Australian Government
Australian Transport Safety Bureau

Accidents involving Visual Flight Rules pilots in Instrument Meteorological Conditions

Australia's national transport safety investigator

Avoidable Accidents No. 4

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Accidents involving Visual Flight Rules pilots in Instrument Meteorological Conditions

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Introduction

Weather-related general aviation accidents remain one of the most significant causes for concern in aviation safety; the often-fatal outcomes of these accidents are usually all the more tragic because they are avoidable.

The dangers of visual flight rules (VFR) pilots flying into instrument meteorological conditions (IMC) have been recognised for a very long time, yet VFR pilots still fly into deteriorating weather and IMC. In the decade from 1 July 2009 to 30 June 2019, 101 VFR into IMC occurrences in Australian airspace were reported to the ATSB. Of those, nine were accidents resulting in 21 fatalities. That is, about one in 10 VFR into IMC events result in a fatal outcome.

Flying into IMC can occur in any phase of flight. However, a 2005 ATSB research publication – General Aviation Pilot Behaviours in the Face of Adverse Weather (B2005/0127) – concluded that the chances of a VFR into IMC encounter increased as the flight progressed, with the maximum chance occurring during the final 20 per cent of the flight distance.

This publication describes a selection of weather-related general aviation accidents and incidents that show weather alone is never the only factor affecting pilot decisions that result in inadvertent IMC encounters. These investigations consistently highlight that conducting thorough pre-flight planning is the best defence against flying into deteriorating weather.

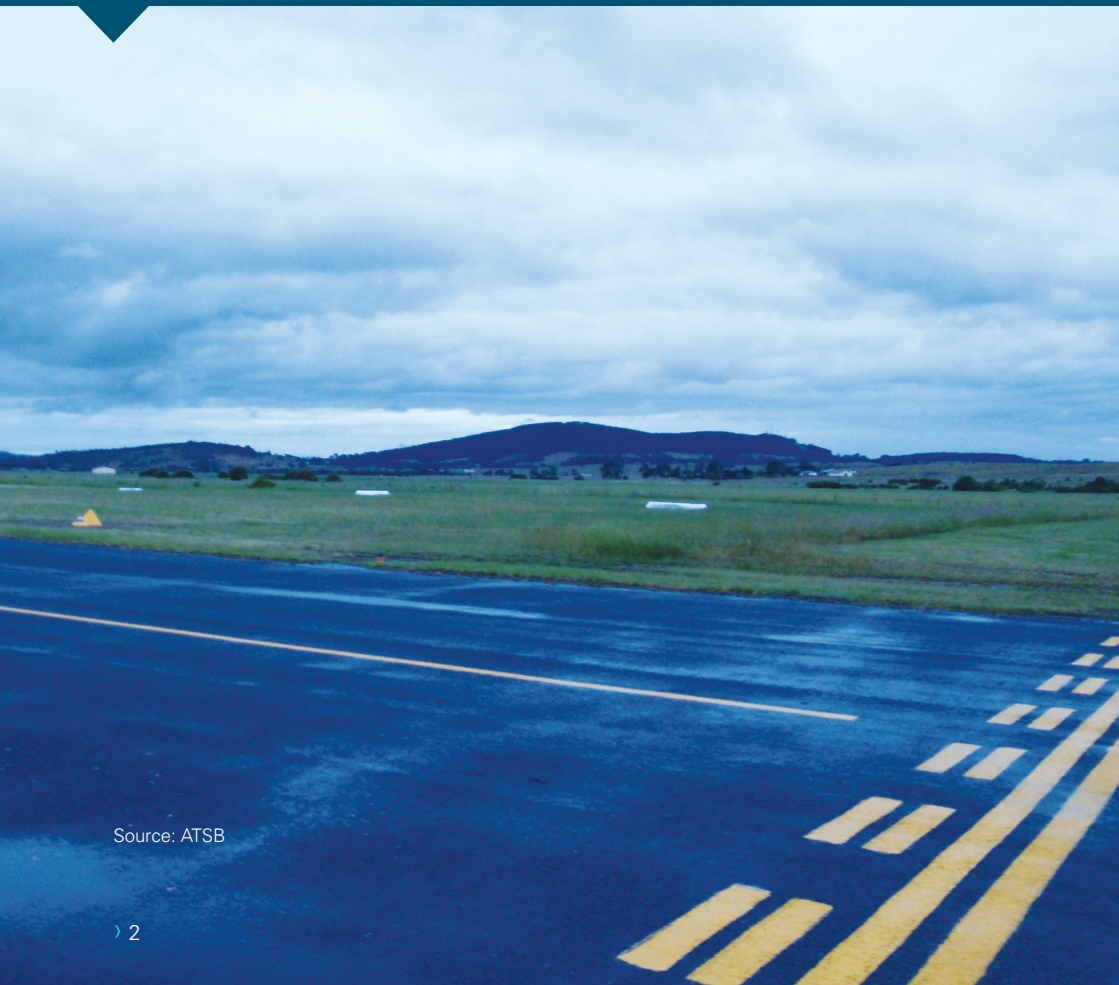
The ATSB encourage all pilots, no matter what their experience level, to develop the knowledge and skills required to avoid unintentional operations in IMC. Have alternate plans in case of unexpected changes in weather, and make timely decisions to turn back, divert or hold in an area of good weather. The use of a 'personal minimums' checklist can also be a strong mitigator against the risk of flying into bad weather. Checklists can help pilots more clearly identify risk factors.

Flight planning requirements

Prior to a flight, a pilot must study all available information appropriate to the intended operation, including the current weather forecasts. This is even a requirement in the Civil Aviation Regulations (CAR 174) and repeated in the Aeronautical Information Publication.

Apart from the more straightforward and mechanical elements of the flight preparation, such as how much fuel to carry, planning should include anticipating the unusual, and preparing a course of action should it occur.

Pre-flight planning minimises in-flight decision errors because it removes the unforseen element from situations that arise during the flight. Failure to carry out this prior planning can result in decisions being made under a situation of considerable stress and increases the likelihood of poor or incorrect decision making.



Source: ATSB

Cessna Source: CASA

No way out

Investigation AO-2008-083

In December 2008, a Cessna 172 with a pilot and one passenger departed Mudgee, New South Wales (NSW), on a private VFR flight to a property near Glen Innes, NSW. Although having visually assessed the weather conditions at Mudgee Aerodrome as suitable for departure, the pilot chose not to obtain the relevant aviation weather forecasts for the flight.

About 15 minutes after departure, the weather ahead deteriorated, with increasing cloud above and below the aircraft and the cloud base lowering. With the intention of assessing the weather ahead, the pilot climbed the aircraft to 'on top' of the cloud. Observing that the cloud ahead was increasing, with a blanket of cloud below and building thunderstorms, the pilot decided not to stay above the cloud. Rather than choosing to turn back or divert, the pilot descended the aircraft visually through a hole in the cloud, while continuing on toward the intended destination.

When levelling out, the pilot realised the aircraft had descended into a closed valley framed by ridgelines on its eastern, western and northern sides. After flying up the valley for a short time, the pilot decided to turn back.

During the turn-back manoeuvre, the aircraft entered cloud, the pilot became disoriented and the aircraft collided with terrain. The pilot and passenger were seriously injured in the collision and shortly after, the passenger succumbed to their injuries.

Lessons learnt

One of the key risk controls to avoid becoming a VFR pilot entering IMC is appropriate pre-flight preparation and planning. Pilots should always obtain up-to-date weather information before and during flight. The more doubtful the weather, the more information you will need to get and the more planning is required. Your passengers trust you to make responsible decisions about whether it is safe to fly.

Wreckage of the Gippsland Aeronautics GA-8 Airvan. Source: Michael Patterson

Hazardous landing

Investigation AO-2010-080

In October 2010, the pilot of a Gippsland Aeronautics GA-8 Airvan, was conducting a charter flight from Lady Barron Aerodrome, Flinders Island, Tasmania. The forecast weather was marginal for flight under VFR, with broken cloud forecast down to 500 ft above mean sea level in the area. However, the pilot's assessment from the ground was that the cloud base was 1,000 ft to 1,500 ft.

During the climb after take-off, the weather conditions deteriorated to below those necessary for flight under VFR. The pilot, concerned about adhering to an unwritten operator rule to maintain a minimum height of 1,000 ft, continued to climb into IMC instead of remaining visual below the cloud and lost all visual reference with the ground and horizon.

The pilot, who was not qualified to fly in instrument meteorological conditions, continued to fly in IMC for several minutes in the hope of climbing above the cloud. When this did not happen, the pilot decided to turn the aircraft back towards Lady Barron Aerodrome, initiating a gentle turn to the right. The pilot succeeded in maintaining controlled flight with reference to the aircraft's flight instruments. While intending to turn through 180°, the pilot inadvertently turned less than this and flew towards high ground in the Strzelecki National Park.

Becoming visual, the pilot turned the aircraft into a valley unable to turn around nor out-climb. The pilot elected to conduct a forced landing into the tree tops, slowing the aircraft to land at the slowest speed possible. Luckily, only one passenger sustained minor injuries and the pilot and other five passengers were uninjured.

Lessons learnt

If you encounter deteriorating weather, turn back or divert before you are caught in cloud. For a non-instrument rated pilot, even with basic attitude instrument flying proficiency, maintaining control of an aircraft in IMC by reference to the primary flight instruments alone entails a very high workload that can result in narrowing of attention and loss of situational awareness.

Don't push it, land it — when it's not right in flight.

Don't push it, land it

Investigation AO-2015-131

At about 5.30 pm on 7 November 2015, the owner-pilot of an Airbus Helicopters (Eurocopter) EC135 departed Breeza, NSW, on a VFR private flight with two passengers on board to Terrey Hills, NSW.

About 40 km to the south-west of the Liddell mine, the pilot diverted towards the coast, probably after encountering adverse weather conditions. Witnesses observed the helicopter overfly the Watagan Creek valley in the direction of higher terrain. The helicopter was then observed to return and land in a cleared area in the valley.

After 40 minutes on the ground, the pilot, who did not hold an instrument rating and was limited to visual flight operations, departed to the east towards rising terrain in marginal weather conditions. About seven minutes later, and approximately 9 km east of the interim landing site, the helicopter collided with terrain. A search was initiated about 36 hours later. The helicopter wreckage was found late on 9 November 2015. The pilot and two passengers were fatally injured.

The ATSB found that the pilot likely encountered reduced visibility conditions leading to loss of visual reference leading to the collision with terrain. The ATSB also found that the fixed, airframe-mounted emergency locator transmitter had been removed and that personal locator beacons which required manual activation were carried instead. While in this accident it did not affect the outcome for the occupants, the lack of activation, combined with the absence of flight notification information, delayed the search and rescue response.

Lessons learnt

Avoiding deteriorating weather or IMC requires thorough pre-flight planning, having alternate plans in case of an unexpected deterioration in the weather, and making timely decisions to turn back or divert. For VFR pilots pressing on into IMC conditions carries a significant risk of encountering reduced visual cues leading to disorientation. This can easily affect any pilot, no matter what their level of experience. In the event of inadvertent entry into IMC, pilots are encouraged to contact air traffic control for assistance.

CASA's '178 seconds to live' Source: CASA

Spatial disorientation

In order to correctly sense the orientation of the body relative to its environment, a pilot relies on a number of sensory systems in order to establish or maintain orientation:

- the visual system
- the vestibular system, which obtains its information from the balance organs in the inner ear
- the somatic sensory system which uses the nerves in the skin and proprioceptive senses in our muscles and joints to sense gravity and other pressures on the body.

The visual system is by far the most important of the three systems, providing some 80 per cent of the raw orientation information. In conditions where visual cues are poor or absent, such as in poor weather, up to 80 per cent of the normal orientation information is missing. Humans are then forced to rely on the remaining 20 per cent, which is split equally between the vestibular system and the somatic system. Both of these senses are prone to powerful illusions and misinterpretation in the absence of visual references, which can quickly become overpowering.

Pilots can rapidly become spatially disoriented when they cannot see the horizon. The brain receives conflicting or ambiguous information from the sensory systems, resulting in a state of confusion that can rapidly lead to incorrect control inputs and resultant loss of aircraft control.

Simulator experiments at the University of Illinois determined that on average, a pilot with no instrument training can expect to retain control of their aircraft for only 178 seconds after entering bad weather and losing visual contact.

Watch CASA's '178 seconds to live' video on YouTube.

Wreckage of the Bell 206L helicopter Source: ATSB

Engulfed by cloud

Investigation AO-2009-077

In December 2009, a Bell 206L helicopter was being operated in the area of Dorrigo, NSW, conducting fire observation, water bombing and personnel insertion duties under VFR. The cloud in the area of the helicopter landing and take-off point at around the time of the accident was fluctuating around the minimum required for VFR flight.

During the initial take-off, the experienced pilot recalled raising the helicopter into a low hover and conducted a pedal turn through 360° to get a better look at the weather and establish an appropriate departure direction. The pilot said that the weather looked better in the low hover than it did on the ground, so elected to climb to about 100 ft into a high hover.

The pilot reported looking inside the cockpit for a couple of seconds to survey the instruments. When returning focus outside, the pilot lost visual reference and became spatially disoriented, rapidly leading to incorrect control inputs and loss of control. The helicopter impacted the ground in an uncontrolled state. The passenger was fatally injured and the pilot was seriously injured.

Lessons learnt

Even momentary loss of outside visual reference can result in spatial disorientation, incorrect control inputs, and loss of control.

Whenever the natural horizon is not clear enough to control the aircraft by visual reference, such as often occurs in marginal VMC, all pilots, no matter what their flight experience level, are potential victims of spatial disorientation.


Don’t push it,
DON’T GO
A
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atsb.gov.au/dontgo

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Know your limits before flight

Into the void

Investigation AO-2007-061

In November 2007, the pilot of a Cessna 337 Skymaster was conducting a private VFR flight from Moorabbin Airport, Victoria, to Merimbula, NSW. The pilot, who was only qualified to operate in VMC, had indicated the flight would track along the coast at low level.

The forecast weather included isolated showers or thunderstorms over the sea and coast, and low cloud over the sea/exposed coast. The low cloud was expected to be broken stratus between 800 ft and 2,000 ft. Visibility was quoted as reducing to 3 km in thunderstorms with rain and 6 km in showers of rain.

About 30 minutes after departing Moorabbin, people on a beach south-east of Venus Bay heard and then suddenly saw the aircraft emerge from fog at low level, flying above the water line on the beach with the wings level. Within seconds, the Skymaster turned right at a steep angle of bank while maintaining height and headed out to sea before disappearing from sight into the fog. Witnesses reported no apparent problem with the engines and the aircraft appeared to be under control. About two seconds after the aircraft disappeared from view, they heard a 'bang' and then silence.

Two days later, wreckage of the aircraft and three of the deceased occupants were found washed up on the beach. The pilot was not found.

The investigation concluded that while manoeuvring over water at low level in conditions of reduced visibility, the pilot probably became spatially disorientated and inadvertently descended into the water.

By turning away from the land in the foggy conditions, the pilot would have encountered a featureless, grey environment with no visible horizon, making it extremely difficult to judge the aircraft's attitude and/or height.

Lessons learnt

As a pilot you should accept that flying under VFR will not always enable you to reach your planned destination. Weather often does not act as the forecast predicts. You must have alternatives available and you must be prepared to use them—even if it means returning to your departure point.

In forecast marginal weather, careful pre-flight planning is essential and must include a thorough analysis of the latest weather forecasts and consideration of your available options. Those options should be evaluated while en route to ensure you have an alternative course of action available which provides for a safe landing.

Personal limitations

When deciding on whether it is safe to fly, pilots should consider not only the route to be flown, the prevailing weather and aircraft serviceability, but their own physical and emotional fitness and flying experience. In other words, to be a competent pilot, you must know and fly within your own limitations.

Adhering to a pre-flight 'personal minimums' checklist will go a long way toward keeping you safe. For example, the decision to turn back or divert will be easier if you have decided in advance what your personal minimum VFR flying altitude will be. That minimum altitude may well be much more conservative than the legal requirement.

Wreckage of the Cessna 206 aircraft. Source: ATSB

Hostile environment

Investigation AO-2008-063

In September 2008, a Cessna 206 departed Bankstown, NSW, on a private flight to Archerfield, Queensland, via Scone, NSW. The private pilot had purchased the aircraft on the morning of the accident flight and was advised that the flight should track along the coast to Archerfield to avoid any weather problems. However, the pilot indicated an intent to visit friends in Scone.

The aircraft landed at Scone Airport and was met by friends of the pilot, who observed the subsequent take-off, in what was described by another pilot as 'poor weather'. The aircraft was reported missing when it did not arrive at its planned destination. The following day, the wreckage of the aircraft was located on top of a ridge in rugged terrain, approximately 56 km north-north-east of Scone Airport. The pilot and his two passengers were fatally injured.

The investigation concluded that the pilot was probably attempting to return to Scone after encountering weather unsuitable for flight under VFR, and that the circumstances of the accident were consistent with controlled flight into terrain after encountering IMC.

It was determined that both the forecast and actual weather conditions were not suitable for VFR flight on the planned route, with low cloud, rain showers and high winds. The pilot most probably did not check the forecast weather before the flight. The route chosen for the flight was not suitable for the aircraft in the prevailing weather conditions.

Lessons learnt

Although the pilot would have been generally aware of the weather situation from observations during the flight from Bankstown, and at Scone itself, without knowledge of the forecast weather on the route selected it is unlikely that adequate consideration was given to the risks inherent in continuing the flight.

Attempting continued VFR flight when the weather clearly does not support it compromises the safety of yourself and your passengers. Running out of altitude and/or visibility leaves you without alternatives.

A stock image of a Cessna Caravan float plane.

Calming influence

Investigation AO-2007-014

In June 2007, a Cessna Caravan float plane departed Broome Airport, Western Australia (WA), on a VFR charter flight to Talbot Bay, WA. On board the aircraft were the pilot and 10 passengers.

About 40 minutes into the flight, the weather conditions deteriorated and the pilot elected to return to Broome. During the return, the aircraft entered an area of reduced in-flight visibility that resulted in the loss of the visual horizon and, while manoeuvring the aircraft to regain VMC, the pilot became disoriented.

The non-instrument-rated pilot made a general radio broadcast requesting assistance, which was received by the crew of another aircraft who initially advised the pilot of the Caravan to concentrate on maintaining the aircraft's orientation using its attitude indicator. After confirming that the Caravan pilot was maintaining the aircraft's attitude with reference to its instruments, the assisting pilot advised to set cruise power, and to maintain level flight with reference to the vertical speed indicator.

The crew of the assisting aircraft reported that, about five minutes after the initial radio contact, the pilot of the Caravan sounded less stressed and advised the aircraft was in level flight. The flight continued on to Broome, which required the pilot to descend through cloud before becoming visual and landing safely.

Lessons learnt

The potentially severe consequences of this occurrence were probably avoided by the pilot's decision to seek assistance and the ability of the flight crew of the other aircraft to provide appropriate input and guidance. If you find yourself in marginal weather and becoming disoriented or lost, seek whatever help is available. Air traffic control can provide assistance, especially if you are in radar coverage.

Having entered deteriorating weather, many pilots will descend to remain in VMC. Apart from the terrain hazards, descending may eliminate radar and communication contact. In order to get the aircraft safely on the ground it is up to the pilot to keep the aircraft under control. Being able to make a 180° turn, and if necessary climb to a safe altitude, requires proficiency at basic flying manoeuvres on instruments. Those skills, learned while training for the Private Pilot Licence, disappear if not regularly practised.

Personal minimums checklist

Investigation AO-2017-061

On 16 June 2017, a Cessna 172 was being operated on a private flight from Southport Mason Field, Queensland, to Ballina Airport, NSW. The purpose of the flight was to ferry the aircraft to Ballina for scheduled maintenance before the expiry of the aircraft's maintenance release on 17 June 2017.

En route, near the town of Bangalow NSW, the aircraft entered an area of reduced visibility, including low cloud, fog and drizzle. The aircraft diverted off the initial track and was last seen disappearing into cloud heading inland. A short time later the aircraft collided with terrain and the pilot was fatally injured.

The ATSB found that the decision to depart on the flight had placed the pilot at risk of encountering conditions of reduced visibility. On entering those conditions, the pilot likely became spatially disoriented, resulting in a loss of control and a collision with terrain. The investigation also found that the pilot was likely under some degree of self-imposed pressure to meet a pre-arranged appointment, despite the inclement weather conditions.

Lessons learnt

VFR pilots should use a 'personal minimums' checklist to help control and manage flight risks by identifying risk factors that include marginal weather conditions and only fly in environments that do not exceed their capabilities.

A personal minimums checklist is an individual pilot's own set of rules and criteria for deciding if and under what conditions to fly or to continue flying based on your knowledge, skills and experience. As a personal 'go/no go' checklist they can help take the stress out of difficult decisions both before and during flight, acting as a safety buffer between the demands of the situation and the extent of a pilot's skill.

Conclusion

Pilot decision making, particularly weather-related decision making, is complex and there is no single solution to the problem of VFR into IMC occurrences. However, there are a number of measures which can be used to reduce the significant risk inherent in the operation of VFR into IMC.

The ATSB's report *Improving the odds: Trends in fatal and non-fatal accidents in private flying operations*, found that problems with pilots' assessing and planning were contributing factors in about half of all fatal accidents in private operations. The report encourages all pilots to consider the following strategies:

- make decisions before the flight
- continually assess the flight conditions (particularly weather conditions)
- evaluate the effectiveness of their plans
- set personal minimums
- assess your fitness to fly
- set passenger expectations by making safety the primary goal
- seek local knowledge of the route and destination as part of their pre-flight planning.

Also, becoming familiar with the aircraft's systems, controls and limitations may alleviate poor aircraft handling during non-normal flight conditions. Finally, pilots need to be vigilant about following rules and regulations that are in place—they are there to prevent errors being made before and during flight. Violating these regulations only removes these 'safety buffers'.

References

Australian Transport Safety Bureau. (2005). *General Aviation Pilot Behaviours in the Face of Adverse Weather.* Aviation Research Investigation Report B2005/0127.

Australian Transport Safety Bureau. (2007). *An overview of spatial disorientation as a factor in aviation accidents and incidents*. ATSB Aviation Research and Analysis Report B2007/0063.

Australian Transport Safety Bureau. (2010). *Improving the odds: Trends in fatal and non-fatal accidents in private flying operations*. Aviation Research and Analysis Report AR-2008-045.

ATSB reports are available at www.atsb.gov.au

Further reading and resources

CASA Online Store: shop.casa.gov.au

- Flight Planning Kit — always thinking ahead. A flight planning guide designed to help you in planning and conducting your flight. Includes a handbook outlining eight stages of a flight; flight planning notepad; personal minimums checklist; time in your tanks card and more.
- Weather to Fly DVD — highlights the dangers of flying in cloud, and how to avoid VFR into IMC.
- Look out! Situational Awareness — an informative DVD on situational awareness and why it is vital to flying safety.
- Safety Behaviours: Human factors for pilots (second edition) resource kit — includes a series of booklets and videos on a wide range of topics such as situational awareness, decision-making, and threat and error management.

  Also available online at www.casa.gov.au/hf

CASA AvSafety seminars

CASA holds free seminars for pilots held across Australia. VFR operations into IMC, situational awareness and decision making are just some of the safety issues covered. Find out more at www.casa.gov.au/avsafety

CASA Flight Safety Australia magazine (www.flightsafetyaustralia.com)

Flight Safety Australia, CASA's flagship aviation safety magazine and website, is topical, technical, but reader-friendly, with articles covering all the key aviation safety issues.

Flight Safety Australia has produced a number of articles that focus on VFR into IMC, and spatial awareness, including:

- Don't believe your ears
  www.flightsafetyaustralia.com/2014/03/dont-believe-your-ears
- 178 seconds to live — VFR into IMC
  www.flightsafetyaustralia.com/2016/01/178-seconds-to-live-vfr-into-imc

CASA on YouTube

www.youtube.com/user/CASABriefing

US FAA

The US Federal Aviation Administration (FAA) has published a comprehensive Personal and Weather Risk Assessment Guide. It includes an example of a personal minimums checklist and a flight assessment form.

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Civil Aviation Safety Authority

Standing personal minimums checklist

(Review every 100 hours, or annually, or on completion of new rating/endorsement)

Endorsement, training & experience summary	Self-assessment factors	Revised self-assessment
Endorsement/ratings (eg: night VFR, MPPC–manual propeller pitch control)		
Flight review		
Time since last instruction in aircraft #1:		
Time since last instruction in aircraft #2:		
Time since last instruction in aircraft #3:		
Familiarity with avionics/GPS		
Experience		
Total flying time in hours		
Number of years flying		
Hours in the last year		
Hours in this or identical aircraft in last year		
Landings in last year		
Night hours in last year		
Night landings in last year		
High density altitude hours in last year		
Mountainous terrain hours in last year		
Strong crosswind or gusty landings in last year		
Personal minimums		
	Example: 100 hour VFR pilot	Your personal minimums
Maximum crosswind as % of pilot's operating handbook figure for type	50%	
Minimum runway requirement as % of pilot's operating handbook figure for type	150%	
Minimum visibility – day VFR	12km	
Minimum visibility – night VFR	10km or more	
Minimum ceiling – day VFR	3,000 feet	
Minimum ceiling – night VFR	5,000 feet	
Maximum surface wind speed & gusts	15 knots 5 knot gust	
Maximum cross wind	7 knots	
Other VFR (eg: mountain flying, over water beyond gliding distance)	Consult instructor/ mentor	
Fuel reserves (day VFR)	1 hour	
Fuel reserves (night VFR)	1½ hours	

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