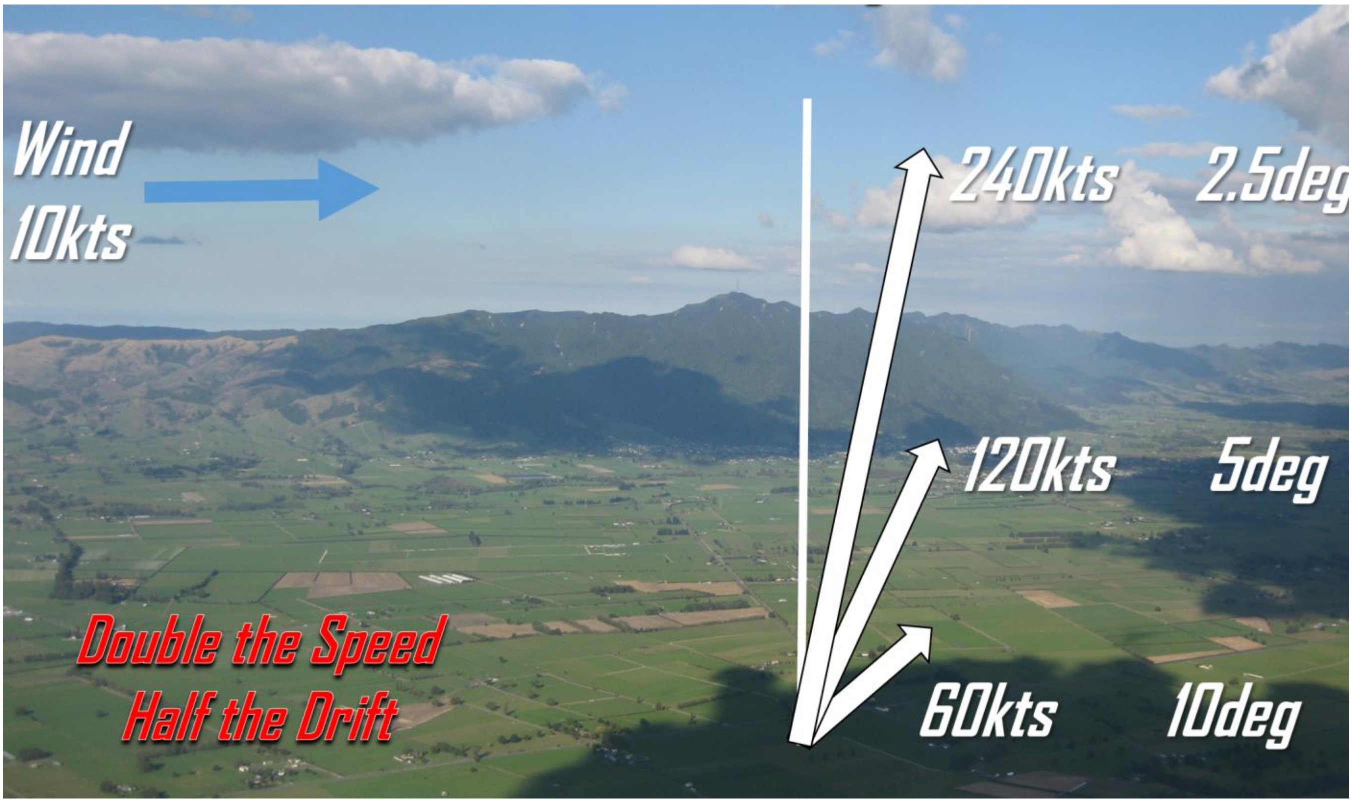
The pattern begins once you pass overhead the holding fix. You then make a 180 turn in the holding direction and roll out on the outbound leg. Once wings level, time for 1 minute, then turn in the same direction to intercept the inbound course, following it to the fix and thus completing one 'lap'.

In still air conditions, this is the basic technique. If a crosswind is present, you must account for wind drift.

HOLD WIND CORRECTIONS

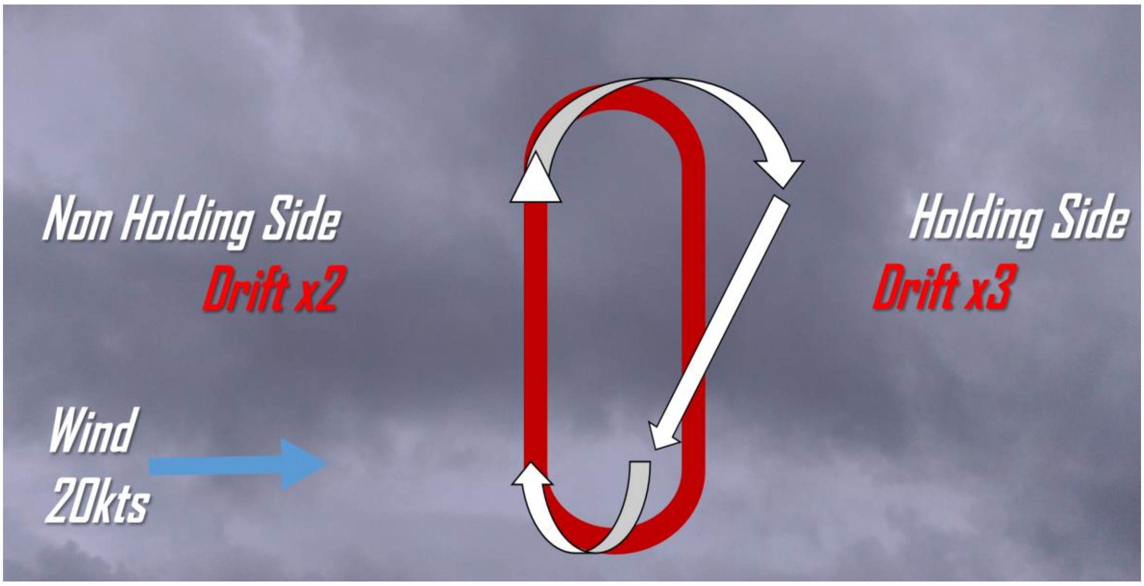


When tracking a course, you fly a heading that accounts for the wind in order to fly the correct track. All directions listed on charts are tracks. A crosswind is considered a 'full' crosswind if it is coming from more than 60 degrees off your nose. E.g. HDG 360, wind from 070 is a 'full' crosswind.



At 60kts and a full crosswind, your drift angle will equal the wind speed. So, with a 20kt wind from your left, you will drift 20 degrees to the right of your HDG. To track 360 would require a HDG of 340.

Increasing speed reduces your drift angle. If you double your speed, you halve the angle. So, the same 20kt wind at 120 knots will make you drift only 10 degrees, requiring a HDG of 350 to track 360.



As both turns are made at rate 1, the only opportunity to make corrections is by adjusting the outbound leg.

Essentially, if the wind is coming from the NON-HOLDING side (the left in our example), apply DOUBLE the drift angle to your outbound leg.

If wind is from the HOLDING side, apply TRIPLE the drift angle.

IFR 06. VOR APPROACH

C172 G1000

Procedure Turns

Non-precision Approach

Minimum Descent Altitude

NON-PRECISION APPROACHES

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

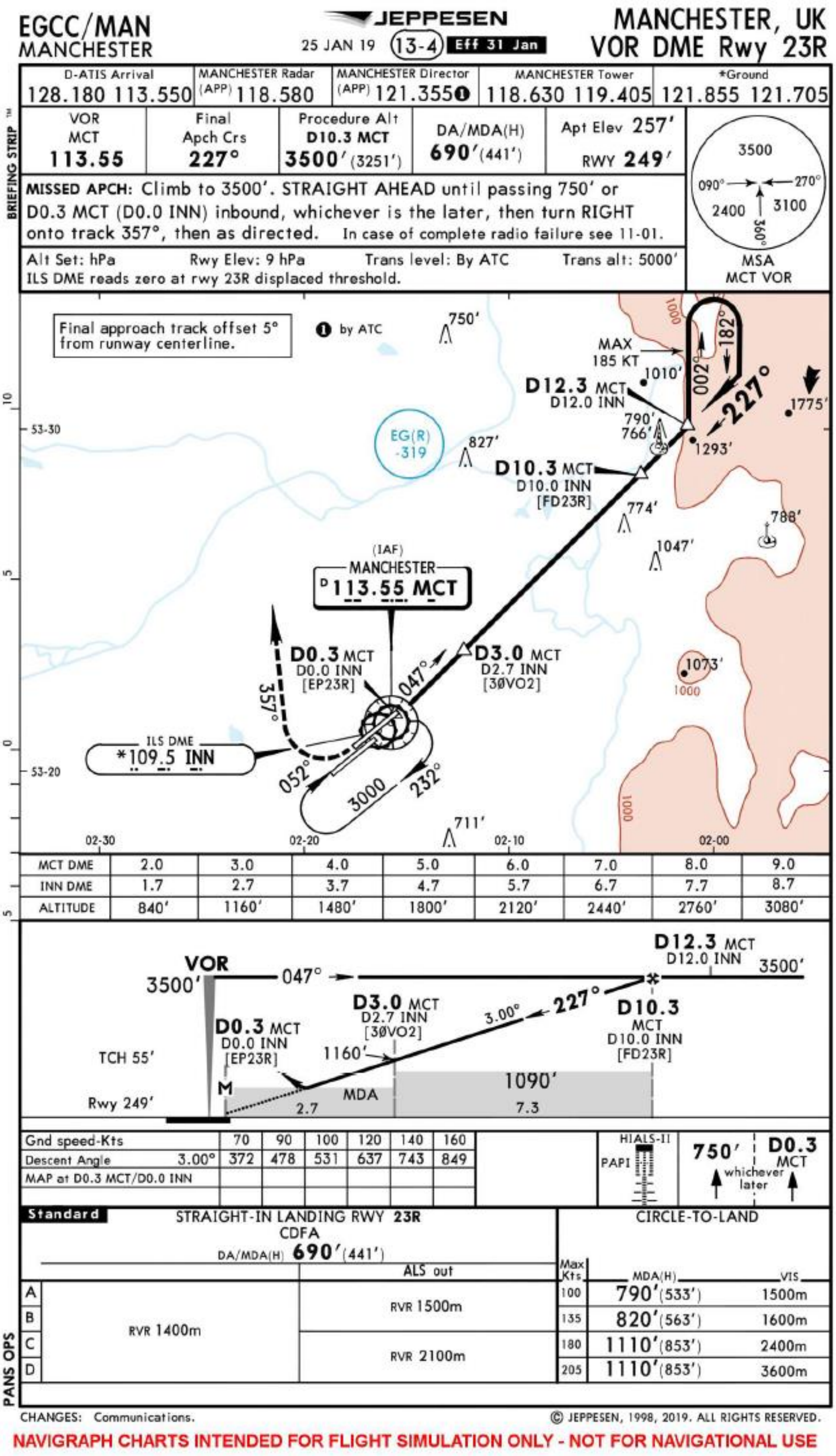
Flying an instrument procedure is essentially the combination of everything we have learned so far. You'll need your spare capacity to read and utilise the approach charts to understand what is required of you.

It may be helpful to remember 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.

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 descent and drift. As you reduce groundspeed, 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 into-wind adjustment will need to be increased as you reduce your groundspeed towards touchdown.

MANCHESTER VOR 23R



IFR 07. NDB APPROACH

C172 G1000

Hold Entry

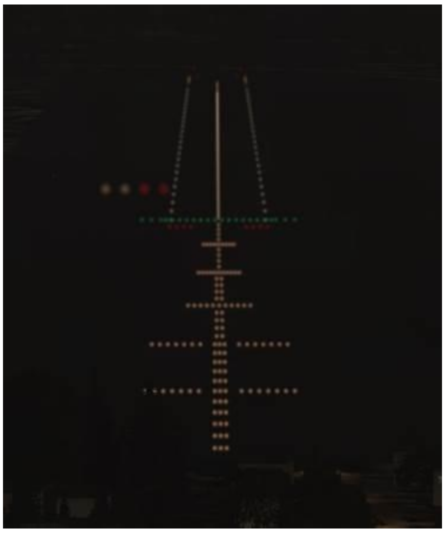
NDB Approach

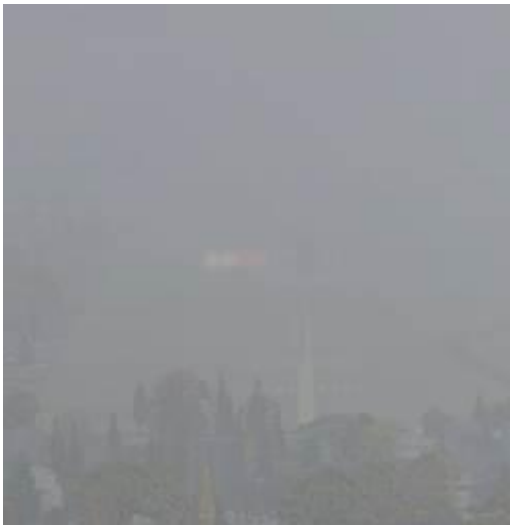
APPROACH MINIMA

You must never descend below a Minimum Descent Altitude (Non-precision approaches) without being visual, whereas with a Decision Altitude (ILS), 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 below MDA are any ONE or MORE of these:

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





SOUTHAMPTON NDB 20

EGHI/SOU
SOUTHAMPTON

JEPPESEN

1 MAR 19 (16-2) CAT A, B & C

SOUTHAMPTON, UK
NDB DME Rwy 20

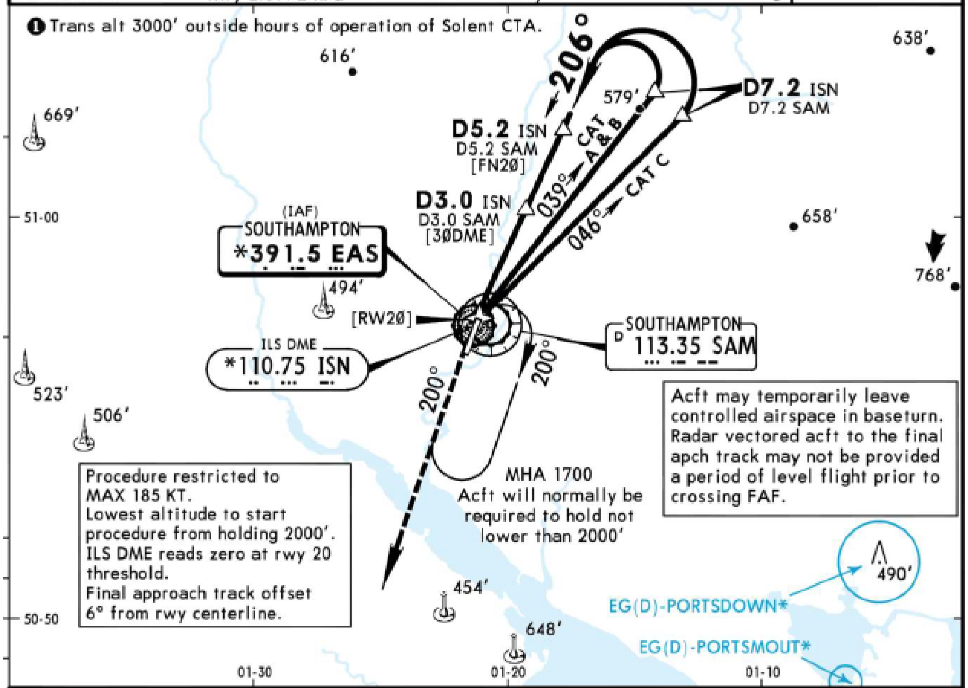
*ATIS	*SOLENT Radar (APP)	*SOUTHAMPTON Radar (APP)	*SOUTHAMPTON Tower
130.880	120.230	122.730	118.205

Lctr EAS	Final Apch Crs	Procedure Alt D5.2 ISN	DA/MDA(H)	Apt Elev 44' Rwy 44'
*391.5	206°	1800' (1756')	540' (496')	

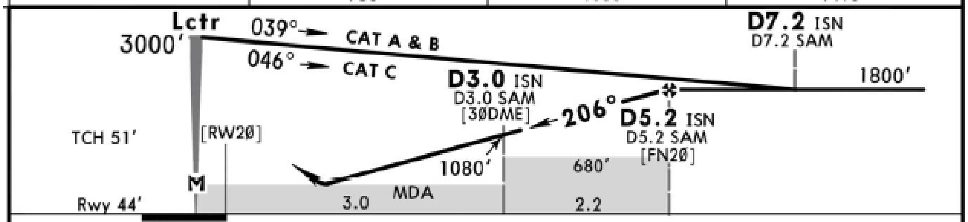
MSA EAS Lctr: 2300

MISSED APCH: Continuous climb to 3000'. Initially climb STRAIGHT AHEAD to Lctr, then proceed on 200° from Lctr, then as directed.
MISSED APCH WITH COMM FAILURE: Continuous climb to 3000'. Initially climb STRAIGHT AHEAD to Lctr, then climb on 200° from Lctr to 2000' or D7.7 ISN/D8.0 SAM, whichever is later, then climbing turn RIGHT to Lctr and hold at 3000'.

Alt Set: hPa Rwy Elev: 2 hPa Trans level: By ATC Trans alt: 6000' ❶



ISN DME/SAM DME	2.0	3.0	4.0
ALTITUDE	750'	1080'	1410'



Gnd speed-Kts	70	90	100	120	140	160
Descent Angle 3.10°	384	494	548	658	768	878
MAP at Lctr						

HIALS PAPI | EAS 391.5 | LT | 200° from EAS 391.5

Standard

STRAIGHT-IN LANDING RWY 20
CDFA
DA/MDA(H) 540' (496')

		ALS out
A, B	RVR 1500m	RVR 1500m
C	RVR 1800m	RVR 2300m
D	NOT APPLICABLE	

CIRCLE-TO-LAND

	Max Kts	MDA(H)	VIS
A	100	670' (626')	1500m
B	135	700' (656')	1600m
C	180	890' (846')	2400m
D		NOT APPLICABLE	

CHANGES: Communications.

IFR 08. ILS APPROACH

C172 G1000
Interception
Localiser
Glideslope
Decision Altitude

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.

LOCALISER

The lateral element of your Instrument Landing System is the Localiser. A beam is emitted from the far end of the runway centreline, directed up the extended centreline to an effective range of 25nm.

The Course Deviation Indicator will display your left or right deviation in the conventional sense, where a left deflected needle or bar indicates you need to fly left to recapture the centreline.

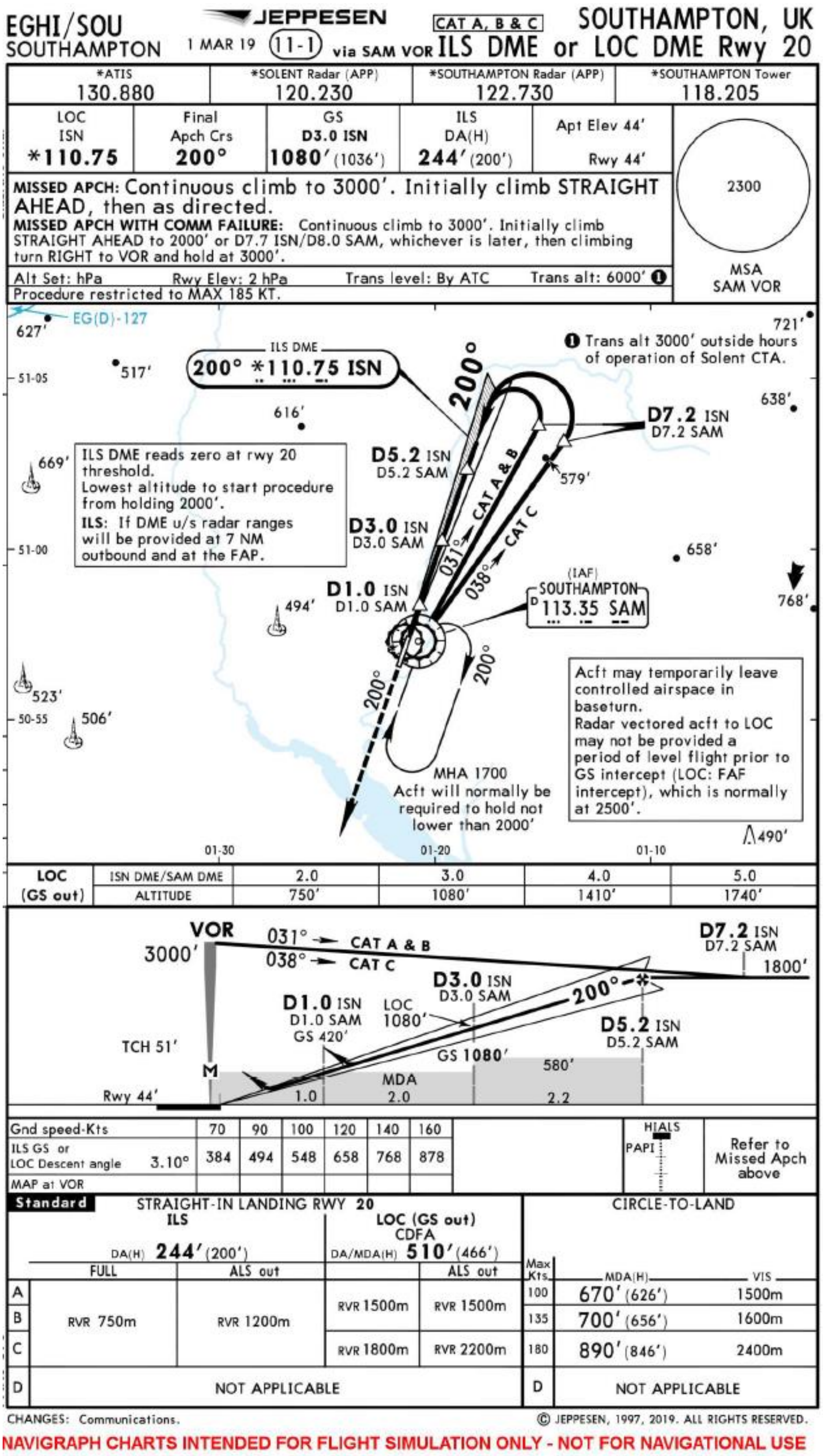
The bearing or course you select has no influence. A glass cockpit aircraft will automatically align the CDI to the runway course by displaying the course the avionics hold in their database. The morse code ident for an ILS approach identifies the localiser beam only.

GLIDESLOPE

A glideslope works in an equivalent way to the localiser, but for vertical guidance. It is transmitted from an antenna alongside the touchdown point and is set to the approach angle, typically 3 degrees.

There is no ident for a glideslope, so until you are visual with the runway, check your altitude vs DME distance to verify you are on the correct path. The effective range of the G/S is 10nm. Beware that a false glidepath may be picked up by your instrumentation, appearing genuine but indicating as about twice as steep as the true glideslope. This is why we use check altitudes to verify the glidepath.

SOUTHAMPTON ILS 20



IFR 09. DEPARTURES

C172 G1000
Takeoff Follow SID ATC Climb

DEPARTURE

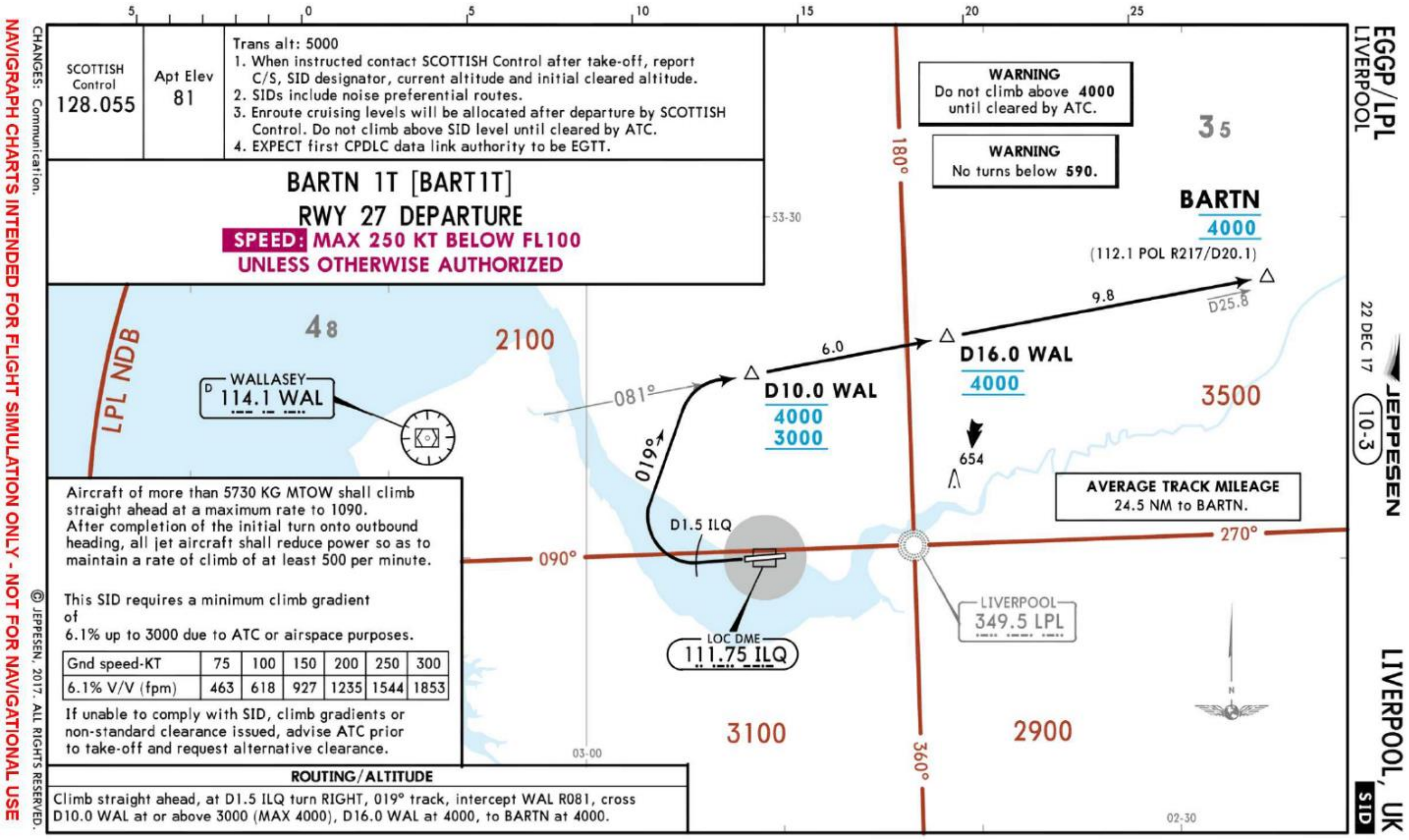
Now we know how to get to where we need to go, let's get airborne.

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.

Be aware that when 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.

The initial climb altitude will be predetermined and displayed on the chart. Looking at the BARTN 1T, we see you are to be between 3000ft and 4000ft at WAL 10DME, then AT 4000ft by WAL 16DME. Not the warning at the top right advising of the need for ATC clearance to climb above the initial altitude of 4000ft.

LIVERPOOL BARTN 1T SID



IFR 10. ENROUTE NAVIGATION

DA62

VOR Tracking

NDB Tracking

Turn Anticipation

TURN ANTICIPATION

If you want to leave a navaid on a radial and you waited until reaching overhead the station before starting your turn, you would greatly overshoot your desired next radial, requiring a large and unnecessary interception.

Instead, you can roughly calculate a distance to go at which you should begin your rate 1 turn.

If you take 1% of your groundspeed, use the number you get as a DME distance to go. If cruising at 180kts groundspeed, turning 1.8nm before your beacon will typically set you up to rollout on your next track with the CDI centred.

IFR CRUISING LEVELS

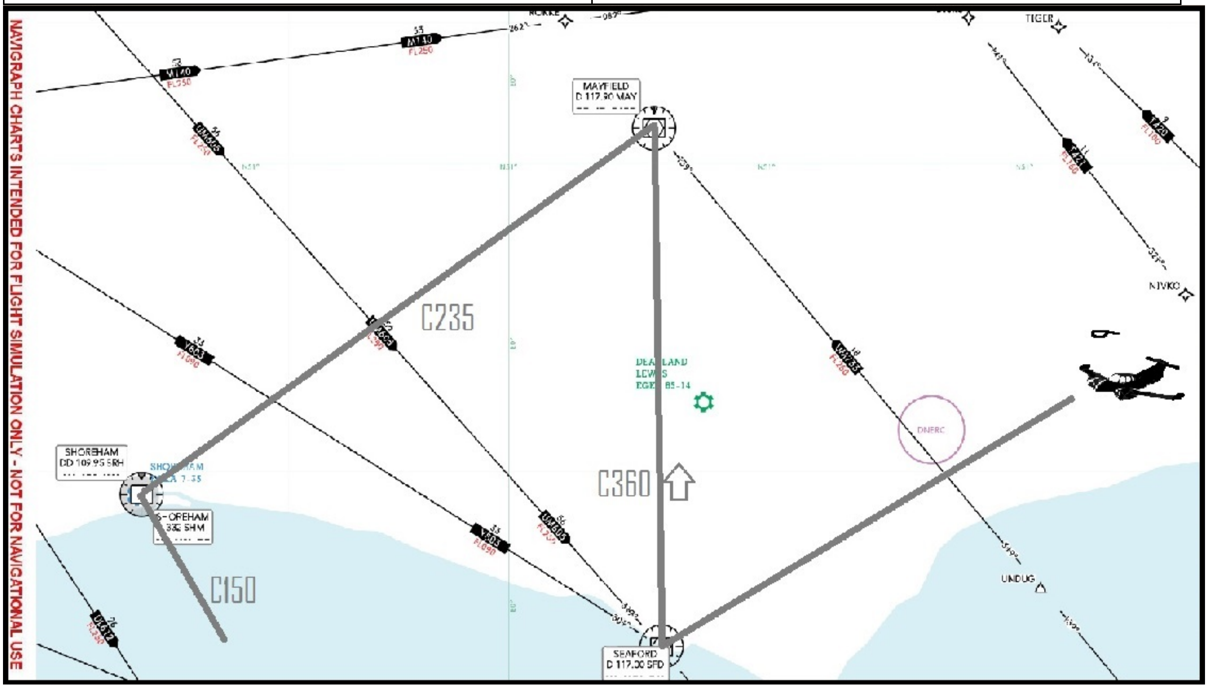
When flying a route, you need to choose a compatible altitude to fly.

There is a simple system in place for this, designed to avoid two aircraft approaching each other head-on at the same altitude. The altitude you choose depends on the direction you are flying for that leg.

If flying IFR **above 3000ft AGL** (Above Ground Level) then pick an EVEN altitude when flying WEST or an ODD altitude when flying EAST, always with increments of 1000ft.

The same rules apply when flying VFR (Visually) but with +500ft to the altitude. This system continues all the way up to the Transition Altitude, which is the highest available altitude for your region before the Flight Level system begins to be used instead.

TRACKING WEST	TRACKING EAST
EVEN	ODD



NAVLOG

FROM	TO	MAG TRACK	DISTANCE
START	SFD VOR (117.0)	245	15
SFD VOR (117.0)	MAY VOR (1117.9)	360	15
MAY VOR (117.9)	SHM NDB (332)	235	19
SHM NDB (332)	MANUAL LEG	150	5

MINIMUM FLIGHT ALTITUDES

It is the responsibility of the pilot 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 own 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.

IFR 11. CIRCLING

DA62
Intercept ILS
Level Off at Circling Minima
Visual Circuit

CIRCLING APPROACHES

Not all airport environments allow for a full, straight in instrument approach such as an ILS.

Terrain or airspace conflictions may prevent an instrument approach to one end of an airfield's runway, which can cause issues if that runway is required to be used due to wind conditions etc.

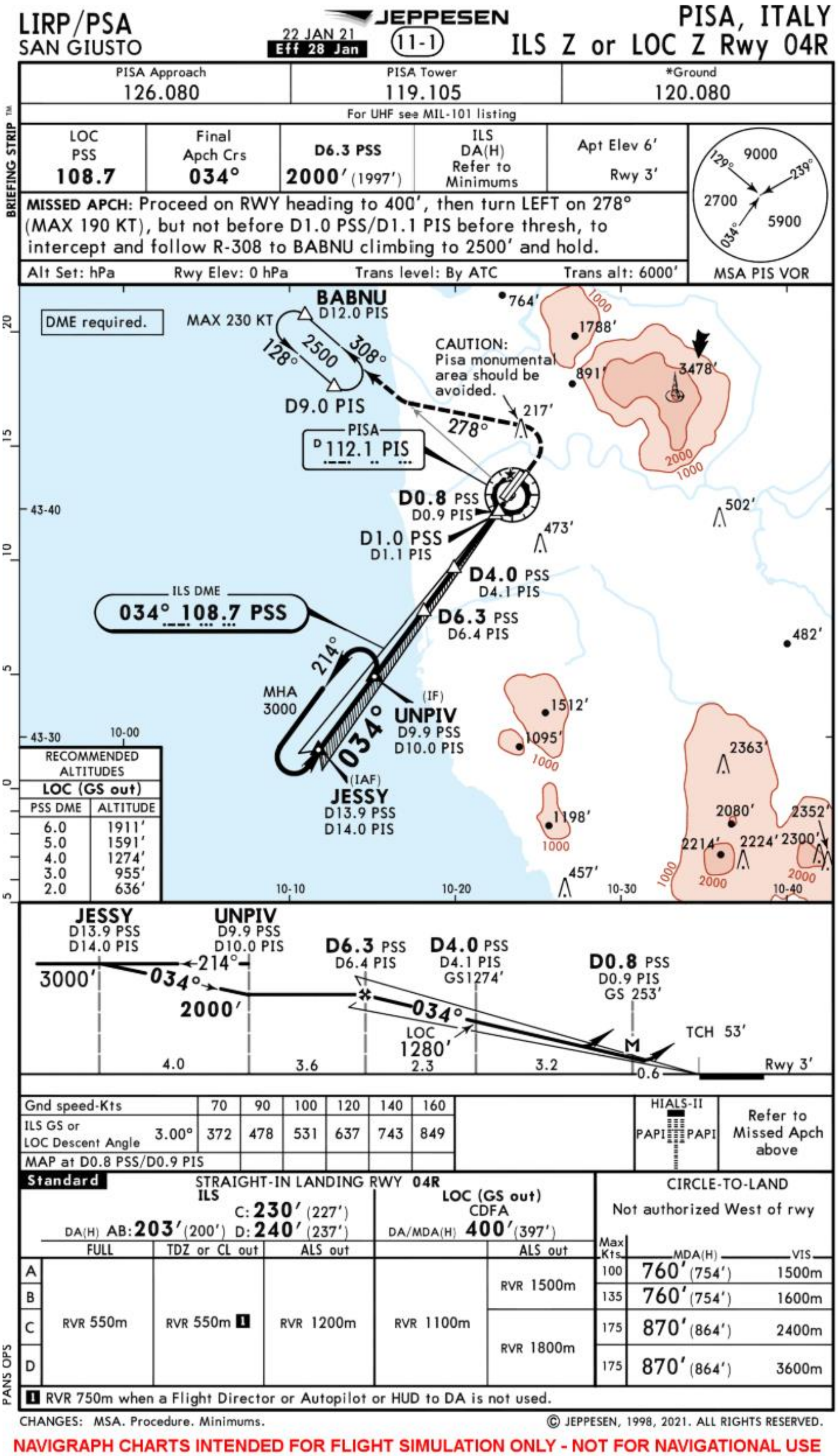
If a Circling minimum is published, you may still land on the runway by initiating an instrument approach to the runway, performing a visual circuit and landing on the opposite end.

We will do this in Pisa, Italy, by flying the ILS Z to 04R before circling and landing on 22L.

Look to the bottom right of the chart to find the circling minima, which we must remain above until we make our final turn to land. We configure with gear and flap whilst on the initial approach, to set the proper groundspeed and ensure proper proportions for our visual circuit. The process is as follows:

- Commence instrument approach (04R ILS)
- Once visual with the runway, level off at or above circling minima (760ft)
- Turn 45 degrees and time 30secs once wings level (Right turn, as West circling is prohibited)
- Fly parallel to the runway
- Once abeam the landing threshold (22L), start timing
- Time for 3secs per 100ft Above Airfield Level (AAL.)
- Make an initially level turn onto final, take full flap and land

PISA ILS Z 04R



FLIGHT 12. IR CHECKRIDE

DA62
Departure
VOR Tracking
NDB Tracking
Hold Entry
NDB Approach + Go Around
ILS Approach

THE IR CHECKRIDE

Once you are comfortable with the topics we have covered so far, take your virtual IR Checkride.

The flight profile is as follows:

- Depart Liverpool
- Track CRS297 to WAL VOR (114.1)
- Leave WAL VOR CRS200
- Fly direct to HAW NDB (340)
- Enter the Hold at HAW NDB
- Perform the NDB 22 Approach at Hawarden
- Missed Approach
- Leave HAW NDB CRS045
- Fly to LPL NDB (349.5)
- Perform the ILS 27 Approach (111.75) and make a full stop landing

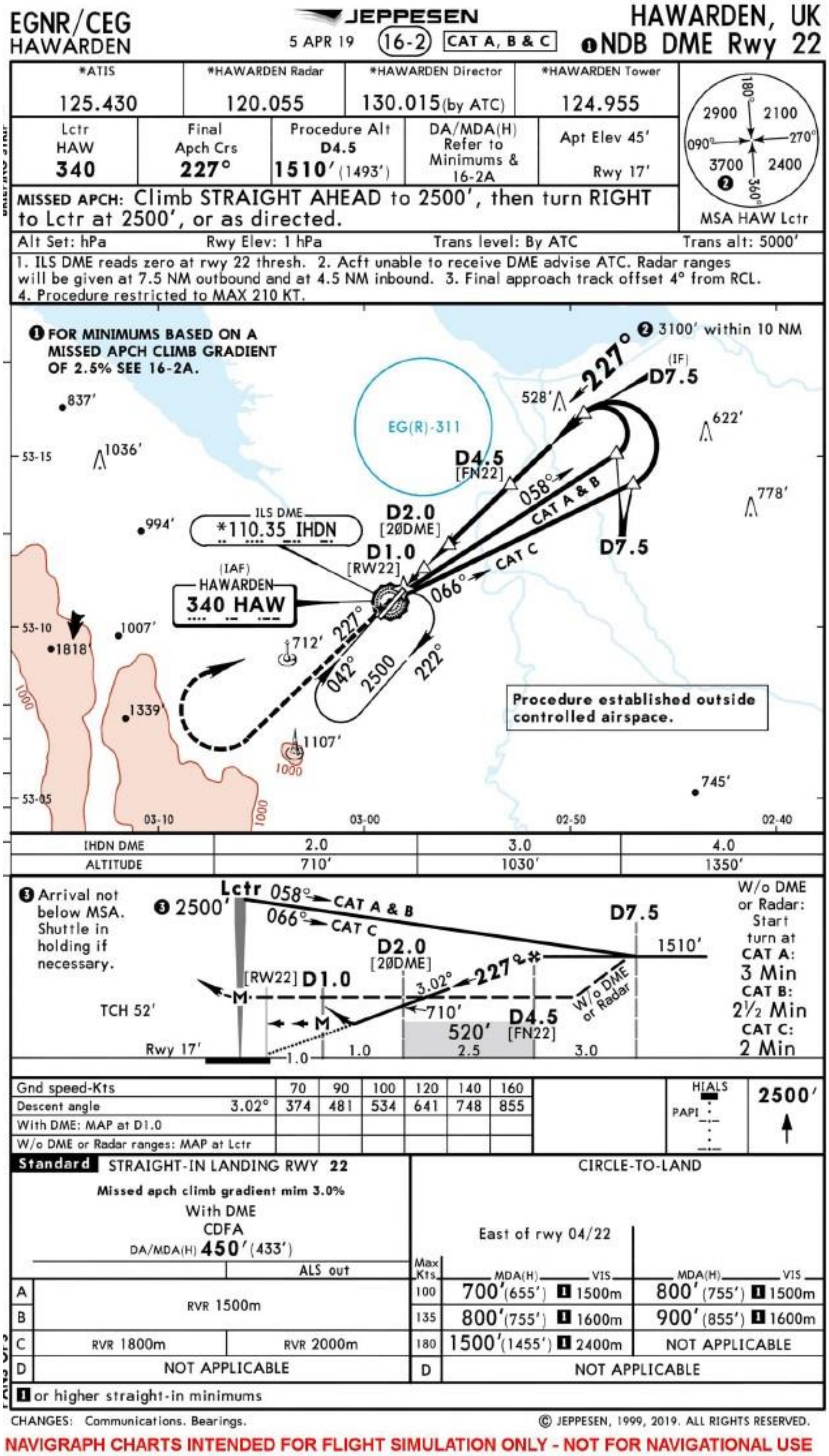
The examiner will take care of the radios and will provide you with important details from the chart such as outbound legs and DMEs, but setting the avionics are your responsibility. Ensure you Tune, Identify and Display all navaids correctly before using for navigation.

Tolerance exceedances in speed, turns and altitudes will be announced by the examiner and must be corrected in a timely manner. Failure to do so will result in a fail, which you will be informed of at the time and will cease the examination for a retest, requiring you to restart the flight.

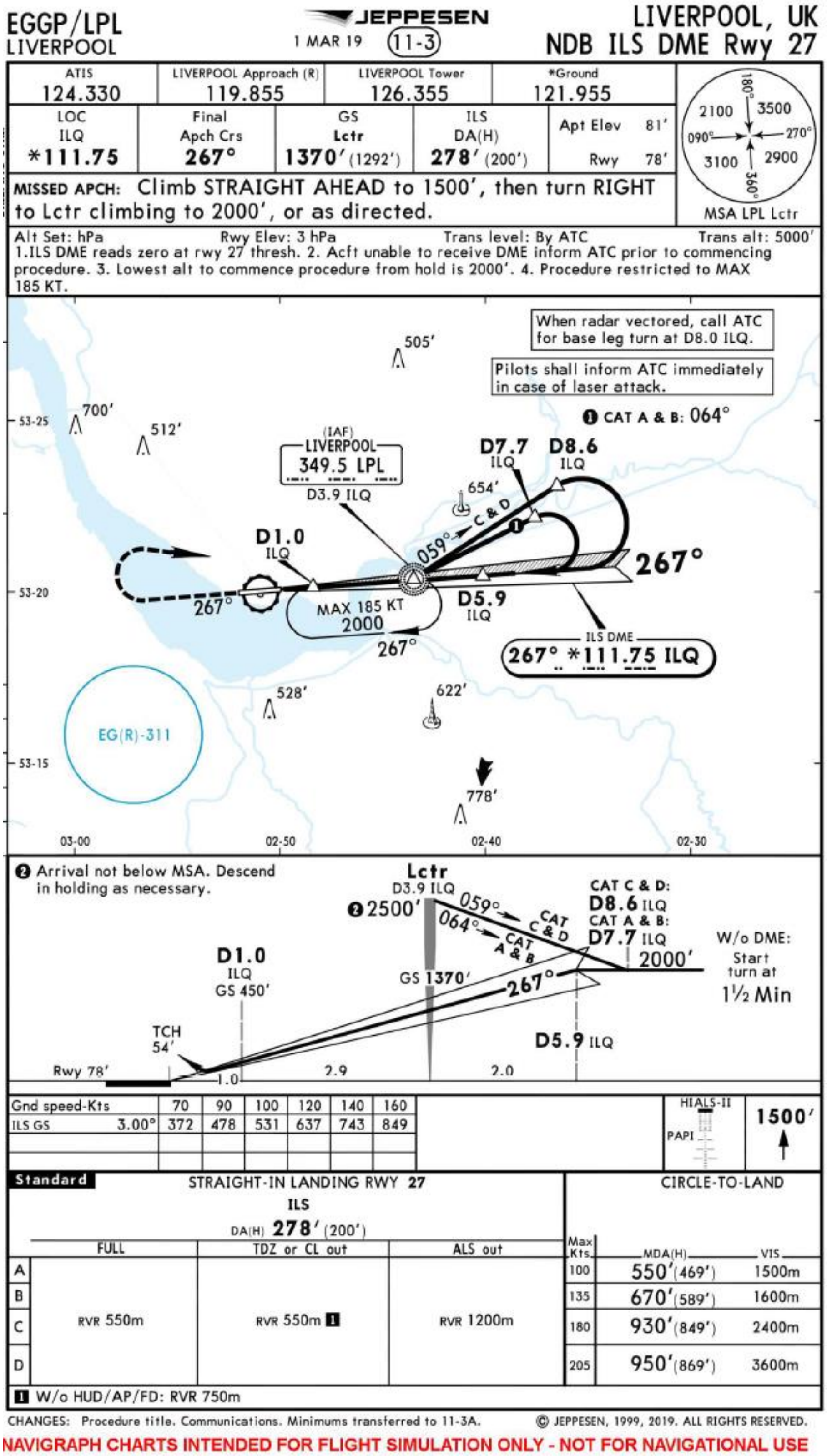
Maintain a cruising airspeed of 150kts for all cruise portions of the flight. The examiner will advise when you may adjust your speed freely.

Best of Luck...

HAWARDEN NDB 22



LIVERPOOL NDB ILS 27



EGGP/LPL
LIVERPOOL

JEPPESEN
1 MAR 19 (11-3)

LIVERPOOL, UK
NDB ILS DME Rwy 27

ATIS	LIVERPOOL Approach (R)	LIVERPOOL Tower	*Ground
124.330	119.855	126.355	121.955

LOC ILQ	Final Apch Crs	GS Lctr	ILS DA(H)	Apt Elev	Rwy
*111.75	267°	1370′ (1292′)	278′ (200′)	81′	78′

MISSED APCH: Climb STRAIGHT AHEAD to 1500′, then turn RIGHT to Lctr climbing to 2000′, or as directed.

MSA LPL Lctr: 2100, 3500, 3100, 2900 (180°, 270°, 360°, 090°)

Alt Set: hPa Rwy Elev: 3 hPa Trans level: By ATC Trans alt: 5000′
1. ILS DME reads zero at rwy 27 thresh. 2. Acft unable to receive DME inform ATC prior to commencing procedure. 3. Lowest alt to commence procedure from hold is 2000′. 4. Procedure restricted to MAX 185 KT.

Gnd speed-Kts		70	90	100	120	140	160
ILS GS	3.00°	372	478	531	637	743	849

HIALS-II PAPI 1500′

Standard

STRAIGHT-IN LANDING RWY 27
ILS
DA(H) 278′ (200′)

	FULL	TDZ or CL out	ALS out
A, B, C, D	RVR 550m	RVR 550m ❶	RVR 1200m

CIRCLE-TO-LAND

	Max Kts	MDA(H)	VIS
A	100	550′ (469′)	1500m
B	135	670′ (589′)	1600m
C	180	930′ (849′)	2400m
D	205	950′ (869′)	3600m

❶ W/o HUD/AP/FD: RVR 750m

CHANGES: Procedure title. Communications. Minimums transferred to 11-3A.

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 as gentle and 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.

We 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.

Congratulations 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 small sample of relevant differences are shown below. They won't be a factor for our course, but are included as some pilots may find them useful:

	ICAO (WORLDWIDE)	**FAA** (USA)
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

WHERE NEXT?

FS ACADEMY *VOYAGER*

If you want to expand your VFR experience and tackle full-length bush trips, FS Academy – Voyager is a series of 7 journeys across glorious locations from around the world. All with Jeppesen charts and fully prepared NavLogs, plus an expansive manual to boost your VFR skills even further.

FS ACADEMY *VFR*

Explore the vast and varied world of visual flight. Brought to you by a real airline captain, VFR gives you the authentic knowledge and teaches you how to fly like the professionals to get maximum realism and authenticity from your flight simulation, covering ATC, airspace, circuits, mountain flying, cross-country navigation and more.

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. **Bold** indicates commonly used abbreviations for IFR flight.

AAL	**Above Airfield Level**
ACARS	Aircraft Communications and Reporting System
ADF	**Automatic Direction Finding**
AI	**Attitude 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/Approach 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
G/S	**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/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. Shorter range NDB.
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 System
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
RTIL	**Runway Threshold 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**

SUPPORT

If you find any technical difficulties flying the missions in IFR, head to our website to see the up-to-date FAQ.

www.fsacademy.co.uk/support-ifr