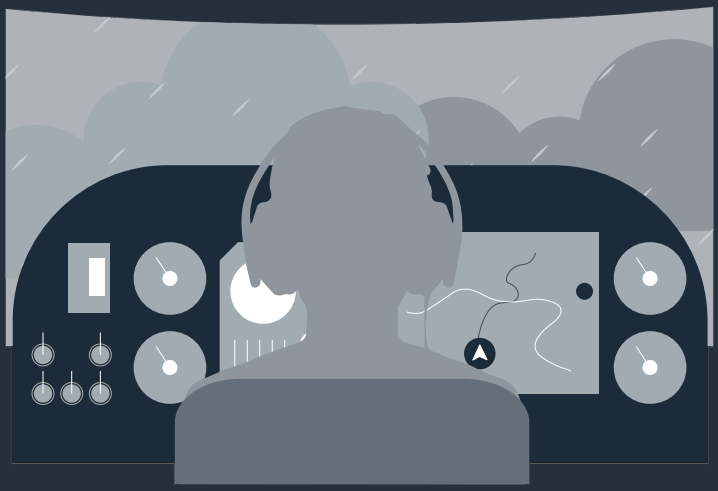
MAY 24

UK Civil Aviation Authority



VFR FLIGHT INTO IMC

SAFETY SENSE

SS33

YOUR SAFETY SENSE LEAFLET FOR:
VFR FLIGHT INTO IMC

Visual Flight Rules (VFR) flight into Instrument Meteorological Conditions (IMC) is a significant cause of accidents in General Aviation flying. A VFR flight into IMC scenario occurs when a pilot enters IMC, despite intending to operate under VFR. When an unqualified pilot enters IMC, a loss of control or flight into terrain will often result.

This leaflet gives guidance on planning to avoid a VFR into IMC scenario and what actions to take if you are confronted with poor weather conditions when not qualified to fly in IMC.

Pilots qualified to enter IMC may also be at risk if the entry is unplanned or the pilot is not in adequate instrument flying practice.

Common factors

Weather planning

Complex or uncertain weather forecasts are often a factor before many VFR into IMC accidents. Review all available information, noting areas of uncertainty. Establish best and worst-case weather scenarios. If you do not have access to updated weather briefings or fail to interpret the information correctly, you may encounter unanticipated weather conditions. Focusing only on the departure and destination weather often neglects the 'big picture' weather situation and how it will evolve during the flight.

Changing weather

Even with appropriate prefight planning, it is possible for the weather to deteriorate more than forecast. Several recent VFR into IMC accidents in the UK involved a significant deterioration in the weather forecast and actual conditions either shortly before or during the flight. You may begin a flight in good weather, but as conditions deteriorate, you may find yourself being forced to fly lower or suddenly entering cloud, without the necessary qualifications or preparation.

Pressure to continue

You may feel pressure to commence or continue a flight due to factors such as time constraints, passenger expectations, disruption to your personal life or the continuation bias of wanting to execute the intended plan. The effect of these pressures is sometimes referred to as 'get-there-itis' and can lead to a disregard for weather conditions or an overly optimistic interpretation of the situation, increasing the likelihood of a VFR into IMC scenario.

Distraction

Distractions inside the cockpit or external factors can divert your attention from monitoring the weather. Focusing on navigating complex airspace, radio communications, or other tasks may cause a loss of situational awareness. You may not detect visual cues indicating deteriorating weather. SSL 31 discusses the subject of distraction in more detail.

No qualification

If you are not adequately trained and qualified in instrument flying, you will struggle to control the aircraft in a VFR into IMC scenario. Flight with sole reference to the instruments is an additional skill above that required for VFR flight and without the correct training, the loss of visual references will likely cause spatial disorientation. You may suffer a loss of control accident – most accidents of this nature involved a pilot who was not qualified to fly in IMC.

VFR FLIGHT INTO IMC

Spatial disorientation

When an unanticipated entry into IMC occurs, you may experience spatial disorientation. This occurs when your perception of the aircraft's position, attitude, or motion does not align with reality. You may make control inputs based on this false perception, and experience loss of control. Key illusions that contribute to spatial disorientation:

- **Visual:** In certain conditions, visual cues can contribute to spatial disorientation. For example, the "false horizon" illusion can occur when a sloping cloud formation or obscured horizon misleads the pilot into perceiving a false level horizon. Visual illusions can cause you to misjudge the aircraft's attitude and make incorrect control inputs. A complete loss of visual reference is not necessary for loss of control to occur, partial obstruction of the real horizon may be sufficient.
- **Vestibular:** The vestibular system, which includes the inner ear, plays a crucial role in maintaining balance and spatial orientation. However, in the absence of visual references, the vestibular system is easily deceived, leading to various types of illusions. For example, the 'leans' illusion can make you feel as though the aircraft is banking in the opposite direction to reality.
- **Somatogravic:** During acceleration or deceleration, you may feel that the aircraft's pitch is changing. In cases of rapid acceleration, you may perceive that the aircraft is pitching up, resulting in an instinct to pitch down in response.
- **Coriolis:** The Coriolis illusion can occur when a pilot rapidly moves their head during a prolonged turn, especially while fixated on an instrument. This movement can cause a false sensation of rotation in a different axis, leading to disorientation.
- **Inversion:** The inversion illusion is associated with abrupt and sustained changes from climb to level flight or from descent to level flight. In this illusion, the pilot may feel that the aircraft is in an inverted position.

Case Study

A private pilot undertook a VFR flight in the early afternoon from a private airstrip. Enroute and approaching high ground, the pilot estimated there was around 800 ft between the cloud base and terrain. The pilot reported that the cloud suddenly descended, and he entered IMC.

The pilot attempted to climb using full power but became disoriented. The pilot believes the aircraft then stalled and they lost control of the aircraft. The aircraft completed three 360° right turns.

As the aircraft emerged from the cloud there was enough height available to regain control and the flight continued. Later the pilot decided the weather was not suitable to continue to the original destination and they safely diverted.

This pilot had completed training for the IMC rating some time ago but had not completed any refresher or instrument flying practice since.

VFR FLIGHT INTO IMC

Planning to avoid IMC

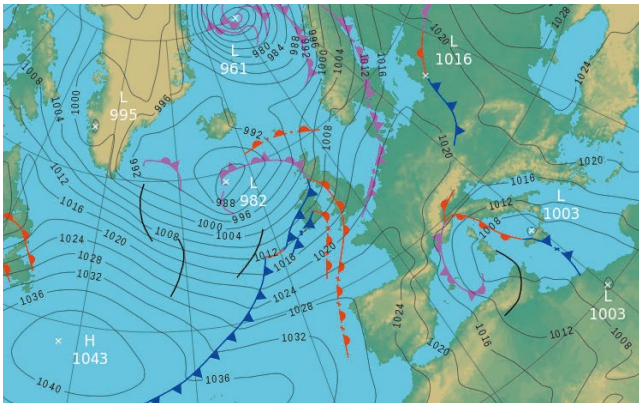
The risk of encountering IMC can be greatly reduced by thorough pre-flight planning, respect for the weather, threat and error management and effective decision making.

Review the weather

Monitoring the weather in the days leading up to the flight will better prepare you for any need to cancel or amend your plans. If the forecast appears poor, consider an early decision to cancel or postpone the flight.

Review departure and destination weather and determine that the cloud base and visibility are suitable. You also need to build a picture of the weather enroute – this will assist situational awareness in the event of encountering deteriorating conditions. The 'Metform 215' chart is a good source for understanding the broader weather situation. The Met Office aviation briefing service is available online.

Review a selection of METARs and TAFs for aerodromes along the route and remember to account for elevation differences when considering the reported cloud levels. If



using third party weather data, it is important to understand the source of the information and how any forecasts have been derived. Often weather data will be repackaged from elsewhere or may be derived from interpolations and models that have not been verified by a human forecaster.

Uncertainty

In periods of atmospheric instability or frontal weather, the intensity or location of the most severe weather can be difficult to forecast. This highlights the importance of checking the weather shortly before departure and adapting to any changes.

Indicators of uncertainty in the forecast are a red flag that should prompt caution – for example the widespread use of 'PROB30' in TAFs or large time windows within which the weather is expected to change. Always consider the plan if the worst possible weather materialised at the most inconvenient time.

If you are departing early in the morning, you may find that not all aerodromes enroute are reporting recent TAFs or METARs. If the weather conditions are unclear, consider delaying until more recent information is available.

Know your Met

Understanding the conditions associated with different weather systems will assist in determining whether there is a threat from the weather:

- Warm fronts will bring low cloud, rain and poor visibility.
- Cold fronts will bring rain showers with good visibility between clouds. The location and development of cloud will be unpredictable.
- Occluded fronts in the UK are normally cold occlusions, when the cold air reaches the warm air from behind, forcing it to climb. This raising of the warm air may generate frontal storms.
- Convective weather is more common in the summer and may bring thunderstorms. Heavy turbulence will be encountered inside clouds with significant vertical development, particularly cumulonimbus.
- Persistent high pressure and stable weather will often result in haze or smog, with reduced inflight visibility.

Dense haze or fog can be encountered in anti-cyclonic conditions when the atmospheric pressure is high. Unlike a moving weather front, areas of poor visibility may be inconsistent and difficult to predict. During prolonged stable weather the sky may look clear from the ground but horizontal visibility in the air is poor and the horizon ill defined.

Another risk of entering IMC is ice – if you are above the freezing level in cloud, ice will likely start forming on the aircraft, which is a serious risk if not equipped and approved for flight in icing conditions. Ice formation increases the weight and stall speed of the aircraft, and will result in control difficulties.

To go or not?

If there is doubt about the conditions, it is safer to reschedule or modify the planned flight rather than dealing with an enroute diversion. You may be tempted to get airborne and 'have a look', but this could lead you into a difficult situation later. Many VFR into IMC accidents could have been avoided by not commencing the flight.

Safety Sense Leaflet 23 discusses decision making in more detail. The Skyway Code also details the so called 'Hazardous Attitudes' – reflect on these and ensure you are looking at the situation objectively.

Have a plan B

If you decide to commence the flight, consider deteriorating weather conditions as part of your threat and error management. What will your response be at different points enroute?

It is beneficial to play out possible scenarios in advance – once you enter a potential VFR into IMC scenario, you will have limited mental capacity to establish the best escape option.

Do not think only in terms of returning to the departure point – that may not be a viable option. Your review of the enroute weather conditions should indicate aerodromes suitable for enroute diversion. Consider factors such as elevation and surrounding terrain.

Think about the practical implications of diverting – you will be more likely to execute a diversion if you have already thought about factors such as onward travel or alternative accommodation.

In advance of the flight, explain to passengers that sometimes the weather makes it unsafe to continue and there may be a risk of disruption. Manage expectations to avoid disappointment.

Minimum safe altitudes

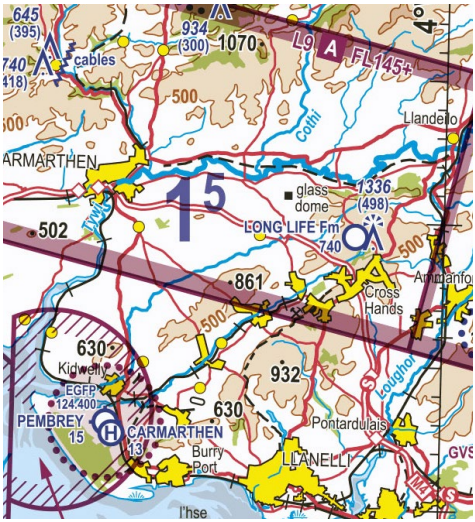
VFR into IMC scenarios often involve a lowering cloud base and repeated descent to avoid entering IMC. This trap can be avoided by setting a minimum altitude, below which you will not descend without either turning around or diverting towards better weather.

UK VFR charts contain a 'Maximum Elevation Figure' (MEF) for each quadrangle of latitude/longitude lines. The MEF indicates either the highest known obstacle or highest terrain, with an allowance for unknown obstacles.

The MEF itself does not represent a 'safety altitude' – common practice is for pilots to add a further margin to the MEF (for example 500 ft or 1,000 ft) to derive a minimum safe altitude for each quadrangle the flight crosses.

It is possible to define a safe altitude within a narrower margin around the planned route, but consider the possibility of having to divert off route, do you know what obstacles or terrain may be around you?

Enroute flight below 1,500 ft AGL is not recommended – it will make visual navigation challenging and you may encounter low flying military aircraft. Even in poor conditions that are technically still VFR, at low level you may not spot obstacles such as masts or rapid changes in terrain elevation.



VFR on top

VFR pilots are permitted in some circumstances to fly 'VFR on top', meaning the aircraft is flying in visual meteorological conditions (VMC) but above cloud and without sight of the surface. An associated risk is that there might not be a suitable break or 'hole' in the cloud layer for a VFR descent at your destination. You should also consider the risk of experiencing an engine failure or other emergency while above a cloud layer.

If you intend to fly VFR on top, your pre-flight planning and inflight monitoring of weather conditions needs extra attention. It may be that you must descend earlier than planned or take another route to ensure you maintain VMC.

In class G airspace VFR flights must always be in sight of the surface when at or below 3,000 ft AMSL, or 1,000 ft above terrain, whichever is higher. When above 3,000 ft AMSL, VFR requires 5 km inflight visibility, 1500 m horizontal and 1,000 ft vertically.

For full details of VMC minima, see the Skyway Code p66.

Case Study

The pilot departed his home airfield, with one passenger on board. Their intention was to fly VFR to the Isles of Scilly for a day trip, before returning later that afternoon. At the time of departure, the local weather was described by witnesses as clear skies with good visibility. The pilot climbed to his altitude and continued enroute.

Around 2 hours later, the pilot called a nearby aerodrome radio frequency, using "PAN, PAN, PAN" asking about the weather conditions at the airfield and stating that he was unable to land at his destination because he was stuck above cloud. The radio operator replied that the weather at the airfield was poor – the cloud base was 'on the deck' and the visibility was 400 m. He suggested the pilot contact a local radar unit or the Distress and Diversion (D&D) Cell on 121.5 MHz.

After the initial contact with the D&D, the aircraft was transferred to a nearby aerodrome approach control. Unfortunately, during the handover of the aircraft from one unit to the other, some details of the situation were not discussed. The new controller was unaware that the aircraft or pilot were not IFR qualified and proceeded to provide a Surveillance Radar Approach (SRA). The controller provided heading and descent information for the pilot to land at the aerodrome, despite conditions being well below VFR minima.

The pilot, who was not qualified to fly in cloud, lost control of the aircraft during the subsequent descent in IMC and the aircraft was destroyed when it hit a tree. Both occupants were fatally injured.

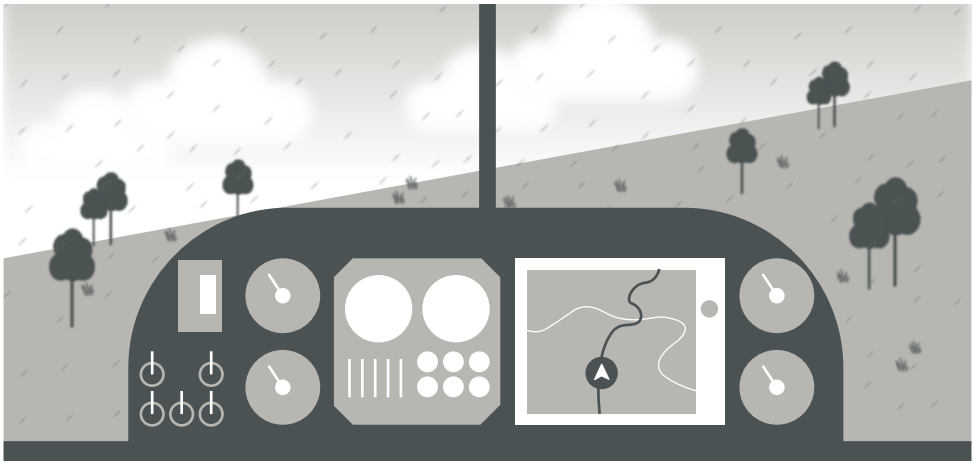
The investigation determined that at the time of the accident there were at least two aerodromes available with weather conditions suitable for a visual approach.

The accident raised several human factors issues for both pilots and air traffic control.

VFR FLIGHT INTO IMC

Responding to IMC

Monitor the weather



Even with good preflight planning, it is possible for weather conditions to deteriorate in flight; for example fronts may change speed or direction. Cold fronts or convective weather will often bring sudden and localised changes – you may be in good VFR conditions, but with extensive cloud formations and showers close by.

Use the planned decision points along the route and determine if it is still safe to continue. If conditions are deteriorating, think of your options and contingency plans. Keep looking towards the horizon and either side of your track – where are conditions best if you need to divert from track? Consider asking ATC for weather reports from relevant aerodromes or tuning into nearby ATIS frequencies.

You must be prepared and willing to divert or turn back if conditions deteriorate. It does not reflect badly on your ability as a pilot if you turn back in the face of poor weather. Responding to changes reflects good airmanship and a mature attitude to risk. Even commercial air transport flights sometimes divert due to weather – there is no shame in doing so.

Do not think of recovery only in terms of a manoeuvre to be executed once you are in IMC – a recovery should be initiated after recognising a potential VFR into IMC scenario and addressing the situation as soon as possible. Many accidents involving loss of control or flight into terrain could have been avoided had an earlier decision been made to divert.

Recognising trouble

An impending VFR into IMC scenario may not always be obvious, particularly if experiencing one for the first time. Look for cues that you may be entering a degraded visual environment. Small amounts of cloud may pass close to the aircraft and the ground or horizon may be intermittently obscured.

Lowering cloud associated with a warm front will normally be visible ahead – the sky may be grey above you, with medium level stratus ahead of the lower cloud and precipitation. As the front approaches, the gaps between the clouds will start to close – becoming lower and changing from scattered to broken or overcast. You may find yourself descending to 'duck under' the clouds or weave to avoid them.

Loss of visual reference may also be caused by haze, fog or rain. You may experience a gradual fading of the horizon and horizontal visibility, until the view out the front of the aircraft is a dull haze of grey. This situation is particularly insidious when flying at night, over the sea or a flat, featureless landscape – eventually the ground or water fades into the sky. The precise moment at which you are no longer in VMC may not be obvious.

Helicopters

Compared to fixed wing aircraft, helicopters are able to fly at lower speed and have more options to make a precautionary landing. However, analysis in the 2000s showed that around 70% of inadvertent VFR into IMC scenarios involving GA helicopters resulted in a fatal accident.

Making a safe precautionary landing requires a positive decision while adequate visual references and separation from terrain still exists. Once you have entered IMC, the chances of a safe outcome are greatly reduced. Pilots often delay taking the appropriate action and suffer loss of control or collision with terrain.

How to respond

- Respect the minimum safe altitude established at the planning stage – if cloud forces you lower, turn in the direction of better weather.
- Once established on a heading away from IMC, ensure the aircraft is under control and re-establish situational awareness. Call an appropriate ATC unit, or D&D on 121.5 MHz, and explain your situation.
- If turning around is not a viable option, climbing above cloud may be possible, but consider your options for making a descent in VMC.
- You may naturally focus on returning to your departure point, but this is not always the best option. If you have a reasonable fuel endurance, there is a high probability that an aerodrome with better weather is within range, but travelling some distance may be necessary.
- Consider how the weather may be evolving – whereabouts is it getting better or worse? Use ATC to gather as much information as possible about conditions within your circle of range.

Precautionary landing

If the weather is closing in all around, consider a precautionary landing in a field – it may seem like an extreme option that could result in damage to the aircraft, however this is preferable to experiencing a loss of control accident, which is normally fatal. If you are flying a helicopter, a precautionary landing is an easier option, but still requires adequate visual reference and a timely decision to do so.

VFR FLIGHT INTO IMC

Recovery from IMC

If you find yourself in IMC, be aware of the potential sensory illusions. Trust and focus on your instruments. The aim is to retain control of the aircraft and exit IMC.

Aviate, Navigate, Communicate: This mantra should guide your actions. Always prioritise flying the aircraft. You will likely not have much mental capacity for navigation – even simple tasks such as reviewing your VFR moving map device will be challenging if you are in IMC.

Stay Calm: Maintain a calm and focused mindset. Panic can lead to poor decision-making and loss of control. Take several slow, deep breaths and keep your head still – this will reduce any false sensation of accelerations. If the flight path was stable on entry to IMC, it will not suddenly change, unless in heavy turbulence. Do not destabilise the aircraft by applying sudden or large control inputs.

Stay in Control: Transition to instrument flight. Focus on the attitude indicator and make small corrections to maintain heading and altitude. Trust your instruments. Avoid making large control inputs or power changes. Ensure the aircraft is in trim. If the aircraft has an autopilot, engaging it will allow you to retain control of the aircraft and free up capacity for situational awareness.

Avoid fixating on a single instrument – keep your eyes moving in a scan pattern, including the attitude indicator, altimeter, airspeed indicator, heading indicator and vertical speed indicator.

Do not be concerned by minor variations in altitude, it is more important to keep the aircraft's attitude approximately correct. Keep returning your focus to the attitude indicator – do not chase the altimeter or VSI with control inputs, doing so will lead to increasing pitch oscillations.

Exit from IMC: Ensure you have control of the aircraft before attempting a turn. With the aircraft under control, commence a turn to exit IMC – either 180º or whichever direction you believe will take you to VMC.

If you are struggling to control the aircraft, aim to maintain straight and level flight until you have stabilised your flight path. Focus on your instruments and avoid making turns or changes in power, as this will make spatial disorientation more likely.

If turning through 180º does not result in regaining VMC, are you able to climb above or descend below cloud? Your prefight planning may have indicated the likely vertical extent of IMC. Do not attempt a descent below your minimum safe altitude in IMC.

Conducting the 180° turn

The 180° degree turn is best deployed prior to actual entry into IMC. In IMC, you should only perform the turn if you can maintain control during the manoeuvre. If in IMC and you are unable to perform the turn safely, consider alternative options to regain visual conditions, such as continuing straight and level or climbing or descending (depending on terrain) to regain visual conditions.

To perform the turn:

1. **Heading:** Note the target heading to rollout on.
2. **Direction:** Decide on the direction of your turn.
3. **Establish the turn:** Slowly apply bank. The turn should be smooth and coordinated. Aim for a rate 1 turn – do not exceed a bank angle of 20°. When using the rudder to coordinate the turn, make inputs small and gradual. A slight amount of back pressure will be required to avoid descending.
4. **Focus on the instruments:** Continually scan the attitude indicator, heading indicator, airspeed indicator and turn coordinator to maintain coordinated flight.
5. **Maintain straight and level:** As you approach the intended heading, roll wings level and maintain your attitude and altitude.
6. **Exiting IMC:** It may take some time to reach VMC, so hold your heading and be patient. Remain focused on the instruments until clear visual references emerge. Once in VMC, you will probably still feel disoriented – ask ATC for navigational assistance towards an aerodrome in VMC. If you do not regain VMC, consider your options – ask ATC for any information that may assist in regaining VMC.

Without an attitude indicator

If your aircraft is not equipped with an attitude indicator, maintaining control will be more challenging, but still possible. Use the altimeter and 'turn and slip' indicator. Make small changes in pitch to establish an attitude at which the altimeter remains steady – then trim the aircraft. Use the turn and slip indicator to keep the wings level.

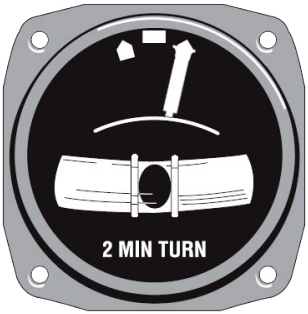
Without a stabilised direction indicator (DI), you may need to perform timed turns – an older style 'whiskey' fluid compass does not read accurately while turning. A rate 1 turn is one in which it takes 2 minutes to complete a 360° turn, so 180° will take 1 minute.

Loss of control recovery

Safety Sense Leaflet 30 includes more information about recovery from loss of control events. If you lose control of the aircraft, apply upset recovery techniques to attempt to regain straight and level flight.

To perform a 180° timed turn:

- Bank until the turn and slip indicator shows a rate 1 turn;
- Time one minute, then roll wings level;
- Allow the compass to stabilise; and
- Confirm heading is approximately correct.



Turn and slip indicator showing a rate 1 turn to the right.

VFR FLIGHT INTO IMC

Assistance from ATC

Whether you are in IMC or need assistance avoiding it, call ATC as soon as mental capacity allows. Flying the aircraft remains the priority, do not drop the aircraft to fly the radio. The precise contents and order of the call are not important, but a 'MAYDAY' call should be made when in a VFR flight into IMC scenario. Pride can be a killer – you may be reluctant to admit you are in trouble, so be honest with ATC about the nature of your situation.

An ATC unit with surveillance capability, or the Distress and Diversion (D&D) cell, are best equipped to help you. Stress that you are not qualified to fly in IMC and require assistance in maintaining VMC. ATC will help you find an aerodrome suitable for a VFR approach.

Attempting to land in conditions below VFR minima should only be considered when no VFR alternatives exist. A surveillance radar approach (SRA) may be the most appropriate method for achieving this – the likelihood of success will be greatly increased by prior practice (see Instrument training on the next page).

Case study: MAYDAY call

A student pilot had been briefed to carry out a planned navigation exercise around the local area.

The pilot flew to the north of his planned track, to avoid poor weather around a local town, he remained clear of cloud and in sight of the surface and was able to regain a track for his first turning point.

He could see the next turning point but as he approached it, he was forced to adjust course again to avoid cloud. There appeared to be blue sky and better weather conditions towards the west, so he decided to continue in that direction.

Shortly after this, the aircraft entered IMC. In accordance with his training, he commenced a 180° turn, expecting to regain VMC. However, during the turn, the aircraft descended and turned through 300°, with the pilot experiencing disorientation. Having recognised the loss of altitude, the pilot applied full power and intended to climb above MSA. He was aware that he was in the vicinity of an obstacle with an elevation of 1,837 ft.

The pilot then decided to carry out two 360° turns, with the aim of stabilising his position and to "gather his thoughts and intentions". During these turns the pilot realised that he was near the ground and took "evasive action". The right main landing gear contacted terrain and the impact also caused damage to the windscreen and a brief loss of control, which the pilot recovered from. A 'MAYDAY' call was then transmitted.

The pilot managed a climb to 2,600 ft and was given radar vectors towards VMC conditions. He maintained VMC and returned to the departure aerodrome.

VFR FLIGHT INTO IMC

Instrument training

Instrument training is valuable for any pilot. Even if you do not intend to obtain a formal instrument qualification, doing some instrument training will be beneficial. It could be a subject to cover in your biennial refresher training with an instructor. By training to rely on your instruments and developing proper scanning techniques, you will be better equipped to maintain control and override the misleading sensations of spatial disorientation.

A potentially useful exercise is to practice a surveillance radar approach (SRA) into a suitably equipped airport. During an SRA the approach controller will provide vectors and altitude monitoring on the final approach, without the need for any pilot interpreted approach aids in the cockpit. However, in a VFR into IMC scenario, your priority should always be to regain VMC – attempting an instrument approach is a very last resort.

Unless you are doing so towards an instrument qualification, training should be regarded as an additional safety mitigation and not as a means to fly in poor weather conditions.

Pilots are encouraged to obtain an IMC rating[1] or Instrument Rating, however instrument flying is a perishable skill, and it is possible to have a valid rating but not have sufficient recent practice. The fact that you could do something safely six weeks ago does not mean you can do it now.

A skill is like a message written in chalk on an outdoor wall – it gets eroded a little every day. If the writing is retraced repeatedly, it will become more enduring. Even then, it will be eroded eventually if it is not periodically refreshed. Skills fade over time; refresh your skills via practice, annual or recency checks or post-qualification training.

[1]Endorsed as 'Instrument Rating (Restricted)' on a Part-FCL licence

SUMMARY

Pre-Flight Planning

> Conduct a thorough pre-flight brief of weather conditions for departure, destination, alternates and enroute expected conditions.

Know your MSA

> Calculate your minimum safe altitude for each leg of your flight.

Weather conditions

> Continuously monitor weather conditions ahead of and around your aircraft.

Approaching IMC

> Avoid IMC before you enter it. Consider your available options carefully. Conduct a 180° degree turn to remain VMC.

Fly the Aircraft

> If you inadvertently enter IMC, focus on the attitude indicator and maintain straight and level. Trust the instruments and avoid large control input.

Decide

> Once the aircraft is under control, assess your options and decide on a course of action.

ATC

> Call the ATC unit you are speaking with or call D&D.