



# Mountain Search Pilot Course Guide



## Civil Air Patrol

Auxiliary of the United States Air Force



## **Mountain Search Pilot Course Guide**

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## Mountain Search Pilot Course Guide

### Dedication:

*Mountain Fury* is dedicated to all the men and women of the  
Civil Air Patrol who gave their lives so that others may live.  
Strength through training!

Published by:



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# INTRODUCTION

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## Introduction

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## FORWARD

This *Mountain Fury Mountain Search Pilot Course Guide* is the culmination of a project involving work from a broad spectrum of individuals from within and without CAP who are known for their knowledge of mountain flying and mountain search flying. Their goal of incorporating the mountain flying knowledge, techniques and search procedures into one package has but one purpose, to enhance the safety of CAP search operations.

The payoff of merging these expert's knowledge will not be realized until this information is successfully passed on to you, the CAP search pilot. It is up to you to learn, practice and develop the art of mountain search, to fly missions safely, and to find those who are missing, "so that others may live."

Because mountain search flying involves flight in close proximity to mountainous terrain at slow airspeed, it is hazardous. The airplane is maneuvered into areas where it might never be flown except for a search for someone who has already flown into trouble.

Mountain searches, by their nature, result in decreased aircraft performance. The weather is modified and amplified in the mountains. These factors combine to provide a difficult challenge for the mountain pilot.

Experience in search flying and flying in general does not give the pilot all the tools necessary to safely and effectively perform a mountain search. CAP pilots with thousands of flight hours, who were otherwise proficient search pilots, have been involved in serious accidents during mountain searches. Lack of knowledge

of specific weather hazards or of flying techniques have been factors in these accidents. The exposure to danger will be minimized by ensuring all CAP mountain search pilots are provided with the information they need.

This book has not been formulated to encumber you with unnecessary information. It contains the advice, the warnings, and the rules of thumb necessary to reduce the risks. Adherence to these established procedures, outlined in Blocks 1 through 4, will help keep you out of harm's way.

## BLOCKS

This book contains four blocks:

- Block 1 - High Altitude Flying
- Block 2 - Mountain Weather
- Block 3 - Mountain Flying
- Block 4 - Mountain Search Procedures

## DEFINITION OF MOUNTAIN FLYING

For the purpose of this course, *mountain flying consists of flying and searching in close proximity to precipitous terrain.*

## SORTIE PREPARATION

In order to conduct safe and effective flight operations involving flight at high density altitudes, a pilot must accomplish a degree of flight planning not normally associated with flight operations in the flatlands. Based on the best available weather reports and forecasts, the Pilot's Operating Handbook (POH—required to be carried aboard all aircraft certified after March 1, 1979), the weight-and-balance data for your planned sortie, and appropriate aeronautical charts, determine and record the following information on a Mission Sortie Planning Sheet:

### Your Sortie

- ✓ Administrative and operational items
- ✓ Weight and balance for your aircraft and crew

### Weather

- ✓ Current reports and area forecast
- ✓ Pilot reports (PIREPS) along your route of flight and in your operating area
- ✓ Winds and temperature aloft forecast for altitudes extending to three times the elevation of the highest terrain on your route of flight

- ✓ Density altitude at the departure and destination airports as well as at the anticipated operating altitude
- ✓ Evidence of inversions at altitude and indications of standing waves

### Aircraft Performance

- ✓ Takeoff distance at the computed density altitude.
- ✓ Landing distance at the computed density altitude.
- ✓ Time, fuel and distance to climb to your en route altitude.
- ✓ En route cruise performance.
- ✓ Maximum rate of climb at all anticipated operating density altitudes.

### CONVENTIONS

To make certain information meaningful, icons have been incorporated to assist you in sorting out nice-to-know, need-to-know, advisory, precautionary, and warning information.



The "Note" icon denotes information that you should know before flying a search mission in the mountains.



The "Remember" icon marks information that you will use over and over. It should be remembered to enhance the safety of flight.



The "Rule of Thumb" icon points out procedures that save time and trouble. The "rule of thumb" is roughly correct, but not meant to be scientifically precise.



The "Warning" icon represents a situation, event, or area that can get you into trouble or cost you money because of airplane damage, if you do not adhere to the recommendations.







# HIGH ALTITUDE FLYING

## Block 1 High Altitude Flying

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## HIGH ALTITUDE AIRCRAFT PERFORMANCE

### Maximum Operating Altitude



The *maximum-safe-operating altitude* is the altitude at which the aircraft has a 300-foot-per-minute rate of climb at full power. This minimum safe rate of climb may be increased at the discretion of the pilot and/or the Mission Coordinator. For example, the winds aloft may create a condition that dictates a minimum rate of climb of 500-feet per minute.

The purpose of this limitation is to assure that the aircraft has adequate reserve performance capabilities while operating and maneuvering during high density altitude operations. While the maximum rate of climb can be calculated from forecast temperatures and the Pilot's Operating Handbook (POH—the POH is required to be aboard all aircraft manufactured since March 1, 1979), the actual rate of climb should be verified when the aircraft reaches the maximum expected operating altitude.

Many pilots are accustomed to operating aircraft at low density altitudes and are familiar and comfortable with the performance and response of their aircraft at those altitudes. In high density altitude and mountain environments, the pilot may encounter the extreme upper limits of their aircraft performance capabilities. For example, an aircraft may not be able to circle a crash site in a 45-degree bank while maintaining altitude ... if attempted, altitude loss or stall buffet may occur. Areas that were easily reached during the winter may require additional time to climb the last 500 feet during the summer; this hard-won 500 feet may then be lost while performing a single 45-degree bank turn.

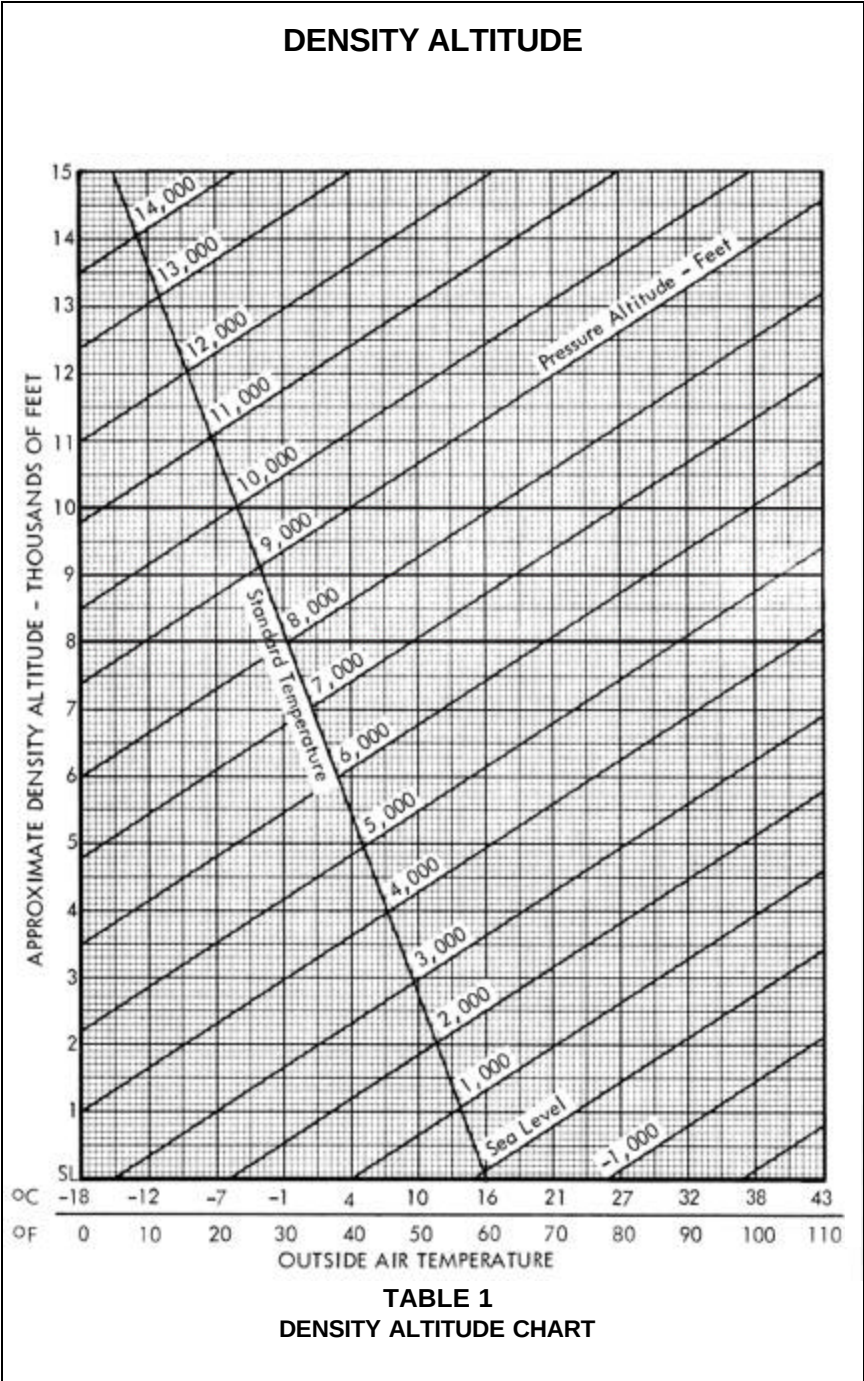
Pilots should calculate the performance parameters of their fully loaded aircraft before the flight is released. Pilots need to learn and understand some basic performance parameters and theory before they are qualified and approved to fly on high altitude search missions. Once the theory and performance limitations are learned, search maneuvers need to be practiced at search altitude in a safe area before flying in close proximity to the mountains.

## DENSITY ALTITUDE



Even knowledgeable pilots often become complacent about density altitude, but this is an important factor and this error should be avoided. Density altitude is comprised of three variables, *pressure*, *temperature* and *humidity*. The altitude and pressure are combined to determine the *pressure altitude*. Non-standard temperature is factored in to obtain the *density altitude*. Pilots have no practical way of determining the effects of humidity.

*Density altitude is the pressure altitude corrected for non-standard temperature.* Density altitude and aircraft weight have a tremendous effect on aircraft performance. Both must be accurately calculated for all mountain flying missions. This process can be time-consuming, as it involves obtaining weather reports and forecasts, performing calculations through the use of aircraft charts, and weighing of survival kits. BUT DO IT! Your life and the success of the mission depends upon it.



At high density altitude airports (density altitude above 3,000 feet) some aircraft require leaning before takeoff. Follow the manufacturer's recommendation.



The density altitude may be approximated with a rule of thumb. For each 10°F above standard temperature, add 600 feet to the field elevation. For each 10°F below standard temperature, subtract 600 feet from the field elevation. This rule of thumb rarely results in an error exceeding 200-300 feet.

## PREDICTING DENSITY ALTITUDE

### Density Altitude Chart Method

The density altitude can be easily and graphically obtained from Table 1 on page 1-3. For example, suppose the desired search altitude is 9,000 feet. The forecast temperature at 9,000 feet is 60°F. The nearest reported altimeter setting is 28.50. It is necessary to obtain the pressure altitude. Subtract the altimeter setting from 29.92. (29.92 – 28.50 = 1.42 inches). One inch of mercury is equivalent to approximately 1,000 feet (925 feet per 1,000 feet of Mercury is more accurate), so 1.42 represents 1,420 feet. Since the altimeter is lower than 29.92, it must be turned “up” to reach 29.92. This would raise the pressure altitude to 9,000 + 1,420, or 10,420 feet.

Start on the table at 60°F on the “Outside Air Temperature” axis and move straight up to a point about 42 percent of the way between the slant lines for PA = 10,000 ft and PA = 11,000 ft. Then move straight left to the density altitude axis and read the approximate value of 12,900 feet.

### Density Altitude Formula Method

Predicting density altitude requires the value of both the pressure altitude and the outside air temperature. For temperature, use the most current *Winds and Temperatures Aloft Forecast* for the intended area of operation. To predict the pressure altitude at the operating location, use the current altimeter setting at the closest weather reporting station. Both items of data can be obtained from a Flight Service Station or by computer from DUATS. The necessary (approximate) formulas, in order of their application, are:

$$PA = H - 925 \times (S - 29.92)$$

$$TS = 59 - (0.003566 \times PA)$$

$$DA = PA + 66 \times (T - TS)$$

where

PA = pressure altitude at search altitude prediction, ft.

- H = search altitude (altimeter face reading when searching), ft.  
 S = Altimeter setting at weather station, in. Hg.  
 DA = density altitude at search altitude prediction, ft.  
 T = forecast temperature at search altitude, degrees F.  
 TS = standard temperature at predicted pressure altitude, degrees F.

Example: We want the predicted density altitude for a 9,000-foot MSL search location. Forecasts call for a temperature of 60-degrees Fahrenheit at the specified altitude. A current altimeter setting of 28.50 in. Hg. has been obtained from an FAA AFSS, National Weather Service (NWS) station, or by DUATS.

$$\begin{aligned}
 PA &= H - 925 \times (S - 29.92) \\
 &= 9,000 - 925 \times (28.50 - 29.92) \\
 &= 9,000 - 925 \times (-1.42) \text{ (Watch the plus/minus signs!)} \\
 &= 9,000 + 1,313 \\
 &= 10,313\text{-feet pressure altitude} \\
 TS &= 59 - (0.003566 \times PA) \\
 &= 59 - (0.003566 \times 10,313) \\
 &= 59 - 36.8 \\
 &= 22.2\text{-deg. F, standard temperature}
 \end{aligned}$$

$$\begin{aligned}
 DA &= PA + 66 \times (T - TS) \\
 &= PA + 66 \times (60 - 22.2) \\
 &= PA + 66 \times 37.8 \\
 &= 10,313 + 2,495 \\
 &= 12,808\text{-foot density altitude}
 \end{aligned}$$

For another brief example, assume while flight planning for a sortie it is determined that the highest terrain in the assigned search grid is 7,500-feet MSL. It is a good operating procedure that the search terrain is overflown upon arrival, preferably at 2,000 feet above the highest terrain. This requires flight at 9,500-feet MSL. From the weather station closest to the search area, obtain the *Winds and Temperatures Aloft Forecast* and the altimeter setting from the *Surface Observation*. Since 9,500 feet will not appear in the forecast, interpolate between 9,000 and 12,000 feet to find the expected temperature. Once the calculation sequence (as in the previous example) is complete, the best estimate of the density altitude is obtained. Density altitude determines aircraft performance. Figures 1 through 6, applying interpolation or extrapolation as necessary, will provide a good preview of the various parameters of aircraft performance to be expected during the search sortie.

## AIRCRAFT PERFORMANCE

The following table (**Table 2 - Effect of Weight and Density Altitude on ROC**), illustrates the effect of density altitude and aircraft weight on the rate of climb (ROC) of a 160-horsepower Cessna 172 at 300-pounds under gross weight (2,100 lbs.) and at maximum allowable gross weight (2,400 lbs.).

| PRESSURE ALTITUDE 4,000 FEET  |                        |                    |                    |
|-------------------------------|------------------------|--------------------|--------------------|
| Temperature                   | Density Altitude, Feet | ROC @ 2,100 Pounds | ROC @ 2,400 Pounds |
| 10°F                          | 1,600                  | 820                | 630                |
| 60°F                          | 5,000                  | 650                | 470                |
| 100°F                         | 7,500                  | 540                | 370                |
| PRESSURE ALTITUDE 6,000 FEET  |                        |                    |                    |
| Temperature                   | Density Altitude, Feet | ROC @ 2,100 Pounds | ROC @ 2,400 Pounds |
| 10°F                          | 4,000                  | 700                | 520                |
| 60°F                          | 7,500                  | 540                | 370                |
| 100°F                         | 10,000                 | 410                | 260                |
| PRESSURE ALTITUDE 10,000 FEET |                        |                    |                    |
| Temperature                   | Density Altitude, Feet | ROC @ 2,100 Pounds | ROC @ 2,400 Pounds |
| 10°F                          | 9,000                  | 460                | 300                |
| 60°F                          | 12,400                 | 315                | 160                |
| 100°F                         | 15,000                 | 200                | 50                 |

**TABLE 2 - Effect of Weight and Density Altitude on ROC**  
Cessna 172, 160 HP: ROC at 300-pounds UNDER Maximum Gross Weight and ROC AT Maximum Gross Weight

## PERFORMANCE CHARTS

The charts on the following pages show the effects of density altitude on climb rate, turn radius, the ability to maintain altitude during a steep turn, and the stall speed at various bank angles.

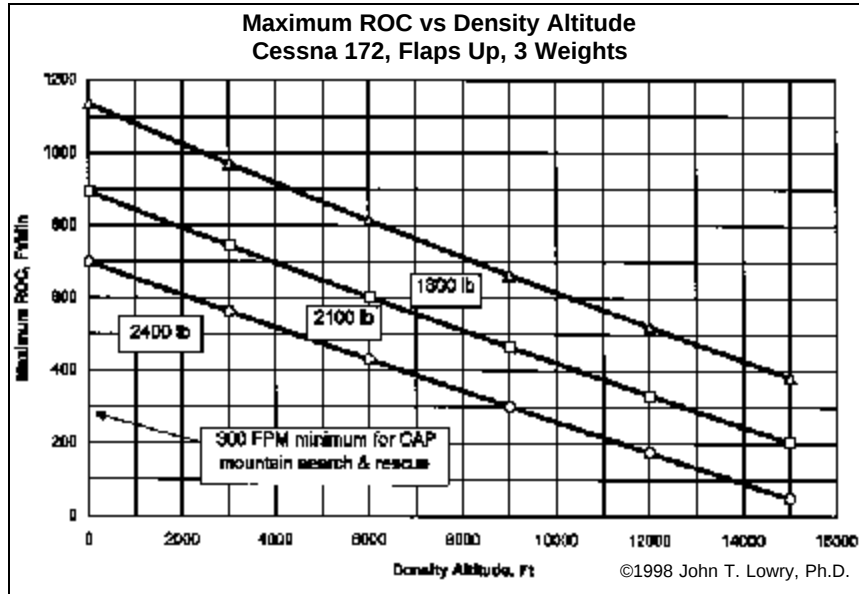


FIGURE 1 - Maximum ROC vs. Density Altitude

This chart was used to calculate the values in Table 2, page 1-6. Once the highest density altitude for the assigned search area is determined, find the maximum ROC for the airplane's gross weight in the search grid. For example, if the aircraft weight is 2,400 lbs. and the density altitude is 10,000 feet, the maximum ROC will be 260 fpm (by interpolating). This is less than the 300-fpm climb requirement. The chart shows that the gross weight of the aircraft would have to be reduced approximately 100 lbs. to accept this sortie. If the assigned grid has a density altitude of 9,000 feet, the sortie could be flown at the maximum allowable gross weight of 2,400 lbs.

**DISCLAIMER:** The information contained in this chart is for one sample Cessna 172 and should be taken as only illustrative of the behavior of similar airplanes. According to Federal Aviation Regulation, if there is any discrepancy between the information derived from this chart and the information contained in the POH, the POH shall be used as the final authority.

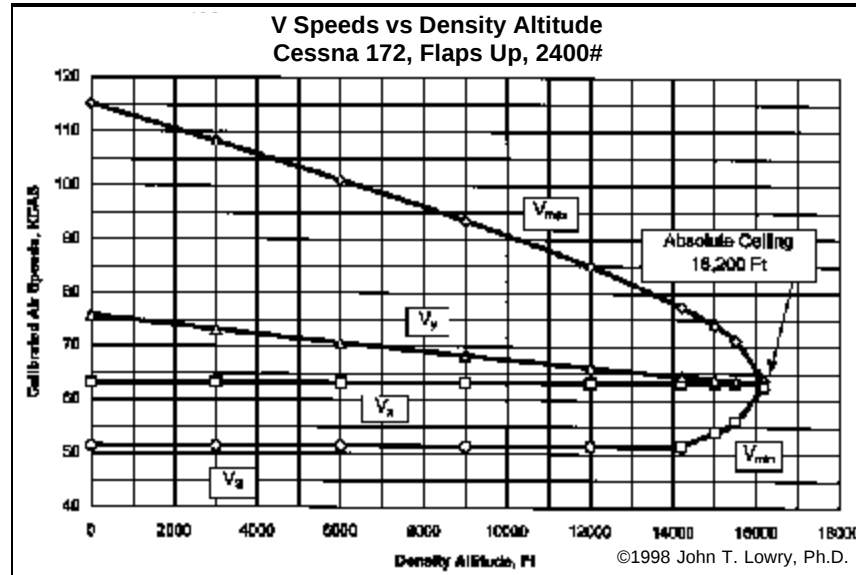


FIGURE 2 - V SPEEDS VS. DENSITY ALTITUDE

This chart provides the important message that a density altitude above 14,000 feet is not a good place to be in the Cessna 172. Note that the stall speed,  $V_S$ , and the best angle-of-climb speed,  $V_X$ , as calibrated air speeds, do not change with density altitude.

Also note that the minimum level-flight speed,  $V_{MIN}$ , is not operationally accessible until the airplane is operated at high altitude, because it is below  $V_S$ , and the aircraft would stall first.

At very high altitudes the opposite is true, where the minimum level flight speed is greater than the stall speed. With a temperature 20°F above standard temperature the 14,000-foot density altitude will be encountered at less than a 13,000-foot pressure altitude (see the Density Altitude, Table 1, page 1-3). Figure 2 also shows that the best rate-of-climb speed decreases from 76 KCAS at sea level to 63 KCAS at 16,000 feet. This is important to remember when making long climbs. The maximum airspeed decreases from 115 KCAS at sea level to 63 KCAS at 16,000 feet. At the absolute ceiling, there is only one possible level flight speed. It is sometimes disconcerting to discover how low the full-power indicated airspeed is at high search altitudes.

**DISCLAIMER:** The information contained in this chart is for one sample Cessna 172 and should be taken as only illustrative of the behavior of similar airplanes. According to Federal Aviation Regulation, if there is any discrepancy between the information derived from this chart and the information contained in the POH, the POH shall be used as the final authority.

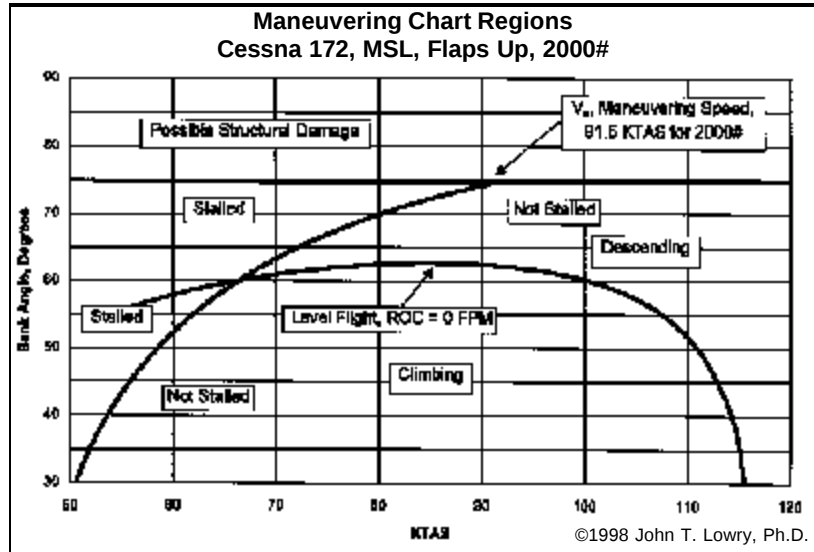


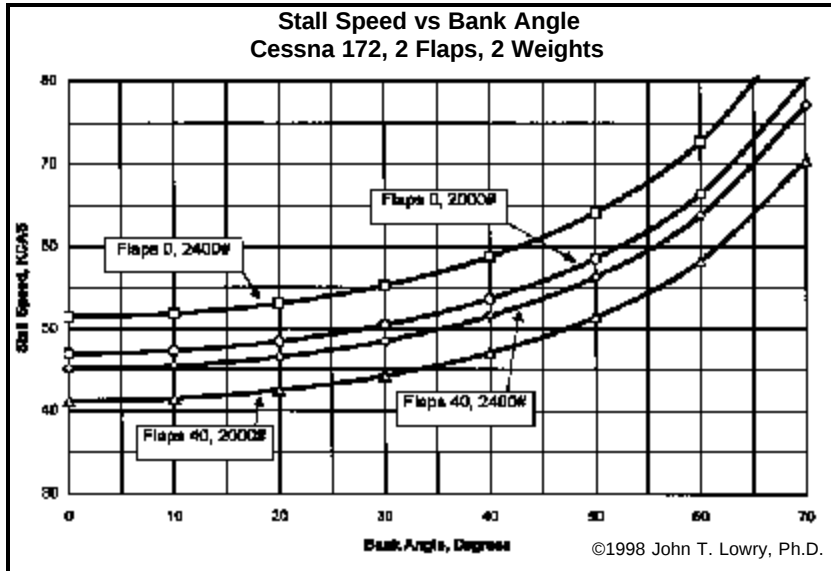
FIGURE 3 - MANEUVERING CHART REGIONS

This is an interesting chart as it provides a guide to maintaining level flight while banking at various airspeeds. If the airplane is banked in the region below the line labeled "Level Flight, ROC = 0 FPM," the aircraft is able to maintain altitude or climb.

For example, in a 60-degree bank at 90 KTAS, the airplane may still climb slightly. At a KTAS value resulting in operation to the right side of the chart ("Level Flight, ROC=0 FPM" line) the airplane will be descending. During a 45-degree bank at 115 KTAS, the aircraft will descend.

NOTES:

**DISCLAIMER:** The information contained in this chart is for one sample Cessna 172 and should be taken as only illustrative of the behavior of similar airplanes. According to Federal Aviation Regulation, if there is any discrepancy between the information derived from this chart and the information contained in the POH, the POH shall be used as the final authority.



**FIGURE 4 - STALL SPEED VS. BANK ANGLE**

Figure 4 provides the stall speeds for an airplane operated at two different weights, 2,000 lbs. and 2,400 lbs., and with 40-degrees flap extended and with the flaps retracted, at various bank angles.

Both Figures 3 and 4 show the limits of bank angle and speed. Select conservative performance envelopes for the aircraft operation.

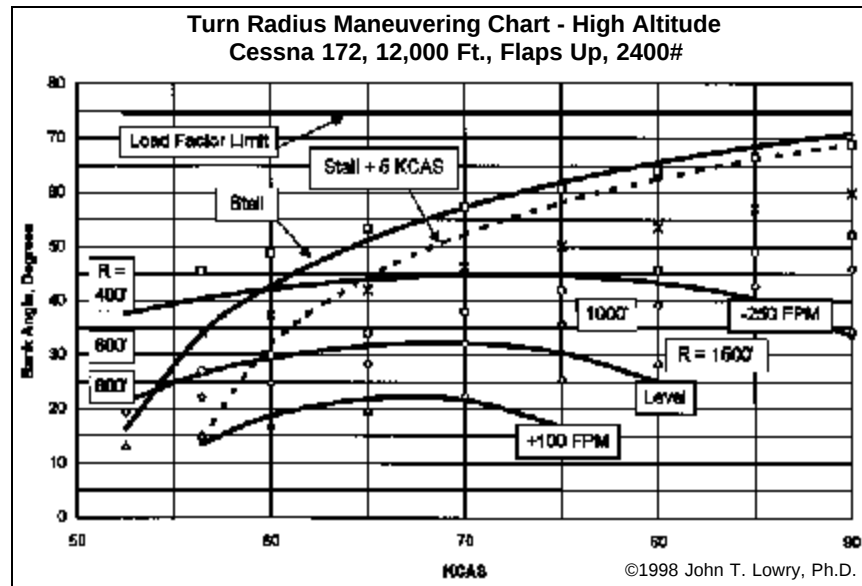
NOTES:

**DISCLAIMER:** The information contained in this chart is for one sample Cessna 172 and should be taken as only illustrative of the behavior of similar airplanes. According to Federal Aviation Regulation, if there is any discrepancy between the information derived from this chart and the information contained in the POH, the POH shall be used as the final authority.



One possibility for making a 500-foot-radius turn would be at a bank angle of 40- to 45-degrees of bank at an airspeed of 70 to 80 knots true airspeed. This keeps the airplane comfortably above the stall +5 speed (dashed line), while providing the ability to maintain level flight.

**DISCLAIMER:** The information contained in this chart is for one sample Cessna 172 and should be taken as only illustrative of the behavior of similar airplanes. According to Federal Aviation Regulation, if there is any discrepancy between the information derived from this chart and the information contained in the POH, the POH shall be used as the final authority.



**FIGURE 6 - TURN RADIUS MANEUVER CHART - HIGH ALTITUDE**

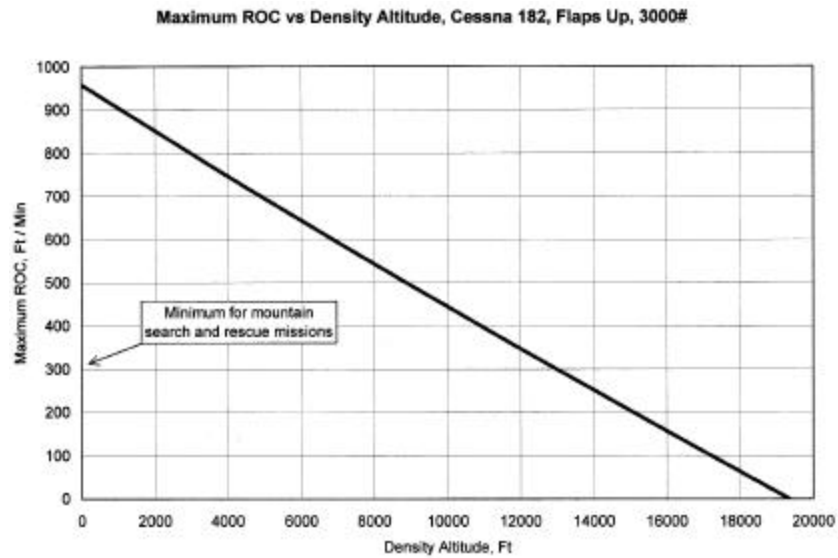
This chart provides the same data as Figure 5, for a density altitude of 12,000 feet. To perform the circling maneuver at this altitude, the airplane is limited to a 32-degree bank angle at a speed of approximately 68 KCAS. The turn radius is about 1,000 feet.

These conditions prevent a good view of the ground object. If the terrain allows the loss of altitude during the circling maneuver, use a 45-degree bank turn at the minimum recommended search speed of 78 KIAS ( $V_Y + 10$ ). This will provide a turn radius of 750 feet while descending at 250 fpm (about 30 seconds is required to complete the turn). According to Figure 1, page 1-7, the altitude loss can be regained at a rate of 170-feet per minute.

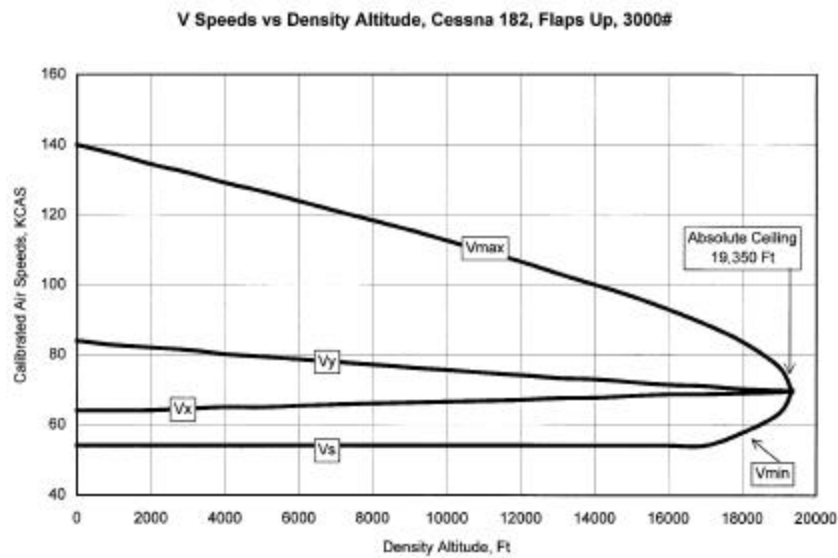
Alternatively a 30-degree bank would produce a turn radius of 1,330 feet, but altitude could be maintained. These numbers indicate that it would be better to fly at a lower gross weight under these conditions.

This chart illustrates why an underpowered aircraft should not be flown on a sortie at a 12,000-foot density altitude, and why there is a minimum 300-fpm climb rate requirement for sorties.

**DISCLAIMER:** The information contained in this chart is for one sample Cessna 172 and should be taken as only illustrative of the behavior of similar airplanes. According to Federal Aviation Regulation, if there is any discrepancy between the information derived from this chart and the information contained in the POH, the POH shall be used as the final authority.



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**FIGURE 7 - MAXIMUM RATE OF CLIMB v. DENSITY ALTITUDE, CESSNA 182**

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**FIGURE 8 - V SPEEDS v. DENSITY ALTITUDE - CESSNA 182**

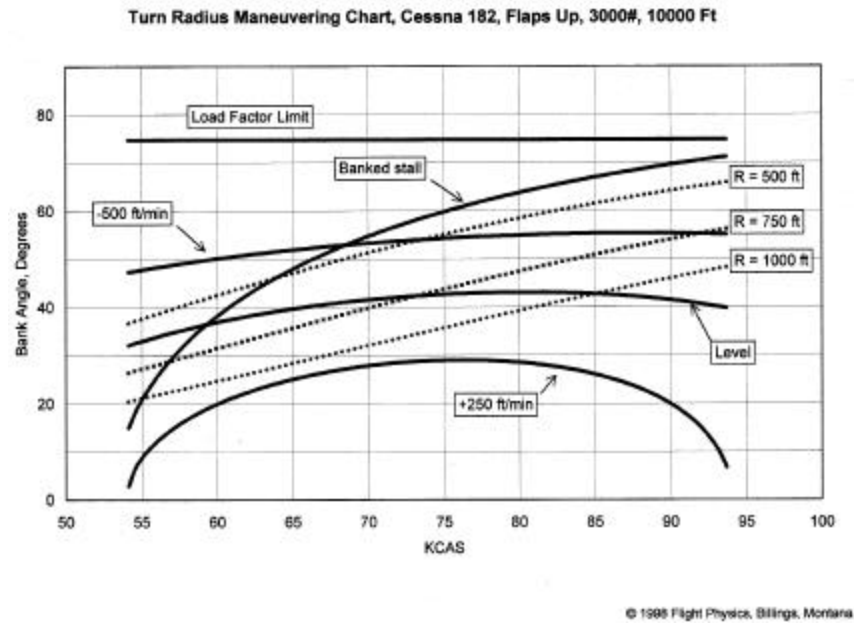


FIGURE 9 - TURN RADIUS MANEUVER CHART - HIGH ALTITUDE - CESSNA 182

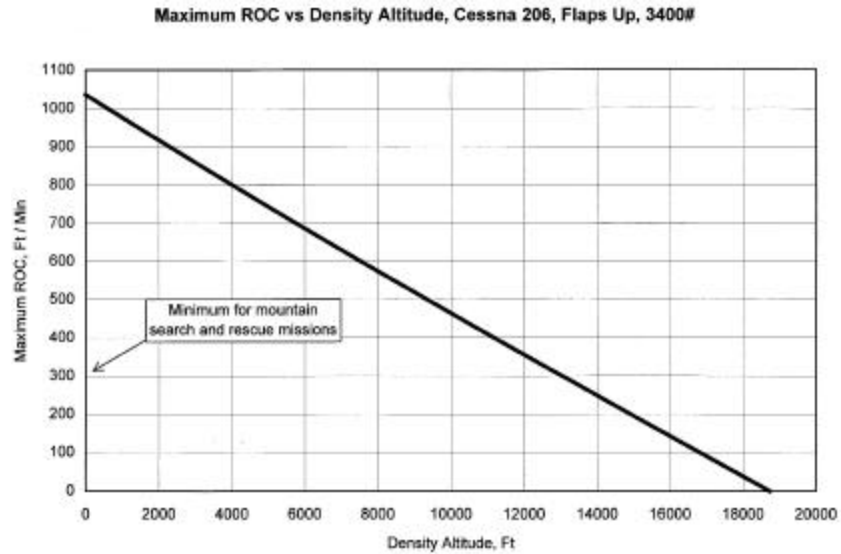


FIGURE 10 - MAXIMUM RATE OF CLIMB v. DENSITY ALTITUDE, CESSNA 206

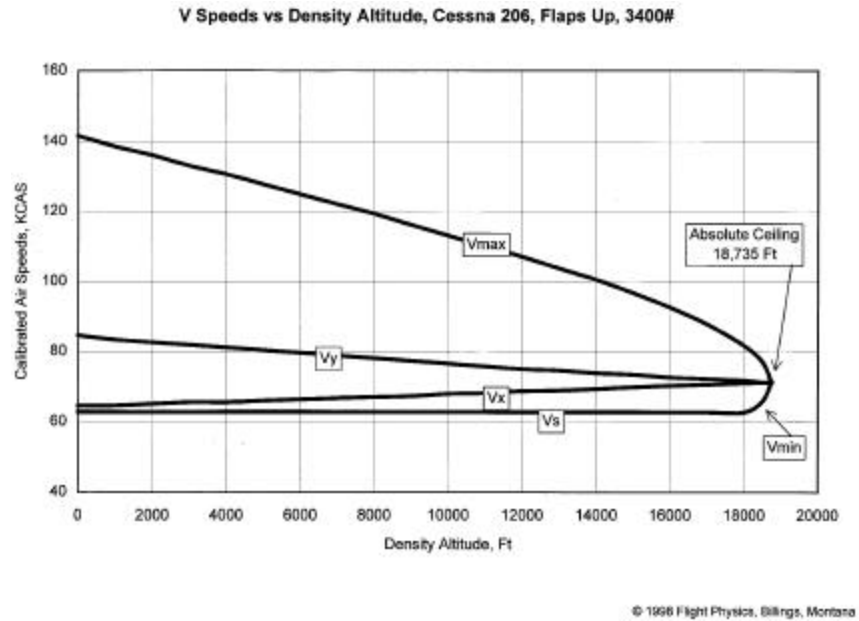


FIGURE 11 - V SPEEDS v. DENSITY ALTITUDE - CESSNA 182

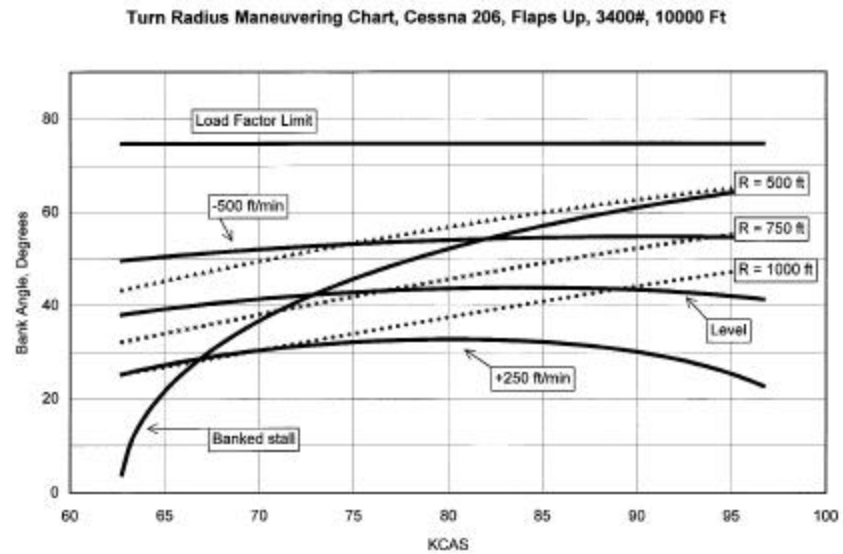


FIGURE 12 - TURN RADIUS MANEUVER CHART - HIGH ALTITUDE - CESSNA 206

## PHYSIOLOGICAL EFFECTS OF ALTITUDE

### OXYGEN

Federal Aviation Regulations require the pilot and required crew members to use supplemental oxygen when flying between 12,500 and 14,000 MSL for more than one-half hour. The pilot and required crew shall use supplemental oxygen at all times when flying above 14,000 feet. At 15,000 feet, all occupants of the aircraft must be provided with supplemental oxygen.



While this is a realistic rule, search flying involves a considerable level of effort, and the FAR requirements for oxygen use may be inadequate to guarantee safety and good crew performance. Experienced mountain search pilots recommend that oxygen be used whenever conducting search operations above 10,000 feet.

Note that, while the regulation is based upon physical altitude above sea level, the body responds to the density altitude. The density altitude may be much higher than the physical altitude.

Flying for several hours at altitudes above 10,000-feet MSL under the stress of searching, especially if the air is turbulent, will produce fatigue, the onset of which may initially be unnoticed. Twenty minutes of breathing oxygen will do wonders for your well being and alertness.

### HYPOXIA



Hypoxia is the lack of oxygen at the tissue level of the body. This may be due to a decrease of the oxygen partial pressure in the inspired air or because of conditions that prevent or interfere with the diffusion or absorption of oxygen.

The body has no built-in warning system against hypoxia. It is not painful; to the contrary, the greatest danger of hypoxia is that it renders the pilot euphoric (a feeling of well being). This is similar to the effects of alcohol, and the pilot and crew are unable to sense anything wrong. Because it is insidious, the pilot does not perceive the onset of forthcoming incapacitation. Hypoxia is a serious consideration; if unconsciousness occurs, without remedy, death may occur.

#### Common causes of hypoxia include:

1. Flight at an altitude where there is an insufficient partial pressure of oxygen to cause oxygen transfer.
2. A mechanical malfunction of the supplemental oxygen equipment.
3. Ingestion or inspiration of drugs (carbon monoxide, nitrites, sulfa, etc.) that interfere with the blood's ability to absorb or transport oxygen from the lungs to the cells.

4. Malfunction of the circulatory system (heart failure, occlusion of a blood vessel, etc.).
5. Positive "g" forces preventing fresh, oxygenated blood from reaching the brain.

**There are three types of hypoxia:**

1. **Histotoxic Hypoxia** — When alcohol, narcotics or poisons interfere with the tissues' ability to metabolize the delivered oxygen.
2. **Hypemic Hypoxia** — Reduction of the blood's ability to carry oxygen due to such causes as chronic anemia, blood loss, or smoking. The solubility of carbon monoxide (CO) in blood (such as from smoking) is 20-times higher than the solubility of oxygen; CO therefore displaces the oxygen the blood needs to carry. A smoker at sea level will have a physiologic altitude equal to a non-smoker at 3,000 to 8,000 feet.
3. **Hypoxic Hypoxia** — This is the classic "lack of oxygen" condition that results from the decrease in the partial pressure of oxygen at altitude.

**Symptoms of Hypoxia**

Among the first symptoms of hypoxia are mental confusion and mild euphoria, often accompanied by shallow, rapid breathing. Later, increased confusion, decreased mental capacity, and cyanosis of the fingernails will be apparent.

One person's symptoms of hypoxia may be quite different from another person's. To learn your particular reaction to or traits of hypoxia, attend an altitude chamber training session. An application form may be obtained at any FAA district office.

**Stages of Hypoxia**

1. **Indifferent Stage** — The only adverse affect is reduced dark visual adaptation.
2. **Compensatory Stage** — Physiological compensations provide some defense against hypoxia so that the effects are reduced, unless exercise is undertaken. Respiration may increase in depth or slightly in rate. The pulse rate, the systolic blood pressure, the rate of circulation, and the cardiac output will all increase.
3. **Disturbance Stage** — Subjective symptoms may include fatigue, exhaustion, drowsiness, dizziness, headache, breathlessness, and euphoria. Objective symptoms include central and peripheral vision impairment, and the extraocular muscles becoming weak; intellectual impairment also occurs, making it improbable the individual can comprehend his or her own disability.
  - Calculations are unreliable
  - Memory is faulty
  - Judgment is poor
  - Reaction time is delayed.

4. **Critical Stage** — This is the stage where consciousness is lost. Death follows shortly.

### **Prevention of Hypoxia**

The onset of hypoxia depends upon the following variables:

1. Absolute altitude
2. Rate of ascent
3. Duration at altitude
4. Ambient temperature
5. Inherent tolerance
6. Physical fitness
7. Emotionality
8. Acclimatization

Maintain your body in good condition. Utilize the lowest practical flight level, and use supplemental oxygen to eliminate or minimize the onset and effects of hypoxia. Just because oxygen is not required by regulation does not mean it cannot be used to the pilot's benefit at any flight altitude. Many experts recommend use of supplemental oxygen above 5,000 MSL at night for increased visual acuity.

### **SINUS PRESSURE**

Often in mountain flying, the terrain may require maintaining a high altitude along the entire route without the opportunity for a gradual descent to the destination airport. Without proper warning from the pilot, crew members with sinus problems or nasal congestion may experience severe sinus pain and even eardrum damage due to rapid pressure changes experienced in the descent. If this occurs, climb back to an altitude that relieves the discomfort, then descend more slowly while having the person perform the Valsalva maneuver (described below) during the entire descent.

### **The Valsalva Maneuver**

The Valsalva maneuver is performed to make the ears "pop." It is a forced expiratory effort with the nose and mouth closed in order to inflate the eustachian tubes and thereby relieve pressure in the middle ear. To perform the Valsalva maneuver:

1. Close the mouth and keep it closed.
2. Pinch the nostrils tightly closed.
3. Force the tongue against the roof of the mouth.
4. Exhale forcibly through the upper throat into the nasal cavity.

When the ears “pop,” the pressure has been at least partially equalized. This maneuver should be continued through the descent until after the landing. This procedure will not cause damage to the ear drum.

As an alternative or adjunct to the Valsalva maneuver, the use of a nasal inhaler (e.g. *Vicks*) immediately prior to descent may assist in equalizing middle ear pressure. Pilots should consider carrying such a device, as some passengers may be unable or unwilling to perform the Valsalva maneuver. Serious harm can occur from pressure build up during descent.

### **ULTRAVIOLET RADIATION PROTECTION**

Another issue is ultraviolet radiation. At higher altitudes, the UV bandwidth of radiation from the sun is especially strong. Damaging solar rays will cause sunburn and long-term damage to skin if it is subject to prolonged exposure through side windows. Eye protection in the form of good-quality sunglasses is also important; ensure the sunglasses block out UV-A and UV-B wavelengths.

### **CLOTHING/SURVIVAL EQUIPMENT**

Due to the presence of modern aircraft heaters, pilots tend to dress for a mission according to the temperature and weather conditions at the points of departure and destination. Think instead of flying your mission with an inoperative heater, or of spending a night in the high altitudes of a mountain environment due to a forced landing. The most important survival equipment may be the warm clothes you are wearing. Also evaluate the survival kit. Does it provide sufficient warm clothing and high-calorie food to endure the below-freezing temperatures found in the mountains, even in the summer months? A warm sleeping bag can be a lifesaver, especially in the event of injury.

### **NOTES:**

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# MOUNTAIN WEATHER

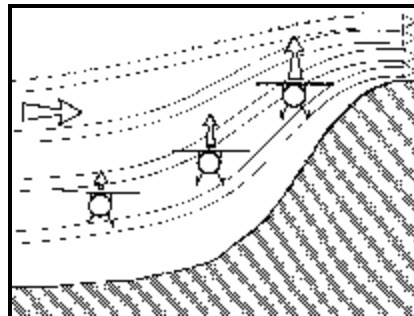
## Block 2 Mountain Weather

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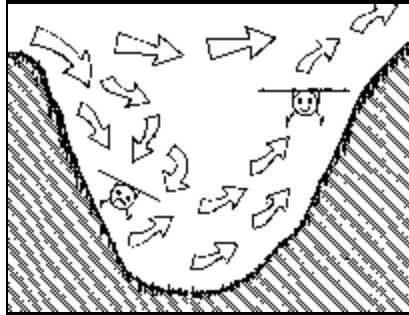
The weather patterns and hazards that a pilot experiences in flatland flying also apply to mountain flying. These include cold fronts, warm fronts, fog and thunderstorms. Moving air in the mountains is modified by canyons, peaks, ridges, valleys and ravines. This modification creates updrafts, downdrafts and turbulence. Steady-state wind flow may be modified by terrain features in the mountains so that local winds become variable. This is often responsible for the development of localized mini-weather systems within mountainous regions. These conditions reduce safety margins, making it important for the pilot to know and understand mountain weather phenomenon.

### WIND

In the United States, most mountain ranges are oriented approximately perpendicular to the prevailing westerly winds. On the upslope or “windward” side, the ride is smooth and the updrafts help climb performance. When air passes over summits and ridges and begins moving downslope, it can become unstable and turbulent. On the downwind or “leeward” side, there may be a



**Lift is obtained from flow up the windward side of the mountain**



**With wind across a valley, fly the upflow side**

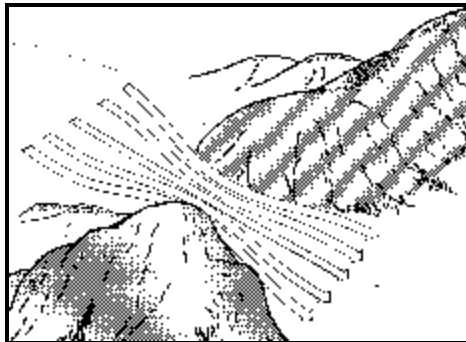
rough ride and downdrafts. Sometimes it is necessary to stay away from the lee side completely.

In the absence of frontal systems, the warming of air in the valleys by convection causes winds to blow up the valleys at about 6 to 8 knots in the mornings. This is called a *valley breeze*. A *mountain breeze* of about 10 to 12 knots may occur in the late afternoon or evening when cooling air slides down the valleys.

An unstable air mass, especially one containing appreciable moisture, is likely to produce clouds and perhaps thunderstorms as it rises over mountain ridges. The stability of the air depends on the change in temperature with changes in altitude. For dry air this "adiabatic lapse rate" is about 5.5°F per thousand feet, for moist air it is about 3.3°F per thousand feet. If the air does contain moisture, and depending on the stability of the profile, there will probably be afternoon thunderstorms over the mountains. Thunderstorms are generated by moist, unstable air when exposed to some lifting action. Before leaving on a mission, it is important to determine the moisture content of the air and its direction, velocity and temperature from the surface up to several thousand feet above the planned search altitude.



As wind crosses a ridge, a venturi effect may greatly accelerate the wind. A 30-knot wind may double to 60 knots or more when passing over a ridge. Wind passing through a mountain pass might cause the wind velocity to triple the steady-state wind. For these reasons, wind with a velocity of more than 30 knots can produce severe turbulence in a mountain environment.



**The venturi effect - wind flowing between two mountains will accelerate**

Lee-side turbulence is a function of the stability of the air and the severity or steepness of the mountain face on the lee side. A high mountain with a gentle slope, even with moderate wind velocity, may produce light turbulence

compared to a low mountain with a steep or a vertical slope that produces extreme turbulence.

Moderate winds in the presence of ridges rising 5,000 feet or higher above the local terrain often create a mini-weather system completely different from the weather in the surrounding area.

Stable air may create a cloud over a ridge top starting about a mile upwind of the ridge and usually extending a couple of miles downwind. There usually is not much vertical development. Violent swirls often develop under the crest, sometimes diving, sometimes rolling.

With unstable air, clouds often rise thousands of feet, sometimes building into towering cumulus and thunderstorms. It is possible to get into the downdraft part of a stable wave and not (initially) encounter any turbulence. Areas of this type should be avoided, especially if the wind exceeds 20 knots. Along the east face of one 10-mile long, 6,000-foot high ridge in the Appalachians, there are 14-aircraft wrecks resulting from such turbulence or downdrafts.

As opposed to the prevailing westerlies, an east wind will sometimes upset established weather patterns. Examples would be the Santa Ana winds in Southern California or Nor'easters along the Atlantic coast.

## **VISUALIZATION**



Look at the shape of the mountain to determine how air will flow over it and where the downdrafts are likely to occur. The above illustrations are typical situations.

## **MOUNTAIN WAVE**

When airflow over mountainous terrain meets certain criteria, a phenomenon known as a standing wave or mountain wave may exist. The three requirements for a standing wave are:

1. Wind flow that is within 30 degrees of perpendicular to the ridge, with velocities of 20 knots or more at mountaintop level.
2. A wind profile which shows an increase in wind velocity with altitude and a strong steady flow at higher levels up to the tropopause. The tropopause varies from 55,000 feet over the equator to around 28,000 feet over the Poles. It averages 35,000 to 40,000 feet in the latitudes of the U.S.
3. An inversion or stable layer somewhere below 15,000 feet.

Intensities of any given wave are determined by mountain height, degree of slope and strength of the wind flow.

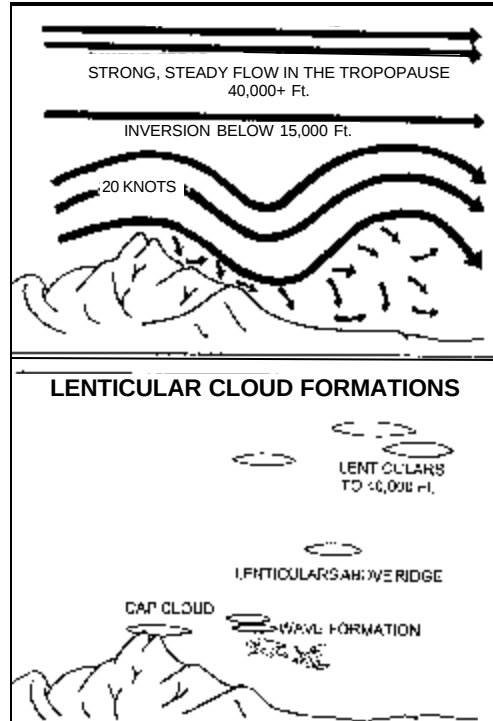
The inversion tends to hold the flow down at lower altitudes while the high upper flow accelerates the lower flow. When this air flow hits a ridge, the flow

is squeezed and a venturi-type acceleration may occur. A wave may form that can extend downwind from the ridge for many miles, often several times the height of the ridge. With a 50-knot wind, the turbulence can extend downrange hundreds of miles. Satellite photos have shown the wave extending over 700-miles downwind from the mountains.

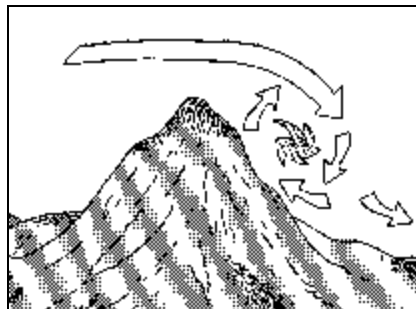


Associated with a standing wave in air containing sufficient moisture are the “sign-post” clouds indicating the wave:

- Lenticular clouds are the smooth and often lens-shaped clouds that are found at altitudes from just above ridges to more than 40,000 feet.
- Rotor clouds, which occur downwind and parallel to a ridge, may appear as a horizontal tornado or something as benign as a fair-weather cumulus. They can produce updrafts and downdrafts in excess of 5,000-8,000 feet per minute.
- Cap clouds appear as a stationary, white cap covering the top of a mountain. As with the lenticular, the wind may be flowing through this cloud at high velocity. As the air moves up the windward side of the ridge mois-



THE MOUNTAIN WAVE



Rotor cloud



Cap cloud

ture is condensed out, then causes dissipation of the cloud on the lee side as it moves down and the heat of compression reabsorbs the moisture. A major part of the cloud may extend upwind, with finger-like extensions running down the slope on the downwind side of the ridge. On ridges, the cap cloud may run the length of the ridge.

In a *dry wave* situation, the standing wave may exist with none of the characteristic cloud formations, but with all the associated updrafts, downdrafts and turbulence.

The existence of a standing wave indicates probable turbulence. The type of turbulence will vary from barely perceptible to extreme. Above the ridges you may encounter very smooth up and downdrafts. Don't expect lift below the ridge, or for that matter, above the ridge, all the time.

Meteorologists are able to accurately forecast standing waves. You can also predict a standing wave by requesting a printout of the air temperature and the winds aloft from the surface to 40,000 feet. If it shows wind velocity at the level of the peaks of 30 knots or more, with higher winds above and the wind direction relatively constant, then there is a good possibility of a standing wave.

In planning a mountain flight, a pilot who suspects or is informed by the weather briefer that a standing wave is forecast, should know what to expect and plan accordingly. Using visualization of the wavelength will show the areas of updraft, downdraft and turbulence (rotor). Check PIREPS and find out what other pilots are reporting. Consult with local pilots for the best routes to fly and routes to avoid. The search aircraft should have an extra measure of performance when flying during a period of mountain wave activity. Standing waves may last from two hours to two days.



When a strong wind, 20 knots or greater, is flowing over a mountain range, whether the flow is in the form of a standing wave or just wind flowing over a mountain, a potentially dangerous situation exists. The standing wave situation is more organized and predictable at altitudes above the summit. When there is a mountain wave or a strong wind flow, it is too dangerous to fly light aircraft near and below the ridges.

## CEILINGS AND VISIBILITY

The CAP weather minimums for VFR flight are three-miles visibility and a 1,000-foot ceiling. Because of the variability of terrain elevations in the mountains, five-miles visibility is recommended. Make cautious judgments regarding the ceiling.

Visibility in haze, rain or snow can be tricky. Ascertain that you can see at least five miles into a well-known area; increase the visibility requirement in unfamiliar terrain. Remember, the intensity of rain or snow showers and the

associated visibility may change rapidly. Rain also causes a visual illusion of being higher than you actually are. Sometimes in haze, rain, snow, and approaching darkness, the mountains are hard to distinguish from the clouds. Always have a safe escape where you can turn around and get back to good weather.

Be very cautious flying between rain or snow showers. Characteristically they will fill in the space you were hoping to fly through about the time you get there. This is true in the flatlands as well as in the mountains.

When low ceilings require flight close to the terrain, VOR reception is poor. Use GPS or LORAN, if available. False VOR indications can cause course bending in excess of 30 degrees, even when it appears that there is a good signal. Don't blindly believe what the VOR is indicating. Verify your position with visual check points.

Early morning fog pockets are common in valleys where there is lush vegetation and a close temperature/dew point spread. Fog usually burns off by 10 a.m. after the sun raises the temperature.

If the search area is under a fog bank, search the areas accessible or call Mission Base for instructions. Reports on search-area weather to Mission Base may be valuable to other search pilots and to Mission Base operations.

A weather report or forecast in the mountains of a 2,000-foot ceiling for an airport may sound good, but remember that there may be 6,000-foot ridges blocking the route to the airport. Ceilings are reported above ground level. Sometimes there are valleys to fly through. But, be careful because these valleys can be traps. During a search these areas may be high-probability search areas.

In the winter, visibility is usually much better due to cold dry air and more frequent ventilation of local haze and pollution. Watch for the usual weather patterns that occur throughout the United States. The limitation in the mountains is that you cannot always duck down to get under the weather. If flight is made at a low altitude, radio navigation and communications become difficult or impossible.

## **THUNDERSTORMS**

Thunderstorms in the mountains are caused by frontal systems, orographic lifting and convection.

### **Frontal Thunderstorms**

Frontal thunderstorms, usually associated with cold fronts, can be predicted with sufficient advance warning that they are not a surprise to anyone. Wait them out on the ground. Lines of thunderstorms imbedded in fronts usually do not cross the mountains as a line. The thunderstorms diminish after crossing medium-height ridges because of the interruption of the inflow of the vast amounts of moist air necessary to propagate or sustain a thunderstorm. They are still thunderstorms, however, and should be treated as such. Squall lines in advance of a cold front usually do not occur in the mountains. Squall lines are caused by the downflow of cool air from a fast-moving cold front. The mountains break this flow as it levels off near the surface, and inhibit the organized flow needed to produce the squall line.

### **Orographic Thunderstorms**

Orographic lifting occurs when a parcel of air is pushed up a mountain slope or rising terrain. If sufficient moisture is present, and the air is unstable, it may condense, producing enough heat to become a self-sustaining cumulus cloud and eventually a thunderstorm. Moisture-laden air pushed up along the west side of the Sierra Nevadas, the Continental Divide, or the Appalachian mountains often forms late afternoon thunderstorms.

### **Convective Thunderstorms**

When unstable air and clear skies are present, convective turbulence can be present in most areas of the country, including flatlands, rolling hills and mountains. The exception is over large bodies of water such as the Great Lakes. Unstable air, forced upward by ground heating, will rise until the temperature, through expansion and cooling, reaches the temperature of the surrounding air. When flying above this level, flight will be smooth. If there is enough moisture present, small cumulus clouds will start to appear. You will first feel light turbulence about mid-morning at 4,000- to 6,000-feet AGL. Through midday, this level continues to rise and the degree of cumulus cloud formation continues to increase. By afternoon, the level may increase to 10,000- to 12,000-feet AGL with cloud coverage becoming scattered to broken. Below this level expect moderate turbulence.

The afternoon is also the time some of the cumulus clouds start towering. Thunderstorms may begin to develop, depending upon the amount of moisture present, the lapse rate, and other factors that are not well understood. A towering cumulus that has wispy edges, as opposed to smooth edges, is an indication that it is drying out and evaporating as it rises. One that is really "boiling" and has smooth well-defined edges is not drying out. Keep an eye on these ... they may become full-blown thunderstorms.

In the absence of frontal activity, the best weather for mountain flying will occur during the morning and the late afternoon. Convection causes cumulus clouds to form in mountainous areas as moist air, warmed by the sun and trapped in the valleys, starts rising up the mountain slopes. This rising air picks up moisture from the lush vegetation and may form small to moderate-sized thunderstorms. Bases are sometimes not much higher than the tops of the mountains. The valleys and ridges also limit the air inflow and thus limit the size, but not the fierceness. These storms produce considerable lightning. The areas where this type activity occur are fairly predictable. The same-size thunderstorms in the same locations can be seen day after day during typical summer weather. It is common to have multiple-cell thunderstorms and downbursts.



Always have an escape path you know is clear. Don't take chances. Once an area has experienced rain, the ground will have cooled sufficiently to make it very unlikely that there will be another thunderstorm in that area the same day. However, remember that ground fog will likely form in these same valleys after sunset.

If, while searching, thunderstorms or towering cumulus are observed, broadcast over the radio what is visible and the grids where they are located. Even if Mission Base cannot hear the broadcast, transmission to "all aircraft" may be helpful. Also broadcast the areas that remain clear. Someone who gets rained out might find that information useful in returning to Mission Base.



Stay at least 20 miles away from a thunderstorm, whether in the mountains or in flatlands. Lightning can strike a mile or more in front of or beside a thunderstorm and up to 10 miles from the cell boundaries on the back side of the thunderstorm. Hail can be thrown from the anvil of a thunderstorm into the clear air immediately downwind of the anvil. There are recorded instances of hail occurring under the anvil in the clear air 10 miles ahead of the storm.

Haze can hide a thunderstorm, and it is possible to get closer than you should before you see or feel it. If a thunderstorm is suspected, but cannot be seen well enough to go around it, it may be better to turn around.

As in the flatlands, thunderstorms can be isolated or in groups. If there are a number of thunderstorms in the same area, they combine during the dissipation stage into a large area of light rain and low visibility. This is no weather in which to conduct a search.

If, during a search on a hazy day, there is a gray-hazy area that is darkening, start paying attention to it. You may not be able to tell if it is a towering cumulus, but if it appears to be a thunderstorm of any size, forget the search.

Contact Flight Service, advise them of your position and inquire what they see on radar. The Flight Service has weather radar that can see precipitation better than the ATC radar with circular polarization that is used for observing traffic; however, Flight Service cannot see you on their radar, so it is necessary to know your location accurately. If contact with Flight Service cannot be made, call the ARTCC or approach control facility and ask what they can see. It might be wise to ask them for vectors back to your home base to avoid thunderstorms.

If the Mission Coordinator, in listening to pilot reports and checking with the FSS, sees increasing thunderstorm activity, he will probably suspend the air search.

## TURBULENCE

Turbulence is not particularly easy to forecast. You can find it in many unexpected places. Sometimes it can be explained and sometimes it can't. Mountain wave action can be as smooth as silk, and yet a still, clear, early morning flight can have big bumps.

Turbulence can be divided into three general categories by cause:

1. **Convective** — Thermals occurring on a hot summer afternoon.
2. **Mechanical** — The wind flowing around and over mountains, buildings, trees, and obstructions.
3. **Shear** — Two air masses moving in different directions produce shear at their interface, such as that occurring with cold fronts and downbursts

The correct reaction to turbulence is to slow down. If the turbulence is light, be sure to slow the airspeed below the yellow range on the airspeed indicator. If moderate or greater turbulence is encountered, slow to maneuvering speed.

## WEATHER FORECASTS

Flight Service can provide a fairly accurate picture of current weather and forecasts in the flatlands. In mountainous areas the problem of mini-weather systems, caused by localized air flow over and around the mountains, makes forecasting less precise and more general in nature.

Always obtain a complete weather briefing, including the current reports and forecasts, before flying in the mountains. Always ask for pilot reports. On missions, talk to returning crews about the weather in the search area. After take off and approaching the search area, compare the weather encountered with the reported weather to assess the quality of the forecast. Weather can change very fast in the mountains due to localized conditions. Weather conditions different from forecast should be broadcast to Mission Base and all other mission aircraft. Always have a weather escape route to a safe airport, and don't hesitate to use it

if necessary.

**Tips on Mountain Flying** (Courtesy FAA Publication)

Pilots who understand the limitations of observations and forecasts usually are the ones who make the most effective use of the weather forecast service. Safe pilots continually view aviation weather forecasts with an open mind. They know that the weather is always changing and consequently, the older the forecast, the greater is the chance that some part of it will be wrong. The weather-wise pilot looks upon a forecast as professional advice rather than an absolute surety. To have complete faith in weather forecasts is almost as bad as having no faith at all.

Recent studies of aviation forecasts indicate the following:

- Up to 12 hours—and even beyond—a forecast of good weather, ceiling 3,000 feet or more, and visibility three miles or greater is much more likely to be correct than a forecast of conditions below 1,000 feet or less than one mile.
- If poor weather is forecast to occur within three to four hours, the probability of occurrence is better than 80 percent.
- Forecasts of poor flying conditions during the first few hours of the forecast period are most reliable when there is a distinct weather system, such as a front, a trough, precipitation, etc. There is a general tendency to forecast too little bad weather in such circumstances.
- The weather associated with fast-moving cold fronts and squall lines is the most difficult to forecast accurately.
- Errors occur when attempts are made to forecast a specific time that bad weather will occur. Errors are made less frequently, of course, when forecasting that bad weather will occur during some period of time.
- Surface visibility is more difficult to forecast than ceiling height. Visibility in snow is the most difficult of all visibility forecasts. Skill in these forecasts leaves much to be desired.

Available evidence shows that forecasters can predict the following at least 75 percent of the time:

- ✧ The passage of fast-moving cold fronts or squall lines within plus or minus two hours, as much as 10 hours in advance.
- ✧ The passage of warm fronts or slow-moving cold fronts within plus or minus five hours, up to 12 hours in advance.
- ✧ The rapid lowering of ceilings below 1,000 feet in pre-warm front conditions within plus or minus 200 feet and within plus or minus four hours.
- ✧ The time rain or snow will begin, within plus or minus five hours.

Forecasters cannot predict the following with an accuracy that satisfies present aviation operational requirements:

- The time freezing rain will begin.
- The location and occurrence of severe or extreme turbulence.
- The location and occurrence of heavy icing.
- Ceilings of 100 feet or zero before they exist.
- The onset of a thunderstorm that has not yet formed.

**NOTES:**

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# MOUNTAIN FLYING

## Block 3 Mountain Flying

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### MOUNTAIN WEATHER DECISIONS

A complete check of the weather is necessary to develop an educated go/no-go decision. Stay out of marginal weather areas.

Winds aloft greater than 30 knots at operating altitude usually denotes that the flight should be delayed or postponed until more favorable conditions prevail.

The most critical aspect of mountain flying is the weather. Spend some extra time developing a mental picture of the weather situation.

## BASIC PREMISES

The mountain flying search requires strict adherence to the following basic premises of mountain flying. Without exception, whether flying “in the mountains” or flying “over the mountains,” you must adhere to the two basic premises.

- Always remain in a position where you can turn toward lowering terrain.

While the novice mountain pilot should plan to fly 2,000 feet above the terrain along the route of flight, mission search pilots may fly as close as 500 to 1,000 feet from mountain ridges and terrain (providing the wind allows this operation).

This premise means you will never fly up a canyon, drainage or cove (short, rounded canyon) if there is not room to perform a turnaround maneuver. Narrow canyons, without space for a turnaround, are always to be flown from the top to the bottom.

- Never fly beyond the point of no return\*.

*\*The point of no return is defined as a point on the ground of rising terrain where the terrain out climbs the aircraft. The turn-around point is determined as the position where, if the throttle is reduced to idle, the aircraft can be turned around during a glide without impacting the terrain.*

*(It is not proper technique to reduce the throttle for the turnaround, this merely denotes the point where the turnaround must be initiated.)*

## ANTICIPATING TURBULENCE

### Wind Velocity and Turbulence

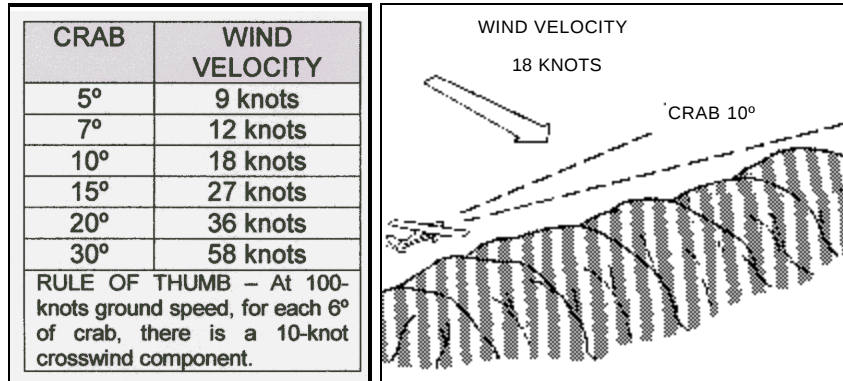
Most modern light aircraft can easily fly high enough to safely cross mountainous terrain in all but severe weather or in some mountain wave situations. In CAP searches, we need to get in close to the mountains in order to

| WIND VELOCITY<br>Knots | WIND RESULT<br>Precaution                                                                        |
|------------------------|--------------------------------------------------------------------------------------------------|
| 0-10                   | Not much of a problem                                                                            |
| 11-15                  | Light turbulence                                                                                 |
| 16-20                  | Use caution on the lee side, expect updrafts on the windward side and downdrafts on the lee side |
| 21-24                  | Stay away from the lee side of severe slopes                                                     |
| 25-34                  | Stay 2,000 feet above the terrain                                                                |
| 35+                    | Severe turbulence over and downwind from the mountains. Do not fly in the mountains              |

### WIND FLOW AND FLIGHT OPERATIONS

This table provides rules of thumb pertaining to wind velocity and mountain operations.

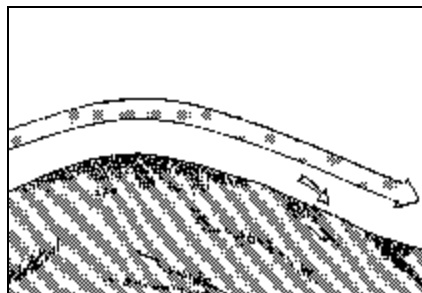
better scan the terrain. To do this it is necessary to fly beside and below the ridges. This is “true mountain flying” as opposed to flying over the mountains. This is where the most severe turbulence occurs. In a strong wind situation, only certain areas on the windward side can be searched, leaving the lee side for a better day.



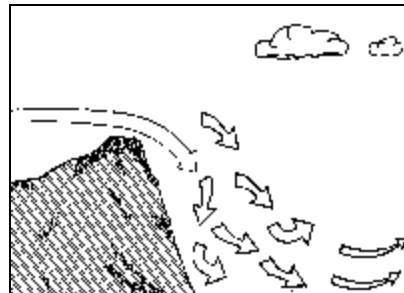
**RELATIONSHIP OF CRAB ANGLE AND WIND VELOCITY**  
Air Speed, 100 Knots - Wind Perpendicular to Ridge

On days with light to moderate winds, the pilot needs to get a feel of the winds before venturing below the ridge line on the lee side. This can sometimes be done by flying over a ridge and parallel to it, assessing the amount of crab required to maintain straight flight along the ridge. This crab angle can provide a close approximation of the wind velocity from the above table.

If you decide to try lee side contour flying, first try out a slope that is gentle with a good escape available. A severe (steep) slope will produce the most severe turbulence. In a downdraft, the air near the top of the slope may be smooth



Wind flow over a gentle slope



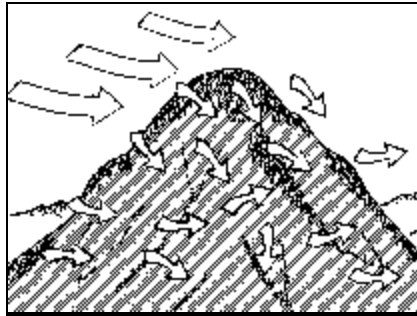
Wind flow over a severe slope

When the wind is blowing, try experimenting on a lee-side gentle slope before trying a severe slope.

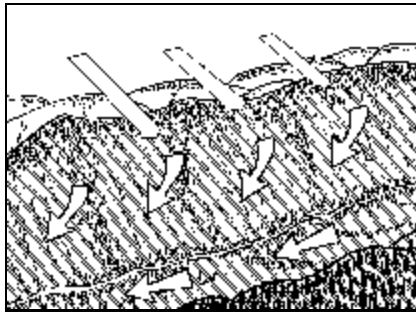
extending several hundred feet down. Watch the vertical speed indication. If it is high, approaching 1,000 fpm down, you will quite likely experience some severe jolts. At the first sign of rapid altitude loss or severe bumps, turn away from the ridge.

It is possible to fly in relatively strong winds on the windward side of a mountain or ridge. Consider the effect, through visualization, that mountains located upwind of a windward slope might have in producing unexpected turbulence.

For most flights you can use visualization to fly through a canyon picking areas of updraft and downdraft. Occasionally the visualization doesn't work and you are not able to climb or get out of a downdraft. Because this can (and will) happen, maintain a position where you can turn toward lowering terrain. Move to another position even if you think this may be a stronger downdraft area. Mother Nature tries to maintain a balance in the atmosphere. If there is a downdraft somewhere, there has to be a compensating updraft elsewhere. Your job is to find it. Updrafts tend to be smaller in size than downdrafts. Updrafts will usually be on the opposite side of the valley from the downdrafts.



**Turbulence is encountered to the side as well as the lee side**



**The winds aloft will often line up with a valley**

When encountering moderate to severe turbulence, slow to maneuvering speed. This allows the airplane to perform an aerodynamic stall, to relieve stress, rather than "break" the airplane prior to the stall.

## **CROSSING RIDGES**

### **VISUAL ASPECTS OF CROSSING A RIDGE**

The visual aspects of mountain flying can be deceiving making it difficult to determine if there is adequate altitude to cross a ridge. If you can see more and more of the terrain on the other side of the ridge, you are higher than the ridge and can probably continue (unless a downdraft is encountered over the ridge).

As you near a ridge and have arrived at a position where, in your judgment, the power can be reduced to idle and the airplane can glide to the center of the top of the ridge line, a commitment to continue across the ridge can be made. At this position, the airplane has been maneuvered close enough to the ridgeline without experiencing a downdraft, so that any downdraft that is encountered will not be strong enough to cause a problem. If a downdraft is encountered, apply full power and lower the nose to maintain airspeed.

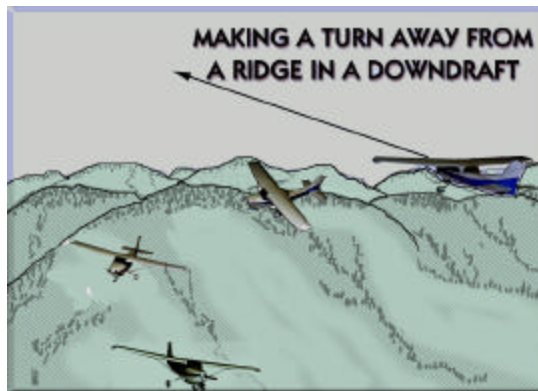
### WIND SHEAR HAZARD

It is dangerous to fly directly towards the lee side of a ridge when slightly above, level or below the ridgeline when the wind exceeds 10 knots. It is particularly hazardous to descend while approaching the lee side. In addition to turbulence and downdrafts, strong wind shear and wind direction reversal can occur. A 20-knot wind that reverses its direction of flow results in a 40-knot wind shear. When flying through such a shear at  $V_Y$ , the airspeed may instantaneously drop below stall speed, allowing the nose to drop to near vertical with no warning.

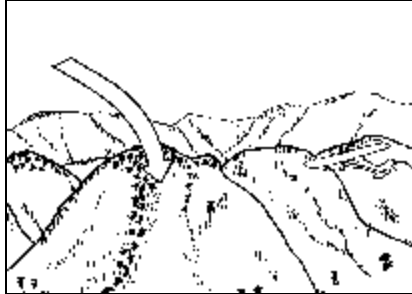
### ESCAPING DOWNDRAFTS

When crossing ridges or a series of ridges while heading generally into the wind, you should always turn to approach the ridge at a 45-degree angle when within 1/4 mile of the ridge. Choose your crossing point and anticipated direction of turn (right or left) so that the turnaround path will be free of obstructions. This provides the option of escaping toward lowering terrain and reversing the course with only a 135-degree turn rather than a 180-degree turn.

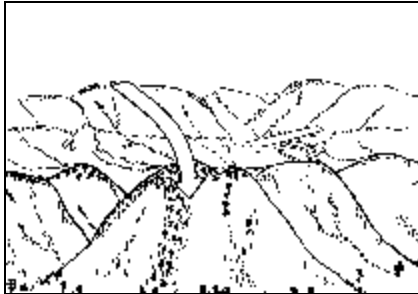
Assume that you have chosen a good escape route. While attempting to cross the ridge at a 45-degree angle, you find yourself descending in a strong downdraft. If it is doubtful that you can safely cross the ridge, start the turn immediately, heading away from the ridge. Apply full power and fly in a climb attitude at maneuvering speed. The aircraft may still be descending. It is important to get as far away from the ridge as possible as quickly as possible. The further away from the ridge, the less downdraft and the less turbulence will be encountered.



**Making a turn away from a ridge in a downdraft**



The aircraft is approaching a ridge at a 45-degree angle. A downdraft is present, but the airplane has to get close to the ridge before experiencing its effect.



If you can see more and more of the terrain on the other side of the ridge and you are in a position to glide, power-off, to the ridge, it is safe to continue.

Maneuvering speed is used because it is the fastest speed possible that prevents overstressing the aircraft in severe turbulence. Although the transition to maneuvering speed may increase the rate of descent, the overall time period the airplane is in the downdraft is shortened, resulting in less altitude loss.

Initially the downdrafts are smooth and you may not even realize you are in one unless you are watching your vertical speed indicator. For this reason, monitor the vertical speed indicator in the mountains. Typical downdrafts are 1,000 to 1,400 feet-per-minute and on occasion may be much higher.

Flying in a downdraft area may produce a sudden and severe jolt, similar to hitting a curb in an automobile. Next may be a lull followed by another bump or series of bumps. The jolts may come from all directions, vertical and horizontal. Sometimes the turbulence is severe enough to tip the airplane up on one wing. It keeps you very busy and it may be difficult to maintain full control.

Be careful not to over-control, especially with the elevator control. Fly an attitude and accept altitude loss. When the airplane approaches lower terrain, the severe turbulence will subside, sometimes as suddenly as it began. At this point, the airplane may still be unable to climb, as the air above is still cascading down. It may be possible to climb to a certain altitude and then the rate of climb goes to zero. It may be necessary to fly toward a windward slope or some distance downwind from the ridge that is causing the downdraft before the airplane can establish a positive rate of climb.

While maneuvering to get out of the downdraft, if the situation looks critical, all available power may be required. With a constant speed prop, advance the control for low pitch (high RPM). Lean the engine for maximum power. If

the engine incurs extra stress, so be it. This is preferable to the stress caused by running into trees.

Downwind of the downdraft may be sloping terrain on the windward side of higher terrain that can be used to gain back the lost altitude. The upslope flow is usually smooth. Regain the lost altitude and try crossing again. This time, climb 2,000 to 3,000 feet above the ridge while several miles downwind of the ridge.

Crossing ridges while flying in a downwind direction usually dictates flight directly at the ridge, rather than at a 45-degree angle. This depends on the altitude as the ridge is approached. A straight line is the quickest way to put distance between you and the ridge.

In a high wind condition, a downdraft may be encountered even if you are 2,000 or 3,000 feet above the ridge. Expect downdrafts and turbulence when the wind is strong.

Some of the accidents caused by a pilot encountering a downdraft are due to the pilot's concern about altitude loss, rather than an escape away from the ridge that is causing the downdraft.

Flying at maneuvering speed, rather than the best rate-of-climb airspeed, will place the airplane farther away from the slope in less time. The difference in altitude loss may be as little as a 100-feet per minute difference while flying at  $V_A$  rather than  $V_Y$  during the time required to get out of this area. The total altitude loss, even though the rate of descent is greater when flying at maneuvering speed, will be less overall.

An example is given in the following table.

|                                    | Speed<br>Knots | Rate-of-<br>Climb,<br>FPM | IN 30 SECONDS                     |                        |
|------------------------------------|----------------|---------------------------|-----------------------------------|------------------------|
|                                    |                |                           | Distance<br>from<br>Mountain, ft. | Altitude<br>Loss, Feet |
| Maximum Angle of Climb             | $V_X$          | 500                       | 3,050                             | 450                    |
| Maximum Rate of Climb              | $V_Y$          | 600                       | 3,813                             | 400                    |
| Rate-of-Climb Maneuvering<br>Speed | $V_A$          | 400                       | 4,575                             | 500                    |

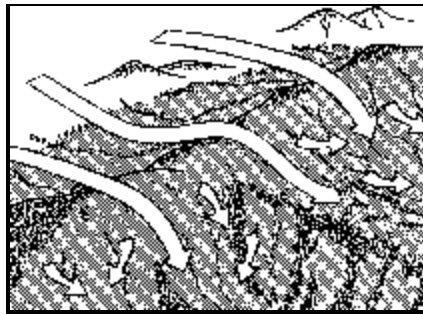
**DISTANCE FROM THE MOUNTAIN VS. ALTITUDE LOSS IN 30 SECONDS**  
**1,400 FPM downdraft**  
**Cessna 172, 160 HP, full power**  
**Altitude 3,500 feet ASL, Temperature 75°F**

With full power and flight at maneuvering speed in a 1,400-fpm downdraft, the angle of descent is six degrees. The angle of descent at  $V_Y$  and  $V_A$  are approximately the same under these conditions.

During the 30-second escape maneuver, maintaining  $V_X$  results in 450-foot altitude loss while traveling 3,050 feet downwind from the mountain. Flight at  $V_Y$  results in 400-foot altitude loss and a distance from the mountain of 3,813 feet. Although flight at  $V_A$  resulted in a total altitude loss of 500 feet, the distance from the mountain is increased to 4,575 feet.

This translates to a loss in feet-per nautical mile of 896 at  $V_X$ , 637 at  $V_Y$ , and 664 at  $V_A$ . This should prove that it is best to fly at  $V_A$  in a downdraft.

When crossing a ridge that is perpendicular to the wind, try to find a ridge



**Avoid downdrafts by flying above the ridges parallel to the wind flow**

extending off from that ridge, downwind and parallel to the wind flow. This ridge will act as a ramp and tend to keep the wind from diving and developing downdrafts. It is important to remain directly over the downwind ridge.

Also, in crossing a ridge, if you can find an area with a more gentle slope as opposed to a severe face, you would be much more likely to avoid a downdraft. Try to visualize the manner in which air will flow over the

mountain's surface.

All up and downdrafts are not necessarily associated with ridges. Sustained up and downdrafts can occur anywhere.

## CANYON FLYING

During a search it may be impractical to fly to the head of each canyon and then fly down the sloping terrain. If the canyon is not steep and if it is wide enough to allow a turnaround, it is acceptable to fly up the canyon, but only when it is certain that a turnaround maneuver can be successfully accomplished.

### Rules of Thumb for Canyon Flying

- Never enter a canyon if there is not room to turn around.
- Always remain in a position to be able to turn toward lowering terrain.
- Never fly beyond the point of no return.
- Fly along one side of the canyon to provide the full canyon width to turn.

To determine if there is enough room to turn around in a canyon, climb above the canyon and while flying directly above one side, make a 180-degree turn while observing the canyon walls below. This will enable you to visualize whether there is enough room to make the turn in the valley. Allow yourself a generous safety margin; turning downwind, or into a downdraft, will decrease this margin.

A stratus layer at the top of the mountains will force pilots to fly through the valleys. Several rules should be adhered to for valley flying. In remote areas without weather reporting, telephone and check the destination weather before takeoff.

- ✓ Always make sure you can see through the valley to the other side of a pass.
- ✓ Always fly to one side of a valley in case you need to make a quick turn around.
- ✓ Be proficient in performing slow, steep turns in order to make a quick turn-around in the minimum space.
- ✓ Know your reciprocal heading before you turn in case you get disoriented or brush through scud.

One scenario for disaster is trying to sneak through a mountain range in hazy weather with an indefinite ceiling obscuring the mountain tops. The pilot may try following a rising valley that ends in the overcast. This may result in collision with higher terrain along the sides or at the upper end of the valley. This makes the faces of high terrain along the flight path a high probability search area. Several recent accidents may have been caused by this response to low ceilings and low visibility.

### **POWER LINES**

Power lines are often strung across canyons and rivers. You must be alert, looking more for the support structures than the actual lines. Depending upon the light condition, the wires may be very difficult to see.

### **FLIGHT THROUGH VALLEYS AND STEEP TERRAIN**

When it is necessary to climb, climb in an open area where there is plenty of room to maneuver. Never fly toward a rising slope or valley. Sometimes orographic lift will assist the climb. If it is necessary to follow a valley through a pass, ascertain that the airplane is high enough to clear the pass before entering the valley. Obtain the height of the pass from a sectional chart. Fly to one side before starting through to allow room to make a 180-degree turn if it becomes necessary. If there is not much room to turn around and you can't see through the

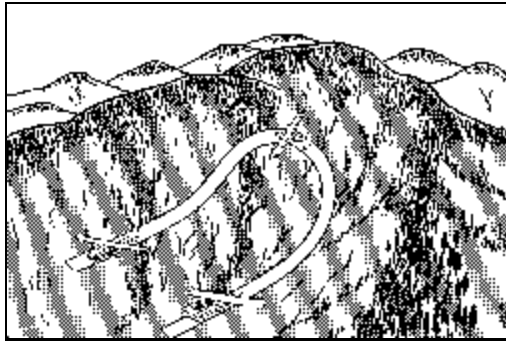
pass, don't start. Many aircraft have been lost in the mountains because they did not heed these safety precautions.

If you do get into a tight place and need to turn around, the sooner you start, the better.

There are generally two critical situations, one where you can climb and one where climb is restricted.

### Modified Wingover

First, assume we are flying into a cove during a contour search. After starting in, it becomes apparent that it will be impossible to make the planned turn. It is a clear day, with no restriction to limit a climb. One escape procedure is to perform a modified-wingover maneuver. This turn allows the aircraft to slow down, climb and make a 180-degree turn to the reciprocal heading all at the same time.



**The modified wingover used for course reversal in restrictive terrain.**

To perform the modified-wingover turn:

- ✗ Apply back pressure to pull the nose up rather steeply, about 30 degrees of pitch.
- ✗ As the airspeed decreases to about 70 KIAS in the Cessna 172, promptly apply rudder in the desired direction of turn.
- ✗ Keep the ailerons neutral.
- ✗ Ninety degrees through the turn relax the back pressure and rudder pressure.
- ✗ The aircraft will have assumed about a 30- to 45-degree bank during the turn and will continue to turn.
- ✗ As the airplane completes the 180-degree turn, apply back pressure gently and level out before you build up too much speed.

The diameter of the turn will be about 650 feet (325-foot radius). This is not the aerobatic wingover where a 90-degree bank is used. The aerobatic wingover should not be used. Pitch should not exceed 45 degrees. You will probably have gained a little altitude. This maneuver can be entered at search

speed, at cruise speed or while in a climb. Pulling the nose up reduces the airspeed, which also reduces the turning radius.

### Steep Turn

Many pilots prefer the steep turn method of course reversal:

- ✗ Maintain power.
- ✗ Trade airspeed in excess of the speed for best angle of climb for altitude by climbing.
- ✗ Make a 180-degree turn at a 60-degree bank. The steepest bank at the slowest speed results in the smallest radius of turn.

The Cessna 172 can be safely flown in a 60-degree bank at 75 KIAS. This translates to a 288-foot radius of turn (compared to 325 feet for the modified wingover).

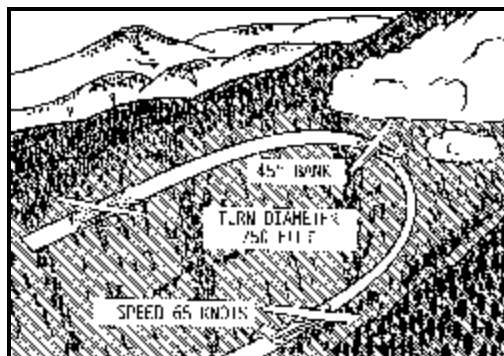


Expect to lose altitude when performing a steep turn at a high density altitude.

The second critical situation involves flight through a valley because of a restrictive ceiling. The airplane should be flown on one side of the valley. In this example, the valley narrows, the ceiling lowers, and there is a need to turn around.

- ✗ First, we note our reciprocal heading in case we accidentally brush through some clouds.
- ✗ Here, we can't trade speed for altitude because of the restrictive ceiling.
- ✗ We must reduce our speed by reducing our power substantially.
- ✗ As soon as we slow down, we apply full power and start as steep a turn as we can safely make.
- ✗ Consider the use of partial flaps to reduce stall speed.

In a Cessna 172, at maximum allowable gross weight, the stall speed in a coordinated, 45-degree bank, with no flaps is 53 KIAS. The airplane may be safely flown at 65 KIAS while performing a 45-degree bank turn to reverse course. The diameter of the turn will



**Course reversal in a narrow valley with a low ceiling.**

be about 750 feet. If it looks like the airplane may not clear the other side of the valley, steepen the bank to 60 degrees. If the terrain allows, some altitude loss in the turn is acceptable.



**NOTE:** The turn diameter figures for the above example are for sea level conditions. The diameter of the turn increases by approximately 4-percent per thousand feet of density altitude.

## MOUNTAIN AIRPORTS

Mountain airports and airstrips come in all varieties, shapes and sizes. Many of them have non-standard approaches because the standard approach is blocked by a mountain or ridge.

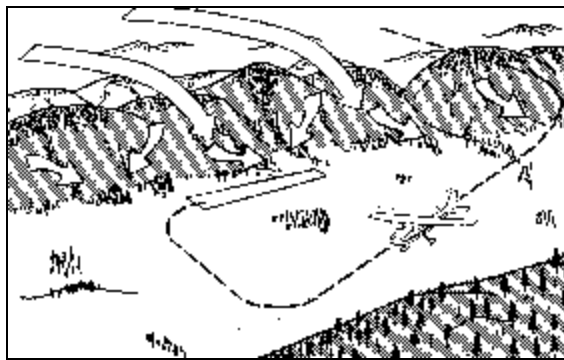
Talk to local pilots to determine proper approach and take off procedures. Some mountain runways are one way. That is, you land uphill and take off downhill, without exception, because of terrain constraints.

At sloped airports, unless the wind is over 10 to 15 knots, it is often better to land uphill with a tailwind rather than downhill with a headwind. A judgment call based on your knowledge of the airport and your experience may be required.

Choose a go-around point based on the landing performance of the airplane. If the airplane requires 1,000 feet to land and the airport is 2,000-feet long, the go-around point would be the half-way point of the runway.

In gusty conditions, follow the rule of adding one-half the wind-gust speed to the approach speed.

Some airports are located in a valley along the lee side of a mountain. If there is a strong flow of air over the ridges, it is wise to turn away from the mountain after takeoff, regardless of the normal traffic pattern. When descending into a valley to land, descend on the downwind side of the valley to avoid the turbulent downdrafts on the lee side of the upwind terrain. Usually, the turbulence will be more manageable at the lower altitudes.



**DESCEND ON THE DOWNWIND SIDE OF A VALLEY TO AVOID TURBULENT DOWNDRAFTS.**

When approaching to land at an airport with ridges on either side, be a little creative with the pattern. Fly the pattern that will result in the safest operation. Announce your intentions on the radio.

One method used by some pilots, similar to the military overhead approach, is to fly directly over the runway at pattern altitude in the direction of landing. Maintain altitude while maneuvering to the crosswind leg and onto the downwind leg.

### RUNWAY LENGTHS



A handy rule of thumb for operating from a short runway in calm winds is that if you obtain 71 percent of the speed necessary for rotation at the halfway point of the runway, you can takeoff in the remaining distance. This guarantees takeoff performance, but not sufficient rate of climb for terrain clearance.

### UPHILL VERSUS DOWNHILL TAKEOFF

Landing on a sloping runway requires the proper technique. When landing uphill, extra flare and greater nose up attitude is required. Otherwise, the landing is too flat and the airplane may bounce along the runway.

On the other hand, landing on a downhill runway with a little extra speed may result in a float with a glide that approximates the same angle that the runway is descending.

It is a good idea to check the AIM Airport Facilities Guide for all pertinent information before going into unfamiliar mountain airports. Some states publish excellent aeronautical maps and airport directories.

Some airports, especially in the Western States, have a mountain or a blind valley blocking one end. In this case it is a mandatory one-way approach and landing with no go-around. Plan very carefully. Some mountain airports become one-way only at night due to night visibility limitations.

To decide whether to take off downhill with a tailwind or uphill with a headwind we can use the following formula to approximate the break-even headwind for your airplane based on the runway slope, the POH takeoff distance, and your POH liftoff speed converted to KTAS. The break-even headwind is the uphill headwind component for which it would not make any difference which direc-

$$V_{TW \text{ Breakeven}} = \frac{0 \times d_{LO}}{5V_{LO}}$$

tion you took off. If the actual local wind component is lower than the break-even headwind you take off downhill with a tailwind. If the actual local headwind

component is higher than the break-even headwind you takeoff uphill into the wind.

The formula is:

Where:

$\theta$  is the slope of the runway in degrees

$d_{lo}$  is the POH no-wind takeoff distance at the local altitude/temperature on a flat surface of the same type

$V_{LOT}$  is the liftoff speed from the POH converted to KTAS.

If you don't know the slope of the runway, taxi to each end of the runway and note the altitude change. Divide that number by the length of the runway. Use the chart on the right.

| $\Delta h/L$ | Runway Slope |
|--------------|--------------|
| 0.00         | 0.00°        |
| 0.01         | 0.57°        |
| 0.02         | 1.15°        |
| 0.03         | 1.72°        |
| 0.04         | 2.29°        |
| 0.05         | 2.87°        |
| 0.06         | 3.44°        |
| 0.07         | 4.01°        |
| 0.08         | 4.59°        |
| 0.09         | 5.16°        |
| 0.10         | 5.74°        |
| 0.11         | 6.32°        |
| 0.12         | 6.89°        |

## CLIMB OUT

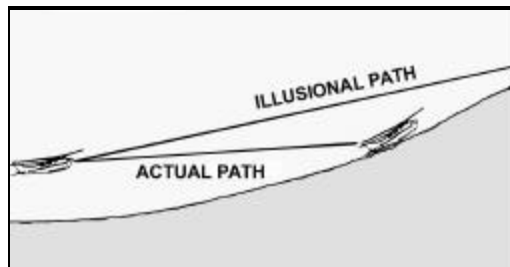
The first consideration for takeoff from an airstrip surrounded by mountains is terrain clearance. A considerable amount of time may be required circling to climb to the en route altitude prior to turning on course.

## SENSORY ILLUSIONS

### True Horizon versus Apparent Horizon

Perhaps one of the greatest causes of accidents in mountain flying, especially in search flying, is the perceptual illusion of rising terrain appearing less steep than it is in actuality. This illusion is especially deceptive in less rugged terrain such as alluvial fans, mountain bases and valleys.

Most of the time, while flying in the mountains, there is no visible true (natural) horizon. A pilot, inexperienced in mountain flying, encountering a gentle slope that is rising up to a distant ridgeline may mistake the ridge as the



Pulling up to avoid the terrain often causes a stall due to slow airspeed. ✓ Never fly perpendicular toward rising terrain. ✓ Approach at a 45-degree angle or circle before continuing.

horizon. If this pilot is flying lower than the ridge, he may unconsciously be climbing toward this false horizon. This may lead to the pilot's sudden realization that the aircraft is too close to the terrain and that the airspeed has decayed. In this situation, many pilots pull up the nose by reflex, only to discover there is no excess airspeed, causing the aircraft to stall too close to the ground for recovery.

When flying in the mountains be aware of the altitude of all ridges and terrain in the search area and along the route to and from the search area. Monitor the airspeed and rate of climb while approaching within a mile of a ridge. While in level flight, the airspeed should be at the proper indicated cruise speed for the altitude and power setting. The vertical speed should be at zero and the altitude should remain constant. If you think you are level and the airspeed is low and/or the vertical speed indicator shows a climb, the airplane is probably in a climb attitude and the pilot is experiencing an illusion.

Illusions of this type can also occur when making steep turns, especially within 500 feet of the terrain or when circling at low altitude. It is because of situations like these that the pilot is to spend full time flying the aircraft and not allow distractions or participation in ground scanning.

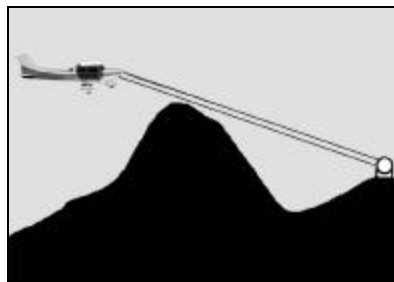
## REPORTING EMERGENCIES

While flying in the mountains, determine the best frequency to use for reporting emergencies. The emergency frequency of 121.5 MHz may not always be the best one for the area where you are flying. An ATC Center frequency that has a remote repeater or a remote FSS frequency may work better. Try it out. Just ask for a radio check. The best time to determine this is before there is an emergency.

## MOUNTAIN FLYING AT NIGHT

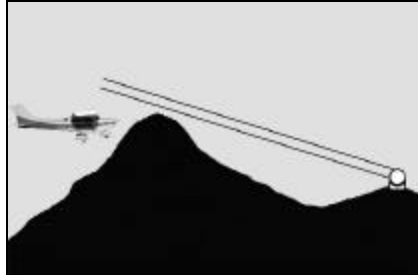
Around mountain towns at night you can see the lights of the towns and the yard lights in the surrounding areas, but mountains on a dark night appear as large, dark, ill-defined shapes, if visible at all. Know where you are at all times, and make sure you have plenty of altitude to clear the terrain.

If flying VFR and receiving vectors from ATC, don't count on them providing terrain clearance unless you ask for it and they agree to provide advisories. Even if you are receiving vectors with terrain clearance, and you are not comfortable with what you see (or don't see), ask about the surrounding terrain or ask for a higher altitude.



**Crossing mountains at night. When lights are visible ahead—Okay**

If you are flying straight and level and have a mountain in front of you, but you can see lights of a town or road in the distance ahead of you, you will clear the mountain. If you cannot see lights, then there is some doubt. Check your sectional for terrain elevation. If you are uncertain about your position, climb or reverse course.



When crossing the mountains VFR at night, it is comforting to follow roads. It helps keep track of your position and if you do have an emergency, it will be better to have it by a road. It is also a good idea, in the mountains or anywhere, to contact ATC to obtain flight following.

**Crossing mountains at night with no visible lights ahead - ???**

Keep a close eye on the temperature/dew point spread, especially when it is clearing up after a rain during the day. Use caution when the spread is fewer than 4°F. The earth is giving up its heat rapidly and the temperature/dew point can come together quickly. You may first notice little patches of fog in the low areas. If they start growing and filling in, it is best to get back to an airport and land as soon as possible.

What if you experience a power loss at night in the mountains and there are no lights or roads around? Complete the usual emergency cockpit check. If you see a light of any kind, head for it. Sometimes lakes and rivers show up at night, even with starlight illumination.

If all you see is a black void, extend full flaps, trim for nose up at a speed just above stall speed. The indicated forward speed, depending on the type of aircraft, will be about 45 knots and the vertical descent will be about 500 fpm.

If your model aircraft, with full flaps extended, causes a descent in excess of 700 fpm, use the one-half flap setting. This is the best compromise. Turn the fuel valve off. Turn on the ELT, if you can. Turn on the landing light and try to find some soft trees. Put something in front of your face just before impact. We will come and find you.

## SAFETY AND EMERGENCIES

Each emergency situation is different and the most important ingredient in any emergency action is always good judgment.





# MOUNTAIN SEARCHING

## Block 4 Mountain Searching

|                                                   |      |
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| ➤ GRIDS .....                                     | 4-1  |
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### LOCATING AND REMAINING WITHIN SEARCH GRIDS

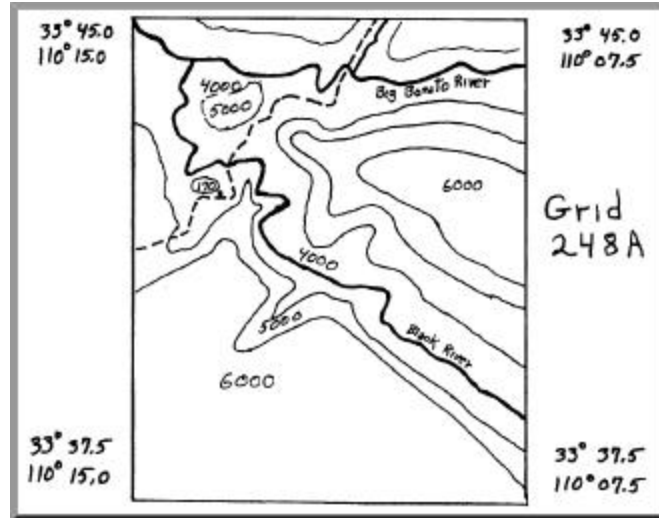
Virtually all CAP aircraft are equipped with GPS or Loran and many CAP members possess handheld GPS units. These two navigation tools will be considered the principal method of navigation for mountain searching. However, don't rely solely on them.

#### GRIDS

When you are assigned a grid to search, draw a large square on a piece of paper and write the coordinates of the grid at each corner. Using the sectional chart, pick out the principal ridges and sketch them in with elevations. Sketch in individual mountains, prominent valleys and rivers and anything else you may use to reference your position within that grid. Review this with your crew before

you takeoff so everyone has a good idea of the terrain you will encounter.

Plan the entry corner and, if able, input the coordinates in the GPS as a waypoint. Take off and track to the entry corner waypoint. Approach the grid 2,000 feet above the general terrain elevation. Verify



**Draw your grid on a piece of paper. Write the coordinates at each corner. Sketch in major terrain features.**

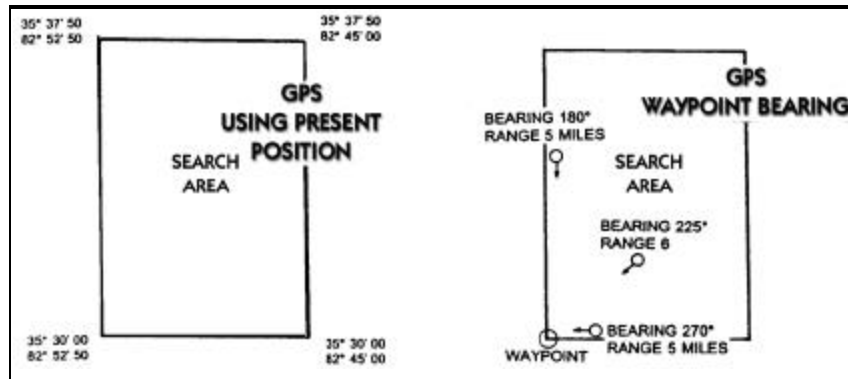
the entry corners with both the GPS and visual terrain features. Take the extra time to fly over your grid and identify each corner visually. You don't necessarily have to fly directly over each corner, but fly to where you can visually identify each corner.

If there is a wind, assess the areas where the wind passes over severe slopes as probable downdraft producers. This is a good time to add additional features to your hand-drawn grid map. This is also the time to plan your search strategies, agree on a course of action and descend to search altitude.

When a crash site is located, set the GPS to allow immediate capture of the crash site coordinates as you fly over. This may be the "hold" feature of the unit. When you report the location of a crash site, report the latitude, the longitude and the altitude. The altitude report should include both the altitude from which you see the crash site and, as accurately as possible, the actual altitude of the crash site. This is of special interest to ground teams going into the area as well as subsequent aircraft arrivals.

It is important to accurately remain in your assigned search grid to assure complete search coverage and to avoid conflict with aircraft searching in adjacent grids. It is not always easy to do this visually. The most popular method is to compare the lat/long readout from the GPS to the coordinates on your hand drawn map.

Another good method is to establish a corner of your grid as a GPS waypoint. Set the GPS to read true bearing and distance to the waypoint. By watching the bearing and distance from the corner, you continually know your position relative to the two boundaries radiating from that corner.



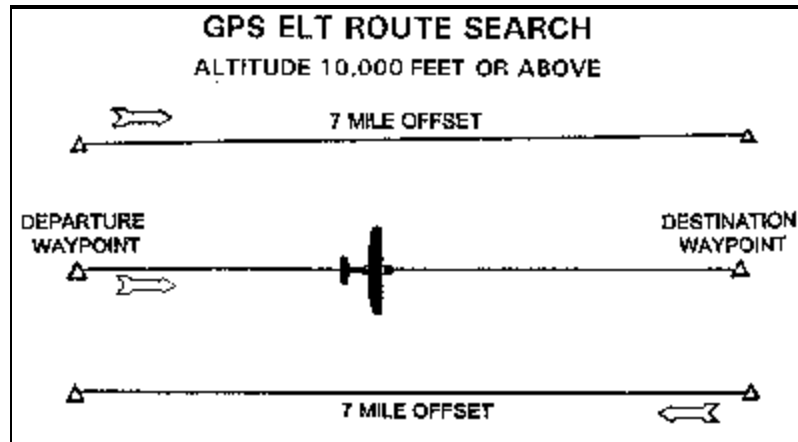
**Technique for remaining in the assigned search grid using GPS**

In the above illustration, the southwest corner of the grid has been selected and entered into the GPS. As long as the bearing is between 180 degrees and 270 degrees, you will be located to the east of the waypoint (east and north of the western and southern boundaries). With the distance about 6 miles, you are located within the grid area. To the north, the distance may increase to 7.5 miles. If the bearing to the waypoint exceeds 270 degrees, for example, 280 degrees, then the airplane is south of the southern boundary. If the bearing to the waypoint is fewer than 180 degrees, then the airplane is west of the western boundary of the grid.

Yet a third good GPS technique is to set up waypoints at the north and south corners on one side and then monitor the distance from that course line.

When you first arrive at an unfamiliar mountain grid, all the mountains may look alike. You may start a contour search on one ridge and end up on a different ridge. The more time you spend in this grid, the more familiar you will become with its features and navigation will become easier. Indicate on the hand-drawn map the areas that were searched and make other notes appropriate for crew debriefing.

When you are ready to depart the assigned grid and return to Mission Base, climb to a higher altitude that is suitable for your return leg. Navigate by the most appropriate method.



Using GPS for an ELT route search

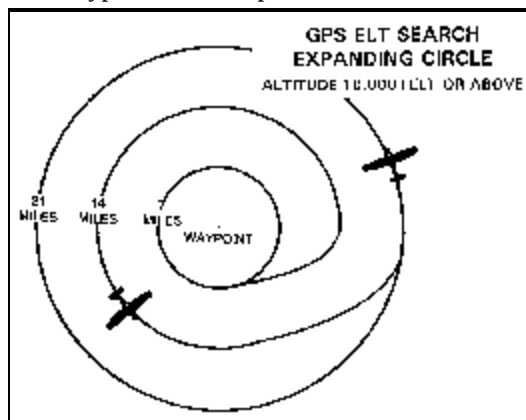
### ELT SEARCHES

ELT signals in mountainous terrain may be severely localized, especially if the crash site is in a valley or on the side of a mountain.

If you are assigned a route search for an ELT signal, set up departure and destination waypoints. The ELT search should be conducted at as high an altitude as is safe and practical.

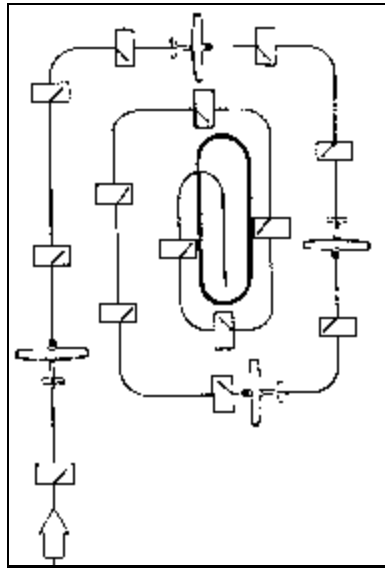
Fly the initial assigned route. If no ELT signals are heard, set up and fly a seven-mile-offset course (a course parallel to the original course) on each side of the original course. Use GPS waypoints to set up the offset course. If no results, expand the search to a 14-mile offset. Depending on the circumstances and judgment, more offsets may be justified.

Suspected areas of deep canyons should be searched individually. ELT signals bounce around in the mountains, often making identification of the crash site difficult. Calling in ground teams can be a big help in this case.



The GPS expanding circle ELT search technique.

Electronic searches can be conducted under IFR conditions and at night. They should be conducted as soon as possible, before the ELT batteries run down. This is especially true in mountain searches with low nighttime temperatures, even in the summer.



**Box-pattern ELT search**

If there is a suspected crash area for the ELT signal search, one option is to set a waypoint in the center of the area and fly concentric circles around this point with the GPS indicating a constant distance from the center (like a DME arc). For mountainous terrain the radius should be increased five to seven miles at a time depending on your knowledge and familiarity of the terrain. Conduct this search at the highest practical altitude to enhance ELT signal reception.

Sometimes tracking an ELT signal in the mountains can be frustrating due to signal bounce that causes fluctuations of the DF needle. One tracking method that helps is the *box method of tracking*. Fly a cardinal direction that gives a full needle deflection, let's say to the right.

After tracking the original heading for a few minutes turn right 90 degrees and see if the needle still gives a right deflection. If it does fly the new heading for a few minutes and make another right 90-degree turn. Continue doing this until you have flown a box and have determined that the signal is coming from somewhere within the box. Fly smaller and smaller boxes by timing the legs. When the box is a mile or two across try homing on the signal and listen for the build and fade.

## KEEPING TRACK

Remembering and identifying the areas you have searched can be a problem. Marking areas already searched on the hand drawn map is the best method. The map can be attached to your Form 104 during the debriefing. You might consider using a yellow see-through marker.

Irregular ridges and low ridges coming off of higher ridges may interrupt and divide your contour pattern. When this happens, try to find some identifying feature in the areas you have yet to search and note this on your map. The more experience you gain, the easier this becomes.

## CHECKING LEADS

Not all sorties involve grid searches. You may be tasked to search a particular terrain feature based on information called in by people living in the area, ground team sightings or a previous sighting by an aircraft. The task may be to search a slope, a ridge, a valley, or some specific point.

The terrain you find may not look anything like what was described to you. Remember people on the ground are seeing terrain from a different perspective than you will from the air. Get all the specific information you can before departure.

If possible, get the person reporting the point to mark it on the map. Have them identify roads, buildings or other prominent features. Obtain magnetic bearings and the estimated range from prominent objects, if possible. The briefing officer should help you with this. If, when you arrive and the terrain does not look as it was described, climb and look over the area. You, or they, may have been on the wrong ridge.

## MOUNTAIN SEARCH STRATEGIES

The Mission Coordinator is responsible for determining the general strategies of the search. When you arrive at the assigned search area, the specific details and strategies of the search are at your discretion.

The climb performance of your aircraft should be calculated, prior to departing on a mission, for the anticipated density altitude condition. This information will dictate the number of crewmembers on the mission, the fuel loading and, therefore, the mission duration. It may turn out that the mission cannot be flown at all under the existing weather or density altitude conditions.

Always, with no exception, on calm days and on windy days, with high or low density altitude, start searches at the **top** of the terrain and work your way down.

## SCENARIOS AND PROBABILITY

Based on the strategy chosen by the Air Operations Director, search crews are usually assigned search areas consisting of 7 1/2-minute quarter-grids. In the mountains, the logical method to search is by contour flying. But there may be areas within this quarter-grid where a crash is more likely to have occurred; this may justify one or two extra sweeps. You can see these areas from the air, while the operations personnel may not be aware of them.

Obtaining information about the pilot's background and flying habits can help a lot. If the pilot flew this area often, he or she may have had favorite

routes to get through the mountains under low ceilings. It is helpful to develop several scenarios of the pilot's probable plan of action.

If the weather at the time of the flight indicated low ceilings and low visibility, the pilot may have followed a highway, a river, or headed for a low pass or valley leading to the destination. The pilot may, however, have illegally punched into the clouds without a clearance. In this case the crash might well be on the face of high terrain between the last known position (LKP) and the destination. If there was a low ceiling, it is helpful to know the ceiling height. Chances are the pilot was flying just under the ceiling to take advantage of maximum height. This level, plus or minus a few hundred feet, would be a likely search altitude to take an extra sweep. Of course, no area should be neglected.

Some pilots simply program a direct route from the departure to the destination and the crash site can be found along that line at the first ridge where the cruising altitude meets the terrain elevation.

Searching a terrain feature such as a ridge, canyon, or mountain peak, instead of a grid, may be justified at the discretion of the Air Operations Director.

If there was a thunderstorm in the area at the time, it may have been a factor. Your Intelligence Officer may obtain satellite pictures from the National Weather Service Forecast Office that show the location of thunderstorms and other weather at the suspected time of the crash.

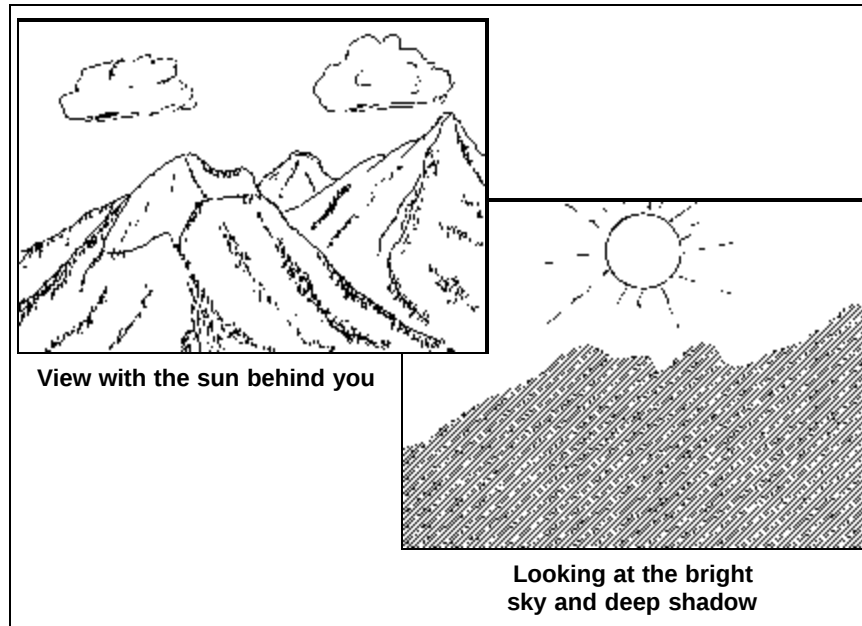
## **LIGHTING**

Lighting is very important in being able to observe the terrain during contour searches. The best light, in flatland or less severe hills and mountains, is between 10 a.m. and 3 p.m. Mountains with more severe slopes may have shadows almost anytime of the day.

In a shadow, whether caused by a mountain or clouds, objects on the ground lose contrast with the surrounding area and become more difficult to detect.

Spend your time searching where you have good light. Concentrate on the east slopes early in the day. The west slopes of the mountains should be searched later in the day because the low angle of the sun may be perpendicular to the steep slope of the mountain. Deep narrow valleys should be searched midday. Advise the debriefing office if you encountered shadowed areas that should be searched at a different time of day.

When the sun is low in the sky, stay away from the shady side of the mountain. To observe the shady side of the mountain you must look toward a dark slope that has the sun or a bright sky behind it. It is nearly impossible to see detail on the mountain. You may find you cannot distinguish ridges below the mountaintop, and neither can you judge your distance from the terrain. This is a very



dangerous place to be and it is useless to try to search. Plan to return when the sun is shining directly on this terrain.

### CONTOUR SEARCHING

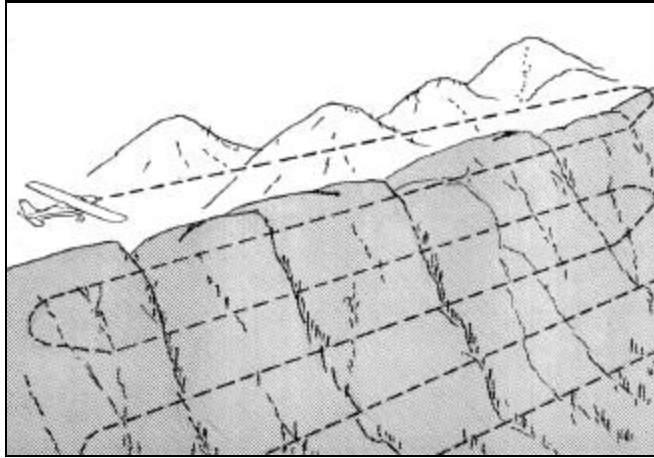
For searching, 500-foot vertical and lateral spacing is ideal. Any closer or any farther away and the observers/scanners cannot see properly. The 500-foot spacing cannot always be maintained. There are several risk factors that must be considered in determining how close the airplane should be positioned to canyon walls. The winds aloft, turbulence, downdrafts, updrafts, terrain features, and width of the canyon must all be considered.

Once the spacing interval is established, the airplane should generally maintain this same spacing interval as the terrain features vary. But, be forewarned, cut across small gullies and ravines. Turning into a narrow area may not afford the opportunity to get back out. If you cannot see into these areas, return later and fly a drainage search down through these areas.

The pilot's main objective is to place the observer and scanner in a position that allows an effective scan without distractions, with reasonable comfort and with utmost safety.

The pilot should not try to participate in the scanning. The pilot should be continuously *planning his flight path, assuring proper terrain clearance,*

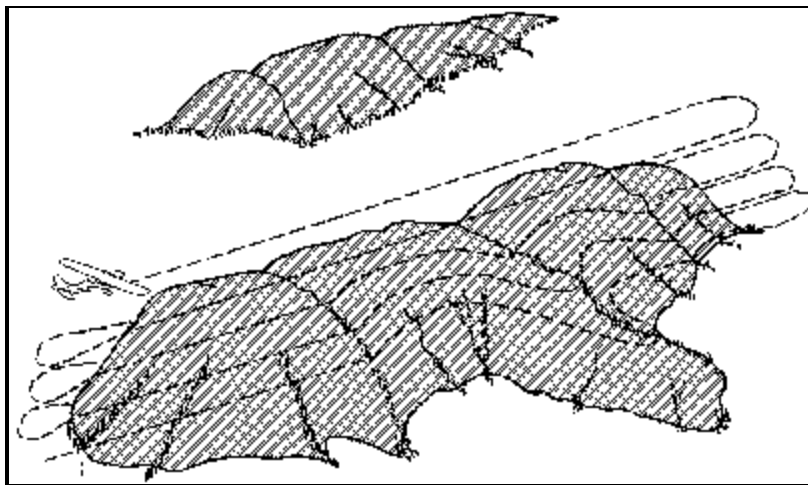
*maintaining a constant altitude, keeping track of the areas that have been searched and those remaining to be searched. The optimum distance from the terrain being searched is about 500 feet. This doesn't necessarily mean vertical distance; it is usually a slant distance. Any closer*



**Searching the face of a ridge**

than 500 feet and the terrain appears to be moving too fast, causing blurring. In forested areas, any further away than 500 feet and you lose sight-penetration depth into the foliage (the distance you can see into the trees). Because of irregular terrain, this distance cannot be continually maintained since the aircraft cannot follow every nook and cranny along the mountain side. The search speed should be 80 to 100 knots.

Always start a contour search high. Slow the aircraft to search airspeed. Trim the aircraft and get comfortable and are on the mountain side of the aircraft. Make sure the observer and scanner are ready and comfortable. If searching a



**Contour search pattern with intercepting ridge**

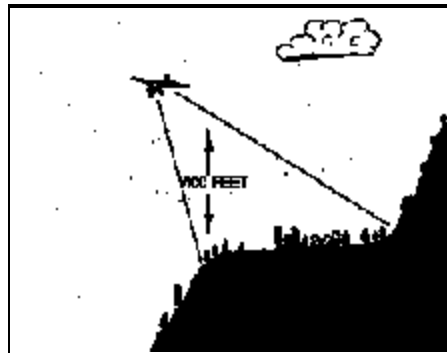
ridge, start with the highest ridge in the assigned grid. Because ridges are not usually level, descend with the ridge. Begin with a *look-down search* of the ridgeline. Fly about 500 feet above and to one side of the ridgeline so the observer and scanner can get a good look at the top of one side of the ridge. Then search the other side of the ridge in the same manner. This is where many crashes occur.

Following the look-down search of the ridgeline, begin a contour, or constant altitude search. When the ridge drops below your altitude, turn around the end of the ridge and begin a search of the other side of the ridge until you have searched all the terrain at that altitude. Upon completing each circuit of the ridge at a given altitude, descend 500 feet and conduct another circuit. In the event you encounter a lower ridge running off the main ridge, either include it in your current circuit or return to search it separately. As you drop down to lower and lower contours, you will find the contours are considerable longer than they were near the top of the ridge.

Depending on the terrain, you may want to search one side of a mountain ridge, especially if the light is good, before moving on to the other side of the mountain. In this case, it is good to have two pilots in the front seat. This allows you to search back and forth along the ridge. The pilot/observer on the side away from the mountain is always the pilot. The pilot on the side next to the mountain becomes the observer/scanner and is responsible for scanning. When the course is reversed the pilots reverse their pilot/observer scanner responsibilities.

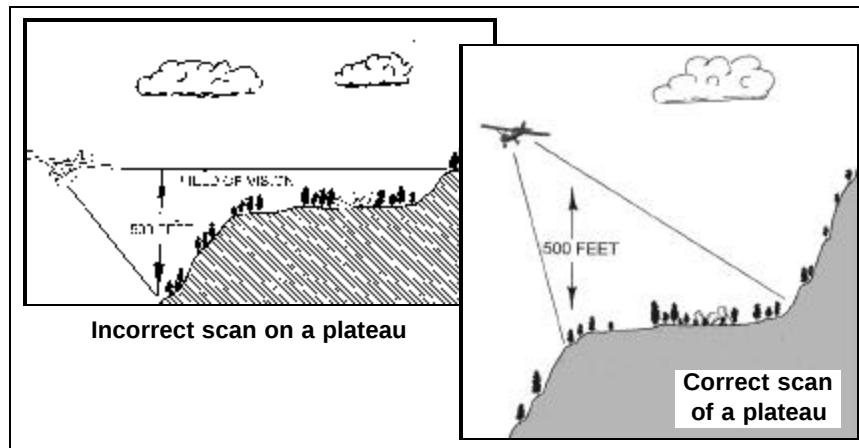
When two pilots work together this way, it is extremely important that *transfer of control is accomplished affirmatively*. "I got it," could mean that the pilot sees something. "My airplane"/"Your airplane," is better. Also, when you start flying, you *must* stop scanning. You cannot do both safely at once.

Within a 7 1/2-minute grid there may be several ridges, plateaus and valleys. Generally, start searching the highest ridges first and work down to the valleys. The contour search pattern may have to be modified for searching valleys where the drainage-type search may then be most appropriate. Wide valleys may require a creeping line or a parallel-track search. Your ingenuity and good judgment will be required.



Normal scan of a steep slope

The proper scan while searching a steep slope is illustrated here. Descending 500 feet at the completion of each circuit works well as long as the slope is steep.



Sometimes there will be a level plateau part way down the ridge, which might not be scanned properly if the 500-foot descent pattern is followed without some modification.

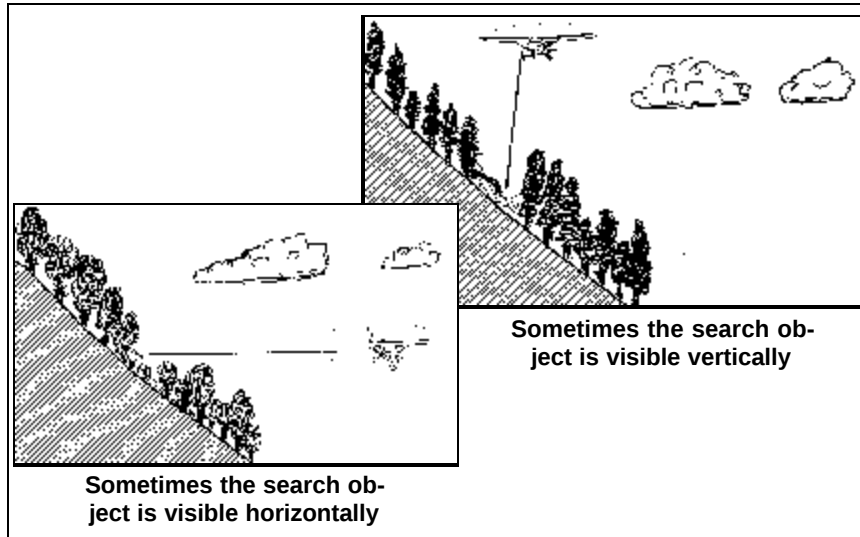
The proper method of scanning a plateau on a slope is illustrated below, along with an incorrect method that may result in blank spots in the area searched.

With dense foliage, it may be extremely difficult to see a downed aircraft in or below trees. It is more likely that you will see broken trees or limbs. Splintered wood from a broken tree appears white, and forms good contrast with the green background of foliage. Trees impacted by an aircraft traveling at a high speed may have a very clean break without splintering, like a chain saw cut. As the crash aircraft slows down due to impact, the trees start to splinter. A few days after a crash, expect to see dried leaves.

Once you find something suspicious, mark it on your map and start making repeated passes along the area. The downed aircraft may have traveled a considerable distance under the foliage, so expand your search several hundred feet around the area. In the winter, without foliage on deciduous trees and without snow, it is much easier to see downed aircraft.

Snow cover makes it more difficult to spot downed aircraft because these aircraft often penetrate the surface of the snow. If fresh snow has fallen since the crash occurred, the structure can become partially or completely buried, making detection extremely difficult or even impossible.

Scanners and observers can sometimes see further into the trees and can more easily spot a wreckage if they are looking horizontally into the trees. This is especially true on very steep slopes. When looking down, the ground is some-



#### SEARCH OBJECT VISIBILITY

times blocked by the foliage. By looking horizontally, scanners may be able to see under the foliage to a crash that is located on the ground below. Other times, and depending on the types of foliage, looking straight down may be better. If you are flying beside a steep slope and have two scanners, put both scanners on the side next to the mountain. Have one scanner concentrate on a downward scan and have the other scan more horizontally into the trees.

In searching a U-shaped valley, the distance you can penetrate into the valley is a matter of your experience level and your aircraft's turning radius. At a given bank angle, the slower the speed, the smaller the radius of the turn.

Continually visualize your flight path, be smooth and confident, and do not take chances.

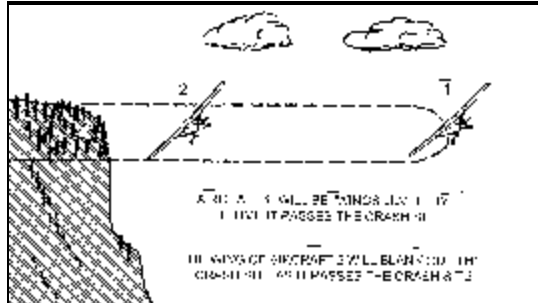


Searching a cove

Take time to explain your plan and intentions to your crew, especially when going into a tight area. If they spend more time monitoring the aircraft path than in scanning, you have defeated the purpose of flying into the area. If you are uncomfortable flying into a cove, use the drainage search method instead.

When flying along a slope or a ridge in a high wing aircraft, if the terrain cuts sharply away from the airplane and if you follow that sharp turn, the wing will block the observer's view during the turn.

In this case, continue flying away from the terrain, then reverse the course and fly back into the drainage with the wings level as you approach the slope to be searched. This allows the observer and scanner an unobstructed view.

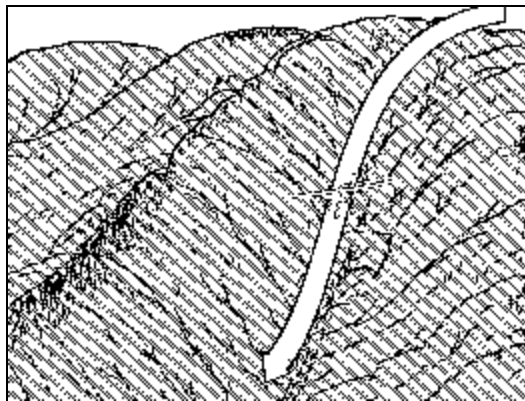


Turn beyond a "sharp turn" to avoid blank spots due to the high wing

## SEARCHING STEEP VALLEYS

There will be steep areas you cannot effectively search using a contour pattern. These canyons, or drainages, will require a use of a technique known as the "drainage search," which involves flying directly down the drainage with the observer and scanner simultaneously scanning the two walls of the drainage on opposite sides of the aircraft.

Explain your intentions to your crew prior to beginning the maneuver.



Searching a steep valley

Check the area from above for obstacles such as power lines, looking also for their support structures. Begin the maneuver by flying towards the top of the drainage from the far side. Approach at an altitude a few hundred feet above the top of the drainage and at the slowest safe airspeed for your aircraft with no more than 10 degrees of flaps. (Note: Some pilots may choose to use flaps.)



Comment: Most of us fly Cessna aircraft with 10 degrees of flaps during searches at speeds of 80 to 100 knots. If the flaps fail in the down position with only 10 degrees deployed, you can't get into much trouble. If

you start down a drainage in a slip verses 30 degrees of flaps and experience turbulence, you can get out of a slip much faster than you can raise electric flaps. If the flaps fail while extended to 30 degrees, you may well lose needed performance. Drainage angles will sometimes change from steep to shallow and back to steep. It is much easier to change the amount of slip than to raise or lower the flaps.

Upon crossing the top edge of the drainage, reduce the power and lower the nose of the aircraft, expecting an increase in airspeed until it becomes stabilized in the descent. Use a slip as needed to control the airspeed.

If you don't slow down before beginning the descent, the speed will stabilize at a speed too fast for effective searching. Follow the valley downward, maintaining a distance of 500 feet from the terrain below and to the sides of the aircraft. If this area is on the leeward side of a mountain during a period of sufficient wind that produces turbulence, don't try this procedure. Wait for a better day.

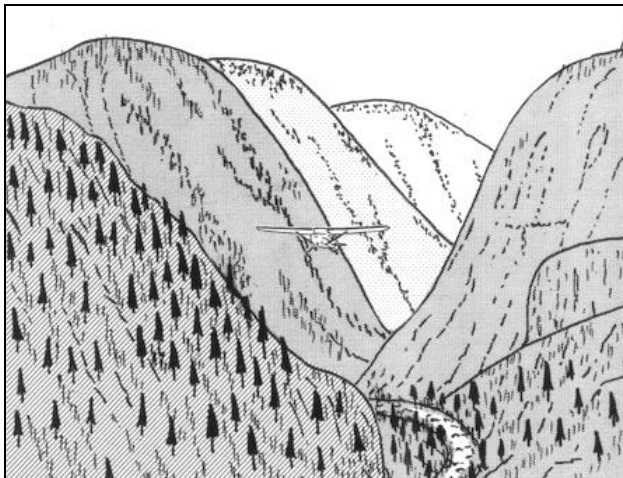
Always check, from above, your path in advance for powerlines and other obstructions. Remember, the lines themselves can be very difficult to spot; look for support structures along the top of the canyon walls.

Always fly through a steep valley going downstream. The pilot should give his full and undivided attention to flying the aircraft and watching ahead for the proper path. Canyons sometimes make sharp turns. If you are not sure of the proper route, climb and refamiliarize yourself with the terrain.

Another error to guard against is mistaking a tributary stream for a main stream. If you are following the main stream downhill and choose the tributary by mistake, it may lead in an upstream direction into rising terrain, and perhaps a box canyon. Don't take chances ... this kind of mistake can prove fatal.

#### **CREW CONSIDERATION**

The crew should be in good physical



**Searching a canyon**

and mental condition and should have had adequate rest before making a flight. Searching at any altitude is hard, tedious and tiring work. The pilot must concentrate on flying a precise path and altitude to assure complete coverage of the assigned search area. The crew members must concentrate on maintaining a constant and vigilant scan pattern. To make matters worse, the scanners are twisted around sideways in their seats in order to obtain a good unobstructed view out of the window.

It is better to rest before you get tired than to try to recover after becoming tired and tense. Every 20 to 30 minutes, pull away from the terrain for a few minutes and give your crew, as well as yourself, a short rest. Pick a reference point in the search path, pull up and circle around this area for a few minutes. Allow your crew to unwind, have a drink of water, and a snack. This will be a valuable refresher that has been proven to make the crew more alert.

This is also a good time to switch the fuel tank selector, if needed, as more altitude gives you more time to deal with any problem that may arise with the tank switch.

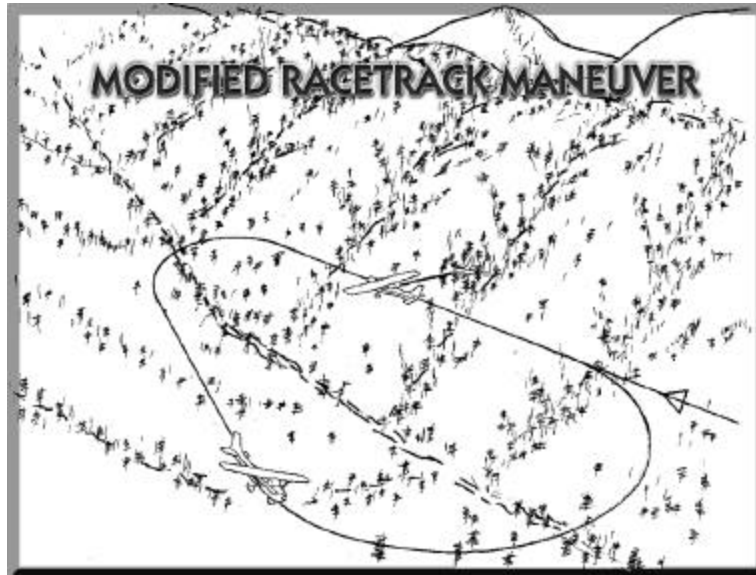
Two hours in the search area is about the maximum time for crew efficiency, especially at altitudes above 8,000 feet. If it takes a half hour to fly to the grid and a half hour to return, then two hours in the grid makes three hours in the air. By this time, both the aircraft and the crew are approaching their maximum range.

From time to time, ask your observer and scanner how they are doing and if they can see clearly. You are on the opposite side of the aircraft from your crew on a contour search, and it may be hard for you to judge your distance from steep terrain. Ask your crew for suggestions.

### **WHEN YOU FIND SOMETHING**

When the scanners spot something unusual, investigate immediately. If the GPS is set so that you may immediately capture your position, utilize this function. Check quickly for a terrain feature to use as a reference point before turning back. It is also important to note your exact altitude. In heavy foliage, some crash sights can only be seen from a certain angle, requiring your subsequent pass to be at the same altitude as when it was first sighted.

While a course-reversal would put you back in the same location, you would be attempting to view the area from the opposite side of the aircraft. You must be very careful flying a 360-degree racetrack pattern to return to the location. This allows an exact replay of your first pass; however, it can be very dangerous for the novice pilot, especially with an upslope wind. It is VERY IMPORTANT to offset the reciprocal leg away from the terrain to prevent initiating the turn towards terrain with insufficient turning radius to avoid the mountain. Watch the spacing and the wind drift as you begin the turn toward the mountain. It is sometimes



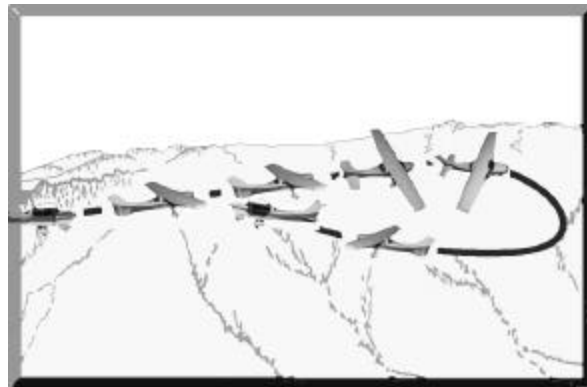
**Modified racetrack pattern to get back to a sighting.**

**CAUTION:** Pay attention to the drift as you turn toward the mountain.

hard to get back to the same point ... make repeated sweeps past the spot until the object is identified.

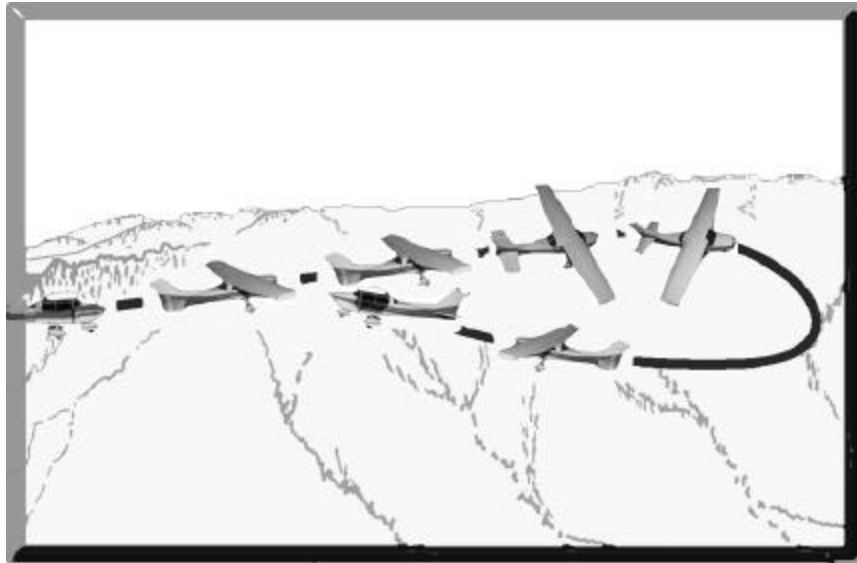
Using a sailplane pilot technique (modified teardrop), turn the aircraft away from the mountain and continue the turn until approaching the mountain at an angle. This places the airplane in a position to escape toward lower terrain.

This method has the disadvantage of placing the aircraft in a direction opposite from the initial sighting. If nothing is spotted during this pass, the same turn is made again, turning away from the mountain. During this pass the airplane will be in its original position.



**Modified teardrop method of course reversal to return to a possible "find."**

Any time you report a "find" to Mission Base or a ground team, remem-



**TURN AWAY FROM THE MOUNTAIN, THEN MOVE  
BACK, APPROACHING AT A 45-DEGREE ANGLE.**

ber to include the altitude of your aircraft when the sighting was made and the actual or estimated altitude of the find.

### **YOUR JOB AS A MOUNTAIN-QUALIFIED MISSION PILOT**

It must be stressed that the only reason the pilot is in the airplane is to put the observers and scanners in a position where they can safely, efficiently and comfortably scan the terrain for the search object. If the pilot does not fly close enough to the terrain for the crews to make an efficient scan, the job is not being done properly. If the aircraft is flown in a manner that causes the observer and scanner to be uncomfortable or frightened, the job is not being done properly. If areas are left unsearched, the job is not being done properly. If the airplane is not being flown with the utmost safety, the job is not being done properly.

Mountain flying is very demanding, yet at the same time, very rewarding. Maintaining an awareness and a proficiency of the principals and methods described in this course will allow you to safely and effectively perform the duties and responsibilities of a mountain-flying pilot with the Civil Air Patrol.

**TOPOGRAPHIC MAPS**

Except on very long trips where the expense and trouble would be prohibitive, you might consider the advisability of having topographic maps in the cockpit (and also for mission planning). They are helpful, especially when wending your way among big peaks in something like a Cessna 172, because they have lots more detail on human structures and the like. Also, the contour information is useful on predicting downdraft speeds.

In many of the western states an atlas is available that contains all the topographic maps in the state. These are quite convenient.

**NOTES:**



# APPENDIX

## Appendix

|                                            |      |
|--------------------------------------------|------|
| > RULES OF THUMB.....                      | A-1  |
| > MISSION SORTIE BRIEFING.....             | A-4  |
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## RULES OF THUMB

### Climb Performance / V speeds

Maximum Search Ceiling Altitude: climb rate of 300 feet per minute

Effect of Weight on climb performance (less weight is better):

C-172: for each 100 lb. weight reduction, ROC increases 60 fpm

C-182/Arrow: for each 100 lb. weight reduction, ROC increases 80 fpm

Most V speeds change as 1/2 the percentage of the change in weight (the square root of the ratio of weights is more precise)

### Turn Technique

Bank angles for search:

Maximum of 30° while scanning

Maximum of 45° to position the aircraft for a pass

The 60° bank is reserved for an emergency escape (It may result in altitude loss)

Canyon turn: entry speed ~ 1.5 V<sub>so</sub>, approach flaps, 60 degree bank, pull to

stall warning (AVOID ACTUAL STALL), may lose altitude.

Modified Wingover: Pull up to ~ 30° pitch, when airspeed drops to ~ 70 kts apply rudder in direction of turn, ailerons neutral; after 90° of turn, relax back pressure and rudder pressure. Recover from nose-down with gentle back pressure.

### **Speed / Size/ Distance Estimation**

1 knot = 100-feet per minute

Crosswind estimation: at 100 kts, each 6 degrees of crab is equal to 10 knots of crosswind component

Direction/velocity estimation: Over a distinct point, enter a 45-degree turn at 100 KTAS. After a full circle, check position back to the point.

Wind direction is from the point to current position

Velocity in knots is the distance in thousands of feet times 2

Turn Radius (in feet):

45-degree bank,  $r = (\text{speed in kts, squared}) \div 10$  (11.26 to be precise)

30-degree bank = 75% larger

60-degree bank = 40% smaller

At 100 knots, a 45-degree bank turn has a radius of ~900 feet

At 100 knots, you travel 1,000 feet in 6 seconds.

Time in seconds to make a 360° turn at 45° bank =  $\text{speed in kts} \div 3$

same rules for as for radius for 30° and 60° banks above apply for time

3° descent =  $20/1$  @100 kts,  $3^\circ = 100/20 = 5$  kts or 500 fpm OR multiply speed in knots by 5 to get fpm (100 kts x 5 = 500 fpm)

4.5° descent: multiply speed in knots by 8 to get fpm descent rate

### **Rules for Ridges and Canyons**

Approach ridges at 45° angle when within 1/4 to 1/2 mile

Always remain in a position where you can turn toward lowering terrain

Safe to cross a ridge when you could cross the ridge in a power-off glide

Fly along windward/downwind sides of canyons to allow use of the full width to turn around

### **Altimetry**

Pressure Altitude: set altimeter to 29.92 to display, or add 1,000-feet per inch of mercury above 29.92 (subtract below 29.92)

Standard Temp: 59°F - 3.5° per thousand feet MSL (Standard Lapse Rate)

Density Altitude: Pressure Alt +  $66 \times (\text{Ambient Temp} - \text{Std Temp } ^\circ\text{F})$  or add 600 feet for each 10 °F above Standard Temperature

Temp Conversion: Double °C and add 30 for °F (exact °F = °C x 9/5 + 32)

True airspeed increases ~ 2% per thousand feet of altitude

### **Downdrafts**

For each 10 knots wind speed, fly 1000 feet above terrain

If wind is > 30 knots at peaks, don't go unless absolutely necessary

Mountain Wave conditions (AVOID):

- 1) Forecast winds aloft at alt of peaks > 30 kts
- 2) Wind direction +/- 30 degrees of perpendicular to obstruction
- 3) Wind velocity steadily increasing with increasing altitude (wind velocity at 34,000 feet > 75 kt is a strong indicator for wave)
- 4) Wind direction relatively constant with increasing altitude

Wave Downdraft Escape: If descending at  $V_y$  faster than you should be ascending:

- 1) Turn toward lower terrain,
- 2) Increase speed to cruise speed, (use  $V_a$  if any turbulence is present) to fly out of the downdraft area

Turning downwind is the fastest direction to fly out of the downdraft

### **Takeoff / Landing Distances**

If you don't have 71% of takeoff speed at midpoint of runway, abort the takeoff because you won't reach takeoff speed before the end of the runway.

Takeoff distance varies as the square of the weight.

For each 1,000' DA above sea level, add 12% to the sea level takeoff distance, add 4% to the landing distance.

Takeoff surface:

- firm turf: add 7%
- rough, rocky, or short grass (< 4" high): add 10%
- long grass (> 4" high): add 20-30%
- soft field: add 23-75%
- mud or snow: add 50+%

For each 1% of downslope, subtract 5% from takeoff distance

For each 1% of upslope, add 7% to takeoff distance

### **Oxygen**

O<sub>2</sub>:

Is required for the pilot after 30 minutes above 12,500 feet;

At all times above 14,000;

For all passengers above 15,000

Recommended for search operations above 10,000

**MISSION SORTIE BRIEFING****Mission Priorities**

Safety — Live to See Another Day  
Conserve Resources  
Find the Target

**Weather**

Current/Forecast  
Stable/Unstable Air  
Wind Velocity (Airports, Grid)  
Terrain Effects  
Visibility  
Temperature/Density Altitude

**Aircraft**

Crew Responsibilities  
Crew Communications  
Fuel (Load, Burn, Endurance, min reserve)  
CAPCOM Aircraft  
Airspeeds ( $V_r$ ,  $V_x$ ,  $V_y$ ,  $V_s$ ,  $V_{so}$ , Best Glide, Approach, Max Endurance, Max Range)  
Expected Take-off / Climb Performance  
Runways  
Distances  
SIDs  
Emergency Procedures

**En route**

Route  
Radios/ATC/CAP  
Altitudes  
Approach to Grid  
Time to Grid

**Grid**

Terrain  
Obstructions  
Altitude (MSL, AGL)  
Divert Fields with fuel  
Emergency Airports  
Off-airport Landing Opportunities  
Time in Grid  
Time to and from Grid  
“Bingo” Fuel  
Wind Effects  
Military Training Routes, Special Use Airspace

**Recovery/ RTB**

Route  
Time to Base  
Altitude  
Instrument Procedures/Minima  
Airspeeds  
Lights  
Airfield Notes  
Divert/Emergency Fields

**Miscellaneous**

Radio/Nav Failures  
Mission Target Sighting  
Procedures/Communications

## Mission Sortie Planning Sheet

A/C ID \_\_\_\_\_ CAP CALL SIGN \_\_\_\_\_ Mission Number \_\_\_\_\_

Mission Base \_\_\_\_\_

### Grid Data:

Grid Number \_\_\_\_\_

Lat North Edge \_\_\_\_\_

Lon West Edge \_\_\_\_\_

Lat South Edge \_\_\_\_\_

Lon East Edge \_\_\_\_\_

### Winds Aloft

| station | 3     | 6     | 9     | 12    |
|---------|-------|-------|-------|-------|
| _____   | _____ | _____ | _____ | _____ |
| _____   | _____ | _____ | _____ | _____ |
| _____   | _____ | _____ | _____ | _____ |

Route from Base to Grid: \_\_\_\_\_

Appx Dist from Base to Grid: \_\_\_\_\_ Appx True Course to Grid: \_\_\_\_\_

Cruise True Airspeed: \_\_\_\_\_

Est. Grndspd TO Grid: \_\_\_\_\_ Est. Time to Grid: \_\_\_\_\_

Route from Grid to Base: \_\_\_\_\_

Est. Grndspd FROM Grid: \_\_\_\_\_ Est. Time from Grid: \_\_\_\_\_

### FUEL PLANNER

Fuel O/B before Takeoff: \_\_\_\_\_

- Reserve Fuel \_\_\_\_\_ hours \* \_\_\_\_\_ (Cruise GPH) = \_\_\_\_\_

Available Fuel \_\_\_\_\_

- Fuel used for Takeoff: \_\_\_\_\_

Remaining Fuel \_\_\_\_\_

- Est Time to Grid: \_\_\_\_\_ / 60 \* \_\_\_\_\_ (Cruise GPH) = \_\_\_\_\_

Remaining Fuel \_\_\_\_\_

- Est Time from Grid: \_\_\_\_\_ / 60 \* \_\_\_\_\_ (Cruise GPH) = \_\_\_\_\_

Remaining Fuel \_\_\_\_\_

/ \_\_\_\_\_ (Search Power GPH) = \_\_\_\_\_ hours max time in grid

## Mission Sortie Data Sheet

A/C ID \_\_\_\_\_ CAP CALL SIGN \_\_\_\_\_ Mission Number \_\_\_\_\_

### Base Data:

|                             |                           |
|-----------------------------|---------------------------|
| Mission Base _____          | Base Call Sign _____      |
| Phones _____                | Freqs _____               |
| Alternate Base _____        | Alt. Base Call Sign _____ |
| Alt. Base Phones _____      | Freqs _____               |
| Ground Team Call Sign _____ | Grd Team Freq _____       |

Target A/C ID \_\_\_\_\_ Type \_\_\_\_\_ Colors \_\_\_\_\_

### Grid Data:

|                      |                     |
|----------------------|---------------------|
| Grid Number _____    |                     |
| Lat North Edge _____ | Lon West Edge _____ |
| Lat South Edge _____ | Lon East Edge _____ |

### Winds Aloft

| station | 3     | 6     | 9     | 12    |
|---------|-------|-------|-------|-------|
| _____   | _____ | _____ | _____ | _____ |
| _____   | _____ | _____ | _____ | _____ |
| _____   | _____ | _____ | _____ | _____ |

### Performance Data:

Density Altitude at Departure Point: \_\_\_\_\_

Expected Takeoff Climb Performance: \_\_\_\_\_

Grid Search Altitude Range: \_\_\_\_\_

Density Altitude Range at Grid Search Altitudes: \_\_\_\_\_

Expected Grid Climb Performance: \_\_\_\_\_

### Speeds:

|          |                     |  |
|----------|---------------------|--|
| Vr _____ | Best Glide _____    |  |
| Vx _____ | Max Range _____     |  |
| Vy _____ | Max Endurance _____ |  |
| Va _____ |                     |  |

### Routes / Times:

|                                    |                                 |
|------------------------------------|---------------------------------|
| Route from Base to Grid: _____     |                                 |
| Appx Dist from Base to Grid: _____ | Appx True Course TO Grid: _____ |
| Altitude to Fly TO Grid: _____     | Cruise True Airspeed: _____     |
| Est. Grndspd TO Grid: _____        | Est. Time to Grid: _____        |

### Route from Grid to Base:

Altitude to Fly FROM Grid: \_\_\_\_\_ Appx True Course FROM Grid: \_\_\_\_\_

Est. Gridspd FROM Grid: \_\_\_\_\_ Est. Time from Grid: \_\_\_\_\_

Times: Block In: \_\_\_\_\_  
 Depart Grid: \_\_\_\_\_  
 Enter Grid: \_\_\_\_\_  
 (Grid Time: \_\_\_\_\_) Block Out: \_\_\_\_\_  
 Sortie Time: \_\_\_\_\_

Max time in Grid from Fuel Planner \_\_\_\_\_ hours

**FUEL LOG:**

Fuel O/B before Takeoff: \_\_\_\_\_  
 - Reserve Fuel \_\_\_\_\_ hours \* \_\_\_\_\_ (Cruise GPH) = \_\_\_\_\_  
 Available Fuel \_\_\_\_\_  
 - Fuel used for Takeoff: \_\_\_\_\_  
 Remaining Fuel \_\_\_\_\_  
 - Act. Time to Grid: \_\_\_\_\_ / 60 \* \_\_\_\_\_ (Cruise GPH) = \_\_\_\_\_  
 Remaining Fuel \_\_\_\_\_  
 - Act. Time in Grid: \_\_\_\_\_ / 60 \* \_\_\_\_\_ (Search GPH) = \_\_\_\_\_  
 Remaining Fuel \_\_\_\_\_  
 - Other Flight Time: \_\_\_\_\_ / 60 \* \_\_\_\_\_ (GPH) = \_\_\_\_\_  
 Remaining Fuel \_\_\_\_\_  
 - Other Flight Time: \_\_\_\_\_ / 60 \* \_\_\_\_\_ (GPH) = \_\_\_\_\_  
 Remaining Fuel \_\_\_\_\_  
 - Act. Time from Grid: \_\_\_\_\_ / 60 \* \_\_\_\_\_ (Cruise GPH) = \_\_\_\_\_  
 Remaining Fuel \_\_\_\_\_

**Divert Airports with Fuel:**

Name Appx Bearing / Distance From Grid IIR Apch (Y/N)

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Emergency Airports**

Name Appx Bearing / Distance From Grid

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Emergency Landing Sites**

Name Appx Bearing / Distance From Grid

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**"MOUNTAIN FURY" FLYING GRADE SHEET**

PILOT'S NAME \_\_\_\_\_

CAPSN

INSTRUCTOR'S NAME \_\_\_\_\_

[COMMENTS (on back with UnibItem number)]

| UNIT | ITEM |
|------|------|
|------|------|

#### 4 Basic Aircraft Performance

### a. Preflight Preparations

- i. Weather station: temperature, precipitation, light, plant production
- ii. A smart irrigation: soil conditions, water balance, emergency survival gear
- iii. Evergreen plants: tolerance to light stress, recovery from stress of  $\text{CO}_2$
- iv. Discuss power savings, vapors, softoff function: point, call, density at 1 W, expanded ROC

b. Take-off and Climb Out

1. Analyze the data and create data
2. Analyze the data, record the results
3. If  $D \leq 3000$  ft, use the simple PGM (use the simple only) use the simple (use the simple)
4. Compute the density (use the simple) use the simple (use the simple)
5. Compute the density (use the simple) use the simple (use the simple)
6. Compute the density (use the simple) use the simple (use the simple)

#### e. Airplane Configurations and Power Setting vs. Airspeed

1. Low light  $\rightarrow$  mesopic regime, low light, m.s.s. - Rods upsearch setting, sensitivity, quantum, peak of  $\lambda$  maximum and high altitude (4500) foot
2. Chief change: highly sensitive to colour, heading altitude, wavelength. Note power required to maintain constant altitude, stimulus go-around
3. Determine space for max RGC with peak density: full fovea
4. Maximum effort associated to occur upshifting, "high chg" also

#### d. Operations at Search Ceilings

- i. Click to fit slides with your setting for 300 times (until) head light at second reading
  - ii. Perform approach to still normal status in darkness (normal reading) normal hearing
  - iii. Remove approach, then check of status
  - iv. Perform minimum radius, constant at 100-180 times right and left
  - v. Perform modified angles: 150° turn, constant, add, at late back, forward
- distance between, above, a technique for comparison in a different way
- vi. Repeat: 1 times at standard that actually increase (3000) per 1000 at 1000 reading

a. Takeoffs and Landings

15. For each island, note island's distance, identify associated features, allow 100% confidence rating in calculations (10/10/10); perform cross-visit island

## 2 Advanced Aircraft Performance

- a. Technical Flying Demonstration Practices

1. Turn throttle for 30" AT SAFE and AT 5000 ft. (5000 ft. technique, emphasis on 30" delay for "smooth" ride to establish position, however, AT 5000 ft. emphasis on escape)
2. Cruise (normal climb) - maintain alt. above wing tip (altitude 1000 ft., fastest airspeed)
3. Climb (normal climb) - straighten the flight, and "over-climb" to 1000 ft.
4. AT SAFE ALTITUDE should start controlled rapid extension if it was original power
5. Controlled extension by drop angle, verify with electronics if possible
6. "Ride starting" technique (steep climb) - for searching a ridge tops
7. "KICK" difference between using sea level max gross wt. and AT controlled for Wt. 5 altitude
8. Rise, level downclimb escape - soaring techniques speed up in downclimb
9. Rise, level downclimb, at max altitude

S-Semifactory, T-Training Required,  
U-Usersubscribing Programs

| FLIGHT<br>NUMBER | 1 | 2 | 3 | 4 | 5 | 6 |
|------------------|---|---|---|---|---|---|
| DATE             |   |   |   |   |   |   |

Winnipeg, 10/10/2014, 10:00 AM

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[illegible]

## "MOUNTAIN FURY" FLYING GRADE SHEET

PILOT'S NAME \_\_\_\_\_

CAPSN \_\_\_\_\_

INSTRUCTOR'S NAME \_\_\_\_\_

S—Satisfactory, T—Training Required,

U—Unsatisfactory Progress

(COMMENTS run back with Unit/Item number)

UNIT / ITEM

| POCNY<br>NUMBER | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------------|---|---|---|---|---|---|
| DATE >          |   |   |   |   |   |   |

X. Repeat climb exercise at high altitude

## 3. High Altitude Takeoff/Landing, Mountain Navigation, Up/Downdrafts

## a. High Altitude Takeoffs and Landings

- Takeoffs/landings, 3 min run including short field and field, power-off approach
- On the ground at high altitude airports, not wind direction and reported flight time (temp), describe procedure including how power is added for survival after forced landing.

## b. Terrain Navigation

- Establish altitude close to terrain but well above obstructions.  
Exclude level terrain; compute capacity for each maneuver (altitude & fuel)
- Demonstrate navigation using horizon (AIMS) close to terrain
- Survival equipment (airborne) - how to use
- If scattered, include clouds provided, discuss options to maintain safe VFR operations
- Discuss the importance of flight at maximum speed (V<sub>max</sub>) in turbulence.  
Note that V<sub>max</sub> generally decreases with increasing gross weight.

## c. Updraft and Downdraft Locations and Magnitudes

- Find flight altitude on mountainous terrain, record power setting
- Locate the downdraft and updraft areas during flight through a valley or canyon  
wind-line perpendicular to the direction of the prevailing wind
- Fly to leeward side of a ridge (no downdraft area), maintain a 100% power  
Note: reduced airspeed, increased pitch to climb against downdraft
- Repeat climb on windward side of a ridge in updraft; maintain altitude as well  
Note: increased airspeed, decreased pitch from downwind climb
- Repeat (downwind) climb; maintain a 100% power  
Note: reduced airspeed (V<sub>SI</sub>) reaching a higher downdraft intensity
- Repeat (downwind) climb; establish max ROC configuration.  
Observed ROC obtained is max ROC for the conditions minus magnitude of the downdraft

## d. High = Altitude / Unfamiliar Field Approach / Landing

- Survey route (wind, obstacles, runway condition, clear approach)
- Max power climb (100% power) to downwind; up - add air altitude
- Note need for low airspeed and higher descent rate on final due to higher  
true airspeed with same indicated air speed as at sea level
- At each field, observe difference in reading field elevation w/out local altimeter setting
- Practice short field, soft field and low power landings and an extended landing

## e. High Altitude / Unfamiliar Field Takeoff

- If the runway has visible slope, lead to runway ends to obtain elevations,  
divide difference by runway slope to get slope (EG: 60' / 2000' = 3% or 1/34)
- Before takeoff, lean for max power during a full power run-up as per POH,  
or if altitude difference, identify short takeoff procedure, a low TLEP,  
and/or emergency, calculate V<sub>0</sub>, V<sub>1</sub>, V<sub>2</sub>, perform max power takeoff
- Compare actual distance to predicted takeoff run, 50% per

**"MOUNTAIN FURY" FLYING GRADE SHEET**

PILOT'S NAME \_\_\_\_\_

CAPTAIN \_\_\_\_\_

INSTRUCTOR'S NAME \_\_\_\_\_

3. Solo Category: T Training Required

(U) Unsupervised Program

(COMMENTS (on back with Unit/Item number))

UNIT / ITEM

| PRIORITY<br>NUMBER | 1 | 2 | 3 | 4 | 5 | 6 |
|--------------------|---|---|---|---|---|---|
| DATE >             |   |   |   |   |   |   |

**4. High Altitude Search**

- a. Pre-Flight Discussion - flight planning (off from the grid + grid search)
  - i. Operations briefing
  - ii. Air ops assigning a grid and flight mission
  - iii. Brief route to and from the search grid area
  - iv. Types of search patterns for assigned grid based upon terrain, weather, performance, etc. consider one / procedure to search the assigned grid
  - v. Determine probability of detection based upon planned flight
  - vi. Review search effectiveness factors
  - vii. Use of technical charts and navigational equipment - I (CRAN, GPS, WPT), etc.
- b. Identifying the Grid Area
  - i. Identify assigned grid through road recovery and navigational aids
  - ii. Verify the grid at altitude / identify corners
  - iii. Note aircraft performance of this higher altitude, winds, turbulence, etc.
  - iv. Identify search plan as appropriate for searching the grid area
  - v. Review flighting critical areas
  - vi. Review ground-to-air and air-to-ground signals
  - vii. Have crew record time off, time to grid, time in grid, etc. (use mission sortie data sheet)
  - viii. Review communications procedures - air-to-air, air-to-ground, etc.
  - ix. Review role of ground teams
  - x. Situational awareness of a threat / crew
  - xi. Make turns - shallow and steep turns to keep away from any threat and make the turn radius, time to turn and effect on the aircraft performance
- c. Searching in the Grid Area
  - i. Fly from highest elevation in grid, by pre-flight or area-dial plot.
  - ii. Demonstrate various search methods appropriate - conical, sweeping, etc., etc.
  - iii. Emphasize low and slow does not generate the best probability of detection
  - iv. Review safe search air speeds based upon aircraft weight, flight conditions, etc.
  - v. Emphasize safe altitudes and always having an escape route or out
  - vi. Review with crew procedures for breaking route and helping pilot
  - vii. Discuss scanning techniques based upon the terrain being scanned
  - viii. Emphasize the pilot is to fly, observe and scan and scan
  - ix. Verify winds aloft by time to fly from one side of the grid to the other - crab angle, verify ground track/winds with navigational aids.
- d. Return to Base
  - i. Debrief with operations to include complete paperwork
  - ii. Debrief pilot and crew on flight, lessons learned, how to improve
  - iii. Review search effectiveness and crew factors to include mission
  - iv. Summarize findings.
- e. If possible, perform practice ELT search in mountainous area
- f. If possible, perform practice air-ground coordination exercise with CAP vehicles / personnel in known locations for the pilot and crew to identify

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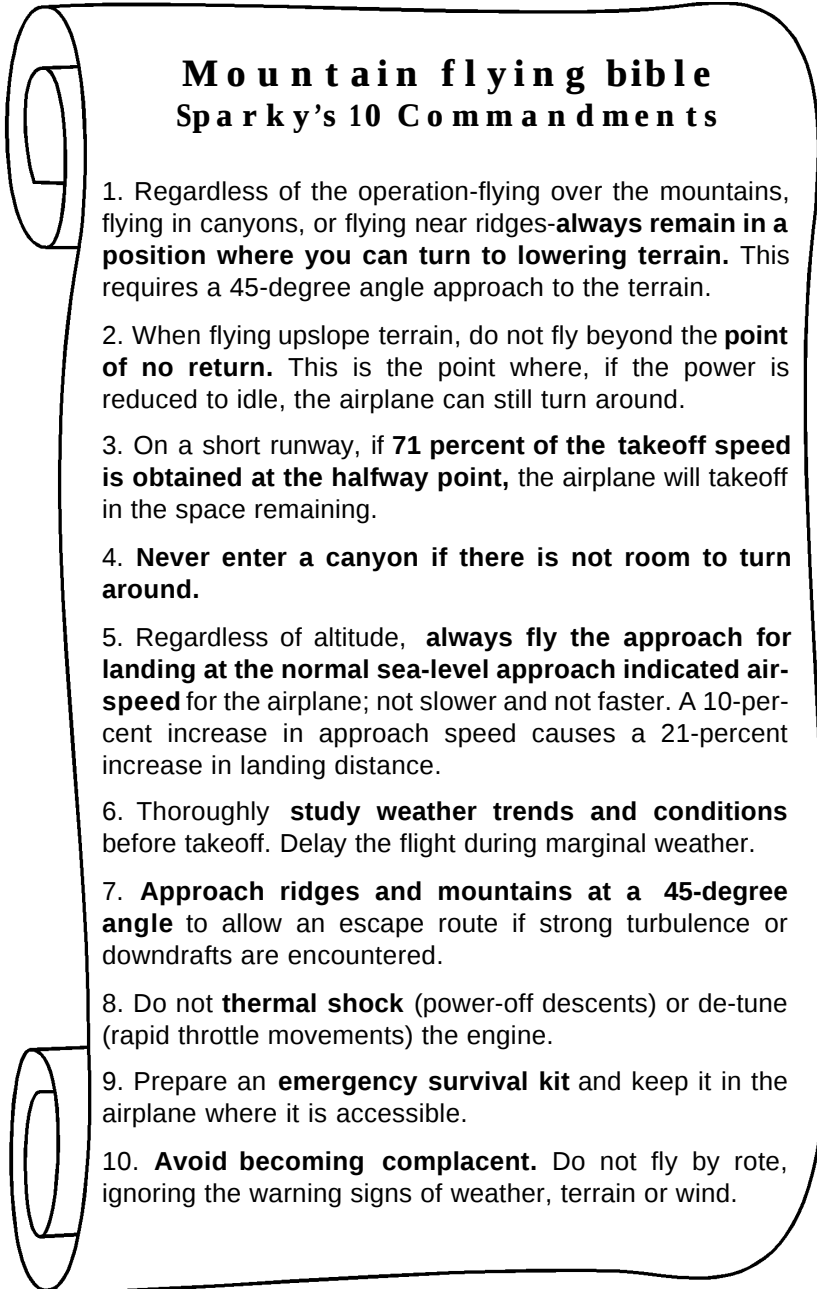
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### Mountain flying bible Sparky's 10 Commandments

1. Regardless of the operation-flying over the mountains, flying in canyons, or flying near ridges-**always remain in a position where you can turn to lowering terrain.** This requires a 45-degree angle approach to the terrain.
2. When flying upslope terrain, do not fly beyond the **point of no return.** This is the point where, if the power is reduced to idle, the airplane can still turn around.
3. On a short runway, if **71 percent of the takeoff speed is obtained at the halfway point,** the airplane will takeoff in the space remaining.
4. **Never enter a canyon if there is not room to turn around.**
5. Regardless of altitude, **always fly the approach for landing at the normal sea-level approach indicated air-speed** for the airplane; not slower and not faster. A 10-percent increase in approach speed causes a 21-percent increase in landing distance.
6. Thoroughly **study weather trends and conditions** before takeoff. Delay the flight during marginal weather.
7. **Approach ridges and mountains at a 45-degree angle** to allow an escape route if strong turbulence or downdrafts are encountered.
8. Do not **thermal shock** (power-off descents) or de-tune (rapid throttle movements) the engine.
9. Prepare an **emergency survival kit** and keep it in the airplane where it is accessible.
10. **Avoid becoming complacent.** Do not fly by rote, ignoring the warning signs of weather, terrain or wind.

### SPARKY'S DO'S AND DON'TS OF MOUNTAIN FLYING

✗ DON'T fly into unimproved mountain strips without a minimum of 150-hours total flight experience. Even then, be proficient at slow flight maneuvering.

✗ DON'T plan a cross-country flight into the mountains when the wind at mountaintop level exceeds 30 knots unless you are experienced in this type operation (strong updrafts, strong downdrafts and moderate or greater turbulence). This does not preclude taking a "look-see." Often with a stable air mass the air will contain very little turbulence during these high-wind conditions. Expect the wind velocity to double or more in mountain passes and over the ridges due to a venturi effect.

✗ DON'T choose a route that would prevent a suitable forced-landing area.

✗ DON'T leave the airplane without a compelling reason if you have executed an emergency or precautionary landing. Temporary evacuation may be necessary if a fire hazard exists.

✗ DON'T become quiescent with weather reports of ceilings of 1,000-2,000 feet. The ceiling is reported above ground level. Often, in the mountains, the weather reporting facility will be surrounded by mountains that extend thousands of feet higher than the facility. Clouds may obscure the mountains and passes in the vicinity.



✗ DON'T go if the weather is doubtful or "bad."

✗ DON'T fly VFR or IFR in the mountains in an unfamiliar airplane make and model. It is required that you learn the flight characteristics, slow flight and stalls in various configurations, beforehand.

✗ DON'T make the landing approach too slow. Some pilots feel they have to make a low approach on the backside of the power curve to get into a mountain strip. This "hanging on the prop" is a dangerous operation. Use a stabilized approach for all landings.

✗ DON'T operate low-performance aircraft into marginal mountain strips. If in doubt about your takeoff, use the "sufficient runway length" rule of thumb.

✗ DON'T rely on cloud shadows for wind direction (unless you are flying at or near the cloud bases). Expect the wind to be constantly changing in direction and velocity because of modification by mountain ridges and canyons.

✗ DON'T fly close to rough terrain or cliffs when the wind approaches 20 knots or more. Dangerous turbulence may be encountered.

✗ DON'T fail to realize that air, although invisible, acts like water and it will "flow" along the contour of the mountains and valleys. Visualize where the wind is from and ask yourself, "What would water do in this same situation?"

✗ DON'T slow down in a downdraft. By maintaining your speed, you will be under the influence of the downdraft for a lesser period of time and lose less altitude overall.



✗ DON'T forget or fail to realize the adverse effect of frost. Less than 1/8 inch of frost may increase the takeoff distance by 50 percent and reduce the cruise speed by 10 percent. Often, if the airplane becomes airborne, the smooth flow of air over the wings is broken up by the frost and the extra drag prevents the airplane from climbing out of ground effect.

✗ DON'T give insufficient attention to the importance of fuel and survival equipment. It is important to keep the airplane light, but don't skimp on these items.

✗ DON'T fly the middle of a canyon. This places you in a poor position to make a turnaround and it subjects you to shear turbulence.

✗ DON'T fail to use the same indicated airspeed at high-altitude airports that you use at low-altitude or sea level airports for the takeoff or for the approach to landing.

✗ DON'T be too proud or too vain to check with experienced mountain pilots concerning operations to and from unfamiliar fields.

✗ DON'T attempt VFR flight in mountainous terrain unless you have the minimum visibility you have established as a personal safety standard.

✗ DON'T become complacent about the horizon when flying with outside visual reference. A gentle upslope terrain may cause an unknown constant climb with the possibility of an inadvertent stall. The horizon is the base of the mountains some six to eight miles away.

☐ DO file a flight plan for each leg of your flight. Also, make regular position reports to allow search and rescue personnel to narrow down the search area if you are overdue on the flight plan.

☐ DO check all aspects of the weather including weather reports and forecasts.

☐ DO familiarize yourself with the high-altitude characteristics and performance of your airplane. This includes the takeoff and landing distance and rate of climb under various density altitude conditions.

☐ DO spend some time studying the charts to determine the lowest terrain along the proposed route of flight. If possible, route the flight along airways.

☐ DO have confidence in the magnetic compass. The compass (unless it has leaked fluid or someone has placed interfering metal near its magnets) is the most reliable instrument. Charts will show the areas of local magnetic disturbance that may affect the accuracy of the compass reading.



☐ DO plan the fuel load to allow flight from the departure to the destination airport with a reserve to counter unexpected winds.

☐ DO fly a downdraft, that is, maintain speed by lowering the nose of the airplane. Unless the airplane is over a tall stand of trees or near a shear cliff, the downdraft will not extend to the ground (exception: microburst).

☐ DO use Sectional Aeronautical Charts instead of World Aeronautical Charts (WAC) because of the greater detail (8 miles per inch).

☐ DO approach ridges at an angle. The recommendation is to use a 45-degree angle approach when in a position of one-half to one-quarter mile away. This allows an escape, with less stress on the pilot and airplane, if unexpected downdrafts or turbulence are encountered. Flying perpendicular to the ridge, rather than at a 45-degree angle, does not mean you cannot escape the downdraft or turbulence by making a 180-degree turn. But, it does mean the airplane will be subjected to the effects of the downdraft and turbulence for a greater period of time. Usually, a steeper bank will be required to make the 180-degree turn. This will increase the g-loading stress on the airplane.

☐ DO count on the *valley breeze* (wind blowing upstream during the morning hours) and the *mountain breeze* (wind blowing downstream during the evening hours). In an otherwise calm wind condition the valley breeze will create an approximate 4-knot tailwind for landing upstream. The mountain breeze will cause an approximate 8-knot to 12-knot tailwind for takeoff downstream.

☐ DO use horse sense (common sense) when performing takeoffs or landings at mountain strips. If you have any doubt about the operation, confirm the aircraft performance using the Pilot's Operating Handbook or Owner's Manual. If the physical conditions are adverse and compromise the operation, delay the operation until conditions are better.

☐ DO make a stabilized approach for landings. Since the late '60s the power-off approach has been discouraged because of thermal shock to the engine.

☐ DO remember your study of aerodynamics. It is possible to stall the airplane at any airspeed and any attitude (providing you are strong enough and the airplane doesn't break first). If a stall is entered in the same manner, for

example, with a slow deterioration of the airspeed, it will stall at the same indicated airspeed at all altitudes.

## WEATHER ACCIDENTS

Statistically, weather accidents are the most severe in general aviation, where severe means those accidents with the most injuries, fatalities, and aircraft damage. Weather demands your respect.

How do these weather accidents occur? There is a pattern and the sad fact is that we are not learning from that pattern. The FAA has done an admirable job since the initiation of their accident prevention program in 1971. Often the pilots who need to attend these meetings find some excuse for not going. Whatever the reason, every year many VFR-only pilots intentionally fly into marginal weather and do not come back. If you and the airplane are not equipped for instrument flying, don't do it. It's a guaranteed way of getting seriously killed.

When examining the National Transportation Safety Board (NTSB) accident statistics for any year they have records available, you will find the same things causing the same accidents, year after year, in almost the exact same proportion.

When a non-instrument-rated pilot tries scud running or suddenly and unintentionally becomes trapped by weather and he no longer has outside visual reference, statistics say he is going to be involved in an accident. The FAA has determined that the one likely to be involved in a weather accident is a private pilot having gained between 100-300 hours flight experience. After receiving a reasonably accurate weather briefing he crashes during daylight hours with one additional passenger, after having failed to file a flight plan.

These pilots do not intentionally get into instrument weather. The conclusion is that they did not recognize the instrument weather and flew into it without an escape route. Once into the weather, statistics bear out that a crash is highly probable.

This study strongly points out the need to:

- ✓ Learn what comprises critical weather situations from weather reports and forecasts.
- ✓ Learn to recognize critical weather situations visually from the air, from a distance.
- ✓ Do not scud run in the mountains with less than a 2,000-foot ceiling or less than 5-miles visibility. Be ready to land or turn back before becoming vulnerable to entering an area of obscuration or clouds that reduce visibility.
- ✓ Analyze a weather briefer's caution for the potential of encountering a critical weather situation en route. Always have an out to keep from becoming trapped by the weather.

## **MOUNTAIN METEOROLOGY**

Mountain weather is not so much different than weather occurring elsewhere. It just seems that there's more of it—and sometimes it is very intense. Sure, there are katabatic winds (any wind blowing down an incline) and mechanical lifting that don't normally occur over flatland. But the basic weather is the same. However, flying in the mountains when adverse weather conditions exist, does require more judgment and skill than when flying over the flatland.

Probably the biggest trap for the unsuspecting pilot is his choice to make a VFR flight based upon the lowest reported ceiling along his route. With the scarcity of reporting stations, the forecast weather may not occur. Look at the total weather pattern to make a go/no-go flight decision.

## **GO/NO-GO DECISION**

There have been times when the FSS (Flight Service Station) or DUATS (Direct User Access Terminal Service) has been unable to provide the information necessary to make an intelligent go/no-go decision. This isn't their fault; the weather information just isn't available to them. Sometimes a phone call to an FSS or weather bureau near your destination can clear up any question of doubt in your mind.

With the proliferation of computers, many pilots subscribe to a private weather service or use DUATS. Even with the computer, there will be times when the pilot must talk with a Flight Service Station specialist to make an informed decision.

## **MOUNTAIN AIRSTRIP WEATHER**

Most mountain strips (as opposed to mountain airports) do not have weather reporting facilities or personnel. If it is necessary to further check the weather, call the closest town for information. This call may be made to the sheriff's department, police department, game and fish department, forest service, state aeronautics department, or radio station. Although this isn't "official" weather, it may be invaluable information.

## **WEATHER BRIEFINGS**

Sometimes the pilot gets what he asks for from the FSS. Don't call and say, *"How's the weather from Jackson to Denver?"* Your request may provide you with very little information; although the briefer will solicit background information from you so he can provide a briefing appropriate to the proposed flight. This is especially true if you know the briefer and he thinks you know something about flying.

There are three basic types of preflight briefings, *Outlook Briefing*, *Standard Briefing*, and *Abbreviated Briefing*. The *preflight briefing* should be obtained in person or by telephone. Pilots flying at remote mountain strips use the *In-flight Briefing*. It can provide the same information as the outlook, standard or abbreviated briefings.

It is your responsibility to specify to the briefer the type of briefing you want (except for the in-flight briefing) along with background information. The FSS briefer is not authorized to make original forecasts, but he is authorized to translate and interpret available forecasts and reports directly into terms describing the weather conditions that you can expect along your flight route and at your destination. He may not read weather reports and forecasts verbatim unless specifically requested by you.

#### **Outlook Briefing —**

The *outlook briefing* is designed to provide forecast information for planning purposes only. Request an outlook briefing whenever your proposed departure is six or more hours in advance.

#### **Standard Briefing —**

If you have not received a previous briefing such as TWEB, PATWAS, VRS or DUATS, you should request the *standard briefing*. The briefer will automatically provide the following:

- ☐ *Adverse Conditions* of a meteorological and an aeronautical nature.
- ☐ *VFR Flight Not Recommended* when conditions make the flight doubtful.
- ☐ Synopsis.
- ☐ Current Conditions.
- ☐ En Route Forecast.
- ☐ Destination Forecast.
- ☐ Winds Aloft.
- ☐ NOTAMs.
- ☐ ATC Delays.

Ask for any information you feel the briefer may have missed. Jot down notes for these questions to allow the briefer to make a chronological presentation without interruption. Ask the questions after his briefing. This will provide you a better briefing.

#### **Abbreviated Briefing —**

Request an *abbreviated briefing* when you need to update a previous briefing or when you need only one or two specific items.

**BACKGROUND INFORMATION** (provide to the briefer)

Request specific information using a checklist.

- ☐ Type of Flight, VFR or IFR
- ☐ Aircraft Identification
- ☐ Aircraft Type
- ☐ Departure Airport
- ☐ Route of Flight
- ☐ Destination
- ☐ Flight Altitude(s)
- ☐ Estimated Time of Departure
- ☐ Estimated Time En Route, or
- ☐ Estimated Time of Arrival

**BRIEFING FORMAT** (ask for these items)

- ☐ Adverse Conditions
- ☐ Synopsis
- ☐ Current Weather
- ☐ En Route Forecast
- ☐ Destination Forecast
- ☐ Winds and Temperatures aloft and on the ground
- ☐ Aeronautical Information (NOTAMs)
- ☐ Request PIREPs
- ☐ Miscellaneous (icing level, lapse rate, inversions, alternates)

**VFR INTO ADVERSE WEATHER**

We all agree that pushing the weather on a VFR flight is not wise. If anyone asked us, we would vehemently reject any suggestion that we could get into a situation of continued flight when the ceiling or visibility begins to deteriorate so that it will disallow forward visibility.

But, look at the statistics. Each year some 200 accidents are listed as “*continued VFR flight into adverse weather conditions*.” The sad thing about these accidents is that about 65 percent are fatal accidents.

The first two items on the NTSB list are easy to fix because they involve pilot education, practice and experience. The third causal factor is harder to control, because, not only does it require education, but it also demands pilot judgment. Some of the 200 accidents caused by unintentional weather encounters may be unplanned, but most of the time *scud running* is the culprit.

In open country you can easily detour around scattered clouds, but in a narrow canyon these clouds may pose a big problem. It’s not generally the scattered clouds that will “get ya.” It is a complete weather system that the pilot

has been warned about, and maybe even given the warning, “VFR not recommended.” The pilot has “gethomeitis” and scud running is his only way home. Not all “scud runners” are low time pilots who don’t know better. Some are high-time pilots and may even hold an instrument rating.

## SCUD RUNNING

There are some valid reasons for scud running. IFR flight at minimum en route altitudes may not be practical because of icing, winds, or turbulence aloft. Or, the pilot may have navigational or communication equipment failure. Also, a flight to a destination without an instrument approach facility is a good reason for not flying IFR if there is not another airport within the vicinity that would allow an instrument approach with continued VFR flight to the destination.

Whatever the reason, pilots scud run. Some pilots scud run successfully. They do so by learning how to scud run safely.



To an experienced mountain pilot, VFR during changeable weather with a 2,000-foot ceiling and five-miles visibility is marginal. Weather conditions less than these, in the mountains, can make the flight turn into a terrifying adventure. What can a pilot do to make scud running a safe operation?

### 1. ESTABLISH MINIMUM WEATHER CONDITIONS

The smart—and usually experienced—pilot develops rules, and he will not, under any circumstances, breach these rules. If you select 2,000 feet and 5 miles as your minimums, adhere to them. Reverse course and land if it gets worse. If this is impossible, make a precautionary landing.

### 2. FLY IN THE LOWER THIRD OF THE CLOUD QUADRANT

The experienced pilot listens to his mom, “Fly low and slow, sonny.” So throttle back to a comfortable slow-speed cruise and keep the terrain features clearly in sight.

Mentally divide the area from ground level to the cloud base into thirds. Fly in the lower third. The reason for this is simple. A pilot, flying near the cloud base, can fly into trouble before knowing it. At the cloud base the forward visibility is restricted. It is possible to enter a cloud without ever having seen it. And it is possible to fly into a mountainside without seeing it in time to perform an evasive maneuver.

### 3. KEEP NAVIGATION SIMPLE

Keep navigation simple by following a highway or railroad. Pay attention to your chart to make sure there isn’t a tunnel. Be cautious about following a river when the temperature and dew point are close together. That’s usually where the poorest visibility is encountered because of low clouds and fog.

#### 4. TURN ON THE LIGHTS

Turn on all the aircraft's lights. It's not likely that anyone else will be out there with you, but if they are, you want them to see and avoid you.

#### 5. FLY LIKE YOU DRIVE

When flying through the Gorge—between Portland and The Dalles, Ore.—or any narrow canyon, it is customary to remain to the right side, just as on a highway, to avoid pilots going the other way. If you are not concerned about other traffic in a remote area, fly the updraft side.

#### LIFESAVING MANEUVER

Presentation of the following information is with a certain amount of reluctance and is not meant as encouragement for pilots to scud run. It is merely a means of avoiding the terrain if you get caught in bad weather.

Because some pilot is going to use this as a crutch to go scud running when he shouldn't, I hesitate to mention this lifesaving maneuver. It is an emergency life-saving procedure only. It is not to be used or performed as a routine part of flying.

When the ceiling is less than 2,000 feet or the visibility is fewer than five miles, park the airplane on an airport, not the side of a mountain. This is the original emergency lifesaving maneuver.

If you have checked the weather and find the parameters along the route and extending beyond your destination meet your idea of a safe flight, you are set to go. The takeoff and en route portion of the flight may show weather conditions better than forecast. This could lead to complacency.

When you become trapped, slow down and descend to a ground reference maneuver altitude, about 600 to 800 feet agl. Find a *prominent* landmark such as a tree, large rock, small pond or whatever. Don't spend time fussing about the landmark. Determine that you can circle this landmark without worrying about the lateral terrain clearance. Then fly. Fly around and around and around and around and around this landmark until the visibility improves. You might be stuck there for a half-hour or more. But it's better to be stuck there than against the side of a mountain. Don't concern yourself with flying the perfect "turn about a point" or "on-pylon eight." The object is to remain flying without running into something during the period of reduced visibility. Please reserve this maneuver for a real emergency and don't use it as a standard practice.

