



## EMERGENCY SITUATIONS

This chapter contains information on dealing with non-normal and emergency situations that may occur in flight. The key to successful management of an emergency situation, and/or preventing a non-normal situation from progressing into a true emergency, is a thorough familiarity with, and adherence to, the procedures developed by the airplane manufacturer and contained in the FAA-approved Airplane Flight Manual and/or Pilot's Operating Handbook (AFM/POH). The following guidelines are generic and are **not** meant to replace the airplane manufacturer's recommended procedures. Rather, they are meant to enhance the pilot's general knowledge in the area of non-normal and emergency operations. If any of the guidance in this chapter conflicts in any way with the manufacturer's recommended procedures for a particular make and model airplane, **the manufacturer's recommended procedures take precedence.**

## EMERGENCY LANDINGS

This section contains information on emergency landing techniques in small fixed-wing airplanes. The guidelines that are presented apply to the more adverse terrain conditions for which no practical training is possible. The objective is to instill in the pilot the knowledge that almost any terrain can be considered "suitable" for a survivable crash landing if the pilot knows how to use the airplane structure for self-protection and the protection of passengers.

### TYPES OF EMERGENCY LANDINGS

The different types of emergency landings are defined as follows.

- **Forced landing.** An immediate landing, on or off an airport, necessitated by the inability to continue further flight. A typical example of which is an airplane forced down by engine failure.
- **Precautionary landing.** A premeditated landing, on or off an airport, when further flight is possible but inadvisable. Examples of conditions that may call for a precautionary landing include deteriorating weather, being lost, fuel shortage, and gradually developing engine trouble.
- **Ditching.** A forced or precautionary landing on water.

A precautionary landing, generally, is less hazardous than a forced landing because the pilot has more time for terrain selection and the planning of the approach. In addition, the pilot can use power to compensate for errors in judgment or technique. The pilot should be aware that too many situations calling for a precautionary landing are allowed to develop into immediate forced landings, when the pilot uses wishful thinking instead of reason, especially when dealing with a self-inflicted predicament. The non-instrument rated pilot trapped by weather, or the pilot facing imminent fuel exhaustion who does not give any thought to the feasibility of a precautionary landing accepts an extremely hazardous alternative.

### PSYCHOLOGICAL HAZARDS

There are several factors that may interfere with a pilot's ability to act promptly and properly when faced with an emergency.

- **Reluctance to accept the emergency situation.** A pilot who allows the mind to become paralyzed at the thought that the airplane will be on the ground, in a very short time, regardless of the pilot's actions or hopes, is severely handicapped in the handling of the emergency. An unconscious desire to delay the dreaded moment may lead to such errors as: failure to lower the nose to maintain flying speed, delay in the selection of the most suitable landing area within reach, and indecision in general. Desperate attempts to correct whatever went wrong, at the expense of airplane control, fall into the same category.
- **Desire to save the airplane.** The pilot who has been conditioned during training to expect to find a relatively safe landing area, whenever the flight instructor closed the throttle for a simulated forced landing, may ignore all basic rules of airmanship to avoid a touchdown in terrain where airplane damage is unavoidable. Typical consequences are: making a 180° turn back to the runway when available altitude is insufficient; stretching the glide without regard for minimum control speed in order to reach a more appealing field; accepting an approach and touchdown situation that leaves no margin for error. The desire to save the airplane, regardless of the risks involved, may be influenced by two other factors: the pilot's financial stake in the airplane and the

certainty that an undamaged airplane implies no bodily harm. There are times, however, when a pilot should be more interested in sacrificing the airplane so that the occupants can safely walk away from it.

- **Undue concern about getting hurt.** Fear is a vital part of the self-preservation mechanism. However, when fear leads to panic, we invite that which we want most to avoid. The survival records favor pilots who maintain their composure and know how to apply the general concepts and procedures that have been developed through the years. The success of an emergency landing is as much a matter of the mind as of skills.

## BASIC SAFETY CONCEPTS

### GENERAL

A pilot who is faced with an emergency landing in terrain that makes extensive airplane damage inevitable should keep in mind that the avoidance of crash injuries is largely a matter of: (1) keeping vital structure (cockpit/cabin area) relatively intact by using dispensable structure (such as wings, landing gear, and fuselage bottom) to absorb the violence of the stopping process before it affects the occupants, (2) avoiding forceful bodily contact with interior structure.

The advantage of sacrificing dispensable structure is demonstrated daily on the highways. A head-on car impact against a tree at 20 miles per hour (m.p.h.) is less hazardous for a properly restrained driver than a similar impact against the driver's door. Accident experience shows that the extent of crushable structure between the occupants and the principal point of impact on the airplane has a direct bearing on the severity of the transmitted crash forces and, therefore, on survivability.

Avoiding forcible contact with interior structure is a matter of seat and body security. Unless the occupant decelerates at the same rate as the surrounding structure, no benefit will be realized from its relative intactness. The occupant will be brought to a stop violently in the form of a secondary collision.

Dispensable airplane structure is not the only available energy absorbing medium in an emergency situation. Vegetation, trees, and even manmade structures may be used for this purpose. Cultivated fields with dense crops, such as mature corn and grain, are almost as effective in bringing an airplane to a stop with repairable damage as an emergency arresting device on a runway. [Figure 16-1] Brush and small trees provide considerable cushioning and braking effect without destroying the airplane. When dealing with natural and manmade obstacles with greater strength than the dispensable airplane structure, the pilot must

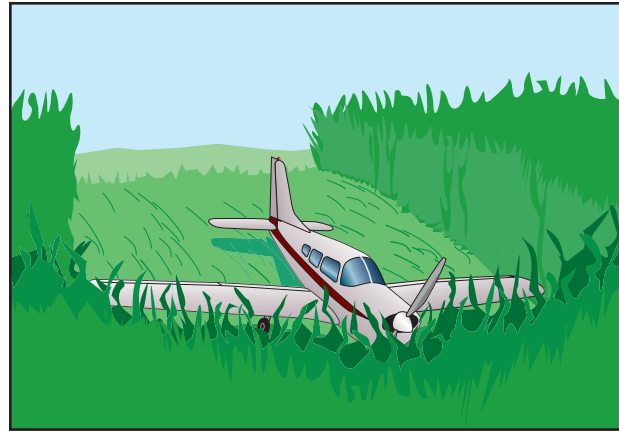


Figure 16-1. Using vegetation to absorb energy.

plan the touchdown in such a manner that only non-essential structure is “used up” in the principal slowing down process.

The overall severity of a deceleration process is governed by speed (groundspeed) and stopping distance. The most critical of these is speed; doubling the groundspeed means quadrupling the total destructive energy, and vice versa. Even a small change in groundspeed at touchdown—be it as a result of wind or pilot technique—will affect the outcome of a controlled crash. It is important that the actual touchdown during an emergency landing be made at the lowest possible *controllable* airspeed, using all available aerodynamic devices.

Most pilots will instinctively—and correctly—look for the largest available flat and open field for an emergency landing. Actually, very little stopping distance is required if the speed can be dissipated uniformly; that is, if the deceleration forces can be spread evenly over the available distance. This concept is designed into the arresting gear of aircraft carriers that provides a nearly constant stopping force from the moment of hookup.

The typical light airplane is designed to provide protection in crash landings that expose the occupants to nine times the acceleration of gravity (9 G) in a forward direction. Assuming a uniform 9 G deceleration, at 50 m.p.h. the required stopping distance is about 9.4 feet. While at 100 m.p.h. the stopping distance is about 37.6 feet—about four times as great. [Figure 16-2] Although these figures are based on an ideal deceleration process, it is interesting to note what can be accomplished in an effectively used short stopping distance. Understanding the need for a firm but uniform deceleration process in very poor terrain enables the pilot to select touchdown conditions that will spread the breakup of dispensable structure over a short distance, thereby reducing the peak deceleration of the cockpit/cabin area.

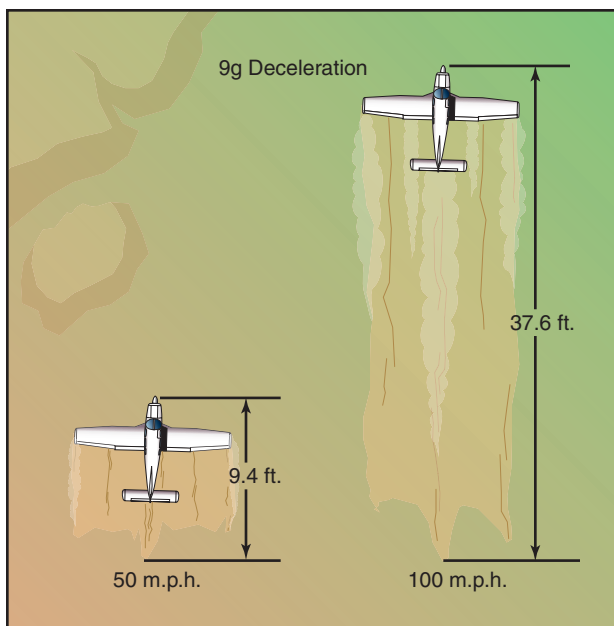


Figure 16-2. Stopping distance vs. groundspeed.

### ATTITUDE AND SINK RATE CONTROL

The most critical and often the most inexcusable error that can be made in the planning and execution of an emergency landing, even in ideal terrain, is the loss of initiative over the airplane's attitude and sink rate at touchdown. When the touchdown is made on flat, open terrain, an excessive nose-low pitch attitude brings the risk of "sticking" the nose in the ground. Steep bank angles just before touchdown should also be avoided, as they increase the stalling speed and the likelihood of a wingtip strike.

Since the airplane's vertical component of velocity will be immediately reduced to zero upon ground contact, it must be kept well under control. A flat touchdown at a high sink rate (well in excess of 500 feet per minute (f.p.m.)) on a hard surface can be injurious without destroying the cockpit/cabin structure, especially during gear up landings in low-wing airplanes. A rigid bottom construction of these airplanes may preclude adequate cushioning by structural deformation. Similar impact conditions may cause structural collapse of the overhead structure in high-wing airplanes. On soft terrain, an excessive sink rate may cause digging in of the lower nose structure and severe forward deceleration.

### TERRAIN SELECTION

A pilot's choice of emergency landing sites is governed by:

- The route selected during preflight planning.
- The height above the ground when the emergency occurs.
- Excess airspeed (excess airspeed can be converted into distance and/or altitude).

The only time the pilot has a very limited choice is during the low and slow portion of the takeoff. However, even under these conditions, the ability to change the impact heading only a few degrees may ensure a survivable crash.

If beyond gliding distance of a suitable open area, the pilot should judge the available terrain for its energy absorbing capability. If the emergency starts at a considerable height above the ground, the pilot should be more concerned about first selecting the desired general area than a specific spot. Terrain appearances from altitude can be very misleading and considerable altitude may be lost before the best spot can be pinpointed. For this reason, the pilot should not hesitate to discard the original plan for one that is obviously better. However, as a general rule, the pilot should not change his or her mind more than once; a well-executed crash landing in poor terrain can be less hazardous than an uncontrolled touchdown on an established field.

### AIRPLANE CONFIGURATION

Since flaps improve maneuverability at slow speed, and lower the stalling speed, their use during final approach is recommended when time and circumstances permit. However, the associated increase in drag and decrease in gliding distance call for caution in the timing and the extent of their application; premature use of flap, and dissipation of altitude, may jeopardize an otherwise sound plan.

A hard and fast rule concerning the position of a retractable landing gear at touchdown cannot be given. In rugged terrain and trees, or during impacts at high sink rate, an extended gear would definitely have a protective effect on the cockpit/cabin area. However, this advantage has to be weighed against the possible side effects of a collapsing gear, such as a ruptured fuel tank. As always, the manufacturer's recommendations as outlined in the AFM/POH should be followed.

When a normal touchdown is assured, and ample stopping distance is available, a gear up landing on level, but soft terrain, or across a plowed field, may result in less airplane damage than a gear down landing. [Figure 16-3]



Figure 16-3. Intentional gear up landing.



Deactivation of the airplane's electrical system before touchdown reduces the likelihood of a post-crash fire. However, the battery master switch should not be turned off until the pilot no longer has any need for electrical power to operate vital airplane systems. Positive airplane control during the final part of the approach has priority over all other considerations, including airplane configuration and cockpit checks. The pilot should attempt to exploit the power available from an irregularly running engine; however, it is generally better to switch the engine and fuel off just before touchdown. This not only ensures the pilot's initiative over the situation, but a cooled down engine reduces the fire hazard considerably.

## APPROACH

When the pilot has time to maneuver, the planning of the approach should be governed by three factors.

- Wind direction and velocity.
- Dimensions and slope of the chosen field.
- Obstacles in the final approach path.

These three factors are seldom compatible. When compromises have to be made, the pilot should aim for a wind/obstacle/terrain combination that permits a final approach with some margin for error in judgment or technique. A pilot who overestimates the gliding range may be tempted to stretch the glide across obstacles in the approach path. For this reason, it is sometimes better to plan the approach over an unobstructed area, regardless of wind direction. Experience shows that a collision with obstacles at the end of a ground roll, or slide, is much less hazardous than striking an obstacle at flying speed before the touchdown point is reached.

## TERRAIN TYPES

Since an emergency landing on suitable terrain resembles a situation in which the pilot should be familiar through training, only the more unusual situation will be discussed.

### CONFINED AREAS

The natural preference to set the airplane down on the ground should not lead to the selection of an open spot between trees or obstacles where the ground cannot be reached without making a steep descent.

Once the intended touchdown point is reached, and the remaining open and unobstructed space is very limited, it may be better to force the airplane down on the ground than to delay touchdown until it stalls (settles). An airplane decelerates faster after it is on the ground than while airborne. Thought may also be given to the desirability of ground-looping or retracting the landing gear in certain conditions.

A river or creek can be an inviting alternative in otherwise rugged terrain. The pilot should ensure that the

water or creek bed can be reached without snagging the wings. The same concept applies to road landings with one additional reason for caution; manmade obstacles on either side of a road may not be visible until the final portion of the approach.

When planning the approach across a road, it should be remembered that most highways, and even rural dirt roads, are paralleled by power or telephone lines. Only a sharp lookout for the supporting structures, or poles, may provide timely warning.

## TREES (FOREST)

Although a tree landing is not an attractive prospect, the following general guidelines will help to make the experience survivable.

- Use the normal landing configuration (full flaps, gear down).
- Keep the groundspeed low by heading into the wind.
- Make contact at minimum indicated airspeed, but not below stall speed, and "hang" the airplane in the tree branches in a nose-high landing attitude. Involving the underside of the fuselage and both wings in the initial tree contact provides a more even and positive cushioning effect, while preventing penetration of the windshield. [Figure 16-4]
- Avoid direct contact of the fuselage with heavy tree trunks.
- Low, closely spaced trees with wide, dense crowns (branches) close to the ground are much better than tall trees with thin tops; the latter allow too much free fall height. (A free fall from 75 feet results in an impact speed of about 40 knots, or about 4,000 f.p.m.)
- Ideally, initial tree contact should be symmetrical; that is, both wings should meet equal resistance in the tree branches. This distribution of the load helps to maintain proper airplane attitude. It may also preclude the loss of one wing, which invariably leads to a more rapid and less predictable descent to the ground.
- If heavy tree trunk contact is unavoidable once the airplane is on the ground, it is best to involve both wings simultaneously by directing the airplane between two properly spaced trees. **Do not attempt this maneuver, however, while still airborne.**

## WATER (DITCHING) AND SNOW

A well-executed water landing normally involves less deceleration violence than a poor tree landing or a



**Figure 16-4. Tree landing.**

touchdown on extremely rough terrain. Also an airplane that is ditched at minimum speed and in a normal landing attitude will not immediately sink upon touchdown. Intact wings and fuel tanks (especially when empty) provide floatation for at least several minutes even if the cockpit may be just below the water line in a high-wing airplane.

Loss of depth perception may occur when landing on a wide expanse of smooth water, with the risk of flying into the water or stalling in from excessive altitude. To avoid this hazard, the airplane should be “dragged in” when possible. Use no more than intermediate flaps on low-wing airplanes. The water resistance of fully extended flaps may result in asymmetrical flap failure and slowing of the airplane. Keep a retractable gear up unless the AFM/POH advises otherwise.

A landing in snow should be executed like a ditching, in the same configuration and with the same regard for loss of depth perception (white out) in reduced visibility and on wide open terrain.

## **ENGINE FAILURE AFTER TAKEOFF (SINGLE-ENGINE)**

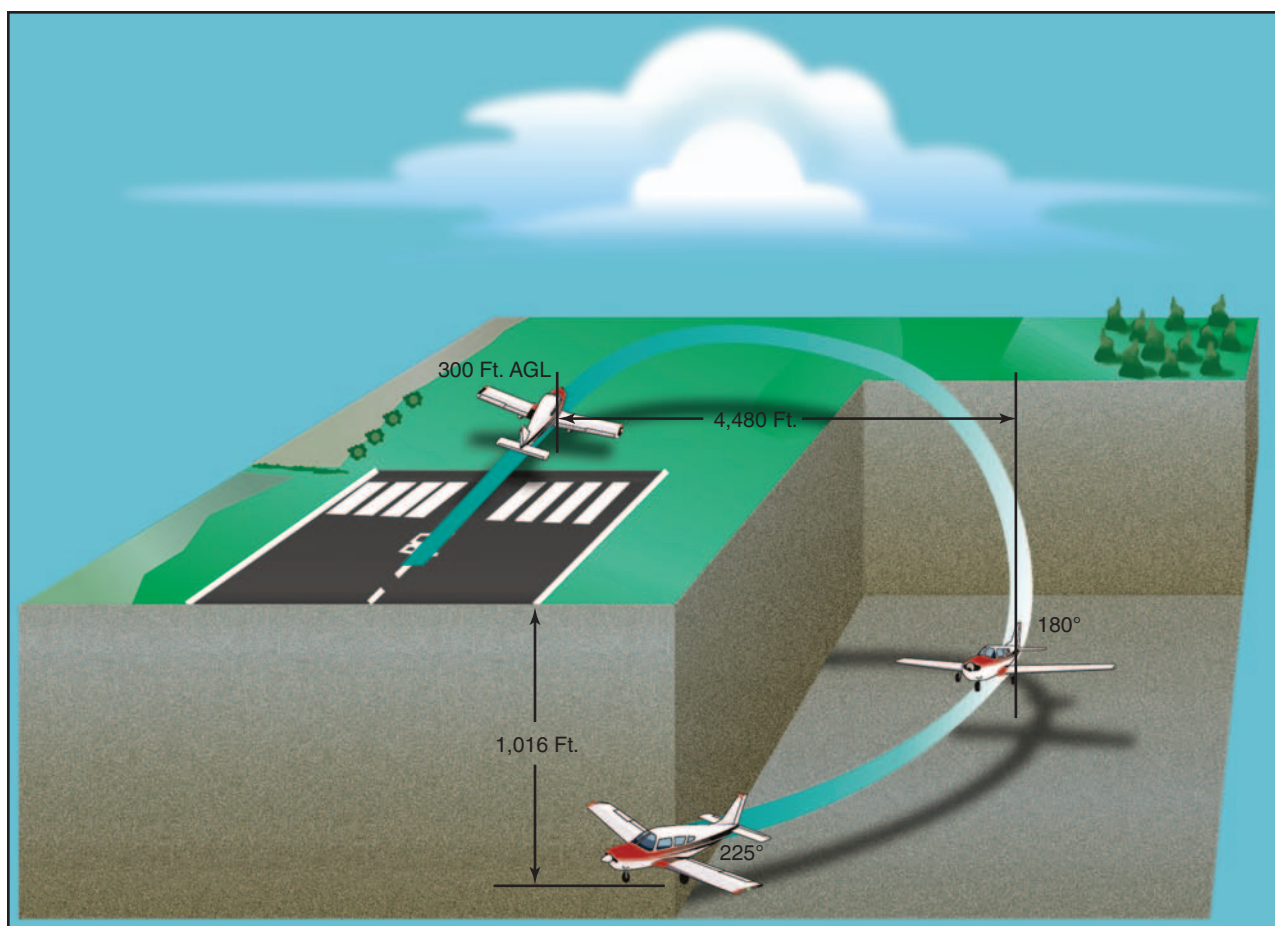
The altitude available is, in many ways, the controlling factor in the successful accomplishment of an emergency landing. If an actual engine failure should occur immediately after takeoff and before a safe maneuvering altitude is attained, it is usually inadvisable to attempt to turn back to the field from where the takeoff was made. Instead, it is safer to immediately establish the

proper glide attitude, and select a field directly ahead or slightly to either side of the takeoff path.

The decision to continue straight ahead is often difficult to make unless the problems involved in attempting to turn back are seriously considered. In the first place, the takeoff was in all probability made into the wind. To get back to the takeoff field, a downwind turn must be made. This increases the groundspeed and rushes the pilot even more in the performance of procedures and in planning the landing approach. Secondly, the airplane will be losing considerable altitude during the turn and might still be in a bank when the ground is contacted, resulting in the airplane cartwheeling (which would be a catastrophe for the occupants, as well as the airplane). After turning downwind, the apparent increase in groundspeed could mislead the pilot into attempting to prematurely slow down the airplane and cause it to stall. On the other hand, continuing straight ahead or making a slight turn allows the pilot more time to establish a safe landing attitude, and the landing can be made as slowly as possible, but more importantly, the airplane can be landed while under control.

Concerning the subject of turning back to the runway following an engine failure on takeoff, the pilot should determine the minimum altitude an attempt of such a maneuver should be made in a particular airplane. Experimentation at a safe altitude should give the pilot an approximation of height lost in a descending 180° turn at idle power. By adding a safety factor of about 25 percent, the pilot should arrive at a practical decision height. The ability to make a 180° turn does not necessarily mean that the departure runway can be reached in a power-off glide; this depends on the wind, the distance traveled during the climb, the height reached, and the glide distance of the airplane without power. The pilot should also remember that a turn back to the departure runway may in fact require more than a 180° change in direction.

Consider the following example of an airplane which has taken off and climbed to an altitude of 300 feet AGL when the engine fails. [Figure 16-5 on next page]. After a typical 4 second reaction time, the pilot elects to turn back to the runway. Using a standard rate (3° change in direction per second) turn, it will take 1 minute to turn 180°. At a glide speed of 65 knots, the radius of the turn is 2,100 feet, so at the completion of the turn, the airplane will be 4,200 feet to one side of the runway. The pilot must turn another 45° to head the airplane toward the runway. By this time the total change in direction is 225° equating to 75 seconds plus the 4 second reaction time. If the airplane in a power-off glide descends at approximately 1,000 f.p.m., it



**Figure 16-5. Turning back to the runway after engine failure.**

will have descended 1,316 feet placing it 1,016 feet below the runway.

## EMERGENCY DESCENTS

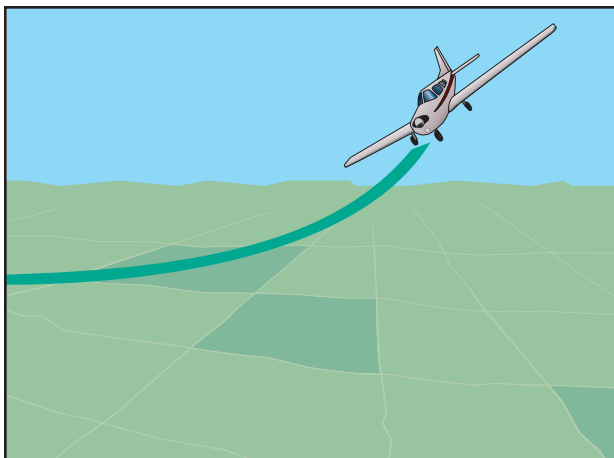
An emergency descent is a maneuver for descending as rapidly as possible to a lower altitude or to the ground for an emergency landing. [Figure 16-6] The need for this maneuver may result from an uncontrollable fire, a sudden loss of cabin pressurization, or any other situation demanding an immediate and rapid descent. The objective is to descend the airplane as soon and as rapidly as possible, within the structural limitations of the airplane. Simulated emergency descents should be made in a turn to check for other air traffic below and to look around for a possible emergency landing area. A radio call announcing descent intentions may be appropriate to alert other aircraft in the area. When initiating the descent, a bank of approximately 30 to 45° should be established to maintain positive load factors (“G” forces) on the airplane.

Emergency descent training should be performed as recommended by the manufacturer, including the configuration and airspeeds. Except when prohibited by the manufacturer, the power should be reduced to idle, and the propeller control (if equipped) should be placed in the low pitch (or high revolutions per minute

(r.p.m.)) position. This will allow the propeller to act as an aerodynamic brake to help prevent an excessive airspeed buildup during the descent. The landing gear and flaps should be extended as recommended by the manufacturer. This will provide maximum drag so that the descent can be made as rapidly as possible, without excessive airspeed. The pilot should not allow the airplane’s airspeed to pass the never-exceed speed ( $V_{NE}$ ), the maximum landing gear extended speed ( $V_{LE}$ ), or the maximum flap extended speed ( $V_{FE}$ ), as applicable. In the case of an engine fire, a high airspeed descent could blow out the fire. However, the weakening of the airplane structure is a major concern and descent at low airspeed would place less stress on the airplane. If the descent is conducted in turbulent conditions, the pilot must also comply with the design maneuvering speed ( $V_A$ ) limitations. The descent should be made at the maximum allowable airspeed consistent with the procedure used. This will provide increased drag and therefore the loss of altitude as quickly as possible. The recovery from an emergency descent should be initiated at a high enough altitude to ensure a safe recovery back to level flight or a precautionary landing.

When the descent is established and stabilized during training and practice, the descent should be terminated.





**Figure 16-6. Emergency descent.**

In airplanes with piston engines, prolonged practice of emergency descents should be avoided to prevent excessive cooling of the engine cylinders.

## IN-FLIGHT FIRE

A fire in flight demands immediate and decisive action. The pilot therefore must be familiar with the procedures outlined to meet this emergency contained in the AFM/POH for the particular airplane. For the purposes of this handbook, in-flight fires are classified as: in-flight engine fires, electrical fires, and cabin fires.

### ENGINE FIRE

An in-flight engine compartment fire is usually caused by a failure that allows a flammable substance such as fuel, oil or hydraulic fluid to come in contact with a hot surface. This may be caused by a mechanical failure of the engine itself, an engine-driven accessory, a defective induction or exhaust system, or a broken line. Engine compartment fires may also result from maintenance errors, such as improperly installed/fastened lines and/or fittings resulting in leaks.

Engine compartment fires can be indicated by smoke and/or flames coming from the engine cowling area. They can also be indicated by discoloration, bubbling, and/or melting of the engine cowling skin in cases where flames and/or smoke is not visible to the pilot. By the time a pilot becomes aware of an in-flight engine compartment fire, it usually is well developed. Unless the airplane manufacturer directs otherwise in the AFM/POH, the first step on discovering a fire should be to shut off the fuel supply to the engine by placing the mixture control in the idle cut off position and the fuel selector shutoff valve to the OFF position. The ignition switch should be left ON in order to use up the fuel that remains in the fuel lines and components between the fuel selector/shutoff valve and the engine. This procedure may starve the engine compartment of fuel and cause the fire to die naturally. If the flames are snuffed out, no attempt should be made to restart the engine.

If the engine compartment fire is oil-fed, as evidenced by thick black smoke, as opposed to a fuel-fed fire which produces bright orange flames, the pilot should consider stopping the propeller rotation by feathering or other means, such as (with constant-speed propellers) placing the pitch control lever to the minimum r.p.m. position and raising the nose to reduce airspeed until the propeller stops rotating. This procedure will stop an engine-driven oil (or hydraulic) pump from continuing to pump the flammable fluid which is feeding the fire.

Some light airplane emergency checklists direct the pilot to shut off the electrical master switch. However, the pilot should consider that unless the fire is electrical in nature, or a crash landing is imminent, deactivating the electrical system prevents the use of panel radios for transmitting distress messages and will also cause air traffic control (ATC) to lose transponder returns.

Pilots of powerless single-engine airplanes are left with no choice but to make a forced landing. Pilots of twin-engine airplanes *may* elect to continue the flight to the nearest airport. However, consideration must be given to the possibility that a wing could be seriously impaired and lead to structural failure. Even a brief but intense fire could cause dangerous structural damage. In some cases, the fire could continue to burn under the wing (or engine cowling in the case of a single-engine airplane) out of view of the pilot. Engine compartment fires which appear to have been extinguished have been known to rekindle with changes in airflow pattern and airspeed.

The pilot must be familiar with the airplane's emergency descent procedures. The pilot must bear in mind that:

- The airplane may be severely structurally damaged to the point that its ability to remain under control could be lost at any moment.
- The airplane may still be on fire and susceptible to explosion.
- The airplane is expendable and the only thing that matters is the safety of those on board.

### ELECTRICAL FIRES

The initial indication of an electrical fire is usually the distinct odor of burning insulation. Once an electrical fire is detected, the pilot should attempt to identify the faulty circuit by checking circuit breakers, instruments, avionics, and lights. If the faulty circuit cannot be readily detected and isolated, and flight conditions permit, the battery master switch and alternator/generator switches should be turned off to remove the possible source of the fire. However, any materials which have been ignited may continue to burn.

If electrical power is absolutely essential for the flight, an attempt may be made to identify and isolate the faulty circuit by:

1. Turning the electrical master switch OFF.
2. Turning all individual electrical switches OFF.
3. Turning the master switch back ON.
4. Selecting electrical switches that were ON before the fire indication one at a time, permitting a short time lapse after each switch is turned on to check for signs of odor, smoke, or sparks.

This procedure, however, has the effect of recreating the original problem. The most prudent course of action is to land as soon as possible.

### **CABIN FIRE**

Cabin fires generally result from one of three sources: (1) careless smoking on the part of the pilot and/or passengers; (2) electrical system malfunctions; (3) heating system malfunctions. A fire in the cabin presents the pilot with two immediate demands: attacking the fire, and getting the airplane safely on the ground as quickly as possible. A fire or smoke in the cabin should be controlled by identifying and shutting down the faulty system. In many cases, smoke may be removed from the cabin by opening the cabin air vents. This should be done only after the fire extinguisher (if available) is used. Then the cabin air control can be opened to purge the cabin of both smoke and fumes. If smoke increases in intensity when the cabin air vents are opened, they should be immediately closed. This indicates a possible fire in the heating system, nose compartment baggage area (if so equipped), or that the increase in airflow is feeding the fire.

On pressurized airplanes, the pressurization air system will remove smoke from the cabin; however, if the smoke is intense, it may be necessary to either depressurize at altitude, if oxygen is available for all occupants, or execute an emergency descent.

In unpressurized single-engine and light twin-engine airplanes, the pilot can attempt to expel the smoke from the cabin by opening the foul weather windows. These windows should be closed immediately if the fire becomes more intense. If the smoke is severe, the passengers and crew should use oxygen masks if available, and the pilot should initiate an immediate descent. The pilot should also be aware that on some airplanes, lowering the landing gear and/or wing flaps can aggravate a cabin smoke problem.

## **FLIGHT CONTROL MALFUNCTION/FAILURE**

### **TOTAL FLAP FAILURE**

The inability to extend the wing flaps will necessitate a no-flap approach and landing. In light airplanes a no-flap approach and landing is not particularly difficult or dangerous. However, there are certain factors which must be considered in the execution of this maneuver. A no-flap landing requires substantially more runway than normal. The increase in required landing distance could be as much as 50 percent.

When flying in the traffic pattern with the wing flaps retracted, the airplane must be flown in a relatively nose-high attitude to maintain altitude, as compared to flight with flaps extended. Losing altitude can be more of a problem without the benefit of the drag normally provided by flaps. A wider, longer traffic pattern may be required in order to avoid the necessity of diving to lose altitude and consequently building up excessive airspeed.

On final approach, a nose-high attitude can make it difficult to see the runway. This situation, if not anticipated, can result in serious errors in judgment of height and distance. Approaching the runway in a relatively nose-high attitude can also cause the perception that the airplane is close to a stall. This may cause the pilot to lower the nose abruptly and risk touching down on the nosewheel.

With the flaps retracted and the power reduced for landing, the airplane is slightly less stable in the pitch and roll axes. Without flaps, the airplane will tend to float considerably during roundout. The pilot should avoid the temptation to force the airplane onto the runway at an excessively high speed. Neither should the pilot flare excessively, because without flaps this might cause the tail to strike the runway.

### **ASYMMETRIC (SPLIT) FLAP**

An asymmetric "split" flap situation is one in which one flap deploys or retracts while the other remains in position. The problem is indicated by a pronounced roll toward the wing with the least flap deflection when wing flaps are extended/retracted.

The roll encountered in a split flap situation is countered with opposite aileron. The yaw caused by the additional drag created by the extended flap will require substantial opposite rudder, resulting in a cross-control condition. Almost full aileron may be required to maintain a wings-level attitude, especially at the reduced airspeed necessary for approach and landing. The pilot therefore should not attempt to land



with a crosswind from the side of the deployed flap, because the additional roll control required to counteract the crosswind may not be available.

The pilot must be aware of the difference in stall speeds between one wing and the other in a split flap situation. The wing with the retracted flap will stall considerably earlier than the wing with the deployed flap. This type of asymmetrical stall will result in an uncontrollable roll in the direction of the stalled (clean) wing. If altitude permits, a spin will result.

The approach to landing with a split flap condition should be flown at a higher than normal airspeed. The pilot should not risk an asymmetric stall and subsequent loss of control by flaring excessively. Rather, the airplane should be flown onto the runway so that the touchdown occurs at an airspeed consistent with a safe margin above flaps-up stall speed.

### LOSS OF ELEVATOR CONTROL

In many airplanes, the elevator is controlled by two cables: a “down” cable and an “up” cable. Normally, a break or disconnect in only one of these cables will not result in a total loss of elevator control. In most airplanes, a failed cable results in a partial loss of pitch control. In the failure of the “up” elevator cable (the “down” elevator being intact and functional) the control yoke will move aft easily but produce no response. Forward yoke movement, however, beyond the neutral position produces a nosedown attitude. Conversely, a failure of the “down” elevator cable, forward movement of the control yoke produces no effect. The pilot will, however, have partial control of pitch attitude with aft movement.

When experiencing a loss of **up-elevator** control, the pilot can retain pitch control by:

- Applying considerable nose-up trim.
- Pushing the control yoke forward to attain and maintain desired attitude.
- Increasing forward pressure to lower the nose and relaxing forward pressure to raise the nose.
- Releasing forward pressure to flare for landing.

When experiencing a loss of **down-elevator** control, the pilot can retain pitch control by:

- Applying considerable nosedown trim.
- Pulling the control yoke aft to attain and maintain attitude.
- Releasing back pressure to lower the nose and increasing back pressure to raise the nose.
- Increasing back pressure to flare for landing.

Trim mechanisms can be useful in the event of an in-flight primary control failure. For example, if the linkage between the cockpit and the elevator fails in flight, leaving the elevator free to weathervane in the wind, the trim tab can be used to raise or lower the elevator, within limits. The trim tabs are not as effective as normal linkage control in conditions such as low airspeed, but they do have some positive effect—usually enough to bring about a safe landing.

If an elevator becomes jammed, resulting in a total loss of elevator control movement, various combinations of power and flap extension offer a limited amount of pitch control. A successful landing under these conditions, however, is problematical.

### LANDING GEAR MALFUNCTION

Once the pilot has confirmed that the landing gear has in fact malfunctioned, and that one or more gear legs refuses to respond to the conventional or alternate methods of gear extension contained in the AFM/POH, there are several methods that may be useful in attempting to force the gear down. One method is to dive the airplane (in smooth air only) to  $V_{NE}$  speed (red line on the airspeed indicator) and (within the limits of safety) execute a rapid pull up. In normal category airplanes, this procedure will create a 3.8 G load on the structure, in effect making the landing gear weigh 3.8 times normal. In some cases, this may force the landing gear into the down and locked position. This procedure requires a fine control touch and good feel for the airplane. The pilot must avoid exceeding the design stress limits of the airplane while attempting to lower the landing gear. The pilot must also avoid an accelerated stall and possible loss of control while attention is directed to solving the landing gear problem.

Another method that has proven useful in some cases is to induce rapid yawing. After stabilizing at or slightly less than maneuvering speed ( $V_A$ ), the pilot should alternately and aggressively apply rudder in one direction and then the other in rapid sequence. The resulting yawing action may cause the landing gear to fall into place.

If all efforts to extend the landing gear have failed, and a gear up landing is inevitable, the pilot should select an airport with crash and rescue facilities. The pilot should not hesitate to request that emergency equipment be standing by.

When selecting a landing surface, the pilot should consider that a smooth, hard-surface runway usually causes less damage than rough, unimproved grass strips. A hard surface does, however, create sparks that can ignite fuel. If the airport is so equipped, the pilot

can request that the runway surface be foamed. The pilot should consider burning off excess fuel. This will reduce landing speed and fire potential.

If the landing gear malfunction is limited to one main landing gear leg, the pilot should consume as much fuel from that side of the airplane as practicable, thereby reducing the weight of the wing on that side. The reduced weight makes it possible to delay the unsupported wing from contacting the surface during the landing roll until the last possible moment. Reduced impact speeds result in less damage.

If only one landing gear leg fails to extend, the pilot has the option of landing on the available gear legs, or landing with all the gear legs retracted. Landing on only one main gear usually causes the airplane to veer strongly in the direction of the faulty gear leg after touchdown. If the landing runway is narrow, and/or ditches and obstacles line the runway edge, maximum directional control after touchdown is a necessity. In this situation, a landing with all three gear retracted may be the safest course of action.

If the pilot elects to land with one main gear retracted (and the other main gear and nose gear down and locked), the landing should be made in a nose-high attitude with the wings level. As airspeed decays, the pilot should apply whatever aileron control is necessary to keep the unsupported wing airborne as long as possible. [Figure 16-7] Once the wing contacts the surface, the pilot can anticipate a strong yaw in that direction. The pilot must be prepared to use full opposite rudder and aggressive braking to maintain some degree of directional control.

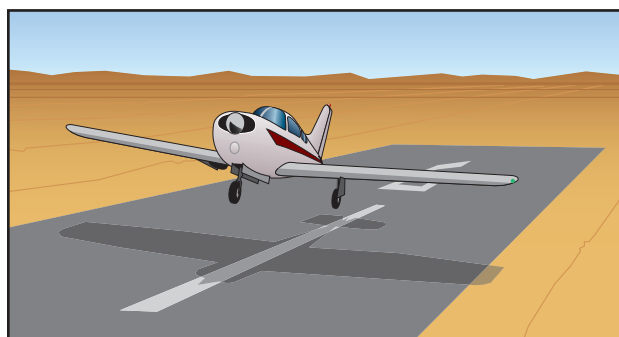


Figure 16-7. Landing with one main gear retracted.

When landing with a retracted nosewheel (and the main gear extended and locked) the pilot should hold the nose off the ground until *almost* full up-elevator has been applied. [Figure 16-8] The pilot should then release back pressure in such a manner that the nose settles slowly to the surface. Applying and holding *full* up-elevator will result in the nose abruptly dropping to the surface as airspeed decays, possibly resulting in burrowing and/or additional damage. Brake pressure should not be applied during the landing roll unless absolutely necessary to avoid a collision with obstacles.

16-10

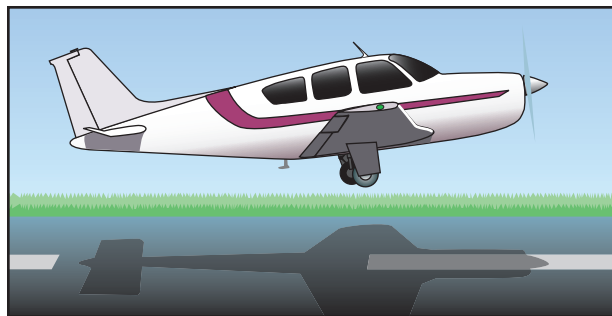


Figure 16-8. Landing with nosewheel retracted.

If the landing must be made with only the nose gear extended, the initial contact should be made on the aft fuselage structure with a nose-high attitude. This procedure will help prevent porpoising and/or wheelbarrowing. The pilot should then allow the nosewheel to gradually touch down, using nosewheel steering as necessary for directional control.

## SYSTEMS MALFUNCTIONS

### ELECTRICAL SYSTEM

The loss of electrical power can deprive the pilot of numerous critical systems, and therefore should not be taken lightly even in day/VFR conditions. Most in-flight failures of the electrical system are located in the generator or alternator. Once the generator or alternator system goes off line, the electrical source in a typical light airplane is a battery. If a warning light or ammeter indicates the probability of an alternator or generator failure in an airplane with only one generating system, however, the pilot may have very little time available from the battery.

The rating of the airplane battery provides a clue to how long it *may* last. With batteries, the higher the amperage load, the less the usable total amperage. Thus a 25-amp hour battery could produce 5 amps per hour for 5 hours, but if the load were increased to 10 amps, it might last only 2 hours. A 40-amp load might discharge the battery fully in about 10 or 15 minutes. Much depends on the battery condition at the time of the system failure. If the battery has been in service for a few years, its power may be reduced substantially because of internal resistance. Or if the system failure was not detected immediately, much of the stored energy may have already been used. It is essential, therefore, that the pilot immediately shed non-essential loads when the generating source fails. [Figure 16-9] The pilot should then plan to land at the nearest suitable airport.

What constitutes an “emergency” load following a generating system failure cannot be predetermined, because the actual circumstances will always be somewhat different—for example, whether the flight is VFR or IFR, conducted in day or at night, in clouds or in the clear. Distance to nearest suitable airport can also be a factor.

Electrical Loads for Light Single	Number of Units	Total Amperes
<b>A. Continuous Load</b>		
Pitot Heating (Operating)	1	3.30
Wingtip Lights	4	3.00
Heater Igniter	1	1-20
**Navigation Receivers	1-4	1-2 each
**Communications Receivers	1-2	1-2 each
Fuel Indicator	1	0.40
Instrument Lights (overhead)	2	0.60
Engine Indicator	1	0.30
Compass Light	1	0.20
Landing Gear Indicator	1	0.17
Flap Indicator	1	0.17
<b>B. Intermittent Load</b>		
Starter	1	100.00
Landing Lights	2	17.80
Heater Blower Motor	1	14.00
Flap Motor	1	13.00
Landing Gear Motor	1	10.00
Cigarette Lighter	1	7.50
Transceiver (keyed)	1	5-7
Fuel Boost Pump	1	2.00
Cowl Flap Motor	1	1.00
Stall Warning Horn	1	1.50
** Amperage for radios varies with equipment. In general, the more recent the model, the less amperage required. NOTE: Panel and indicator lights usually draw less than one amp.		

**Figure 16-9. Electrical load for light single.**

The pilot should remember that the electrically powered (or electrically selected) landing gear and flaps will not function properly on the power left in a partially depleted battery. Landing gear and flap motors use up power at rates much greater than most other types of electrical equipment. The result of selecting these motors on a partially depleted battery may well result in an immediate total loss of electrical power.

If the pilot should experience a complete in-flight loss of electrical power, the following steps should be taken:

- Shed all but the most necessary electrically-driven equipment.
- Understand that any loss of electrical power is critical in a small airplane—notify ATC of the situation immediately. Request radar vectors for a landing at the nearest suitable airport.
- If landing gear or flaps are electrically controlled or operated, plan the arrival well ahead of time. Expect to make a no-flap landing, and anticipate a manual landing gear extension.

## PITOT-STATIC SYSTEM

The source of the pressure for operating the airspeed indicator, the vertical speed indicator, and the altimeter is the pitot-static system. The major components of the pitot-static system are the impact pressure chamber and lines, and the static pressure chamber and lines, each of which are subject to total or partial blockage by ice, dirt, and/or other foreign matter. Blockage of the pitot-static system will adversely affect instrument operation. [Figure 16-10 on next page]

*Partial* static system blockage is insidious in that it may go unrecognized until a critical phase of flight. During takeoff, climb, and level-off at cruise altitude the altimeter, airspeed indicator, and vertical speed indicator may operate normally. No indication of malfunction may be present until the airplane begins a descent.

If the static reference system is severely restricted, but not entirely blocked, as the airplane descends, the static reference pressure at the instruments begins to lag behind the actual outside air pressure. While descending, the altimeter may indicate that the airplane is higher than actual because the obstruction slows the airflow from the static port to the altimeter. The vertical speed indicator confirms the altimeter's information regarding rate of change, because the reference pressure is not changing at the same rate as the outside air pressure. The airspeed indicator, unable to tell whether it is experiencing more airspeed pitot pressure or less static reference pressure, indicates a higher airspeed than actual. To the pilot, the instruments indicate that the airplane is too high, too fast, and descending at a rate much less than desired.

If the pilot levels off and then begins a climb, the altitude indication may still lag. The vertical speed indicator will indicate that the airplane is not climbing as fast as actual. The indicated airspeed, however, may begin to decrease at an alarming rate. The least amount of pitch-up attitude may cause the airspeed needle to indicate dangerously near stall speed.

Managing a static system malfunction requires that the pilot know and understand the airplane's pitot-static system. If a system malfunction is suspected, the pilot should confirm it by opening the alternate static source. This should be done while the airplane is climbing or descending. If the instrument needles move significantly when this is done, a static pressure problem exists and the alternate source should be used during the remainder of the flight.

## ABNORMAL ENGINE INSTRUMENT INDICATIONS

The AFM/POH for the specific airplane contains information that should be followed in the event of any






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 failure  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 Extended 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 air-speed.
- 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



Figure 16-12. Level turn.

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 16-13. 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.



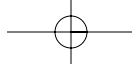
Figure 16-14. Level descent.

## 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.

