Cessna
A Textron Company

Pilot Safety and Warning Supplements

The information contained in this document is not intended to supersede the Owner's Manual or Pilot's Operating Handbook applicable to a specific airplane. If there is a conflict between this Pilot Safety and Warning Supplement and either the Owner's Manual or Pilot's Operating Handbook to a specific airplane, the Owner's Manual or Pilot's Operating Handbook shall take precedence. This publication replaces the original issue (D5099-13) in its entirety.

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INTRODUCTION

Pilots should know the information contained in the airplane's operating handbook, placards and checklists, and be familiar with service/maintenance publications, including service letters and bulletins, to ensure maximum safe utilization of the airplane. When the airplane was manufactured, it was equipped with a Pilot's Operating Handbook, Flight Manual, and/or Owner's Manual. If a handbook or manual is missing, a replacement should be obtained by contacting a Cessna Authorized Service Station.

In an effort to re-emphasize subjects that are generally known to most pilots, safety and operational information has been provided in the following Pilot Safety and Warning Supplements. As outlined in the table of contents, the Supplements are arranged numerically to make it easier to locate a particular Supplement. Supplement coverage is classified in three (3) categories: Flight Considerations, System Operational Considerations, and Maintenance Considerations. Most of the information relates to all Cessna airplanes, although a few Supplements are directed at operation of specific configurations such as multi-engine airplanes, pressurized airplanes, or airplanes certified for flight into known icing conditions.

Day-to-day safety practices play a key role in achieving maximum utilization of any piece of equipment.

WARNING

IT IS THE RESPONSIBILITY OF THE PILOT TO ENSURE THAT ALL ASPECTS OF PREFLIGHT PREPARATION ARE CONSIDERED BEFORE A FLIGHT IS INITIATED. ITEMS WHICH MUST BE CONSIDERED INCLUDE, BUT ARE NOT NECESSARILY LIMITED TO, THE FOLLOWING:

- **PILOT PHYSICAL CONDITION AND PROFICIENCY**
- **AIRPLANE AIRWORTHINESS**
- **AIRPLANE EQUIPMENT APPROPRIATE FOR THE FLIGHT**
- **AIRPLANE LOADING AND WEIGHT AND BALANCE**
- **ROUTE OF THE FLIGHT**
- **WEATHER DURING THE FLIGHT**
- **FUEL QUANTITY REQUIRED FOR THE FLIGHT, INCLUDING ADEQUATE RESERVES**
- **AIR TRAFFIC CONTROL AND ENROUTE NAVIGATION FACILITIES**
- **FACILITIES AT AIRPORTS OF INTENDED USE**

(Continued Next Page)

WARNING (Continued)

- **ADEQUACY OF AIRPORT (RUNWAY LENGTH, SLOPE, CONDITION, ETC.)**
- **LOCAL NOTICES, AND PUBLISHED NOTAMS**

FAILURE TO CONSIDER THESE ITEMS COULD RESULT IN AN ACCIDENT CAUSING EXTENSIVE PROPERTY DAMAGE AND SERIOUS OR EVEN FATAL INJURIES TO THE PILOT, PASSENGERS, AND OTHER PEOPLE ON THE GROUND.

The following Pilot Safety and Warning Supplements discuss in detail many of the subjects which must be considered by a pilot before embarking on any flight. Knowledge of this information is considered essential for safe, efficient operation of an airplane.

Proper flight safety begins long before the takeoff. A pilot's attitude toward safety and safe operation determines the thoroughness of the preflight preparation, including the assessment of the weather and airplane conditions and limitations. The pilot's physical and mental condition and proficiency are also major contributing factors. The use of current navigation charts, the Aeronautical Information Manual, NOTAMs, airport data, weather information, Advisory Circulars and training information, etc., is important. Individuals often develop their own personal methods for performing certain flight operations; however, it is required that these do not conflict with the limitations or recommended operating procedures for a specific airplane.

The pilot should know the Emergency Procedures for the airplane, since there may not be time to review the checklist in an emergency situation. It is essential that the pilot review the entire operating handbook to retain familiarity. He or she should maintain a working knowledge of the limitations of his or her airplane. When the pilot deliberately or inadvertently operates the airplane outside the limitations, he or she is violating Federal Aviation Regulations and may be subject to disciplinary actions.

Cessna does not support modifications to Cessna airplanes, whether by Supplemental Type Certificate or otherwise, unless these certificates are approved by Cessna. Such modifications, although approved by the FAA, may void any and all Cessna warranties on the airplane since Cessna may not know the full effects on the overall airplane. Cessna does not and has not tested and approved all such modifications by other companies. Maintenance and operating procedures and performance data provided by Cessna may no longer be accurate for the modified airplane.

Airplanes require maintenance on a regular basis. As a result, it is essential that the airplane be regularly inspected and repaired when parts are worn or damaged in order to maintain flight safety. Information for the proper maintenance of the airplane is found in the airplane Service/Maintenance Manual, Illustrated Parts Catalog, and in company-issued Service Information

Letters or Service Bulletins, etc. Pilots should assure themselves that all recommendations for product changes or modifications called for by Service Bulletins, etc., are accomplished and that the airplane receives repetitive and required inspections.

Much of the subject matter discussed in the following Supplements has been derived from various publications of the U.S. Government. Since these documents contain considerably more information and detail than is contained here, it is highly recommended that the pilot also read them in order to gain an even greater understanding of the subjects related to flight safety. These publications include the following:

AERONAUTICAL INFORMATION MANUAL (AIM). This Federal Aviation Administration (FAA) manual is designed to provide airmen with basic flight information and Air Traffic Control (ATC) procedures for use in the National Airspace System (NAS). It also contains items of interest to pilots concerning health and medical facts, factors affecting flight safety, a pilot/controller glossary of terms used in the Air Traffic Control System, and information on safety, accident and hazard reporting. This manual can be purchased at retail dealers, or on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

NOTICES TO AIRMEN (Class II). This is a publication containing current Notices to Airmen (NOTAMS) which are considered essential to the safety of flight as well as supplemental data affecting the other operational publications listed here. It also includes current Flight Data Center (FDC) NOTAMS, which are regulatory in nature, issued to establish restrictions to flight or amend charts or published Instrument Approach Procedures. This publication is issued every 14 days and is available by subscription from the Superintendent of Documents.

AIRPORT FACILITY DIRECTORY, ALASKA and PACIFIC CHART SUPPLEMENTS. These publications contain information on airports, communications, navigation aids, instrument landing systems, VOR receiver checks, preferred routes, FSS/Weather Service telephone numbers, Air Route Traffic Control Center (ARTCC) frequencies, and various other pertinent special notices essential to air navigation. These publications are available by subscription from the National Ocean Service (NOS), NOAA N/ACC3 Distribution Division, Riverdale, Maryland 20737, telephone 1-800-638-8972 FAX (301) 436-6829.

FEDERAL AVIATION REGULATIONS (FARs). The FAA publishes the FARs to make readily available to the aviation community the regulatory requirements placed upon them. These regulations are sold as individual parts by the Superintendent of Documents. The more frequently amended parts are sold by subscription service with subscribers receiving changes automatically as they are issued. Less active parts are sold on a single-sale basis. Changes to single-sale parts will be sold separately as issued. Information concerning these changes will be furnished by the FAA through its Status of Federal Aviation Regulations, AC 00-44II.

ADVISORY CIRCULARS (ACs). The FAA issues ACs to inform the aviation public of nonregulatory material of interest. Advisory Circulars are issued in a numbered subject system corresponding to the subject areas of the Federal Aviation Regulations. AC 00-2.11, Advisory Circular Checklist contains a listing of ACs covering a wide range of subjects and how to order them, many of which are distributed free-of-charge.

AC 00-2.11 is issued every four months and is available at no cost from: U.S. Department of Transportation, Distribution requirements Section, SVC 121.21, Washington, DC 20590. The checklist is also available via the internet at http://www.faa.gov/abc/ac-chklist/actoc.htm.

PHYSIOLOGICAL

FATIGUE

Fatigue continues to be one of the most treacherous hazards to flight safety. It generally slows reaction times and causes errors due to inattention, and it may not be apparent to a pilot until serious errors are made. Fatigue is best described as either acute (short-term) or chronic (long-term). As a normal occurrence of everyday living, acute fatigue is the tiredness felt after long periods of physical and/or mental strain, including strenuous muscular effort, immobility, heavy mental workload, strong emotional pressure, monotony, and lack of sleep. In addition to these common causes, the pressures of business, financial worries, and unique family problems can be important contributing factors. Consequently, coordination and alertness, which are vital to safe pilot performance, can be reduced. Acute fatigue can be prevented by adequate rest and sleep, as well as regular exercise and proper nutrition.

Chronic fatigue occurs when there is insufficient time for full recovery between periods of acute fatigue. Performance continues to degrade and judgment becomes impaired so that unwarranted risks may be taken. Recovery from chronic fatigue requires a prolonged period of rest. If a pilot is markedly fatigued prior to a given flight, he or she should not fly. To prevent cumulative fatigue effects during long flights, pilots should conscientiously make efforts to remain mentally active by making frequent visual and radio navigation position checks, estimates of time of arrival at the next check point, etc.

STRESS

Stress from the pressures of everyday living can impair pilot performance, often in very subtle ways. Difficulties can occupy thought processes enough to markedly decrease alertness. Distractions can also interfere with judgment to the point that unwarranted risks are taken, such as flying into deteriorating weather conditions to keep on schedule. Stress and fatigue can be an extremely hazardous combination.

It is virtually impossible to leave stress on the ground. Therefore, when more than usual difficulties are being experienced, a pilot should consider delaying flight until these difficulties are satisfactorily resolved.

EMOTION

Certain emotionally upsetting events, including a serious argument, death of a family member, separation or divorce, loss of job, or financial catastrophe can seriously impair a pilot's ability to fly an airplane safely. The emotions of anger, depression, and anxiety from such events not only decrease alertness but may also lead to taking unnecessary risks. Any pilot who experiences an emotionally upsetting event should not fly until satisfactorily recovered from the event.

ILLNESS

A pilot should not fly with a known medical condition or a change of a known medical condition that would make the pilot unable to meet medical certificate standards. Even a minor illness suffered in day-to-day living can seriously degrade performance of many piloting skills vital to safe flight. An illness may produce a fever and other distracting symptoms that can impair judgment, memory, alertness, and the ability to make decisions. Even if the symptoms of an illness are under adequate control with a medication, the medication may adversely affect pilot performance, and invalidate his or her medical certificate.

The safest approach is not to fly while suffering from any illness. If there is doubt about a particular illness, the pilot should contact an Aviation Medical Examiner for advice.

MEDICATION

Pilot performance can be seriously degraded by both prescribed and over-the-counter medications. Many medications, such as tranquilizers, sedatives, strong pain relievers, and cough suppressant preparations, have primary effects that may impair judgment, memory, alertness, coordination, vision, and ability to make decisions. Other medications, such as antihistamines, blood pressure drugs, muscle relaxants, and agents to control diarrhea and motion sickness, have side effects that may impair the body's critical functions. Any medications that depress the nervous system, such as a sedative, tranquilizer or antihistamine, can make a pilot more susceptible to hypoxia.

FARs prohibit pilots from flying while using any medication that affects their faculties in any way contrary to safety. The safest advice is to not fly while taking medications, unless approved to do so by an Aviation Medical Examiner. The condition for which the drug is required may itself be very hazardous to flying, even when the symptoms are suppressed by the drug. A combination of medications may cause adverse effects that do not result from a single medication.

ALCOHOL

Do not fly while under the influence of alcohol. Flying and alcohol are definitely a lethal combination. FARs prohibit pilots from flying within 8 hours after consuming any alcoholic beverage or while under the influence of alcohol. A pilot may still be under the influence 8 hours after drinking a moderate amount of alcohol. Therefore, an excellent practice is to allow at least 24 hours between "bottle and throttle," depending on the amount of alcoholic beverage consumed.

Extensive research has provided a number of facts about the hazards of alcohol consumption and flying. As little as one ounce of liquor, one bottle of beer, or four ounces of wine can impair flying skills, with the alcohol consumed in these drinks being detectable in the breath and blood for at least three hours. Alcohol also renders a pilot much more susceptible to disorientation and hypoxia. In addition, the after effects of alcohol increase the level of fatigue significantly.

There is simply no way of alleviating a hangover. Remember that the human body metabolizes alcohol at a fixed rate, and no amount of coffee or medications will alter this rate. Do not fly with a hangover, or a "masked hangover" (symptoms suppressed by aspirin or other medication). A pilot can be severely impaired for many hours by hangover.

DRINKING THE RIGHT FLUIDS

One of the main sources of pilot and passenger complaints stems from the relatively lowered humidity during air travel encountered at altitude particularly on extended flights. Even though an individual may not be physically active, body water is continuously expired from the lungs and through the skin. This physiological phenomenon is called insensible perspiration or insensible loss of water.

The loss of water through the skin, lungs, and kidneys never ceases. Water loss is increased with exercise, fever, and in some disease conditions such as hyperthyroidism. Combatting the effects of insensible water loss during flight requires frequent water intake. Unless this is done, dehydration will occur and this causes interference with blood circulation, tissue metabolism, and excretion of the kidneys. Water is vital for the normal chemical reaction of human tissue. It is also necessary for the regulation of body temperature and as an excretory medium.

Beginning a flight in a rested, healthy condition is of prime importance. Proper water balance through frequent fluid intake relieves the adverse effects produced by insensible water loss in an atmosphere of lowered humidity. Typical dehydration conditions are: dryness of the tissues and resulting irritation of the eyes, nose, and throat as well as other conditions previously mentioned plus the associated fatigue relating to the state of acidosis (reduced alkalinity of the blood and the body tissues). A person reporting for a flight in a dehydrated state will more readily notice these symptoms until fluids are adequately replaced.

HYPERVENTILATION

Hyperventilation, or an abnormal increase in the volume of air breathed in and out of the lungs, can occur subconsciously when a stressful situation is encountered in flight. As hyperventilation expels excessive carbon dioxide from the body, a pilot can experience symptoms of light headedness, suffocation, drowsiness, tingling in the extremities, and coolness -- and react to them with even greater hyperventilation. Incapacitation can eventually result. Uncoordination, disorientation, painful muscle spasms, and finally, unconsciousness may ultimately occur.

The symptoms of hyperventilation will subside within a few minutes if the rate and depth of breathing are consciously brought back under control. The restoration of normal carbon dioxide levels in the body can be hastened by controlled breathing in and out of a paper bag held over the nose and mouth.

Early symptoms of hyperventilation and hypoxia are similar. Moreover, hyperventilation and hypoxia can occur at the same time. Therefore, if a pilot is using oxygen when symptoms are experienced, the oxygen system should be checked to assure that it has been functioning effectively before giving attention to rate and depth of breathing.

EAR BLOCK

As an airplane climbs and the cabin pressure decreases, trapped air in the middle ear expands and escapes through the eustachian tube to the nasal passages, thus equalizing with the pressure in the cabin. During descent, cabin pressure increases and some air must return to the middle ear through the eustachian tube to maintain equal pressure. However, this process does not always occur without effort. In most cases it can be accomplished by swallowing, yawning, tensing the muscles in the throat or, if these do not work, by the combination of closing the mouth, pinching the nose closed, and attempting to blow gently through the nostrils (Valsalva maneuver).

Either an upper respiratory infection, such as a cold or sore throat, or a nasal allergic condition can produce enough congestion around the eustachian tube to make equalization difficult. Consequently, the difference in pressure between the middle ear and the airplane cabin can build up to a level that will hold the eustachian tube closed, making equalization difficult, if not impossible. This situation is commonly referred to as an "ear block." An ear block produces severe pain and loss of hearing that can last from several hours to several days. Rupture of the ear drum can occur in flight or after landing. Fluid can accumulate in the middle ear and become infected. If an ear block is experienced and does not clear shortly after landing, a physician should be consulted. Decongestant sprays or drops to reduce congestion usually do not provide adequate protection around the eustachian tubes. Oral decongestants have side effects that can significantly impair pilot performance. An ear block can be prevented by not flying with an upper respiratory infection or nasal allergic condition.

SINUS BLOCK

During climb and descent, air pressure in the sinuses equalizes with the airplane cabin pressure through small openings that connect the sinuses to the nasal passages. Either an upper respiratory infection, such as a cold or sinusitis, or a nasal allergic condition can produce enough congestion around the openings to slow equalization, and as the difference in pressure between the sinus and cabin increases, eventually the openings plug. This "sinus block" occurs most frequently during descent.

A sinus block can occur in the frontal sinuses, located above each eyebrow, or in the maxillary sinuses, located in each upper cheek. It will usually produce excruciating pain over the sinus area. A maxillary sinus block can also make the upper teeth ache. Bloody mucus may discharge from nasal passages. A sinus block can be prevented by not flying with an upper respiratory infection or nasal allergic condition. If a sinus block does occur and does not clear shortly after landing, a physician should be consulted.

VISION IN FLIGHT

Of all the pilot's senses, vision is the most critical to safe flight. The level of illumination is the major factor to adequate in-flight vision. Details on flight instruments or aeronautical charts become difficult to discern under dimly lit conditions. Likewise, the detection of other aircraft is much more difficult under such conditions.

In darkness, vision becomes more sensitive to light, a process called dark adaptation. Although exposure to total darkness for at least 30 minutes is required for complete dark adaptation, a pilot can achieve a moderate degree of dark adaptation within 20 minutes under dim red lighting. Since red light severely distorts colors, especially on aeronautical charts, and can cause serious difficulty in focusing the eyes on objects inside the cabin, its use is advisable only where optimum outside night vision is necessary. Even so, white flight station lighting must be available when needed for map and instrument reading, especially while under IFR conditions. Dark adaptation is impaired by exposure to cabin pressure altitudes above 5000 feet, carbon monoxide inhaled in smoking and from exhaust fumes, deficiency of vitamin A in the diet, and by prolonged exposure to bright sunlight. Since any degree of dark adaptation is lost within a few seconds of viewing a bright light, pilots should close one eye when using a light to preserve some degree of night vision. In addition, use of sunglasses during the day will help speed the process of dark adaptation during night flight.

SCUBA DIVING

A pilot or passenger who flies shortly after prolonged scuba diving could be in serious danger. Anyone who intends to fly after scuba diving should allow the body sufficient time to rid itself of excess nitrogen absorbed during diving. If not, decompression sickness (commonly referred to as the "bends"), due to dissolved gas, can occur even at low altitude and create a serious in-flight emergency. The recommended waiting time before flight to cabin altitudes of 8000 feet or less is at least 12 hours after diving which has not required controlled ascent (non-decompression diving), and at least 24 hours after diving which has required a controlled ascent (decompression diving). The waiting time before flight to cabin pressure altitudes above 8000 feet should be at least 24 hours after any scuba diving.

AEROBATIC FLIGHT

Pilots planning to engage in aerobatic maneuvers should be aware of the physiological stresses associated with accelerative forces during such maneuvers. Forces experienced with a rapid push-over maneuver will result in the blood and body organs being displaced toward the head. Depending on the forces involved and the individual tolerance, the pilot may experience discomfort, headache, "red-out", and even unconsciousness. Forces experienced with a rapid pull-up maneuver result in the blood and body organs being displaced toward the lower part of the body away from the head. Since the brain requires continuous blood circulation for an adequate oxygen supply, there is a physiological limit to the time the pilot can tolerate higher forces before losing consciousness. As the blood circulation to the brain decreases as a result of the forces involved, the pilot will experience "narrowing" of visual fields, "gray-out", "black-out", and unconsciousness.

Physiologically, humans progressively adapt to imposed strains and stresses, and with practice, any maneuver will have a decreasing effect. Tolerance to "G" forces is dependent on human physiology and the individual pilot. These factors include the skeletal anatomy, the cardiovascular architecture, the nervous system, blood make-up, the general physical state, and experience and recency of exposure. A pilot should consult an Aviation Medical Examiner prior to aerobatic training and be aware that poor physical condition can reduce tolerance to accelerative forces.

CHECKLISTS

CONSISTENT USE

Airplane checklists are available for those persons who do not wish to use the operating handbook on every flight. These checklists contain excerpts from the operating handbook written for that particular airplane and are designed to remind pilots of the minimum items to check for safe operation of the airplane, without providing details concerning the operation of any particular system. Checklists should be used by the pilot and not placed in the seat pocket and forgotten. Even pilots who consistently carry the checklists tend to memorize certain areas and intentionally overlook these procedural references. Consequently, in time, these individuals find that operating something as complex as an airplane on memory alone is practically impossible, and eventually, could find themselves in trouble because one or more important items are overlooked or completely forgotten. The consistent use of all checklists is required for the safe operation of an airplane.

NOTE

Abbreviated checklists can be used in place of the airplane operating manual However, they should be used only after the pilot becomes familiar with the airplane operating manual, and thoroughly understands the required procedures for airplane operation.

CONTRIBUTIONS TO SAFETY

Most large airplanes in the transport category are flown by consistent use of all checklists. Experience has shown that pilots who consistently use checklists on every flight maintain higher overall proficiency, and have better safety records. The pilot should not become preoccupied inside the cockpit (such as with a checklist) and fail to remain alert for situations outside the airplane.

CHECKLIST ARRANGEMENT (ORGANIZATION OF ITEMS)

Abbreiviated checklists are written in a concise form to provide pilots with a means of complying with established requirements for the safe operation of their airplane. The checklists are usually arranged by "Item" and "Condition" headings. The item to be checked is listed with the desired condition stated. Key words or switch and lever positions are usually emphasized by capitalization in the "Condition" column. The checklist may also contain supplemental information pertinent to the operation of the airplane, such as performance data, optional equipment operation, etc., that the pilot might routinely use.

EMERGENCY CHECKLISTS

Emergency checklists are provided for emergency situations peculiar to a particular airplane design, operating or handling characteristic. Pilots should periodically review the airplane operating handbook to be completely familiar with information published by the manufacturer concerning the airplane. Emergency situations are never planned and may occur at the worst possible time. During most emergency conditions, there will not be sufficient time to refer to an emergency checklist; therefore, it is essential that the pilot commit to memory those emergency procedures that may be shown in **bold-face** type or outlined with a black border, within the emergency procedures section in operating handbooks or equivalent hand-held checklists. These items are essential for continued safe flight. After the emergency situation is under control, the pilot should complete the checklist in its entirety, in the proper sequence, and confirm that all items have been accomplished. It is essential that the pilot review and know published emergency checklists and any other emergency procedures. Familiarity with the airplane and its systems and a high degree of pilot proficiency are valuable assets if an emergency should arise.

AIRPLANE LOADING

AIRPLANE CENTER-OF-GRAVITY RANGE

Pilots should never become complacent about the weight and balance limitations of an airplane, and the reasons for these limitations. Since weight and balance are vital to safe airplane operation, every pilot should have a thorough understanding of airplane loading, with its limitations, and the principles of airplane balance. Airplane balance is maintained by controlling the position of the center-of-gravity. Overloading, or misloading, may not result in obvious structural damage, but could do harm to hidden structure or produce a dangerous situation in the event of an emergency under those conditions. Overloading, or misloading may also produce hazardous airplane handling characteristics.

There are several different weights to be considered when dealing with airplane weight and balance. These are defined in another paragraph in this supplement. Airplanes are designed with predetermined structural limitations to meet certain performance and flight characteristics and standards. Their balance is determined by the relationship of the center-of-gravity (C.G.) to the center of lift. Normally, the C.G. of an airplane is located slightly forward of the center of lift. The pilot can safely use the airplane flight controls to maintain stabilized balance of the airplane as long as the C.G. is located within specified forward and aft limits. The allowable variation of the C.G. location is called the center-of-gravity range. The exact location of the allowable C.G. range is specified in the operating handbook for that particular airplane.

LOCATING THE LOAD

It is the responsibility of the pilot to ensure that the airplane is loaded properly. Operation outside of prescribed weight and balance limitations could result in an accident and serious or fatal injury.

To determine the center-of-gravity (C.G.) of an airplane, a pilot must have an understanding of the three terms used in weight and balance calculations. These terms are weight, moment, and arm. The principles associated with these terms are applied to each occupant, piece of cargo or baggage, the airplane itself, and to all fuel to determine the overall C.G. of the airplane.

The weight of an object should be carefully determined or calculated. All weights must be measured in the same units as the aircraft empty weight. The arm is the distance that the weight of a particular item is located from the reference datum line or the imaginary vertical line from which all horizontal distances are measured for balance purposes (refer to examples in Figure 1).

The word "moment," as used in airplane loading procedures, is the product of the weight of the object multiplied by the arm.

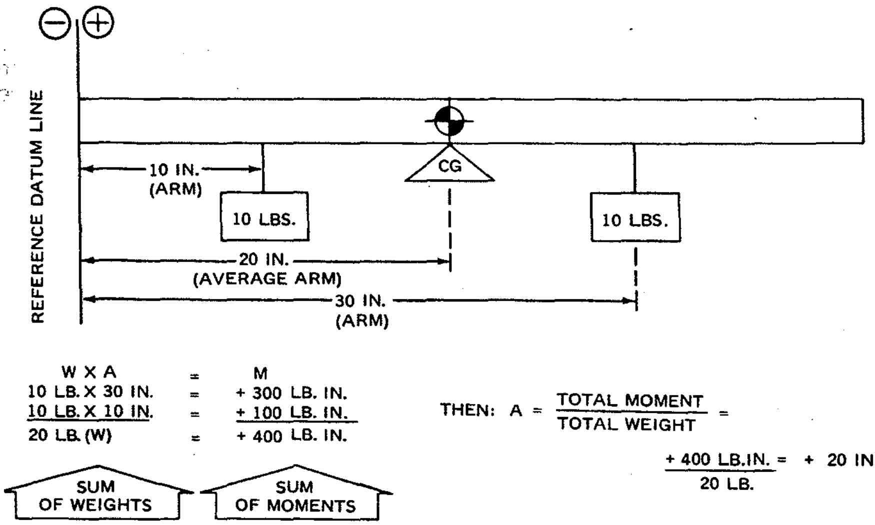
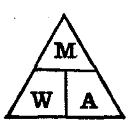


Figure 1. Computing the Center-of-Gravity

Pilots can remember and use the relationship of these terms most easily by arranging them in a mathematical triangle:



weight × arm = moment
moment ÷ weight = arm
moment ÷ arm = weight

The relative position of any two terms indicates the mathematical process (multiplication or division) required to compute the third term.

A loading graph or loading tables, a center-of-gravity limits chart and/or a center-of-gravity moment envelope chart, as well as a sample loading problem are provided in most airplane operating handbooks. By following the narrative directions, the pilot can determine the correct airplane C.G. for any configuration of the airplane. If the position of the load is different from that shown on the loading graph or in the loading tables, additional moment calculations, based on the actual weight and C.G. arm (fuselage station) of the item being loaded, must be performed.

LOAD SECURITY

In addition to the security of passengers, it is the pilot's responsibility to determine that all cargo and/or baggage is secured before flight. When required, the airplane may be equipped with tie-down rings or fittings for the purpose of securing cargo or baggage in the baggage compartment or cabin area. The maximum allowable cargo loads to be carried are determined by cargo weight limitations, the type and number of tie-downs used, as well as by the airplane weight and C.G. limitations. Always carefully observe all precautions listed in the operating handbook concerning cargo tiedown.

Pilots should assist in ensuring seat security and proper restraint for all passengers. Pilots should also advise passengers not to put heavy or sharp items under occupied seats since these items may interfere with the seats' energy absorption characteristics in the event of a crash.

Optional equipment installed in the airplane can affect loading, and the airplane center-of-gravity. Under certain loading conditions in tricycle gear airplanes, it is possible to exceed the aft C.G. limit, which could cause the airplane to tip and allow the fuselage tailcone to strike the ground while loading the airplane. The force of a tail ground strike could damage internal structure, resulting in possible interference with elevator control system operation.

EFFECTS OF LOADING ON THE FLIGHT

Weight and balance limits are placed on airplanes for three principal reasons: first, the effect of the weight on the primary and secondary structures; second, the effect on airplane performance; and third, the effect on flight controllability, particularly in stall and spin recovery.

A knowledge of load factors in flight maneuvers and gusts is important for understanding how an increase in maximum weight affects the characteristics of an airplane. The structure of an airplane subjected to a load factor of 3 Gs, must be capable of withstanding an added load of three hundred pounds for each hundred pound increase in weight. All Cessna airplanes are analyzed and tested for flight at the maximum authorized weight, and within the speeds posted for the type of flight to be performed. Flight at weights in excess of this amount may be possible, but loads for which the airplane was not designed may be imposed on all or some part of the structure.

An airplane loaded to the rear limit of its permissible center-of-gravity range will respond differently than when it is loaded near the forward limit. The stall characteristics of an airplane change as the airplane load changes, and stall characteristics become progressively better as center-of-gravity moves forward. Distribution of weight can also have a significant effect on spin characteristics. Forward location of the C.G. will usually make it more difficult to obtain a spin. Conversely, extremely aft C.G. locations will tend to promote lengthened recoveries since a more complete stall can be achieved. Changes in airplane weight as well as its distribution can have an effect on spin characteristics since increases in weight will increase inertia. Higher weights may delay recoveries.

An airplane loaded beyond the forward C.G. limit will be nose heavy, and can be difficult to rotate for takeoff or flare for landing. Airplanes with tail wheels can be nosed over more easily.

LOAD AND LATERAL TRIM

Some airplanes have a maximum limit for wing fuel lateral imbalance and/or a maximum wing locker load limitation. These limitations are required for one or both of two primary reasons. The first is to ensure that the airplane will maintain certain roll responses mandated by its certification. The other is to prevent overheating and interruption of lateral trim on certain types of autopilots caused by the excessive work required to maintain a wings level attitude while one wing is heavier than the other. Pilots should carefully observe such limitations and keep the fuel balance within the limits set forth in the respective operating handbook.

WEIGHT AND BALANCE TERMINOLOGY

The following list is provided in order to familiarize pilots and owners with the terminology used in calculating the weight and balance of Cessna airplanes. (Some terminology listed herein is defined and used in Pilot's Operating Handbooks only.)

Arm	The horizontal distance from the reference datum to the center-of-gravity (C.G.) of an item.
Basic Empty Weight	The standard empty weight plus the weight of installed optional equipment.

C.G. Arm	The arm obtained by adding the airplane's individual moments and dividing the sum by the total weight.
C.G. Limits	The extreme center-of-gravity locations within which the airplane must be operated at a given weight.
Center-of-Gravity (C.G.)	The point at which an airplane or item of equipment would balance if suspended. Its distance from the reference datum is found by dividing the total moment by the total weight of the airplane or item of equipment.
MAC	The mean aerodynamic chord of a wing is the chord of an imaginary airfoil which throughout the flight range will have the same force vectors as those of the wing.
Maximum Landing Weight	The maximum weight approved for the landing touchdown.
Maximum Ramp Weight	The maximum weight approved for ground maneuvers. It includes the weight of start, taxi and runup fuel.
Maximum Takeoff Weight	The maximum weight approved for the start of the takeoff roll.
Maximum Zero Fuel Weight	The maximum weight exclusive of usable fuel.
Moment	The product of the weight of an item multiplied by its arm. (Moment divided by a constant is used to simplify balance calculations by reducing the number of digits.)
Payload	The weight of occupants, cargo, and baggage.
Reference Datum	An imaginary vertical plane from which all horizontal distances are measured for balance purposes.
Standard Empty Weight	The weight of a standard airplane, including unusable fuel, full operating fluids and full engine oil. In those manuals which refer to this weight as Licensed Empty Weight, the weight of engine oil is not included and must be added separately in weight and balance calculations.)
Station	A location along the airplane fuselage given in terms of the distance from the reference datum.

Tare	The weight of chocks, blocks, stands, etc., used when weighing an airplane, and is included in the scale readings. Tare is deducted from the scale reading to obtain the actual (net) airplane weight.
Unusable Fuel	The quantity of fuel that cannot be safely used in flight.
Usable Fuel	The fuel available for flight planning.
Useful Load	The difference between ramp weight and the basic empty weight.

SINGLE ENGINE FLIGHT INFORMATION (MULTI-ENGINE AIRPLANES)

INTRODUCTION

The following discussion is intended primarily for pilots of propeller-driven, light twin-engine airplanes, powered by reciprocating engines and certified under CAR Part 3 or FAR Part 23. This discussion is not intended to apply to specific models, but is intended, instead, to give general guidelines or recommendations for operations in the event of an engine failure during flight.

SINGLE ENGINE TAKEOFF AND CLIMB

Each time a pilot considers a takeoff in a twin-engine airplane, knowledge is required of the Minimum Control Speed (V_{MC}) for that particular airplane. Knowledge of this speed, is essential to ensure safe operation of the airplane in the event an engine power loss occurs during the most critical phases of flight, the takeoff and initial climb.

V_{MC} is the minimum flight speed at which the airplane is directionally and laterally controllable as determined in accordance with Federal Aviation Regulations. Airplane certification conditions include: one engine becoming inoperative and windmilling; not more than a 5-degree bank toward the operative engine; takeoff power on the operative engine; landing gear retracted; flaps in the takeoff position; and the most critical C.G. (center of gravity). A multi-engine airplane must reach the minimum control speed before full control deflections can counteract the adverse rolling and/or yawing tendencies associated with one engine inoperative and full power operation on the other engine. The most critical time for an engine failure is during a two or three second period, late in the takeoff, while the airplane is accelerating to a safe speed.

Should an engine failure be experienced before liftoff speed is reached, the takeoff must be aborted. If an engine failure occurs immediately after liftoff, but before the landing gear is retracted, continue takeoff while retracting gear. Abort takeoff only if sufficient runway is available. This decision should be made before the takeoff is initiated.

The pilot of a twin-engine airplane must exercise good judgment and take prompt action in the decision whether or not to abort a takeoff attempt following an engine failure, since many factors will influence the decision.

Some of these factors include: runway length, grade and surface condition (i.e., slippery, dry, etc.), field elevation, temperature, wind speed and direction, terrain or obstructions in the vicinity of the runway, airplane weight and single engine climb capability under the prevailing conditions, among others. The pilot should abort the takeoff, following an engine-out, even if the airplane has lifted off the runway, if runway conditions permit. However, under limited circumstances (i.e., short runway with obstructions) the pilot may have to continue the takeoff following a liftoff and an engine-out.

While it may be possible to continue the takeoff at light weights and with favorable atmospheric conditions following an engine failure just after liftoff, long distances are required to clear even small obstacles. Distances required to clear an obstacle are reduced under more favorable combinations of weight, headwind component, or obstacle height.

The pilot's decision to continue the takeoff after an engine failure should be based on consideration of either the single engine best angle-of-climb speed (V_{XSE}) if an obstacle is ahead, or the single engine best rate-of-climb speed (V_{YSE}) when no obstacles are present in the climb area. Once the single engine best angle-of-climb speed is reached, altitude becomes more important than airspeed until the obstacle is cleared. On the other hand, the single engine best rate-of-climb speed becomes more important when there are no obstacles ahead. Refer to the Owners Manual, Flight Manual or Pilot's Operating Handbook for the proper airspeeds and procedures to be used in the event of an engine failure during takeoff. Refer to the warning placard "To Continue Flight With An Inoperative Engine" in the airplane's operating handbook and/or on the instrument panel for additional information.

Should an engine failure occur at or above these prescribed airspeeds, the airplane, within the limitations of its single engine climb performance, should be maneuvered to a landing. After the airplane has been "cleaned up" following an engine failure (landing gear and wing flaps retracted and the propeller feathered on the inoperative engine), it may be accelerated to its single engine best rate-of-climb speed. If immediate obstructions so dictate, the single engine best angle-of-climb speed may be maintained until the obstacles are cleared. In no case should the speed be allowed to drop below single engine best angle-of-climb speed unless an immediate landing is planned, since airplane performance capabilities will deteriorate rapidly as the airspeed decreases. After clearing all immediate obstacles, the airplane should be accelerated slowly to its single engine best rate-of-climb speed and the climb continued to a safe altitude which will allow maneuvering for a return to the airport for landing.

To obtain single engine best climb performance with one engine inoperative, the airplane must be flown in a 3 to 5 degree bank toward the operating engine. The rudder is used to maintain straight flight, compensating for the asymmetrical engine power. The ball of the turn-and-bank indicator should not be centered, but should be displaced about 1/2 ball width toward the operating engine.

The propeller on the inoperative engine must be feathered, the landing gear retracted, and the wing flaps retracted for continued safe flight. Climb performance of an airplane with a propeller windmilling usually is nonexistent. Once the decision to feather a propeller has been made, the pilot should ensure that the propeller feathers properly and remains feathered. The landing gear and wing flaps also cause a severe reduction in climb performance and both should be retracted as soon as possible (in accordance with the operating handbook limitations).

The following general facts should be used as a guide if an engine failure occurs during or immediately after takeoff:

1. Discontinuing a takeoff upon encountering an engine failure is advisable under most circumstances. Continuing the takeoff, if an engine failure occurs prior to reaching single engine best angle-of-climb speed and landing gear retraction, is not advisable.
2. Altitude is more valuable to safety immediately after takeoff than is airspeed in excess of the single engine best angle-of-climb speed.
3. A windmilling propeller and extended landing gear cause a severe drag penalty and, therefore, climb or continued level flight is improbable, depending on weight, altitude and temperature. Prompt retraction of the landing gear (except Model 337 series), identification of the inoperative engine, and feathering of the propeller is of utmost importance if the takeoff is to be continued.
4. Unless touchdown is imminent, in no case should airspeed be allowed to fall below single engine best angle-of-climb speed even though altitude is lost, since any lesser speed will result in significantly reduced climb performance.
5. If the requirement for an immediate climb is not present, allow the airplane to accelerate to the single engine best rate-of-climb speed since this speed will always provide the best chance of climb or least altitude loss.

SINGLE ENGINE CRUISE

Losing one engine during cruise on a multi-engine airplane causes little immediate problem for a proficient, properly trained pilot. After advancing power on the operating engine and retrimming the airplane to maintain altitude, if possible the pilot should attempt to determine if the cause of the engine failure can be corrected in flight prior to feathering the propeller. The magneto/ignition switches should be checked to see if they are on, and the fuel flow and fuel quantity for the affected engine should also be verified. If the engine failure was apparently caused by fuel starvation, switching to another fuel tank and/or turning on the auxiliary fuel pump (if equipped) or adjusting the mixture control may alleviate the condition. It must be emphasized that these procedures are not designed to replace the procedural steps listed in the emergency procedures section of the airplane operating handbook, but are presented as a guide to be used by the pilot if, in his or her judgment, corrective action should be attempted prior to shutting down a failing or malfunctioning engine. Altitude, terrain, weather conditions, weight, and accessibility of suitable landing areas must all be considered before attempting to determine and/or correct the cause of an engine failure. In any event, if an engine fails in cruise and cannot be restarted, a landing at the nearest suitable airport is recommended.

SINGLE ENGINE APPROACH AND LANDING OR GO-AROUND

An approach and landing with one engine inoperative on a multi-engine airplane can easily be completed by a proficient, properly trained pilot. However, the pilot must plan and prepare the airplane much earlier than normal to ensure success. While preparing, fuel should be scheduled so that an adequate amount is available for use by the operative engine. All crossfeeding should be completed during level flight above a minimum altitude of 1000 feet AGL.

During final approach, the pilot should maintain the single engine best rate-of-climb speed or higher, until the landing is assured. An attempt should be made to keep the approach as normal as possible, considering the situation. Landing gear should be extended on downwind leg or over the final approach fix, as applicable. Flaps should be used to control the descent through the approach.

Consideration should be given to a loss of the other engine or the necessity to make an engine inoperative go around. Under certain combinations of weight, temperature and altitude, neither level flight nor a single engine go-around may be possible. Do not attempt an engine inoperative go-around after the wing flaps have been extended beyond the normal approach or the published approach flap setting, unless enough altitude is available to allow the wing flaps to be retracted to the normal approach or the published approach flap setting, or less.

PILOT PROFICIENCY

AIRSPEED CONTROL

Flying other than published airspeeds could put the pilot and airplane in an unsafe situation. The airspeeds published in the airplane's operating handbook have been tested and proven to help prevent unusual situations. For example, proper liftoff speed puts the airplane in the best position for a smooth transition to a climb attitude. However, if liftoff is too early, drag increases and consequently increases the takeoff ground run. This procedure also degrades controllability of multi-engine airplanes in the event an engine failure occurs after takeoff. In addition, early liftoff increases the time required to accelerate from liftoff to either the single-engine best rate-of-climb speed (V_{YSE}) or the single-engine best angle-of-climb speed (V_{XSE}) if an obstacle is ahead. On the other hand, if liftoff is late, the airplane will tend to "leap" into the climb. Pilots should adhere to the published liftoff or takeoff speed for their particular airplane.

The pilot should be familiar with the stall characteristics of the airplane when stalled from a normal 1 G stall. Any airplane can be stalled at any speed. The absolute maximum speed at which full aerodynamic control can be safely applied is listed in the airplane's operating handbook as the maneuvering speed. Do not make full or abrupt control movements above this speed. To do so could induce structural damage to the airplane.

TRAFFIC PATTERN MANEUVERS

There have been incidents in the vicinity of controlled airports that were caused primarily by pilots executing unexpected maneuvers. Air Traffic Control (ATC) service is based upon observed or known traffic and airport conditions. Air Traffic Controllers establish the sequence of arriving and departing airplanes by advising them to adjust their flight as necessary to achieve proper spacing. These adjustments can only be based on observed traffic, accurate pilot radio reports, and anticipated airplane maneuvers. Pilots are expected to cooperate so as to preclude disruption of the traffic flow or the creation of conflicting traffic patterns. The pilot in command of an airplane is directly responsible for and is the final authority as to the operation of his or her airplane. On occasion, it may be necessary for a pilot to maneuver an airplane to maintain spacing with the traffic he or she has been sequenced to follow. The controller can anticipate minor maneuvering such as shallow "S" turns. The controller cannot, however, anticipate a major maneuver such as a 360-degree turn. This can result in a gap in the landing interval and more importantly, it causes a chain reaction which may result in a conflict with other traffic and an interruption of the sequence established by the tower or approach controller. The pilot should always advise the controller of the need to make any maneuvering turns.

USE OF LIGHTS

Aircraft position (navigation) and anti-collision lights are required to be illuminated on aircraft operated at night. Anti-collision lights, however, may be turned off when the pilot in command determines that, because of operating conditions, it would be in the interest of safety to do so. For example, strobe lights should be turned off on the ground when they adversely affect ground personnel or other pilots, and in flight when there are adverse reflections from clouds.

To enhance the "see-and-avoid" concept, pilots are encouraged to turn on their rotation beacon any time the engine(s) are operating, day or night. Pilots are further encouraged to turn on their landing lights when operating within ten miles of any airport, day or night, in conditions of reduced visibility and areas where flocks of birds may be expected (i.e., coastal areas, around refuse dumps, etc.). Although turning on airplane lights does enhance the "see-and-avoid" concept, pilots should not become complacent about keeping a sharp lookout for other airplanes. Not all airplanes are equipped with lights and some pilots may not have their lights turned on. Use of the taxi light, in lieu of the landing light, on some smaller airplanes may extend the landing light service life.

Propeller and jet blast forces generated by large airplanes have overturned or damaged several smaller airplanes taxiing behind them. To avoid similar results, and in the interest of preventing upsets and injuries to ground personnel from such forces, the FAA recommends that air carriers and commercial operators turn on their rotating beacons anytime their airplane engine(s) are operating. All other pilots, using airplanes equipped with rotating beacons, are also encouraged to participate in this program which is designed to alert others to the potential hazard. Since this is a voluntary program, exercise caution and do not rely solely on the rotating beacon as an indication that airplane engines are operating.

PARTIAL PANEL FLYING

All pilots, and especially instrument rated pilots, should know the emergency procedures for partial instrument panel operation included in their respective operating handbook, as well as any FAA training material on the subject. Routine periodic practice under simulated instrument conditions with a partial instrument panel can be very beneficial to a pilot's proficiency. In this case, the pilot should have a qualified safety pilot monitoring the simulated instrument practice.

If a second vacuum system is not installed and a complete vacuum system failure occurs during flight, the vacuum-driven directional indicator and attitude indicator will be disabled, and the pilot will have to rely on the turn coordinator or the turn and bank indicator if he or she flies into instrument meteorological conditions. If an autopilot is installed, it too will be affected, and should not be used. The following instructions assume that only the electrically-powered turn coordinator is operative, and that the pilot is not completely proficient in instrument flying.

EXECUTING A 180° TURN IN CLOUDS

Upon inadvertently entering a cloud(s), an immediate plan should be made to turn back as follows:

1. Note compass heading.
2. Note the time in both minutes and seconds.
3. When the seconds indicate the nearest half-minute, initiate a standard rate left turn, holding the turn coordinator (or turn and bank indicator if installed) symbolic airplane wing opposite the lower left wing index mark for 60 seconds. Then roll back to level flight by leveling the miniature airplane.
4. Assure level flight through and after the turn by referencing the altimeter, VSI, and airspeed indicator. Altitude may be maintained with cautious use of the elevator controls.
5. Check accuracy of turn by observing the compass heading which should be the reciprocal of the original heading.
6. If necessary, adjust heading primarily with skidding motions rather than rolling motions so that the compass will read more accurately.
7. Maintain altitude and airspeed by cautious application of elevator control. Avoid over-controlling by keeping the hands off the control wheel as much as possible and steering only with the rudder.

EMERGENCY DESCENT THROUGH CLOUDS

If conditions preclude reestablishment of VFR flight by a 180° turn, a descent through a cloud deck to VFR conditions may be appropriate. If possible, obtain ATC clearance for an emergency descent. To guard against a spiral dive, choose an easterly or westerly heading to minimize compass card swings due to changing bank angles. In addition, keep hands off the control wheel and steer a straight course with rudder control by monitoring the turn and bank or turn coordinator. Occasionally check the compass heading and make minor corrections to hold an approximate course. Before descending into the clouds, set up a stabilized let-down condition as follows:

1. Extend the landing gear (if applicable).

2. Reduce power to set up a 500 to 800 ft/min rate of descent.
3. Adjust mixture(s) as required for smooth engine operation.
4. Adjust elevator or stabilizer, rudder and aileron trim controls for a stabilized descent.
5. Keep hands off the control wheel. Monitor turn and bank or turn coordinator and make corrections by rudder alone.
6. Check trend of compass card movement and make cautious corrections with rudder inputs to stop turn.
7. Upon breaking out of the clouds, resume normal cruising flight.

RECOVERY FROM A SPIRAL DIVE

If a spiral dive is encountered while in the clouds, proceed as follows:

1. Retard the throttle(s) to idle.
2. Stop the turn by using coordinated aileron and rudder control to align the symbolic airplane in the turn coordinator with the horizontal reference line, or center the turn needle and ball of the turn and bank indicator.
   a. With a significant airspeed increase or altitude loss while in the spiral, anticipate that the aircraft will pitch nose-up when the wings are level. Take care not to overstress the airframe as a result of this nose-up pitching tendency.
3. Cautiously apply control wheel back pressure (if necessary) to slowly reduce the airspeed.
4. Adjust the elevator or stabilizer trim control to maintain a constant glide airspeed.
5. Keep hands off the control wheel, using rudder control to hold a straight heading. Use rudder trim to relieve unbalanced rudder force, if present.
6. If the power-off glide is of sufficient duration, adjust the mixture(s), as required.
7. Upon breaking out of the clouds, resume normal cruising flight.

USE OF LANDING GEAR AND FLAPS

A review of airplane accident investigation reports indicates a complacent attitude on the part of some pilots toward the use of checklists for landing gear and wing flap operation. The main confession of most pilots involved in involuntary gear-up landings is that they “forgot” to lower the gear prior to landing. Consistent use of the Before Landing Checklist would have alerted these pilots and prevented a potentially hazardous situation. Other causes of gear-up landings have been attributed to poor judgment, such as not leaving the landing gear extended while performing several landings while remaining in the traffic pattern. The following recommendations will lessen the possibility of a gear-up landing.

1. Never move the landing gear control switch, handle, or lever while the airplane is on the ground.
2. Do not deliberately disable any landing gear warning device or light unless indicated otherwise in the operating handbook.
3. Apply brakes before retraction of the landing gear to stop wheel rotation.
4. After takeoff, do not retract the landing gear until a positive rate of climb is indicated.
5. When selecting a landing gear position, whether up or down, allow the landing gear to complete the initial cycle to the locked position before moving the control switch, handle, or lever in the opposite direction.
6. Never exceed the published landing gear operating speed (V_{LO}) while the landing gear is in transit or the maximum landing gear extended speed (V_{LE}).
7. Prepare for landing early in the approach so that trim adjustments after lowering landing gear or flaps will not compromise the approach.
8. Leave landing gear extended during consecutive landings when the airplane remains in the traffic pattern unless traffic pattern speeds exceed the Maximum Landing Gear Extended Speed (V_{LE}).

A rare, but serious problem that may result from a mechanical failure in the flap system is split wing flaps. This phenomenon occurs when the wing flap position on one wing does not agree with the flap position on the opposite wing, causing a rolling tendency. Split flaps can be detected and safely countered if flap control movement is limited to small increments during inflight operations from full down to full up and full up to full down. If a roll is detected during flap selection, reposition the flap selector to the position from which it was moved and the roll should be eliminated. Depending on the experience and proficiency of the pilot, the rolling tendencies caused by a split flap situation may be controlled with opposite aileron (and differential power for multi-engine aircraft). Some documented contributing factors to split flaps are:

1. Pilots exceeding the Maximum Flap Extended (V_{FE}) speed for a given flap setting.
2. Mechanical failure.
3. Improper maintenance.

ILLUSIONS IN FLIGHT

Many different illusions can be experienced in flight. Some can lead to spatial disorientation. Others can lead to landing errors. Illusions rank among the most common factors cited as contributing to fatal airplane accidents. Various complex motions and forces and certain visual scenes encountered in flight can create illusions of motion and position. Spatial disorientation from these illusions can be prevented only by visual reference to reliable, fixed points on the ground, or to flight instruments.

An abrupt correction of banked attitude, which has been entered too slowly to stimulate the motion sensing system in the middle ear, can create the illusion of banking in the opposite direction. The disoriented pilot will roll the airplane back to its original dangerous attitude or, if level flight is maintained, will feel compelled to lean in the perceived vertical plane until this illusion subsides. This phenomenon is usually referred to as the "leans" and the following illusions fall under this category.

1. **Coriolis illusion** - An abrupt head movement in a prolonged constant-rate turn that has ceased stimulating the motion sensing system can create the illusion of rotation or movement on an entirely different axis. The disoriented pilot will maneuver the airplane into a dangerous attitude in an attempt to stop this illusion of rotation. This most overwhelming of all illusions in flight may be prevented by not making sudden, extreme head movements, particularly while making prolonged constant-rate turns under IFR conditions.
2. **Graveyard spin** - A proper recovery from a spin that has ceased stimulating the motion sensing system can create the illusion of spinning in the opposite direction. The disoriented pilot will return the airplane to its original spin.
3. **Graveyard spiral** - An observed loss of altitude during a coordinated constant-rate turn that has ceased stimulating the motion sensing system can create the illusion of being in a descent with the wings level. In this case, the disoriented pilot will pull back on the controls, tightening the spiral and increasing the normal load factor on the airplane.
4. **Somatogravic illusion** - A rapid acceleration during takeoff can create the illusion of being in a nose up attitude. The disoriented pilot will push the airplane into a nose low, or dive attitude. A rapid deceleration by a quick reduction of the throttle(s) can have the opposite effect, with the disoriented pilot pulling the airplane into a nose up, or stall attitude.
5. **Inversion Illusion** - An abrupt change from climb to straight and level flight can create the illusion of tumbling backwards. The disoriented pilot will push the airplane abruptly into a nose low attitude, possibly intensifying this illusion.
6. **Elevator illusion** - An abrupt upward vertical acceleration, usually caused by an updraft, can create the illusion of being in a climb. The disoriented pilot will push the airplane into a nose low attitude. An abrupt downward vertical acceleration, usually caused by a downdraft, has the opposite effect, with the disoriented pilot pulling the airplane into a nose up attitude.
7. **False horizon** - Sloping cloud formations, an obscured horizon, a dark scene spread with ground lights and stars, and certain geometric patterns of ground light can create illusions of not being aligned correctly with the horizon. The disoriented pilot will place the airplane in a dangerous attitude.

8. **Autokinesis** - In the dark, a static light will appear to move about when stared at for many seconds. The disoriented pilot will lose control of the airplane in attempting to align it with the light.

Various surface features and atmospheric conditions encountered during landing can create illusions of incorrect height above and distance away from the runway threshold. Landing errors from these illusions can be prevented by: anticipating them during approaches, aerial visual inspection of unfamiliar airports before landing, using an electronic glide slope or visual approach slope indicator (VASI) system when available, and maintaining optimum proficiency in landing procedures. The following illusions apply to this category.

1. **Runway width illusion** - A narrower than usual runway can create the illusion that the airplane is at a higher altitude than it actually is. The pilot who does not recognize this illusion will tend to fly a lower approach, with the risk of striking objects along the approach path, or land short. A wider than usual runway can have the opposite effect, with the risk of flaring high and landing hard or overshooting the runway.
2. **Runway and terrain slopes illusion** - An up sloping runway, up sloping terrain, or both, can create the illusion that the airplane is at a higher altitude than it actually is. The pilot who does not recognize this illusion will fly a lower approach. A down sloping runway, down sloping approach terrain, or both, can have the opposite effect.
3. **Featureless terrain illusion** - An absence of ground features, as when landing over water, darkened areas and terrain made featureless by snow, can create the illusion that the airplane is at a higher altitude than it actually is. The pilot who does not recognize this illusion will tend to fly a lower approach.
4. **Atmospheric illusion** - Rain on the windshield can create an illusion of greater height, and a greater distance from the runway. The pilot who does not recognize this illusion will tend to fly a lower approach. Penetration of fog can create the illusion of pitching up. The pilot who does not recognize this illusion will steepen the approach, often quite abruptly.
5. **Ground lighting illusions** - Lights along a straight path, such as a road, and even lights on trains, can be mistaken for runway and approach lights. Bright runway and approach lighting systems, especially where few lights illuminate the surrounding terrain, may create the illusion of less distance to the runway. The pilot who does not recognize this illusion will tend to fly a higher approach. Conversely, the pilot overflying terrain which has few lights to provide height cues may make a lower than normal approach.

4. Don't fly a light airplane when the winds aloft, at your proposed altitude, exceed 35 miles per hour. Expect the winds to be of much greater velocity over mountain passes than reported a few miles from them. Approach mountain passes with as much altitude as possible. Downdrafts of from 1500 to 2000 feet per minute are not uncommon on the leeward (downwind) side.
5. Severe turbulence can be expected near or above changes in terrain, especially in high wind conditions.
6. Some canyons run into a dead end. Don't fly so far into a canyon that you get trapped. Always be able to make a 180-degree turn, or if canyon flying is necessary, fly down the canyon (toward lower terrain), not up the canyon (toward higher terrain).
7. Plan the trip for the early morning hours. As a rule, the air starts to get turbulent at about 10 a.m., and grows steadily worse until around 4 p.m., then gradually improves until dark.
8. When landing at a high altitude airfield, the same indicated airspeed should be used as at low elevation fields. Due to the less dense air at altitude, this same indicated airspeed actually results in a higher true airspeed, a faster landing speed, and a longer landing distance. During gusty wind conditions, which often prevail at high altitude fields, a "power approach" is recommended. Additionally, due to the faster ground speed and reduced engine performance at altitude, the takeoff distance will increase considerably over that required at lower altitudes.

OBSTRUCTIONS TO FLIGHT

Pilots should exercise extreme caution when flying less than 2000 feet above ground level (AGL) because of the numerous structures (radio and television antenna towers) exceeding 1000 feet AGL, with some extending higher than 2000 feet AGL. Most truss type structures are supported by guy wires. The wires are difficult to see in good weather and can be totally obscured during periods of dusk and reduced visibility. These wires can extend approximately 1500 feet horizontally from a structure; therefore, all truss type structures should be avoided by at least 2000 feet, horizontally and vertically.

Overhead transmission and utility lines often span approaches to runways and scenic flyways such as lakes, rivers, and canyons. The supporting structures of these lines may not always be readily visible and the wires may be virtually invisible under certain conditions. Most of these installations do not meet criteria which determine them to be obstructions to air navigation and therefore, do not require marking and/or lighting. The supporting structures of some overhead transmission lines are equipped with flashing strobe lights. These lights indicate wires exist between the strobe equipped structures.

FUEL MANAGEMENT

POOR TECHNIQUES

Poor fuel management is often the cause of aircraft accidents. Some airplane accident reports have listed such poor fuel management techniques as switching to another fuel tank after the before takeoff runup was completed, and then experiencing engine problems on takeoff. Other reports tell of pilots switching fuel tanks at a critical point on the approach to a landing and inadvertently selecting an empty tank when there is not enough time to compensate for the subsequent loss of power. Flying low during day cross-country, or moderately low at night, can be hazardous if a fuel tank runs dry. Too much altitude may be lost during the time it takes to discover the reason for power loss, select a different fuel tank, and restart the engine. Pilots should be thoroughly familiar with the airplane fuel system and tank switching procedures. Furthermore, it is an unsafe technique to run a fuel tank dry as a routine procedure, although there are exceptions. Any sediment or water not drained from the fuel tank could be drawn into the fuel system and cause erratic operation or even total power loss.

FUELING THE AIRCRAFT

The aircraft should be on level ground during all fueling operations, since filling the tanks when the aircraft is not level may result in a fuel quantity less than the maximum capacity. Rapid filling of a fuel tank, without allowing time for air in the tank to escape, may result in a lower fuel quantity. Some single engine aircraft that allow simultaneous use of fuel from more than one tank have fuel tanks with interconnected vent lines. If the tanks are filled with fuel and the aircraft allowed to sit with one wing lower than the other, fuel may drain from the higher tank to the lower and subsequently out the fuel vent. This will result in loss of fuel. This fuel loss may be prevented by placing the fuel selector in a position other than "both".

Some Cessna single-engine airplanes have long, narrow fuel tanks. If your airplane is so equipped, it may be necessary to partially fill each tank alternately, and repeat the sequence as required to completely fill the tanks to their maximum capacity. This method of fueling helps prevent the airplane from settling to a wing-low attitude because of increased fuel weight in the fullest wing tank.

It is always the responsibility of the pilot-in-command to ensure sufficient fuel is available for the planned flight. Refer to the airplane operating handbook for proper fueling procedures.

UNUSABLE FUEL

Unusable fuel is the quantity of fuel that cannot safely be used in flight. The amount of unusable fuel varies with airplane and fuel system design, and the maximum amount is determined in accordance with Civil or Federal Aviation Regulations (CARs or FARs). Unusable fuel is always included in the airplane's licensed or basic empty weight for weight and balance purposes. Unusable fuel should never be included when computing the endurance of any airplane.

FUEL PLANNING WITH MINIMUM RESERVES

Airplane accidents involving engine power loss continue to reflect fuel starvation as the primary cause or a contributing factor. Some of these accidents were caused by departing with insufficient fuel onboard to complete the intended flight. Fuel exhaustion in flight can mean only one thing - a forced landing with the possibility of serious damage, injury, or death.

A pilot should not begin a flight without determining the fuel required and verifying its presence onboard. To be specific, during VFR conditions, do not take off unless there is enough fuel to fly to the planned destination (considering wind and forecast weather conditions), assuming the airplane's normal cruising airspeed, fly after that for at least 30 minutes during the day, or at least 45 minutes at night.

Departure fuel requirements are a little different when operating under IFR conditions. Do not depart an airport on an IFR trip unless the airplane has enough fuel to complete the flight to the first airport of intended landing (considering weather reports and forecasts) and fly from that airport to the planned alternate airport, and afterwards still fly at least 45 minutes at normal cruising speed.

FLIGHT COORDINATION VS. FUEL FLOW

The shape of most airplane wing fuel tanks is such that, in certain flight maneuvers, the fuel may move away from the fuel tank supply outlet. If the outlet is uncovered, fuel flow to the engine may be interrupted and a temporary loss of power might result. Pilots can prevent inadvertent uncovering of the tank outlet by having adequate fuel in the tank selected and avoiding maneuvers such as prolonged uncoordinated flight or sideslips which move fuel away from the feed lines.

It is important to observe the uncoordinated flight or sideslip limitations listed in the respective operating handbook. As a general rule, limit uncoordinated flight or sideslip to 30 seconds in duration when the fuel level in the selected fuel tank is 1/4 full or less. Airplanes are usually considered in a sideslip anytime the turn and bank "ball" is more than one quarter ball out of the center (coordinated flight) position. The amount of usable fuel decreases with the severity of the sideslip in all cases.

FUEL SELECTION FOR APPROACH/LANDING

On some single-engine airplanes, the fuel selector valve handle is normally positioned to the BOTH position to allow symmetric fuel feed from each wing fuel tank. However, if the airplane is not kept in coordinated flight, unequal fuel flow may occur. The resulting wing heaviness may be corrected during flight by turning the fuel selector valve handle to the tank in the "heavy" wing. On other single-engine airplanes, the fuel selector has LEFT ON or RIGHT ON positions, and takeoffs and landings are to be accomplished using fuel from the fuller tank.

Most multi-engine airplanes have fuel tanks in each wing or in wing tip tanks, and it is advisable to feed the engines symmetrically during cruise so that approximately the same amount of fuel will be left in each side for descent, approach, and landing. If fuel has been consumed at uneven rates between the two wing tanks because of prolonged single-engine flight, fuel leak or siphon, or improper fuel servicing, it is desirable to balance the fuel load by operating both engines from the fuller tank. However, as long as there is sufficient fuel in both wing tanks, even though they may have unequal quantities, it is important to switch the left and right fuel selectors to the left and right wing tanks, respectively, feeling for the detent, prior to the approach. This will ensure that adequate fuel flow will be available to each operating engine if a go-around is necessary. In the case of single-engine operation, operate from the fuller tank, attempting to have a little more fuel in the wing on the side with the operating engine prior to descent.

On all multi-engine airplanes equipped with wing tip fuel tanks, the tip tanks are the main fuel tanks on the tank selector valve controls. Refer to Supplement 12 of this Pilot Safety and Warning Supplements Manual and the applicable airplane operating handbook.

AIRFRAME ICING

Pilots should monitor weather conditions while flying and should be alert to conditions which might lead to icing. Icing conditions should be avoided when possible, even if the airplane is certified and approved for flight into known icing areas. A climb normally is the best ice avoidance action to take. Alternatives are a course reversal or a descent to warmer air. If icing conditions are encountered inadvertently, immediate corrective action is required.

FLIGHT INTO KNOWN ICING

Flight into known icing is the intentional flight into icing conditions that are known to exist. Icing conditions exist anytime the indicated OAT (outside air temperature) is +10°C or below, or the RAT (ram air temperature) is +10°C or below, and visible moisture in any form is present. Any airplane that is not specifically certified for flight into known icing conditions, is prohibited by regulations from doing so.

Ice accumulations significantly alter the shape of the airfoil and increase the weight of the aircraft. Ice accumulations on the aircraft will increase stall speeds and alter the speeds for optimum performance. Flight at high angles of attack (low airspeed) can result in ice buildup on the underside of wings and the horizontal tail aft of the areas protected by boots or leading edge anti-ice systems. Trace or light amounts of icing on the horizontal tail can significantly alter airfoil characteristics, which will affect stability and control of the aircraft.

Inflight ice protection equipment is not designed to remove ice, snow, or frost accumulations on a parked airplane sufficiently enough to ensure a safe takeoff or subsequent flight. Other means (such as a heated hangar or approved deicing solutions) must be employed to ensure that all wing, tail, control, propeller, windshield, static port surfaces and fuel vents are free of ice, snow, and frost accumulations, and that there are no internal accumulations of ice or debris in the control surfaces, engine intakes, brakes, pitot-static system ports, and fuel vents prior to takeoff.

AIRPLANES CERTIFIED FOR FLIGHT INTO KNOWN ICING

An airplane certified for flight into known icing conditions must have all required FAA approved equipment installed and fully operational. Certain airplanes have a flight into known icing equipment package available which, if installed in its entirety and completely operational, allows intentional penetration of areas of known icing conditions as reported in weather sequences or by PIREPS.

This known icing package is designed specifically for the airplane to provide adequate in-flight protection during normally encountered icing conditions produced by moisture-laden clouds. It will not provide total protection under severe conditions such as those which exist in areas of freezing rain, nor will it necessarily provide complete protection for continuous operation in extremely widespread areas of heavy cloud moisture content. The installed equipment should be used to protect the airplane from ice while seeking a different altitude or routing where ice does not exist. During all operations, the pilot must exercise good judgement and be prepared to alter his flight if conditions exceed the capacity of the ice protection equipment or if any component of this equipment fails.

The airplane's operating handbook will indicate the required equipment for intentional flight into known icing conditions. Such equipment may include: wing leading edge deice/anti-ice system, vertical and horizontal stabilizer leading edge deice/anti-ice system, propeller deice/anti-ice system, windshield anti-ice, heated pitot tube, heated static ports and fuel vents, heated stall warning vane/transducer or optional angle-of-attack lift sensor vane, ice detector light(s), and increased capacity electrical and vacuum systems.

If there is any doubt whether the airplane is certified or has all the required equipment, the pilot should assume that the airplane is not certified for flight into known icing and avoid any encounters with areas of icing.

KINDS OF ICING

Airframe icing is a major hazard. It is at its worst when the supercooled (liquid below freezing temperature) water droplets are large and plentiful. Droplets of this type are usually found in cumulus clouds and are the cause of "clear ice". Clear ice is transparent ice deposited in layers, and may be either smooth or rough. This ice coats more of the wing than "rime ice" because the droplets flow back from the leading edge over the upper and lower wing surface before freezing, and the rate of accumulation is higher.

Rime ice is an opaque, granular, and rough deposit of ice that is usually encountered in stratus clouds. Small supercooled droplets freeze instantly when struck by the leading edges of the airplane. Rime ice can quickly change the drag characteristics of the airplane. Under some conditions, a large "double horn" buildup on the leading edges can occur which drastically alters the airfoil shape. Altitude changes usually work well as an avoidance strategy for rime ice. In colder temperatures, these types of supercooled water droplets quickly convert to ice crystals.

Icing in precipitation comes from freezing rain or drizzle which falls from warmer air aloft to colder air below. This results in a very rapid buildup of clear ice, and must be avoided by all means available to the pilot.

If it is snowing, the problem is not so much the snow sticking to the airplane as the icing caused by the supercooled water droplets in the clouds from which the snow is falling. The amount of ice will depend upon cloud saturation.

Pilots should report all icing conditions to ATC/FSS, and if operating under IFR conditions, request new routing or altitude if icing will be a hazard. Be sure to give type of airplane when reporting icing.
The following describe how to report icing conditions:

1. **Trace** - Ice becomes visible. Rate of accumulation is slightly greater than the rate of sublimation. Anti-ice equipment must be on and deice equipment may or may not be required.
2. **Light** - The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 hour). Occasional use of deicing equipment and continuous use of anti-icing equipment removes/prevents accumulation.
3. **Moderate** - The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment and flight diversion is necessary.
4. **Severe** - The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary.

RESULTS OF ICING

Airplane performance can be severely reduced by ice accumulation. Accumulation of 1/2 inch of ice on the leading edges of the wings and empennage can cause a large loss in rate of climb, a cruise speed reduction of up to 30 KIAS, as well as a significant buffet and stall speed increase. Even if the airplane is certified for flight into known icing and the equipment is working properly, ice remaining on unprotected areas of the airplane can cause large performance losses. With one inch of residual ice accumulation, these losses can double, or even triple. Ice accumulation also will increase airplane weight.

INADVERTENT ICING ENCOUNTER

Flight into icing conditions is not recommended. However, an inadvertent encounter with these conditions is possible. The following are things to consider doing if inadvertent icing is experienced. These items are not intended to replace procedures described in any operating handbook. Instead, this list has been generated to familiarize pilots of older model Cessnas with guidelines they can use in the event of an inadvertent icing condition. The best procedure is a change of altitude, or course reversal to escape the icing conditions.

1. Turn pitot heat, stall warning heat, propeller deice/anti-ice, and windshield anti-ice switches ON (if installed).
2. Change altitude (usually climb) or turn back to obtain an outside air temperature that is less conducive to icing.
3. Increase power as necessary to maintain cruise airspeed and to minimize ice accumulation. Maintain a minimum indicated airspeed of V_Y +10 KIAS until assured that all ice is off the airframe.
4. Turn cabin heat and defroster controls full on and open defrost control to obtain maximum windshield defroster effectiveness.
5. Increase engine speed to minimize ice buildup on propeller blades. If excessive vibration is noted, momentarily reduce engine speed with the propeller control, and then rapidly move the control full forward. Cycling the RPM flexes the propeller blades and high RPM increases centrifugal force, causing ice to shed more readily.
6. Watch for signs of induction air filter ice. Regain manifold pressure by increasing the throttle setting and/or selecting alternate air or carburetor heat. If ice accumulates on the intake filter (requiring alternate air), a decrease of manifold pressure will be experienced, and the mixture should be adjusted as required.
7. If icing conditions are unavoidable, plan a landing at the nearest airport. In the event of an extremely rapid ice buildup, select a suitable “off airport” landing site.
8. Ice accumulation of 1/4 inch or more on the wing leading edges may require significantly higher power and a higher approach and landing speed, and result in a higher stall speed and longer landing roll.
9. If practical, open the window and, scrape ice from a portion of the windshield for visibility in the landing approach.
10. Approach with reduced flap extension to ensure adequate elevator effectiveness in the approach and landing.
11. Avoid a slow and high flare-out.
12. Missed approaches should be avoided whenever possible, because of severely reduced climb capability. However, if a go-around is mandatory, make the decision much earlier in the approach than normal. Apply maximum power while retracting the flaps slowly in small increments (if extended). Retract the landing gear after immediate obstacles are cleared.

WEATHER

ALERTNESS

Most pilots pay particularly close attention to the business of flying when they are intentionally operating in instrument weather conditions. On the other hand, unlimited visibility tends to encourage a sense of security which may not be justified. The pilot should be alert to the potential of weather hazards, and prepared if these hazards are encountered on every flight.

VFR JUDGMENT

Published distance from clouds and visability regulations establish the minimums for VFR flight. The pilot who uses even greater margins exercises good judgment. VFR operation in class D airspace, when the official visibility is 3 miles or greater, is not prohibited, but good judgment would dictate that VFR pilots keep out of the approach area under marginal conditions.

Precipitation reduces forward visibility. Although it is perfectly legal to cancel an IFR flight plan whenever the pilot feels he can proceed VFR, it is usually a good practice to continue IFR into a terminal area until the destination airport is in sight.

While conducting simulated instrument flights, pilots should ensure that the weather provides adequate visibility to the safety pilot. Greater visibility is advisable when flying in or near a busy airway or close to an airport.

IFR JUDGMENT

The following tips are not necessarily based on Federal Aviation Regulations, but are offered as recommendations for pilot consideration. They do, however, address those elements of IFR flight that are common causes of accidents.

1. All pilots should have an annual IFR proficiency check, regardless of IFR hours flown.
2. For the first 25 hours of pilot-in-command time in airplane type, increase ILS visibility minimums and raise nonprecision approach minimums.
3. An operating autopilot or wing leveler is strongly recommended for single pilot IFR operations.
4. Do not depart on an IFR flight without an independent power source for attitude and heading systems, and an emergency power source for

at least one VHF communications radio, or a hand-held communications radio.

5. Be sure the airplane has enough fuel to fly to the destination with a headwind calculated at 125 percent of the forecast wind, and a tailwind calculated at 75 percent of forecast wind. Also, include enough fuel to miss the approach at the destination airport, climb to cruise altitude and fly an approach at an alternate airport, plus 45 minutes of fuel for low altitude holding.
6. The IFR takeoff runway should meet the criteria of the accelerate-stop/go distances for that particular twin-engine airplane, or 200 percent of the distance to clear a 50-foot obstacle for a single.
7. Do not enter an area of embedded thunderstorms without on-board weather detection equipment (radar and/or Stormscope$_{TM}$) and unless cloud bases are at least 2000 feet above the highest terrain, terrain is essentially level, and VFR can be maintained. Avoid all cells by five miles, and severe storms by 20 miles.
8. Do not enter possible icing conditions unless all deice and anti-ice systems are fully operational, or the weather provides at least a 1000-foot ceiling and three miles visibility for the entire route over level terrain, and the surface temperatures are greater than 5°C.
9. Adhere to weather minimums, missed approach procedures and requirements for visual contact with the runway environment. If an approach is missed, with the runway not in sight at the appropriate time because of weather conditions, do not attempt another approach unless there is a valid reason to believe there has been a substantial improvement in the weather.
10. Observe the minimum runway requirement for an IFR landing. The minimum IFR runway length for propeller driven airplanes should be considered 200 percent of maximum landing distance. Increase these distances 90 percent for a wet runway and 150 percent for ice on the runway.
11. Make a missed approach if speed and configuration are not stable inside the middle marker or on nonprecision final, or if the touchdown aiming point will be missed by more than 1000 feet. If an approach is missed because of pilot technique, evaluate the reasons and options before attempting another approach.
12. Use supplemental oxygen above a cabin altitude of 5000 feet at night, and above 10,000 feet during the day.

WIND

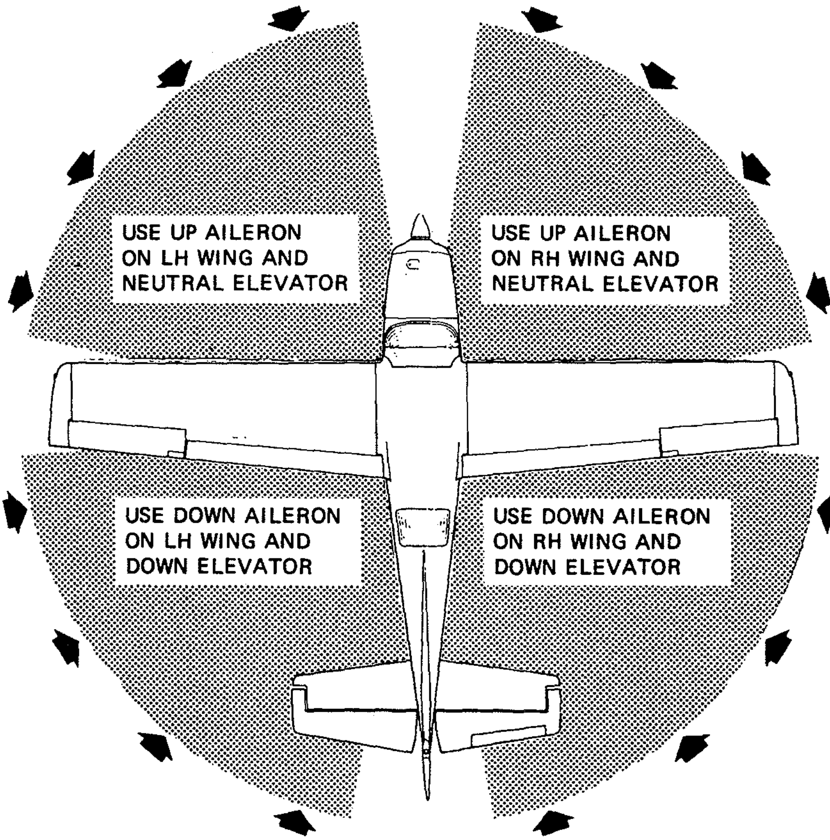
The keys to successfully counteracting the effects of wind are proficiency, understanding the wind response characteristics of the airplane, and a thoughtful approach to the operation. Some operating handbooks indicate a maximum demonstrated crosswind velocity, but this value is not considered to be limiting. There is an ultimate limit on wind for safe operation, which varies with the airplane and pilot. The lighter the airplane and the lower the stalling speed, the less wind it will take to exceed this limit. The way an airplane rests on its landing gear affects handling characteristics. If it sits nose down, the wing will be unloaded and the airplane will handle better in wind than an airplane which sits in a nose up attitude, creating a positive angle of attack. For the latter type, the full weight of the airplane cannot be on the wheels as the airplane is facing into the wind. Airplanes with these characteristics cause pilots to work harder to keep the airplane under control.

CROSSWIND

While an airplane is moving on the ground, it is affected by the direction and velocity of the wind. When taxiing into the wind, the control effectiveness is increased by the speed of the wind. The tendency of an airplane to weathervane is the greatest while taxiing directly crosswind, which makes this maneuver difficult. When taxiing in crosswind, speed and use of brakes should be held to a minimum and all controls should be utilized to maintain directional control and balance (see Crosswind Taxi Diagram, Figure 1).

Takeoffs into strong crosswinds are normally performed with the minimum flap setting necessary for the field length. With the ailerons deflected into the wind, the airplane should be accelerated to a speed slightly higher than normal (on multi-engine airplanes, additional power may be carried on the upwind engine until the rudder becomes effective), and then the airplane should be flown off abruptly to prevent possible settling back to the runway while drifting. When clear of the ground and any obstacle, the pilot should execute a coordinated turn into the wind to correct for drift. The pilot's ability to handle a crosswind is more dependent upon pilot proficiency than airplane limitations.

A crosswind approach and landing may be performed using either the wing-low, crab, or combination drift correction technique, depending upon the training, experience, and desires of the pilot. Use of the minimum flap setting required for the field length is recommended . Whichever method is used, the pilot should hold a straight course after touchdown with the steerable nose or tailwheel and occasional differential braking, if necessary.



CODE

WIND DIRECTION ➡

NOTE

Strong quartering tail winds required caution. Avoid sudden bursts of the throttle and sharp braking when the airplane is in this attitude. Use the steerable nose or tail wheel and rudder to maintain direction.

Figure 1. Crosswind Taxi Diagram

On those airplanes with a steerable tailwheel, landings may be made with the tailwheel lock (if installed) engaged or disengaged. Although the use of the lock is left to the individual pilot's preference, it should be used during strong crosswind landings on rough fields with a heavily loaded airplane. If the lock were disengaged, this condition could lead to a touchdown with a deflected tailwheel and subsequent external forces on the tailwheel that are conducive to shimmy.

LOW LEVEL WIND SHEAR

Low level wind shear is the interflow of air masses near the ground, having different speeds and directions. As an airplane passes through the narrow boundary between the two air masses, large fluctuations in airspeed may be encountered depending on the difference in speed and direction of the air masses. Low level wind shear can be experienced through both the horizontal and vertical plane. One major risk with a wind shear encounter is that a sudden loss of airspeed may render the airplane out of control near the ground. Recovery depends on altitude and the magnitude of the airspeed loss.

A wind shear encounter can be reported as either positive or negative. A positive wind shear is one in which the headwind component suddenly increases. The airplane's inertia makes it tend to maintain the same velocity through space, not through air, so the first thing a pilot is likely to notice is an increase in airspeed. The opposite case, a negative wind shear, is a sudden decrease in headwind component. The airplane will begin to sink immediately, as lift is decreased by the reduced airspeed; and as the natural aerodynamics, and/or the pilot, lowers the nose, the descent rate increases.

The effects of wind shear on smaller airplanes are sometimes less severe than on large jetliners. Smaller airplanes have less mass (and therefore less inertia), and their speed can change more quickly. Thus, a smaller airplane can return to its trimmed speed, after encountering a wind shear, more rapidly than a larger, heavier one.

TYPES OF WIND SHEAR CONDITIONS

Wind shear is encountered in several distinct weather scenarios. Within a frontal zone, as one air mass overtakes another, variations in wind speed and direction can be significant. Fast moving cold fronts, squall lines, and gust fronts pose the highest risk.

A temperature inversion can present a fast moving air mass directly above a very stable calm layer at the surface. Under these conditions an airplane on approach with a headwind aloft will experience a rapid loss of airspeed during descent through the boundary layer to the calm air beneath.

The most violent type of wind shear is that induced by convective activity and thunderstorms. Downdrafts created by local areas of descending air (roughly 5 to 20 miles diameter) can exceed 700 feet per minute. At times, very small areas of descending air (1 mile or so in diameter), called microbursts, can reach vertical speeds of 6000 feet per minute or more. Such downdrafts generate significant turbulence and exceed the climb capability of many airplanes. In addition, as the downdraft/microburst reaches the ground, the air spreads in all directions. The pilot entering the area at relatively low altitude will likely experience an increase in airspeed followed by a dramatic decrease in airspeed and altitude while exiting the area.

INDICATIONS OF WIND SHEAR

The winds near or around the base of a thunderstorm are largely unpredictable, but there are identifiable signs that may indicate that wind shear conditions exist. Small areas of rainfall, or shafts of heavy rain are clues to possible wind shear conditions. Virga, or rain shafts that evaporate before reaching the ground, may indicate cool, dense air sinking rapidly and may contain microburst winds. On the ground, such signs as trees bending in the wind, ripples on water, or a line of dust clouds should alert the pilot.

With the presence of a strong temperature inversion, if low clouds are moving rapidly but winds are calm or from a different direction on the surface, a narrow wind shear zone might exist and the pilot may elect to use a higher climb speed until crossing the zone. Conversely, while in the landing pattern or on an approach, if the reported surface winds are significantly different than that being experienced in flight, it must be taken as a warning to the potential of wind shear.

A pilot who has been holding a wind correction angle on final approach, and suddenly finds that a change has to be made – i.e., the runway (or CDI needle) starts moving off to the side – most likely encountered wind shear. The usual techniques apply, such as an appropriate heading change, but more importantly, the pilot has been alerted to the presence of a wind shear situation and should be ready to deal with a more serious headwind to tailwind shear at any time.

COPING WITH WIND SHEAR

A pilot can cope with wind shear by maintaining a somewhat higher airspeed not to exceed V_A (maneuvering speed), since the conditions conducive to wind shear are also often conducive to turbulence. Pilots should be alert for negative wind shear; if the airspeed is suddenly decreasing, the sink rate increasing, or more than usual approach power is required, a negative wind shear may well have been encountered. Also, the closer the airplane gets to the ground, the smaller the margin for sink recovery. Be prepared to go around at the first indication of a negative wind shear. A positive wind shear may be followed immediately by a negative shear.

Some larger airports are equipped with a low-level wind shear alerting system (LLWAS). Many have ATIS, and or AWOS wind information. All elements of the weather conditions including pilot reports should be carefully considered and any pilot who experiences wind shear should warn others.

In summary, all pilots should remain alert to the possibility of low level wind shear. If wind shear is encountered on final approach, usually characterized by erratic airspeed and altimeter indications and almost always associated with uncommanded airplane attitude changes, do not hesitate to go around. If the approach profile and airspeed cannot be reestablished, it cannot be emphasized too strongly that a go-around is often the pilot's best course of action, and the earlier the decision to go around, the better the chance of recovery.

THUNDERSTORM AVOIDANCE

Much has been written about thunderstorms. They have been studied for years, and while considerable information has been learned, the studies continue because questions still remain. Knowledge and weather radar have modified our attitudes toward thunderstorms. But any storm recognizable as a thunderstorm should be considered hazardous. Never regard any thunderstorm lightly, even when radar observers report the echoes are of light intensity. Avoiding all thunderstorms is the best policy.

The following are some do's and don'ts of thunderstorm avoidance:

1. Don't land or takeoff in the face of an approaching thunderstorm. A sudden gust front of low level turbulence (wind shear) could cause loss of control.
2. Don't attempt to fly under a thunderstorm, even if you can see through to the other side. Turbulence and wind shear under the storm is likely and hazardous.
3. Don't fly near clouds containing embedded thunderstorms. Scattered thunderstorms that are not embedded usually can be visually circumnavigated.
4. Don't trust the visual appearance to be a reliable indicator of the turbulence inside a thunderstorm.
5. Do avoid, by at least 20 miles, any thunderstorm identified as severe or giving an intense radar echo. This is especially true under the anvil of a large cumulonimbus.
6. Do circumnavigate the entire area if the area has 6/10 thunderstorm coverage.
7. Do remember that vivid and frequent lightning indicates the probability of a severe thunderstorm.

RESTRAINT SYSTEMS

SEAT RESTRAINTS

Records of general aviation airplane accident injuries reveal a surprising number of instances in which the occupants were not properly using the available restraint system, indicating the presence of a complacent attitude during airplane preflight briefing inspections. An unbuckled restraint system during a critical phase of flight, such as during turbulence, could cause loss of control of the airplane and/or injuries. Although the ultimate responsibility lies with the pilot-in-command, each user of a restraint system should be cognizant of the importance of proper use of the complete restraint system.

Pilots should ensure that all occupants properly use their individual restraint systems. The system should be adjusted snug across the body. A loose restraint belt will allow the wearer excessive movement and could result in serious injuries. The wearer should not allow sharp or hard items in pockets or other clothing to remain between their body and the restraint system to avoid discomfort or injury during adverse flight conditions or accidents. Each occupant must have their own restraint system. Use of a single system by more than one person could result in serious injury.

Occupants of adjustable seats should position and lock their seats before fastening their restraint system. Restraint belts can be lengthened before use by grasping the sides of the link on the link half of the belt and pulling against the belt. Then, after locking the belt link into the belt buckle, the belt can be tightened by pulling the free end. The belt is released by pulling upward on the top of the buckle. Restraint systems must be fastened anytime the airplane is in motion. Before takeoff, the pilot should brief all passengers on the proper use, including the method of unlatching the entire restraint system, in the event that emergency egress from the airplane is necessary.

Small children must be secured in an approved child restraint system as defined in FAR 91.107 “Use of safety belts, shoulder harnesses, and child restraint systems”. The pilot should know and follow the instructions for installation and use provided by the seat manufacturer. The child restraint system should be installed in an aircraft seat other than a front seat. If the child restraint system is installed in a front seat, the pilot must ensure that it does not interfere with full control movement or restrict access to any aircraft controls. Also, the pilot should consider whether the child restraint system could interfere with emergency egress. Refer to AC 91-62A, "Use of Child Seats In Aircraft" for more information.

If shoulder restraints are not installed, kits are available from Cessna or from other approved sources. Cessna strongly recommends the installation of shoulder harnesses.

SEAT STOPS/LATCHES

The pilot should visually check the seat for security on the seat tracks and assure that the seat is locked in position. This can be accomplished by visually ascertaining pin engagement and physically attempting to move the seat fore and aft to verify the seat is secured in position. Failure to ensure that the seat is locked in position could result in the seat sliding aft during a critical phase of flight, such as initial climb. Mandatory Service Bulletin SEB89-32 installs secondary seat stops and is available from Cessna.

The pilot's seat should be adjusted and locked in a position to allow full rudder deflection and brake application without having to shift position in the seat. For takeoff and landing, passenger seat backs should be adjusted to the most upright position.

SECURITY IN AFT-FACING SEATS

Some aft-facing seats are adjustable fore and aft, within the limits of the seat stops. Ensure the seat stop pins are engaged with the holes in the seat tracks before takeoff and landing. The restraint system should be worn anytime the seat is occupied. Assure that the seats are installed in the correct positions. Approved seat designs differ between forward-facing and rear-facing seats and proper occupant protection is dependent upon proper seat installation.

FUEL SYSTEM CONTAMINATION

ADEQUATE PREFLIGHT OF THE FUEL SYSTEM

A full preflight inspection is recommended before each flight for general aviation airplanes. Inspection procedures for the fuel system must include checking the quantity of fuel with the airplane on level ground, checking the security of fuel filler caps and draining the fuel tank sumps, fuel reservoir(s), fuel line drain(s), fuel selector drains, and fuel strainer(s). To ensure that no unsampled fuel remains in the airplane, an adequate sample of fuel from the fuel strainer must be taken with the fuel selector valve placed in each of its positions (BOTH, LEFT, RIGHT, etc.). Some Cessna airplanes are equipped with a fuel reservoir(s). If so equipped, the pilot should be aware of the location of the fuel reservoir(s) and its drain plug or quick-drain. The fuel reservoir(s) on most single-engine airplanes is located near the fuel system low point where water will accumulate. Therefore, the fuel reservoir(s) must be drained routinely during each preflight inspection. Periodically check the condition of the fuel filler cap seals, pawls, and springs for evidence of wear and/or deterioration which indicates a need for replacement. Check fuel cap adapters and seals to insure that the sealing surfaces are clean and not rusted or pitted. Deformed pawls may affect the sealing capabilities of the seals and/or cause it to be exposed to detrimental weather elements. Precautions should be taken to prevent water entry into fuel tanks, due to damaged filler caps and every effort made to check and remove all water throughout the fuel system. Umbrella caps will assist in preventing water entry into the fuel tank through the fuel filler.

It is the pilot's responsibility to ensure that the airplane is properly serviced before each flight with the correct type of fuel. The pilot must take the time to inspect the airplane thoroughly, making sure all of the fuel filler caps are installed and secured properly after visually checking the fuel quantity with the airplane on level ground. During the check of the fuel tanks, observe the color and odor of the fuel while draining a generous sample from each sump and drain point into a transparent container. Check for the presence of water, dirt, rust, or other contaminants. Never save the fuel sample and risk the possibility of contaminating the system. Also, ensure that each fuel tank vent is clear of restrictions (i.e., dirt, insect nests, ice, snow, bent or pinched tubes, etc.). Refer to the airplanes Maintenance Manual for for fuel tank vent removal and inspection if needed.

PROPER SAMPLING FROM QUICK DRAINS

The fuel system sumps and drains should always be drained and checked for contaminants after each refueling and during each preflight inspection. Drain at least a cupful of fuel into a clear container to check for solid and/or liquid contaminants, and proper fuel grade. If contamination is observed, take further samples at all fuel drain points until fuel is clear of contaminants; then, gently rock wings and, if possible, lower the tail to move any additional contaminants to the sampling points. Take repeated samples from all fuel drain points until all contamination has been removed. If excessive sampling is required, completely defuel, drain and clean the airplane fuel system, and attempt to discover where or how the contamination originated before the airplane flies again. Do not fly the airplane with contaminated or unapproved fuel. If an improper fuel type is detected, the mandatory procedure is to completely defuel and drain the fuel system.

Extra effort is needed for a proper preflight of all fuel drains on a float plane. If water is detected after rocking the wings and lowering the tail, the aircraft should not be flown until after the fuel system is completely drained and cleaned.

80 versus 100 OCTANE FUEL

When 80 octane (red) fuel began to be replaced by 100LL (blue) there was concern about the service life expectancy of low compression engines. It was claimed that some engines experienced accelerated exhaust valve erosion and valve guide wear from the use of highly leaded 100/130 (green) avgas in engines that were rated to use a minimum grade of 80 octane fuel. Engine manufacturers have provided amended operating procedures and maintenance schedules to minimize problems resulting from the use of high lead 100/130 avgas. Experience has now proven that low-compression aircraft engines can be operated safely on 100LL avgas providing they are regularly operated and serviced in accordance with the operating handbook or other officially approved document.

AVGAS versus JET FUEL

Occasionally, airplanes are inadvertently serviced with the wrong type of fuel. Piston engines may run briefly on jet fuel, but detonation and overheating will soon cause power failure. All piston-engine airplanes should have fuel filler restrictors installed to prevent jet fuel from being pumped into the fuel tanks. An engine failure caused by running a turbine engine on the wrong fuel may not be as sudden, but prolonged operation on avgas will severely damage the engine because of the lead content and differing combustion temperature of the fuel. Time limitations for use of avgas in turbine engines are listed in the operating handbook.

AUTOMOTIVE GASOLINE/FUEL

Never use automotive gasoline in an airplane unless the engine and airplane fuel system are specifically certified and approved for automotive gasoline use. The additives used in the production of automotive gasoline vary widely throughout the petroleum industry and may have deteriorating effects on airplane fuel system components. The qualities of automotive gasoline can induce vapor lock, increase the probability of carburetor icing, and can cause internal engine problems.

FUEL CAP SECURITY

The consequence of a missing or incorrectly installed fuel filler cap is inflight fuel siphoning. Inflight siphoning may distort the fuel cell on some airplanes with bladder-type fuel cells. This distortion will change the fuel cell capacity, and may interfere with the operation of the fuel quantity indicator sensing mechanism inside the cell. This condition will generally cause an erroneous and misleading fuel quantity reading and may result in incomplete filling for the next flight.

CONTAMINATION

Solid contamination may consist of rust, sand, pebbles, dirt, microbes or bacterial growth. If any solid contaminants are found in any part of the fuel system, drain and clean the airplane fuel system. Do not fly the airplane with fuel contaminated with solid material.

Liquid contamination is usually water, improper fuel type, fuel grade, or additives that are not compatible with the fuel or fuel system components. Liquid contamination should be addressed as set forth in the section entitled "Proper Sampling from Quick Drains", and as prescribed in the airplane's approved flight manual.

FUEL PUMP OPERATION

AUXILIARY FUEL PUMP OPERATION - GENERAL

The engine-driven fuel pump is designed to supply an engine with a steady, uninterrupted flow of fuel. Temperature changes, pressure changes, agitation in the fuel lines, fuel quality, and other factors can cause a release of vapor in the fuel system. Some airplanes (single and multi-engine) incorporate an auxiliary fuel pump to reduce excess fuel vapor in the fuel supply for each engine. This pump is also used to ensure that a positive supply of fuel is available in the event the engine driven fuel pump should fail.

FUEL VAPOR

Under hot, high altitude conditions, or in situations during a climb that are conducive to fuel vapor formation, it may be necessary to utilize the auxiliary fuel pump(s) to attain or stabilize the fuel flow required for proper engine operation. Use the auxiliary fuel pump(s) in all conditions where there is any possibility of excessive fuel vapor formation or temporary disruption of fuel flow in accordance with operating handbook procedures.

SINGLE ENGINE FUEL PUMP OPERATION (CARBURETED ENGINE)

On some carbureted, high wing, single engine airplanes, the auxiliary fuel pump should be turned on anytime the indicated fuel pressure falls below the minimum. Typically this would only occur in an extreme climb attitude following failure of the engine driven fuel pump. Consult the operating handbook of the affected model for a detailed description of the procedure.

SINGLE ENGINE FUEL PUMP OPERATION (PRECISION/BENDIX FUEL INJECTED ENGINE)

The auxiliary fuel pump is used primarily for priming the engine before starting. Priming is accomplished through the regular injection system. If the auxiliary fuel pump switch is placed in the ON position for prolonged periods with the master switch turned on, the mixture rich, and the engine stopped, the intake manifolds will become flooded.

The auxiliary fuel pump is also used for vapor suppression in hot weather. Normally, momentary use will be sufficient for vapor suppression. Turning on the auxiliary fuel pump with a normally operating engine pump will result in enrichment of the mixture. The auxiliary fuel pump should not be operated during takeoff and landing, since gravity and the engine driven fuel pump will supply adequate fuel flow to the fuel injector unit. In the event of failure of the engine driven fuel pump, use of the auxiliary fuel pump will provide sufficient fuel to maintain flight at maximum continuous power.

To ensure a prompt engine restart after running a fuel tank dry, switch the fuel selector to the opposite tank at the first indication of fuel flow fluctuation or power loss. Turn on the auxiliary fuel pump and advance the mixture control to full rich. After power and steady fuel flow are restored, turn off the auxiliary fuel pump and lean the mixture as necessary.

SINGLE ENGINE FUEL PUMP OPERATION (TCM FUEL INJECTED ENGINE)

The auxiliary fuel pump on single engine airplanes is controlled by a split rocker type switch labeled AUX PUMP. One side of the switch is red and is labeled HI; the other side is yellow and is labeled LO.

The LO side operates the pump at low speed, and, if desired, can be used for starting or vapor suppression. The HI side operates the pump at high speed, supplying sufficient fuel flow to maintain adequate power in the event of an engine driven fuel pump failure. In addition, the HI side may be used for normal engine starts, vapor elimination in flight, and inflight engine starts.

When the engine driven fuel pump is functioning and the auxiliary fuel pump is placed in the HI position, a fuel/air ratio considerably richer than best power is produced unless the mixture is leaned. Therefore, the auxiliary fuel pump must be turned off during takeoff or landing, and during all other normal flight conditions. With the engine stopped and the battery switch on, the cylinder intake ports can become flooded if the HI or LO side of the auxiliary fuel pump switch is turned on.

In hot, high altitude conditions, or climb conditions that are conducive to fuel vapor formation, it may be necessary to utilize the auxiliary fuel pump to attain or stabilize the fuel flow required for the type of climb being performed. Select either the HI or LO position of the switch as required, and adjust the mixture to the desired fuel flow. If fluctuating fuel flow (greater than 5 lbs/hr) is observed, place the auxiliary fuel pump switch in the HI or LO position as required to clear the fuel system of vapor. The auxiliary fuel pump may be operated continuously in cruise, if necessary, but should be turned off prior to descent. Each time the auxiliary fuel pump switch is turned on or off, the mixture should be readjusted.

MULTI-ENGINE FUEL PUMP OPERATION

Cessna multi-engine, low wing airplanes utilize engine driven fuel pumps to assist the continuous flow of fuel to the engine. As a general rule, the auxiliary fuel pumps should be utilized under the following conditions:

1. Every takeoff.
2. Initial climb after takeoff (unless the operating handbook indicates that it is not necessary).
3. When switching the fuel selector(s) from one tank to another.
4. Every approach and landing.
5. Anytime the fuel pressure is fluctuating and the engine is affected by the fluctuation.
6. During hot weather, such as hot engine ground operation where fuel vapor problems cause erratic engine operation.
7. High altitude. (For auxiliary fuel pump operation at high altitude consult the operating handbook.)
8. If the engine driven fuel pump should fail.
9. On some twins when using the auxiliary fuel tanks.

If the auxiliary fuel pump is used during ground operations, such as hot day engine starts or purging fuel vapor, pilots should check the condition of the engine driven fuel pump before takeoff by turning the auxiliary fuel pump OFF briefly, and then back ON for takeoff. If the engine driven fuel pump has failed, the engine will not continue to operate.

If the battery or master switch is on while an engine is stopped on the ground or in flight, the cylinder intake ports can become flooded if the auxiliary fuel pump is turned on. If this situation occurs in excess of 60 seconds, the cylinders must be purged as follows:

1. With the auxiliary fuel pump OFF, allow the induction manifold to drain at least five minutes or until fuel ceases to flow from the drains on the bottom of the engine.
2. If natural draining has occurred, ensure that the auxiliary fuel pump is OFF, the magnetos or ignition switch is OFF, the mixture is in IDLE CUT-OFF, and the throttle is FULL OPEN, then turn the engine with the starter .
3. If natural draining has not occurred, perform maintenance as required.

A mandatory service bulletin (MEB88-3) was issued to replace the automatic fuel pressure sensing and the cockpit auxiliary fuel pump switches for each engine with three-position lever lock type toggle switches. These modifications provide direct pilot activation of the auxiliary fuel pumps.

On low wing multi-engine airplanes (except model 310, 310A, and 310B, which are not affected by this change), the switches are labeled AUX PUMP, L (left engine) and R (right engine) and switch positions are labeled LOW, OFF, and HIGH. The LOW position operates the auxiliary fuel pumps at low pressure and can be used, when required, to provide supplementary fuel pressure for all normal operations. The switches are OFF in the middle position. The HIGH position is reserved for emergency operation, and operates the pumps at high pressure. The switches are locked out of the HIGH position and the switch toggle must be pulled to clear the lock before it can be moved to the HIGH setting. The toggle need not be pulled to return the switch to OFF.

The LOW position of the auxiliary fuel pump switches should be used whenever an original manual/handbook or checklist procedure specifies either LOW (PRIME, in 310C, 310D, 310F, 310G, 310H, 320, and 320A.) or ON. The LOW position is also used anytime there are indications of vapor, as evidenced by fluctuating fuel flow. Auxiliary fuel pumps, if needed, are to be operated on LOW in all conditions except when an engine driven fuel pump fails.

The HIGH position supplies sufficient fuel flow to sustain partial engine power and should be used solely to sustain the operation of an engine in the event its engine driven fuel pump fails. Failure of an engine driven fuel pump will be evidenced by a sudden reduction in the fuel flow indication immediately prior to a loss of power while operating from a fuel tank containing adequate fuel. In an emergency, where loss of an engine driven fuel pump is involved, pull the applicable auxiliary fuel pump switch to clear the lock and select the HIGH position. Then adjust the throttle and mixture controls to obtain satisfactory operation. At high manifold pressure and RPM, auxiliary fuel pump output may not be sufficient for normal engine operation. In this case, reduce manifold pressure to a level compatible with the indicated fuel flow. At low power settings, the mixture may have to be leaned for smooth engine operation. If HIGH auxiliary pump output does not restore adequate fuel flow, a fuel leak may exist. The auxiliary pump should be shut off and the engine secured.

If the auxiliary fuel pump switches are placed in the HIGH position with the engine-driven fuel pump(s) operating normally, total loss of engine power may occur due to flooding.

When performing single engine operations, the auxiliary fuel pump of the engine to be shutdown should be turned OFF prior to any intentional engine shutdown, to preclude fuel accumulation in the engine intake system.

In models 310, 310A, and 310B, which are equipped with pressure type carburetors, the electric fuel boost pumps in the tanks provide a positive fuel flow as emergency pumps in the event of failure of the engine driven fuel pumps. They also provide fuel pressure for priming and starting. The boost pumps are operated by two electric switches, and the up position is ON. Always take off and land with these pumps turned ON. Anytime the boost pumps are turned on without the engines running, mixture controls must be in the idle cut-off position to prevent flooding the intake manifolds.

CENTERLINE THRUST TWINS (FUEL PUMP OPERATION)

The auxiliary fuel pumps on the centerline thrust models (336 and 337 Skymaster) are controlled by two split rocker type switches. The switches are labeled AUX PUMPS and F ENGINE R. One side of each switch is red and is labeled HI. The other side is yellow and is labeled LO. The LO side operates the pumps at low speed, and if desired, can be used for starting or vapor suppression. The HI side operates the pumps at high speed, supplying sufficient fuel flow to maintain adequate power in the event of an engine driven fuel pump failure. In addition, the HI side may be used for normal engine starts, vapor elimination in flight, and inflight engine starts.

When the engine driven fuel pump is functioning and the auxiliary fuel pump is placed in the HI position, a fuel/air ratio considerably richer than best power is produced unless the mixture is leaned. Therefore, these switches must be turned OFF during takeoff or landing, and during all other normal flight conditions. With the engine stopped and the battery switch ON, the cylinder intake ports can become flooded if the HI or LO side of the auxiliary fuel pump switch is turned on.

In hot, high altitude conditions, or climb conditions that are conducive to fuel vapor formation, it may be necessary to utilize the auxiliary fuel pumps to attain or stabilize the fuel flow required for the type of climb being performed. Select either the HI or LO position of the switches as required, and adjust the mixtures to the desired fuel flow. If fluctuating fuel flow (greater than 5 lbs/hr) is observed, place the appropriate auxiliary fuel pump switch in the HI or LO position as required to clear the fuel system of vapor. The auxiliary fuel pump may be operated continuously in cruise, if necessary, but should be turned off prior to descent. Each time the auxiliary fuel pump switches are turned on or off, the mixtures should be readjusted.

AUXILIARY FUEL TANKS

Many twin engine Cessna airplanes incorporate auxiliary fuel tanks to increase range and endurance. These tanks are usually bladder type cells located symmetrically in the outboard wing areas and contain no internal fuel pumps. When selected, the fuel from these tanks is routed to the engine driven fuel pump.

If the auxiliary fuel tanks are to be used, the pilot must first select main tank (tip tank) fuel for at least 60 minutes of flight (with use of 40-gallon auxiliary fuel tanks) or 90 minutes of flight (with use of 63-gallon auxiliary fuel tanks). This is necessary to provide space in the main fuel tanks for vapor and fuel returned from the engine driven fuel pumps when operating on the auxiliary fuel tanks. If sufficient space is not available in the main tanks for this returned fuel, the tanks can overflow through the overboard fuel vents. Since part of the fuel from the auxiliary fuel tanks is diverted back to the main tanks instead of being consumed by the engines, the auxiliary tanks will empty sooner than may be anticipated. However, the main tank volume or quantity will be increased by the returned fuel.

The fuel supply in the auxiliary fuel tanks is intended for use during cruise flight only. The shape of the auxiliary fuel tanks is such that during certain flight maneuvers, the fuel will move away from the fuel tank outlet. If the outlet is uncovered while feeding the engine, fuel flow to the engine will be interrupted and a temporary loss of power may result. Because of this, operation from the auxiliary fuel tanks is not recommended below 1000 feet AGL.

An optional auxiliary fuel tank may be installed on some centerline thrust twins (336 and 337 Skymaster). The system consists of two tanks, each containing 18 gallons (108 pounds) usable, one located in each inboard wing panel. The tanks feed directly to the fuel selector valves. The left auxiliary tank provides fuel to the front engine only and the right auxiliary tank provides fuel to the rear engine only. Fuel quantity for the auxiliary tanks is read on the same fuel quantity indicators used for the main fuel tanks. This is accomplished when the fuel selector valve handles are turned to the AUXILIARY position. As each selector valve handle is turned to this position, it depresses a gaging button, labeled PUSH TO GAGE, located in the AUXILIARY quadrant of the fuel selector valve placard. The depressed button actuates a microswitch and electrically senses auxiliary fuel rather than main fuel quantity. Auxiliary fuel quantity can be checked without changing the selector valve handle, by depressing the PUSH TO GAGE button manually. Depressing the gaging button, either manually or by rotating the selector valve handle to the AUXILIARY position, will illuminate the amber AUX FUEL ON indicator lights mounted above the engine instrument cluster. When fuel is being used from the auxiliary fuel tanks, any excess fuel and vapor from the engine driven pumps is returned to fuel line manifolds. The returned vapor passes through the fuel line manifolds to the vent lines and is routed overboard. The excess fuel passes into the fuel line manifold and is returned to the engine driven pumps.

On some early model Skymasters, fuel vapor from the engine driven fuel pumps is returned to the main fuel tanks. When the selector valve handles are in the AUXILIARY position, the left auxiliary tank feeds only the front engine and the right auxiliary tank feeds only the rear engine. If the auxiliary tanks are to be used, select fuel from the main tanks for 60 minutes prior to switching to auxiliary tanks. This is necessary to provide space in the main tanks for vapor and fuel returned from the engine driven fuel pumps when operating on auxiliary tanks. On some models, auxiliary fuel boost pumps are not provided for the auxiliary fuel tank. Therefore it is recommended to use the auxiliary fuel tanks only in straight and level flight. When unsure of the type of auxiliary tank installation, consult the operating handbook for the respective airplane.

A few single-engine airplanes contain an auxiliary fuel tank. The system's main components include a fuel tank installed on the baggage compartment floor and an electric fuel transfer pump. The auxiliary fuel system is plumbed into the right main fuel tank.

To use the auxiliary fuel system, select the right wing fuel tank in cruise and operate on that tank until the fuel tank has adequate room for the transfer of auxiliary fuel. After selecting the left main tank, turn on the auxiliary fuel transfer pump to refill the right main fuel tank from the auxiliary tank. Transfer will take from 45 minutes to 1 hour. Prior to transfer, ensure that adequate fuel is available in the left tank to allow time for the auxiliary tank to transfer.

Do not operate the transfer pump with the fuel selector valve turned to either the BOTH or RIGHT positions. Total or partial engine stoppage will result from air being pumped into fuel lines after fuel transfer has been completed. If this should occur the engine will restart in 3 to 5 seconds after turning off the transfer pump, as the air in the fuel line will be evacuated rapidly.

After transfer is complete and the pump has been turned off, the selector may be returned to BOTH or RIGHT. Takeoff, climb, and landing should always be conducted with the selector in the BOTH position for maximum safety.

WING LOCKER FUEL TANK USAGE

Some twins may have wing locker fuel tanks installed in the forward portion of each wing locker baggage area. These tanks are bladder type cells for storage of extra fuel to supplement the main tank fuel quantity. The fuel in these tanks cannot be fed directly to the engines. Instead, it has to be transferred to the main tanks by wing locker fuel transfer pumps. Fuel transfer should begin as soon as adequate volume is available in the main fuel tanks to hold the wing locker fuel. Waiting until the main tanks are low before transferring wing locker fuel does not allow early recognition of possible failure to transfer.

If wing locker fuel is to be used, consult the operating handbook for the quantity of main tank fuel which must first be used in the respective main tank for the transferred wing locker fuel. This will prevent overflowing of the main tank(s) when transferring the wing locker fuel.

Wing locker fuel transfer pump switches are provided to manually control the transfer of the wing locker fuel to the main tanks. These switches should be turned ON only to transfer fuel and turned OFF when indicator lights illuminate to show that fuel has been transferred. The transfer pumps use the fuel in the wing locker tank for lubrication and cooling. Therefore, transfer pump operation after fuel transfer is complete will shorten the life of the pump. Fuel should be cross fed, as required, to maintain fuel balance.

INSTRUMENT POWER

VACUUM POWER FAILURES

Many airplanes may be equipped with some type of back-up vacuum system for operation in the event the primary vacuum system becomes inoperative in flight. The backup system may be in the form of another engine-driven vacuum pump, in parallel with the primary pump, or an electric standby vacuum pump, also in parallel with the primary pump, or both. If a back-up system is not available and the attitude and directional indicators are disabled, the pilot must rely on partial instrument panel operation. This may include using the electrically-powered turn coordinator or turn and bank indicator and the magnetic compass, altimeter, airspeed indicator, and rate of climb indicator.

A suction gage, and in some airplanes a low-vacuum warning light, provides a means of monitoring the vacuum system for proper operation in flight. Operating handbooks reflect a desired suction range during normal operation of the airplane. A suction reading outside of this range may indicate a system malfunction, and in this case, the vacuum driven instruments should not be considered reliable. Whenever operation of the airplane's vacuum system is in doubt, land when practical for repairs.

In the event of a directional indicator and attitude indicator failure due to vacuum failure, the pilot must rely on partial instrument panel operation using the remaining instruments. VFR operations can generally be conducted satisfactorily without the vacuum instruments. However, instrument meteorological conditions (IMC) can be considerably more challenging. An instrument rated pilot should stay current on partial panel flying skills but both VFR and IFR pilots should maintain VFR conditions if a vacuum failure occurs while clear of clouds. All pilots should become familiar with the following procedure for executing a 180° turn in clouds with the aid of either the turn coordinator or the turn and bank indicator.

Upon inadvertently entering clouds, maintain control of the aircraft. If it is desired to turn back out of the clouds, the following action should be employed:

1. Note the compass heading.
2. Note the time in both minutes and seconds.
3. When the seconds indicate the nearest half minute, initiate a standard rate left turn, holding the turn coordinator or turn and bank indicator (if installed) symbolic airplane wing opposite the lower left index mark for 60 seconds. Then roll back to level flight by leveling the miniature airplane.
4. Check accuracy of turn by observing the compass heading which should be the reciprocal of the original heading.

5. If necessary, adjust heading primarily with skidding motions rather than rolling motions so that the compass will read more accurately.
6. Maintain altitude and airspeed by cautious application of elevator control. Avoid over controlling by keeping the hands off the control wheel as much as possible and steering only with the rudder.

If conditions dictate, a descent through a cloud deck to VFR conditions may be appropriate. To guard against a spiral dive, choose an easterly or westerly heading to minimize compass card swings due to changing bank angles. In addition, keep hands off the control wheel and steer a straight course with rudder control by monitoring the turn coordinator. Occasionally check the compass heading and make minor corrections to hold an approximate course. Before descending into the clouds, set up a stabilized let-down conditions as follows:

1. Extend landing gear (if applicable).
2. Enrichen the fuel mixture.
3. Use full carburetor heat (if applicable).
4. Reduce power to set up a 500 to 800 ft/min rate of descent.
5. Adjust the elevator trim and rudder trim (if installed) for a stabilized descent at 5 to 20 knots above the best glide speed for the airplane.
6. Keep hands off the control wheel.
7. Monitor turn coordinator and make corrections by rudder alone.
8. Check trend of compass card movement and make cautious corrections with rudder to stop the turn.
9. Upon breaking out of clouds, resume normal cruise flight.

ELECTRICAL POWER FAILURES

Many operating handbooks have emergency procedures for partial or total loss of electrical power in flight. These procedures should be reviewed periodically to remain knowledgeable of what to do in the event of an electrical problem. The pilot should maintain control of the airplane and land when practical if an electrical power loss is evident.

Early detection of an electrical power supply system malfunction can be accomplished by periodically monitoring the ammeter and, if equipped, low-voltage warning light. The cause of these malfunctions is difficult to determine in flight. Common causes of alternator or generator failure are a broken drive belt, alternator or generator drive, a defective alternator control unit or voltage regulator or wiring. Problems of this nature constitute an electrical emergency and should be addressed immediately.

If alternator power cannot be restored, and a second or back up alternator is not available, the pilot must rely on the limited power of the battery only. Every effort should be made to conserve electrical power for use with the most essential equipment, such as communication and navigation radios, by turning off or not using any non-essential equipment. Electric or electro-hydraulic landing gear systems should be extended manually and flaps (if electrically operated) should remain retracted during approach and landing to conserve battery power, especially in instrument conditions.

If an electrical power loss is experienced, continued flight is possible but should be terminated as soon as practical. Such things as fuel quantity and engine temperature indicators and panel lights may no longer work. Hand-held nav/comm radios and other such products are widely available and marketed for just such a scenario; otherwise navigation by pilotage and appropriate loss of communication procedures for the airspace involved should be conducted. The pilot should always have a flashlight available for night flights.

LOSS OF PITOT/STATIC SOURCES

A thorough preflight inspection should reveal any blockage of the pitot tube, drain hole, or static port on the ground to allow corrective action to be taken prior to flight. Pilots should understand the various conditions and remedies associated with a loss of pitot-static sources.

Pitot heat should be used whenever flying in visible moisture and the temperature is near freezing. If airspeed is suspected to be in error while flying in possible icing conditions with the pitot heat on, the pitot heat switch should be cycled and the circuit breaker should be checked. If proper operation cannot be restored, the airspeed indicator must be considered unreliable.

If the pitot tube ram air inlet becomes blocked, the airspeed will drop to zero. If this blockage cannot be removed in flight, the pilot must rely on pitch attitude and power settings to maintain a safe airspeed. A slightly higher than normal power setting should be used to maintain a reasonable margin of extra airspeed on final.

When flying in clear ice conditions and pitot heat is unavailable, both the ram air inlet and the pitot drain hole could become blocked. This will cause the airspeed indicator to react like an altimeter, indicating a higher airspeed at higher altitudes and a lower airspeed at lower altitudes. The airspeed indicator must be ignored. A higher power setting appropriate to the overall icing problem should be used during the landing phase.

Many light single engine airplanes equipped with pitot heat may not be equipped with static source heat. If the static source becomes blocked, the airspeed indicator will still function, but will give erroneous indications. If the airplane climbs after the blockage occurs, the airspeed indicator will indicate lower than normal. If the airplane descends after the blockage occurs, the airspeed will indicate higher than actual. During the landing phase, this condition could deceive the pilot into thinking the airspeed is too high. The altimeter and vertical speed indicator will also be affected by a static source blockage. The altimeter will not indicate a change of altitude and the vertical speed indicator will indicate zero airspeed. Neither instrument will reflect any altitude changes.

Many airplanes are equipped with an alternate static air source vented within the cabin area. If static port blockage is suspected, the alternate static source should be selected. The cabin pressure will be slightly lower than ambient air, but will provide a reasonable level of accuracy to the pitot static system. With slightly less dense air in the cabin, the airspeed indicator and altimeter will both show slightly higher than normal indications.

If the airplane is not equipped with an alternate static source, and pitot/static instruments are essential for continued flight, the glass on the vertical speed indicator may be broken to provide cabin air to the static system lines. The vertical speed indicator will no longer be reliable, but the airspeed indicator and altimeter will be functional again, with slightly higher than normal indications.

GYRO SPIN UP AND SPIN DOWN

Gyro instruments, such as attitude and directional indicators, contain a high-speed rotor assembly driven by either electric or vacuum power. These instruments normally operate at very high RPM and can take up to 10 minutes or more to spin down after power is removed. Although some gyro instruments have a "quick erect" mechanism to permit manual erection of the rotor, which effectively minimizes time required before use, some gyro instruments still require up to 5 minutes or more to spin up and stabilize after power is applied. During this spin up or spin down time, the gyro instruments should not be considered reliable. A failed gyro can be detected by first checking the suction gage and, if available, low-voltage or low-vacuum lights as applicable and, second, checking for slow or erratic indications of the gyro instruments by cross-referencing with other flight instruments for contradictory indications.

FAILED GYRO EFFECT ON AUTOPILOT

Some autopilot systems receive roll and/or yaw rate inputs from the electrically-driven turn coordinator or turn and bank indicator. Other autopilot systems depend on vacuum-driven attitude and directional indicators for horizontal and azimuth reference. If a failure should occur in any of these instruments, the autopilot should be turned off. Random signals generated by a malfunctioning gyro could cause the autopilot to position the airplane in an unusual attitude. Use of the autopilot after a gyro failure may result in an out of trim condition. Be prepared to correct for this when turning off the autopilot.

ALTERNATE AIR SYSTEM

An alternate source of air is provided to ensure satisfactory engine operation in the event the normal induction air filter or air inlet becomes obstructed. Although alternate air controls vary from one airplane to another, the types are: carburetor heat, direct manual control, automatic control, or a combination of automatic and manual controls. In most cases, the alternate air is extracted from inside the engine cowling and is, therefore, unfiltered and hotter than normal induction air. A loss of power will be caused by the hotter air. The richer mixture may require adjustment of the mixture control. Consult the applicable airplane operating handbook for details concerning the use of the alternate air system.

CARBURETOR HEAT AND INDUCTION ICING

Carburetor heat and manually operated alternate air valve(s) are controlled by the pilot. The carburetor heat system uses unfiltered air from inside the engine cowling. This air is drawn into a shroud around an exhaust riser or muffler and then ducted to the carburetor heat valve in the induction air manifold. The carburetor heat valve is controlled by the pilot and should be used during suspected or known carburetor icing conditions. Carburetor heat may also be used as an alternate air source should the induction air inlet or induction air filter become blocked for any reason.

The use of full carburetor heat at full throttle usually results in a 1 to 2 inch loss of manifold pressure or a loss of approximately 150 RPM, depending upon the airplane model. Application or removal of carburetor heat at higher power settings may require adjustment of the fuel mixture. It may be impractical to lean the mixture under low engine power conditions.

When a go-around or balked landing is initiated after use of carburetor heat during the landing approach, the pilot should usually advance the throttle first, then move the carburetor heat to off or cold. The throttle application must be smooth and positive. Rapid throttle advancement in some icing conditions could result in the engine failing to respond and the loss of power could become critical because of the low altitude and low airspeed.

When the relative humidity is more than 50 percent and the ambient air temperature is between 20°F to 90°F, it is possible for ice to form inside the carburetor, since the temperature of the air passing through the venturi may drop as much as 60°F below the ambient air temperature. If not corrected, ice accumulation may cause complete engine stoppage.

A drop in engine RPM on fixed pitch propeller airplanes and a drop in engine manifold pressure on constant speed propeller airplanes are indications of carburetor ice. If the airplane is equipped with a carburetor air temperature gage, the possibility of carburetor ice may be anticipated and prevented by maintaining the recommended amount of heat during cruise and letdown. Without the indications of a carburetor air temperature gage for reference, a pilot should use only the full heat or full cold position. An unknown amount of partial heat can cause carburetor ice. This can occur when ice that would ordinarily pass through the induction system is melted by partial carburetor heat and the water droplets then refreeze upon contact with the cold metal of the throttle plate. A carburetor air temperature gage may allow partial carburetor heat use, resulting in less power loss.

ALTERNATE AIR FOR FUEL INJECTED ENGINE ICING

Either an automatic alternate air system, a manually controlled alternate air system, or a combination automatic and manual system are incorporated on most fuel injected engines to address the potential of a blocked air induction system.

On engines equipped with automatic alternate air, ram air from the engine cowling inlet enters an air filter, which removes dust and other foreign matter that would be harmful to the engine. If the air inlet or the induction air filter should become blocked, suction created by the engine will open an alternate air door, allowing air to be admitted from either inside or outside the cowling, depending upon the airplane model. This air bypasses the filter and will result in a slight decrease in full throttle manifold pressure on non-turbocharged engines, and a notable decrease in manifold pressure from the selected cruise power setting on turbocharged engines. This manifold pressure may be recoverable, up to a particular altitude, with throttle and/or RPM adjustment. The alternate air doors should be kept closed on the ground to prevent engine damage caused by ingesting debris through the unfiltered air ducts. For details concerning a specific model, consult the airplane operating handbook.

Most twin engine airplanes have a manually controlled alternate air door in each engine induction air system. If a decrease in manifold pressure is experienced when flying in icing conditions, the alternate air doors should be manually opened. On most twins, this manual control has two positions. When fully in, normal filtered ram air is provided; when fully out, warm unfiltered air from inside the cowling is provided. Other twins have alternate air controls with an additional intermediate or center detent to provide cool, unfiltered ram air to the induction system in the event the induction air filter is blocked by matter other than ice.

Since the higher intake air temperature of the alternate air results in a decrease in engine power and turbocharger capability, it is recommended that the alternate induction air not be utilized until indications of induction air blockage (decreased manifold pressure) are actually observed.

If additional power is required, the pilot should increase RPM as required, move the throttles forward to maintain desired manifold pressure and readjust the fuel mixture controls as required. These recommendations do not replace the procedure in the airplane operating handbook.

Although most pilots are aware of the potential of carburetor to icing, many may think that a fuel injected engine is not subject to induction icing. Although a fuel injected engine will not form carburetor ice, other parts of the induction system such as bends in the system or the air filter can gather ice. Slush and/or snow can block the induction air filter. Induction air blockage can cause loss of manifold pressure or engine stoppage.

CARBON MONOXIDE

Carbon monoxide is a colorless, odorless, tasteless product of an internal combustion engine and is always present in exhaust fumes. Even minute quantities of carbon monoxide breathed over a long period of time may lead to dire consequences. Carbon monoxide has a greater ability to combine with the blood than oxygen. Once carbon monoxide is absorbed in the blood, it prevents the oxygen from being absorbed.

The symptoms of carbon monoxide poisoning are difficult to detect by the person afflicted and may include blurred thinking, a feeling of uneasiness, dizziness, headache, and loss of consciousness. If any of these symptoms occur, immediately open all cabin vents and turn the cabin heater off. Land as soon as possible at the nearest airport and seek medical attention if needed.

HEATER OPERATION

Many cabin heaters in general aviation airplanes operate by allowing ambient air to flow through an exhaust shroud where it is heated before being ducted into the cabin. Therefore, if anyone in the cabin smells exhaust fumes when using the cabin heater, immediately turn off the cabin heater and open all cabin vents. Land as soon as possible at the nearest airport and seek medical attention if needed.

WINDOW VENTILATION

If carbon monoxide is suspected in the cabin at any time, it is imperative that immediate ventilation be initiated, including the opening of cabin windows. Observe the maximum speed for window opening in flight. Opening a cabin window is probably the best means of ventilating the cabin while on the ground. However, care should be taken when parked with engine(s) operating or when in the vicinity of other airplanes that have their engines running. The exhaust gases from your airplane or the other airplane could enter the cabin through the open window. Also, engine exhaust could be forced into the cabin area during taxi operations or when taxiing downwind.

PRESSURIZED AIRPLANES

Refer to the operating handbook and/or approved flight manual for appropriate ventilation procedures.

TURBOCHARGER

When operating turbocharged engines, any power increases should be accomplished by increasing the propeller RPM first, then increasing the manifold pressure. Power reductions should be accomplished by reducing the manifold pressure first, then the RPM.

During cold weather operation, care should be exercised to insure that overboost does not occur during takeoff as a result of congealed oil in the waste gate actuating system. Before takeoff engine checks should not be accomplished until oil temperature is at least 75°F (minimum approved operating limit). Takeoff should not be started until oil temperature is above 100°F and oil pressure below 100 psi to assure proper oil flow to the turbocharger and its actuating system. Monitor manifold pressure during takeoff so as not to exceed specified takeoff limits. Advance the throttle slowly, pausing momentarily at approximately 30" MP to permit turbine speed to stabilize, then gradually open the throttle to obtain takeoff manifold pressure.

Prior to engine shut down, operate the engine at idle RPM for approximately 5 minutes to allow the turbocharger to cool and slow down. This reduces the possibility of turbine bearing coking caused by oil breakdown. This 5 minutes may be calculated from landing touchdown.

During pilot training, simulated engine out operation requiring the engine be shut down by closing the mixture should be held to an absolute minimum.

TURBOCHARGER FAILURE

The turbocharger system's purpose is to elevate manifold pressure and thus engine power to a level higher than can be obtained without it. A failure of the system will cause either an overboost condition or some degree of power loss. An overboost can be determined on the manifold pressure instrument and can be controlled by a throttle reduction.

If turbocharger failure results in power loss, it may be further complicated by an overly rich mixture. This rich mixture condition may be so severe as to cause a total power failure. Leaning the mixture may restore partial power. Partial or total power loss may also be caused by an exhaust system leak. A landing should be made as soon as practical for either an overboost or partial/total power loss.

IN-FLIGHT FIRES

FIRES IN FLIGHT

A preflight checklist is provided to aid the pilot in detecting conditions which could contribute to an airplane fire. Flight should not be attempted with known fuel, oil, or exhaust leaks, since they can lead to a fire. The presence of fuel or unusual oil or exhaust stains may be an indication of system leaks and should be corrected prior to flight.

Fires in flight must be controlled as quickly as possible by identifying and shutting down the affected system(s), then extinguishing the fire. Until this process is complete, the pilot should assume the worst and initiate action for an immediate landing. A pilot must not become distracted by the fire to the point that control of the airplane is lost. The pilot must be able to complete a deductive analysis of the situation to determine the source of the fire. Complete familiarity with the airplane and its systems will prove invaluable should a fire occur.

ENGINE COMPARTMENT FIRES

An engine compartment fire is usually caused by fuel contacting a hot surface, an electrical short, bleed air leak, or exhaust leak. If an engine compartment fire occurs on a single engine airplane, the first step should be to shut off the fuel supply to the engine by placing the mixture to idle cut off and the fuel selector/shutoff valve to the OFF position. The ignition switch should be left ON in order for the engine to use up the fuel which remains in the fuel lines and components between the fuel selector/shutoff valve and the engine. The airplane should be put into a sideslip, which will tend to keep the flames away from the occupants and the fuel tanks. If this procedure is ineffective, the pilot must make the most rapid emergency descent possible and an immediate landing.

In multi-engine airplanes, **both** auxiliary fuel pumps should be turned off to reduce pressure in the total fuel system (each auxiliary fuel pump pressurizes a crossfeed line to the opposite fuel selector). If equipped, the emergency crossfeed shutoff should also be activated. The engine on the wing in which the fire exists should be shut down and its fuel selector positioned to OFF even though the fire may not have originated in the fuel system. The cabin heater draws fuel from the crossfeed system on some airplanes, and should be turned off as well. The engine compartment fire extinguisher should be discharged if the airplane is so equipped.

An open foul weather window or emergency exit may produce a low pressure in the cabin. To avoid drawing the fire into the cabin area, the foul weather window, emergency exits, or any openable windows should be kept closed. This condition is aggravated on some models, with the landing gear and wing flaps extended. Therefore, it is recommended to lower the landing gear as late in the landing approach as possible. A no flap landing should also be attempted, if practical.

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 effected circuit by checking circuit breakers, instruments, avionics, etc. If the affected circuit cannot be readily detected and flight conditions permit, the battery/master switch and alternator switch(es) should be turned OFF to remove the possible sources of the fire. If at night, ensure the availability of a flashlight before turning off electrical power. Then, close off ventilating air as much as practical to reduce the chances of a sustained fire. If an oxygen system is available in the airplane and no visible signs of flame are evident, occupants should use oxygen until smoke clears.

If electrical power is essential for the flight, an attempt may be made to identify and isolate the effected circuit by turning the Master Switch and other electrical (except magneto) switches off and checking the condition of the circuit breakers to identify the affected circuit. If the circuit can be readily identified, leave it deactivated and restore power to the other circuits. If the circuit cannot be readily identified, turn the Master Switch on, and select switches that were on before the fire indication, one at a time, permitting some time to elapse after each switch is turned on, until the short circuit is identified. Make sure the fire is completely extinguished before opening vents. Land as soon as possible for repairs.

CABIN FIRES

Fire or smoke in the cabin should be controlled by identifying and shutting down the affected system, which is most likely to be electrical in nature, and landing as soon as possible. Smoke may be removed by opening the cabin air controls. However, if the smoke increases in intensity when the air controls are opened, they should be closed as this indicates a possible fire in the heating system, nose compartment baggage area, or that the increase in airflow is aggravating this condition.

In 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 to 10,000 feet, terrain permitting. "Ram Air Dump" handle may be pulled to aid the clearing of smoke from the cabin.

The pilot may choose to expel the smoke through the foul weather window(s). The foul weather window(s) should be closed immediately if the fire becomes more intense when the window(s) are opened. If smoke is severe, and there are no visible signs of flame, use oxygen masks (if installed) and begin an immediate descent.

If a fire extinguisher is used, ventilate the cabin promptly after extinguishing the fire to reduce the gases produced by thermal decomposition. If the fire cannot be extinguished immediately, land as soon as possible.

IN-FLIGHT OPENING OF DOORS

The occurrence of an inadvertent door opening is not as great of a concern to the safety of the flight, as the pilot's reaction to the opening. If the pilot is overly distracted, loss of airplane control may result even though disruption of airflow by the door is minimal. While the shock of a sudden loud noise and increase in sustained noise level may be surprising, mental preparation for this event and a plan of action can eliminate inappropriate pilot reaction.

INADVERTENT OPENING OF BAGGAGE/CARGO DOORS

The flight characteristics of an airplane will not normally be affected by an open baggage or cargo door. The aerodynamic effects on an open door can vary, depending on the location of the door on the airplane and the method used to hinge the door in relation to the slipstream. Baggage/cargo doors mounted on the side of the aft fuselage and hinged at the front will tend to stay in a nearly closed position at most airspeeds and pose no special problems as long as the airplane is not in uncoordinated flight in a direction which would permit unsecured baggage to fall out of the airplane. Because of the door location and the presence of baggage in the immediate area, the door may not be accessible for closing in flight. Passengers, especially children, should never be allowed to occupy the baggage portion of the cabin for the purpose of closing the door in flight. The pilot should slow the airplane to minimize buffeting of the door and land as soon as practical.

Top hinged baggage/cargo doors will react differently than front hinged doors if improperly latched before takeoff. Doors of this type, may pop open at rotation because of the increase in angle of attack and the slipstream pushing underneath the edge of the unsecured door. After the initial opening, a baggage door will generally tend to stay open and then may gently close as speed is reduced and the aircraft is configured for landing (the doors will probably tend to open again during flair). A top hinged door on the side of the aft fuselage of a high wing airplane can sometimes be moved to a nearly closed position by lowering the wing flaps full down (within approved airspeed limitations) so that wing downwash will act upon the door. Unlatched nose baggage doors and large cargo doors on the side of the aft fuselage cannot be closed in flight and a landing should be made as soon as practical. The pilot should avoid any abrupt airplane maneuvers in multi-engine airplanes with an open nose baggage door, as this could throw loose objects out of the baggage compartment and into the propeller.

Front hinged wing locker doors in the aft part of the engine nacelle of multi-engine airplanes will likely trail open a few inches if they become unlatched. Near stall speed just prior to landing, an unlatched door may momentarily float to a full open position.

If a door comes open on takeoff and sufficient runway remains for a safe abort, the airplane should be stopped. If the decision is made to continue the takeoff, maintain required airspeed and return for landing as soon as practical.

INADVERTENT OPENING OF CABIN/EMERGENCY EXIT DOORS (UNPRESSURIZED)

If a cabin or emergency exit door should inadvertently open during unpressurized flight, the primary concern should be directed toward maintaining control of the airplane. Then, if a determination is made to close the door in flight, establish a safe altitude, trim the airplane at a reduced airspeed, and attempt to close the door. To facilitate closing the door, slide the adjacent seat aft slightly to obtain a better grasp of the door handle. The door handle must be in the close position prior to pulling the door closed, followed by rotating the handle to the locked position. Under no circumstances should the pilot leave his/her seat, or unfasten the restraint system to secure a door.

If a cabin door reopens when latched closed, the flight should be terminated as soon as practical and repairs made.

INADVERTENT OPENING OF CABIN/EMERGENCY EXIT DOORS (PRESSURIZED)

An inadvertent opening of a cabin/emergency exit door while the cabin is pressurized and the aircraft is above 12,500 feet, will require the use of supplemental oxygen or an emergency descent to an altitude below 12,500 feet. The pilot may attempt to close the door after ensuring that all occupants are using supplemental oxygen or the cabin altitude is below 10,000 feet. However, the primary concern should be maintaining control of the airplane. The flight should be terminated as soon as practical and the cause of the door opening determined before pressurized flight is continued. Under no circumstances should the pilot leave his/her seat, or unfasten the restraint system to secure a door.

MAINTENANCE

Airplanes require inspection and maintenance on a regular basis as outlined in the operating handbook, service/maintenance manuals, other servicing publications, and in Federal Aviation Regulations. A good visual inspection is a continuing maintenance procedure and should be performed by anyone who is involved with an airplane. This includes pilots, line personnel, and the maintenance department. When worn or damaged parts are discovered, it is essential that the defective parts be repaired or replaced to assure all systems remain operational. The source of information for proper maintenance is the airplane Service/Maintenance Manual and Service Letters or Service Bulletins. Cessna's Service/Maintenance Manuals are occasionally revised. Maintenance personnel should follow the recommendations in the latest revision. The owner/operator must ensure that all unacceptable conditions are corrected and the airplane receives repetitive and required inspections.

UNAUTHORIZED REPAIRS/MODIFICATIONS

All repair facilities and personnel should follow established repair procedures. Cessna does not support modifications to Cessna airplanes, whether by Supplemental Type Certificate or otherwise, unless those modifications are approved by Cessna. Such modifications may void any and all warranties on the airplane, since Cessna may not know the full effects on the overall airplane. Cessna has not tested and approved all such modifications by other companies. Operating procedures and performance data specified in the operating handbook and maintenance procedures specified in the service/Maintenance Manual may no longer be accurate for the modified airplane. Operating procedures, maintenance procedures and performance data that are effected by modifications not approved by Cessna should be obtained from the STC owner.

AIRWORTHINESS OF OLDER AIRPLANES

For an airplane to remain airworthy and safe to operate, it should be operated in accordance with Cessna recommendations and cared for with sound inspection and maintenance practices.

An aging airplane needs more care and attention during maintenance processes and may require more frequent inspection of structural components for damage due to the effects of wear, deterioration, fatigue, environmental exposure, and accidental damage. Typical areas requiring more frequent inspection are:

1. Wing attach points and fuselage carry-through structure.
2. Wing spar capstrips, especially the lower ones.
3. Horizontal and vertical stabilizer attach points and spar structure.
4. Control surface structure and attach points.
5. Engine mounts, beams, and cowlings.
6. Landing gear structure and attach points.
7. Structural and flooring integrity of seat and equipment attachments.
8. Pressurized structures, especially around all doors, windows, windshields and other cutouts on pressurized airplanes.
9. Exhaust and cabin heater systems.

The final responsibility for airplane care rests with the owner/operator. All airplane owners/operators should use the following steps as a minimum guideline to ensure continued airworthiness of their airplanes:

1. Always follow recommended maintenance and inspection procedures.
2. Recognize that corrosion, overloading, or damage to structure can drastically shorten fatigue life.
3. Comply with all applicable Service Bulletins, Service Letters, and FAA Airworthiness Directives.
4. Use one of Cessna's Progressive Care Inspection and maintenance programs to get the maximum utilization of your airplane at a minimum cost and downtime.

CORROSION

Corrosion can cause structural failure if left unchecked. The appearance of the corrosion varies with the metal. On aluminum and magnesium, it appears as surface pitting and etching, often combined with a grey or white powdery deposit. On copper and copper alloys the corrosion forms a greenish oxide and on steel, a reddish rust. When grey, white, green or red deposits are removed, each of the surfaces may appear etched and pitted, depending upon the length of exposure and severity of the attack. If the damage is not too deep, it may not significantly alter the strength of the metal. However, the pits may become sites for crack development. Some types of corrosion can travel beneath surface coatings and spread until the part fails.

Remove corrosion as soon as possible because it attacks and holds moisture in contact with the metal, which causes more corrosion to form. Every visible trace must be removed by some mechanical or chemical means. The surface must then be chemically treated to form a film which prevents oxygen or moisture from contacting the surface. Then, the protective surface (paint) must be restored.

There are several different types of corrosion and different ways of detecting it in its early stages. Uniform surface corrosion is the most common type of corrosion. When an area of unprotected metal is exposed to the atmosphere, there will be a uniform attack over the entire unprotected area. On a polished surface, this type of corrosion is first seen as a general dulling of the surface. If the corrosion is allowed to continue, the surface becomes rough and possibly frosted in appearance.

If surface corrosion is allowed to go untreated, it can progress into the next type of corrosion, called pitting. Pits form in localized areas and appear as white or grey powdery deposits. Metal is converted to salts, and when deposits are cleaned away, tiny pits or holes can be seen on the surface. If allowed to continue, pitting can progress completely through the metal in extreme cases.

Stress corrosion cracking is caused by the simultaneous effects of tensile stress and corrosion. Stress may be either internal or applied. Residual stress from the processes of heat treatment and forming, or sustained operating or static loads, can lead to stress corrosion.

Fretting corrosion is corrosion damage between close fitting parts which are allowed to rub together. It is the corrosive attack on one or both metals because of chafing under a load. The results of fretting are removal or pitting of the metal in the area of contact, galling, seizing, cracking or fatigue of the metal, loss of tolerance in accurately fitted parts, and loosening of bolted or clamped surfaces.

Corrosion is a universal problem that costs considerable amounts of time and money. It is essential that each airplane owner maintain his or her airplane based on the operating conditions, environment, and service experience. Corrosion can be effectively prevented and/or controlled if appropriate action is taken early.

SEAT AND RESTRAINT SYSTEMS

ADJUSTABLE SEAT ASSEMBLIES

Most Cessna manually-adjustable seats are suspended on two parallel, cabin floor mounted seat tracks by roller assemblies which allow the seat to move forward and rearward along the tracks. A series of holes are provided, usually in the forward end of either or both seat tracks, to accommodate a mechanical locking pin(s) which allows intermediate positioning and locking of the seat. To prevent the seat from disengaging from the seat tracks when reaching the ends, a mechanical seat stop is installed near both ends of the track(s).

Incidents of manually-adjustable seats slipping rearward or forward during acceleration or deceleration of the airplane have been reported. The investigations following these incidents have revealed discrepancies such as gouged lockpin holes, bent lockpins, excessive clearance between seat rollers and tracks, and missing seat stops, to name a few. Also, dust, dirt, and debris accumulations on seat tracks and in the intermediate adjustment holes have been found to contribute to the problem. A close check of each seat during daily preflight, improved cabin cleanliness, and replacement of parts when necessary will help prevent accidents involving seats. Visual checks of the airplane should always include the cabin interior.

When inspections are made, examination of the following items is recommended:

1. Check the seat assembly for structural integrity.
2. Inspect the roller assemblies for separation and wear.
3. Check the locking mechanism (actuating arm, linkage, locking pin or pins) for wear.
4. Check all seat track stops for security and proper installation.
5. Inspect seat tracks for condition and security, and the locking pin holes for wear, and dirt or debris accumulation.
6. Determine that the floor structure in the vicinity of the seat tracks is not cracked or distorted.
7. Ensure that the secondary seat stop addressed in mandatory Service Bulletin SEB89-32 is installed.

Damaged or worn parts are a potential hazard which should be immediately repaired or replaced. Cessna recommends repair and/or replacement of damaged components in accordance with the airplane's service or maintenance publications and Service Bulletins.

RESTRAINT SYSTEMS

While performing the cabin portion of the daily preflight, it is recommended that pilots check each restraint system installed in the airplane. This should include a functional check of the restraint belt locking and releasing mechanism. If new passengers or students are to be carried, it is a good practice to insist that they operate the restraint system to become familiar with the procedures.

During inspections, maintenance personnel should check each restraint system installation for serviceability in accordance with current publications applicable to the airplane. Special attention should be given to restraint attachment points and to the nylon bushing on the belt at the point where the shoulder restraint harness attaches. Undetected cracks or broken connections could cause a serious situation to develop when it is least expected. The restraint system webbing should be inspected for degradation. Repair or replace the restraint system per Cessna instructions if damage is detected.

EXHAUST AND FUEL SYSTEMS

THE ENGINE EXHAUST SYSTEM

The primary function of an engine exhaust system is to route exhaust gases safely overboard. Other functions of the exhaust system may include use as the driving source for a turbocharger turbine and/or use as a heat source for carburetor and/or cabin heat requirements.

Heat and carbon monoxide are the unavoidable byproducts of all reciprocating engine operations. The temperatures within the exhaust system of an engine can exceed 1750°F. Consequently, if an exhaust leak should occur, heat damage can occur to the engine mounting structure, and accessories such as hoses, belts, wire bundles, etc. In some cases, the position of the leak could lead to engine stoppage and/or an engine compartment fire.

An exhaust system leak can also lead to carbon monoxide poisoning. This colorless, odorless, tasteless combustion byproduct is always present in exhaust fumes. For this reason, special seals are provided wherever cables, hoses, wire bundles, etc. pass through the engine firewall. For even greater protection from carbon monoxide, special window, door, and fuselage seals are installed. No leakage of exhaust into the cabin should be tolerated.

Exhaust systems should be checked for stains indicative of exhaust leaks at cylinder heads or cracks in the exhaust or tailpipe. The condition and security of the exhaust system in the area of the exhaust muffler shroud should be checked. Any cracks or leaks in this area could be a source for exhaust to enter the cabin.

ENGINE COMPARTMENT TEMPERATURES

High engine compartment temperatures can degrade the operational efficiency of the engine and also accelerate the deterioration of engine components. Several conditions could cause or contribute to a higher than normal engine compartment temperature; however, improper operating techniques are found to be the most common cause. Avoid excessive operation of an engine on the ground. Prolonged ground operations should be done into the wind at rich mixture settings. If the cowling has been removed for maintenance, cooling airflow is poor and cylinder head temperature and oil temperature gages must be monitored during engine runups.

On virtually all air-cooled reciprocating engines, the engine and engine compartment are cooled by utilizing a pressure cooling baffle system with airflow as the cooling medium. The condition of these baffles and their seals is important.

Baffles should be secure and baffle seals should be positioned in a direction which would seal airflow around the engine baffles. Even a slight reduction in cooling efficiency can cause the engine to operate hotter than normal, thus increasing the potential for heat damaged components.

An inspection of the engine compartment, plus careful observation of the engine temperatures during normal flight, can be of great assistance in verifying the condition of the engine. If the pilot takes the time to record engine temperatures on a regular basis, trends within the engine can be detected early and corrected before a serious condition occurs.

HOSES AND WIRE HARNESS INTEGRITY

All fuel, oil, and hydraulic components should be checked for condition, security and any evidence of leakage. All leaks should be repaired before starting the engine.

As airplanes and engines age, there is a need to re-emphasize the inspection or replacement requirements of engine hoses or lines that carry fuel, oil, or hydraulic fluid. For newer Cessnas, a replacement requirement for hoses in the engine compartment (except teflon lined) has been established at each 5 years or at engine overhaul, whichever occurs first. This is considered to include "shelf" life. All hose manufactured for airplane use is marked indicating the quarter-year in which they were manufactured. For instance, a listing of "4Q85" means the hose was manufactured in the fourth quarter of 1985. Maintenance personnel should not use hoses with a high "shelf" life age.

Like time, heat is always a detriment to hoses. The prudent pilot realizes during the daily preflight, that an engine hose might look good, but if it is wiggled, a telltale "crackle" may be heard. This means that the hose is brittle and should be replaced. Also if he slides his hand over the back side of the hose, he may find an abrasion or wear not visible from the front side.

Ignition leads/wire harnesses and spark plugs are also affected by excessive heating in the engine compartment. Overheating of the spark plug barrels, sometimes caused by damaged cylinder baffles or missing cooling air blast tubes, may seriously deteriorate the ignition leads. Any overheating of a spark plug by a defective baffle or exhaust gas leak at the exhaust pipe mounting flange can generate temperatures sufficient to cause pre-ignition and piston distress.

RETRACTABLE LANDING GEAR

The adjustment and rigging of a retractable landing gear system should be done by trained maintenance personnel. Continued reliability of the landing gear system is only possible if it is properly maintained in the prescribed published manner. The rigging process must be performed exactly as published in the Cessna Service/Maintenance Manual and Service Bulletins. For complete emergency procedures concerning landing gear extension, refer to the airplane operating handbook.

PRESSURIZED AIRPLANES

DOOR SECURITY

The conventional and air-stair doors on pressurized airplanes have a series of pins, actuated by an overcenter locking handle, to maintain the door seal during the pressurization cycle. Some air-stair doors are sealed by pressurization air pressing against the cabin door windlace which covers the door gap. Door security can be verified by visually checking the locking indicator for the door handle safety lock, in the case of single-engine airplanes, and checking for correct locking indications provided in the door of multi-engine airplanes. It is recommended that pilots check the locking pins and door seals for cracks or damage during each preflight. Any damaged parts should be repaired prior to pressurized flight.

WINDOWS AND WINDSHIELDS

The windows in pressurized airplanes are exposed to a fatigue cycle each time the airplane is pressurized. These cycles could lead to fatigue cracks in and around the windows. Windows should be inspected frequently for condition and serviceability. Windows or windshields having replacement life limits should be replaced prior to intervals defined in applicable service/maintenance manuals.

The windows and windshields on pressurized airplanes are particularly sensitive to crazing and scratches. Any crazing, cracks, or deep scratches cannot be tolerated for pressurized flight. Consult the airplane's operating manual when in doubt about the severity of the damage. Repairs should be completed prior to pressurized flight.

THE PRESSURE VESSEL

There are significant structural differences between the fuselage of a non-pressurized airplane and one which is pressurized. The pressure vessel is the portion of the cabin area to be pressurized. Pressure differential is the difference between the atmospheric pressure at the altitude at which the airplane is flying and the pressure inside the cabin.

Any seam, joint, or hole where wire bundles or tubing pass through the pressure vessel must be sealed to maintain the selected pressurization. If any of these seals are deteriorated or missing, the normal cabin pressure differential may be impossible to attain. Maintenance personnel should inspect the pressure seals for serviceability. Any cracks in the skin of the pressure vessel could lead to sudden depressurization. Maintenance personnel should carefully inspect the pressure vessel for cracks, corrosion, and deterioration. Any damage should be corrected before pressurized flight.

If the airplane cabin is pressurized and it becomes necessary to use the heated alternate induction air on both engines, the pressurization controls must be selected OFF to preventing nacelle fumes from entering the cabin. The cabin should be depressurized and maximum ventilation provided. Therefore, if the flight altitude is above 10,000 feet, all occupants should use oxygen, if available, or descent should be initiated.

POTENTIAL HAZARDS

PROPELLERS

WARNING

ALWAYS STAND CLEAR OF PROPELLER BLADE PATHS, ESPECIALLY WHEN MOVING THE PROPELLER. PARTICULAR CAUTION SHOULD BE PRACTICED AROUND WARM ENGINES.

Review of propeller accidents indicates that most were preventable. A propeller under power, even at slow idling speed, has sufficient force to inflict fatal injuries. Pilots can be most effective in ensuring that passengers arrive and depart the vicinity of the airplane safely by stopping the engine(s) during loading and unloading.

Cessna airplanes are delivered with propellers using paint schemes to increase visibility of the blades. Owners should maintain the original paint scheme.

Pilots and Service personnel should develop the following safety habits:

1. Before moving a propeller or connecting an external power source to an airplane, be sure that the airplane is chocked, ignition switches are in the OFF position, throttle is closed, mixture is in IDLE CUT-OFF position, and all equipment and personnel are clear of the propeller. Failed diodes in airplane electrical systems have caused starters to engage when external power was applied regardless of the switch position.
2. When removing an external power source from an airplane, keep the equipment and yourself clear of the propeller.
3. Pilots should make certain that all personnel are clear of the propeller, prior to engine start.
4. Attach pull ropes to wheel chocks located close to a rotating propeller(s).
5. Before removing the wheel chocks, the pilot should hold brakes or apply the parking brake.
6. Be absolutely sure that all equipment and personnel are clear of the airplane before releasing the brakes.
7. Ground personnel should be given recurrent propeller safety training to keep them alert to the dangers of working around airplanes.

The pilot should carefully inspect the propeller during each preflight inspection. Some constant speed propellers manufactured by McCauley are subject to a requirement that they be filled with a red-dyed oil. This oil helps lubricate and prevent corrosion of internal propeller parts and may assist in detection of cracks. If a crack is detected, the airplane should not be flown until the propeller is replaced.

AIR CONDITIONING FREON

The refrigerant R- 12 (FREON) is relatively safe to handle when using proper protective safety equipment. Since at sea level the boiling point of R- 12 is -21.6°F, any contact with bare skin will immediately burn (freeze) the area. If R-12 should contact your eye, it will burn and can cause permanent blindness. Treat spills or splashes on your body by washing with clean, cool, water, and seek immediate medical attention. R-12, when heated to a high temperature such as with an open flame or spillage on a hot manifold, generates phosgene gas (a colorless gas with an unpleasant odor). This gas is a severe respiratory irritant and should be considered as a DEADLY POISON.

USED ENGINE OIL

Pilots and maintenance personnel who handle engine oil are advised to minimize skin contact with used oil, and promptly remove any used engine oil from their skin.

The following are some do's and don'ts concerning used engine oil:

1. Do follow work practices that minimize the amount of skin exposed, and the length of time used oil stays on the skin.
2. Do thoroughly wash used oil off skin as soon as possible.
3. Do wash oil-soaked clothing before wearing them again. Discard oil-soaked shoes.
4. Do use gloves made from material that oil cannot penetrate.
5. Don't use kerosene, gasoline, thinners, or solvents to remove used engine oil. These products can cause serious toxic effects.
7. Don't put oily rags in pockets, or tuck them under a belt. This can cause continuous skin contact.
8. Don't pour used engine oil on the ground, or down drains and sewers. This is a violation of Federal Law. The Environmental Protection Agency (EPA) encourages collection of used engine oil at collection points in compliance with appropriate state and local ordinances.

AVIATION FUEL ADDITIVE

Ethylene glycol monomethyl ether (EGME), which is a primary ingredient in aviation fuel additives, is toxic. It creates a dangerous health hazard when breathed or absorbed into the skin. When inhaled, EGME is primarily a central nervous system depressant, and acute inhalation overexposure may cause kidney injury. The primary symptoms of inhalation overexposure include headache, drowsiness, blurred vision, weakness, lack of coordination, tremor, unconsciousness, and even death. EGME is irritating to the eyes and skin and can be readily absorbed through the skin in toxic amounts. Symptoms of overexposure due to skin absorption are essentially the same as those outlined for inhalation.

When servicing fuel with an anti-ice additive containing EGME, follow the manufacturers instructions and use appropriate personal protective equipment. These items would include chemical safety goggles or shield, respirator with organic vapor cartridges, nonabsorbing neoprene rubber gloves and an apron and long-sleeved shirt as additional skin protection from spraying or splashing anti-ice additive.

In the event EGME contact is experienced, the following emergency and first aid procedures should be used.

1. If EGME is inhaled, remove person to fresh air. If breathing is difficult, administer oxygen. If the person is not breathing give artificial respiration. Always call a physician.
2. If eye or skin contact is experienced, flush with plenty of water (use soap and water for skin) for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Thoroughly wash contaminated clothing and shoes before reuse.
3. If ingested, drink large quantities of water and induce vomiting by placing a finger far back in throat. Contact a physician immediately. If vomiting cannot be induced, or if victim is unconscious or in convulsions, take immediately to a hospital or physician. Do not induce vomiting or give anything by mouth to an unconscious person.

Diethylene glycol monomethyl ether (DIEGME), a fuel anti-icing additive approved for use in some airplanes, is slightly toxic if swallowed and may cause eye redness, swelling and irritation. DIEGME also is combustible. Before using DIEGME, refer to all safety information on the container.

BIRDS, INSECTS, AND RODENTS

Bird, insect, and mouse nests in airplanes are both hazardous and costly. They seem to find even the smallest opening on an airplane to make their nests. Evidence of nest building activities may include the following:

1. Any mud smears or droplets at pitot/static masts, fuel tank vents, crankcase breathers, stall warning vanes, cabin air vents, and any fluid drain holes are indications of mud dauber wasp activities.
2. Straw, string, or blades of grass extending from cowling openings, carburetor air intakes, blast tubes, or exhaust stacks are signs of birds at work.
3. Cotton batting, shreds of fabric, and/or paper at wheel wells and empennage openings are frequently indicators that rodents such as

mice have been or may still be on board. They may gnaw on any material in the airplane including wire bundles and rubber or plastic tubing.

If nests or building materials are found on the airplane, they must be removed before flight. It is strongly recommended that a qualified mechanic thoroughly inspect components such as pitot/static systems for remains of any nesting material after its removal and before flight to ensure complete removal. Even small amounts of foreign material can result in significant problems in flight.

Some precautions can be taken to prevent problems. Always use the pitot tube cover and any other external covers when the airplane is being stored. If the airplane is hangared, make sure the hangar is kept clean and neat to prevent insects and mice from lodging in the hanger in the first place. If need be, set traps for rodents and/or spray the area for insects. Models of predators that appear life-like such as owls or snakes may also be effective at preventing some birds from lodging in a hangar.

Removal of the nest of an insect, bird, or rodent does not prevent reconstruction elsewhere on the airplane or even in the same location again. Some creatures are not easily discouraged and may return to cause problems within a very short time period. Regardless of precautions used to prevent such problems, the pilot should be alert to the evidence of small animal activities during every preflight inspection.

FIRE EXTINGUISHER AGENTS

Halon, Bromochloromethane (CB), Carbon Dioxide (CO2), and dry chemical extinguishing agents are four of the most common types of fire extinguishing agents found in and around airplanes. Prolonged exposure (5 minutes or more) to any of these agents in a confined area could cause serious injury or even death. Pilots and ground personnel should become familiar with the precautions associated with each particular agent. Adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit.

The discharge of large amounts of carbon dioxide to extinguish a fire may create hazards to personnel such as oxygen deficiency and reduced visibility. The dilution of the oxygen in the air, by the carbon dioxide concentrations that will extinguish a fire, may create an atmosphere that will not sustain life. Personnel rendered unconscious under these conditions can usually be revived without any permanent ill effects when promptly removed from the adverse condition.

The discharge of large amounts of dry chemical agents may create hazards to personnel such as reduced visibility and temporary breathing difficulty. Where there is a possibility that personnel may be exposed to dry chemical agents, suitable safeguards should be provided to ensure prompt evacuation.

OXYGEN

Before servicing any airplane with oxygen, consult the specific airplane service/maintenance manual to determine the proper type of servicing equipment to be used. Airplanes should not be serviced with oxygen during refueling, defueling, or other maintenance work which could provide fuel and a source of ignition. Also, oxygen servicing of an airplane should be accomplished outside, not in hangars.

Oxygen is a very reactive material, combining with most of the chemical elements. The union of oxygen with another substance is known as oxidation. Extremely rapid or spontaneous oxidation is known as combustion. While oxygen is non-combustible in itself, it strongly and rapidly accelerates the combustion of all flammable materials; some to an explosive degree.

The following are some do's and don'ts when handling or using oxygen:

1. Do check that only "aviators breathing oxygen" is going into the airplane system.
2. Don't confuse aviators breathing oxygen with "hospital/medical" oxygen. (The latter is pure enough for breathing, but the moisture content is usually higher which could freeze and plug the lines and valves of an airplane oxygen system.)
3. Do reject any oxygen that has an abnormal odor (good oxygen is odorless).
4. Do follow the published applicable instructions regarding charging, purging, and maintenance of airplane oxygen systems.
5. Don't use oil or grease (including certain lipsticks and lip balms) around oxygen systems.
6. Don't expose oxygen containers to high temperatures.

COMPRESSED AIR

Compressed air is a mechanic's tool as versatile as electricity, and can be as deadly. The use of compressed air to blow dust or dirt from parts of the body or clothing is a dangerous practice. As little as 12 psi can dislocate an eyeball. Air can enter the navel through a layer of clothing and inflate and rupture the intestines. Compressed air has been known to strike a small wound on a person's hand and inflate the arm.

Never look into or point any compressed air apparatus toward any part of the body. Always wear prescribed personal protective equipment. Also, continuously check the condition of air tools and air hoses to make sure they do not show signs of damage or looseness. A loose hose carrying pressure is like a bullwhip and can cause serious injury to personnel and/or cause damage to surrounding equipment. If a situation such as this should occur, do not attempt to catch the hose end; shut off the air source first.

STATIC ELECTRICITY

Static electricity, by definition, is a negative or positive charge of electricity that an object accumulates, and creates a spark when the object comes near another object. Static electricity may accumulate on an airplane during flight or while it is on the ground, as long as air is flowing over its surfaces. Unless static electricity is carried away by ground wires, an explosion may be caused during any fueling operations.

Grounding an airplane is a good safety precaution because static electricity cannot be seen until it's too late. To properly ground an airplane, attach one end of a static ground wire to an unpainted point on the airplane and the other end to an approved grounding stake. Attaching the ground wire to the airplane first will ensure that any spark of static electricity will occur at the grounding stake and not at the airplane. Do not attach a ground wire to any antenna. Antennas are poor grounding attachment points because they are insulated from the airplane structure.

On some airplanes, wick-type static dischargers are installed to improve radio communications during flight through dust or various forms of precipitation (rain, snow or ice crystals). Under these conditions, the build-up and discharge of static electricity from the trailing edges of wings, rudder, elevator, and propeller tips can result in loss of usable radio signals on all communications and navigation radio equipment. Usually the ADF is first to be affected and VHF communication equipment is the last to be affected. Installation of static dischargers reduces interference from precipitation static, but it is possible to encounter severe precipitation static conditions which might cause the loss of radio signals, even with static dischargers installed.

Static dischargers lose their effectiveness with age, and therefore should be checked at every scheduled inspection by a qualified technician. If testing equipment is not available, it is recommended that the wicks be replaced every two years, especially if the airplane is operated frequently in IFR conditions.

ELT BATTERY AND GAS SPRING/DAMPER DISPOSAL

To prevent bodily injury, do not compact (compress) or incinerate an ELT battery-pack or gas spring/damper. The ELT battery pack should be discarded in accordance with local EPA standards.

A gas spring or gas damper contains an inert gas and oil under pressure, and reacts much like an aerosol can when compressed or heated; it may explode. Therefore, all unserviceable gas springs or dampers should be depressurized, using the maintenance manual instructions.

HEARING LOSS

Hearing loss due to overexposure to loud noise levels is a real possibility while working near operating airplane engines. Continuous exposure to excessive noise diminishes hearing acuity, with high frequency response failing first. If the overexposure continues, the middle frequencies, most important in conversation, are also lost. Earmuffs, some headset types, and earplugs are very useful to avoid hearing loss. By far, the earplug has proven to be the best protection overall. Limits have been established which relate sound level (dB) to exposure time. These limits are based on daily exposures for long intervals.

Sound Level (dB)	115	110	105	100
Maximum Time (min.)	15	30	60	120

WEATHER RADAR EXPOSURE

The dangers of exposure to airborne weather radar operated on the ground include the possibility of damage to low tolerance parts of the human body and ignition of combustible materials by radiated energy. Low tolerance parts of the body include the eyes and testes. Airborne weather radar should be operated on the ground only by qualified personnel. The radar should not be operated while the airplane is in a hangar or other enclosure unless the radar transmitter is disconnected, or the energy is directed toward an absorption shield which dissipates the radio frequency (RF) energy.

Personnel should never stand near or directly in front of a radar antenna which is transmitting. When the antenna is transmitting and scanning, personnel should not be allowed within 15 feet of the area being scanned by the antenna.

Personnel should not be allowed at the end of an open waveguide (hollow duct work through which electromagnetic waves are conducted to and from the antenna) unless the radar is off and will remain off. Radar should not be operated with an open waveguide unless a "dummy load" is connected to the portion which is connected to the transmitter. Personnel should not look into a waveguide, or the open end of a coaxial connector or line connected to a radar transmitter.

Weather radar installed on any airplane should not be operated while that airplane, or an adjacent airplane is being refueled or defueled.