FS ACADEMY

NAVIGATOR

MANUAL VERSION

14 APRIL 2022

Contents

FS ACADEMY

NAVIGATOR

NAVIGATOR will add a new dimension to your flying, enabling you to navigate cross-country using real techniques to find your way. Find NAVIGATOR in **ACTIVITIES → CUSTOM CONTENT**.

Escape the shackles of the airfield circuit and spread your wings by learning step by step the skills and techniques required to go and explore.

Starting off with the basic principles of waypoint selection, we will build up to incorporate timings, wind drift and varied landscapes to complete your skillset and prepare you for embarking upon your own adventures.

The first thing we need to cover is how your aerial vantage point changes the look of the landscape below you, so that you can select useful ground features to use as waypoints when planning your journey. From there we will progress to stringing a series of waypoints together, forming a basic route towards San Francisco before incorporating more advanced techniques including drift corrections, night flight and tackling winter flying.

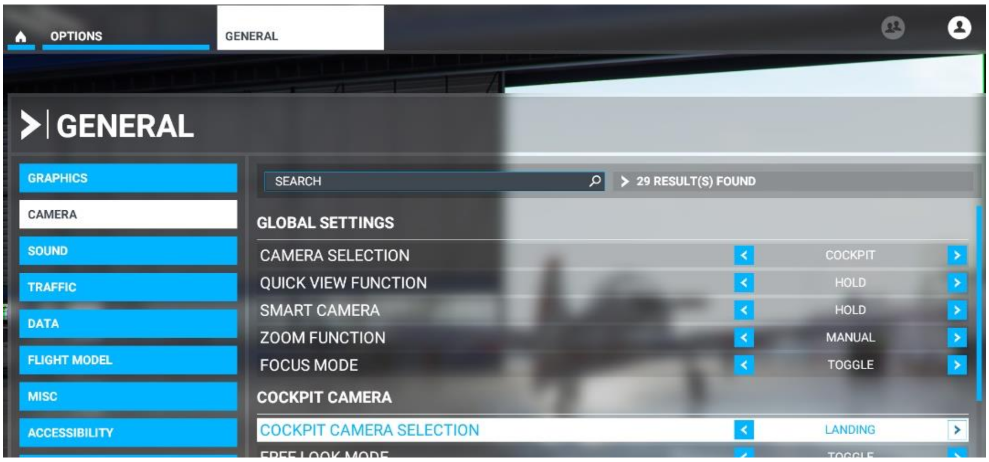
Our aircraft of choice is the trusty Cessna 152. With its high-wing configuration it offers a clear view of the ground below, plus overall great visibility and conventional instrumentation. We will explore some of the world's most iconic destinations and cover a wide range of weather conditions and situations to give you the broadest skillset possible.

Once we begin more advanced navigation you can find the relevant 'NavLogs' and maps in the dedicated chapters of this manual.

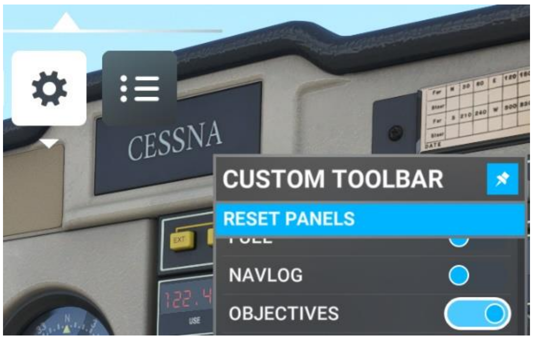
Please note that for each turning point it is required that the turn be made promptly, otherwise you may stray too far from the route for your instructor to be able to help you.

COCKPIT CAMERA

We will be visually acquiring towns, buildings and other ground features, so a good view forward is essential. By default, your viewpoint is slightly low in the cockpit, so raising your seating position to the 'Landing' Cockpit Camera Selection can improve forward visibility. Also consider shifting your virtual seating position left slightly, so you can get a better view from the cockpit side window. Also, consider using the external view to enhance your vision of waypoints.



OBJECTIVES PANEL



The directions from your instructor will be supplemented by on-screen objectives in flight, which will display what you need to do next in order to progress through the tutorial.

Make sure to have the objectives panel displayed, so that you don't miss any important steps. Enable the objectives panel using the custom toolbar menu in-game.

SUBTITLES

Full subtitles in English are available and can be displayed by enabling subtitles, found here:

OPTIONS → GENERAL → ACCESSIBILITY

TRACK KEEPING

A crucial aspect of navigation is starting your turns promptly and precisely. Your instructor will remind you to commence your turn if they notice a delayed change of heading and may terminate the lesson if this delay becomes excessive. In such a case, your instructor will ask that you restart the lesson. This is due to the risk of a compounding error, where a sequence of late and/or inaccurate turns end up causing major track keeping issues, pushing you too far off course to make reasonable corrections. Please ensure that turns are made to the correct next heading accurately and in a timely manner. Strive for a high accuracy of heading keeping, as this is the cornerstone of a successful navigation flight.

Your instructor, subtitles, route maps, on screen objectives and visual markers are all there to help you, but we cannot detect all potential navigation errors. If the mission does not appear to be progressing, it may be that you have not turned correctly or accurately onto your next leg. If you suspect this to be the case, please restart the mission to reattempt, checking the route maps and navlog.

Each lesson that includes a route to fly is accompanied by a map and navigation log in the relevant chapters of this manual. When we begin to use enroute fixes, you will need to be able to refer to the drift lines drawn on your map to check your track keeping, so it may be useful to have the map printed out or displayed in another window or on a device such as a phone or tablet. You can pause the mission at these enroute checks to help you with this and your instructor will assist you inflight with their estimation of any tracking errors.

Some landmarks will be highlighted on screen by a marker to aid identification, but as these are not always located on the centreline of your route, this does not necessarily imply you should steer towards them. Your instructor will guide you appropriately.

VFR navigation requires concentration and discipline, as a single major error can disrupt your entire route. We will try our best to help you, but we suggest that you will get best use of this course if you permit yourself the undistracted time to focus on the content. Reading the associated chapters in this manual prior to launching a mission will be most rewarding and will open up your capacity to take on this new set of skills.

WORLD UPDATES

The world scenery included with Flight Simulator is updated and improved over time in a series of 'World Updates'. Make sure to have installed the appropriate World Update scenery so that you benefit from the best available visual experience. World Updates are available for free from the in-game marketplace.

INSTRUMENTATION

Let's run through the main cockpit instruments and equipment you will be using which are most relevant to VFR navigation, so that you are familiar with them when the time comes to put them to use.

A Airspeed Indicator (ASI)

The airspeed indicator is essentially a pressure gauge. The harder the air is hitting the aircraft and flowing into the Pitot Tube, the higher the reading, which is calibrated to display Nautical Miles Per Hour (Knots). The speed of the air going over the wing is directly related to the lift produced.

The cruise speed we will plan for our C152 will be 100kts.

B Attitude Indicator (AI)

The main use of the attitude indicator for navigation is to ensure consistent turns and to aid with setting a straight and level attitude. A bank angle of 20 degrees is appropriate for normal turns, as shown here.

When established on a heading, regularly refer to the AI to ensure that you have level wings, as any roll will cause a turn, taking you from your desired heading over time.

C Clock

Time keeping is an essential element of proper navigation techniques, so the importance of even a simple analog clock should not be underestimated.

You can use any timing device you wish, such as a wristwatch or stopwatch.

D Altimeter

Normally set to display altitude Above Mean Sea Level (AMSL) the altimeter displays your vertical height in feet. Maintaining accurate altitude control is especially important when flying through or near to airspace boundaries, as we often avoid entering controlled airspace by flying at an altitude below the floor of airspace above us.

E Heading Indicator (HI)

The heading indicator is your primary reference for flying particular headings. Over time, the heading indicator will drift out of proper alignment. Your instructor will help you check that your instrumentation remains aligned with the magnetic compass and point out if significant drift is present.

Take care when making any adjustments, as an improperly set heading indicator could cause large tracking errors that may be confusing to diagnose and correct. Your instructor will continue their dialog once they see the correct alignment.

You can **press D to quick-align** the heading indicator with the compass, but only in straight and level flight.

F Yoke Clickspot

Some switches are located on the lower section of the cockpit panel, but are obscured by the yoke. To hide the yoke, click on the base of the control column. This will give you full view of the panel. To re-show the yoke, click on the hole that the control column passes through. You will likely need to hide the yoke when turning on the pitot heat in lesson 7.

G Fuel Gauges

Located beneath the heading indicator there are a pair of fuel gauges which display the remaining fuel quantities for both the left and right fuel tanks, located in the wings.

Some aircraft require manual switching between left and right tanks, which must be performed by the pilot periodically in order to consume fuel evenly and ensure that the aircraft remains balanced.

H Oil Gauges

Normal operation of the engine oil system is indicated by the temperature and pressure gauges displaying their needles in the green band. High oil temperature or low oil pressure indicate an issue with the engine, so this must be monitored periodically to ensure that any unusual indications are spotted quickly, allowing time to troubleshoot and perform a precautionary landing if necessary.

I Communications Radio

The C152 is fitted with two communications (COMM) radios. Each radio is fitted with an active/use window and a standby window. Turning the inner and outer knobs to the bottom right of the radio allows for tuning of the standby frequency. Once correctly set to the desired frequency, pushing the white swap button (**<->**) swaps the standby frequency with the active frequency. We will be primarily using the COMM1 radio, which is located at the top left of our radio stack.

J Transponder (XPDR)

The code we set into the transponder is known as our ‘squawk’ code and is visible on the Air Traffic Control (ATC) radar screen. To set the squawk, turn the knobs located under each number, which have a range of 0-7. Lighting conditions in Flight Simulator can often make the transponder difficult to read, so you may need to zoom in to get a clear view. Leave the transponder mode knob in the Altitude Reporting (ALT) position.

K Pitot Heat

As discussed above, you may need to hide the yoke in order to get a clear view of the pitot heat switch, which is located at the bottom of the instrument panel, towards your knees. To the left of the pitot heat switch is the dome light switch, which can be turned on if you find cockpit lighting conditions to be too dark, depending on your display and graphics settings.

L Throttle Control

Speed control is achieved by use of the throttle lever. Make smooth adjustments to the throttle in order to change speed, as rapid movements make sudden changes to speed and lift, which can make altitude holding more challenging.

M Mixture Control

Beside the throttle you will find the mixture control. When flying at higher altitudes the air becomes thinner. As the engine runs most efficiently at a certain fuel:air ratio, we reduce the fuel flow slightly after climbing in order to preserve this ideal ratio. This ensures proper engine running and fuel efficiency.

N Magnetic Compass

Found at the top of the windscreen, the magnetic compass is the reference we use to ensure that the heading indicator remains reliable. The compass is subject to several inaccuracies when the aircraft is doing anything other than straight and level flight at constant speed, making the compass more difficult to use during turns and manoeuvres. Also be aware of the ‘parallax’ error when viewing the compass from either side, as the thin white reference bar only appears atop the correct magnetic heading when viewed from straight on.

You can **press D to quick-align** the heading indicator with the compass, but only in straight and level flight.

SUPPORT

Please visit our support page if you encounter difficulties.

fsacademy.co.uk/support-navigator

Let's get started...

NAVIGATOR 01.

THE VIEW FROM ABOVE

Commence your exploration into the world of VFR (Visual Flight Rules) navigation by getting to grips with the range of ground features available to you for route planning. See the pros and cons of line, point and area features with a tour of the UK's south coast on a warm summer's day.

Navigation is a fundamental skill of aircraft flying. Finding your way visually is one of the most rewarding activities you can undertake in a light aeroplane, picking out landmarks and touring the landscape by sight.

We will take a look at the different types of ground features we can use for enroute navigation as we cruise across the UK's south coast between West Sussex and Hampshire.

Choosing the right ground features to look for is an important step in planning a successful route, so we will start by introducing you to the various 'features' that are most useful to you as a pilot.

Features are roughly divided into three main types, which we will cover in turn:

LINE	Road	Railway	Coastline	Powerline
POINT	Landmark	Bridge	Junction	Airfield
AREA	Town	City	Woodland	Lake

LINE FEATURE

A feature of great length such as a highway or railway can provide excellent navigational guidance in a single dimension.

This is to say that whilst following a line you have an accurate and clear indication of your lateral position in relation to the line. You can instantly see if you are to the right or left of the feature. However, there is little indication of distance travelled along the line, unless it is supplemented by other features such as service stations, junctions or towns along its length.

Often spanning long distances, some line features such as major highways and railways will be the only feature you need to get between large towns and cities, as this is the function that such major infrastructure is designed for. However, as a road must be built across the landscape it must compromise according to the terrain, so will often not be the most direct route.

Keep line features to your left as this will make them easier to see from your seating position in the cockpit. Other aircraft should be doing this too, which will give some reassurance regarding separation. There is no guarantee of this however, so be sure not to neglect looking out for other air traffic and do not become fixated on ground features.

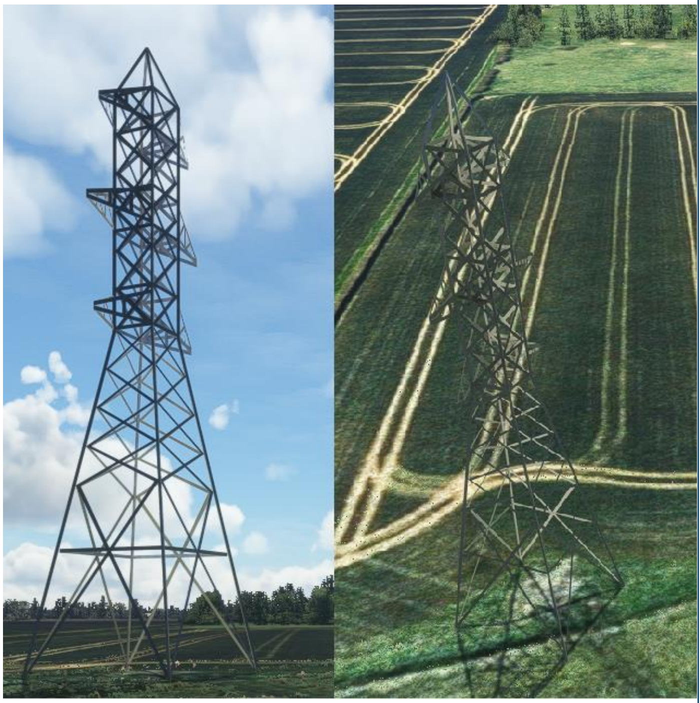
Great care must be taken when in the presence of many similar line features that you are in fact following the line you intended, as roads and railways tend to look practically identical, especially when viewed from a distance.

Highways may split off into multiple smaller roads and railways can be shrouded by trees.

Some features which appear obvious and highly visible from the ground or on a map can look very different from the air.

Powerlines may be especially difficult to pick out, as the thin cables and skeletal-structured pylons can seem to vanish when viewed from above. This is an example of the importance of contrast, as the bright blue sky becomes replaced by green fields when viewed from altitude. This is exacerbated by fading light and misty conditions.

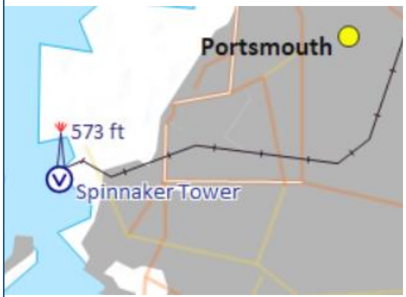
Small chimneys and radio masts can have the same effect, with their red obstacle lights practically invisible by day and their slender appearance providing poor contrast against the landscape.



POINT FEATURE

The most useful point features are unmistakable and distinctive, such as prominent local landmarks. These provide a single accurate location, which make them suitable for turning points, setting you off on the next leg of your route with the confidence that you commenced the leg in the right spot.

As point features exist at a single spot on the ground, they will unlikely be of any assistance with lateral guidance, as little indication will be given regarding the direction from which you are approaching the feature.



Some local landmarks are designated as Visual Reporting Points (VRPs). These are officially recognised and are chosen for their standout features. As these are obvious choices for point features, be wary of other traffic utilising the same features, as they are frequented by not only aircraft enroute but also local area flights on training exercises or flight experiences. VRPs are often congested, giving rise to a collision risk.

Enhance your lookout for other traffic when nearing a VRP or popular local point feature, as conflicting aircraft may also be making their approach, intending to use the landmark as a turning point, making changes of direction overhead a point feature commonplace and difficult to predict.

Airfields can make for excellent point features, as they are clearly charted and many have unique features. Disused airfields can be particularly useful, as there is no longer any air traffic operating from the runways to watch out for or Air Traffic Control (ATC) to become involved with. However, as disused landing strips are attractive for re-development, they can take on a wide range of appearances in accordance with their usage, meaning their original runways may be missing or unrecognisable, making prior research important before selecting these as waypoints.

Road junctions take a wide range of forms and are often highly visible and well lit. Major highways in particular have large, sweeping intersections as dictated by the high speed and volume of the traffic travelling along them. Many motorway junctions are of sufficient size and visibility that they are designated as VRPs. These can add a useful point feature to add distance information to this otherwise single-dimension line feature.

AREA FEATURE

Covering large areas of ground, area features are visible from great distances due to their size. What is gained in long range visibility is traded for a loss in terms of pin-point accuracy.

A large woodland, lake or forest may be highly visible from a distance but lack any discernible landmarks or point features within them. They will also lack the night lighting of a town or city.

Even by day, built up areas can be very uniform in appearance, making exact position determination difficult once you have arrived overhead.

Overflying wide expanses of congested areas also requires extra care in a single engine aeroplane, as you must be able to glide clear and land in a safe spot in the event of an engine failure.

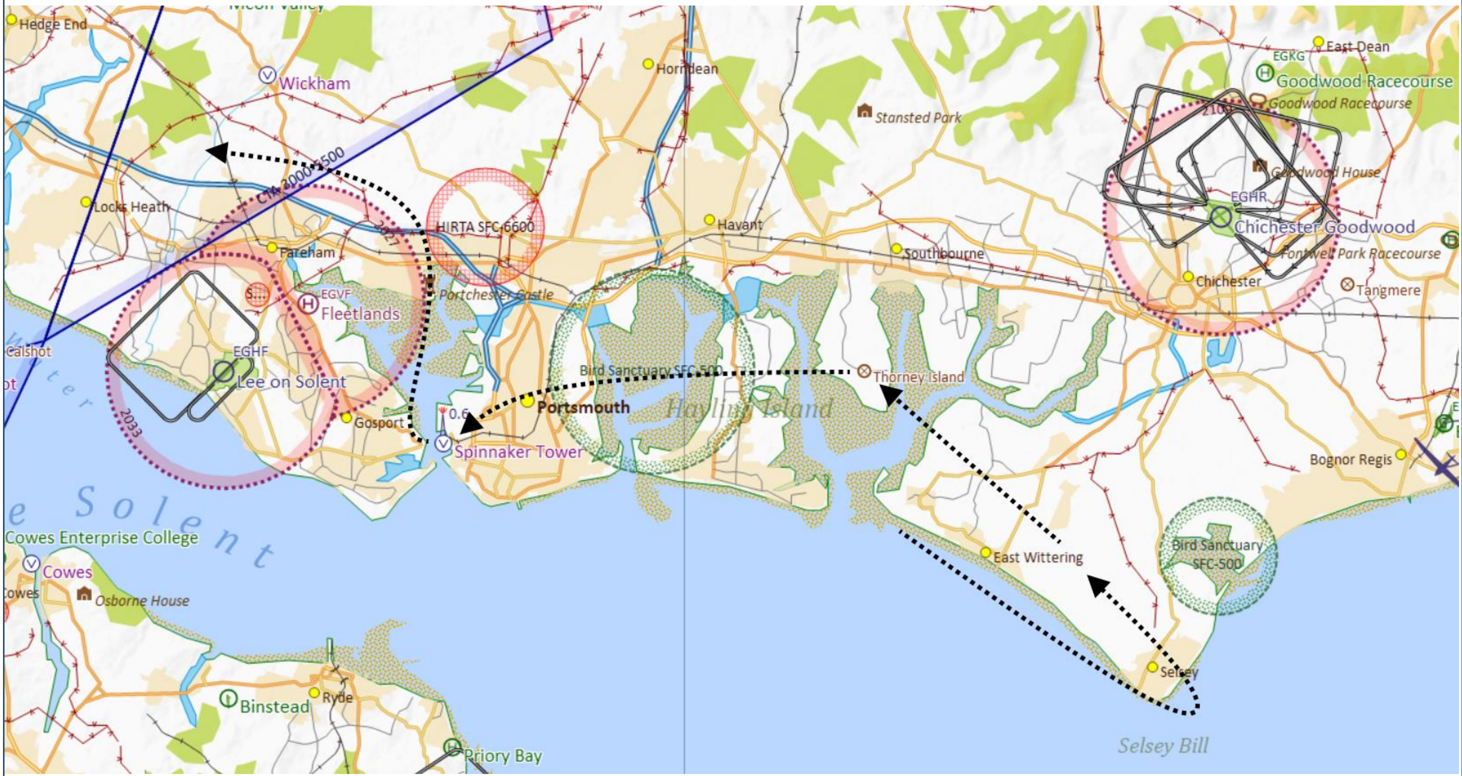
COMBINING FEATURES

All types of features have benefits and limitations, so the best choices for route making are often a combination of several types.

You may follow a motorway across the countryside towards a large town. Once arriving at the edge of town, use a prominent point feature such as a sports stadium or iconic building within the town to provide high accuracy.

Using the edge of an otherwise large and featureless area, such the dam wall of a reservoir or opening in the forest, utilises both the legibility of the area’s size with the accuracy of a recognisable point.

MAP – NAVIGATOR 01



Map courtesy of SkyDemon

NAVIGATOR 02.
STEPPING STONES

Use what you have just learned about ground features to string a series of features together into a simple route across California towards San Francisco.

Now that you have seen examples of the various types of waypoints we can select for navigation, we will connect the dots and take a short trip across the San Francisco Bay, terminating at the Golden Gate Bridge.

The simplest form of navigation is to fly visually from one feature to the next, like hopping between stepping stones. This requires the distances between waypoints to be limited however, as you must be able to see the next ground feature in order to turn towards it. This can become an issue when traversing featureless terrain or when visibility is restricted.

However, if conditions permit this can be an easy and effective method of finding your way across the landscape, requiring only minimal pre-flight planning and works particularly well when flying in an area you are familiar with, offering total flexibility.

TRANSPONDER

As we approach San Francisco, we will have to be mindful of the airspace surround San Francisco International (SFO). The first aspect of airspace we will encounter is the arrival into a Transponder Mandatory Zone (TMZ). This is a defined area that surrounds many major airports that require a transponder to be fitted to your aircraft in order to be permitted entry.

Usage	Squawk Code
VFR - USA, Canada, Australia, NZ	1200
VFR - ICAO Standard	7000
Emergency	7700
Radio Failure	7600
Unlawful Interference	7500

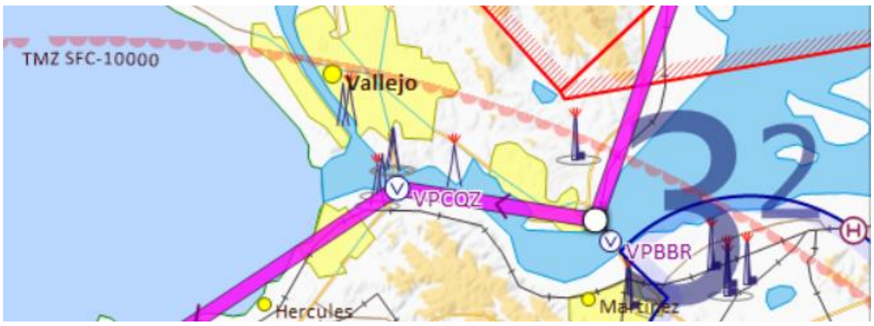
The transponder (often shortened to XPDR) of our Cessna 152 can be found at the base of the radio stack and is set to a 'squawk' code of 1200. This is the standard code in the USA and some other locations to label us on the ATC radar screen as a light aircraft flying under Visual Flight Rules (VFR) and is referred to as the 'conspicuity' code.

Other countries will use the International Civil Aviation Organisation (ICAO) conspicuity code of 7000.

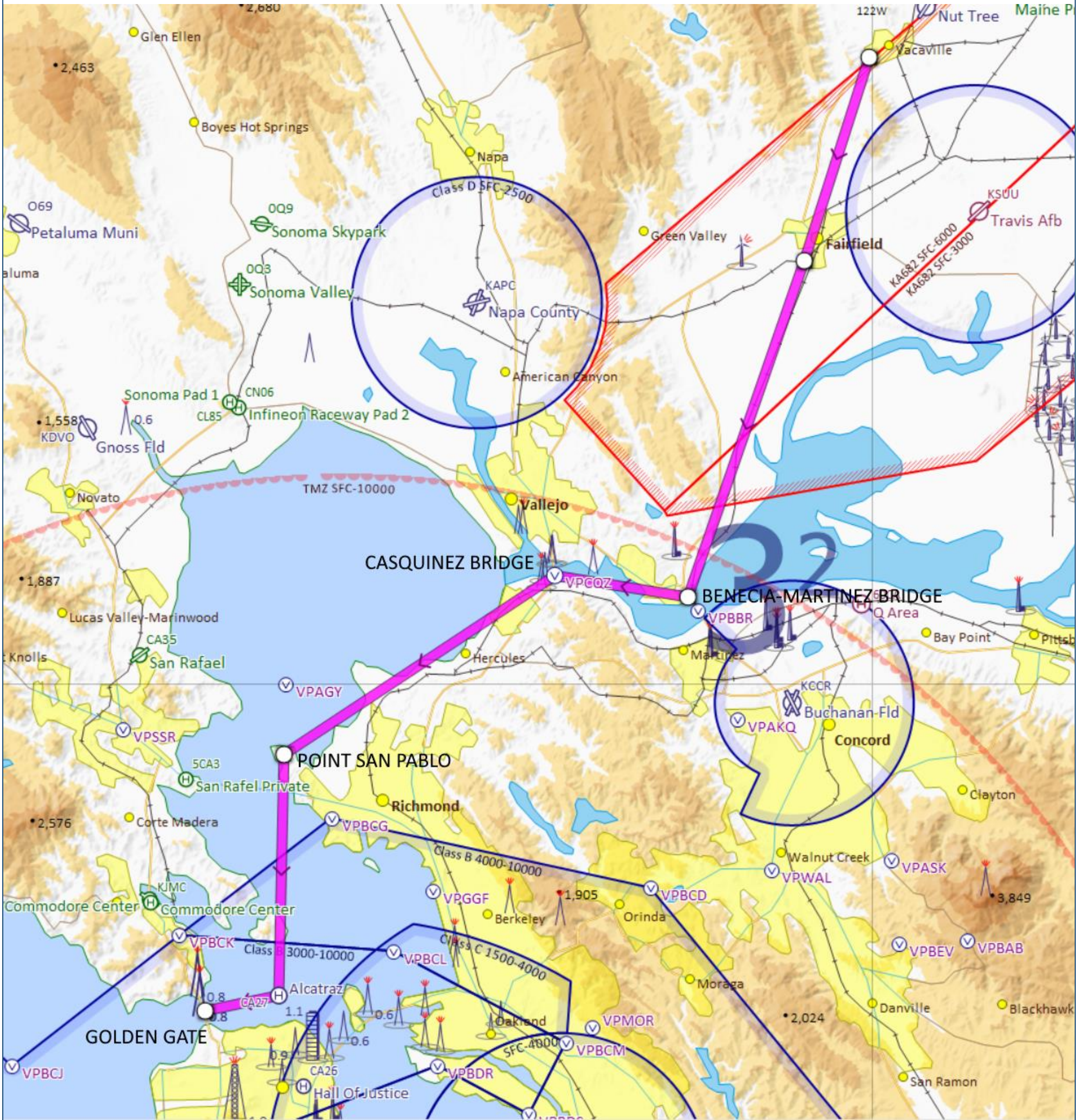
Other codes are inserted into the transponder in the event of emergencies and radio faults. By setting these codes, ATC can instantly see that we are encountering difficulties and will provide assistance where possible.

Transponders vary in terms of sophistication. The most common type found in a light aircraft is categorised as 'Mode C' which transmits our squawk code and indicated altitude, allowing this information to be displayed to ATC.

'Mode S' transponders are more advanced units which can transmit much more data, such as speed, aircraft type and autopilot settings and can even communicate with other similarly equipped aircraft to provide collision avoidance functionality. Our more simplistic Mode C transponder is more than enough to allow us into the TMZ, which is denoted on the map by the red scalloped circle. This TMZ is listed as stretching from the Surface (SFC) to 10,000ft.



MAP – NAVIGATOR 02



Map courtesy of SkyDemon

NAVIGATOR 03.
WATCHING THE CLOCK

The stepping stone method is limited to features that are within visual range of each other. This works well for areas dense with useful features, but we will now add the element of time to enable more flexible planning options which are unrestrained by line of sight. Use the five T's to keep on top of your progress as we introduce the navigation log.

NAVLOG			
TO WAYPOINT	ALT	HDG	TIME
REDRUTH	3000	205	4
ST ANTHONY HEAD	"	130	5
MEVAGISSEY	"	050	6
EDEN PROJECT	"	014	3
COLLIFORD LAKE	"	036	6

DEAD RECKONING

Using waypoints as stepping stones works well when you are surrounded by a familiar landscape on a clear day, but we will rarely find that this is the most direct route and we also remain vulnerable to poor visibility. We also lack an accurate indication of arrival times, which are sometimes crucial to the success of a flight.

If your next waypoint is beyond visual range, obscured by terrain or difficult to spot from a distance, knowing which magnetic heading you should turn to will set you off in the right direction. If you accurately follow this heading for a pre-planned amount of time, you will arrive at your waypoint after that time has elapsed.

This method of flying a heading for a time is known as Dead Reckoning and relies upon accurate flying in order to work correctly. If you have a heading error of just 1 degree, after 60 miles you will be 1 mile off laterally course, a phenomenon known as the 1 in 60 rule.
We will cruise in our Cessna 152 at 100kts indicated airspeed (IAS). Keeping accurate speed control is also important, as this is the basis of our time calculations.

To move on to this more sophisticated method of navigation, we need to complete some additional pre-flight preparation. This involves plotting our intended route onto a VFR map and measuring the exact directions and distances between each waypoint.

NOTE: Please decide upon a method of keeping time before commencing this tutorial. It can be a stopwatch or any other timing device, which you should have to hand.

ROUTE PLANNING

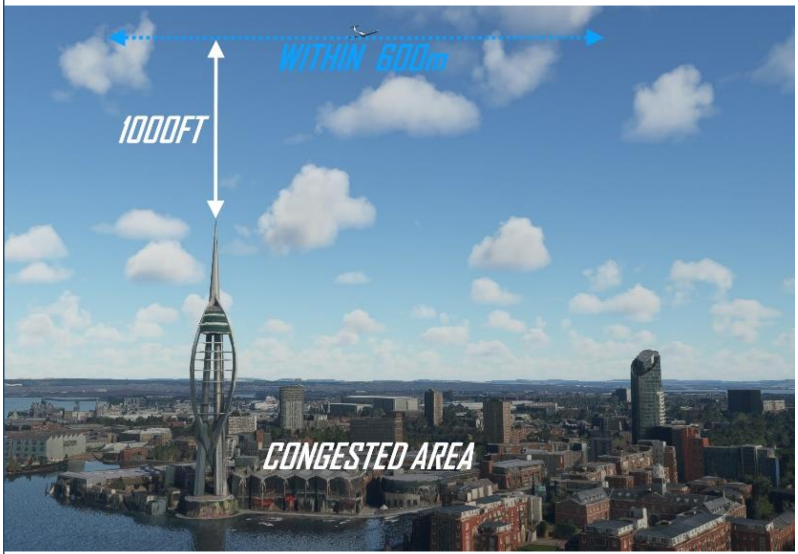
The Navigation Log or 'NavLog' is a top-to-bottom list of each leg of your route with the required altitudes to fly, magnetic headings and enroute times in minutes. Let's look at each of these parameters. You can find all relevant NavLogs for our tutorials in this manual, along with the route maps.

ALTITUDE
The altitude for each leg of your route is determined in the planning stage and is decided upon depending on high terrain, airspace conflicts and cruising level regulations. In terms of minimum altitudes, there are a handful of considerations to be made:

A minimum height of 500ft above the surface or any obstacle within 500ft (150m) of the aircraft must be maintained, except for the purposes of taking off or landing.

Flying at such a low height restricts your options considerably in the event of an engine failure and increases the chance of bird strikes, proximity to hazards such as power lines and less tall obstacles not included on VFR maps, as only those taller than 300ft AGL are represented.

Military low flying is concentrated below 1000ft AGL, particularly in the UK across most of the country, although activity is concentrated along published low level flying routes used by the RAF.
When crossing congested areas such as towns and cities, a safety margin of 1000ft is to be applied to the tallest obstacles within 2000ft (600m) of your aircraft. The ability to glide clear after an engine failure remains a requirement and must also be observed.



The highest terrain within 10nm laterally of your route is noted and a 1000ft (2000ft in mountainous areas) altitude safety margin is added. This figure is known as the Minimum Safety Altitude (MSA).

Airspace is defined by both lateral and vertical dimensions, with the latter reported in altitude. As we saw in lesson 2, we may wish to avoid controlled airspace by flying underneath it.

If planning to fly above 3000ft Above Ground Level (AGL) then VFR cruising levels become a factor. Although they may vary slightly across different countries, the general principle is if you are flying VFR on a westerly heading you are expected to fly at an altitude beginning with an even digit, then add +500ft, e.g. 6500ft. If travelling eastbound, an odd number altitude +500ft would be selected, such as 5500ft.

TRACKING WEST EVEN +500ft	TRACKING EAST ODD +500ft

MAGNETIC HEADING

This is the heading you will fly, as displayed by the cockpit instruments. After drawing a line between two waypoints onto a map by hand, you can use a protractor to obtain the exact direction that the line describes, known as a 'bearing'. From a map, the bearing measured will be in degrees True, which needs converting into degrees Magnetic.

The difference between True and Magnetic bearings are a consequence of the earth's magnetic north not residing at the same spot as the North Pole, where all lines of longitude converge. The angular difference between True and Magnetic bearings is referred to as Variation and is shown on aeronautical maps.

ESTIMATED TIME ENROUTE (ETE)

Using a chosen cruise airspeed for a known distance will result in an 'estimated time enroute' or ETE. If we fly on the correct heading for this calculated time, we will arrive at our waypoint, ready to begin the next leg of our route. Time elapsed can be monitored by stopwatch, aircraft clock or other timekeeping method of your choice.

THE FIVE T's

Upon reaching a waypoint it is time to turn onto the next leg of our route. Even a small error or delay here can cause considerable harm to the accuracy of the next leg, so it is important that we remain organised and have a quick procedure in place to avoid missing any steps. One such system is the Five T's, which list a series of parameters to check and confirm at each turning point:

TURN	Ensure an accurate turn onto your planned magnetic heading
TIME	Start timing for this leg and check the ETE
TUNE	Set radios and transponder codes. Check Heading Indicator
TEMP	Check that engine temperatures and pressures are normal
TANK	Consider switching fuel tank and that sufficient quantities remain

The first item is **TURN**. This emphasises the importance of a correct and accurate turn onto your planned magnetic heading. Be wary of simple mistakes such as turning to 120 instead of 210, as making a wrong move at the start of a leg compromises the accurate tracking of that leg, greatly increasing your chances of going off route and becoming lost.

Once your turn is complete, begin to **TIME** the leg. This can be performed in a number of ways, such as noting the current time on the aircraft clock or starting a stopwatch. Instrumentation can vary greatly between light aircraft types, so ensure you have a satisfactory timing device before departing, as one may not be fitted in the cockpit.

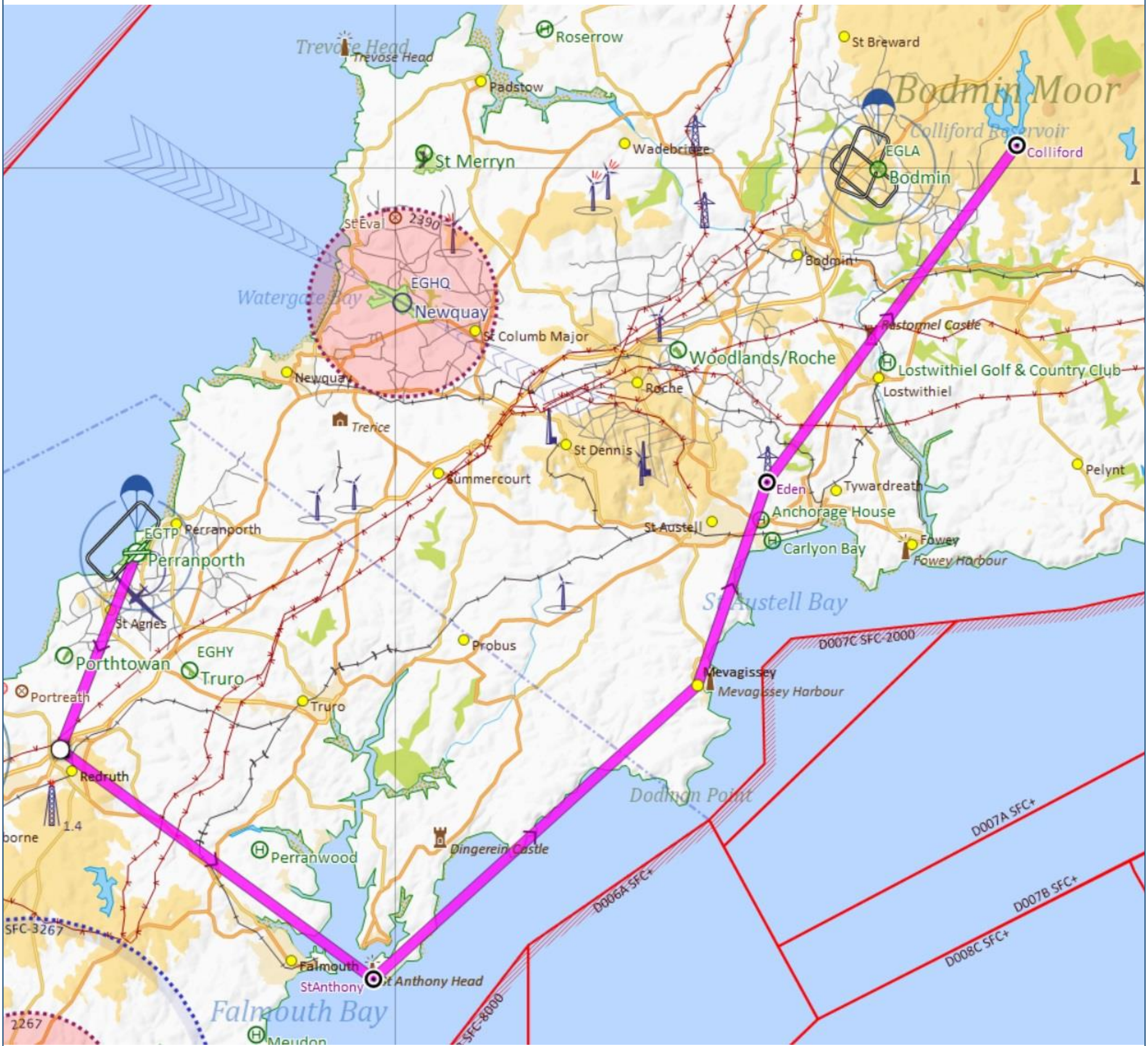
Now that we are on our heading with the clock running, we check for any frequencies that we should **TUNE** into our radio equipment. If we are planning to arrive at a controlled airfield or pass though controlled airspace, we would make a note of the radio frequencies needed for quick reference in flight.

As maintaining an accurate heading is important, we need to periodically check that the Heading Indicator/Directional Gyro is aligned with the magnetic compass, as this instrument will drift over time.

TEMP: Check that engine Temperatures and Pressures (Ts & Ps) are in their normal ranges.

TANK: Fuel leaks can be detected by unexpected imbalances between left and right fuel tanks. Also, some aircraft require that pilot periodically switches which tank is feeding the engine.

MAP – NAVIGATOR 03



Map courtesy of SkyDemon

NAVIGATOR 04.

BLOWN AWAY

Famous for its strong winds, Fuerteventura is the ideal place to demonstrate how the effect of wind plays its part in navigation. Learn the simple clock face method of estimating your drift angle, allowing for a quick calculation of your required heading to keep you on track when the wind blows.

DRIFT ANGLE

We steer the aircraft inflight by turning to a magnetic Heading (HDG), as displayed on the Heading Indicator in the cockpit. Your heading is the direction that the aircraft nose is pointing. This is distinct from the actual path we fly over the ground, which is our Track (TRK).

The difference between our HDG and TRK is known as our drift angle and is the result of the wind. Understanding wind drift is an important aspect of navigation, as we must be able to account for the effects of wind in order to fly the correct TRK between our waypoints.

Wind direction is reported with reference to the direction from which it blows in degrees and its velocity. Therefore, a wind from the west blowing at 10 knots is denoted as 270/10.

In the planning stage, we will obtain the latest wind forecast and use this figure to calculate how much drift angle we can expect on each leg and what HDG we need to steer in order to obtain our planned TRK.

By applying the drift angle to our planned TRK, we get the HDG required for us to steer to follow that TRK.

Although electronic flight planning software will take care of computing the navlog, having a base understanding of the components of drift is beneficial for the VFR pilot to understand, so that quick inflight calculations can be made if needed. We can estimate our required HDG to fly a desired TRK by completing a few steps:

STEP 1 – WIND ANGLE

Finding the difference between our desired TRK and the wind direction gives us our Wind Angle. For example, for TRK090 and a wind of 060/20 then we have a 30-degree wind angle.

STEP 2 – CROSSWIND COMPONENT

To estimate how much of the wind will be acting with a sideways force, known as the crosswind component, we can use a clockface analogy to determine how much of the wind speed we should consider to be acting as a crosswind.

Imagine the minutes on a clockface. In the same sense that 30 minutes is ½ of an hour, a 30-degree wind angle means we take ½ of the wind speed as a crosswind component.

For a 45-degree wind angle, 45 minutes is ¾ of an hour so we would use ¾ of the wind speed as a crosswind component.

If we had a 60-degree wind angle (or greater), 60 minutes is one full hour, so the full wind speed is considered to be a crosswind component.

In our example, we have a 20kts wind from a 30-degree angle. 30-degrees gives a factor of ½, so when applied to the wind speed we get a 10kts crosswind component.

STEP 3 – CROSSWIND COMPONENT vs AIRSPEED

The faster we travel over the ground, the smaller our drift angle will be. If travelling at 60kts our drift angle equals the crosswind component. A 10kts crosswind component at 60kts airspeed gives a 10-degree drift angle.

Doubling our airspeed will halve our drift angle, so if we accelerated to 120kts, our drift angle would halve to 5-degrees. We now apply this drift angle into-wind, to give us our required HDG to steer.

Example: Desired TRK: 120° Wind: 090/20 Airspeed: 120kts

Wind Angle 120 – 90 = 30°

½ of 20 = 10kts crosswind component

Drift Angle: 10 ÷2 = 5° **HDG TO STEER:** TRK120 – 5 Drift Angle = **115°**

NAVIGATOR 05.

STRETCHING YOUR LEGS

More direct routes are possible when you know how to tackle longer legs, which is the subject of this flight across New Zealand's North Island. Use enroute fixes and the drift lines from your map to estimate your tracking and learn how to make corrections to keep you on course.

NAVLOG			
TO WAYPOINT	ALT	HDG	TIME
NGARUAWAHIA	2400	299	9
LAKE WAIKARE	2400	343	8
PUKEKOHE	2400	294	12

A successful route is easiest to achieve when you get off to a good start. If you are planning to fly your first leg at 3000ft and 100kts, ensure that you are stabilised at this altitude and speed before reaching your starting point, as climbs and speed changes enroute will all affect your ETE timings.

Have your maps and timing device to hand and ready for use, remaining mindful of your first turn HDG. When enroute, stick closely to your plan, as any deviations will make error checking and resolving much more difficult.

ENROUTE FIX

When embarking upon longer legs, it is helpful to have selected some ground features along the leg for reference enroute, as gross-error checks. These do not have to be located precisely beneath your flight path, but they should be clearly visible and unlikely to be misidentified, such as the town of Huntly (shown) we have selected as an enroute fix between Ngaruawahia and Lake Waikare.

We can designate an enroute fix by a simple annotation to the map. We'll use a small black line across the magenta track, as shown on the map excerpt below, near Meremere.

During planning, we can add 'drift lines' to our maps, to allow for a quick estimation enroute of our lateral accuracy. The black line we have drawn here from Lake Waikare represents a 10-degree drift line. When checking our position at an enroute fix, if we find that we are on this line, then we have drifted by 10 degrees to the right.

We use the line as a reference for interpolation, so if we are halfway between the magenta track and the black drift line, we have drifted 5 degrees right. Left drift can be determined by super-imposing a mirrored drift line to the left of course, or drawing a second drift line to the left of track. It is best to minimise map clutter however, as each time we draw on a map we obscure ground features, so using your imagination is usually sufficient and keeps the map cleaner.

DRIFT CORRECTIONS

Despite disciplined and precise pre-flight planning, we have to base our navlog calculations on the forecasted wind, which will invariably have slight deviations to reality. This is compounded by any other errors such as HDG accuracy, airspeed discipline and instrumentation limitations all combining to introduce errors into our tracking.

Using our drift lines, we may have determined that we have drifted about 3 degrees to the left of track. If we were to simply turn right 3 degrees, this would stop us from drifting any further to the left, but will only result in us paralleling our track. We want to recapture our route centreline, so instead we turn by double the drift, turning right by 6 degrees.

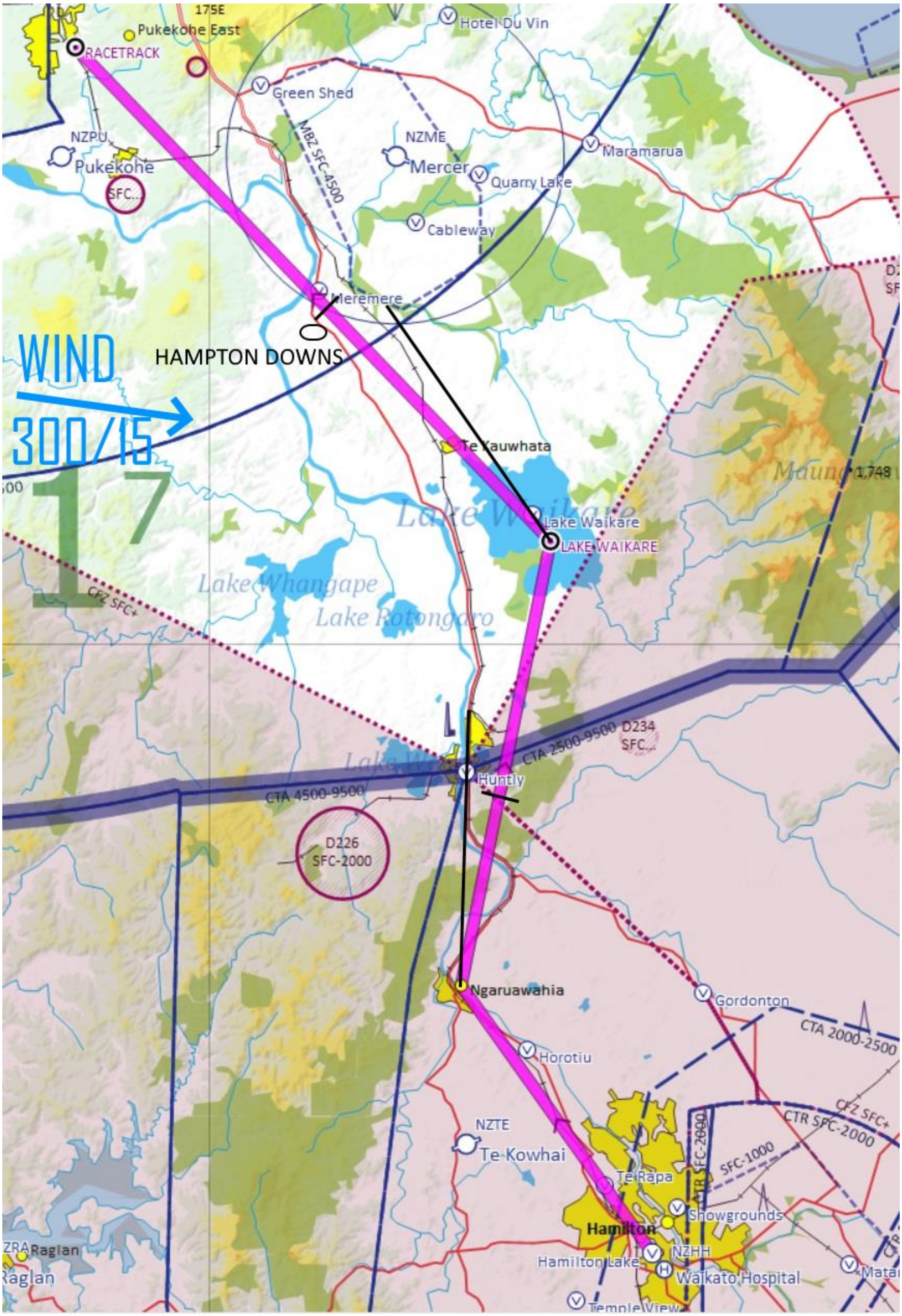
For example, if we find ourselves overhead the town of Huntly, rather than just to the east of it, we have drifted left by around 10 degrees, as shown by the black 10-degree drift line we have drawn. We would now apply double the drift and turn right by 20 degrees, which would start to bring us back on track.

This method works best if the correction is applied around the halfway point on that leg, as this gives equal time for the error to occur and then be corrected for. If applied too early in the leg, doubling the drift may be too much, sending us through the route centreline and off to the right of course.

The next enroute fix on this route is on the Lake Waikare to Pukekohe leg. We have selected a tarmac racetrack and go-kart circuit at Hampton Downs (shown below), represented by the black oval beside the Meremere VRP. We should pass Hampton Downs with it close to our left wing. If you appear to be off-course, check the drift line and interpolate your tracking error, then apply double this error to get you back on course by the time you reach Pukekohe.

You instructor will help you with enroute fixes inflight, giving you an estimation of your drift and what corrections to make.

MAP – NAVIGATOR 05



Map courtesy of SkyDemon

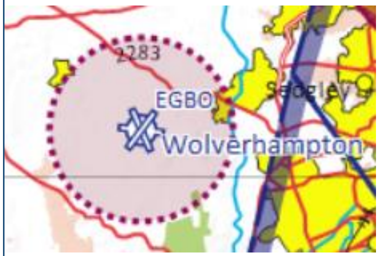
NAVIGATOR 06.
RADAR CONTACT

Venture into controlled airspace for the first time whilst learning how to operate the radios and negotiating an Aerodrome Traffic Zone (ATZ) before flying the special Low-Level Route between Liverpool and Manchester, followed by a zone transit.

NAVLOG			
TO WAYPOINT	ALT	HDG	TIME
STRETTON	1100	204	2
SANDIWAY	1100	208	5
WINSFORD FLASH	1100	138	2

We're going to fly a route across the Greater Manchester and Cheshire regions of the UK to explore how we can utilise the options that are open to us once we understand how VFR flights can integrate into the Air Traffic Control (ATC) system. Whilst it is tempting and, in some ways, simpler to avoid controlled airspace, having the knowledge and reassurance that ATC can lend a helping hand opens up new possibilities for route planning.

AERODROME TRAFFIC ZONE



Whilst large airports will have a Control Zone (CTR), smaller controlled airfields in the UK have an Aerodrome Traffic Zone (ATZ). These surround the airfield with a cylindrical shape, the height of which is 2000ft Above Ground Level (AGL). To determine the ceiling of an ATZ in terms of altitude, add 2000ft to the airfield elevation, which is displayed on the airfield charts, or as shown in your planning software.

The radius of the cylinder depends on the length of the main runway at that airfield. Runways of 1850m and below have an ATZ radius of 2nm (Nautical Miles), whereas the radius around a runway greater than 1850m is 2.5nm.

Some ATZs in the vicinity of other controlled airspace will not have a complete circular shape, but may be 'cut' by the larger airspace, such as in the case of the Manchester Control Area (CTA) and the Barton ATZ. An ATZ may also be established surrounding an offshore installation such as an oil rig.

Levels of ATC service varies between ATZs, the simplest being an 'Information' service, which can provide basic information to pilots such as runway in use and weather conditions, but do not convey any ATC clearances other than taxi instructions.

LISTENING SQUAWK

Although we may be remaining outside of controlled airspace, it is often very sensible to listen-in on or 'monitor' the frequency of nearby airspace, to remain situationally aware and allow the relevant controller to be able to contact us if needed. To signal to ATC that we are outside of airspace but tuned to their frequency, we set a designated Frequency Monitoring Code (FMC) or 'Listening Squawk' into the transponder.

As we progress through the corridor, we will tune to the Manchester FMC of 7366. Once away from the airspace boundary and no longer wish to monitor the frequency, we would re-enter the conspicuity code of 7000.

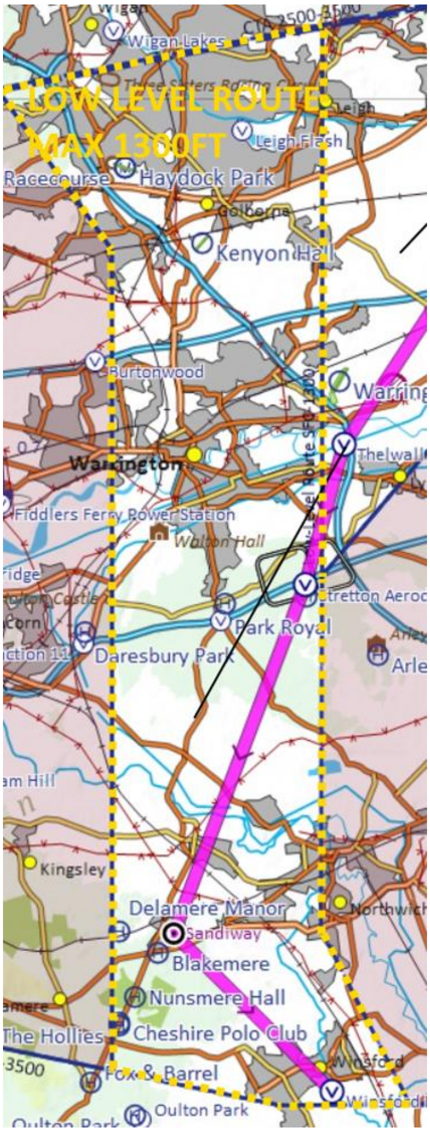
ALTIMETER SETTINGS

As we are often navigating near to controlled airspace, remaining beneath the floor of airspace above us, it is important to ensure that our altimeter is set correctly.

Our primary reference for VFR flight is our altitude Above Mean Sea Level (AMSL) which is correctly displayed on our aircraft altimeter only if we have set the current air pressure reference, known as our QNH.

QNH is reported on the Automated Terminal Information Service (ATIS) of an airfield, which transmits the current weather conditions on a dedicated frequency.

LOW LEVEL ROUTE



This area of the UK is particularly busy, as we have two main airports, several flying schools, major cities and a central location. As Liverpool and Manchester airports are in close proximity, their combined airspace forms a wide zone that would require ATC approval to transit. As there is no guarantee that ATC will be able to accommodate us, we would have to plan a long diversion to circumnavigate this controlled airspace, totalling a distance of around 60nm, compared to a much more palatable 30nm for a straight line through the area.

A compromise was established to greatly ease north/south light aircraft traffic in the form of the Low-Level Route often referred to as 'the corridor'.

The corridor is much like a tunnel that slots between Liverpool and Manchester, allowing passage for VFR traffic as long as they remain below 1300ft altitude.

This of course has the side effect of focussing traffic into a narrow region both laterally and vertically, so traffic activity can be intense and requires an enhanced look out.

We will use the corridor to make our way from Barton airfield to Cheshire, before turning northbound again in the hope of being permitted a transit through the Manchester control zone (CTR).

ZONE TRANSIT

If ATC capacity allows, there is a possibility that a VFR flight may be allowed to fly through the control zone (CTR) of a major airport, known as a zone transit.

This will require us to contact ATC and request the transit, which may consist of flying between VRPs or allocated headings. An 'orbit' may also be required, where we make a 360° turn, much like a holding pattern, to sequence us in relation to commercial traffic which are taking off or landing. This unpredictability makes planning a route through a zone inexact, but will certainly still equate to a more direct and efficient route compared to avoiding the area entirely.

To get the best chances of being permitted to transit, it is best to arrange your flight so that your transit would cause the controller the least amount of disruption. This can be achieved by planning to cross major runways with a perpendicular flight path, rather than attempting to fly down the length of the runway. It is common that you will be instructed to cross over a runway at the landing threshold, as this keeps you out of the way of any departing traffic.

COMMUNICATIONS RADIO

To communicate with ATC and other aeroplanes we operate our communications or 'COMM' radios.

The C152 is fitted with two COMM radios, known as COMM1 and COMM2. For each radio, we have both active and standby frequencies displayed. Turning the knobs on the face of the radio equipment will set the frequency in the standby (STBY) window, which can be made active by pressing the swap button. The larger knob is turned to set the larger frequency numbers before the decimal point, whilst the small knob on top sets the numbers after the decimal.

SPECIAL USE AIRSPACE

During the planning stage, an important aspect to consider is the location of any Special Use Airspace (SUA) near to our route.

There are many classes of SUA, to cover a wide range of aerial activities. These include hang gliding, gliding, training airfields, parachute drop zones and aerobatic flying.

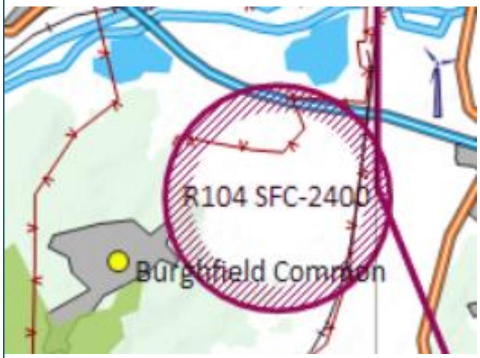
Generally, it is best to avoid these areas outright, as this provides the greatest level of safety to ourselves and those around us, plus it simplifies our route and reduces the risk of airborne conflict.

However, if operating in a busy area and faced with an alternative of a long diversion, flying through a SUA can be done with care. Many are only active between published times or dates, allowing us to safely transit the area in the knowledge that the SUA is not currently active.

A map symbol with a ‘G’ (as seen in the first three symbols above) represents a gliding launch zone and if an altitude figure is also present this indicates that glider winch launches are in use up to that altitude. You must not fly through a launch zone below this indicated altitude as you may encounter a winch cable. ‘2.5’ represents 2500ft AMSL. Where a figure is not provided, towing operations can be assumed, where a powered aircraft tows the glider airborne, which also presents a hazard to passing aircraft.

Once airborne, gliders are not restrained to remain within their launch zone and can be found soaring many miles from their home base, usually accompanied by several other gliders as they tend to congregate around features which produce rising air, known as thermals.

Parachute drop zones often have published hours of activity and may stretch as high as 15,000ft. Hang gliding typically occurs from steep valley walls and cliff edges.



Other areas are designated as Prohibited or Danger areas, which are not to be entered unless confirmed as inactive, although many of these surround sensitive locations such as nuclear power stations and military firing areas and are active at all times.

Whilst services are available at some locations to assist with the controlled transit of Prohibited and Danger areas, such as a Danger Area Crossing Service (DACS), these add complexity and risk of conflict to our route so are best avoided wherever possible.

AIRSPACE CLASSES

The international airspace system is divided up into 'classes.' For a VFR flight, the most relevant classes of airspace will be C, D and G.

Classes A to E are controlled airspace, meaning that you will need permission from ATC before entry. Class G is uncontrolled so can be used with no interaction with ATC.

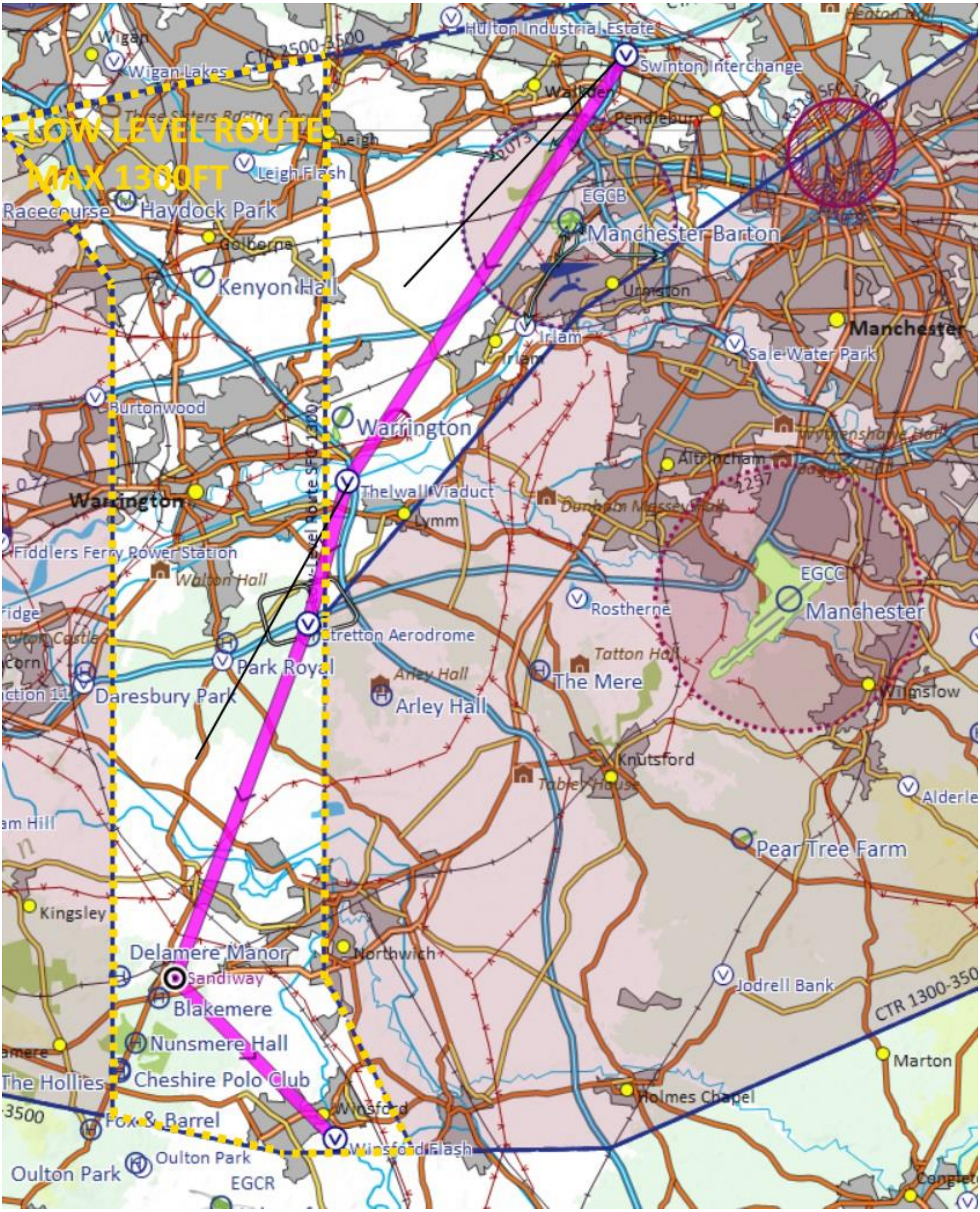
A large controlled airport is typically surrounded by a Control Zone (CTR) which stretches from the ground (also known as the 'surface' or SFC) upwards to around 2500ft. Above the CTR covering greater vertical and horizontal dimensions is the Control Area (CTA).

A CTR is typically Class D, whereas a CTA is usually Class C. The main difference between these two classes for VFR flight is that Class C provides formal separation instructions to keep you clear of other traffic, while only traffic information is passed within Class D.

Class A	Reserved for Instrument Flight Rules (IFR) traffic. No entry to VFR.
Class B	Mainly **Canada + USA**, surrounds busy airports with ATC traffic separation.
Class C	ATC provides separation **INSTRUCTIONS** between VFR and IFR traffic.
Class D	ATC provides separation **INFORMATION** between VFR and IFR traffic.
Class E	Radio not mandatory if VFR. Traffic may be separated if radio is used.
Class G	**Uncontrolled** airspace.

	CONTROLLED					UNCONTROLLED
	A	B	C	D	E	G
RADIO + ATC	NO ENTRY	YES	YES	YES	NO	NO
SEPARATION		ALL	FROM IFR	INFO	INFO	NO
SPEED LIMIT		NO	YES	YES	YES	YES

MAP – NAVIGATOR 06



Map courtesy of SkyDemon

NAVIGATOR 07.

FROSTBITE

Keep the show on the road after temperatures plummet and the snow moves in. Take to the skies above southern Sweden to learn how to adapt to the new perspective offered by a snowy landscape so that the winter months do not leave you grounded.

NAVLOG			
TO WAYPOINT	ALT	HDG	TIME
YSTAD	2400	141	8
SMYGEHUK	1400	238	9
HÖLLVIKEN	1400	279	8
MALMÖ	2400	005	7

We will take to the skies above the Skåne region of Sweden to take a look at how our ground features can become unusable or of changed appearance after snowfall.

Winter flying does have the benefits of generally quieter airspace, allowing more direct routings and calmer weather conditions, providing smooth cruising.

Engine power is also aided by cold air, so aircraft performance is enhanced, reducing fuel consumption. The winter landscape offers a scenic and impressive view on a clear day, which coupled with the efficiency benefits and more direct routings make winter flying rewarding, as long as we are aware of the hazards.

Many of our ground features such as disused airfields, small roads and grass airstrips are concealed by snow and therefore unreliable as visual references.

AIRCRAFT ICING

We must be wary of icing conditions in the winter months, as all traces of icing must be removed from the aircraft before departure, which can involve expensive and time-consuming de-icing procedures, which may not be available at all airfields.

Inflight protection is also required, as icing can block the air intakes of critical instrumentation, rendering them useless. To protect our airspeed indicator, we have the pitot heating system, which electrically heats the pitot tube, used to measure the pressure of the oncoming airflow for conversion to an indicated airspeed. If our pitot tube becomes blocked with ice, the pitot tube will no longer be able to detect oncoming airflow and so our airspeed indication will drop to zero.

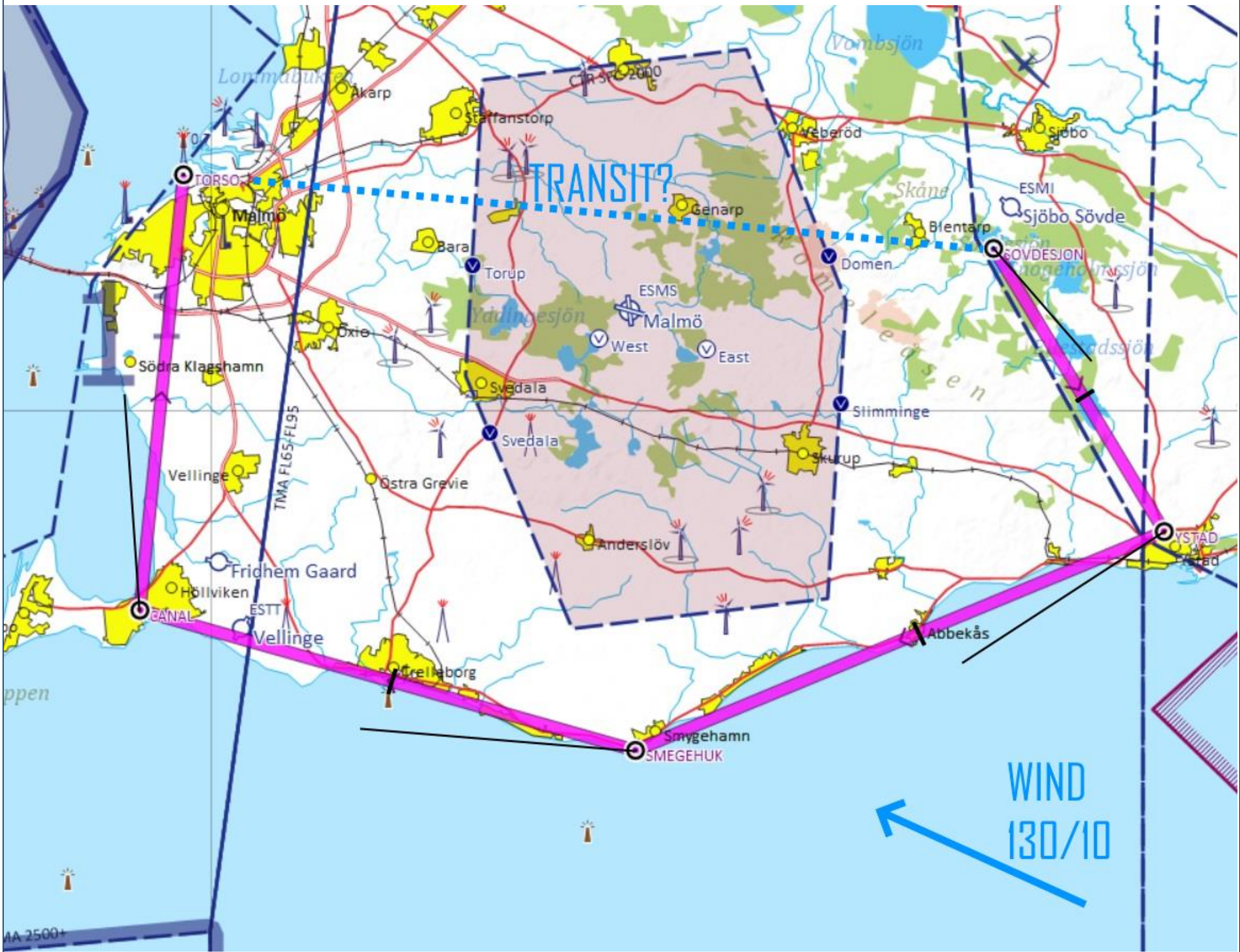
Sharp objects, such as the pitot tube, are usually the aircraft parts that freeze first, which is why the pitot system in particular has a dedicated heating system.

To turn on the pitot heat in our Cessna, use the switch below the instrument panel. You may need to click on the yoke to hide it, as the yoke may block your view of the pitot heat switch. Click again to unhide the yoke afterwards.

When considering your view of the landscape, as the removal of snow and ice is expensive and resource intensive, usually only major infrastructure is kept clear, such as main highways and airport runways. Smaller grass airstrips are unlikely to receive this treatment, so be sure that the airfields you are planning to fly to or use as potential diversions are in fact open at the time of your flight.

As daylight hours are shorter in the winter, give thought to your expected arrival time, as what may seem only a moderate delay to departure could push your landing time back to after dark, which has its own set of considerations as discussed in the next tutorial.

MAP – NAVIGATOR 07



Map courtesy of SkyDemon

NAVIGATOR 08.

NIGHT SHIFT

Be adaptable to the lighting conditions and see how you may need to reconsider your options when operating after dark.

Once the daylight fades, we still need to retain the ability to navigate cross-country if we are to have the full skill set of a VFR navigator. We will tour the skies above Las Vegas on a clear evening to introduce how the picture changes after the sun goes down.

GROUND FEATURES

We must adapt our choices of waypoints to include ground features which remain useful after dark. Features that may be highly visible and practically unmissable in the daytime can appear to vanish after nightfall, so more care is to be taken when forming a route.

In a similar fashion as winter flying, many of the minor airfields and ground features may be less visible or unavailable after sun-down, reducing our options considerably.

One of the most significant changes to our choice of waypoints is the highly visible street lighting of towns and cities, possibly providing visibility of many miles and being much easier to spot than during daylight hours. Conversely, most natural features such as rivers, ridges and water bodies become practically invisible at night, so these would be unwise waypoint or enroute fix choices for a VFR night flight.

The lack of a clear horizon will make visual flight more challenging, as you will have to give more importance to your Attitude Indicator (AI) to ensure the correct flying attitudes, especially the enforcement of level wings to avoid drifting off your headings.

LIGHTING

Airfield lighting will generally be one of two extremes. The airport may come to life after dark with an array of runway and approach lighting systems, or fade away into the darkness and be impossible to see. Airfield lighting in the USA usually includes an airfield beacon, which rotates on top of a tall mast and is seen as a flashing green and white light, making picking out an airfield surrounded by built up areas easier.

Civil and military airfields are distinguished by a change to the flashing of the airfield beacon. A civil airport beacon will have one green flash followed by one white flash, whereas at a military installation the green flash is followed by two white flashes. Note that the presence of a beacon helps with visually acquiring an airfield at night, but does not guarantee that the airfield is open to traffic, nor do the regulations require a beacon to be used.

Tall buildings and manmade obstacles may be fitted with red lights to assist visibility in the dark, but there will unlikely be the presence of any lighting on steep terrain and other natural features, so particular attention must be given at the planning stage with regards to obstacles and high terrain along your flight path. Be aware that VFR maps will only display obstacles such as masts that are greater than 300ft AGL and such smaller structures may also be unlit.

In clear conditions, other aircraft become considerably easier to spot at night, as all aircraft approved for night-flight are required to be equipped with a system of lights, which not only make the aircraft visible after dark but also provides an indication of its direction of travel.

The right wingtip is fitted with a green position light, with a red light fitted to the left wingtip and a white light on the tail. This gives orientation information to the observer, as it is possible to interpret the direction of travel based on which lights are visible.

For example, if only a green light is in view, the observer can be sure that they are looking at the right wing of the traffic. If both red and green position lights are in view, you are approaching roughly head-on.

Sports stadiums can be large, brightly-lit landmarks when a game is on, but may not be nearly as conspicuous in the off-season. Their usage for night navigation is often best if treated opportunistically, rather than a fundamental part of your plan. A delayed departure, stadium power failure or game cancellation could all scupper your plans and require last minute in-flight replanning.

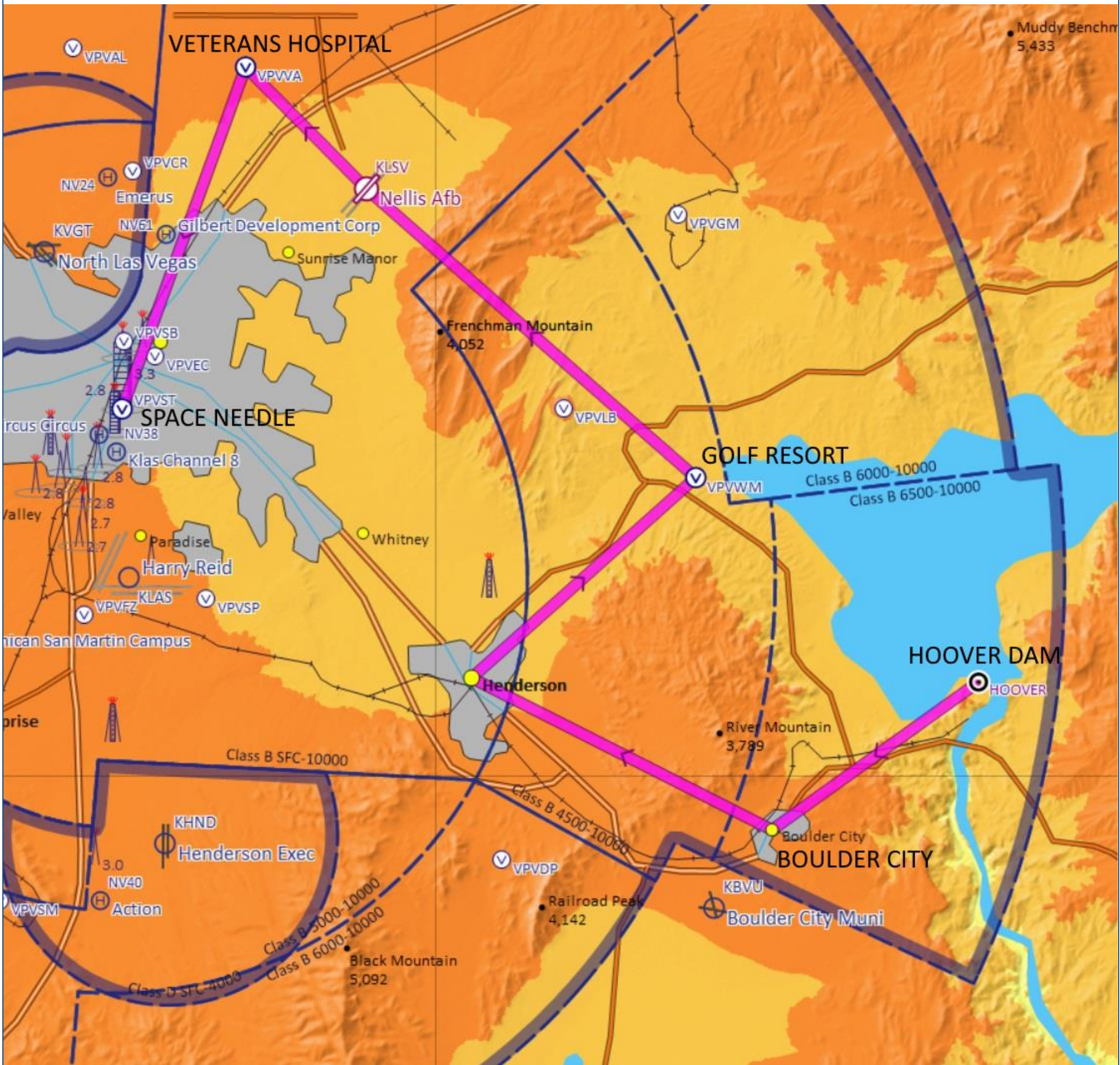
In all cases, care must be taken when selecting point features that are lighting dependant, as there is no guarantee that these lights will be operational at the time of your flight. Towns and cities present highly visible area features, with only the very unlikely possibility of a widespread blackout causing a threat to their use.

NIGHT VISION

Preserving your night vision is an important aspect worth considering. Picking out VFR waypoints in the dark, lit or otherwise, will be more difficult if you have not allowed your eyes to properly adjust to low lighting conditions.

It can take around 30mins to gain full night adaptation, but even a single flash of white light can reset your vision, requiring an additional 30mins to restore. Keep cockpit lighting low, and avoid the use of flashlights or camera flashes. Red lighting has a far lower impact on night vision, so any additional lighting should be red in colour wherever possible. Be aware however, that reading a map under coloured light will affect its appearance as some colours on the map will be absent when lit monochromatically.

MAP – NAVIGATOR 08



Map courtesy of SkyDemon

NAVIGATOR 09.

MOUNTAINEER

Forced down into the valleys by low cloud, complete your route to Chambery through the twists and turns of mountain flying.

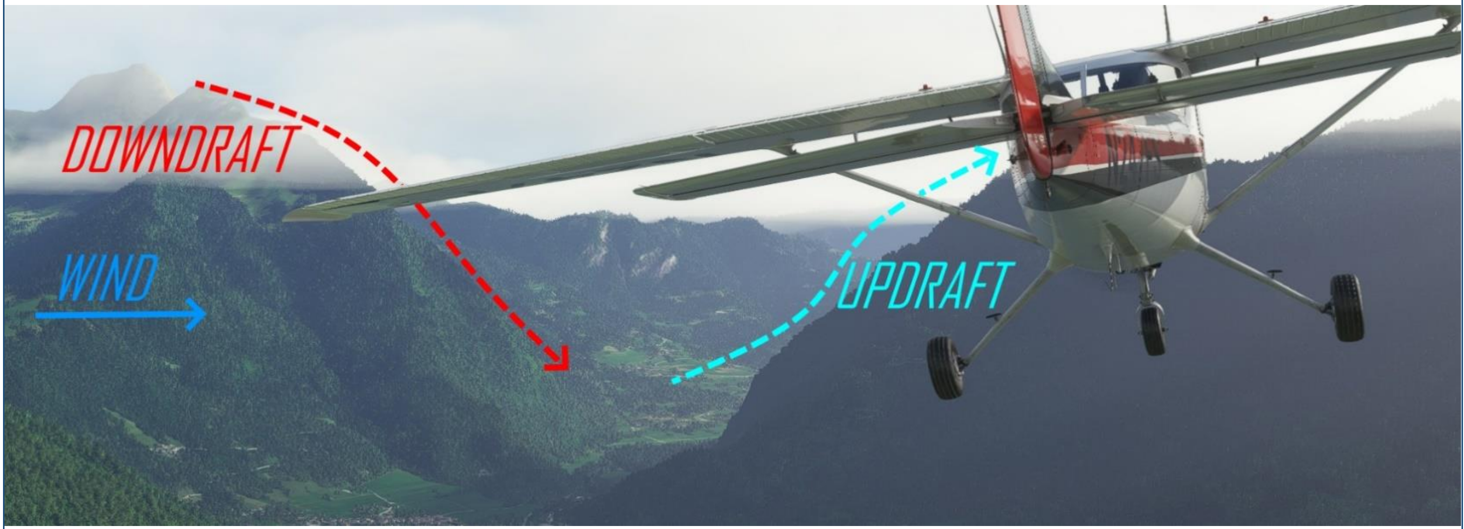
NAVLOG			
TO WAYPOINT	ALT	HDG	TIME
FAVERGE	4000	143	8
VAL DE CHAISE	"	059	2
UGINE	"	194	3
ALBERTVILLE	"	194	3
INTERCHANGE	"	232	10
CHAMBERY	"	315	3

A system of designated routes is often available for popular mountainous regions, allowing for easy flight planning and making your flight path and those of other traffic easy to predict and communicate. In this lesson we will find that our original intended route has become unavailable by cloud which is lower than forecast, causing us to take the longer routes through a series of valleys in the French Alps.

The twists and turns of a valley flight makes the importance of correct identification of your turning points all the more critical, as one wrong turn could easily lead you towards a dead end in the valley or lead you astray more subtly, with your confusion growing as the miles pass.

When identifying features, avoid the temptation to succumb to what is known as "confirmation bias" where you consider only the clues which agree with your assumptions and disregard those that defy them.

VALLEY AIRFLOW

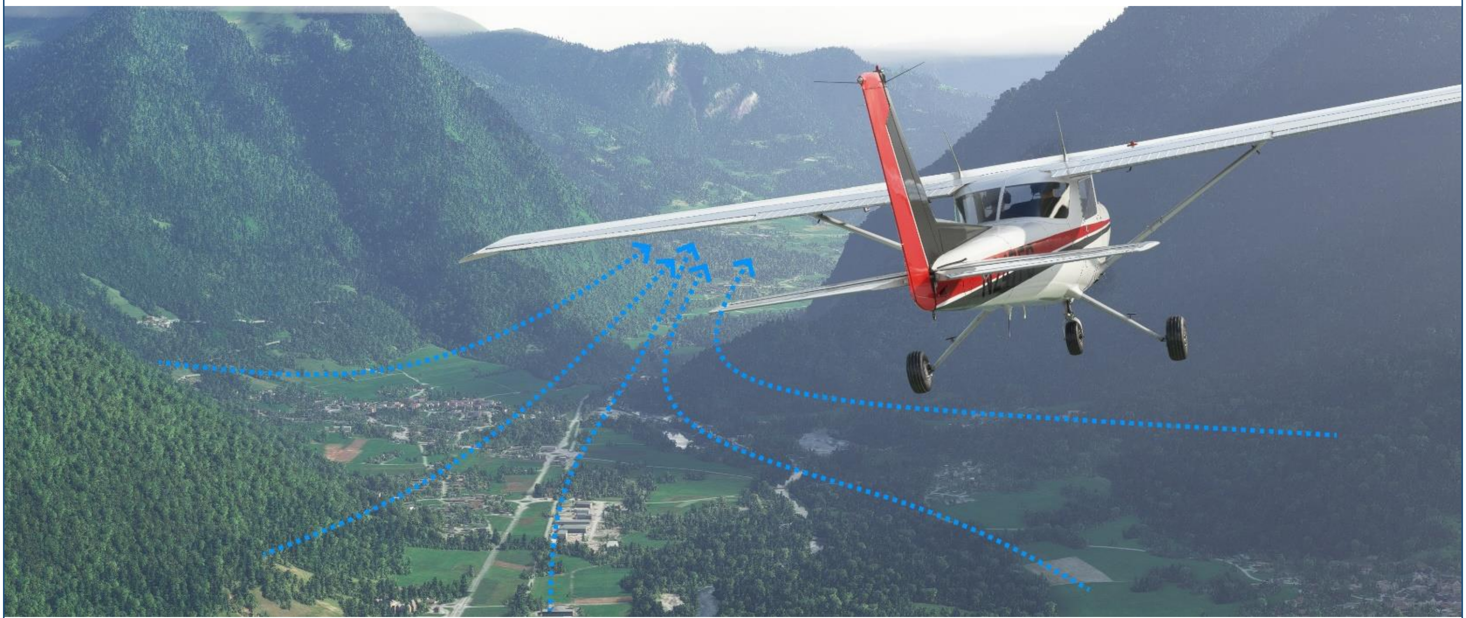


Valley flying can present a multitude of hazards to the uninitiated, even on days with otherwise moderate weather conditions. Wind has a profound effect on the safety of a mountain route, as the air acts much like fast-flowing water, spilling down one valley wall and rushing up the other. A downward flow of air is called a downdraft and when strong, they can prove to be hazardous to light aircraft. They occur on the downwind (leeward) side of the valley. Where the air is pushed up and over the upwind (windward) side, the rising air is an updraft and makes for much smoother conditions.

Fighting a downdraft can cause you considerable difficulties, such as uncontrolled descent, severe turbulence and considerable loss in performance. An updraft however can be very beneficial, allowing you to ride along a wave of rising air, saving fuel and enhancing climb performance. It should be noted however that the attraction of an updraft can cause a congregation of other traffic and gliders, who are also looking for an easy path through the valley.

In windless conditions, it is customary to fly on the right-side of a valley, to aid with separation with opposite direction traffic. During stronger wind conditions this may no longer be safe or possible, so beware of oncoming aeroplanes that may be flying along the same valley wall as you are.

As air reaches a restriction, such as a narrowing of the valley, the venturi effect can cause the wind speed to increase locally and rapidly. This can be troublesome when flying with a tailwind as the speed of this tailwind can quickly increase, leaving you with a loss of lift. As you take the turns through a valley route, the air can do more unpredictable things such as quickly changing direction or speed, so high wind speeds must be a careful consideration if planning a mountain flight.



Strong sunshine can also cause effects to the air, as exposed rock surfaces can heat quickly in the sun, causing strong but very localised columns of rising air known as thermals. The same bright sun can cause dark shadows, obscuring potential obstacles such as rock formations, trees or cables that might stretch across the valley.

MAXIMUM ELEVATION FIGURE

Maximum Elevation Figures (MEF) are depicted on VFR charts to alert the pilot regarding the highest elevation within a particular grid square on the map. The most common method to determine the MEF is to take the highest point of terrain within each grid square and then add a 300ft margin before rounding up. If 13_4 is indicated, this represents an MEF of 13,400ft.

These figures give rough terrain clearance guidance at a glance, which can be especially useful when having to leave your planned route due to weather or airspace restrictions. Note that each map provider may have differing criteria for determining an MEF, so care should be taken to add your own safety margin.

MAP – NAVIGATOR 09

Map courtesy of SkyDemon

NAVIGATOR 10.
SKYLINE

What better place is there to take in the NYC skyline than from your airborne vantage point above the Hudson. Take advantage of a Class B Exclusion Zone and slip through the crowded New York airspace and around the Statue of Liberty.

Major cities around the world are usually surrounded by one or more international airports, with their associated airspace network. Such busy areas could be impassable by light VFR traffic, as the constant flow of jetliner traffic would preclude any possibility of a zone transit. To help alleviate this issue for VFR pilots, many locations have incorporated special procedures to allow safe transit.

In the USA these often take the form of 'Flyways' which are agreed routes across busy metropolitan areas, where VFR traffic can make their way across the city, safely keeping out of the way of commercial traffic.

The route we're going to take will allow us to follow the Hudson southbound, passing NYC on our left and New Jersey on our right. To do this, we will use the 'Class B Exclusion Zone', part of the New York Special Flight Rules Area (SFRA).

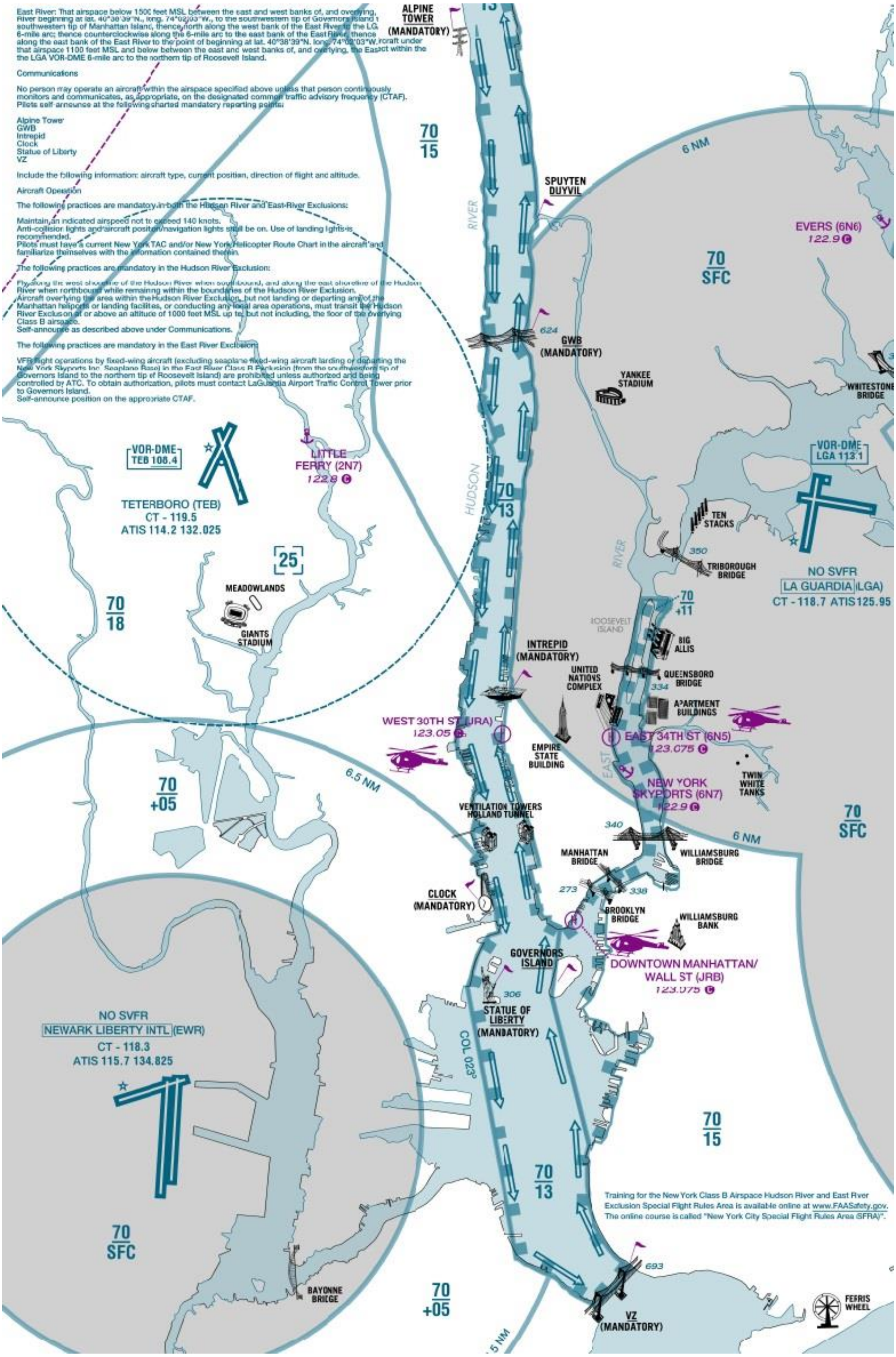
The concept is simple, if we remain below 1300ft and keep to the right-side of the river, we can traverse this otherwise intensely busy airspace. We will need to make position reports as we pass each 'mandatory reporting point' along the designated route, using the following format:

AIRCRAFT TYPE – LOCATION – ALTITUDE – DIRECTION

Example: **"Cessna – Statue of Liberty – 1000ft – Southbound"**

This will be transmitted on the assigned Common Traffic Advisory Frequency (CTAF). This type of radio frequency is dedicated to pilot-pilot communication, allowing VFR pilots to remain aware of each other's locations and avoid other aircraft without the supervision of ATC.

MAP – NAVIGATOR 10



NAVIGATOR 11.

ISLANDER

Traverse the stunning landscape surrounding the Isle of Arran, Scotland, crossing stretches of water as you set up for the VFR entry procedure into Glasgow, keeping and eye on your fuel mixture.

NAVLOG			
TO WAYPOINT	ALT	HDG	TIME
MOUNT STUART HOUSE	4000	059	6
INVERKIP	1900	034	5
GREENOCK	"	056	3
BISHOPTON	1100	106	4

VFR ENTRY/EXIT ROUTE

Traffic flying under IFR (Instrument Flight Rules) routinely follow pre-determined routes to and from airfields, known as STARs (Standard Terminal Arrival Routes) and SIDs (Standard Instrument Departures). VFR traffic can take advantage of a similar philosophy, where dedicated routes are established to allow aircraft to enter and exit a control zone in an organised manner, known as Entry/Exit routes.

Common at UK airports, the use of Entry/Exit procedures allows for simplification of ATC clearances. To arrive at Glasgow, we are going to follow the River Clyde entry route.

WATER CROSSING

Modern and well-maintained aircraft engines are incredibly reliable. However, once faced with the prospect of a large stretch of water, having some background knowledge of your gliding ability becomes more of a priority. As a general rule in an aircraft such as our C152, you can glide 1.5nm for every 1000ft of altitude. We will cross over from the Isle of Arran to the Isle of Bute, which involves a water crossing of roughly 6nm in length.

To calculate a suitable altitude to enable us to glide clear in the event of an engine failure, we can divide the distance by our 1.5nm gliding range:

6NM ÷ 1.5 = 4000ft

This is of course a conservative figure, as this would allow us to glide the full 6nm distance, whereas our real worst-case scenario is for the engine failure to occur once furthest from land, at the halfway point.

FUEL MIXTURE

Aircraft engines perform most efficiently at an optimal fuel:air ratio. When flying at higher altitudes, the air becomes less dense, so we need to reduce the fuel flow to help preserve our fuel:air balance.

The engine is considered to be running 'rich' if too much fuel is being supplied. This can cause carbon deposits within the engine and cause rough running and poor fuel economy.

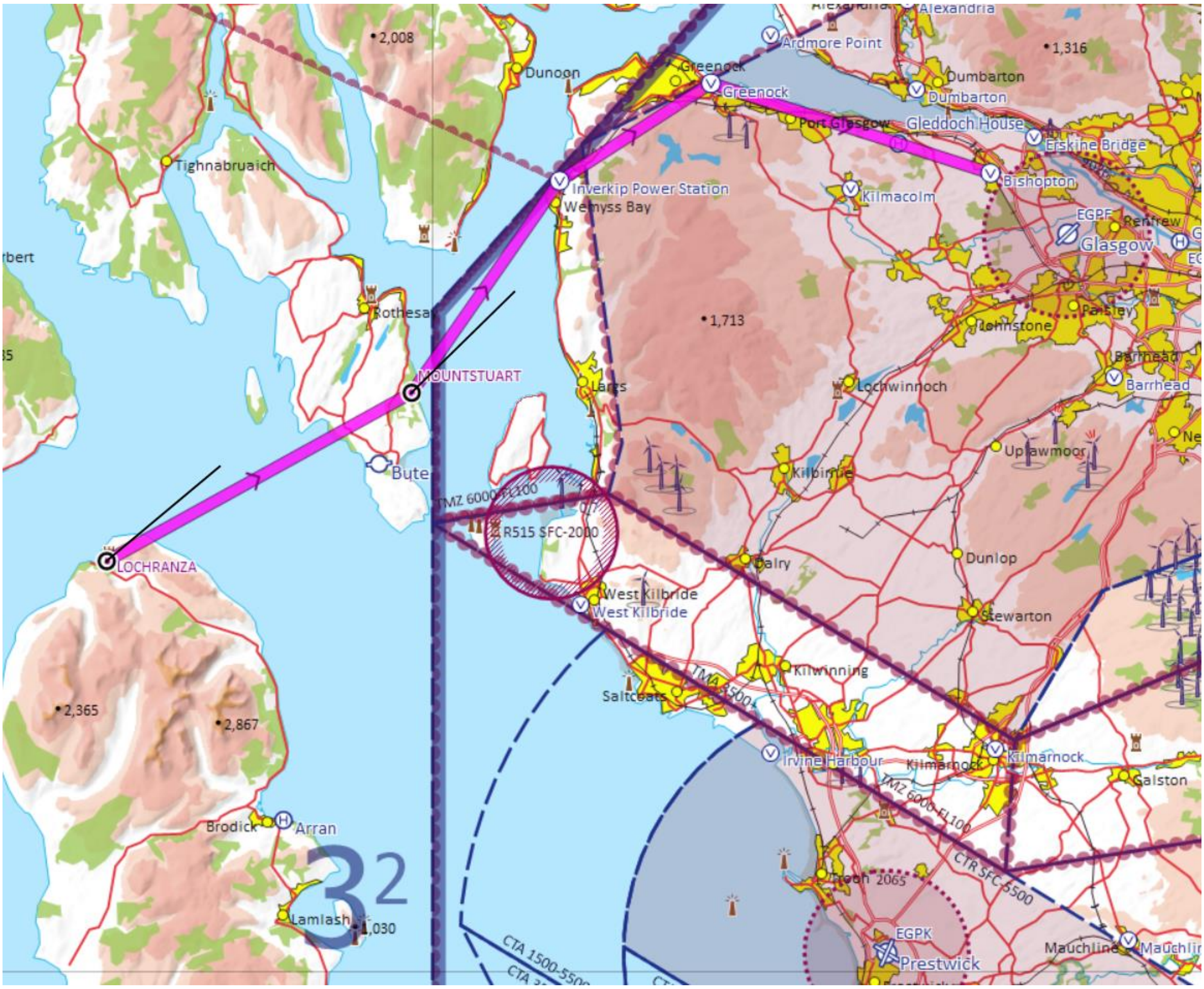
The red mixture control knob is used to reduce the engine's fuel flow slightly, a process known as 'leaning' the mixture.

Be sure not to pull the mixture control back too far, as this will close the fuel supply completely and shut down the engine!

Once flying level after a climb, lean the mixture by pulling the mixture control back a small amount, until you notice the engine RPMs rise. Leaning too much will cause the RPM to drop again and engine temperature will start to rise. Find the mixture setting that gives the highest RPM.

When coming in to land, the mixture is returned to full rich, so that maximum fuel is available in the event of full engine power being required for a go-around.

MAP – NAVIGATOR 11



Map courtesy of SkyDemon

NAVIGATOR 12.
HIGHLANDER

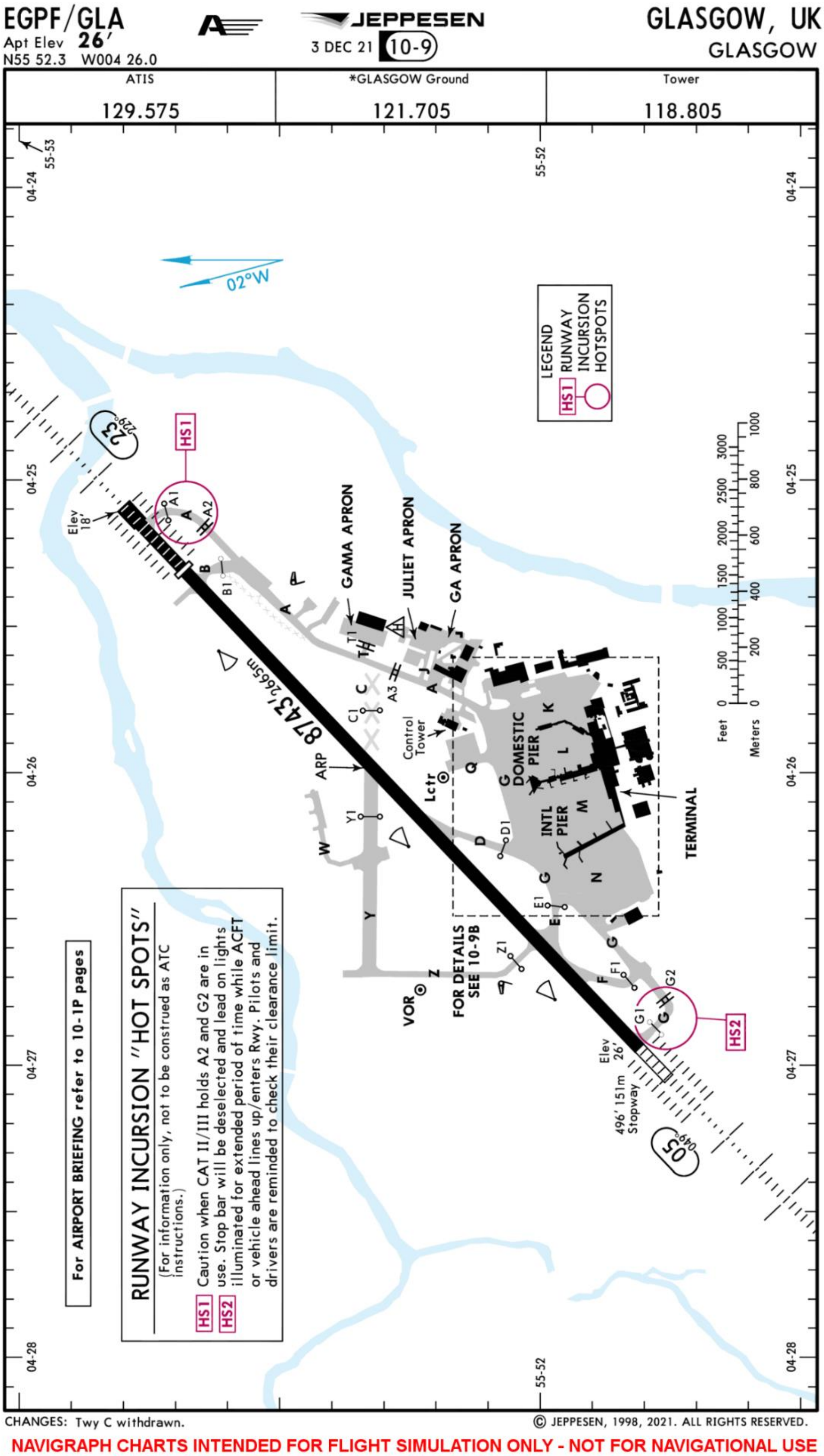
Put your new skills to practice and complete your Navigator experience by going solo and taking to the skies above the Scottish Highlands, looking down upon some of the most glorious landscapes imaginable in this authentic multi-leg Bush Trip.

Find Navigator 12. Highlander within the Bush Trip category of your Custom Content menu.

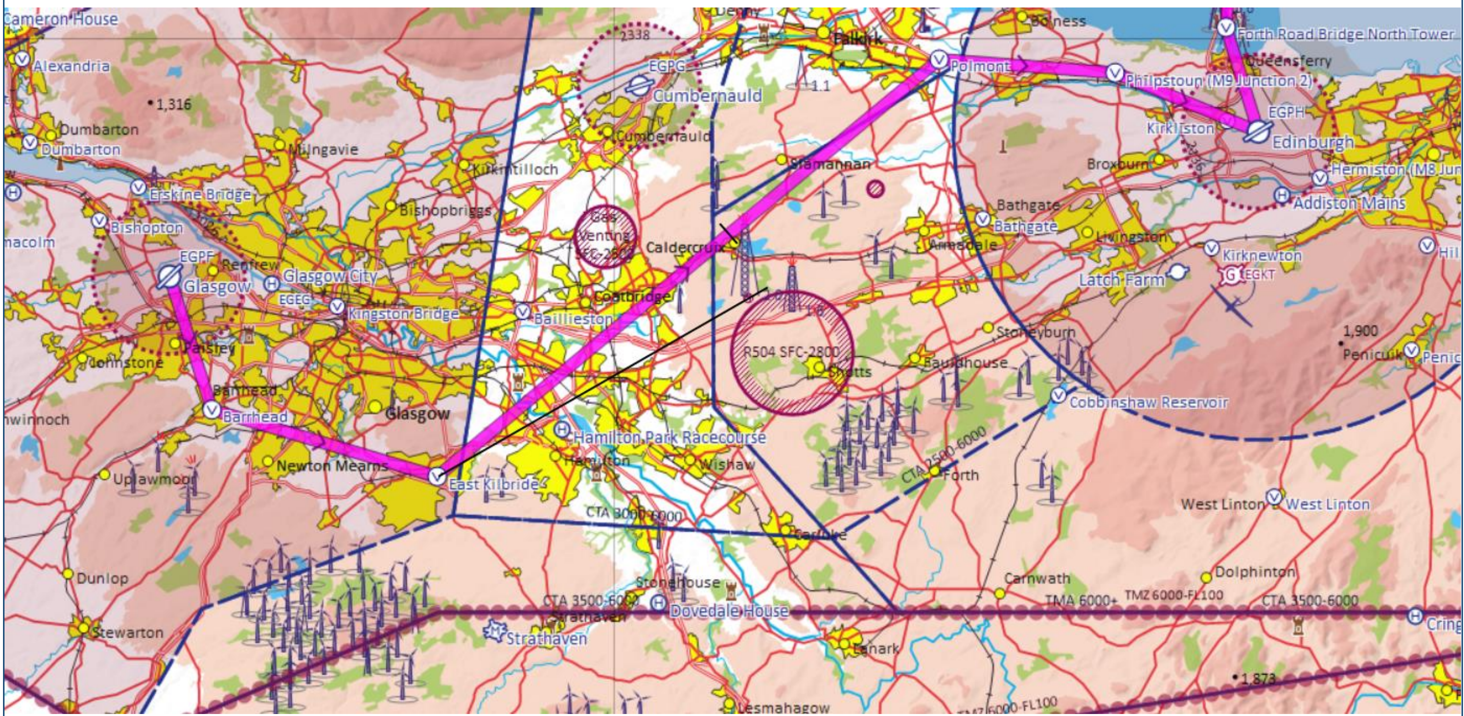
Split up into 5 legs, this trip will take you across the Highlands and give you ample opportunity to settle into a longer journey, putting your new skills to good use. Use the in-game navlog to see your headings and ETEs in-flight, which also features a stopwatch function to help you keep track of the time enroute. We have provided the airfield charts for those destinations that have published Jeppesen charts (all except for Oban), courtesy of Navigraph.

NAVLOG			
TO WAYPOINT	ALT	HDG	TIME
BARRHEAD	2000	163	3
EAST KILBRIDE	"	104	4
POLMONT	"	048	12
PHILIPSTOUN (M9 J2)	"	092	3
EGPH - EDINBURGH	ELEV 136	110	3
FORTH ROAD BRIDGE	3000	344	2
KELTY	"	004	4
PERTH	"	354	9
EGPN - DUNDEE	ELEV 17	074	8
BROUGHTY CASTLE	1100	080	3
FORFAR	3000	357	6
LAURENCEKIRK	"	048	10
STONEHAVEN	1400	045	6
GIRDLE	"	025	7
BRIDGE OF DON	"	335	1
EGPD - ABERDEEN	ELEV 215	299	3
KINTORE	1400	296	3
INVERURIE	"	340	2
INSCH	"	299	4
HUNTLY	4500	321	5
KEITH	"	321	4
FOCHABERS	"	316	3
FORRES	"	275	9
EGPE - INVERNESS	ELEV 31	261	8
INVERNESS	CLIMB	237	4
DORES	4500	218	3
FORT AUGUSTUS	"	223	9
FORT WILLIAM	"	220	12
CORRAN POINT	"	223	4
CASTLE STALKER	DESCEND	212	5
EGEO - OBAN	ELEV 24	187	4

EGPF - GLASGOW

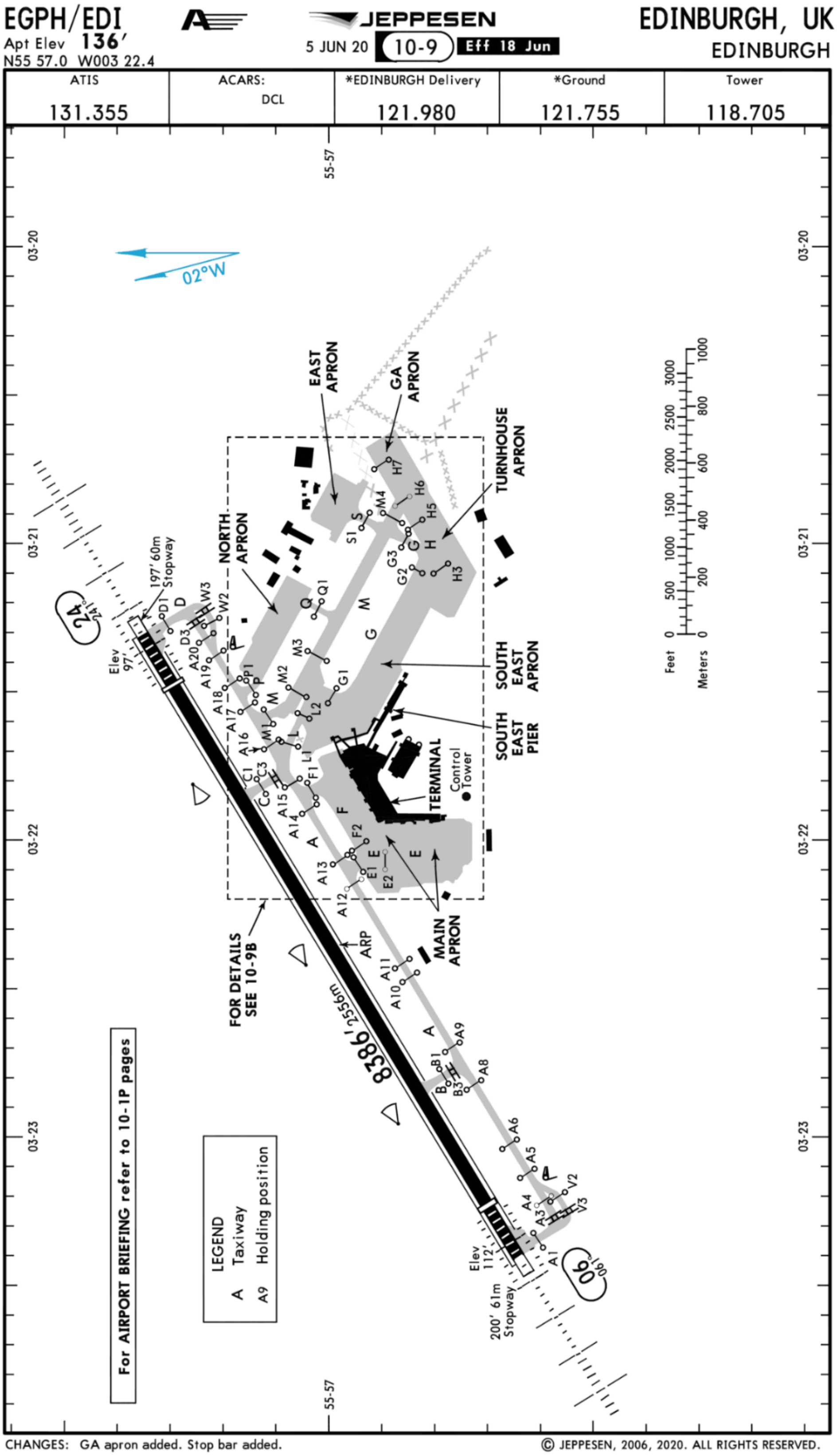


LEG 1 – GLASGOW TO EDINBURGH



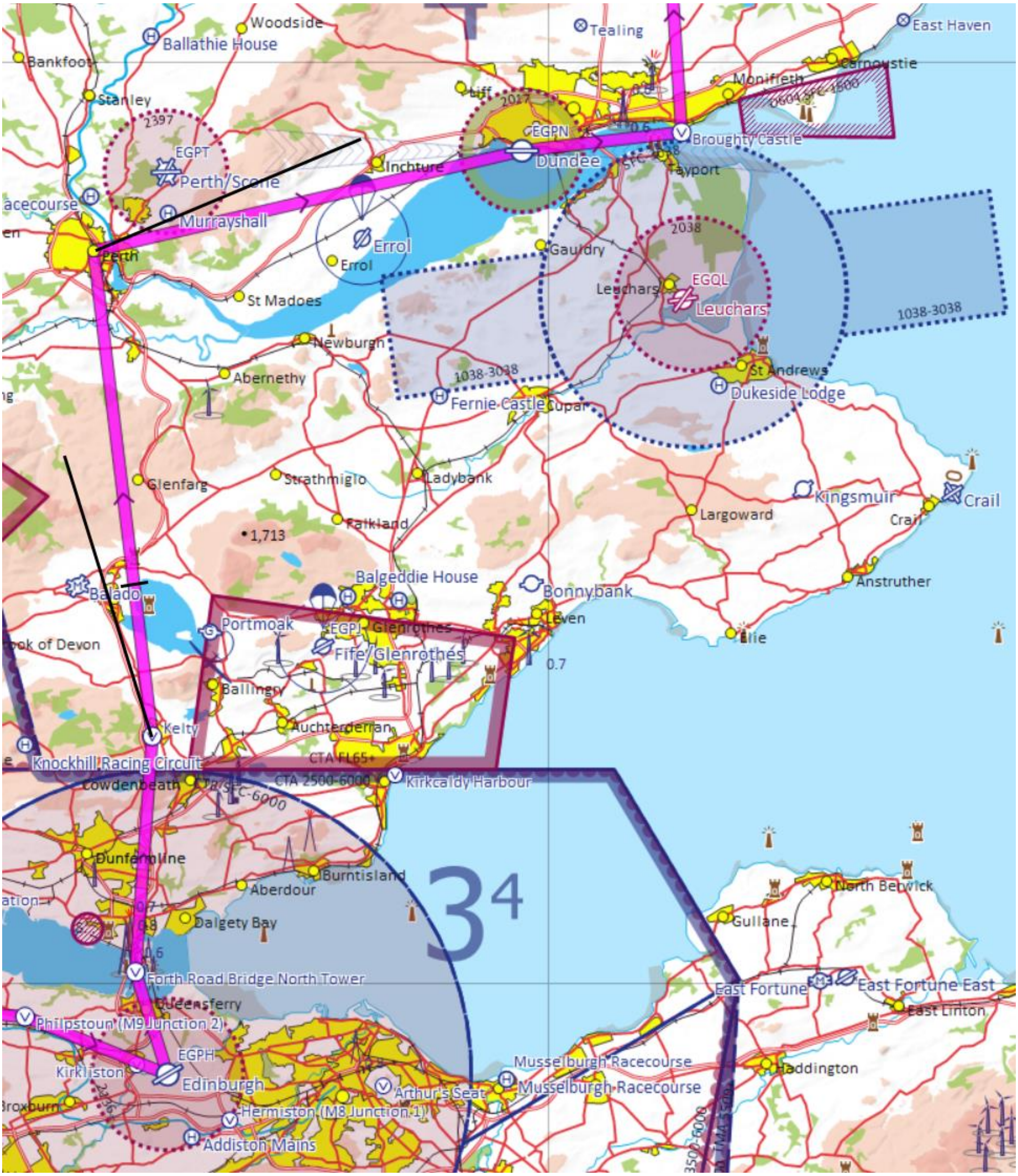
Map courtesy of SkyDemon

EGPH - EDINBURGH



NAVIGRAPH CHARTS INTENDED FOR FLIGHT SIMULATION ONLY - NOT FOR NAVIGATIONAL USE

LEG 2 - EDINBURGH TO DUNDEE



Map courtesy of SkyDemon

EGPN - DUNDEE

EGPN/DND
Apt Elev **17'**
N56 27.2 W003 01.6

JEPPESEN
30 JUL 21
Eff 12 Aug
(10-9)

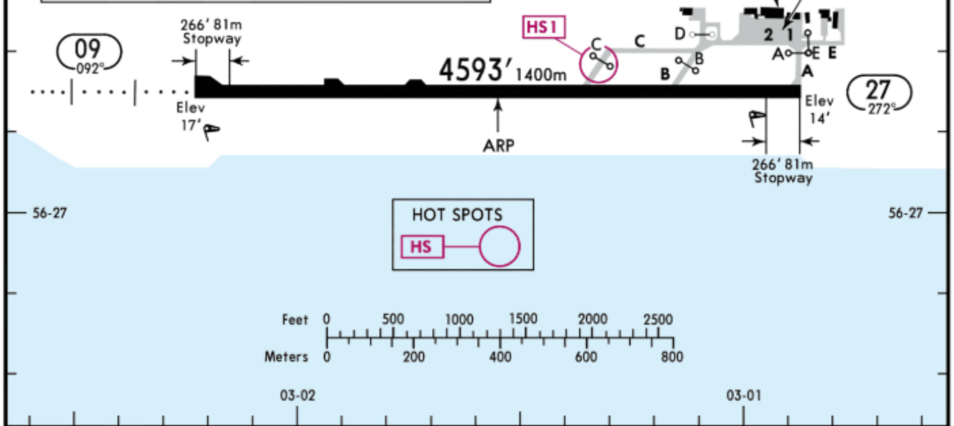
DUNDEE, UK
DUNDEE

*ATIS	*DUNDEE Tower
119.330	122.905

Birds in vicinity of airport. Helicopter activity North of treshold 09.
Start-up requests are mandatory for all aircraft parked on the Main and Western Aprons.
Twy C restricted to acft with max 5700 kg. Twy C available DAYLIGHT only and by ATC.
Due to constraints of the circuit, increased chance of TCAS events occuring whilst joining or flying within visual circuit. Rwy 09 right-hand circuit.

High visibility clothing is mandatory.
Possible turbulence on both runways during strong north winds.
Auxiliary Power Units are only to be operated 30 minutes after/before on/off block times.
Extremis request outside these times are at the discretion of ATC.

PARKING POSITIONS	
STAND	COORDINATES
1, 2	N56 27.2 W003 00.9



ADDITIONAL RUNWAY INFORMATION

RWY			USABLE LENGTHS LANDING BEYOND Threshold	Glide Slope	TAKE-OFF	WIDTH
09	HIRL HIALS PAPI-L(angle 3.0°)	grooved		3801' 1159m	4327' 1319m	98' 30m
27	HIRL PAPI-L(angle 3.75°)	grooved				

HOT SPOTS

For information only, not to be constructed as ATC instructions.

HS1 Restricted view of C hold from Control Tower. No Guard Lights.

Standard TAKE-OFF & DEPARTURE PROCEDURE

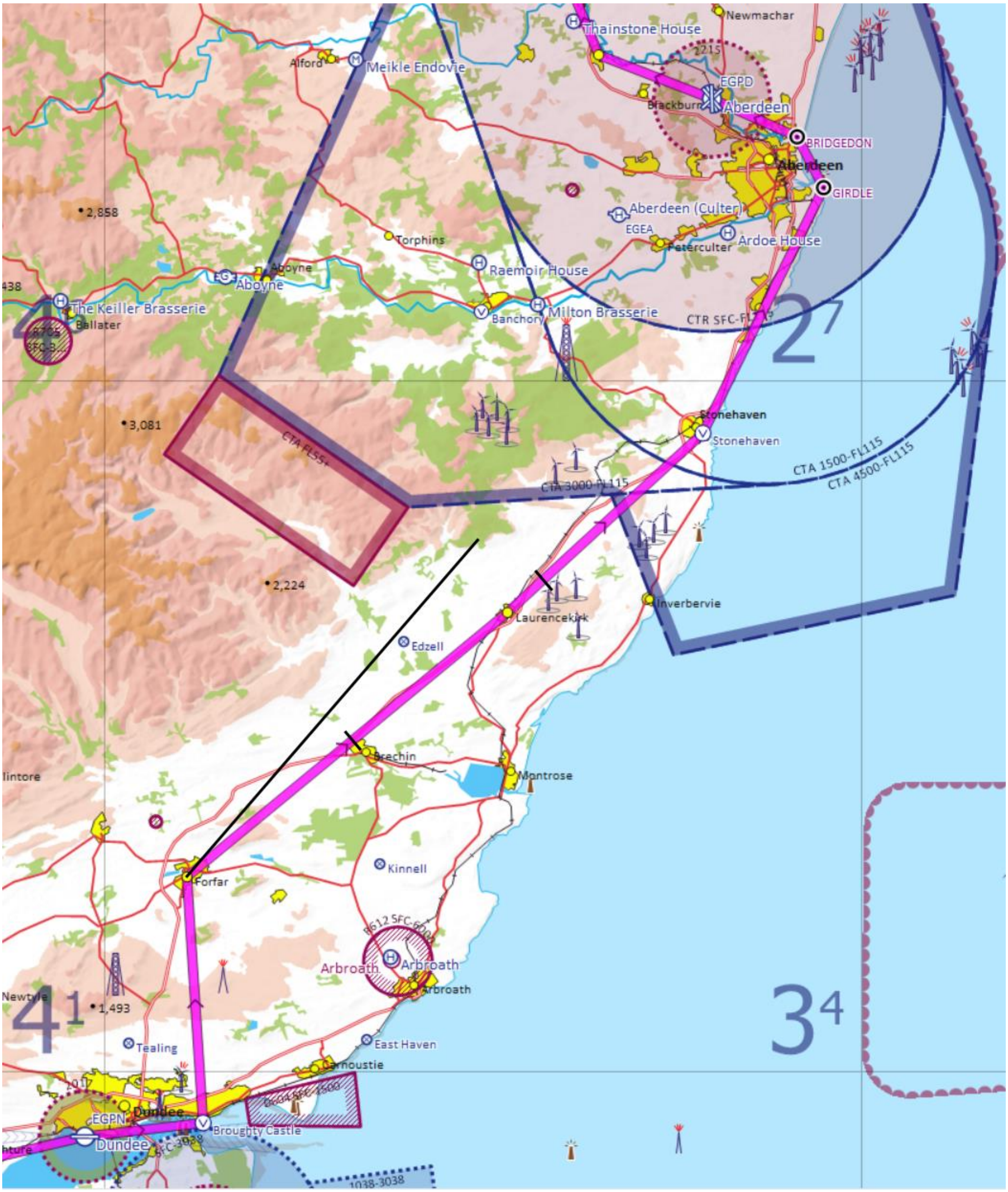
	Low Visibility Take-off Day: RL & RCLM Night: RL	Day: RL or RCLM Night: RL	Adequate vis ref (Day only)
A B C	RVR 300m	400m	500m
D	NOT APPLICABLE		

DEPARTURE PROCEDURE TO THE NORTH

Either climb STRAIGHT AHEAD to 2000' before setting course or turn south off runway heading and set course overhead not below 2000'.
Avoid overflying of hospital 306° T/1.2 NM from airport.

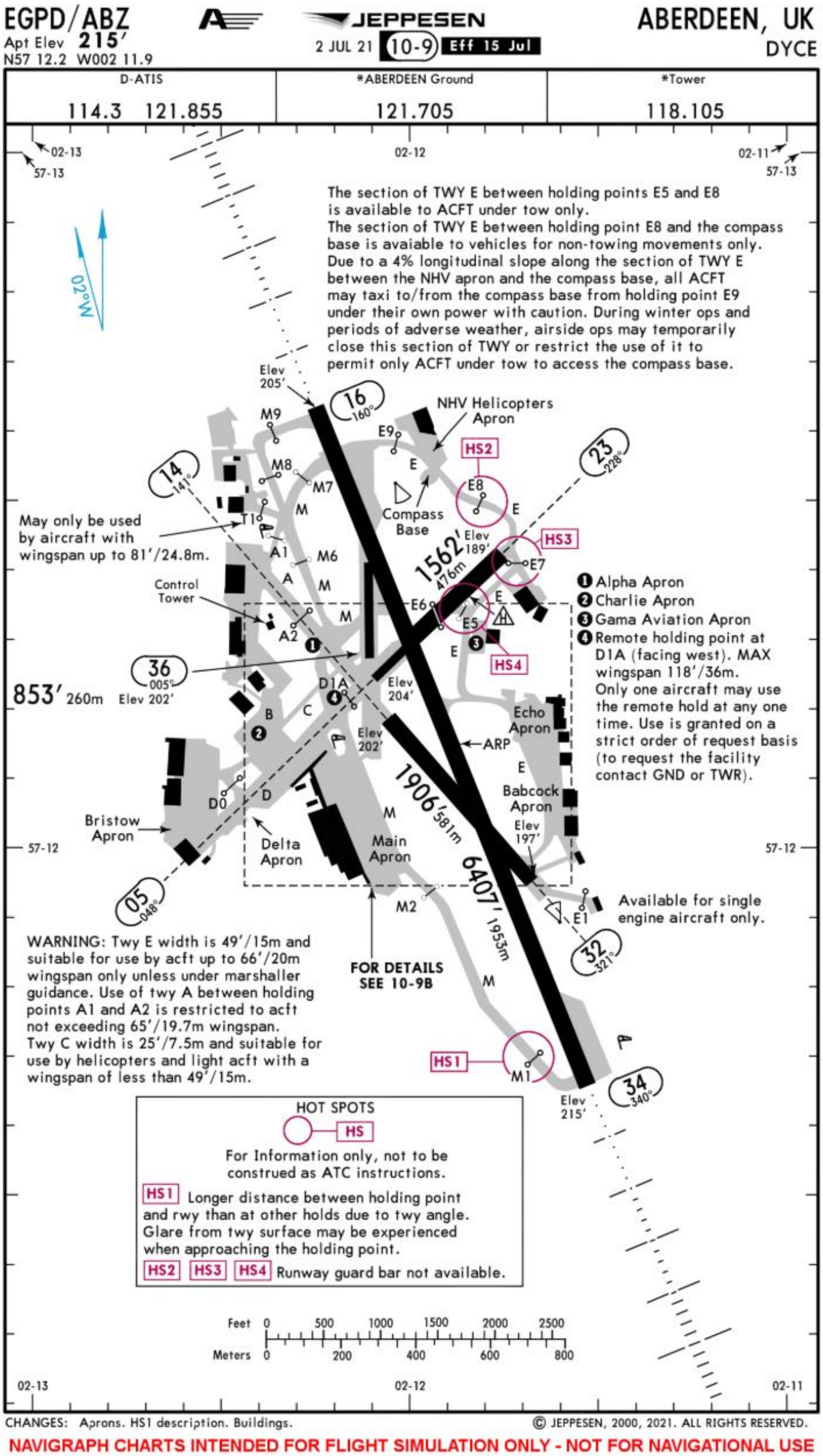
CHANGES: HS1.

LEG 3 – DUNDEE TO ABERDEEN

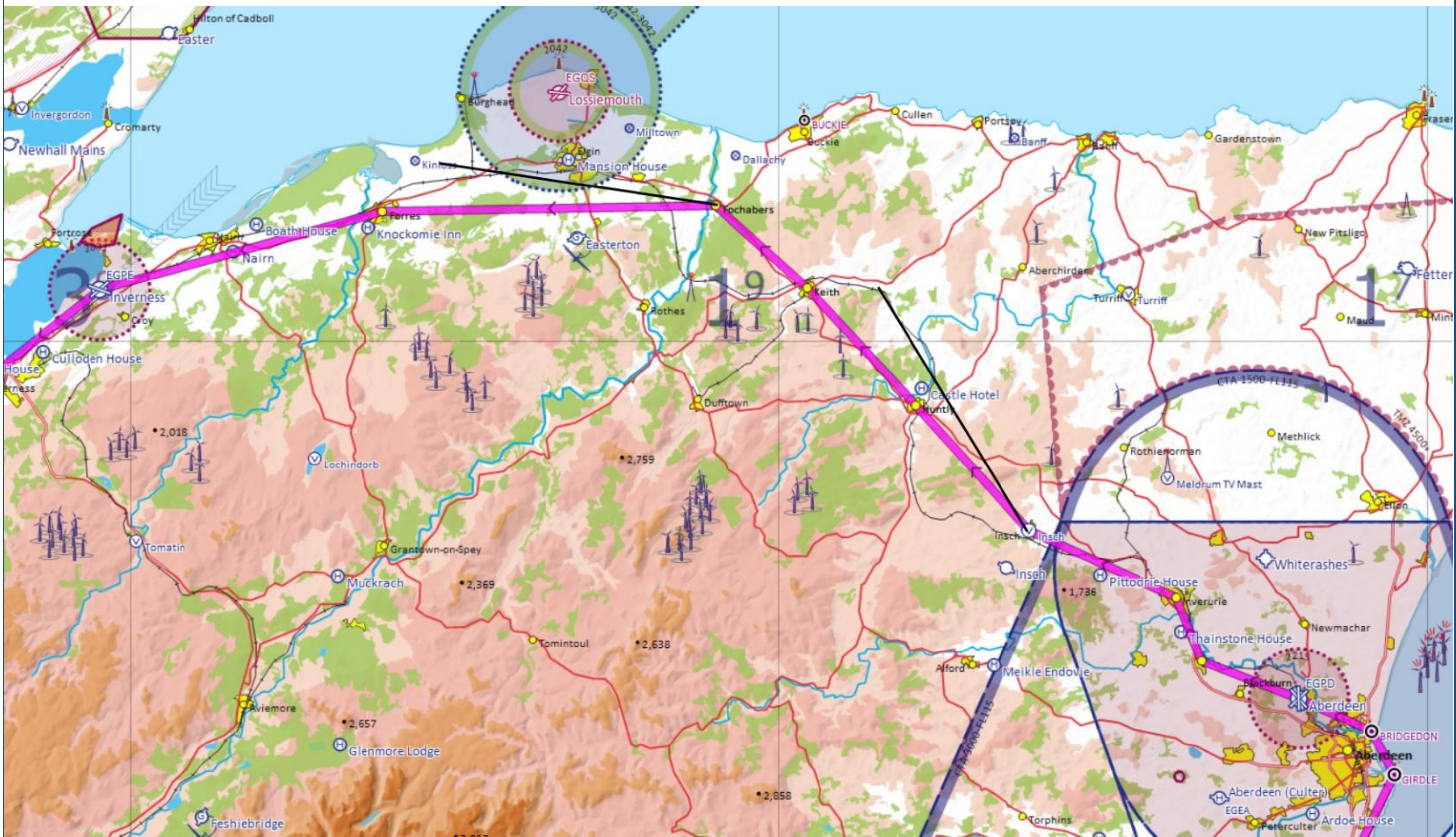


Map courtesy of SkyDemon

EGPD - ABERDEEN



LEG 4 - ABERDEEN TO INVERNESS



Map courtesy of SkyDemon

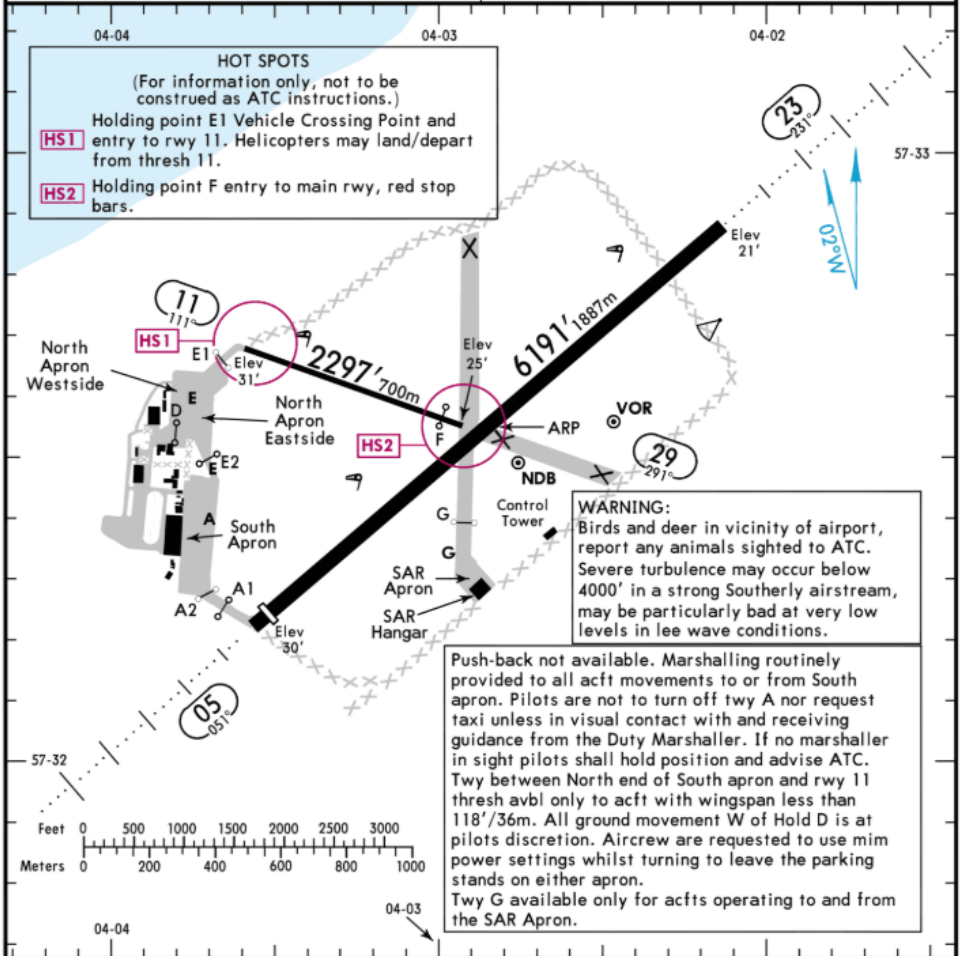
EGPE - INVERNESS

EGPE/INV
Apt Elev 31′
N57 32.6 W004 02.9

JEPPESEN
30 JUL 21 10-9 Eff 12 Aug

INVERNESS, UK
INVERNESS

ATIS	*INVERNESS Tower
109.2	118.405 122.605X



ADDITIONAL RUNWAY INFORMATION

RWY		USABLE LENGTHS LANDING BEYOND Threshold	Glide Slope	TAKE-OFF	WIDTH
05 / 23	HIRL HIALS PAPI-L (angle 3.0°) grooved RVR	5972′ 1820m	4938′ 1505m	❶	151′ 46m
11 ❷ 29					59′ 18m

❶ TAKE-OFF RUN AVAILABLE

RWY 05: From rwy head 6191′ (1887m); rwy 11 int 3107′ (947m)

RWY 23: From rwy head 5971′ (1820m); rwy 11 int 2776′ (846m)

❷ Not available at night.

LOW VISIBILITY PROCEDURES (LVP)

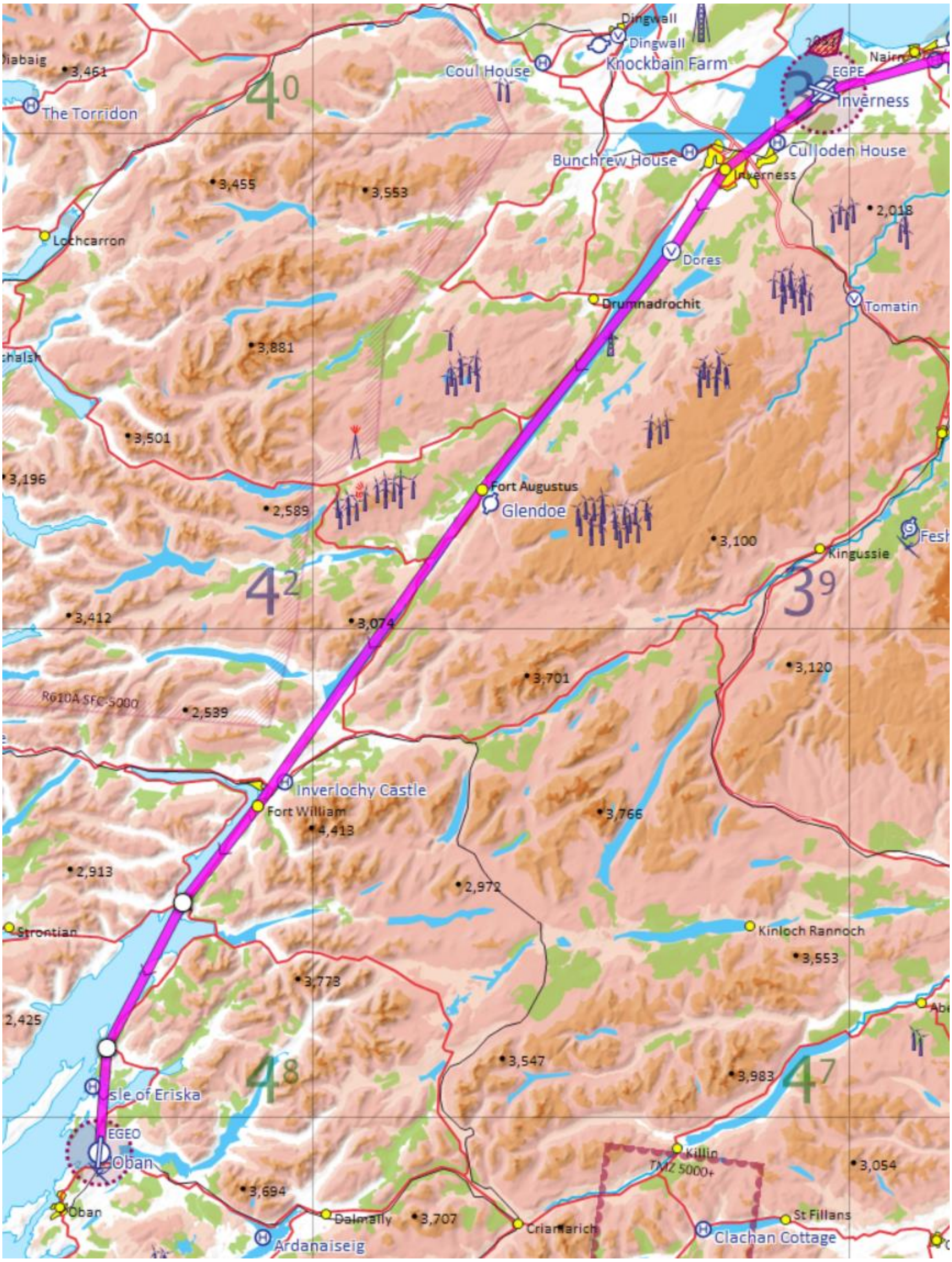
Preparation for LVP will commence when reported MET VIS or RVR is 1500m and falling. Pilots will be informed when LVP are in operation by ATIS.

Standard TAKE-OFF

	Low Visibility Take-off Day: RL & RCLM Night: RL	Day: RL or RCLM Night: RL	Adequate vis ref (Day only)
C	RVR 300m	400m	500m
D	NOT APPLICABLE		

CHANGES: Magnetic variation. Runway bearings.

LEG 5 – INVERNESS TO OBAN



Map courtesy of SkyDemon

MISSION ACCOMPLISHED

...or is it?

It takes a disciplined approach and high accuracy to visually navigate in a light aircraft, so we hope that you can feel the sense of accomplishment from completing this course.

Now that you are armed with the VFR navigation skillset, you can go forwards and plan your own trips, safe in the knowledge that you are doing it in an authentic and true to life fashion, which is the goal of all FS Academy tutorial packs.

From the FS Academy team, we wish you years of enjoyment in exercising your new skills and we hope that it will help you explore our world with new eyes.

WHERE NEXT?

FS ACADEMY *VFR*

Navigator has taught you how to get from place to place once airborne. Learn how to operate a light aircraft from takeoff to landing, including handling exercises, entering the airfield circuit and overhead joins.

FS ACADEMY *VOYAGER*

If you want to expand your VFR experience and tackle full-length Bush Trips, Voyager is a series of 7 journeys across glorious locations from around the world. All trips are supplied with Jeppesen charts and fully prepared navlogs.

FS ACADEMY *IFR*

When the weather turns sour and the clouds roll in you must navigate by your instruments alone. The perfect introduction to the world of instrument flight, learn the true to life procedures and techniques used to keep the show on the road.

FS ACADEMY *JETLINER*

Learn a whole new way of flying by stepping up to the heavy metal. Discover the handling techniques required to control a modern airliner during a routine flight from London Gatwick to Barcelona plus execute emergency procedures such as engine failures and depressurisation.

fsacademy.co.uk

ABBREVIATIONS

Aviation is 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 some of the most commonly used abbreviations for VFR navigation.

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
CTA	Control Area
CTAF	Common Traffic Advisory Frequency
CTR	Control Zone
CVR	Cockpit Voice Recorder
DA	Decision Altitude
DACS	Danger Area Crossing Service
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
ETE	Estimated Time Enroute
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	Frequency Monitoring Code
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
KM	Kilometres
KTS	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
MBST	Microburst
MCDU	Multifunction Control and Display Unit
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MEA	Minimum Enroute Altitude
MEF	Maximum Elevation Figure
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
MSFS	Microsoft Flight Simulator

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
RAF	Royal Air Force
RAIL	Runway Alignment Indicator Lights
RAIM	Receiver Autonomous Integrity Monitoring
RASN	Rain and Snow
RCLL	Runway Centreline Lights
RCLM	Runway Centreline 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
SFRA	Special Flight Rules Area
SG	Snow Grains
SH	Showers
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
SUA	Special Use Airspace
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
VRP	Visual Reporting Point
VV	Vertical Visibility
WIP	Work in Progress
WKN	Weakening
WS	Windshear
WTH	Wheel to Threshold Height
WX	Weather
WXR	Weather Radar
XPDR	Transponder