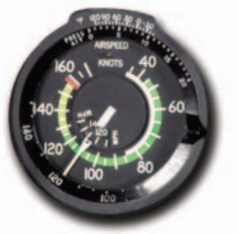
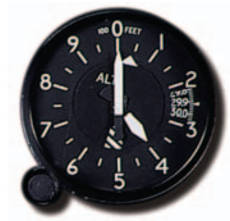
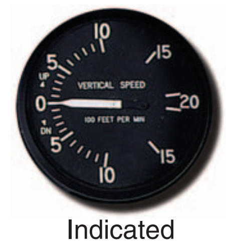
Effect of Blocked Pitot/Static Sources on Airspeed, Altimeter and Vertical Speed Indications	 Indicated Airspeed	 Indicated Altitude	 Indicated Vertical Speed
Pitot Source Blocked	Increases with altitude gain; decreases with altitude loss.	Unaffected	Unaffected
One Static Source Blocked	Inaccurate while sideslipping; very sensitive in turbulence.		
Both Static Sources Blocked	Decreases with altitude gain; increases with altitude loss.	Does not change with actual gain or loss of altitude.	Does not change with actual variations in vertical speed.
Both Static and Pitot Sources Blocked	All indications remain constant, regardless of actual changes in airspeed, altitude and vertical speed.		

Figure 16-10. Effects of blocked pitot-static sources.

abnormal engine instrument indications. The table on the next page offers generic information on some of the more commonly experienced in-flight abnormal engine instrument indications, their possible causes, and corrective actions. [Table 1]

DOOR OPENING IN FLIGHT

In most instances, the occurrence of an inadvertent door opening is not of great concern to the safety of a flight, but rather, the pilot's reaction at the moment the incident happens. A door opening in flight may be accompanied by a sudden loud noise, sustained noise level and possible vibration or buffeting. If a pilot allows himself or herself to become distracted to the point where attention is focused on the open door rather than maintaining control of the airplane, loss of control may result, even though disruption of airflow by the door is minimal.

In the event of an inadvertent door opening in flight or on takeoff, the pilot should adhere to the following.

- Concentrate on flying the airplane. Particularly in light single- and twin-engine airplanes; a cabin door that opens in flight seldom if ever compromises the airplane's ability to fly. There may be some handling effects such as roll and/or yaw, but in most instances these can be easily overcome.
- If the door opens after lift-off, do not rush to land. Climb to normal traffic pattern altitude, fly a normal traffic pattern, and make a normal landing.
- Do not release the seat belt and shoulder harness in an attempt to reach the door. Leave the door alone. Land as soon as practicable, and close the door once safely on the ground.
- Remember that most doors will not stay wide open. They will usually bang open, then settle partly closed. A slip towards the door may cause it to open wider; a slip away from the door may push it closed.
- Do not panic. Try to ignore the unfamiliar noise and vibration. Also, do not rush. Attempting to get the airplane on the ground as quickly as possible may result in steep turns at low altitude.
- Complete all items on the landing checklist.
- Remember that accidents are almost never caused by an open door. Rather, an open door accident is caused by the pilot's distraction or failure to maintain control of the airplane.

INADVERTENT VFR FLIGHT INTO IMC

GENERAL

It is beyond the scope of this handbook to incorporate a course of training in basic attitude instrument flying. This information is contained in FAA-H-8083-15, *Instrument Flying Handbook*. Certain pilot certificates and/or associated ratings require training in instrument flying and a demonstration of specific instrument flying tasks on the practical test.

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
Loss of r.p.m. during cruise flight (non-altitude engines)	Carburetor or induction icing or air filter clogging	Apply carburetor heat. If dirty filter is suspected and non-filtered air is available, switch selector to unfiltered position.
Loss of manifold pressure during cruise flight	Same as above Turbocharger failure	Same as above. Possible exhaust leak. Shut down engine or use lowest practicable power setting. Land as soon as possible.
Gain of manifold pressure during cruise flight	Throttle has opened, propeller control has decreased r.p.m., or improper method of power reduction	Readjust throttle and tighten friction lock. Reduce manifold pressure prior to reducing r.p.m.
High oil temperature	Oil congealed in cooler Inadequate engine cooling Detonation or preignition Forth coming internal engine faiure Defective thermostatic oil cooler control	Reduce power. Land. Preheat engine. Reduce power. Increase airspeed. Observe cylinder head temperatures for high reading. Reduce manifold pressure. Enrich mixture. Land as soon as possible or feather propeller and stop engine. Land as soon as possible. Consult maintenance personnel.
Low oil temperature	Engine not warmed up to operating temperature	Warm engine in prescribed manner.
High oil pressure	Cold oil Possible internal plugging	Same as above. Reduce power. Land as soon as possible.
Low oil pressure	Broken pressure relief valve Insufficient oil Burned out bearings	Land as soon as possible or feather propeller and stop engine. Same as above. Same as above.
Fluctuating oil pressure	Low oil supply, loose oil lines, defective pressure relief valve	Same as above.
High cylinder head temperature	Improper cowl flap adjustment Insufficient airspeed for cooling Improper mixture adjustment Detonation or preignition	Adjust cowl flaps. Increase airspeed. Adjust mixture. Reduce power, enrich mixture, increase cooling airflow.
Low cylinder head temperature	Excessive cowl flap opening Excessively rich mixture Exteneded glides without clearing engine	Adjust cowl flaps. Adjust mixture control. Clear engine long enough to keep temperatures at minimum range.
Ammeter indicating discharge	Alternator or generator failure	Shed unnecessary electrical load. Land as soon as practicable.
Load meter indicating zero	Same as above	Same as above.
Surging r.p.m. and overspeeding	Defective propeller Defective engine Defective propeller governor Defective tachometer Improper mixture setting	Adjust propeller r.p.m. Consult maintenance. Adjust propeller control. Attempt to restore normal operation. Consult maintenance. Readjust mixture for smooth operation.
Loss of airspeed in cruise flight with manifold pressure and r.p.m. constant	Possible loss of one or more cylinders	Land as soon as possible.
Rough running engine	Improper mixture control setting Defective ignition or valves Detonation or preignition Induction air leak Plugged fuel nozzle (Fuel injection) Excessive fuel pressure or fuel flow	Adjust mixture for smooth operation. Consult maintenance personnel. Reduce power, enrich mixture, open cowl flaps to reduce cylinder head temp. Land as soon as practicable. Reduce power. Consult maintenance. Same as above. Lean mixture control.
Loss of fuel pressure	Engine driven pump failure No fuel	Turn on boost tanks. Switch tanks, turn on fuel.

Table 1.

Pilots and flight instructors should refer to FAA-H-8083-15 for guidance in the performance of these tasks, and to the appropriate practical test standards for information on the standards to which these required tasks must be performed for the particular certificate level and/or rating. The pilot should remember, however, that unless these tasks are practiced on a continuing and regular basis, skill erosion begins almost immediately. In a very short time, the pilot's *assumed* level of confidence will be much higher than the performance he or she will actually be able to demonstrate should the need arise.

Accident statistics show that the pilot who has not been trained in attitude instrument flying, or one whose instrument skills have eroded, will lose control of the airplane in about 10 minutes once forced to rely solely on instrument reference. The purpose of this section is to provide guidance on practical emergency measures to maintain airplane control for a limited period of time in the event a VFR pilot encounters IMC conditions. The main goal is *not* precision instrument flying; rather, it is to help the VFR pilot keep the airplane under adequate control until suitable visual references are regained.

The first steps necessary for surviving an encounter with instrument meteorological conditions (IMC) by a VFR pilot are:

- Recognition and acceptance of the seriousness of the situation and the need for immediate remedial action.
- Maintaining control of the airplane.
- Obtaining the appropriate assistance in getting the airplane safely on the ground.

RECOGNITION

A VFR pilot is in IMC conditions anytime he or she is unable to maintain airplane attitude control by reference to the natural horizon, regardless of the circumstances or the prevailing weather conditions. Additionally, the VFR pilot is, in effect, in IMC anytime he or she is inadvertently, or intentionally for an indeterminate period of time, unable to navigate or establish geographical position by visual reference to landmarks on the surface. These situations must be accepted by the pilot involved as a genuine emergency, requiring appropriate action.

The pilot must understand that unless he or she is trained, qualified, and current in the control of an airplane solely by reference to flight instruments, he or she will be unable to do so for any length of time. Many hours of VFR flying using the attitude indicator as a reference for airplane control may lull a pilot into a false sense of security based on an overestimation of his or her personal ability to control the airplane solely by instrument reference. In VFR conditions, even though the pilot thinks he or she is controlling the airplane by instrument reference, the pilot also receives an overview of the natural horizon and may subconsciously rely on it more than the cockpit attitude indicator. If the natural horizon were to suddenly disappear, the untrained instrument pilot would be subject to vertigo, spatial disorientation, and inevitable control loss.

MAINTAINING AIRPLANE CONTROL

Once the pilot recognizes and accepts the situation, he or she must understand that the only way to control the airplane safely is by using and trusting the flight instruments. Attempts to control the airplane *partially* by reference to flight instruments while searching outside the cockpit for visual confirmation of the information provided by those instruments will result in inadequate airplane control. This may be followed by spatial disorientation and complete control loss.

The most important point to be stressed is that the pilot **must not panic**. The task at hand may seem overwhelming, and the situation may be compounded by extreme apprehension. The pilot therefore must make a conscious effort to relax.

The pilot must understand the most important concern—in fact the only concern at this point—is to keep the wings level. An uncontrolled turn or bank usually leads to difficulty in achieving the objectives of any desired flight condition. The pilot will find that good bank control has the effect of making pitch control much easier.

The pilot should remember that a person cannot feel control pressures with a tight grip on the controls. Relaxing and learning to "control with the eyes and the brain" instead of only the muscles, usually takes considerable conscious effort.

The pilot must believe what the flight instruments show about the airplane's attitude regardless of what the natural senses tell. The vestibular sense (motion sensing by the inner ear) can and will confuse the pilot. Because of inertia, the sensory areas of the inner ear cannot detect slight changes in airplane attitude, nor can they accurately sense attitude changes which occur at a uniform rate over a period of time. On the other hand, *false* sensations are often generated, leading the pilot to believe the attitude of the airplane *has* changed when, in fact, it has not. These false sensations result in the pilot experiencing spatial disorientation.

ATTITUDE CONTROL

An airplane is, by design, an inherently stable platform and, except in turbulent air, will maintain approximately straight-and-level flight if properly trimmed and left alone. It is designed to maintain a state of equilibrium in pitch, roll, and yaw. The pilot must be aware, however, that a change about one axis will affect the stability of the others. The typical light airplane exhibits a good deal of stability in the yaw axis, slightly less in the pitch axis, and even lesser still in the roll axis. The key to emergency airplane attitude control, therefore, is to:

- Trim the airplane with the elevator trim so that it will maintain hands-off level flight at cruise airspeed.
- Resist the tendency to over control the airplane. Fly the attitude indicator with fingertip control. No attitude changes should be made unless the flight instruments indicate a definite need for a change.
- Make all attitude changes smooth and small, yet with positive pressure. Remember that a small change as indicated on the horizon bar corresponds to a proportionately much larger change in actual airplane attitude.
- Make use of any available aid in attitude control such as autopilot or wing leveler.

The primary instrument for attitude control is the attitude indicator. [Figure 16-11] Once the airplane is trimmed so that it will maintain hands-off level flight at cruise airspeed, that airspeed need not vary until the airplane must be slowed for landing. All turns, climbs and descents can and should be made at this airspeed. Straight flight is maintained by keeping the wings level using "fingertip pressure" on the control wheel. Any pitch attitude change should be made by using no more than one bar width up or down.

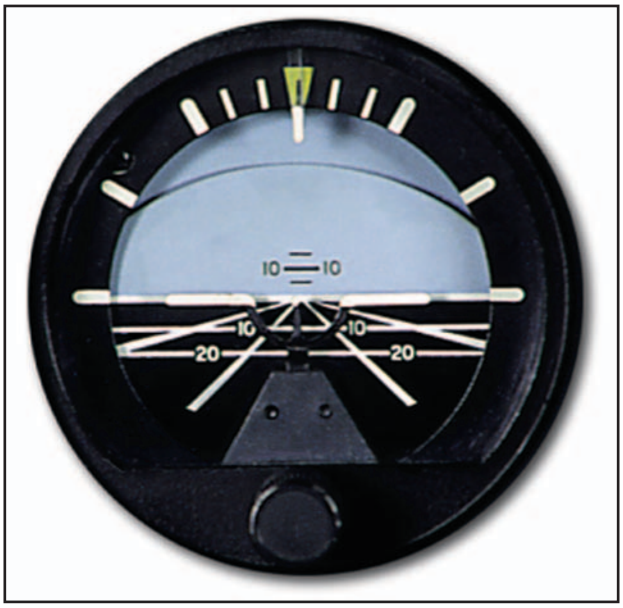


Figure 16-11. Attitude indicator.

TURNS

Turns are perhaps the most potentially dangerous maneuver for the untrained instrument pilot for two reasons.

- The normal tendency of the pilot to over control, leading to steep banks and the possibility of a "graveyard spiral."
- The inability of the pilot to cope with the instability resulting from the turn.

When a turn must be made, the pilot must anticipate and cope with the relative instability of the roll axis. The smallest practical bank angle should be used—in any case no more than 10° bank angle. [Figure 16-12] A shallow bank will take very little vertical lift from the wings resulting in little if any deviation in altitude. It may be helpful to turn a few degrees and then return to level flight, if a large change in heading must be made. Repeat the process until the desired heading is reached. This process may relieve the progressive overbanking that often results from prolonged turns.

CLIMBS

If a climb is necessary, the pilot should raise the miniature airplane on the attitude indicator no more than one bar width and apply power. [Figure 16-13] The pilot should not attempt to attain a specific climb speed but accept whatever speed results. The objective is to deviate as little as possible from level flight attitude in order to disturb the airplane's equilibrium as little as possible. If the airplane is properly trimmed, it will assume a nose-up attitude on its own commensurate with the amount of power applied. Torque and P-factor will cause the airplane to have a

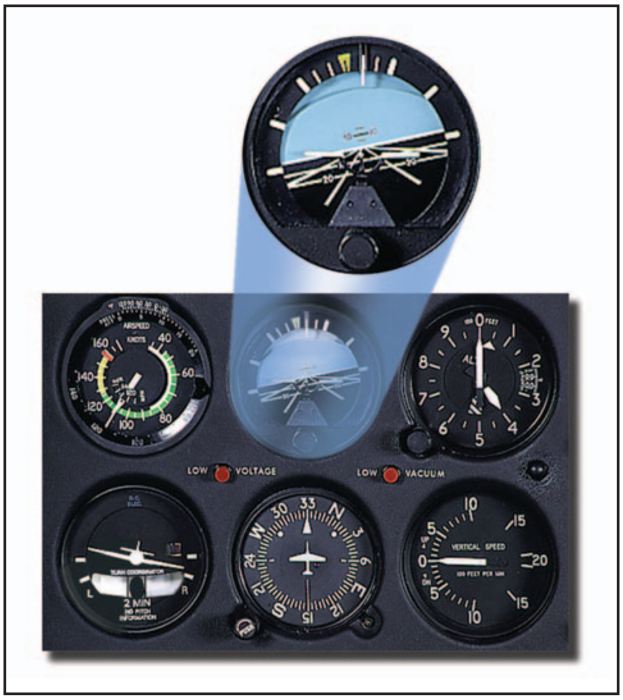


Figure 16-12. Level turn.

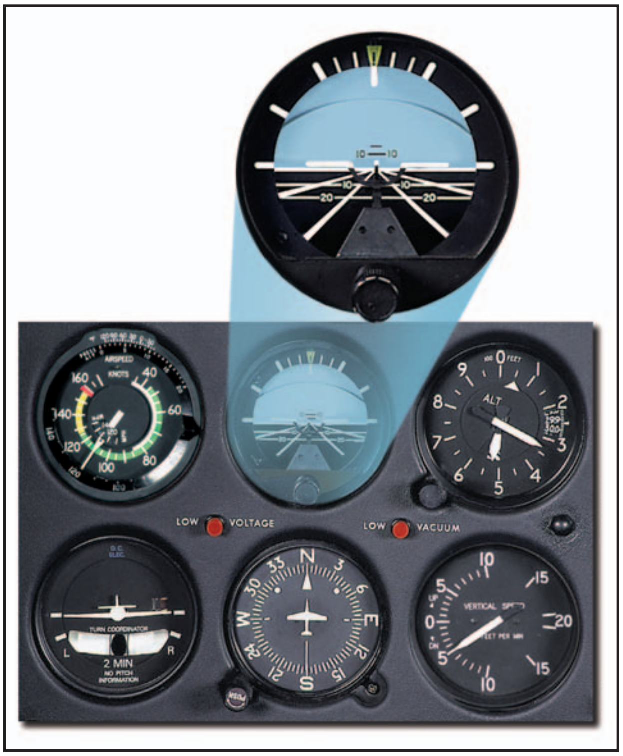


Figure 16-13. Level climb.

tendency to bank and turn to the left. This must be anticipated and compensated for. If the initial power application results in an inadequate rate of climb, power should be increased in increments of 100 r.p.m. or 1 inch of manifold pressure until the desired rate of climb is attained. Maximum available power is seldom necessary. The more power used the more the airplane will want to bank and turn to the left. Resuming level flight is accomplished by first decreasing pitch attitude to level on the attitude indicator using slow but deliberate pressure, allowing airspeed to increase to near cruise value, and then decreasing power.

DESCENTS

Descents are very much the opposite of the climb procedure if the airplane is properly trimmed for hands-off straight-and-level flight. In this configuration, the airplane requires a certain amount of thrust to maintain altitude. The pitch attitude is controlling the airspeed. The engine power, therefore, (translated into thrust by the propeller) is maintaining the selected altitude. Following a power reduction, however slight, there will be an almost imperceptible decrease in airspeed. However, even a slight change in speed results in less down load on the tail, whereupon the designed nose heaviness of the airplane causes it to pitch down just enough to maintain the airspeed for which it was trimmed. The airplane will then descend at a rate directly proportionate to the amount of thrust that has been removed. Power reductions should be made in increments of 100 r.p.m. or 1 inch of manifold pressure and the resulting rate of descent should never exceed 500 f.p.m. The wings should be held level on the attitude indicator, and the pitch attitude should not exceed one bar width below level. [Figure 16-14]

COMBINED MANEUVERS

Combined maneuvers, such as climbing or descending turns should be avoided if at all possible by an untrained instrument pilot already under the stress of an emergency situation. Combining maneuvers will only compound the problems encountered in individual maneuvers and increase the risk of control loss. Remember that the objective is to maintain airplane control by deviating as little as possible from straight-and-level flight attitude and thereby maintaining as much of the airplane's natural equilibrium as possible.

When being assisted by air traffic controllers from the ground, the pilot may detect a sense of urgency as he or she is being directed to change heading and/or altitude. This sense of urgency reflects a normal concern for safety on the part of the controller. But the pilot must not let this prompt him or her to attempt a maneuver that could result in loss of control.

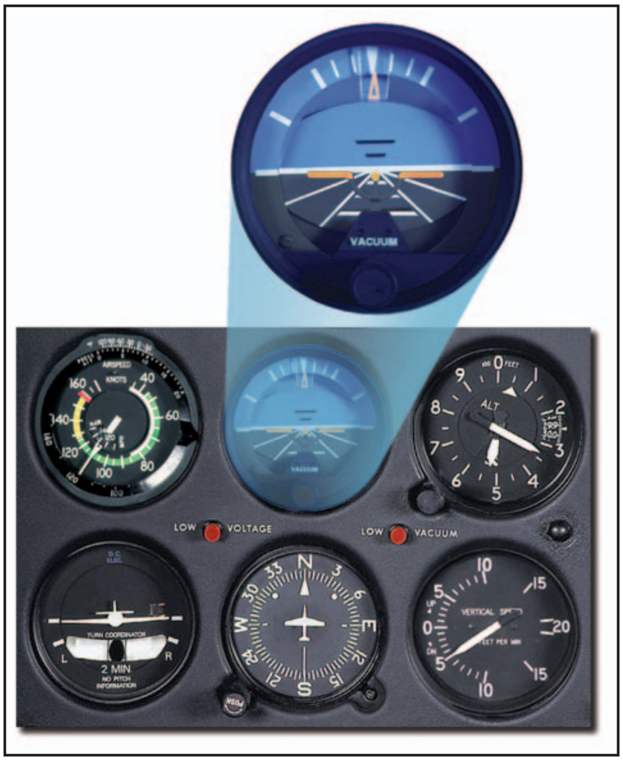


Figure 16-14. Level descent.

TRANSITION TO VISUAL FLIGHT

One of the most difficult tasks a trained and qualified instrument pilot must contend with is the transition from instrument to visual flight prior to landing. For the untrained instrument pilot, these difficulties are magnified.

The difficulties center around acclimatization and orientation. On an instrument approach the trained instrument pilot must prepare in advance for the transition to visual flight. The pilot must have a mental picture of what he or she expects to see once the transition to visual flight is made and quickly acclimatize to the new environment. Geographical orientation must also begin before the transition as the pilot must visualize where the airplane will be in relation to the airport/runway when the transition occurs so that the approach and landing may be completed by visual reference to the ground.

In an ideal situation the transition to visual flight is made with ample time, at a sufficient altitude above terrain, and to visibility conditions sufficient to accommodate acclimatization and geographical orientation. This, however, is not always the case. The untrained instrument pilot may find the visibility still limited, the terrain completely unfamiliar, and altitude above terrain such that a "normal" airport traffic pattern and landing approach is not possible. Additionally, the pilot will most likely be under considerable self-induced psychological pressure to get the airplane on the ground. The pilot must take this into account and, if possible, allow time to become acclimatized and geographically oriented before attempting an approach and landing, even if it means flying straight and level for a time or circling the airport. This is especially true at night.