OPERATION MANUAL

SOP

MOUNTAINOUS

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PT. Smart Cakrawala Aviation

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APPENDIX A CATEGORY MOUNTAINOUS AIRPORTS/AIRSTRIPS AT PAPUA AREA				

PT. SMART CAKRAWALA AVIATION	D G C A
CAPT. PURWANTO CONDRO USODO OPERATION MANAGER	**CAPT ALI RIDHO SHAHAB** CERTIFICATION PROJECT MANAGER

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PREFACE

PT Smart Cakrawala Aviation is authorized to conduct air transportation under SI 8900-2.6 MOUNTAINOUS OPERATIONS, and CASR Part 135 current amendment to carriage of passengers in non-scheduled Operation within the contiguous Indonesia. This Manual has been prepared as guidance of Operation personnel in the execution of their duties. It contains policies and procedures applicable to all flight Operation conducted under CASR 135 current amendment. All duties shall be conducted in accordance with the procedures and minimum times contained in this manual and in accordance with Civil Aviation Safety Regulations (CASR).

This manual explains the internal organization system in detail, including the continuity of flight operation responsibility. It is gives samples of flight operation forms used and their method of execution. The manual gives a detailed explanation of the following portions of the flight operation system.

The instructions, policies and procedures contained in this manual are in accordance with the laws and regulations of Indonesia. They are intended to summarize and display those provisions of the regulations applicable to PT Smart Cakrawala Aviation, Operation and equipment, not replace existing regulations. In the event of conflict, the CASR take precedence.

This manual or applicable part thereof will be distributed to all personnel concerned with the conduct of Operation. Holders of this manual will be responsible for its safe custody.

Any reference made in this manual to the company, and/ or the Air Operator, shall be taken to mean PT Smart Cakrawala Aviation.

Any question or comments pertaining to the use of this manual or the information contained herein should be directed to the Operation Manager, or the appropriate division of Operation at headquarters in PT Smart Cakrawala Aviation.

1. MOUNTAINOUS FLYING

CATEGORIZATION

The Papua air strip categorization due to factors below:

1. More than 4% slope in 1st 300’ of runway
2. More than 3% sideslope
3. Boundaries
4. Excessive rate of change in 1st 500’
5. Strip width does not allow excursion R & L of center of more than 32’ (10m)
6. Illusion
7. Go around point, required before touchdown
8. One way strip
9. Non-standard approach/departure requires steep turns and/or descend
10. Weight restriction
11. Wind/turbulence problems that can prohibit operations
12. People and animal control problem
13. No radio reporting - strip condition not assured
14. Dog leg
15. Very slippery and/or soft when wet
16. Poor maintenance (rough, long grass, etc)

Note: Some strips may be classified into different categories based on seasonal variations, time of day or current local conditions and the latest information should be sought. It is not a requirement for the strip to exhibit all of the associated characteristics and each may have a unique reason for being classified into the current category.

(A) Mountain Category 1

Conditions & Facilities

Airports included in this category have a minimum requirement:

- Elevation: <6000 feet
- Runway length: 1000 meters - 2500 meters
- Available Runway: 2 (Two) way take off and landing
- Surface Runway: Asphalt
- Airspace Control: Aerodrome Control Service (ATC)
- Navigation Aids: NBD, VOR
- Airport Category: Airport

(B) Mountain Category 2

Conditions & Facilities

Airports included in this category have a minimum requirement;

- Elevation: 1000 feet - 6000 feet

- Runway length: 1000 meters - 1500 meters
- Available Runway: 2 (Two) way take off and landing
- Surface Runway: Asphalt
- Airspace Control: Aerodrome Flight Information Service
- Navigation Aids: NBD
- Airport Category: Airport

(C) Mountain Category 3

Conditions & Facilities

Airports included in this category have a minimum requirement;

- Elevation: 2000 feet - 9000 feet
- Runway length: <1000 meters
- Available Runway: 1 (one) way take off and landing
- Surface Runway: Asphalt, Grass
- Airspace Control: -
- Navigation Aids: -
- Airport category: Airstrip

(D) Mountain Category 4

Facility And Condition

Airports included in this category have a minimum requirement;

- Elevation: 2000 feet - 9000 feet
- Runway length: 600 meters
- Available Runway: 1 (one) way take off and landing
- Surface Runway: Grass
- Airspace Control: -
- Navigation Aids: -
- Airport category: Airstrip

Detail area that included in this category specified in the table of Appendix A, especially for Papua areas.

1.1. MINIMUM KNOWLEDGE

INTRODUCTION

Operations in the mountains are little different than any place else. It's just that the safety margins are reduced to a greater extent, so a pilot can't get away with many practices that are common at lower elevation (with better aircraft performance) and more hospitable terrain (that allows the pilot to go where he wants to go).
This doesn't mean we can't fly safely in the mountains. It means we have to be aware of' the differences to be able to effectively deal with them.

1.2. DEFINITIONS

Crosswind landing — Fluctuating wind direction and velocity at mountain strips makes the mechanical-slip technique for crosswind landing dangerous. To avoid a mechanical slip, maintain runway centerline alignment with ailerons, moving the aileron control back and forth as required. Maintain the aircraft's longitudinal axis parallel to the runway with rudder movement.
Point of NO Return — When flying upslope terrain, the area beyond a place where if the throttle is reduced to idle, there is sufficient altitude to allow a 180-degree turn.

Scud Running — VFR flight in marginal weather (scud running) often results in flight into a visibility condition that prohibits further flight. Scud running is discouraged; however, if you get trapped, circle a prominent landmark at low altitude until the visibility improves.

Spot Method — Used to cope with visual illusions during landing. For example, approaching a downslope runway gives the illusion of being too low, causing the pilot to approach too high. Approaching an upslope runway gives the illusion of being too high, causing the pilot to approach too low with the possibility of insufficient power to make it to the runway. Approaching a runway, or even a mountain ridge, in rain tricks the pilot into thinking he is too high. Make a grease pencil mark on the windshield about one-half inch below where the horizon intersects the windshield at cruise airspeed, cruise-power setting, and level flight. (It may need to be adjusted up or down a little.) For landing, align the windshield mark with the aiming point on the runway (point where the flare is made).
Maintain a constant indicated airspeed. Add power if the aiming point moves up from the windscreen mark; reduce power if the aiming point moves down from the windscreen mark.

1.3. MOUNTAIN FLYING DESIGNATIONS

Mountain flying can be broken down into four designations or types.

a) **Flatland to flatland over the mountains.**
When departing a flatland airport and flying to a flatland destination with mountains in between, the novice pilot could climb to an altitude 2,000 feet above the highest terrain along his route and proceed to the destination without much concern for the mountains unless there is bad weather.

b) **Flatland to a mountain destination.**
The same logic applies for departure from a flatland airport and going to a mountain destination.
The flight may be made at 2,000 feet above the terrain and then circle down for landing at the mountain airport destination.

c) **Mountain departure to a flatland destination.**
Departure from the mountain airport would involve circling while climbing to 2,000 feet above the terrain and flight to the flatland destination. For most conditions the inexperienced mountain pilot will find that 2,000 feet terrain clearance will be comfortable and adequate. With experience, and the confidence experience in skills, the minimum altitude will decrease.

d) **Contour/Drainage/Terrain flying, simply called mountain flying.**
Classic mountain flying—sometimes called contour, drainage or terrain flying—is practiced mainly by the purist or the pilot having a need to operate close to the terrain (search and rescue, game and fish surveys, fire patrol, law enforcement, aerial photography, training, or personal enjoyment). This mountain pilot adheres strictly, not only to the tradition, but also to the rules of mountain flying.
This is not to suggest that it is inappropriate to fly 2,000 feet above the terrain. Under certain conditions, such as a mountain wave, even the purist will maintain a terrain-clearance altitude that provides safety, rather than hugging the ridges. This qualified mountain pilot will fly an altitude (maybe even more than 2,000 feet above the terrain) that avoids strong downdrafts and escapes the associated turbulence.
An altitude that generally provides adequate terrain clearance and escape from destructive turbulence is determined by subtracting the elevation of the base of the mountain from the top.
Use one-half of this value as the altitude to cross the mountain.
Remember the rule for crossing mountains: approach the mountain at a 45-degree angle, even in a no-wind condition. The lack of wind (and hopefully downdrafts) does not invalidate the rule, it only changes the distance from the ridge that the approach is commenced.

What exactly is so different about mountain flying?

- The air is thin. Thin air affects the lift of the wings, the thrust of the propeller and the power output of the engine.
- thin air is moving creating updrafts, downdrafts and turbulence. Thin moving air requires specialized flying techniques in the mountains.
- The airplane is in close proximity to the terrain. For someone inexperienced in mountain flying this can be very intimidating.
- The terrain creates airflow modifications that may vary from the steady-state wind aloft. This requires visualization to determine the wind direction at any particular point of location.
- Over flat land when you take off and climb you might expect the upper winds to increase in velocity and switch somewhat clockwise from the surface wind direction. You can't always expect this to occur in the mountains; ridges, mountains and valleys may change the airflow.
- Density altitude adversely affects the aircraft performance.
- And, you cannot take off from all mountain fields and turn directly on course. Often it is necessary to circle while gaining altitude before turning on course.

Note the airplane is “hugging” the right side of the canyon to allow for an escape turn back down the canyon.

Approaching the point of no return. Turn awayfrom the mountain and gain additional altitude prior to going beyond this point.

Flying beyond the point of no return will result in an accident.

1.4. COMPLACENCY

Webster 's defines complacency as **a calm sense of well-being and security, or selfsatisfaction accompanied by un-awareness of actual dangers or deficiencies**.

Smug, familiar, bored, overconfident, and self-contented are adjectives describing complacency. Lack of judgment and overconfidence can often result from repetition. You might discover yourself becoming complacent if you scrutinize the manner in which you do your preflight inspection. Do you really examine the airplane or are you paying less attention to detail? The same thing applies to the actual flight. Do you think ahead of the airplane, planning for all contingencies? If not, you might be setting yourself up for an accident. **Remember, complacency kills!**

Flying the mountains demands an attentive pilot, one who is aware of the special conditions that can create hazards. Knowledge and experience, where the pilot develops a wariness that keeps him from becoming trapped, enhance recognition of the potential hazards. At times the pilot will experience apprehension. This is normal, fear is not normal.

A wariness of mountain flying is good. A true fear of mountain flying means you should not be flying in the mountains. A concern for where you are and what you are doing is healthy; and, as all veteran mountain pilots will expound, you must maintain a constant vigilance of your surroundings and have an escape route in mind should one be needed. Do not fear flying in the mountains. Learning of the dangers that might exist and knowing how to minimize or avoid them replaces fear with knowledge. During mountain flying an inexperienced pilot will find himself in situations he has never before encountered. As good as this book is, it is impossible to cover every situation, so employ CAUTION while exercising the privilege of mountain flying.

Some pilots may develop an attitude of fearing the mountains. If this extends beyond a normal protective reaction, do not fly in the mountains with-out additional dual instruction.

Another extreme, having no respect for the mountains at all, is almost as bad, leading the pilot toward an accident. The novice mountain pilot requires a basic knowledge and appreciation of mountains, airplanes and weather.

Your mountain flying techniques will be developed over a period of time. Don't expect to know everything before flying in the mountains. Let me take some liberty with an old saying and paraphrase it to state: **Mountain flying in itself is not inherently dangerous, but even more so than flatland flying, it is terribly unforgiving of carelessness, neglect and incompetence**. It's mighty easy to ignore your surroundings when gazing at wildlife or unique terrain features; perhaps more so for the experienced pilot than the novice. The new pilot or pilot new to mountain flying will be wary and will be looking around.

This manual is an attempt to collect all the information necessary to function safely in the mountains under various conditions.

1.5. MOUNTAIN FLYING 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 (approximately 500-feet AGL) where, if the power is reduced to idle, the airplane can still turn around without impacting the terrain.
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 airspeed 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 make power-off descents or sudden rapid throttle movements to 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.

1.6. MANDATORY AND RESTRICTION OF MOUNTAIN FLYING

PT Smart Cakrawala Aviation pilot restriction:

- 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 moreangerous 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.

Mandatory for PT Smart Cakrawala Aviation pilot:

- 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 fore-casts.
- 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 tail 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 down-stream.
- 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 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 air-plane 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.

1.7. MINIMUM KNOWLEDGE OF MOUNTAIN FLYING

The following is a summation of the minimum knowledge needed to fly safely in the mountains. Additional study and flight instruction is required prior to flight in the mountains. This minimum knowledge information is intended to supplement—not replace—such preparation.

1.7.1. Basic Rules

Adhere to the two basic rules of mountain flying to keep out of trouble.

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

The novice mountain pilot should plan the flight to remain 2,000 feet above the terrain along the route of flight. When approaching mountain ridges, turn to approach the ridge at a 45-degree angle when about one-half to one-quarter mile away. This permits an easy escape with less stress on the airplane if downdrafts and/or turbulence are encountered.
Never fly in a canyon where there is no room to execute a turnaround maneuver.

- **Never flies beyond the point of no return.**
When flying upslope terrain, the "point of no return" is defined as the point where, if you reduce the throttle to idle, you can lower the nose of the aircraft for a normal glide and perform a 180-degree turn without impacting the ground. At or prior to this "point of no return," circle (away from the mountain) to gain additional altitude before proceeding.

1.7.2. Mountain Meteorology

A complete check of the weather is necessary to develop a go/no-go decision. Stay out of marginal weather areas. For the novice, winds aloft greater than 30 knots at cruise altitude usually means the flight should be delayed or postponed until more favorable conditions prevail.

1.7.3. Density Altitude

Density altitude is the altitude the airplane thinks it is flying and performs accordingly. High, hot and humid conditions may raise the physical altitude to a performance altitude by many thousands of feet higher.

1.7.4. Runway Length

A handy rule of thumb for operations from a short runway (or high-density altitude) is:

If you obtain 71 percent of the speed necessary for rotation at the halfway point of the runway, you can take off in the remaining distance. If not, abort the takeoff.

1.7.5. Approaching Ridges

Turn to approach ridges at a 45-degree angle to provide the option of turning toward lowering terrain. The visual aspects of mountain flying can be deceiving, but 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. When approaching a ridge and the airplane is in a position where the power can be reduced to idle and it will glide to the top of the ridge line, a commitment to cross the ridge can be made. At this position, the airplane is close enough to the ridge line not to experience an unexpected downdraft of a nature to cause a problem. If a downdraft is encountered, keep the power on, lower the nose to maintain airspeed and the airplane should clear the ridge.

1.7.6. Flying Canyons

Until you have experience, do not fly up canyons. If it is necessary to fly in a canyon, gain altitude, fly to the head of the canyon, then fly down slope terrain.

1.7.7. Airspeed Control

Landing at short mountain strips requires exact airspeed control to eliminate float. A 10-percent increase in the proper approach speed results in a 21-percent increase in the landing distance. Use the same indicated airspeed for approach when landing at a high-elevation mountain strip as you would at a sea-level airport. The thin air at high altitudes affects the airspeed indicator to result in an automatic compensation of the correct amount.

1.7.8. True Airspeed

A rule of thumb states that the airplane flies faster than the indicated airspeed at altitudes above sea level. This is approximately two-per-cent-per-thousand feet faster than indicated airspeed.

1.7.9. Darkness

Allow a minimum of an extra half-hour of daylight if your destination is in the mountains.
There may be plenty of daylight at cruise altitude, but darkness may exist at your valley destination.

1.7.10. Gross Weight

The takeoff distance varies with gross weight. A 10-percent increase in takeoff gross weight (while not exceeding the maximum allowable gross) will cause a:

- 5-percent increase in the speed necessary for takeoff.
- 9-percent decrease in acceleration to takeoff speed.
- 21-percent increase in the takeoff distance.

1.7.11. Climbout

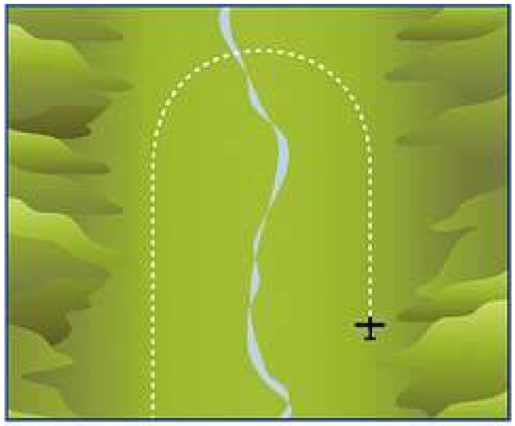
The first consideration for takeoff from a strip surrounded by mountains is one of terrain clearance. A considerable amount of time may be required to circle and circle, climbing to the en route altitude prior to turning on course.

1.7.12. Downdrafts

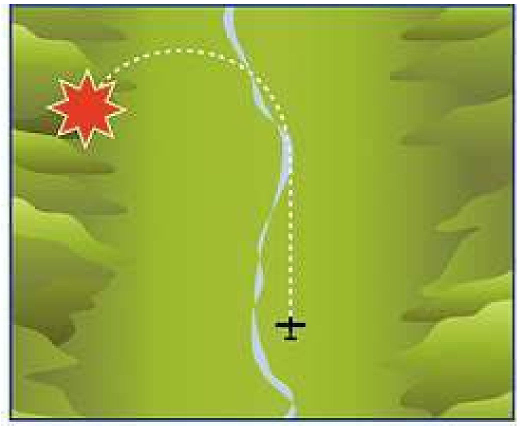
Use visualization to determine possible downdraft areas. Air behaves like water. Ask yourself, "What would water do if it were flowing as the winds aloft flow?" You can then picture areas of downdrafts, updrafts and splashes (turbulence). If you encounter unexpected downdrafts, diving to maintain air-speed will generally lessen the total displacement effect of the downdraft (altitude loss). At the higher airspeed you will be under the influence of the sink for a shorter period of time.

1.7.13. Course Reversal

Everyone flying in the mountains will encounter situations when it becomes necessary to make a 180-degree turn. Forget the hammerhead turn, wingover, chandelle and other fancy maneuvers. For course reversal, slow down—to decrease the radius of turn—by pulling back on the control wheel to trade airspeed for altitude. In conjunction with this airspeed/altitude trade, make the steepest turn you can safely make.



Positioning to one side of the valley leaves maximum room to turn. Always use the maximum room available in case a 360-degree turn is required.



Positioning in the middle of the valley means a steeper turn is necessary and there may be insufficient room to turn back safely.

1.7.14. Arrival

The mountainous terrain surrounding many strips prevents a normal descent from cruise altitude to pattern altitude. It is necessary to make progressive power reductions to prevent thermal stresses from being induced in the engine. This allows the engine to cool slowly, preventing thermal shock of the engine. Do not detune the engine.

1.7.15. Summary

Although the preceding is considered the minimum knowledge for mountain flying, it barely touches the surface of the "mountain" of information available to those contemplating a safe flight over or through the mountains. The summarized information is presented here - in this introduction section - to provide the background information that will "flag" the text that follows as something that is important and that requires further study. Be sure to read the following chapters very carefully.

1.7.16. Rules Of Thumb

- If 70.7 percent of the speed necessary for rotation is obtained at the halfway point of a runway, you can take off in the remaining distance. If not, abort the takeoff.
- A 10-percent increase in the proper approach speed results in a 21-percent increase in the landing distance.
- Use the same indicated airspeed for approach to a high-elevation mountain strip that you would use at a sea level strip.
- The airplane flies faster at altitudes above sea level, by approximately two-percent-per-thousand feet above sea level.
- A 10-percent increase in takeoff gross weight will cause a 5-percent increase in the speed necessary for takeoff, a 9-percent decrease in acceleration to takeoff speed, and a 21-percent increase in takeoff distance.

1.8. PREFLIGHT

Flying, especially in the mountains, requires a total commitment that becomes the ultimate challenge of exploring yourself, your airplane, the terrain and the elements. You must have some basic knowledge and appreciation of each of these before attempting mountain flight.

Questions of concern when contemplating a mountain flight might be:

- How does the service ceiling (or absolute ceiling) of the airplane compare with the terrain along planned routes? This is based on the density altitude en route, not the indicated altitude.
- How much time and distance will it take to get to this altitude?
- How much safety margin will I have operating at en route altitudes and high altitude airports?
- How is the weather different in the mountains?
- How and where will winds create updrafts, downdrafts and turbulence?
- What are the special techniques used for flying in the mountains?
- An examination of aeronautical charts may bring to mind questions about chart reading and interpretation.

Mountain Flying Safety Rule
Never maneuver the airplane into a position where it has the opportunity to crash.

1.9. BASIC RULES

PT Smart Cakrawala Aviation pilot faces two limitations or restrictions in his quest for safety through-out his flying career.

First, he/she is concerned with his own limitations as a pilot. His aviation background, education, training and experience delineate what he can and can't do.

Second, the airplane defines the types of operations that can be safely conducted, such as IFR or high-altitude flight.

Technical advances in the manufacture of airframes and engines combined with improved pilot training techniques have reduced the inherent risk of flight. Follow-up safety programs are important to eliminate the element of risk, but the people who need to go to these programs, the ones who are involved in accidents, never have the time or inclination to attend.

The pilot's liability to err prevents total elimination of aircraft accidents. If you, personally, establish safety standards and adhere to them, you, at least, will be prepared to avoid an accident. You might begin by inculcating a rule to avoid mountain flight when the ceiling is less than 2,000 feet or the visibility is less than 5 miles. Only knowledge and experience will allow you to change these self-imposed limits. But, changing this restriction before having the knowledge and experience to do so may rule out the occasion of changing them in the future.

Establish your own personal limitations of weather, runway length, loading and range and abide by them. Don't let a passenger especially someone who knows nothing about flying pressure you into compromising these standards. Learn to accept the inconvenience and expense incurred when you have to cancel a flight due to questionable weather. Don't let an important business engagement become a compelling reason to venture out in bad weather. Pilot error leading to an accident may occur when you want to prevent disappointment for your passengers when a long anticipated flight has to be canceled because of weather. The same thing applies to equipment. The most qualified pilot in the world can still get into trouble trying to push an aircraft beyond it's limitations. If the equipment available is not suitable for the flight, change the flight or change the airplane. In recognizing the airplane's limitations, you have to bear in mind that even though you may hold an instrument rating or an ATP certificate, the weather is not always such that you can fly your plane.

1.10. MUST KNOW INFORMATION

You do not have to learn everything about mountain flying prior to flying in the mountains. Specialized techniques do not have to be learned all at once. It will take time to become proficient in all areas of mountain flying. Start out slow. Recognize and abide by your limitations until you are able to learn, absorb and practice the advanced techniques. It makes sense to:

- Know your limitations
- Use a checklist
- Pre-plan your flight
- Preflight your airplane
- Know your aircraft systems
- Know your aircraft performance limits

You must have some basic knowledge and appreciation of mountains, airplanes and weather before attempting mountain flying.

1.11. FLY YOUR EXPERIENCE LEVEL

This manual provides you with knowledge of mountains, airplanes, yourself and weather.

An appreciation and understanding of advanced operations develops after you fly the mountains with a qualified mountain pilot. The advice given herein for mountain flying - contour, drainage or terrain flying - is not bold, macho or foolhardy. But, it does require background, education, knowledge, training, practice and experience. Don't try to fly someone experience level, fly yours!

1.12. MOUNTAIN FLYING RULES

There are only two rules to be able to fly in the mountains with safety. Need to ingrain these truisms into your mind. With these axioms firmly adhered to, will not get into trouble when flying the mountains.

Basic rules #1 of all mountain flying - ALWAYS REMAIN IN A POSITION WHERE CAN TURN TO LOWERING TERRAIN.

This encompasses the idea that will not fly in an area where there is insufficient room to turn around, for example, a narrow canyon. It also means that will approach ridges at an angle to allow an escape turn at any time.

Basic rules #2 of all mountain flying - DO NOT FLY BEYOND THE POINT OF NO RETURN.

This rule pertains to flying upslope terrain. It is actually an extension of the first axiom. The point of no return is the place defined by reducing the throttle to idle and having sufficient altitude to turn around. (It is not meant to be implied that it is proper technique to reduce the throttle to idle to turn around.) When arrive at a position, where if reduce the throttle to idle and lower the nose for the proper glide attitude, and can complete the 180-degree turn without impacting the terrain, this is the point of no return.

Do not fly beyond this point. Turn the airplane (away from the mountain) and gain additional altitude before flying beyond this point. When a pilot flies beyond the point of no return, the terrain out climbs the air-plane. The pilot has two options when this occurs and both lead to an accident. The first, and usually less serious, involves landing the airplane straight ahead into whatever terrain exists. The second choice involves the stallspin accident because there is either insufficient altitude or insufficient maneuvering space to complete the turn. By trying to hurry the turn, excessive bottom rudder is used leading to a tuck-under spin entry. The majority of accidents classified as flight into a blind canyon result from flying beyond the point of no return or entering an area that does not allow the physical space for a turn around.

FLY A POSITION THAT ALLOWS A TURN TO LOWERING TERRAIN.

Make a placard for the aircraft's panel that lists the two basic premises. Then adhere to them and will fly safely in the mountains.

1. Be able to turn to lower terrain

2. Do not fly beyond the point of no return.

Learning is often enhanced when you are exposed to the same information in different ways. Another way of stating the basic rules is: Always have an escape route in mind and be in a position where you can exercise this option. Or, constantly evaluate where you are and decide if you can lose altitude prior to having to turn the airplane. If not, you are narrowing your options and approaching an area where you may not be able to extricate yourself. You will often find that instinct does not work in an airplane.

For example, look at a pilot who has never experienced a spin. If he finds himself in a situation where the aircraft's nose appears to be pointing straight down while rotating, his "instinct" is to pull back on the control wheel to raise the nose. It doesn't work. He must first break the stall, then recover with back pressure.

You will find the basic axioms of mountain flying are not instinct. They must be ingrained as conditioned responses. They will become a part of your innermost being.

1.13. MOUNTOLOGY—The PSYCHOLOGY of MOUNTAIN FLYING

In trying to persuade you to train yourself to react to mountain flying situations, it is necessary to provide some basic definitions. The three terms are conditioned, reflex and instinct.

- Conditioned in psychology means exhibiting or trained to exhibit a conditioned reflex (response).
- Reflex in psychology means an unlearned or instinctive response to a stimulus.
- Instinct means an innate aspect of behavior that is unlearned, complex and normally adaptive.

An instinctive response to a stimulus does not work all the time in an airplane. For example, when an airplane is in a spin, your instinct is to pull back on the control wheel to raise the nose. It has worked before, but now it is not adaptive. You must be trained to "break" the stall before pulling back on the control wheel. This is a conditioned response.

The basic premises of mountain flying must also be ingrained as a conditioned reflex. True mountain flying (terrain, contour or drainage flying as opposed to flying above the mountains) can be done with total safety only when the pilot becomes conditioned to apply the basic premises during flight without having to think about them.

Basic rules #1: Always remain in a position where you can turn toward lowering terrain. Another way of stating this truth is **to have an escape route in mind and be in a position to exercise this option.**

Basic rules #2: Do not fly beyond the point of no return. Constantly evaluate where you are and decide if you can lose altitude prior to having to turn the aircraft. If not, you are narrowing your options substantially.

If you know and abide by these two basic rules of mountain flying, you can go flying, with safety.

CONSIDERATIONS

You must prepare for mountain flying. Regulations specify the pilot is responsible for the safety of the flight. He must be physically fit and mentally knowledgeable to exercise judgment while performing the flight. The weather must be suitable for the proposed operation. The flight must be planned and the airplane must be prepared. Regardless of whether these items are regulation or not, it is only after evaluating each of these and being aware of the basic rules of all mountain flying, that you are ready to go flying.

1.14. FLIGHT PLANNING CONSIDERATIONS

Before spending a lot of time planning a flight, call the Flight Operation Staff personnel to determine the trend of the weather along the route of flight.

NOTE;

- If the ceilings vary en route, look with suspicion at what is causing the weather fluctuations.
- Trying to sneak through a narrow pass under a low ceiling is asking for trouble.
- Strong downdrafts and turbulence may be encountered until the airplane is far enough into the pass.
- Rule of thumb has stated when the temperature and dew point are within 5 degrees, with a trend showing closure, you can expect low clouds and fog. It remains a valid rule, especially in the mountains. Once the temperature/dew point are within 4 degrees, head for the nearest airport before encountering a dangerous situation that can get you into trouble.
- The sun sets earlier in a canyon because the sun's rays are blocked by the mountains. Flying en route to a valley destination may pose problems. You are flying along in beautiful sunlight, but the airstrip may already be shrouded in darkness. A destination airstrip without runway lighting means you have to divert to your alternate airport.

1.14.1. Thin Air

The density of the air decreases with altitude. The airplane in flight experiences two kinds of drag, induced drag (greatest at low speeds) that is related to lilt being produced and parasite drag (greatest at high speeds) that is associated with air flow interference, eddy and form drag. For a particular power setting, the higher the airplane climbs, while still being able to maintain the desired power setting, the faster the airplane will fly. Remember the rule of thumb about indicated airspeed and true airspeed? For each 1,000 feet above sea level, the true air-speed is two percent faster than indicated.

1.14.2. Effect Of Wind

Occasionally the winds aloft are less at high altitudes than near the ground. For this reason it is wise to check the winds aloft at all altitudes where it is possible to fly. Although a headwind may be stronger at a higher altitude, its direction may be more favorable, producing less of a ground speed reduction. Additionally, the increase in true airspeed at higher altitudes may more than compensate for a stronger headwind as well as provide a smoother flight void of convection currents or mechanical turbulence.

After takeoff, while climbing to the en route cruising altitude, it is recommended you climb at the best rate-of-climb airspeed whenever a no-wind condition or tail wind ispresent. A maximum rate schedule is used to conserve climb fuel for the more efficient operating environment at altitude, unless a lower pitch attitude is required for better forward visibility or engine cooling. When climbing into a headwind, use a faster cruise climb airspeed to minimize the effect of a lower ground speed.

1.14.3. Preflight Safety Tips

- Be familiar with the airplane's operating limitations.
- Check the weather. If the weather is marginal, delay or postpone the flight.
- File a flight plan and make regular position reports.
- Route your trip along airways and over valleys choosing a route that allows for a forced landing.
- Become familiar with the destination field. Talk to someone familiar with operating at the strip or study the state-published airport information.
- Take advantage of early-morning air, but beware of flying blind (flying in to the sun).
- Carry survival equipment in the aircraft.
- Have oxygen available for flights above 12,500 feet MSL.

1.14.4. Plan Early Morning Flights

Flight instructors generally recommend that mountain flights should be made early in the morning to take advantage of the calm air. Usually, by 11:00 (local time), convection makes the air unstable. The air becomes progressively worse until around 16:00, when it slowly improves. You might be surprised by the number of days the air is calm and it is not hazardous to fly during the middle of the day. Be aware, however, that the density altitude increases, with the possibility of convection currents creating additional turbulence. Beware also of flying blind.

1.15. PREPARATION

1.15.1. Charts

PT Smart Cakrawala Aviation provide :

1. AIP Chart
2. INDOAVIS Chart
3. INDOAVIS VFR ONC Chart (scale 1: 1,000,000)

Charts provide more than terrain information. Airspace classifications, airspace restrictions, man-made obstructions and new communication and navigation frequencies are handy to have.

Some mountain areas are so vast and the terrain so varied that even pilots with adequate charts can get lost by attempting short cut. The conscientious pilot will make notes during the flight. If he takes up a different heading from that list-rid on his flight log, he notes the heading and time. If the short cut doesn't work out —you're temporarily misplaced—it's easy to plot where you probably are.

The sectional aeronautical chart turns out to be the chart of choice for VFR flight in mountainous areas. With its scale of eight miles to the inch, there is plenty of detailed to pographical information. Cultural and geographic landmarks are depicted with the physical characteristics to provide sufficient detail for accurate identification.

Current Charts

Responsible pilots agree that it is important to use current aeronautical charts for all cross-country flights. The use of outdated charts may cause the unknowing and unsuspecting pilot to fly into Class D airspace (airport traffic area, terminal control area), Class C airspace (ARSA), TRSA, Class B air-space (TCA), or restricted areas without proper authorization.

Chart Reading

All Smart Cakrawala Aviation pilots must be familiar with chart reading.

1.15.2. Routes

The shortest distance between two points is a straight line. Pilots like direct flights because they reduce flight time, and time is money. There are circumstances that make direct flights in the mountains undesirable.

Another consideration in choosing the route will be the anticipated density altitude at cruise altitude. The service ceiling of the airplane will be reached at the density altitude, not the physical altitude. Remember the body's need for supplemental oxygen will also be reached at the prevailing density altitude, not the physical altitude. The first consideration in establishing these routes is that of terrain clearance, followed by radio reception and finally, the emergency landing places are taken into account.

In choosing a route:

- Determine the time-to-climb to the required cruise altitude versus the time required for following more favorable terrain.

- Determine the density altitude at the planned cruise altitude and compare this to the service ceiling of the airplane (and the pilot).
- Determine if supplemental oxygen will be required.
- Plan your route along rivers valley if feasible. Study the terrain along the route.
- When selecting a route during a time of suspected or reported mountain wave activity, try to route the flight on the windward side of the mountains if the winds aloft report (or forecast) is 20 knots or greater. The leeward side of the mountains will be predominantly downdrafts with the resulting turbulence.

1.15.3. FLIGHT PLANNING

Judgment errors are magnified in the mountains. You must monitor the weather and fuel reserve constantly. Because of this, the value of preflight planning can't be overstated.

The airplane's performance parameters must be taken into account. The service ceiling and rate of climb influence your choice of flight path. Determine the maximum noreserve range and the power setting you will be using.

Plan legs that will put you on the ground with at least one-hour fuel reserve.

Your flight course often depends on the characteristics of the terrain. Plan the route of flight within the parameters of your airplane's altitude and range capability.

1.16. METHODS OF NAVIGATION

There are several methods of navigating from one point to another. While you can use any one of them for a flight, it is best to use a combination of them. This redundancy will keep you from becoming temporarily misplaced (lost).

- **PILOTAGE**
  Flying cross-country when using only a chart and flying from one visible landmark to another is known as pilotage. This method requires the flight be conducted at comparatively low altitudes so the landmarks ahead may be easily seen and identified.
  Therefore, it cannot be used effectively in areas that lack prominent landmarks or under conditions of low visibility.
  Advantages—It is comparatively easy to perform and it does not require special equipment. If the navigational equipment fails en route, you can keep track of our position.
  Disadvantages—A direct course is usually impractical because it is often necessary to follow a zigzag route to prominent geographical landmarks, often resulting in a longer flight.

- **DEAD RECKONING**
  Dead reckoning is the navigation of an airplane solely by means of computation, based on airspeed, course, heading, wind direction and speed, ground speed and elapsed time. To oversimplify, it is a system of determining where the air-plane should be on the basis of where it has been. It is literally, deduced reckoning, and the term has been shortened from deduced to dead reckoning.
  The most common form of VFR navigation is a combination of dead reckoning and pilotage, where the course flown and the airplane's position are calculated by true dead reckoning and then constantly corrected for error and variables filter visually checking nearby landmarks.

- **RADIO NAVIGATION**
  Radio navigation includes any method that allows a pilot to follow a predetermined flight path over the earth's surface by utilizing the properties of radio waves. The primary systems are VOR, ADF, LORAN, and GPS. Often you cannot maintain line of sight when using VORs in the mountains, rendering these radio stations unusable.

1.16.1. Preflight

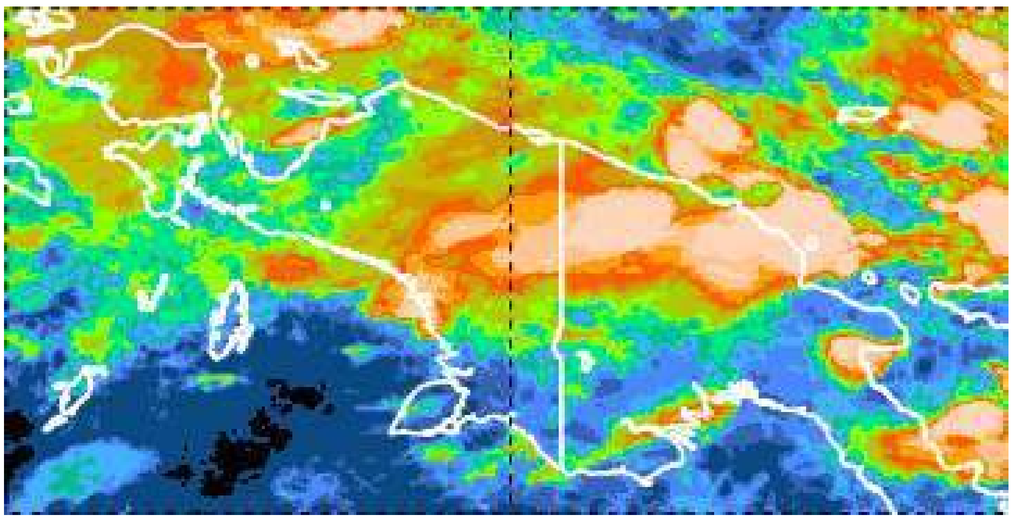
Safety statistics show many general aviation accidents could have been avoided with the proper flight planning. Air navigation begins and ends on the ground.
CASRs require certain flight planning be performed for a flight, also require weather and aircraft performance determinations. This includes obtaining pertinent weather information, plotting the course on an aeronautical chart, selecting checkpoints, measuring distances and computing flight time, headings, fuel requirements, weight and balance and takeoff and landing distances under the expected conditions of runway elevation and temperature (density altitude).

- **Equipment**

  Assemble all the materials needed for flight planning. In order to facilitate this, as well as to assist during en route navigation, it is a good idea to keep all of your equipment in one place. A flight bag is recommended for your charts, computer, plotter, lap board or knee board, airport diagram book, notebook, pens and pencils, flashlight (with spare bulb and batteries), ear plugs, stop watch, screw driver and pliers. You have to use some common sense in preparing a flight bag.

  Checking Weather Check the weather to see if the flight is feasible and that route would be the best.

  This is just a preliminary check called an outlook briefing, to determine the weather is VFR and to obtain the winds aloft forecast to use in computing ground speeds and wind correction angle. A comprehensive check is made later and is called standard weather briefing.



The infra red thermal imaging can be downloaded at http://satelit.bmkg.go.id in the part MTSAT IR Enhanced. The image will be re-fresh every 10 minute past the hour.

It is better if you can download two image at different hour before your departure time, so you can compare the cloud formation data along your propose route.

Plotting the Course Sectional aeronautical charts are the best for cross-country flight planning because of their scale of 1:500,000 and the abundance of detail, as compared to WAC Chart (World Aeronautical Chart) with a scale of 1:1,000,000.

Sectional Aeronautical Chart Scale 1:500,000 8 statute miles per inch (6.95 nautical miles)

World Aeronautical Chart (WAC) and ONC Chart Scale 1:1,000,000 16 statute miles per inch (13.9 nautical miles) If your route of flight takes you near the border of the chart be sure to have the charts of the area adjoining the flight route. In this way you are prepared if you need to circumnavigate weather or need to find your position should you become temporarily misplaced.

- **Weather**

When examining the Komite Nasional Keselamatan Transportasi (KNKT) 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 DGCA 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. These pilots do not intentionally get into instrument weather. The conclusion is that they did not recognize the instrument weather and flew into it with-out 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.

1.16.2. Mountain Meteorology

Mountain weather is not so much different than weather occurring else-where. It jusseems that there's more of it—and sometimes it is very intense. Sure, there arkatabatic winds (any wind blowing down an incline) and mechanical lifting that don'normally occur over flatland. But the basic weather is the same. However, flying in themountains when adverse weather conditions exist, does require more judgment anskill than when flying over the flatland. In the mountains, when the weather is good, s really good; when the weather is bad, it is terrible. Typical summer forecasts state"Partly cloudy with widely scattered afternoon and early evening rain showers anhunder-storms." As long as the forecast remains valid, that is, widely scattered, thers no problem circumnavigating the weather over flatland. Thunderstorms, scatteredor not, can set up a total roadblock when operating in the mountains.

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.

1.16.3. Go - Or - 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.

1.16.4. Mountain Airstrip Weather

Most mountain strips (as opposed to mountain airports) do not have weather reporting facilities or personnel. It is necessary to check the actual weather to your local agent or local radio operator. Although this isn't "official" weather, it may be invaluable information.

1.16.5. Marginal Weather

Present day weather forecasts are very accurate, but they have limitations. Some pilots have complete faith in forecasts and tend to ignore warning signs en route.
Other pilot has no faith at all. It is best to consider forecasts as professional advice instead of the unmitigated truth.
The mountains, like the plains, experience frontal movement and weather phenomena. It's just that in the mountains a weather system moving across uneven terrain receives greater modification than it would over flat land. This is what makes mini-weather systems so unpredictable and often violent.
Spend some time thinking about marginal weather situations prior to flying in the mountains and establish some personal safety standards. To begin with, you should consider parking the airplane and waiting for better conditions whenever the ceiling is less than 2,000 feet or the visibility is less than five miles. If you aren't instrument rated, you must learn to recognize instrument weather from a distance and be ready to divert to the nearest airport and land or go back before getting into instrument weather. Even if you have an instrument rating, but without the proper equipment (altitude capability, anti-icing and deicing equipment), it may be foolhardy to try IFR.

Stay out of unfamiliar areas—or even familiar areas—when marginal weather prevails along your route of flight. It is difficult to determine your position because everything looks different when clouds obscure a portion of the terrain. From a safety standpoint, you must learn there is no marginal weather that allows VFR flight.
If it is VFR, fly it VFR. If it is IFR, do not try to fly VFR.

1.16.6. Visibility

One of your personal limitations to be established for flying the mountains is a minimum visibility. This is a value that is colored by your experience level and knowledge of the weather situation. The visibility is every bit as important as the ceiling. Without both your established minimum ceiling and visibility, it is time to turn around. If the weather has deteriorated behind you, find a place to land the plane and wait until conditions improve.
Keep in mind:

- Rain can severely restrict forward visibility and provide a visual illusion of being higher than you actually are.
- A thunderstorm with its accompanied rain can cause darkness in a canyon during the middle of the day.
- The transition from daylight to dusk makes it difficult to discern terrain. A mountain may appear to be just another dark area.


Be careful when evaluating a reported ceiling of 2,000 or 3,000 feet and thinking the weather is suitable to fly to your destination. The ceiling is the lowest layer of clouds (or obscuring phenomena) above the ground (or water) at the reporting station that is classified as broken, overcast or obscuration and not classified as thin or partial.
Although a ceiling of 2,000 or 3,000 feet may match your personal limitation for VFR flight in the mountains, a mountain pass may be enough higher than the reporting station's level that it is obscured by clouds, or it results in a ceiling or visibility below your established personal limitation.

1.16.7. Fog

We know there is a lack of weather reporting stations in the mountains. The only way a pilot knows about the actual weather is through pilot reports. Some depart a clear area, unaware of the possibility of interior valley fog, and have their plans spoiled. Valley fog occurs most often after rain showers have passed an area. The excess moisture combined with radiational cooling during the night creates the fog.
Pilots make a PIREP concerning the weather, good or had, in the vicinity of mountain strips.

1.16.8. Stability

The pilot is vitally concerned with the stability of his aircraft. A stable aircraft, If disturbed by the movement of the controls or by an external force (turbulence), will lend to return to a balanced steady flight condition. An unstable aircraft, however, will continue to move away from the normal flight attitude.

So it is with the atmosphere. The normal flow of air tends to be horizontal. If flow is disturbed, a stable atmosphere will resist any upward or downward displacement and will tend to return quickly to normal horizontal flow. An unstable atmosphere, on the other hand, will allow these upward and downward disturbances to grow, resulting in rough air.

Atmospheric resistance to vertical motion, called stability, depends upon the vertical distribution of the air's weight at a particular time. The weight varies with air temperature—hot air is lighter than cold air. Therefore, if air is warmer its surroundings, it is forced to rise. For example, if a balloon is filled with lilt of the same temperature as the surrounding air, it will not rise—indicating a condition. On the other hand, a balloon filled with air that is warmer than the surrounding air will rise, since the atmosphere–that cannot resist this vertical motion–is unstable. The atmosphere can only be at equilibrium when light air is above heavy air; just as oil mixed with water will rise to the top to obtain equilibrium.

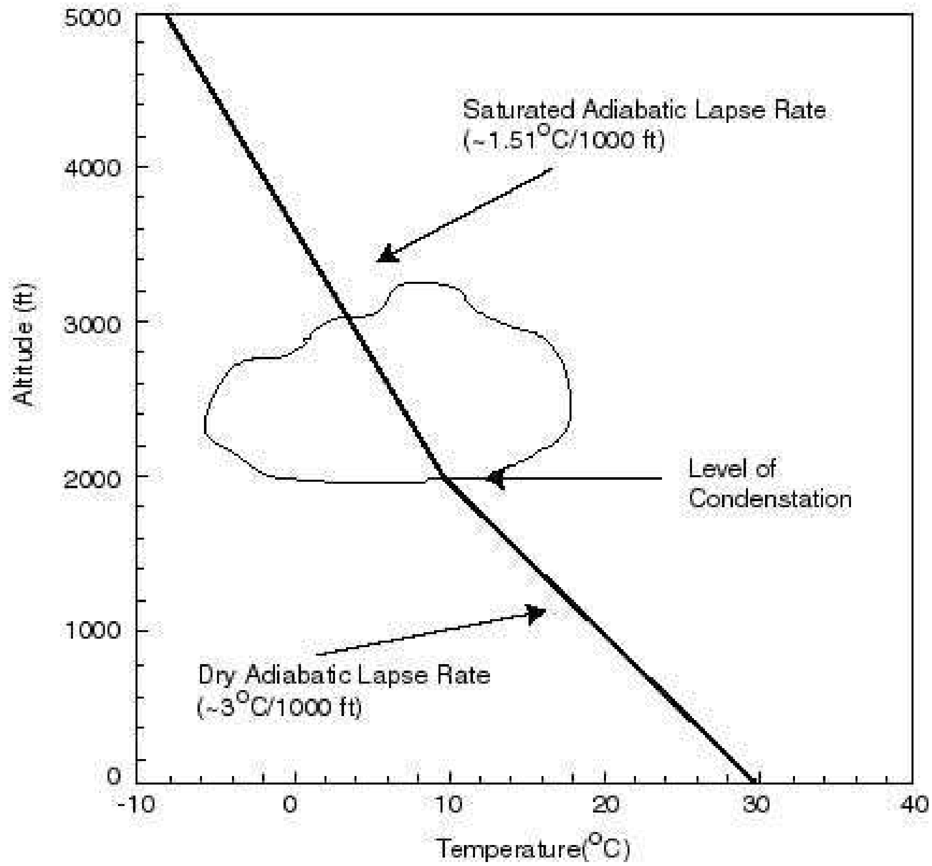
In the same manner that the balloon with warm air rises, the air that is heated the earth's surface on a hot summer day will rise, too. The speed and vertical extent of its travel depends on the temperature distribution of the atmosphere. Vertical air currents resulting from the rise of air can vary from the severe updrafts and compensating downdrafts associated with thunderstorms, to the closely spaced upward and downward bumps that are felt on warm days when flying at low levels.

The type and intensity of the weather are directly related to the atmospheric stability, stability being affected by temperature and moisture. When air is heated or when moisture is added, it tends to become unstable. These two factors are interrelated.

When the air temperature is increased, it will hold more moisture and cause a greater rate of evaporation when it comes into contact with large bodies of water.

When moisture evaporates, it carries with it a small amount of latent heat. The latent heat does not affect the surrounding air until the water vapor is condensed into a water droplet, at which time it gives up latent heat.

LAPSE RATES



The temperature of air is an index of its density. A comparison of the temperature from one level to another can indicate the degree of the atmosphere's stability that is, how much it will tend to resist vertical motion. Generally temperature decreases with altitude, and that rate at which it decreases is called the lapse rate. The lapse rate, commonly expressed in degrees per thousand feet, gives a direct measurement of the atmosphere's resistance to vertical motion. The degree of stability of the atmosphere may vary from layer to layer as indicated by change of lapse rate with height.

1.16.9. Some Effects Of Stability And Instability

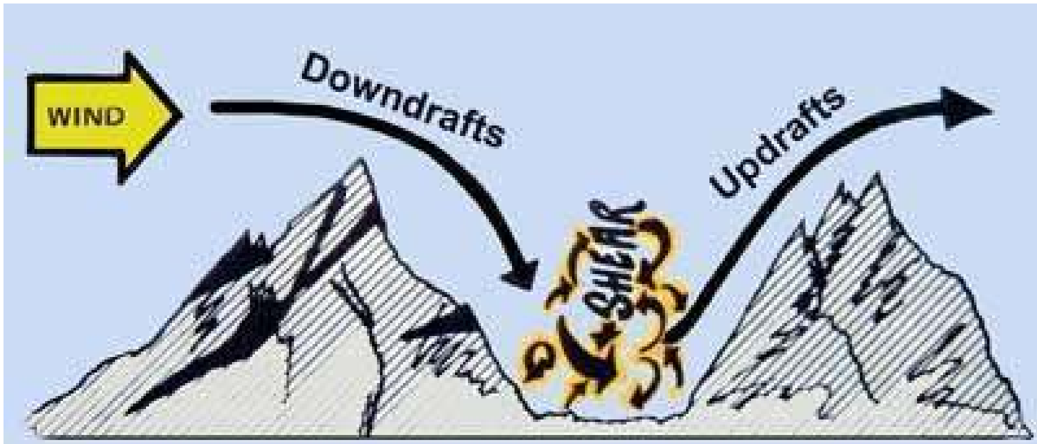
The degree or stability of the atmosphere helps to determine the type o clouds, if any, that form. For example, if very stable air is forced to ascend mountain slope, clouds will be layer-like with little vertical development and little or no turbulence.

Unstable air, if forced to ascend the slope, would cause considerable vertical development and turbulence in the clouds.

If air is subsiding (sinking), the heat of compression frequently causes inversion of temperature, increasing the stability of subsiding air. Sometime when this occurs, a surface inversion formed by radiational cooling is already present. The subsidence produced inversion, in this case, will intensity the surface inversion, placing a strong Lid above smoke and haze.

Poor visibility in the low levels of the atmosphere results, especially near industrial areas. Such conditions frequently persist for days.

1.16.10. Wind

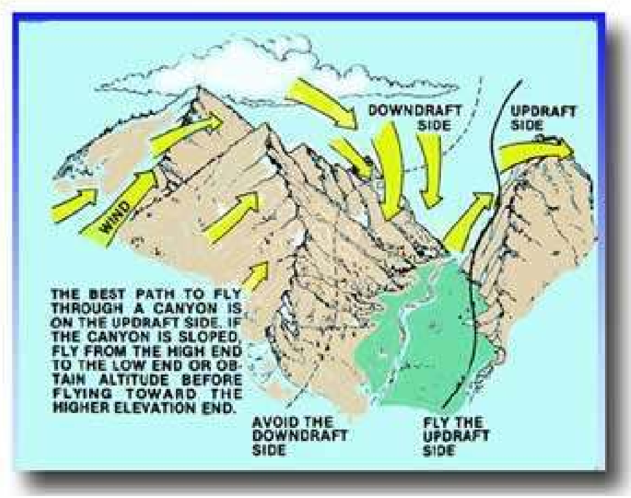


Although there are exceptions to every rule, normally the inexperienced pilot is advised to avoid mountain flying when the surface wind exceeds 20 knot. This is indicative of stronger winds aloft. The rule does not prevent the pilot from taking a "look-see."

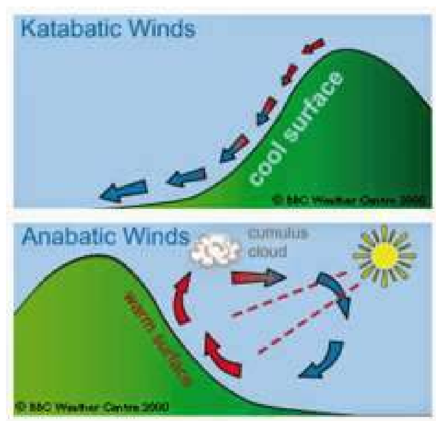
Flying in the flatlands, the pilot discovers the wind will assume a more or less constant speed and direction in a horizontal plane. Under these circumstances may not be a hazardous operation to fly when moderately strong winds exist. I the mountains, a different situation may occur where mountains, valley canyons and obstructions modify the wind flow and create turbulence that may prevent safe flight.

Inexperienced pilots often observe movement of cloud shadows and assume the wind will conform to that shadow movement. This is true only if the pilot is flying at or near the cloud base. At altitudes lower than the cloud base, terrain modification of the wind flow makes the cloud shadow useless, except when used in conjunction with visualization of possible modification.

1.16.11. Mountain And Valley Winds



A katabatic wind is any wind blowing down an incline. The mountain breeze is a type of katabatic wind. To be classified as a katabatic wind, the mountain breeze must be observed to be blowing down an incline, under circumstances such that the incline itself is responsible for the existence of the primary characteristics of the wind. There are many other katabatic winds other than mountain breeze, and some of them have received colorful names of local origin, since they are often quite dramatic in their local effect.

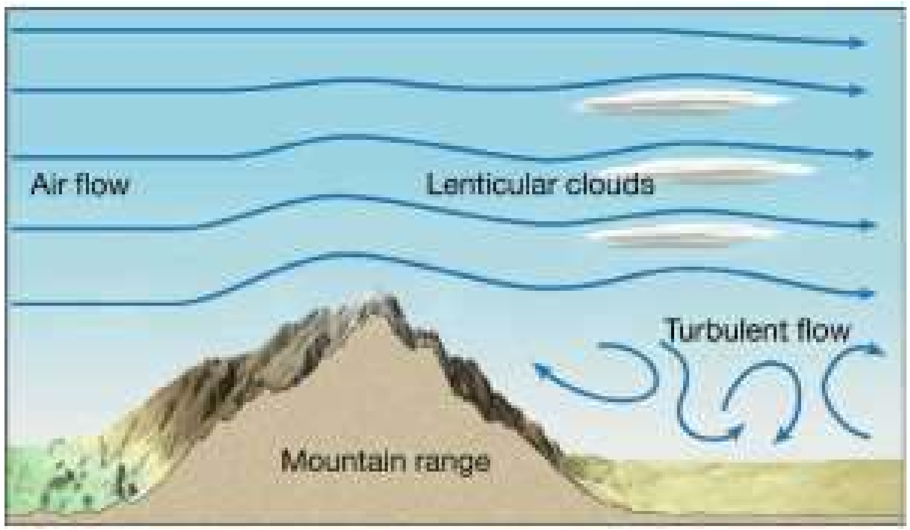


Any katabatic wind originates because a cold, and therefore heavy, air mass spills down over sloping terrain, displacing the warmer and less dense air ahead of it. If the descent persists through a sufficient altitude, the air will become warmed by compression until it is actually warmer than the air ahead of it. But, by that time it has momentum enough to continue displacing the colder air. Under these circumstances, the katabatic wind can usually be observed at the surface only a relatively short distance, for as soon as the warm air loses its momentum, it will no longer be able to displace the cold air. It will then ride over colder air, leaving the original surface wind unchanged while the katabatic wind may still be observed at some altitude above ground level. Sometimes, however, the cold air receding from the slope, and the warming from the downslope winds may be felt many miles from the steeper slopes.

In such cases it is impossible to define a clear-cut line between the katabatic wind and the winds resulting from existing pressure gradient forces.

1.16.12. Winds Aloft

Wind flow characteristics in mountainous areas demand that the pilot spend time studying its causes and effects. Wind has substance just like water. It obeys the laws of physics in the same manner. Because of this it is possible to study flowing water in various riverbeds to gain some appreciation of lift, sink and turbulence.
When you find an area with obstructions, visualize what you think the water would do, then move up close to check it out. Experience makes it possible to accurately predict areas of updrafts, downdrafts and turbulence. Previous experience combined with the study of wind allows us to come up with some generally acceptable rules of thumb to apply when contemplating a mountain flight.

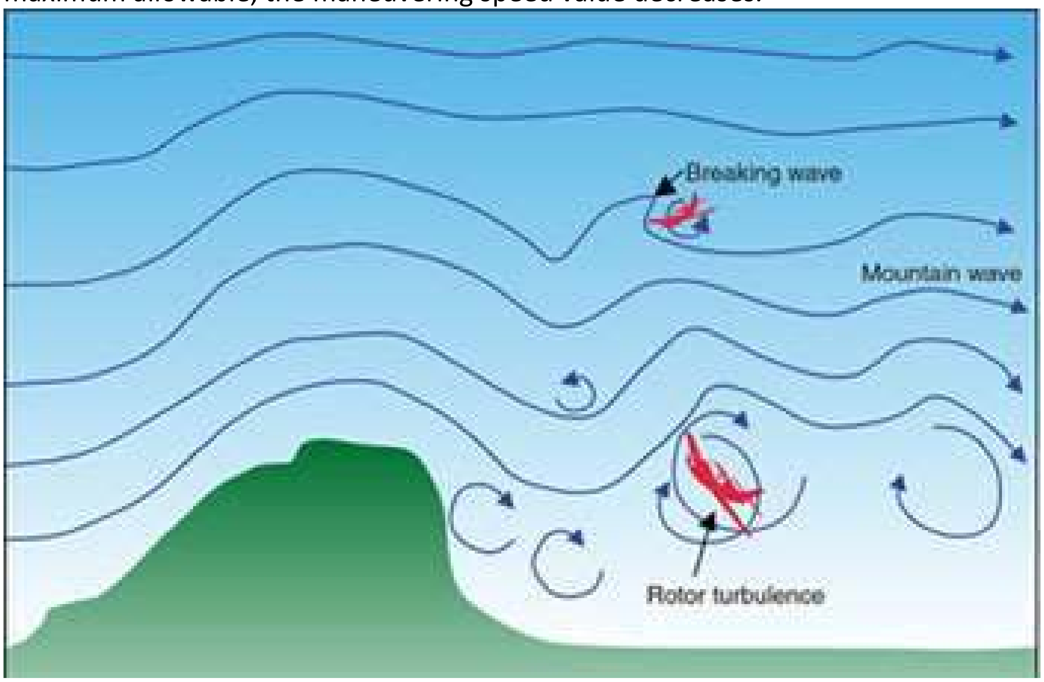


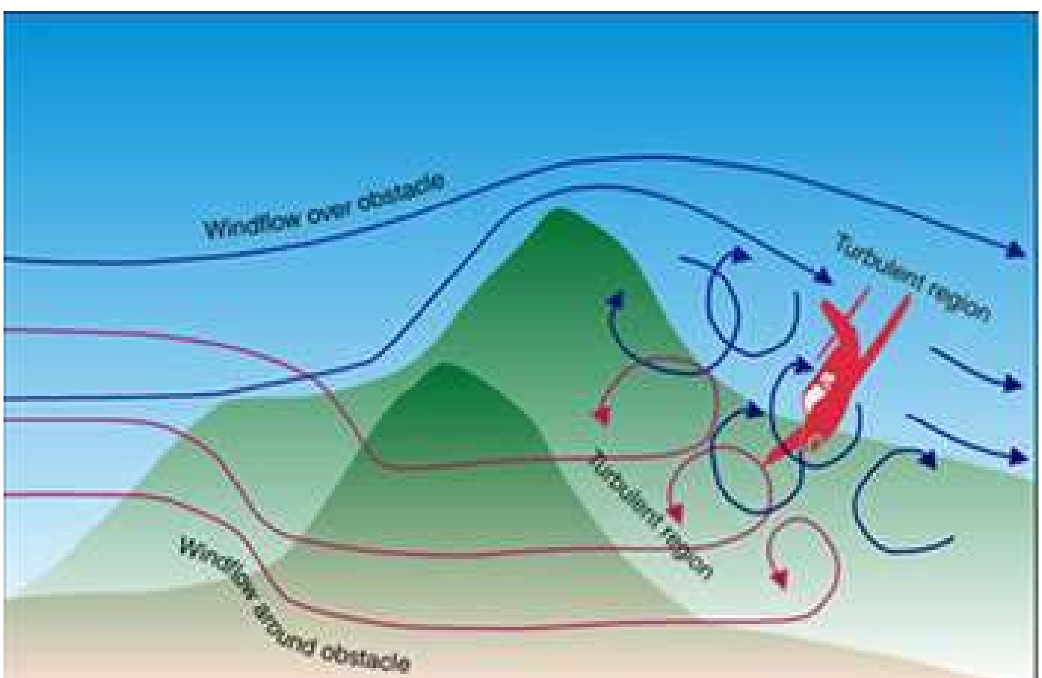
- When the surface wind becomes 20 knots or greater, or the ridge-level winds are greater than 20 knots, the flight should be executed with caution. If the Geostrophic wind (wind caused by rotation of the earth) approaches 30 knots or more, consider postponing or delaying the flight.
- In the mountains a condition known as a valley breeze occurs in the morning and a mountain breeze occurs in the evening. The valley breeze begins around mid-morning and lasts until late evening. Heating of the surface causes the air to rise and flow upslope. The mountain breeze occurs due to cooling and the air slides down the slopes.
- Ridges should be approached and crossed at an angle. This allows an escape away from the ridge with the least amount of turn if downdrafts or turbulence are experienced.

1.16.13. Turbulence

Whenever moderate turbulence or greater is experienced, it is essential that you immediately slow to the maneuver speed or rough air speed to prevent structural damage. With strong updrafts and downdrafts, fly an attitude rather than to hold a hard altitude. It is possible to exceed the structural limits of the airframe or wings when trying to hold the altitude. Allow minor airspeed and altitude deviations. Visualize what is causing the turbulence and fly out of the area.

Maneuvering speed is determined to protect the airplane from exceeding any G forces that can "break" the airplane. The pilot adhering to the maneuvering speed will be protected. Remember also that as the gross weight of the airplane decreases from the maximum allowable, the maneuvering speed value decreases.

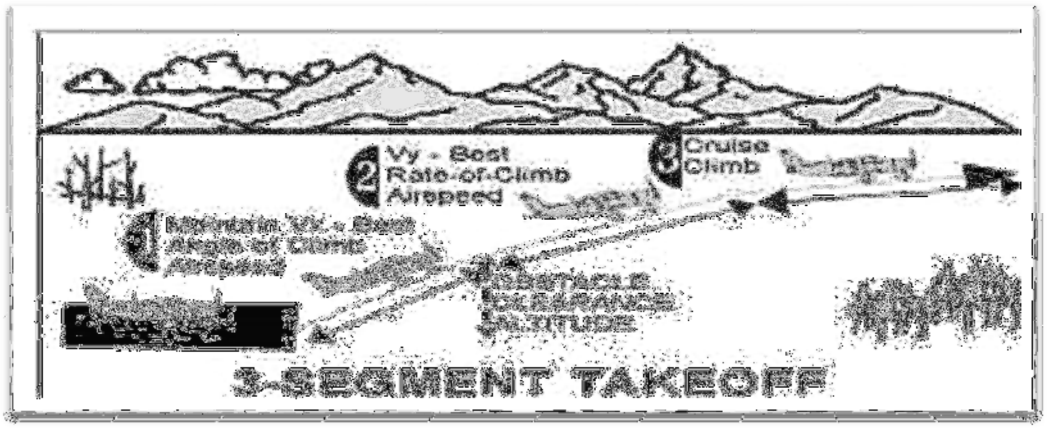




1.17. TAKEOFFS

1.17.1. Takeoff Considerations

The worst time to be studying about an emergency is during the middle of one. Before beginning a takeoff, consider the following topics. Familiarization makes it easy to cope with adverse conditions or an emergency, if should one arise.



1.17.2. Airspeed

Airspeed control is important during the takeoff and climb from a mountain strip. With exact airspeed control you are able to extract the maximum performance from the airplane.

Very few operations can associate a rule with the "always" or the "never" monicker without exception...because there are always exceptions to the rule. But, for normal operations, as opposed to special exceptions like adding half the wind-gust factor to the takeoff speed or approach speed, we will, at any airport elevation regardless of density altitude, always use the same indicated airspeed for takeoff as that used at sea level. We will always use the same indicated air-speed for approach to landing that we use for approach to landing at a sea-level airport. Let's see why this is true.

An airplane accelerating for takeoff from a sea-level airport under standard conditions (assuming no instrument error) will register the true airspeed of the airplane on the airspeed indicator. That is, the indicated airspeed and true airspeed are the same.

When the airplane operates at a high altitude airport (any airport above sea level) the indicated airspeed is less than the true airspeed.

Assume an airplane is departing from airport elevation 9,927 feet msl. At sea level this airplane uses 65 knots true airspeed to rotate. You know the true airspeed must be faster at high altitudes to compensate for the increased true airspeed stalling speed. The thin air affects the power output of the engine, the thrust of the propeller, and the lift of the wings.

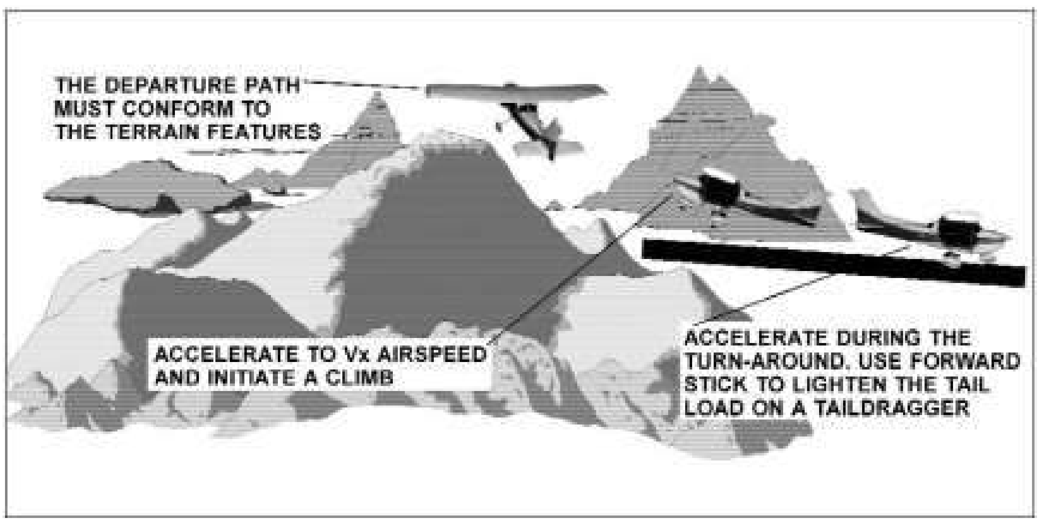
As the airplane accelerates and reaches a true airspeed of 65 knots, the air-speed indicator will only indicate about 56 knots (with standard conditions) because the thin air cannot expand the diaphragm inside the airspeed indicator as much as the thicker air does at sea level. By the time the airspeed indicator shows 65 knots (the speed used to rotate), the airplane is actually going about 75.5 knots true airspeed, automatically compensating for the thin air.

1.17.3. Takeoff Power

Many years ago, the FAA conducted tests to determine the benefits of setting full power before brake release for takeoff. They determined that, aerodynamically, the prop must move forward through the air before becoming efficient; therefore, this static run-up does not increase the takeoff performance by shortening the take-off roll.

On a rough field this technique of setting full power before brake release may damage the propeller and horizontal stabilizer.

Although, theoretically, that it does no good to make a full-power application before brake release, prefer to hold the brakes on a short-field take-off, assuming it can be done without damaging the propeller or horizontal stabilizer. This is especially true if the engine is turbocharged or supercharged. A progressive power application without surging or over-boosting is the reason. This technique reduces the urgency to shove the throttle through the panel as the end of the runway approaches.

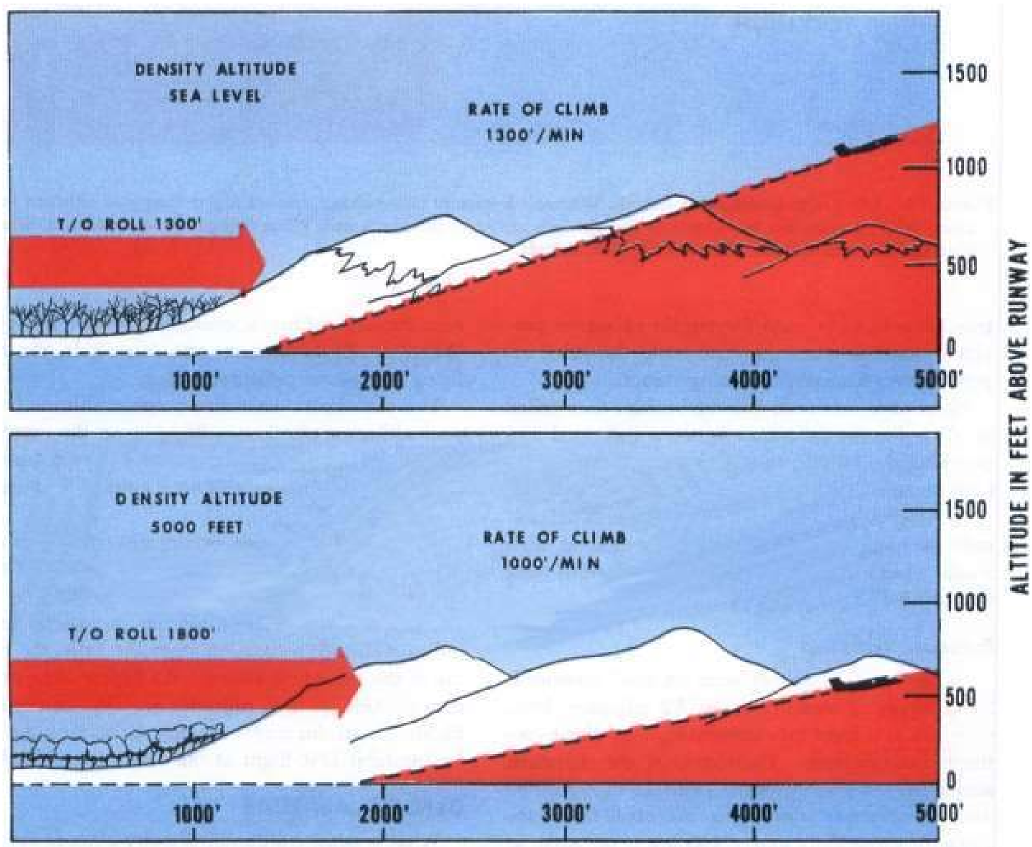


RULE OF THUMB: **WHEN THE RUNWAY LENGTH IS DOUBTFUL, MARK THE MIDPOINT OF THE RUNWAY. IF 71% OF THE TAKEOFF SPEED IS OBTAINED AT THE 50% POINT ON THE RUNWAY, SUFFICIENT RUNWAY IS AVAILABLE FOR THE TAKEOFF. IF NOT, ABORT THE TAKEOFF AND WAIT FOR BETTER CONDITIONS. (COOLER TEMPERATURE, MORE HEADWIND, OR OFF-LOAD SOME PASSENGERS AND BAGGAGE.**

1.17.4. Runway Length Requirement

When you fly from a short runway and you have doubts that the performance of the airplane is adequate to takeoff in the distance available under existing conditions of density altitude and aircraft loading, use the “runway length sufficient” rule of thumb. Mark the mid-point of the runway. The reason for this is because the airplane stops better than it accelerates. If you accelerate to the halfway point and determine you have insufficient speed for takeoff, you can easily stop in the remaining distance.

Take the square root of 50 (percentage of liftoff distance required equals half or 50 percent of the runway). This value is 7.07. Multiply this by 10 (10 times the square root), for a total of 70.7. **If 71 percent of the liftoff speed is attained by the halfway point of the runway, the airplane will take off in the space remaining**.
This does not guarantee the rate of climb will be sufficient to clear any obstacles that may be present after takeoff, but it does guarantee that you can takeoff in the space available.



1.17.5. Gusty Wind Takeoff

For takeoff operations during gusty wind conditions, keep the airplane on the ground until obtaining a speed of VR plus one half the gust factor.

1.17.6. Tailwind Takeoff

Due to terrain considerations, backcountry airstrips are generally located beside creeks and rivers where more or less flat terrain exists. It is desirable to land upstream and takeoff downstream at backcountry strips to let the sloping terrain work with you. But, you must be mindful of the wind.
When wind is created by solar effect, the air rises and begins moving upslope. The sun heats the canyon creating convection currents and these morning winds—called a Valley Breeze—blow up the canyons. The valley breeze is generally 4-6 knots. This means, when landing upslope (upstream), the airplane will experience a tailwind.

In the evening, as the air cools and becomes heavier, it slides down the mountains creating evening winds—called a Mountain Breeze. The mountain breeze is stronger than the valley breeze, usually around 10-12 knots. This means a flight departing during the late afternoon or evening, flying down slope, will be exposed to a tailwind. RULE OF THUMB for **the effect of a tailwind on takeoff distance**

The tailwind takeoff distance is equal to 110 percent of the computed takeoff distance for the existing density altitude plus the value of the tailwind component divided by the rotation speed.
How does a tailwind affect the takeoff distance? For an airplane with a take-off distance of 1,000 feet, a rotation speed of 50 knots and a 10-knot tailwind, the takeoff distance would be:
1,000 x 1.10 = 1,100 feet (takeoff distance x 110 percent) plus 1,000 x 10/50 = 200 feet (tailwind/rotation speed)
Total 1,100 feet plus 200 feet = 1,300 feet

1.17.7. Upslope Or Downslope Runway

RULE OF THUMB **Upslope or Down slope Runway Takeoff Distance** For takeoff on an upslope runway, from one degree up to two degrees, add 10 percent per degree.
For down slope runways, decrease the takeoff distance five percent per degree.

1.18. AIRCRAFT PERFORMANCE

1.18.1. Cold Air

Cold air is heavy and dense providing the perfect medium for flying. Compared with warmer air, cold air gives the wings more lift, gives the engine more air (by weight) to provide power and gives the propeller more air (thicker) to produce thrust.

1.18.2. Effect Of Altitude

The operating altitude can be increased by flying to a field with a higher elevation or by operating at a field with nonstandard higher temperature. In either case air density is decreased resulting in increased takeoff and landing distances and a decrease in the rate of climb.

Types of Altitude

Pilots sometimes confuse the term "density altitude" with other definitions of altitude. To review:

Indicated Altitude – Altitude shown on the altimeter using the current altimeter setting

True Altitude – Height above mean sea level (MSL)

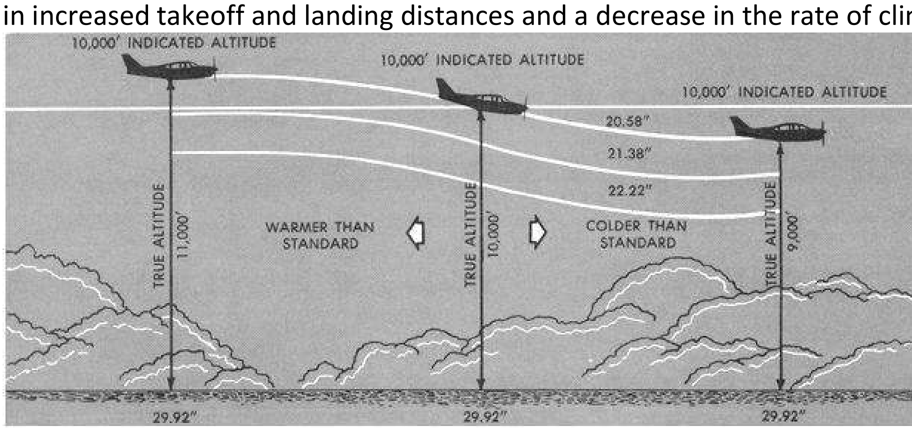
Absolute Altitude – Height above ground level (AGL)

Pressure Altitude – Indicated altitude when an altimeter is set to 29.92 in Hg and used primarily in performance calculations and in high-altitude flight

Density Altitude – Pressure altitude corrected for non-standard temperature variations

1.18.3. Effect Of Temperature

Heated air expands reducing its density. A decrease in air density will have a resulting in increased takeoff and landing distances and a decrease in the rate of climb.



1.18.4. Effect Of High Humidity

When the temperature and pressure are the same, the air density varies inversely with the humidity. This means that as the humidity increases, the air density decreases; and, as the humidity decreases, the air density increases.

As air is heated its moisture-carrying ability increases. For each 20°F increase in temperature, the air's capacity for holding moisture is doubled. If the relative humidity is 80 percent on a hot day and again on a cool day, the air will contain more moisture on the hot day.

The aerodynamic effects of humidity have been mostly ignored because humidity affects the power output of the engine more than the aerodynamic efficiency of the wings. There is no rule of thumb for determining the effect of humidity on aircraft performance. If high humidity exists, add 10 percent to the computed takeoff distance.

Anticipate a reduced rate of climb.

1.18.5. Density Altitude

The novice pilot who does not heed density altitude warnings, or even knowledgeable pilots who become complacent, often have a rude awakening when experiencing the effect of density altitude. Four variables, altitude, pressure, temperature and humidity, comprise density altitude. Altitude and pressure used to determine the pressure altitude. The value of pressure altitude can be read directly from the altimeter when it is adjusted to 29.92 inches of mercury. Using a flight computer or calculator, non-standard temperature is applied to the pressure altitude to determine the value of density altitude.

High Density Altitude – a condition of the atmosphere that reduces aircraft’s performance capability to below a level of standard performance at a specified altitude.

Occasionally a pilot will confuse the term "high density altitude," thinking this means the airplane will perform well. The term means the air is experiencing a low density that is associated with a high altitude in the standard atmosphere.

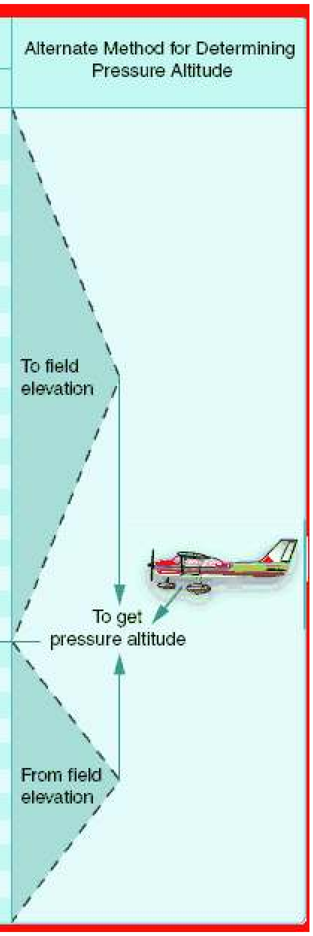
When the altimeter setting is lower than 29.92 and the altimeter is adjusted to obtain the pressure altitude, the pressure altitude will be higher than standard. The pressure altitude can be determined without adjusting the altimeter. This is accomplished with the rule of thumb that 1-inch of mercury equals 1,000 feet.

RULE OF THUMB—The altimeter setting's equivalent-feet values, 1 inch of mercury equals 1,000 feet; 0.1 inch equals 100 feet; 0.01 inch equals 10 feet.

Method for Determining Pressure Altitude

Altimeter setting	Altitude correction
28.0	1,825
28.1	1,725
28.2	1,630
28.3	1,535
28.4	1,435
28.5	1,340
28.6	1,245
28.7	1,150
28.8	1,050
28.9	955
29.0	865
29.1	770
29.2	675
29.3	580
29.4	485
29.5	390
29.6	300
29.7	205
29.8	110
29.9	20
29.92	0
30.0	−75
30.1	−165
30.2	−255
30.3	−350
30.4	−440
30.5	−530
30.6	−620
30.7	−710
30.8	−805
30.9	−895
31.0	−965

Add (28.0–29.9); Subtract (30.0–31.0); Field elevation is sea level



When the reported altimeter setting is lower than 29.92, subtract the setting 29.92 and convert to equivalent feet of altitude. Add this value to the field elevation to obtain pressure altitude.

EXAMPLE: The altimeter setting is 29.66 (lower than 29.92). What is the pressure altitude? Airfield elevation is 6,445. Subtract 29.66 from 29.92 = (0.26) inch and convert to 260 feet. Add 260 feet to the airfield elevation and the pressure altitude is 6,675.

If the reported altimeter setting is higher than 29.92, subtract 29.92 from the altimeter setting. Subtract this value from the field elevation to pressure attitude.

EXAMPLE: The altimeter setting is 30.21. What is the pressure altitude? Subtract 29.92 from 30.21 to obtain 0.29. Convert this to 290 feet and subtract from elevation of 5,883 obtain the pressure altitude of 5,593.

Density Altitude = PA + (120 X (actual OAT – ISA Temp))

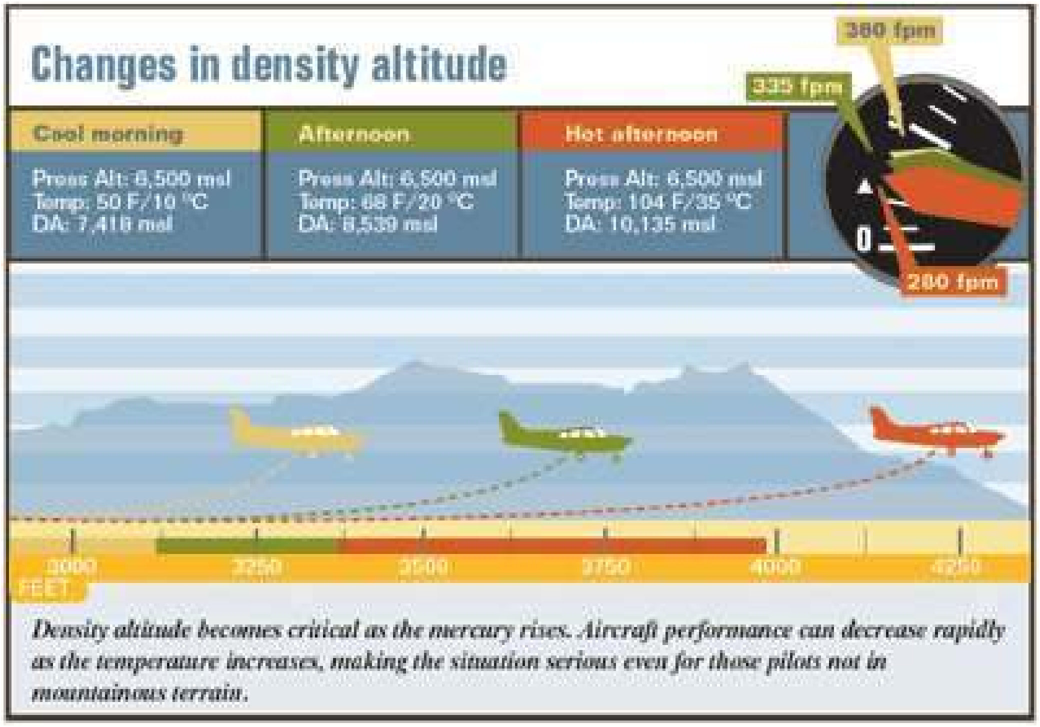
High Density Altitude Hazards

- Reduced Power (engine ingests less air to support combustion)
- Reduced Thrust (propeller has less "grip" and jet exhausts less mass)
- Reduced Lift (air exerts less upward force on the airfoils)
- Longer takeoff roll is required
- Smaller rate of climb
- Lowers aircraft's service ceiling
- Longer landing roll required

Service Ceiling – The maximum density altitude where the best rate of climb airspeed will produce 100 feet per minute climb at maximum weight in a clean configuration with maximum continuous power.

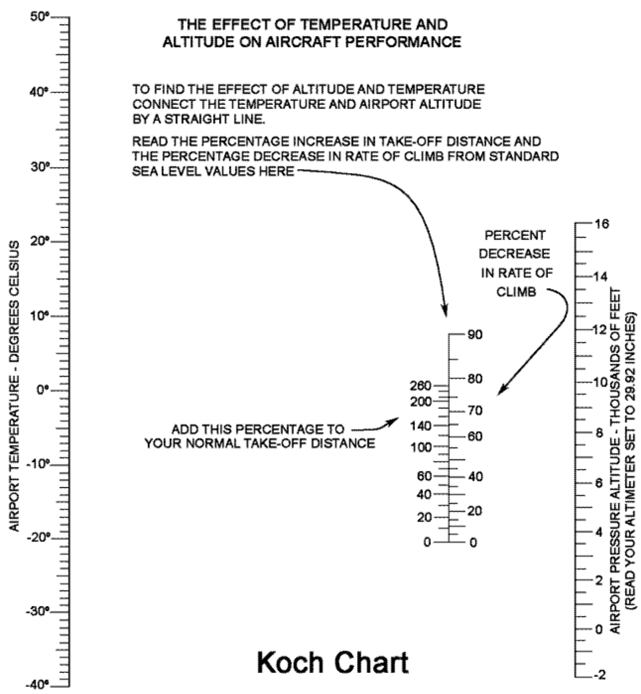
1.18.6. Combined Effect Of Altitude, Temperature And Humidity On Flight

Even at near sea-level airports, density altitude affects an airplane. At mountain airports--with higher elevations--the effects of density altitude are more dramatic.
When altitude, temperature and humidity are combined their adverse conditions are aggravated. BEWARE OF HIGH, HOT, HUMID CONDITIONS. The Only way to guarantee that the aircraft performance is sufficient to deal with the condition is to check the Airplane Flight Manual, or Pilot's Operating Handbook to delve into the performance charts.



RULE OF THUMB - Determine Density Altitude For each 10 °F above standard temperature for the airport's elevation add 600 feet to the field's elevation.
For each 10 °F below standard temperature for the airport's elevation, subtract 600 feet from the field's elevation.

DENSITY ALTITUDE TAKEOFF DISTANCE



RULE OF THUMB— Constant-Speed (Variable Pitch) Propeller Density Altitude Takeoff Distance To the standard, sea level takeoff distance, add 10 per-cent for each 1,000 feet density altitude up to 8,000 feet. Add 15 percent for each additional 1,000 feet density altitude above 8,000 feet.

RULE OF THUMB—Density Altitude Rate of Climb—Variable-Pitch Propeller Airplane Reduce sea level rate of climb 6% for each thousand feet density altitude up to 8,500 feet and 8% for each thousand feet above 8,500 feet.

COMBINED EFFECT OF ALTITUDE, TEMPERATURE, AND MOISTURE ON THE TAKEOFF AND RATE OF CLIMB THIN AIR REDUCES LIFT. HOT AIR AT HIGH ALTITUDE IS THIN.

THE THIN AIR AT HIGHER ALTITUDE LOWERS THE EFFICIENCY OF THE ENGINE AND THE PROPELLER AND LESSENS A PLANE'S RATE OF CLIMB.

REMEMBER: ANY INCREASE IN OPERATING ALTITUDE, DUE TO ELEVATION, HIGH TEMPERATURE OR LOW PRESSURE WILL GREATLY INCREASE THE TAKEOFF AND THE LANDING ROLL.

DENSITY ALTITUDE IS THE ALTITUDE THE AIRPLANE THINKS IT IS AT AND PERFORMS IN ACCORDANCE WITH.

OTHER FACTORS

While density altitude is a good gauge of the performance you may expect, some other factors that require consideration for takeoff would be: gross weight, wind, humidity, runway surface, gradient, aircraft and engine condition, pilot skill and effect of local terrain.

1.18.7. Weight

Remember the takeoff distance varies with the square of the gross weight.

A 10 percent increase in takeoff gross weight will cause:

- a 5 percent increase in the speed necessary for takeoff;
- at least a 9 percent decrease in acceleration; and,
- at least a 21 percent increase in takeoff distance.

Conversely, a 10 percent decrease in takeoff gross weight will cause:

- a 5 percent decrease in the speed necessary for takeoff;
- at least a 9 percent increase in acceleration; and,
- at least a 21 percent decrease in takeoff distance.

RULE OF THUMB—The takeoff distance varies as the square of the gross weight.

1.18.8. Wind

The presence of a headwind will assist in the takeoff and landing in terms of shortening the distance required to takeoff or land. For an approximation of the effect of the wind use the following rule of thumb.

RULE OF THUMB—**Headwind Reduces Takeoff Distance**

A headwind will reduce the normal takeoff distance for any particular density altitude equal to 90 percent of the take-off distance minus the value of the ratio of the headwind component divided by the rotation speed. If you don't want to do any mathematical computations, use the following for 1 rough estimate of the effect of the headwind.

Headwind—Reduce Takeoff Distance

10 knots = 27%
15 knots = 39%
20 knots = 52.5%
25 knots = 65%
Whenever operating with a crosswind present, the wind is divided into two vector forces. One component is a crosswind, the other component a headwind (this does not apply to a direct headwind or a 90-degree crosswind). The headwind (or tailwind) component is equal to the Cosine of the wind angle multiplied by the wind velocity.
The direct crosswind component (90-degree angle crosswind) is equal to the Sine of the wind angle multiplied by the wind velocity.

1.18.9. Tailwind Component

Occasionally, especially at a one-way strip, it is necessary to depart with tailwind if the flight is going to be made. In an airplane with a rotation speed of 60 knots, a tailwind of 6 knots (10 percent of the takeoff speed) will increase the takeoff distance by 21 percent. This may create one of the situations where you think to yourself, "Gee, I don't know if I can make it." Whenever doubt creep into flight, it's time to dig out the Airplane Flight Manual or Pilot's Operating Handbook to determine the takeoff distance. Until you gain experience and can judge that the airplane does what the book states it will do, it would be wise to add a safety factor to the 21 percent you add to the takeoff distance, probably a additional 10 percent.

1.18.10. Humidity

If the temperature and pressure are constant, air density varies inversely with humidity. If the humidity increases, the air density decreases.

1.18.11. Runway Surface

The performance data provided by manufacturers in airplane manuals for takeoff assumes the surface will be a paved runway. Whenever the airplane's wheels are exposed to a surface that increases the drag due to friction, the take off distance will be increased. Those surfaces increasing the takeoff distance are long grass, dirt, mud, sand, slush, snow, or gravel. The following rule o thumb lists takeoff and landing data that may be helpful.
RULE OF THUMB—**Takeoff from various surfaces**
Increase the takeoff distance based on the runway surface:

- Firm turf - add 7%
- Rough, rocky, or short grass (up to 4") - add 10%
- Long grass (4" or more) - add 20 to 30%
- Soft field - add 23 to 75%
- Mud or snow - add 50% or more

For combinations of various surfaces, add the percentage of each variable. For example, if the surface is soft (recent rain) and grass covered, to the normal take off distance add 10 percent for the grass, plus 23 percent for the soft surface.

1.18.12. Gradient (Sloped Runway)

Few airports are "flat." Whenever a slope exists, even if it is a slight incline of only a few degrees, it can affect the takeoff. Normal operation calls for landing upslope and takeoff downslope.

"Normal," in this case, assumes that the existing wind and any obstructions that may exist do not create a factor that you need to consider.

A one-percent downslope is generally equivalent to a 10-percent reduction in takeoff distance. But, if the wind is more than 15 knots, an upslope takeoff is recommended into the headwind, providing the aircraft has enough performance available to clear intervening obstructions and will outclimb any rising terrain. The additional drag and rolling friction caused by a one-percent upslope can result in a two percent to four percent increase in the takeoff distance.

To the normal takeoff distance for any particular density altitude, add 10% more runway for each one-degree of upward slope in the runway.

To the normal takeoff distance for any particular density altitude, subtract five percent of the takeoff distance for each one-degree of downward slope in the run-way.

The following list is more accurate than the general rule of thumb:

- 2% downslope reduces takeoff distance 11%.
- 4% downslope reduces takeoff distance 19.5%.
- 6% downslope reduces takeoff distance 28.5%.
- 1% upslope increases takeoff distance 7.5%.
- 2% upslope increases takeoff distance 14%.
- 4% upslope increases takeoff distance 25.5%.
- 6% upslope increases takeoff distance 39.5%.

1.18.13. Aircraft And Engine Condition

When computing takeoff distance and rate of climb consider that an older air-plane with a worn engine cannot be expected to perform in accordance with the performance charts.

1.18.14. Pilot Skill

The more experience you have, the greater the performance you can obtain from your airplane. Often gaining experience will place the pilot in a precarious position. If you are delving into unknown aircraft performance areas, it is wise to enlist the aid of an experienced flight instructor.

1.18.15. Effect Of Local Terrain

Local terrain around a mountain airstrip can modify the wind circulation patterns from that of the general wind flow. Strong downdrafts or wind shear may exist shortly after takeoff that will prevent the airplane from climbing above the terrain if the flight path is maintained. It is wise to have a plan of action in mind to allow maneuvering away from the higher terrain whenever climbing. Before proceeding on course, be certain that you have gained sufficient altitude so you can execute a turn toward lowering terrain if an unexpected downdraft occurs.

DENSITY ALTITUDE AFFECTS THE AIRPLANE DURING EN ROUTE OPERATIONS TOO.

1.19. EN ROUTE

Operating safely in a mountain environment requires you to establish some personal safety standards relating to mountain flying such as weather, minimum runway lengths and aircraft loading.

Depending on your experience, these weather minimums might be a 2,000 - or 3,000 foot ceiling and 5 (five) miles visibility. If the ceiling or the visibility drops below your established minimum, divert to an alternate and wait on the ground until conditions improve.

Once you have established your personal safety standards, only experience will allow you to expand them. Don't let a passenger—especially someone who knows nothing about flying—pressure you into compromising these standards. A passenger impatient to get home might say, "The weather looks okay, let's go."

The same thing applies to equipment. The most qualified pilot in the world can still get into trouble trying to push an aircraft beyond it's limitations

Weather is the most dangerous aspect and the primary cause of general aviation accidents. This includes flatland and mountain operations. Weather is the final determining factor in making any mountain flight. The pilot may be physically and mentally prepared and the airplane may have the performance capability to deal with the en route terrain. But, unless you are foolishly optimistic, obtain a weather briefing before spending a lot of time on flight planning. The weather briefer may discourage you from making the flight. Or, he may suggest an alternate route that would skirt the weather.

Statistics show weather-involved accidents cause more general aviation injuries and deaths than any other operating factor.

Weather is the most important consideration in determining the suitability or probability of making a particular flight. Do not push the weather. When operating in an familiar area and weather is marginal, you may experience confusion over your location. Easily recognizable landmarks, that appear during good VFR weather, seem to disappear when you need them.

It is best to listen to the advice of experienced pilots, but you may wish to make your own mistakes. One thing you will learn—whether it is from the advice of others or through your own experience—what affects the safety of flight is that the weather in the mountains is either good VFR or it is IFR and it should be flown as such.

Do not fly during marginal VFR conditions in the mountains.

The basic rules of mountain flying should always be kept in the front of your mind.

- Always remain in a position where you can turn to lowering terrain if you encounter downdrafts, if you have inadequate terrain clearance, or if you experience a power loss or a power failure.
- Do not fly beyond the point of no return when flying upslope terrain. Before reaching the point of no return, circle to gain additional altitude before proceeding.

For the pilot new to mountain flying the visual aspects are often deceptive. It recommended that you start out flying the mountains with 2,000-feet terrain clearance.As your experience, skills and techniques improve; you may be able lower this personal limitation. Maintain an awareness of the wind direction and velocity.

Visualize the wind as water and ask yourself what the water do as it flows up and down the mountain ridges and slopes. In areas where there is an abrupt change in terrain, turbulence may occur.

Keep in mind the false horizon effect. The natural horizon will be represented by the base of the mountains about six to eight miles from the airplane.

Some pilots have been tempted to fly up a blind canyon while climbing out from a valley airport. It is usually best to circle and gain altitude before turning on course. If you do fly into a blind canyon sometimes called a box canyon or dead end canyon—stay to the side. if the canyon narrows, perform a 180-degree turn before getting trapped. If the terrain out climbs the airplane, turn around before passing the point of no return.

RULE OF THUMB - **Increased Takeoff Distance**

For each 1,000 feet above sea level, the takeoff run will increase approximately 12 percent.

RULE OF THUMB - **Increased Landing Speed**

The landing speed (true airspeed) will increase about 2 percent for each 1,000 feet above sea level when using the same indicated airspeed for approach as at a sea level airport.

Do not fly close to terrain that has abrupt changes—such as cliffs or other rugged areas—when there are strong winds aloft. Dangerous turbulence may be generated in these areas.

1.19.1. Altitude

The novice pilot generally tries to fly over mountains at the highest altitude his airplane will climb. This provides a feeling of comfort when he is the farthest he can be away from those mountains. If you have supplemental oxygen or a pressurized airplane this is an acceptable method of crossing the mountains. If you are restricted to lower altitudes by aircraft performance, oxygen limitations, or extremely strong winds aloft, follow the mountain pilots' advice of flying 2,000 feet above the terrain. This is the recommended altitude for crossing higher ridges and mountains during the en route phase of flight.

The recommended crossing altitude varies with the upper airflow. A strong-wind condition will require more clearance. A no-wind condition will allow flight at a lesser clearance altitude. When flying in strong winds with the possibility of downdrafts or turbulence, flying half again as high as the mountains will avoid destructive turbulence.

RULE OF THUMB - Wind and Cruise Altitude When the wind exceeds 20 knots at mountaintop level, fly half again as high as the terrain.

This does not mean that when you are flying over a 14,000-foot mountain that you should fly at 21,000 feet (half the altitude, 7,000 feet, plus the mountain height). It means that you should subtract the prevailing terrain elevation from the mountain elevation and use half of this value. For example, the terrain surrounding the 14,000foot mountain might approximate 10,000 feet. The mountain is 4,000 feet above the terrain. Half of this value means you would fly 2,000 feet above the mountain.

1.19.2. Horizon Check Line

The altitude of the airplane in relation to the mountains can be deceptive for the inexperienced mountain pilot. It is desirable to determine whether the airplane is at an altitude that will provide clearance to cross the mountain ridge before arriving at the ridge. While this is desirable, it is not always possible. There are several techniques that assist in making this determination.

By checking the sectional aeronautical chart and identifying the mountain by its location on the chart, it is simple to fly 2,000 feet above the known elevation. With the possibility of human error in chart reading, it is a good idea to establish a habit of checking the terrain clearance altitude by using the spot method (sometimes called the flight-path horizon or visual check line)

ho•ri•zon (noun) - the apparent junction of earth and sky.

Pilots use the horizon line for visual attitude flying. Mountains destroy the perception of where the earth and sky meet, making it difficult for the inexperienced pilot to know where the actual horizon exists. If you use the base of the mountains at least six to eight miles (or more) ahead of the airplane, the natural horizon can be approximated. If the terrain requires that you use a side window to determine the base of the mountains six to eight miles away, with minimal practice, it is easy to circumscribe a line to the front of the airplane.

Sometimes—in some canyons—you will be flying in an area where you cannot determine or see the base of the mountains. Visualization has to be used. There is no easy rule for this interpretation; it comes with experience.

The spot method, consists of a wind-shield mark and an aiming point on the ground.

The windshield mark is what you use in determining terrain clearance for crossing ridges. The windshield mark is established during cruise flight with cruise power. It is where the natural horizon, appears about two to four inches up from the base of the windshield. This depends on the airplane and your parallax as you sit in the airplane.

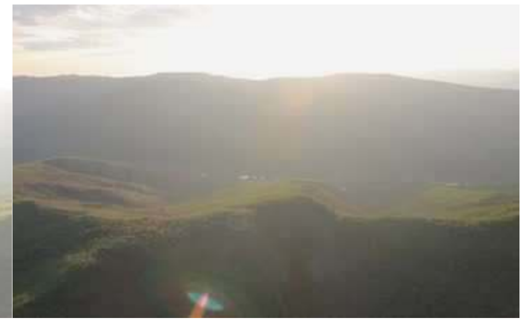
If the ridge juts up above the windshield mark, the mountain is higher than your airplane and it will be necessary to maneuver for additional altitude before trying tocross the ridge.

1.19.3. Flying Blind

Flight instructors recommend that mountain flights be made during the early morning when the air is calmer and there is less concern about density altitude and turbulence.

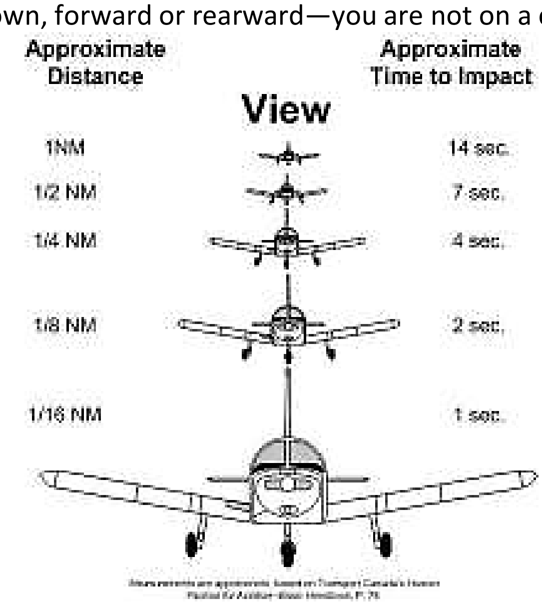
When your flight direction is toward the sun and the sun is at a low angle to the horizon, you may not be able to see the mountains ahead of you. This becomes a serious problem when you are flying at an altitude below the highest terrain. The best solution to this problem is to climb 2,000 feet above the terrain before going on course.

A word of caution is required here.



1.19.4. Collision Avoidance

Whenever you become concerned about another airplane's flight path that might be approaching you on a collision course, look at the airplane through any window. If the other airplane remains in a constant spot on the window and the flight path is converging, you are on a collision course. If the airplane moves from the spot in any direction—up or down, forward or rearward—you are not on a collision course.



If the airplane is climbing or descending, you will have to continue to watch it. If it maneuvers to a position where it becomes stationary on the window, look out. This technique works regardless of the window (windshield or side windows) where you view the other airplane.

1.19.5. Common Sense

Common sense is defined as sound and prudent but often unsophisticated judgment, horse sense, native good judgment, or wisdom.

Flight instructors get into arguments about whether or not a student can be taught good judgment. Perhaps good judgment can be taught, mainly by example, if the instructor establishes parameters of flight (personal safety standards) that are carefully explained. For example, crosswind limitations should be addressed as well as the minimum ceiling and the minimum visibility for scud running. "Use common sense and sound judgment." That sounds easy enough, but people do not always exercise common sense. Ask a pilot what he would do if the fuel supply were running low on a cross-country flight? Most will explain that they would make an unscheduled fuel stop.

Or, what if the landing approach turns sour? You would be surprised how often these people—safely on the ground—will make the right decision, but in the airplane they might try to save some time by stretching the fuel, or continuing on the landing approach when he knows he should make a go around.

Why do people gamble on life threatening decisions? Many of us have a subconscious feeling where we regard certain unworthy of a pilot. Don't let your "professional pride," prevent you from making that necessary go-around just because someone is watching you. Use good old common "horse sense" in all your flying. Many of us have been in situations where we have doubt. I know I have. Usually it's late at night, not in an airplane. I tell myself, "Gee, I don't know if I should be doing this." And sure enough, I shouldn't have been doing that. This is when you have the opportunity to exercise common sense.

After removing yourself from whatever predicament you faced, you reflect back on the experience and determine if it could have been handled differently, but in a safe manner. You might even want to discuss the situation with a competent flight instructor to see what they would have done ... and why.

1.19.6. Climb Out

Terrain clearance is the most important consideration during climb out from a mountain airstrip. It may be necessary to maintain the best rate-of-climb airspeed or the best angle-of-climb airspeed until above the terrain.

Learn to fly by attitude. It is possible to cover the airspeed indicator and fly an exact airspeed by using outside visual reference; that is, checking where the nose is in relation to the horizon. Often there will not be a natural horizon. It is necessary to use the base of the mountains some six to eight miles from the airplane (farther is preferable). With experience, a natural horizon can be imagined when flying in canyons that do not allow the reference of the mountains six to eight miles away.

It is during the climb out that you can test the air for turbulence. If the conditions are not favorable, return to the airport and wait it out. Remember to maintain the maneuvering speed when encountering turbulence classified as moderate or greater.

Also remember that the visual cues relating to your altitude above the terrain can be confusing when approaching ridges. Use the spot method to determine terrain clearance. This only works when the airplane is being flown in a level-flight attitude.

Perhaps better, to discourage "tunnel vision" is that if you can see more and more of the terrain on the other side of the ridge, the airplane is higher than the ridge and can probably continue.

The main point to be made is that if there is a visible rise in the terrain, and the airplane is climbing at approximately 5 degrees nose up attitude , will be unable to clear the slope without circling to gain additional altitude.

1.19.7. Approaching Ridges

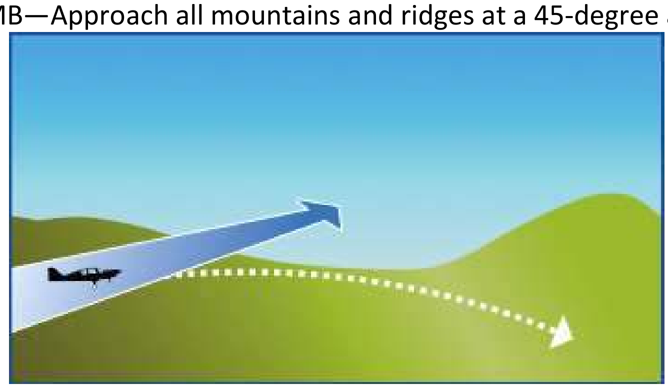
When approaching a mountain ridge from the upwind side (headwind) the pilot will encounter an updraft (there are exceptions) that will normally help in crossing the ridge.

When approaching the mountain ridge on the lee side or downwind side (tailwind), and the wind velocity is 20 knots or more at mountaintop level, the airflow will come over the ridge and flow downward producing turbulence and downdrafts.

Twenty knots of wind velocity seems to be the magic number for turbulence under most atmospheric stability conditions. With fewer than 20 knots of wind, there isn't much turbulence. More than 20 knots and the wind will create eddy currents that translates into turbulence.

The possibility of encountering eddy currents and downdrafts from which there is no escape is the basis for establishing the rule that all mountains and ridges (or any higher terrain) are approached at a 45-degree angle.

RULE OF THUMB—Approach all mountains and ridges at a 45-degree angle.



It is not necessary or beneficial to approach the mountains at a 45-degre angle when you are four or five miles away from the ridge. If you are not comfortable using the one quarter mile from the ridge recommendation, try one-half mile.

You may determine that the existing weather conditions do not produce down-drafts and feel that it is not necessary to approach the ridges at the 45-degree angle. This is not true. What the lack of downdrafts means is that instead of transitioning to the 45degree angle for approach when one-half mile or one-quarter mile from the ridge, it is acceptable to wait until you are several hundred yards from the ridge to move to the approach angle.

The lack of downdrafts and turbulence doesn't change the rule, it just changes the distance from the ridge where the transition to the 45-degree angle approach is made.

If you approach the mountains straight-on (perpendicular), the airplane must be turned beyond 90 degrees if an escape becomes necessary. Once a strong downdraft is encountered, the natural tendency is to pull back on the control wheel with the resultant decrease in airspeed. Safety is behind the airplane and to avoid the mountain and reach the safety of lowering terrain, a steep turn is required. The stall speed increases with bank angle to further complicate matters (the stall speed increases as the square root of the wing load factor).

APPROACH ALL RIDGES AT A 45-DEGREE ANGLE WHEN WITHIN 1/2 TO ¼ MILE. TERRAIN CLEARANCE OF 2,000 FEET IS SAFE UNDER MOST CONDITIONS. FEWER THAN 500 FEET OF CLEARANCE MAY BE ADE-QUATE WITH LIGHT WINDS AND STABLE AIR.

Approaching the mountain at the perpendicular isn't necessarily bad, but when you combine the G loading of the turn with the stress of the turbulence, the decrease in airspeed, and the increase in stall speed, it is safer and more comfortable for the airplane (and occupants) to have approached at a 45-degree angle. With the 45degree approach, any turn greater than 45 degrees will place the airplane in a position to advance toward lowering terrain. Once the ridge is crossed, the course can be resumed in any direction (either a diagonal or perpendicular direction) providing the airplane maintains a position that allows turning toward lowering terrain.

If there are a series of closely spaced ridges along the flight path and the wind is creating downdrafts on the lee side of each ridge, it is easy to zigzag, making a series of course alterations back and forth to stay more or less on the planned course. The first ridge is crossed at the 45-degree angle, then the heading is changed approximately 45 degrees to the opposite direction, and so on, for any more ridges.

RULE OF THUMB—Stall Speed Increase

The stall speed increases as the square root of the wing load factor. For example, in a 60-degree bank the load factor is 2 Gs. The square root of two is 1.41, resulting in a 41 percent increase in stall speed.

1.19.8. Determine Adequate Altitude

There are several methods that can be used to determine if you have sufficient altitude to cross a ridge.

- Fly 2,000 feet above the known elevation of the ridge.
- If you see more and more of the terrain on the other side of the ridge, you can probably continue.
- A variation of this is to choose two spots. If the distance between the two is increasing, you are higher than the ridge.
- Use the spot method to determine the horizon check line.

1.19.9. Crossing Ridges

If you elect to make your mountain flight without maintaining a 2,000-foot clearance altitude above the ridges, there are several techniques you can use to eliminate the deceptive visual aspect of crossing ridges.

Using the technique of choosing two spots, one spot would be the terrain seen at the ridge line and the other spot would be an arbitrary point above this first point. If the airplane is higher than the ridge, when it approaches closer and closer, the first spot will be visible at a lower point. The distance between the two points is increasing. This confirms that the airplane is higher than the ridge.

Many instructors have discontinued using this explanation to provide a method to determine adequate altitude to cross a ridge. The reason for this is because the pilot can develop "tunnel vision," where his whole world is encompassed in paying attention to the spacing between the chosen points. Nothing else matters and nothing else is recognized. This pilot could fly into trouble and have no awareness of what is going on around the airplane.

It is better to use the spot method or merely look at the ridge line to see if more and more of the terrain is coming into view. As you approach the ridge at a 45-degree angle, it is a simple matter to turn inward lowering terrain if you determine you do not have sufficient altitude to cross the ridge. What is this elusive "sufficient altitude?" It depends on the winds aloft that Influence updrafts, downdrafts and turbulence. The clearance may be as little as 100 feet, or less, terrain clearance under a stable atmosphere with little or no wind.

A ridge may be defined as a mountain where the terrain on the approach side of the ridge slopes down toward the approaching airplane and the other side slopes down away from the top of the mountain.

RULE OF THUMB - Crossing a Ridge

When approaching a ridge and arriving at a position where you can dive, with the power reduced to idle, and hit the top of the ridge, you can commit to crossing the ridge.

It is not proper technique when approaching a ridge to reduce the power to idle and dive at the ridge. This is merely used as a "yardstick" for you to judge when you are in a position to continue. If you don't have the altitude required to reduce the power and glide to the top of the ridge, then you don't have sufficient altitude to continue flying toward the ridge.

When you approach a ridge with less than 2,000-feet clearance altitude, look it the terrain on the other side of the ridge. If you can see more and more of the other side as you approach closer and closer, there will probably be sufficient altitude to cross the ridge.

If the terrain starts to disappear, start climb to higher altitude before continuing.

If this technique of crossing ridges causes you worry or concern, rather than challenging your flying ability, do not do it. You should elect instead to maintain 2,000 feet clearance altitude above the terrain along the route of flight. If you are flying during strong wind conditions or if a mountain wave exist, generally you can subtract the ground elevation from the mountaintop elevation, and use one-half of this value as the terrain-clearance altitude. This helps avoid the stronger downdrafts and aids in escaping destructive turbulence.

1.19.10. Mountain Downdrafts

If you fly the mountains long enough, in all types of weather conditions, eventually you may take a short cut to cross a ridge. You haven't found any down drafts and have now come to ignore the 45-degree angle approach. When the air-plane encounters an unexpected downdraft while in a position to cross the ridge, it may make turning dangerous or impossible.

FLY THE UPDRAFT SIDE OF A CANYON. AVOID THE DOWNDRAFT SIDE (OFTEN THE SHADOW SIDE). STAY AS CLOSE TO THE SIDE AS CONDITIONS ALLOW TO AFFORD PLENTY OF ROOM FOR A TURN AROUND. TO FLY AT LOW ALTITUDE FOR GROUND OBSERVATION, FLY FROM THE HIGH END TO THE LOW END.

1.19.11. Flying Canyons

Mention the word "canyon" and some pilots conjure a vision of a narrow canyon with steep rocky walls. It's true, flying up a narrow canyon requires an experienced mountain pilot's skill, knowledge and judgment. The majority of canyon flying is done in canyons that afford plenty of room to turn around if the terrain out-climbs the airplane or if downdrafts are encountered.

Flying in canyons or through canyons could involve a path through a mountain drainage where the terrain is fairly level. Or, it may embody a path through a drainage with sloped terrain, either flying up the canyon or flying down the canyon.

RULE OF THUMB - Canyon Flying.

- Never enter a canyon in which there is not room to turn around (remain in a position to turn toward lowering terrain).
- Never fly beyond the point of no return.
- Fly the side of the canyon.

The novice pilot flying through a canyon for the first time will invariably fly in the center of the canyon. This places him the farthest away from the scary wall mountains. It

also places him in a poor position to make a turnaround if he encounters strong downdrafts or determines that the terrain is climbing faster than the airplane. He has only half the canyon width to effect the turn.

When air flows over one side of the canyon it swoops down and goes up the other side. In the center, there is an intermixing of the airflow that causes shear turbulence. Flying the side of the canyon avoids this type of turbulence.

There are several factors that must be considered in determining how close the airplane is positioned to the canyon wall. The winds aloft, turbulence, down drafts, updrafts, terrain features, and width of the canyon must all be considerod.

When there is not sufficient wind to produce updrafts and downdrafts, fly either side of the canyon. Divide the canyon into thirds and maintain the aircraft's flight path within one third of the area on one side or the other. Avoid the center third. If one side of the canyon is shadowed, fly the sunny side. There may not be enough solar activity to produce convection that will help the airplane climb, but there may be enough convection to produce a neutral area. If there is any convection—whether it helps you climb or not—downdrafts will occur on the shadow side.

1.20. MARGINAL WEATHER

Do not attempt to fly through a canyon in marginal weather such as low stratus and fog, rain showers that restrict visibility. This is especially true if you are unfamiliar with the area. If you are unacquainted with the terrain of a canyon, you may discover too late, because of reduced visibility, that it narrows down or becomes a dead end, making it difficult or impossible to make a turnaround.

1.20.1. Clouds

Clouds form in the earth's atmosphere when water evaporates into vapor from oceans, lakes, ponds, and even streams and rivers; and by evaporation or transpiration over moist areas of earth's land surface. The vapor rises up into colder areas of the atmosphere due to convective, orographic, or frontal lifting. This subject the rising air to a process called adiabatic cooling.

The water vapor attaches itself to condensation nuclei which can be anything from dust to microscopic particles of salt and debris. Once the vapor has been cooled to saturation, the cloud becomes visible. All weather-producing clouds form in the troposphere, the lowest major layer of the atmosphere.

High Level Clouds; form above 20,000 feet. They are primarily composed of ice crystals.

Cirrocumulus – clouds usually form long rows of puffy clouds composed of ice crystal. Many times they are a precursor of advancing storm system.

Cirrostratus – clouds are sheet-like, high level clouds composed of ice crystal. They can cover the entire sky, but since they are relatively transparent, the sun and moon can easily be seen through them. A halo can be seen around the sun and moon.

Cirrus – clouds are the most common type of high-level clouds. Thin and wispy cirrus clouds are usually found at altitudes greater than 20,000 feet. Composed of ice crystals, cirrus clouds usually occur in fair weather and point in the direction in which the wind blowing.

Mid Level Clouds; the bases of mid-level clouds typically appear between 6,500 to 20,000 feet. They can be made of water droplets or ice crystals.

Altocumulus – are mid-level clouds that then to form as parallel bands or rounded masses between 6,500 to 20,000 feet. One characteristic that makes them distinguishable from the high-level cirrocumulus is the partial shading beneath the cloud. The presence of altocumulus clouds is commonly followed by thunderstorms.

Altostratus - are mid-level clouds composed of liquid water droplets. They can be semi-transparent and may cover the entire sky. The sun and the moon appear fuzzy but with no halos when viewed through these clouds.

Low Level Clouds; the bases generally below 6,500 feet. Low-level clouds are mostly composed of water droplets. However, when temperature are cold enough, these clouds may also contain ice particles and snow.

Stratocumulus – clouds form as a low, lumpy layer that sometimes produces weak precipitation. They then to vary from dark grey to light grey and are made up of water droplets. Usually associated with low pressure systems. Little, if any turbulence. Can be associated with fog and rain.

Nimbostratus – clouds are low-level clouds that produce light to moderate precipitation. Made of water droplets, their bases generally lie below 6,000 feet.

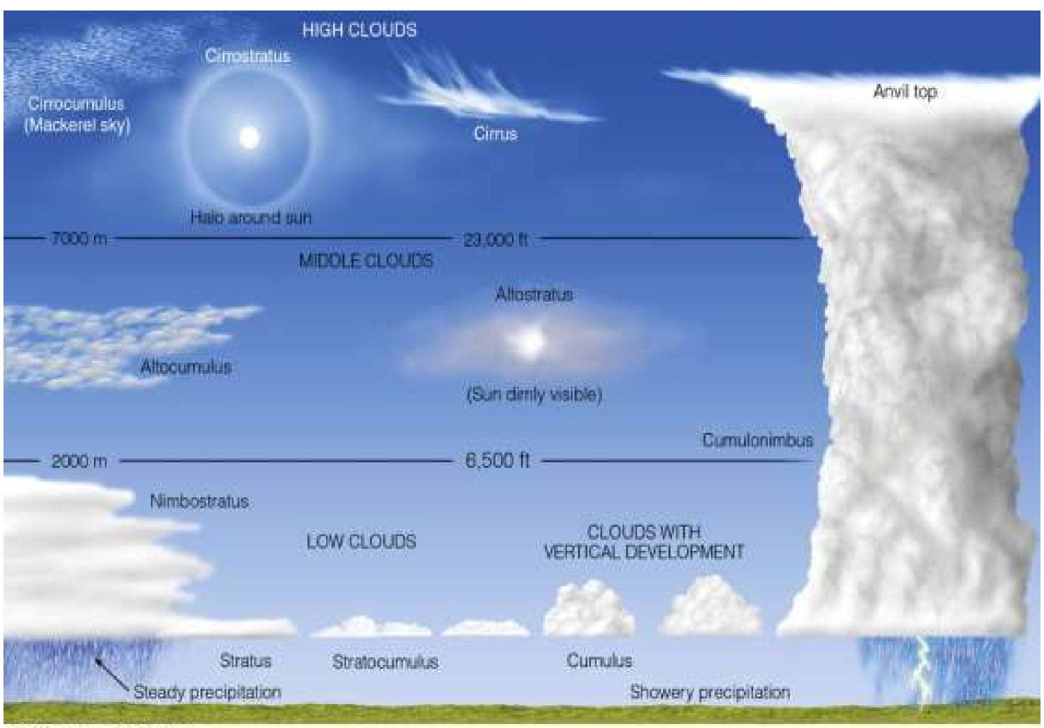
Clouds with Vertical Development; fed by powerful updraft, these clouds can grow to heights in excess of 39,000 feet. They can release incredible amounts of energy through the condensation of water vapor within the cloud itself.

Cumulonimbus – clouds are large, vertically developed storm clouds that can exist as individual towers or form a line of towers called a squall line. The top of cumulonimbus clouds can reach altitudes of 39,000 feet or higher. High altitude winds will flatten the top of the clouds out into an anvil-like shape. The lower levels are made of water droplets, while the higher elevations, where the temperature fall well below freezing, are made of ice crystals. Under certain atmospheric conditions, they can developed into very large and powerful thunderstorms known as supercells.

Violent turbulence likely, always avoid. Anvil points in the direction of movement.

Cumulus – fair weather cumulus clouds have the appearance of floating cotton or couliflower with flat bases. Made primarily of water droplets, the usually exhibit only slight vertical growth. Fair weather cumulus are fueled by buoyant bubbles of air, or thermals, that rise upward from the surface. Younger fair weather cumulus clouds have sharply defined edges and bases, while the edges of older clouds appear more ragged. Convective currents, flat bases dome-shaped tops, rain not likely but turbulence possible.

Orographic clouds – clouds that developed from the forced lifting of air, usually by mountains or other land forms.



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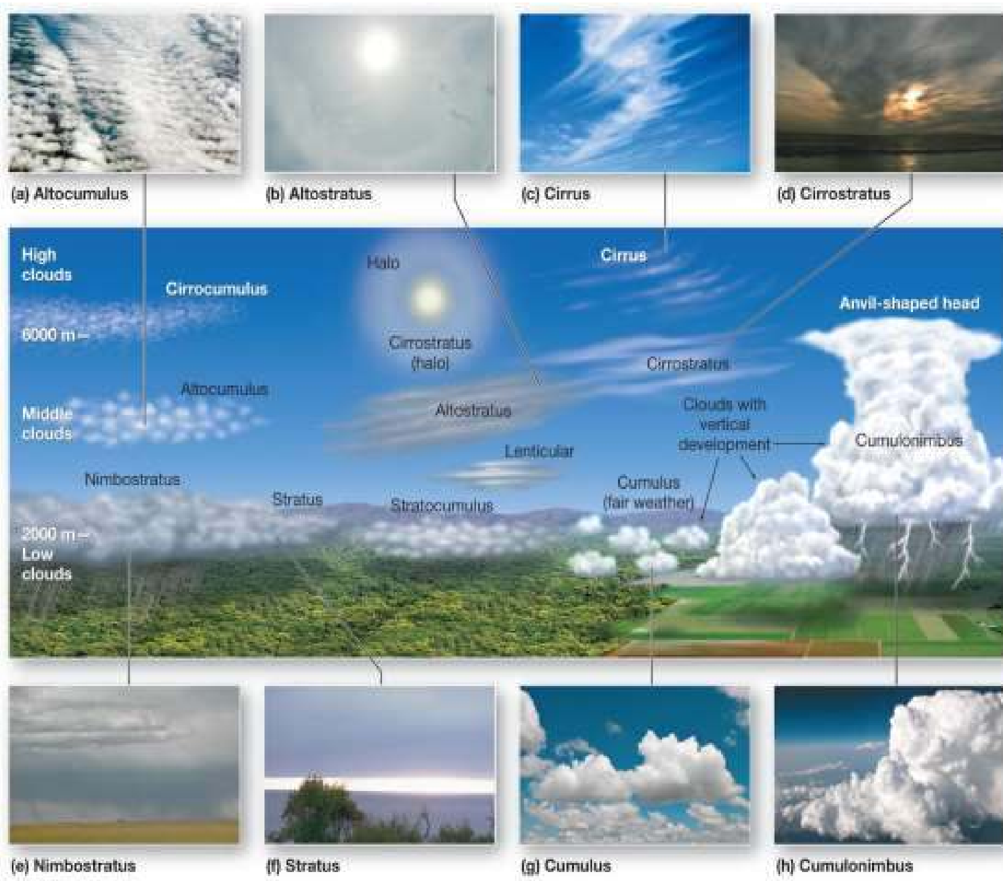
Cloud Type	Description	Forecast
Cirrus	Scattered, high thin clouds cirrostratus	Mostly fair but look out for altostratus
Cirrostratus and Altostratus	Halo around the sun or moon with occasional rainbow effect	Rain within 24 hours if clouds increase If clouds decrease moon can be seen
Cumulus	Scattered cotton wool like clouds	Fair
Cumulus congestus	Cumulus increasing and covers the in sky	Showers within 2 to 4 hours forming towers
Cumulonimbus	Very large towers up to 16km high with anvil shaped tops	Heavy rain and thunderstorms imminent
Cirrocumulus and Altocumulus	High, puffy, cotton ball shaped clouds	Rain within 12-24 hours if increasing
Jet contrails	Trails of condensed vapour at high altitude	Fair weather
Mammatus	Fluffy rolls of dark clouds usually at the base of cumulo-nimbus clouds	Violent thunderstorms imminent
Stratocumulus	Long, dark rolling cloud	No rain but overcast and slow to clear
Stratus	Very low cloud near the ground	Remaining cloudy but without rain



BEYOND THE POINT OF NO RETURN

So what happens if a pilot flies beyond the point of no return? The terrain out climbs the airplane. The pilot has two options and they both lead to an accident.

While not good, the first choice is the best. This involves landing the airplane straight ahead into whatever terrain exists. Because of the upslope it will be hard to go against the self-preservation instinct of pulling the nose up to avoid the terrain. Rather than landing the plane under control—into inhospitable terrain—the pilot in a frenzy tries to keep the airplane flying until it stalls. Treat the treetops like a runway at an international airport. It is required that the nose be lowered to obtain a speed faster than the normal approach speed. The excess speed is used in the transition to parallel the terrain before a normal flare is continued to the landing.

COURSE REVERSAL PROCEDURES

When you get into trouble in a canyon or in any situation comprising rising terrain, your airspeed will probably be at a minimum. It will not allow a hammerhead turn, wing over or chandelle. The safest and the best way to turn around (the author considers it the only way) is to make a slow turn.

RULE OF THUMB - Canyon Turnaround

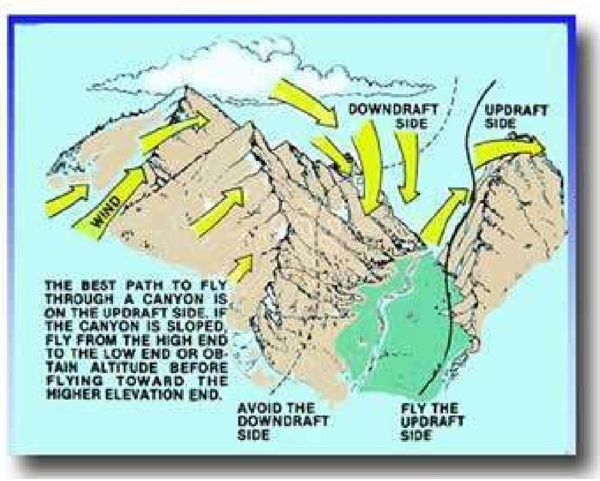
When you approach a "tight," maintain your composure and slow down because the radius of turn decreases as the airspeed decreases. Do not reduce power to slow down. Trade airspeed in excess of the best angle of climb for altitude by climbing as you make a 180-degree turn at the steepest bank you can comfortably make.

1.20.2. Canyon Downdraft

It is important to maintain airspeed when you encounter a downdraft. Fight against the self-preservation instinct of trilling back on the control wheel. Lower the nose to maintain flying speed and maneuver toward lowering terrain.

LOCATION OF UPDRAFTS

When the winds aloft blow nearly perpendicular to a mountain range, updrafts occur on the windward side. Downdrafts and turbulence occur on the lee side. The amount of turbulence is dependent upon air stability and wind flow velocity. The updraft expands, changing its position when the wind velocity increases. Updrafts become stronger and stronger as the airplane is maneuvered closer to the slope. The best updrafts are encountered, not directly over the ridge, but to the windward side. Even the lee side produces appreciable lift in an area above mountaintop level.



1.20.3. Mountain Flying Turbulence

The study of wind provides some general guidelines for flight based on the wind's velocity, but as with other generalizations, there are always exceptions.

Surface winds of greater than 20 knots mean the flight should proceed with caution.

Mountaintop winds of greater than 20 knots convey the need for extra caution.

Greater than 30 knots usually denotes the flight should be delayed or postponed until the wind velocity dies down.

With a stable atmosphere it may be possible to fly in the mountains and avoid any turbulence and downdrafts by using visualization. With an unstable air mass, you will know before reaching the mountains that the course of action is the 180-degree turn.

When flying during a period of winds aloft at 20 knots or more, avoid sharp ridges that are perpendicular to the wind flow. These are very dangerous. The air strikes the full face of the mountain from the top to the bottom. The air flow continues moving into the face. The air at the base doesn't have a chance to escape up and over the top before more onrushing air traps it. The replacement air rides over the trapped air, setting up an eddy current with strong downdrafts and possible severe turbulence.

The forecast wind direction and velocity may differ from the condition experienced due to funneling and the venturi effect. Mountain winds—because of greater modification and the problems inherent with traversing varying terrain features—create a more hazardous flight scenario than flatland winds.

There are three major classifications of turbulence: convection current, mechanical turbulence and wind shear. An examination of each classification provides insight into what to expect and shows the necessity of slowing to the maneuvering speed whenever the intensity of the turbulence approaches moderate or greater.

3.20.3.1. Convection Currents (Thermals)

The sun's heating can cause air at the earth's surface to become heated until it acts like a hot air balloon, moving upward through a colder atmosphere. When ever an updraft occurs, it leaves a void of air and instability. Downdrafts occur usually over a larger area than updrafts—when colder air rushes into the evacuated area to alleviate the instability. Convection currents that cause the annoying turbulence at low altitudes are sometimes welcomed as anabatic lift at other times. The updrafts continue rising until reaching an altitude where its temperature, through expansion cooling matches that of the surrounding air. If the air contains moisture, cumulus cloud may form. Generally the tops of thermal activity are around 10,000 to 12,000 feet, but can extend beyond 15,000 feet in the mountains.

Mountain pilots advocate that early morning flights are desirable because this will minimize the convective turbulence that occurs once the ground heats up. It also allows operating with reduced density altitudes. If the flight must be conducted during the heat of the day, convective turbulence can be minimized by flying above convective clouds, or if there are no clouds, at a computed altitude. A rough rule of thumb is used to determine the approximate altitude to fly order to avoid convective turbulence. It's accuracy is dependent upon the stability of the air and is only a rough guide using average values.

RULE OF THUMB- Base of Convective Activity

Subtract the dew point temperature from the surface temperature. Multiply this value by two. This is the altitude in hundreds of feet (add two zeros), of the base of convective activity.

3.20.3.2. Mechanical (Obstruction To Wind Flow) Turbulence

Obstructions such as mountains, trees and rough terrain (including buildings) disrupt the smooth wind flow into a complicated mishmash of random motion eddies. Winds of fewer than 20 knots create irregular whirls on the upwind and downwind side of the obstruction that results in annoying turbulence. If the air is stable the eddies dissipate slowly.

Mechanical turbulence depends on the wind velocity and degree of roughness or the terrain/obstructions. Winds of more than 20 knots can generate the turbulence to altitudes higher than the mountains and carry the eddies downwind.

If the air is unstable, larger eddies form but they tend to break up quickly. As the wind velocity increases, there is less change in the wind direction, but a greater variability in the speed of the eddies. When the speed changes it may set up "lulls" of brief, sudden, irregular periods of low speed wind and "gusts" of highspeed wind (a gust must have at least a 9-knot variation between the peak and lull).

For the most part, gusts and other types of mechanical turbulence provide advanced warning as you approach a ridge. This warning occurs before you cross over, allowing you the opportunity to change your mind.

Turbulence that is encountered when approaching the mountains from a flat-land area is almost certain to get worse as you get closer to the mountains. You can judge the air stability to make a decision as to whether to continue or not. If you go on, approach the ridges at an angle to allow an escape to lower terrain with a minimum of aircraft maneuvering. Reducing the maneuvering reduces the stress on the airplane structure.

When you meet with turbulence a long distance prior to reaching the mountains it may cause undue apprehension. You don't know whether to continue or not. This consternation is usually resolved based upon your flight experience, the intensity of the turbulence and your comfort level in turbulence. If you don't know whether you should go on or not, you might consider landing. When in doubt...don't proceed.
As an obstruction to wind flow, mountains are the granddaddy of them all.
Destructive turbulence—the kind that has the potential of causing structural failure—may be avoided by flying half again as high as the mountain is above the surrounding terrain. Fly an altitude equal to one-half the distance from ground level (not MSL) to mountaintop level. Flying at this altitude does not and can not guarantee the absence of turbulence, but it does provide a guarantee that you would avoid all destructive rotor turbulence.
IT IS MOSTLY THE WIND FLOW NEAR 10,000 FEET MSL THAT DETERMINES THE EXTENT OF UPDRAFTS, DOWNDRAFTS AND TURBULENCE IN MOUNTAINOUS AREAS.
Downdrafts are similar to stalls as far as the pilot action required. The nose of the airplane should be lowered whenever a downdraft is encountered. This is the opposite of instinct and is more of a conditioned response. But, it is the correct response.
The reason for lowering the nose when a downdraft is encountered is to increase the airspeed and get out of the downdraft faster than if the best rate-of-climb or best angle-of-climb speed is used. It is true that by lowering the nose the vertical speed will increase. But when a slower speed is used, the plane is exposed to the downdraft for a greater period of time and loses more altitude overall.

Turbulence Penetration Procedures

At times it is impossible to avoid turbulence in the mountains. Whenever encountering moderate or greater turbulence, slow to maneuvering speed. The danger from turbulence occurs when operating at speeds above normal cruise air-speed, such as during a descent. The majority of small airplanes do not have a yaw damper, yet the pilot has the ability to effect the same type of function, dampening the effect of turbulence and keeping passengers from getting airsick.
RULE OF THUMB - **Reduce Turbulence Effects**
When turbulence causes fishtailing, step on the right rudder (one quarter of its travel) and apply left aileron to maintain wings level flight.
You might have to experiment with the rudder pressure. It may require less than one quarter of its travel movement, or it may require as much as one third of its movement, depending upon the make and model of airplane. This technique is very effective in dampening the yaw oscillations caused by turbulence. With experience you will probably apply down aileron to maintain the wings level and step on the opposite rudder without thinking about it. It does not have to be the right rudder and left aileron.
Maneuvering speed, abbreviated VA, is often called the "rough air speed.” This is the highest (fastest) speed that can be used to prevent an accidental stall due to gust loads and it is the lowest speed that allows the limit load factor to be developed

aerodynamically to cause a momentary stall to reduce stress before the turbulence can break the airplane.

Pilots get into trouble because of encountering turbulence with excess airspeed, usually during a descent where excess speed is easily obtained. They are lulled into a false sense of security by descent in smooth air. Suddenly and unexpectedly all heck breaks loose (pun). Structural damage or failure is a real possibility.

On the other hand, flight at an airspeed well below maneuvering speed is no recommended or required. The airplane has been built to withstand rough air, providing it is flown at the maneuvering speed in moderate or greater turbulence.

Some pilots, fearing structural damage, slow down too much. They have a difficult time controlling the airplane at the reduced speed because the controls are not as effective.

Aircraft Control

Flight control usage and manipulation in severe or extreme turbulence should be with hesitation. The best technique is to try not to move the controls. If control movement is required, do it very gently. Fly attitude, not altitude, and let the airplane go where it will. Concerns about terrain clearance must be addressed with whatever control movement is necessary. Once maneuvering speed (or a slower speed is obtained, maneuvering speed is preferred), full-control deflection may be used in controlling the airplane. Use coordinated rudder and aileron to control the flight path and the elevator to control pitch attitude. If the turbulence is moderate or greater, try using more rudder instead of coordinated aileron/rudder.

Continuous light turbulence often causes an uncomfortable ride where the airplane seems to wallow through the air and the empennage fish tails. Trying to catch the oscillations of the nose or tail moving back or forth may aggravate the situation; cross-control will dampen the oscillations. When the nose moves to the right, apply some right rudder pressure (about one-quarter of that available) to hold the nose to the right. Use enough left aileron to hold the airplane steady.

Continue this control application until out of the turbulence.

3.20.3.3. Wind Shear

Wind shear occurs when there is a difference of wind direction (wind shift) or wind speed (gradient) or both occurring in a short distance in the atmosphere.

Wind shear generates eddies (shear zones) between the two wind currents of differing velocities. The shear zone consists of irregular motion in either the vertical or the horizontal dimensions, or both.

Horizontal shear occurs when the flight path passes through a wind shift plane such as when crossing a cold front (frontal activity) or when flying in thundertorm areas.

Vertical shear caused by temperature inversions or surface obstructions (buildings or mountains) is most often associated with the takeoff and climb out or approach and landing.

RULE OF THUMB- Turbulence

A wind velocity change of 6 knots per 1,000 feet is sufficient to produce wind shear and turbulence. Vertical shear of 6-knots per 1,000-feet altitude change causes turbulence. With increasing shear values or differences in wind direction comes greater turbulence. The shear of greatest importance to pilots is that shear of vertical dimension that cause changes in the aircraft's angle of attack and may result in a stall. Conditions associated with shear can occur at any level in the atmosphere, but three are of special interest to the pilot.

WIND SHEAR TURBULENCE

1. **Low-Level Temperature Inversion**
   A temperature inversion forms near the surface on a clear, cool night with calm or light surface wind. This allows the layer of air next to the ground to cool ,at a rate faster than the air above. The inversion or reversal of the normal lapse rate causes the temperature to increase with altitude rather than decrease. A wind shear zone of eddy turbulence develops between the calm air of the inversion and the wind flow above. This is particularly hazardous when the low-level jet stream provides the wind.
   Some pilots have been taught that a taxiing airplane is subject to, not only the prevailing wind direction and velocity, but also to the relative wind due to the motion of the aircraft. We may have been told that once the airplane eaves the ground that the wind would have no effect on its flight other than creating drift and modifying the groundspeed.
   This is not true if the wind changes faster than the aircraft's mass can be accelerated or decelerated. It is helpful to discuss some other conditions, then about the causes, effects and procedures to deal with wind shear.

2. **Wind Shear in a Frontal Zone**
   When two air masses meet a frontal zone is developed with abruptly changing wind along the zone. The degree of turbulence depends on the magnitude of the wind shear. The clouds associated with the frontal zone give an indication of turbulence, but when two dry air masses meet the area may be devoid of all indicator clouds.
   Wind shear height above an airport cannot be accurately measured, but weather forecasters, using a model of frontal characteristics, can make an estimation of the height of the wind shear. The cold front, with its heavy, dense air, forms a wedge that pushes warm air above it. The wind shear occurs along the line between cold air and warm air as it passes an airport.
   Frontal movement of 30 knots or greater indicates the height of the shear will be near the surface with frontal passage and sloping to about 5,000 feet above the surface at three hours after frontal passage. The warm front with ts less dense air overrides the cooler air ahead of the surface front. The warm front slope is shallower than the cold front and it move slower. As the front approaches an airport where its slope is 5,000 feet above the surface, wind shear will begin and last for approximately six hours until frontal passage. As a general rule, the warm front will produce greater wind shear turbulence over a longer period of time than the cold front. If the front is moving to the east at about 20 knots, it will produce

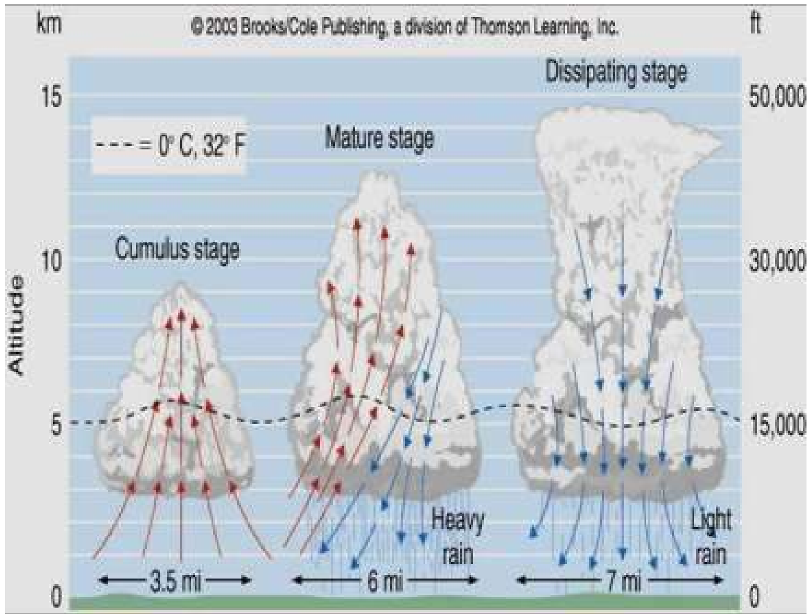
light turbulence. If its movement is 30 knots, expect moderate or greater turbulence. Check the winds aloft before departing or arriving at an airport where you suspect wind shear.

3. **Mountain Wave Wind Shear**
When stable air flows across a mountain range, a condition known as a mountain wave or standing wave may occur. It is so named because enticular don associated with the wave remain essentially stationary in position with the mountain. Associated with the mountain wave, on the lee side, is rotor turbulence that can create hazardous shear values. It is best to avoid destructive turbulence flying half again as high as the mountain (half the value of the base elevation subtracted from the top elevation).
Unstable air crossing a mountain may rush down on the leeward side, spilling and creating eddies that are carried downwind. Airports located on the downwind side of mountains, especially those with a gradual slope from the mountain to the airport, are susceptible to the accelerated wind and eddies.

4. **Sea Breeze Fronts**
A localized airflow condition may be created when there is uneven surface heating occurring between a land mass and a water mass such as the ocean, bay or lakes. Convection currents are set up over the land. As the air rises, it create an instability in the atmosphere that is filled by cooler air from the water. This causes the wind to flow on-shore during the daytime. At night there is a reversal of the airflow. Wind shear is set up because of changes in the wind velocity and direction over a short distance.

5. **Clear Air Turbulence (CAT)**
Clear air turbulence (CAT) is a phenomenon associated with turbulence in lacking clouds, usually at high altitudes. Two conditions are responsible for CAT; the jet stream and the mountain wave. When related to the jet stream, its occurrence is mostly on the polar side of the jet or to the north or northeast of a rapidly deepening surface low pressure area. CAT caused by the mountain wave can extend into all altitudes usable by general aviation aircraft (including jets) and can range 100 to 300 miles downstream from the mountains that caused the wave.

6. **Thunderstorms**
Three conditions are required for a thunderstorm to occur: moist, unstable air, and lifting action. Rising and descending air is modified by atmospheric pressure. Air that is lifted expands. Air that descends is compressed. These pressure changes cause the air to change temperature, cooling as it expands and heating as it is compressed. The mode of temperature change does not affect the surrounding air temperature, only the parcel of air that is lifting or sinking. This process is called an adiabatic change.



When unstable air is caused to rise by frontal action, convection or wind flow forcing its ascension up a mountain (or any combination of these), it cools, but the rate of cooling may be less than that of the surrounding air. When the lifting action is removed, the parcel of air is warmer than the surrounding air and will continue to rise by itself. If the air is moist and unstable the conditions may render a thunderstorm.

DETECTING WIND SHEAR

A pilot—**no matter how good he is or no matter how good he thinks he is -- and his general aviation airplane does not have the ability to fly through all intensities of low-level wind shear. It is better to devise a method of detecting, predicting and avoiding wind shear than it is to deal with it**. Wind shear provides warnings the pilot can use to avoid its consequences.

Check the weather during preflight for thunderstorms observed or forecast near the airport. They can cause wind shear in the departure or arrival areas.

Check surface weather charts for frontal activity. Determine the surface temperature difference immediately across the front and the speed the front is moving. A 10-degree Fahrenheit or greater temperature differential, and/or movement of the front at 30 knots or more is indicative of significant low-level wind shear. Thunderstorms in the vicinity of the airport and frontal activity showing movement at greater than 25 knots or more than a 10-degree Fahrenheit temperature difference are indicators of low-level wind shear.

Check PIREPS and avoid areas that report airspeed loss of 15 knots or more final approach for landing.

For practical purposes wind shear will be present when there is a combination of two or more of the following conditions:

- Extreme variation in wind velocity and wind direction in a relatively short time.
- Any evidence of an approaching gust front.
- The surface temperature in excess of 80°F.
- A temperature/dew point spread of 40°F or more.
- Virga in the vicinity of the airport (precipitation aloft falling from the bases of high-altitude cumulus clouds that evaporates before reaching the ground).

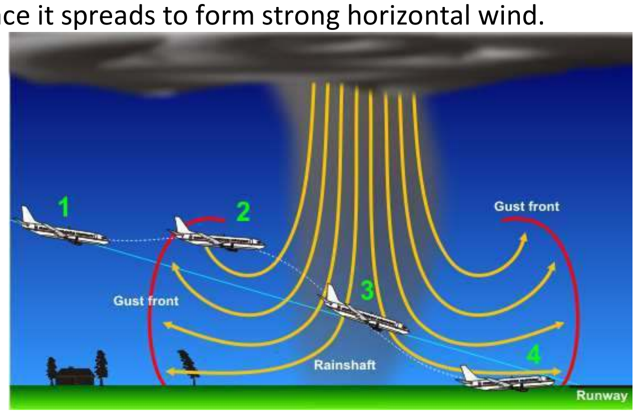
AIRPLANE PERFORMANCE IN WIND SHEAR

1. Power Compensation

Wind shear that causes a headwind to shear to a calm wind or tailwind causes the airplane to experience an abrupt drop in airspeed equal to the velocity difference between the headwind and calm/tailwind speed. This shear causes the nose to drop. Pulling the nose up aggravates the situation.

Add full power to accelerate back to normal airspeed. A tailwind shearing to a headwind or calm wind causes the airspeed to increase. Although a power reduction is initially required to compensate for the ballooning effect, power must be added to counter the headwind. The downburst cell contains a strong downdraft in the center of the thunderstorm cell that flows downward.

Near the surface it spreads to form strong horizontal wind.



Refer to figure. The airplane (1) is on the glide slope at normal approach airspeed. At (2) the airplane encounters an increasing headwind that causes a ballooning effect along with an airspeed increase. The pilot lowers the nose and reduces power to recapture the glide slope beginning at (3). Between (3) and (4) the headwind transitions to a tailwind with a loss of airspeed. The airplane sets up a high sink rate from which there may not be sufficient altitude or thrust to recover before ground contact. Groundspeed is the best indication of entering a downburst cell. When the airspeed increases and the roundspeed decreases, the airplane may be entering position (2).

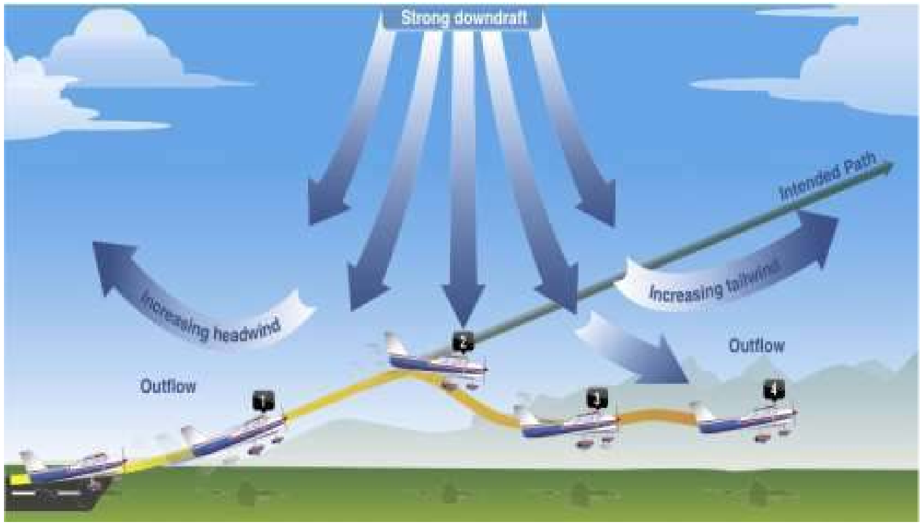
2. **Angle of Attack in a Downdraft**
   A downdraft increasing as a headwind may be stronger than the relative wind causing an increase in the angle of attack, the ballooning at (2). If the pilot fails to compensate, the airplane may experience a stall. After lowering the nose, then encountering a tailwind, between (3) and (4), the angle of attack is reduced through vectorial addition, setting up a high sink rate.

3. **Energy Trade**
   The only two means of correcting for wind shear are an energy trade or a trust change. During flight the kinetic energy can be converted to potential energy where there is a trade of airspeed for altitude or a trade of altitude for airspeed.

4. **Trading Altitude for Speed**
   A pilot experiencing low-level wind shear will apply full power, but the airspeed may still be slow. He will be tempted to lower the nose to trade altitude for speed, but this isn't the safest course of action. There will be a large loss of altitude and only a small gain of airspeed. The pilot is better off maintain the airspeed with the application of full power.

5. **Trading Speed for Altitude**
   If the pilot experiences and notices the low-level wind shear before an airspeed loss, he may be tempted to trade his airspeed for altitude. The speed will dissipate rapidly and if the airplane is carried to the ground there will be no airspeed to flare.

6. **Adding Speed for Wind Shear**
   It is tempting to carry extra airspeed when there are reports of wind shear in the vicinity of an airport. The problem is, if the extra airspeed is not used in the shear, the airplane may be too fast to land in the runway space available.



PROCEDURES FOR COPING WITH WIND SHEAR

An awareness of an imminent wind shear confrontation prepares the pilot to take immediate action at the first sign of the shear.

Wind shear alerts and PIREPS notify the pilot of the possibility of the wind shear phenomenon. If it is reported, avoid the area of wind shear. Increased airspeed results from an increasing headwind or decreasing tail-wind, causing a balloon.

This doesn't pose a problem in most cases.

Decreased airspeed results from a rapidly increasing tailwind, a decreasing headwind, or a downdraft. This is a critical situation for takeoff or approach causing the airplane to pitch downward with a loss of lift.

Reports of severe wind shear for departure means the flight should be delayed, period, no further discussion.

A pilot caught in severe wind shear during takeoff should apply full power and fly an attitude to maintain the best rate-of-climb airspeed. If it appears that ground contact is imminent, slowly increase the pitch attitude, but not to the point of a stall.

PIREPS

For airports without wind shear alert systems, the PIREP is the most valuable source of information. If wind shear is encountered, your PIREP should include the following information:

1. Location of shear encounter.
2. Altitude of shear encounter.
3. Airspeed changes experienced, including the number of knots gained or lost.
4. Type of aircraft.

1.20.4. En Route - Rules Of Thumb

RULE OF THUMB - Increased Takeoff Distance

For each 1,000 feet above sea level, the takeoff run will increase approximately 12 percent.

RULE OF THUMB - Increased Landing Speed

The landing speed (true airspeed) will increase about 2 percent for each 1,000 feet above sea level when using the same indicated airspeed for approach as at a sea level airport.

RULE OF THUMB - Wind and Cruise Altitude

When the wind exceeds 20 knots at mountaintop level, fly half again as high as the terrain.

RULE OF THUMB—Approach all mountains and ridges at a 45-degree angle.

RULE OF THUMB—Stall Speed Increase

The stall speed increases as the square root of the wing load factor. For example, in a 60-degree bank the load factor is 2 Gs. The square root of two is 1.41, resulting in a 41 percent increase in stall speed.

RULE OF THUMB - Crossing a Ridge

When approaching a ridge and arriving at a position where you could dive, with the power reduced to idle, and hit the top of the ridge, you can commit to crossing the ridge.

RULE OF THUMB - Canyon Flying

- Never enter a canyon in which there is not room to turn around (remain in a position to turn toward lowering terrain).
- Never fly beyond the point of no return.
- Fly the side of the canyon

RULE OF THUMB - Canyon Turnaround

When you approach a "tight/narrow" canyon, maintain your composure and slow down because the radius of turn decreases as the airspeed decreases. Do not reduce power to slow down. Trade airspeed in excess of the best angle of climb for altitude by climbing as you make a 180-degree turn at the steepest bank you can comfortably make.

RULE OF THUMB—Turn Radius versus Airspeed

The radius of turn varies as the square of the true airspeed.

RULE OF THUMB - Minimum Width for any Canyon Operation

Double the turn radius and add 200 feet. Do not enter a canyon that is narrower than this computed width.

RULE OF THUMB - Base of Convective Activity

Subtract the dew point temperature from the surface temperature. Multiply this value by two. This is the altitude in hundreds of feet (add two zeros), of the base of convective activity.

RULE OF THUMB - Reduce Turbulence Effects

When turbulence causes fishtailing, step on the right rudder (one quarter of its travel) and apply left aileron to maintain wings level flight.

RULE OF THUMB — Change in Weight/Stall Speed

A two-percent change in weight causes a one-percent change in stall speed.

RULE OF THUMB - Turbulence

A wind velocity change of 6 knots per 1,000 feet is sufficient to produce wind shear and turbulence.

RULE OF THUMB -- Estimating In-flight Visibility

The approximate visibility in miles will equal the number of thousands of feet above the surface when the surface is just visible over the nose of the airplane.

1.21. APPROACH AND LANDING

1.21.1. Stabilized Landing Approach

Back in the "old days," a landing approach consisted of a reduction of power to idle when above the landing point, followed by a glide to the runway. A stabilized approach was developed to prevent thermal shock (sudden power cut) of the engine and to have the engine in a state of readiness if a go-around was required.

The stabilized approach should be used for landing at all airports including mountain airstrips. The stabilized approach means reducing the power to a setting that allows 400- to 600-fpm rate of descent when established on the desired approach speed. The stabilized approach provides a method for exact airspeed control—this is highly desired—and precise glide path control.

The stabilized approach avoids thermal shock to the engine. When approaching a runway, time the initial partial power reduction to allow a minute or two for the temperature of the engine to stabilize before making further reductions. For example, the initial power reduction may be to 20-25 inches. After a minute make another reduction to 17-20 inches. After entering the pattern reduce lie power again to about 12-17 inches. Downwind, opposite the point of landing, make the final reduction to about 10-12 inches.

This gradual reduction in power lets the engine temperatures cool slowly. This is important because the different types of metal used in the various component of the engine have different cooling rates. Allowing the metals to adjust to the change slowly prevents the engine from self-destruction. Also, the engine is ready for either application of go-around power or a total reduction of power to idle for the landing. In either case, the temperature is such that no damage will be incurred.

1.21.2. Recommended Elements of a Stabilized Approach.

All flights must be stabilized by 500 feet above airport elevation in visual meteorological conditions (VMC).

An approach is stabilized when all of the following criteria are met:

1. The aircraft is on the correct flight path;
2. Only small changes in heading/ pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than VREF+20 knots indicated airspeed and not less than VREF;
4. The aircraft is in the correct landing configuration;
5. Sink rate is no greater than 1,000 feet per minute; if an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual;
7. All briefing and checklists have been conducted;
8. Specific types of approaches are stabilized if they also fulfill the following: instrument landing system (ILS) approaches must be flown within one dot of the glide slope and localizer; during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation;

9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.
   An approach that becomes unstabilized below 500 feet above airport elevation in VMC requires an IMMEDIATE GO-AROUND.

1.21.3. Landing Practice

A pilot who has never operated at a high-altitude mountain airport can get some idea of high-altitude airport operations by simulating a landing. This provides insight into the airplane's performance and flight characteristics to provide confidence in the airplane and yourself. Landing at a high-elevation airstrip is no more dangerous than landing at a sea-level airstrip. There are, however, differences of which you should be aware.

Begin your experiment to find out the consequences of landing at a high-elevation airstrip by climbing to the anticipated density altitude of the airstrip.

- At 1,000 feet above the imaginary airstrip, go through the pre-landing cockpit check and establish the same indicated approach airspeed and stabilized approach power setting that is used at sea level.
- Notice the sink rate. Use the same indicated airspeed for approach to landing at this high altitude airport that you use at sea level, but note the same power setting results in a higher sink rate. The airplane requires additional power to create the same rate of descent as at sea level.
- Continue the approach through the flare and progress to a stall. The indicated airspeed is the same for the airplane regardless of the altitude, but the true airspeed is greater.
- After you are comfortable with the approach phase, practice the maneuvering phase. Establish slow flight at 1.3 VSO, then 1.2 VSO and execute medium banked turns to the left and right.
- Practice a go-around from a full flap configuration. Of importance is the altitude where you initiate the go-around and the altitude when the rate of descent is arrested.
- One of the most important aspects of high-altitude landings (any elevation) is that of exact airspeed control. A 10 percent increase in approach speed causes a 21 percent increase in landing distance.

VISION

Your vision is important. To gain the best vision, keep your head in a natural straight ahead position. Use peripheral vision and the movement of the eye rather than head movement to look at the area to either side of the aircraft's nose.

EYE FOCUS

During the approach and landing, do not hold a fixed focus. Instead, look to either side and from close to the nose to the horizon, changing the focus slowly and continually. By looking at different points, the brain—without you realizing it—will compare and record the relationship of the flight attitude to the various points.

GUSTY WIND CONDITIONS

When the steady-state wind is gusty, add one half the gust factor to the computed approach speed to compensate for airspeed changes caused by wind shear. For example, if the wind is 10 knots gusting to 20 knots, the gust factor is the difference between the two values, or 10 knots. Add half this value, five knots, to the calculated approach speed.

1.21.4. Mountain Strip Operations

If your flight will take you to an airstrip you have never operated at before, consider the following prior to arrival at the strip.

- Research the strip using state aeronautical information to become familiar with the operating procedures. Be able to fly over the strip and figure out the approach. At this time determine also the departure path. Determine if the strip is a one-way airstrip (no chance for a go-around maneuver). Check for drainages nearby that could funnel the wind into a crosswind. What is the surface and condition? Does the strip provide for a go/no-go point? Are there any facilities and services available? What is the surrounding terrain like?
- It is important to know the proper approach, whether the strip allows a normal pattern, non-standard pattern, or no resemblance to any pattern.
- All approaches to a mountain strip consist of the stabilized approach, that is, a power-on approach that results in a descent of about 400-600 feet per minute.
- Always incorporate the spot method for landing technique to insure the airplane will arrive over the runway at the desired point of flare.
- Many mountain strips are located at the confluence of creeks that funnel any wind flow to the airstrip. This may cause downdrafts on short approach. Trying to land at the very end of the strip may result in the airplane landing short of the runway. This is another reason for using the spot method for landing. Encountering a downdraft is immediately discernable, and an adjustment can be made before it is too late.
- Normal flight operations call for all landings to be made upstream and all takeoffs to be made downstream to conform to the upslope/downs-lope terrain. Using this technique increases the safety of flight.
  Trust your instincts. If a situation feels uncomfortable ... Get out of it.

OPTIMUM APPROACH SPEED

According to the FAA, the optimum approach speed for a short-field approach is the value of 1.3 Vso. Vso is aircraft stalling speed with full landing flaps. Adjustment of this speed must be made if there is gusty wind (add one-half the gust factor).

STABILIZED APPROACH

The spot method uses a stabilized landing approach. The accuracy of the spot method lies in its ability—while maintaining an exact approach airspeed—to provide an exact glide slope without an electronic aid.

3-DEGREE GLIDE SLOPE

A 3-degree glide slope is the standard for an instrument landing system. To fly a 3degree glide path without electronic guidance, multiply the ground speed in knots by 5.

The result is the rate of descent. When a pre-determined flight path is followed it results in a stabilized approach. The key to a good landing is the stabilized approach. As an example, suppose we are approaching an airstrip in a no-wind condition, using an approach speed of 70 knots. What rate of descent is required to fly a 3-degree glide path? Multiply 70 x 5 for a 350 fpm rate of descent. Don't forget, this rule is applicable when the glide slope factor (5 for the 3° slope and 8 for the 4.5° slope) is multiplied by the groundspeed, not the airspeed.

BEST APPROACH ANGLE

The 3-degree glide slope may not be the most favorable approach angle for our small general aviation airplanes. Compare it with the 4.5-degree approach. You may find the 4.5-degree glide slope makes it easier to make glide path corrections on the approach and it provides a better view of the runway. Try both paths and see which one you prefer. Computation of the 4.5-degree glide path is easy. Multiply the ground speed in knots by 8. For example, 70 x 8 = 560 fpm rate of descent.

1.21.5. Landing Requirements

All pilots should prepare ahead of time for the landing. This preparation should be the same for all airports, performed consistently in the same manner. It doesn't matter if the landing is planned at a sea-level flatland airport or a high altitude one-way mountain airstrip. The following should be determined for each and every landing.

✓ AIMING POINT
✓ TOUCHDOWN POINT
✓ GO-AROUND POINT

AIMING POINT

The aiming point is the point on the runway where the aircraft would impact, if you don't flare. The aiming point is used in conjunction with the windshield mark. **WINDSHIELD** MARK,
the windshield mark is a point on the windshield used to align the airplane with the aiming point.

TOUCHDOWN POINT

The touchdown point, when the proper approach speed is used, will be some 200-300 feet beyond the aiming point.

GO-AROUND POINT

The go-around point is a predetermined point on the runway surface that signals sufficient runway does not remain to stop if the airplane lands. If we are flying an airplane that requires 1,000 feet to land to a runway with a length of 2,000 feet, the goaround point will be the halfway point of he run-way. If the airplane is not firmly on the runway by the halfway point, make a go-around.

PERFORMANCE

A given in aviation is that a constant power and a constant attitude result in a constant performance. This means that if the attitude and power remain the same during a nowind approach, the rate of descent will remain constant. If a power change is required to maintain the windshield mark on the aiming point, the pitch attitude must change to maintain a constant airspeed. If the airplane is too low, adding power will result in an undesired airspeed increase unless the nose is raised. Conversely, if the airplane is too high and power is reduced, the airspeed will bleed off unless the nose is lowered. The nice thing about these power changes is that if the airplane has been properly trimmed to hold the approach airspeed, a reduction of power (the aiming point is moving down on the windshield) causes the nose to lower by itself to maintain the desired airspeed.

If the airplane is too low (aiming point moves up on the windshield), add power to align the marks. The addition of power will cause the nose to raise by itself, again maintaining a constant airspeed.

PITCH CHANGES

Pitch changes are automatic providing the airplane has been trimmed to maintain a constant indicated airspeed during the pre-landing check. Because of the airplane's built-in inherent stability, power changes will cause pitch changes without the necessity to re-trim. Large power changes may necessitate small trim changes.

GUSTY WIND CONDITIONS

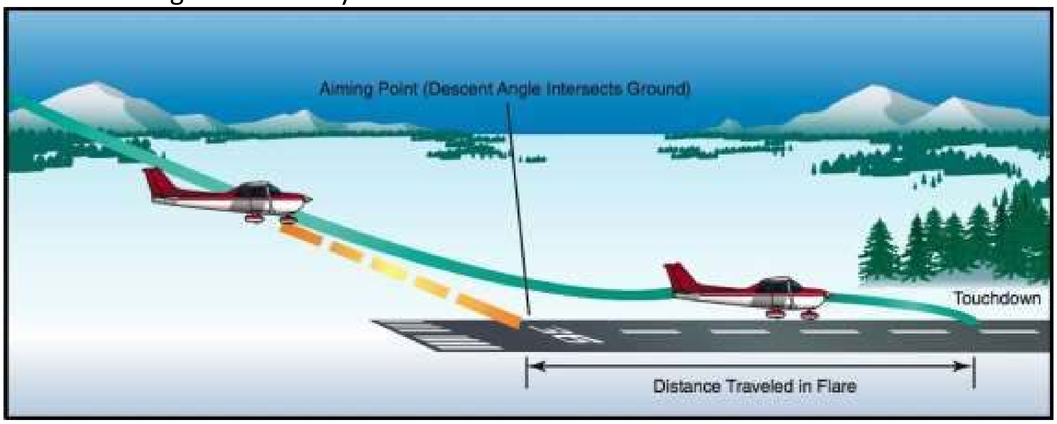
A rule of thumb has evolved over the years to help us compensate for gusty wind conditions that could, if the approach speed is not adjusted, result in an unwanted stall close to the ground. Merely add half the gust factor to the indicated approach speed.

RULE OF THUMB: Gusty Wind Conditions

Add half the gust factor to the indicated approach speed.

1.22. LANDINGS

One way to make consistently good landings, especially when changing from airplane to airplane, involves basic attitude flying. That is, looking at the nose in relation to the horizon. Flying the mountains may require that you use the base of the mountains some six to eight miles away as the natural horizon.



First, determine the attitude for level flight. Look at the horizon line and notice where it intersects the windshield. This will probably be about two to four inches up from the base of the windshield. Next, learn the attitude for climb at the best rate-of-climb airspeed. Memorize the position of the nose with respect to the horizon for these two attitudes. These are the level attitude and the landing attitude. APPROACH AIRSPEED The most common mistake made by a novice pilot in operating to a high-altitude strip is that of approaching with excessive airspeed. It might be the result of inattention on the part of the pilot, or, more commonly, it may be an intentionally flown airspeed. The pilot fails to realize that the same indicated airspeed at a high altitude results in a true airspeed of approximately 2-percent per 1,000 feet faster than indicated. This results in an automatic compensating factor when using the same indicated airspeed for approach to landing at all altitudes.

RULE OF THUMB - Approach Indicated Airspeed

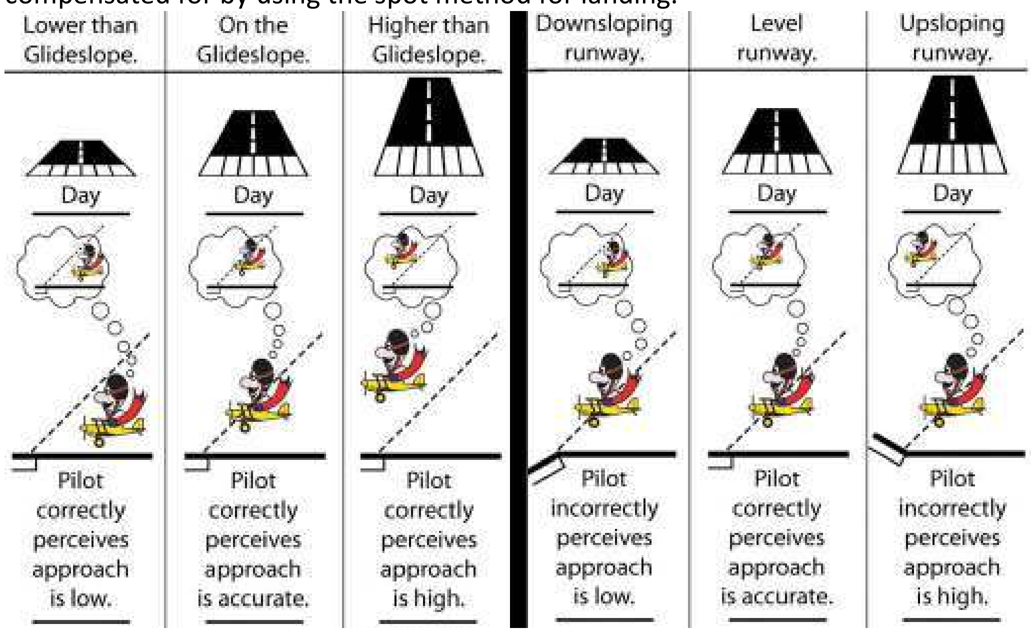
Regardless of altitude, ALWAYS fly your approach for landing at the normal ealevel approach indicated air-speed (IAS) for the airplane.

It is true that flight operations at a high altitude airport mean that the wings have less dense air to produce lift, the prop has less dense air to produce thrust and the engine has less air (by weight) to breathe, reducing its output. Because of this the airplane must fly at a faster true airspeed. When the airplane flies above sea level, its true airspeed increases over the indicated airspeed by about 2 percent per 1,000 feet of altitude gain. This produces an automatic compensation for the reduced aircraft performance that is in the proportion needed for safe flight.

1.22.1. LANDING CONSIDERATIONS

1.22.1.1. LANDING UPHILL/DOWNHILL

When operating at a strange airport, there is an unconscious tendency to visualize the approach with the same perspective, even if the runway is of a different width and length, or if the runway has slope. Trying to approach upslope or downslope runway using the developed sight pattern results in a visual illusion—upslope runway, approach too low; down-slope runway, approach too high—that can only be properly compensated for by using the spot method for landing.



Rule of Thumb - Upslope Runway Takeoff Distance Add 10% per degree to the normal takeoff distance to determine the upslope takeoff distance.

Rule of Thumb - Downslope Runway Takeoff Distance Subtract 5% per degree from the normal takeoff distance to determine the downslope takeoff distance.

BECAUSE THE RUNWAY FORMS AN OBTUSE ANGLE, AN AIRPLANE APPROACHING AN UPSLOPE RUNWAY WILL COMPENSATE BY APPROACHING TOO LOW. BY THE TIME THE VISUAL MISTAKE IS REALIZED, THE AIRPLANE MAY NOT HAVE ENOUGH POWER TO FLY TO THE RUNWAY. AN AIRPLANE APPROACHING A DOWNSLOPE RUNWAY WILL COME IN HIGH. LOWERING THE NOSE TO EFFECT THE LANDING CAUSES EXCESS SPEED AND FLOAT.

When landing on upslope terrain, a visual illusion of a very nose-low attitude befalls the pilot to make it appear the airplane is higher than it actually is on the approach.

1.22.2. LANDING IN RAIN

Refraction is the culprit that causes light rays to pass obliquely through the air and rain, producing a visual illusion that the airplane is higher than its actual altitude. When approaching to land in heavy rain, the apparent approach must be higher than normal. Using the spot method for landing eliminates this visual illusion.

1.22.3. SPOT METHOD FOR LANDING TECHNIQUE

As with other landings, on the downwind leg opposite the landing point, perform the pre-landing check. Adjust the trim for flight at the optimum approach speed and the power for the approach path angle. On final approach use the power to align the windshield mark and the aiming point. Maintain a constant indicated approach speed. The airplane will land exactly where you determined on the downwind leg.

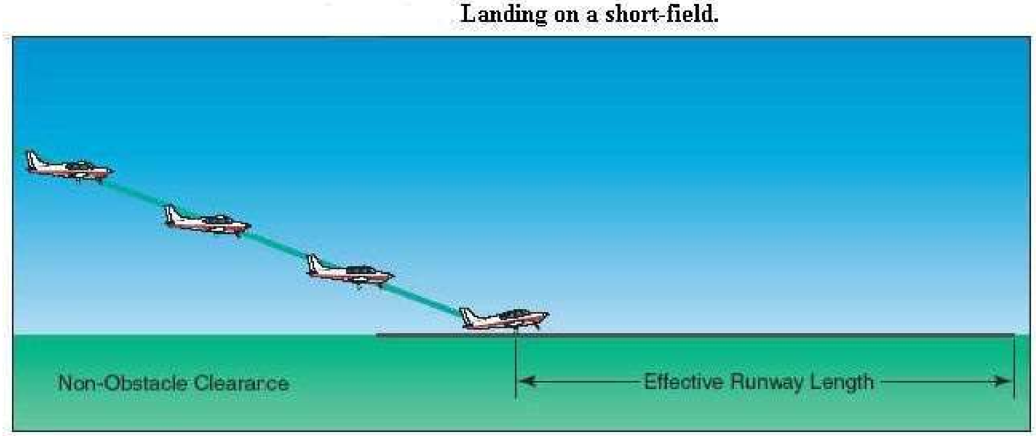
Visual illusions are contributing factors in approach and landing accidents. They are not of the chimera-type illusions (illusion of the mind), but rather a perception that causes misinterpretation caused by the convergence of lines, sloping terrain, or heavy rain. In approaching a runway a pilot customarily adjusts his glide path in accordance with what he sees. He is used to a visual relationship between the altitude and position of his aircraft and the width and length of the runway below. The pilot accustomed to landing on one runway or on runways of similar width may be deceived in his visual approach to a runway of a different width, especially if the length and width proportions appear to be about the same early in the approach.

- With a downslope runway, the angle of descent appears more obtuse (shallower) and the pilot flies higher than normal, resulting in a high and hot approach.
- With an upslope, even relatively small, the pilot has the illusion of being higher than normal. This misleads him into making a lower than normal approach. Depending upon aircraft performance and density altitude, the airplane may not have enough power to make it to the runway.

These visual illusions and other misleading deceptions can be dealt with effectively by incorporating the spot method for landing into all landing approaches, not just at mountain strips.

- Establish and maintain the desired approach speed.
- Align the nose (windshield mark) with the spot on the runway.
- Raise or lower the nose position using the throttle to maintain alignment with the spot. Before delving into the various aspects of the spot method for landing, we will establish a few definitions so we are talking about, and understanding, the same thing.

Landing on a short-field.



The spot method is functional for landings, yet useful for other flight operations.

- Cloud Avoidance - A VFR pilot may become trapped on top of an overcast. If a hole is found it is sometimes difficult to get through the hole without becoming trapped in the clouds. Choosing a point on the ground that is aligned with the windshield mark allows flight through the hole without touching the clouds.
- Descent to Pattern Altitude - When approaching an airport, select an "aiming point" on the ground. Align the windshield mark with the aiming point. It is not necessary to slow to the approach speed. Maintain whatever speed you desire. Level off at the pattern altitude and turn downwind. You will be in the proper position and altitude. This enhances safety since your airplane will not be descending in the traffic pattern.
- Crossing Ridges - From level flight attitude, look at the mountain ridge in relation to the windshield mark. If the ridge is below the windshield mark, the airplane is higher than the ridge. This will not work when climbing. Level off, then check the windshield mark.
- Forced Landings - If the engine fails, lower the nose for the glide attitude. Look at the windshield mark. Whatever it is aligned with on the ground indicates how far you can glide straight ahead. If a suitable landing area is off to the side, subscribe an arc from the ground aiming point and you have defined the area you can use for landing. The airplane can glide to any point within the area of the arc.

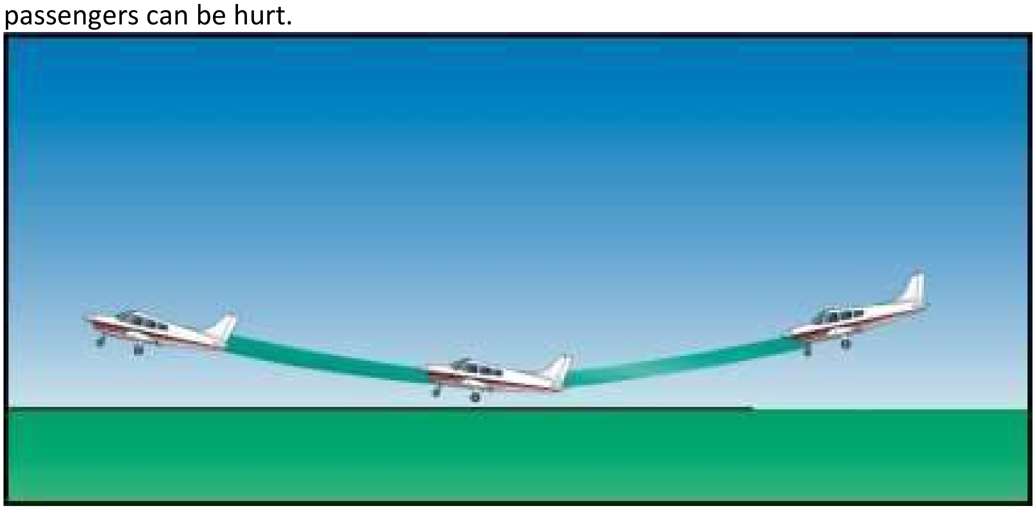
1.23. LANDING IRREGULARITIES

It is impossible to make a perfect flare and landing each time you approach an airport. In fact, each and every landing you will ever make is going to be different from the others in some way. Without knowing the corrective action for porpoising, the nosewheel can be wiped out. Ballooning can cause an unintentional stall and droppingin that may damage the airplane and the occupants.

Whatever the irregularity involved during a landing, it can be fixed. In learning how to take care of landing irregularities, we will discuss ballooning, bouncing, wheelbarrowing and porpoising. Mountain Flying Bible

1.23.1. BALLOONING

When a pilot looks at the ground too closely in front of the airplane the result is a "speed blur." This blur may cause an indication that the ground is rising faster than actuality. During this time it is normal to increase the pitch attitude too fast. This not only stops the descent, but also causes the airplane to start climbing. The danger of ballooning is that the altitude is increasing and the airspeed is decreasing. If the airplane stalls, there is no pitch control to soften the landing, and both airplane and passengers can be hurt.



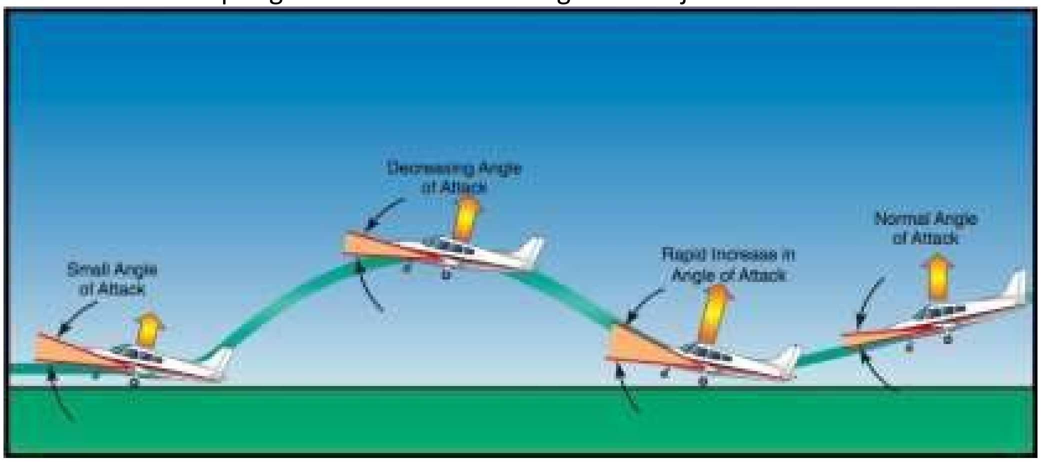
CORRECTIVE ACTION

Ballooning that causes a small increase in altitude is not serious. By maintaining directional control, moving rapidly to the level-flight attitude, and adding a small amount of power, the airplane will stabilize and a normal landing can continued.

A moderate balloon effect will require a greater application of power. If are able to transition immediately to the level flight attitude, the landing may continued.

1.23.2. BOUNCING

A bounced landing is similar to ballooning. The difference is the initial cause factor. An airplane touching (or striking) the runway before the normal landing attitude is attained, will bounce into the air. The height of the bounce depends on the rate of descent at the time of touchdown, or if the airplane is stalled, the height where the airplane begins its fall. Bouncing happens because the airplane strikes the runway before it attains the landing attitude. Because the bounce occurs during the landing, it is invariably accompanied by further back pressure that aggravates the height of the bounce. This is more a matter of startled reaction causing the additional backpressure rather than attempting to establish the landing attitude just as the touchdown occurs.



CORRECTIVE ACTION

Bouncing requires corrective action that is similar to that used for ballooning. If the bounce is slight, there is no particular hazard in making a follow-through landing.

Hold a constant pitch attitude (landing attitude) and maintain directional control using the rudders for longitudinal alignment and ailerons for later alignment. Add power to cushion the landing and reduce power immediately upon touch down.

If the bounce results in the airplane rebounding 10 to 15 feet above the runway, immediately lower the pitch attitude to level-flight attitude. Add power to cushion the landing and immediately before touchdown, transition to the landing altitude.

Reduce the power upon touchdown and maintain the pitch attitude. Several small bounces may follow, but with the elevator control in the landing attitude, these will be minimal.

Remember, once the airplane is on the ground it is important to keep the control wheel back. Too often there is an attempt to continually adjust the flare. This may aggravate the situation and lead to a dangerous porpoise condition.

1.23.3. WHEELBARROWING

Wheelbarrowing is a complication that occurs once the airplane is on the ground. Usually it happens when the pilot tries to hurry the landing and pushes forward on the control wheel. When the airplane is on the ground with a little excess speed and the control wheel is moved forward the wheelbarrow can befall the pilot. Usually, once the airplane is on the ground there is enough lift being produced for the main wheels to lift off the ground, and there is enough lift for the airplane to become unstable while riding on the nosewheel. The airplane may veer off the runway.

Arriving over the run-way threshold with excessive speed and a little float makes it look like the airplane will not get down within the confines of the runway. Just a little forward pressure causes the gear to make contact with the ground. With this scenario a wheelbarrowing effect is easy to imagine. When landing with a tail wind, or even a quartering tail wind, just relaxing the backpressure after touchdown may be enough to cause wheelbarrowing.

CORRECTIVE ACTION

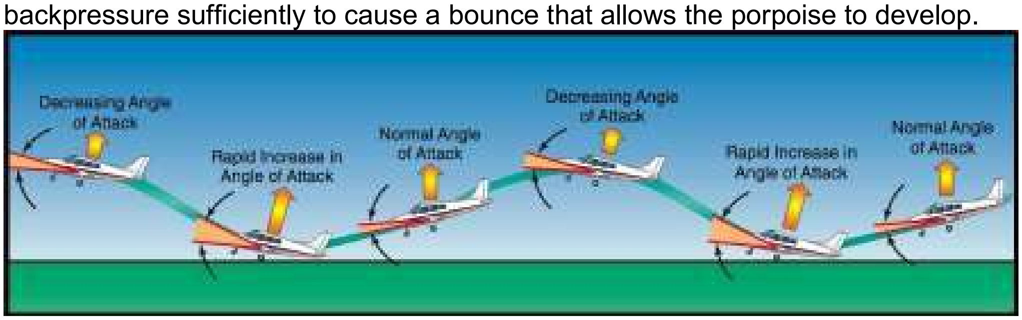
Backpressure will correct any wheelbarrowing tendency. With excessive speed, the airplane may begin flying again. Use the same technique to correct wheelbarrowing that causes the airplane to become airborne again as used for the correction of ballooning.

1.23.4. PORPOISING

The least expected and the most dangerous of the landing irregularities that may cause an accident is the occurrence of porpoising. Porpoising occurs most often after a bounced landing. The natural tendency to pull back on the control wheel after the bounce causes the airplane to rise higher than it would if the control wheel were left alone. Once the pilot determines the airplane is climbing away from the ground, forward elevator control arrest the climb, but now backpressure is required to prevent another impact. This bad, elevator control always occurs just a moment too late and the airplane bounces again.

This sequence of events continues until:

1. Backpressure is used to obtain and hold the landing attitude allowing the airplane to go through a couple of bounces and then stick to the run-way when the airspeed slows.
2. The porpoise continues, getting worse with each contact with the run-way until the nosewheel collapses. We mentioned before that a pilot with excess irspeed—caused by approaching too fast or landing with a tail wind or quartering tail wind—may try to help the airplane land with forward pressure on the control wheel when he sees the runway getting shorter. We said this is the major cause of wheelbarrowing, but when the pilot detects the wheelbarrow beginning, he may use backpressure sufficiently to cause a bounce that allows the porpoise to develop.



CORRECTIVE ACTION

The best recovery technique for the porpoise is backpressure on this elevator control. Immediately raise the nose to the level-flight attitude or slightly above level flight. As the airspeed dissipates, increase the pitch slowly to the landing attitude.

The airplane may bounce once or twice more, but that's about it.

If you try to recover from a porpoise with forward elevator control beyond the level flight attitude, get ready to spend some money. It’s likely the airplane will be damaged.

1.24. CROSSWIND LANDING ERRORS

1.24.1. THE CROSSWIND LANDING

The most common crosswind-landing errors include:

- Failure to correct accurately for drift at the moment of touch down. Either too much or too little drift correction will impose side loads on the landing gear.
- Failure to maintain alignment with the ground path results in erratic direction control and increases the probability of a ground loop.
- Failure to apply and maintain aileron control after the initial touchdown.
- Fly a crab approach along the extended runway centerline, changing the crab as necessary to maintain runway alignment.
- Switch to a side slip when less than 400-feet above the ground.
- Touch down on the upwind wheel first in a side slip.
- Maintain the side slip until the downwind wheel touches the ground.
- Maintain directional control during the rollout.
- Fly the airplane until it is parked, that is, position the controls for the existing wind condition using the "thumbs up method."

1.25. EMERGENCY PRECAUTIONARY

An emergency is a situation or occurrence of a serious nature, developing suddenly and unexpectedly, and demanding immediate action. While this dictionary definition of an emergency is correct, we, as pilots, have a different definition: An emergency is a situation or occurrence involved with the operation of an airplane, where the pilot has the capability of over-coming or dealing with the situation, but does not know how.

Know the operating limitations, performance, normal and emergency procedures and the operational information for your airplane. The worst time to be studying about what to do in an emergency is in the middle of one. The point that it is extremely important to know your airplane inside and out ... that is your airplane systems and performance characteristics.

1.25.1. SURVIVABLE EMERGENCY LANDING TECHNIQUES

When faced with an emergency landing in the mountains you will be exposed to adverse terrain conditions that have prevented previous training. The lack of exposure to this type of forced landing requires that you rely on the recommendations of others that have been in the same situation.

The probability of an engine failure causing a forced landing in the mountains is much less than running out of fuel, poor pilot technique (poor pre-flight, poor flight planning), getting lost or encountering marginal weather.

Except for a biennial flight review, once a private pilot obtains his license he is mostly on his own unless he elects further training. Most of the emergency landing training for the private pilot certificate underscores the need to find "suitable landing area."

Airplanes can be replaced, people can't. Don't desperate attempt to continue flying "VFR in IFR conditions," if you need to make a precautionary landing and the terrain doesn't match your mental picture of the "suitable landing area."

NOTE

By studying how to use the aircraft structure to protect yourself and your passengers, you can perform a survivable crash landing in almost any terrain.

1.25.2. TYPES OF EMERGENCY LANDINGS

Emergency landings are defined as:

- FORCED LANDING—The forced landing is an unintentional, but required landing on or off an airport, that occurs because the engine has failed or the airplane has experienced structural failure.
- PRECAUTIONARY LANDING—The precautionary landing is a deliberate, on- or off-airport landing caused by forethought and planning due to deteriorating weather, imminent fuel exhaustion, partial power loss or the approach of dusk in rugged terrain.
- DITCHING—Ditching is a planned (precautionary) or imminent (forced) landing on water.

1.25.3. PRECAUTIONARY LANDING

A pilot can elect to set it down (precautionary landing) before he runs out options when he flies into adverse weather. A controlled precautionary landing into a bad field may produce better results than continuing the flight until you a forced to land.
Generally the precautionary landing is less hazardous than a forced landing because there is more time to select the landing area and the engine is available to adjust the glide path. If the approach hasn't turned out as planned, you have the option of making a go-around.
For the pilot trapped by deteriorating weather, who has ignored the fact that this situation requires a precautionary landing, he has abandoned the beneficial advantages of making a controlled landing. The alternative may be inadvertent flight into the side of a mountain.

1.25.4. PSYCHOLOGICAL HAZARDS

Components of a pilot's mental makeup may interfere with his capacity to act timely and in an appropriate manner when faced with an emergency:

- RELUCTANCE TO ACCEPT THE EMERGENCY SITUATION
  Some pilots have an unconscious desire to keep the airplane in the air. This may go against all reason because the circumstances may put the airplane on the ground despite everything the pilot does or hopes. The unconscious longing to maintain flight may result in failure to lower the nose to maintain flying speed, procrastination in the selection of a touchdown area, and indecision in general.
- DESIRE TO SAVE THE AIRCRAFT
  Pre-certificate training that conditions one to expect a safe landing area can influence a pilot to avoid landing where the terrain is likely to cause aircraft damage. This has a tendency to cause pilots to try to stretch the glide to reach a better looking field. The ensuing stall negates the decision to reach a smoother field. It can also influence the pilot into trying to make a 180-degree turn back to a runway before he has sufficient altitude to complete the maneuver.
  Discounting the risks involved in the desire to save the airplane, some pilot's having a financial stake in the airplane believe that if the airplane is not damaged, the people within it will not be damaged. To hell with the airplane. If it can be sacrificed so the people can survive, so be it.
- UNDUE CONCERN ABOUT GETTING HURT
  Fear is fundamental and vital part of our self-preservation makeup. If fear leads to panic, it can cause improper decisions. Studying beforehand the techniques that result in successful emergency landings in adverse terrain can prevent fear where mind over matter seems to be more important than skill.

1.25.5. BASIC CONCEPTS OF CRASH SAFETY

A pilot who is faced with an emergency landing in terrain that makes extensive aircraft damage inevitable should keep in mind that the avoidance of crash injuries is largely a matter of:

- Keeping the vital structure (cockpit and cabin area) relatively intact by using dispensable structure (wings, landing gear, fuselage bottom) to absorb the violence of the stopping process before it affects the occupants.
- Avoiding forceful bodily contact with the interior structure.

- ENERGY ABSORPTION
  The study of accidents demonstrates that it is important to have crushable structure between the impact point and the occupants. Because there is more structure in front of the occupants, it is better to strike the impact point straight ahead instead of from the side.
  Energy-absorbing material has a direct bearing on the severity of the transmitted crash forces. In addition to the aircraft structure, the pilot can use vegetation, trees, fences or other man-made structures. Dense crops such as corn grain are very effective in stopping the airplane.

- OCCUPANT RESTRAINT
  The second basic concept involves the requirement that the occupants avoid forcible contact with the interior structure. When seat belts and shoulder harnesses are used, it helps the occupant to decelerate at the same rate as the airplane. Without a shoulder harness, the occupant may experience a violent stop the result of being forced forward until encountering some part of the airplane in a second collision.
  Older airplanes, although not equipped with shoulder harnesses, may contain structural fittings for their installation. A shoulder harness installation is the cheap insurance.

- SPEED AND STOPPING DISTANCE
  Deceleration during an emergency landing is controlled by ground speed stopping distance. Speed is the most decisive in determining whether grievous harm will occur.
  The severity of deceleration is governed by the square of the ratio of the actual speed divided by the desired speed. If the ground speed is doubled, the destructive energy is quadrupled.
  The physics of deceleration are such that a small change in the touchdown groundspeed can have an enormous effect in the outcome of the emergency landing. For example, an impact at 80 mph is twice as hazardous as one at 56.6 mph. The occupants are three times safer crashing at 50 mph than at 86.6 mph. Whenever faced with an emergency landing situation, decelerate, using flaps to the slowest controllable airspeed possible. Don't worry about finding a large, flat field for your emergency landing. Very little stopping distance is required during a forced landing.
  The typical general aviation airplane has been designed to provide occupant protection up to 9 Gs. To give you some insight of the required forced landing area, we will examine the minimum stopping distances at various speeds, assuming a uniform 9G crash deceleration.

At 44 knots the required distance is 9.4 feet. At 87 knots the required distance is 37.6 feet. Although the speed is not quite doubled, the distance required is four times as long.

Knowing you should have a uniform deceleration in adverse terrain allows the pilot to choose a landing area that will dissipate or breakup the dispensable structure over a short area. It is not desired that the airplane stop all at once, but rather that it decelerates evenly.

- ATTITUDE AND SINK RATE CONTROL

  The pilot needs to guard and protect himself from making a critical error during the execution of a forced landing. That error is the loss of aircraft attitude and sink rate at the moment of touchdown. For example, a nose low attitude may use the nose wheel to stick in the ground and flip the airplane over. Performing last minute steep banks to adjust the flight path may result in catching a wing tip on the ground. Although an airplane has been designed to provide protection up to 9 Gs in a forward direction, there is very little protection against touchdown with a high sink rate. Vertical forces are to be avoided because the lack of cushioning can cause serious compression forces for the occupants. Try to touchdown at 500 fpm or less rate of descent.

- SIMULATED FORCED LANDINGS

  When a pilot simulates a forced landing, the practice helps ensure he will act promptly and appropriately during an actual emergency situation. This practice, while assisting in the development of accuracy, judgment, planning and confidence, creates two false concepts to be ingrained.

  The first is that the pilot will always be able to find a suitable landing field. The second false impression is that the only reason for making an emergency landing is when engine failure occurs. The collection of data reveals that flight in marginal weather and fuel exhaustion are the leading causes of forced landings.

  An emergency landing demands the pilot to develop an immediate action checklist:

  a. Maintain aircraft control. Establish a glide at the proper speed. At low altitudes, get that nose down in a hurry to prevent a stall.
  b. Select a field and plan an approach.
  c. Perform a cockpit check.

- TERRAIN SELECTION

  A pilot's choice of emergency landing sites en route depends on:

  a. The preflight planning route that was selected.
  b. The aircraft's height above the ground when an emergency occurs.
  c. The aircraft's airspeed. If an emergency landing occurs shortly after takeoff, excess airspeed can be converted into altitude, but this is much less efficient that if you already have the altitude. Always climb at the best rate-of-climb or best angle-of-climb speed until reaching a safe altitude.

- FIELD SELECTION

Conditioned pilots are constantly, although it may be subconsciously, looking for emergency landing sites. Obviously, you would want your emergency to allow landing at an established airport or road. In reality, the choice involves other hostile environment. Select the best of what is available. If there are cultivated fields, they will work. Even plowed fields can be acceptable if nothing else presents itself. Try to avoid areas with large rocks or boulders or any uneven field that may contain ditches. You are not searching for the largest area in which to land, but rather a suitable area. Keep in mind that you might be able to change the aircraft heading only a few degrees to take advantage of energyabsorbing terrain that can insure a survivable forced landing.

- AIRCRAFT CONFIGURATION
  The purpose of flaps is to allow a steeper approach angle without an increase in airspeed. They do this by increasing lift and drag. Drag is directly proportional to lift. A direct benefit to us is that with flaps the airplane can be maneuvered at slower speeds and the stall speed is reduced. Exercise caution. The premature application of flaps may cause more altitude to be lost than you can afford.

- APPROACH
  Plan your approach considering:
  a. The wind direction and velocity.
  b. The field dimensions and slope.
  c. Final approach path obstacles.
  If these three factors do not seem to be compatible under the circumstances, a compromise would be to consider first the wind, then obstacles and finally the terrain. Keep in mind that it is less hazardous to strike an obstacle at the completion of the ground roll than it is while the airplane is close to approach speed. Landing on a bad landing field may be better than not being able to reach a good field.

- TOUCHDOWN
  Maintain the aircraft attitude (where the nose is in relation to the horizon) the normal glide attitude and the sink rate will be as normal. The sink rate can be reduced during the flare. Let's look at some of the unusual situations that occur in the mountains.

- CONFINED AREAS
  If you have selected a forced landing area where open space is at a premium, it might be wise to force the airplane down to the ground to begin deceleration before encountering obstacles. Sometimes the airplane can be ground looped to avoid hitting solid objects.
  Rivers or creeks devoid of large boulders provide an alternative to rugged mountainous terrain. The area must be wide enough to reach the water without snagging the wings. A word of caution if you plan to land on a road. Telephone lines and power lines generally parallel the road. It is difficult, if not impossible, to

see these lines under certain lighting conditions. Rather, you should search for their support structures (towers or poles).

- TREES (FOREST)

  Survivable tree landings, although not something to look forward to, can be accomplished by:

  a. Pretending you are landing at an international airport.
  b. Using full flaps with the landing gear extended.
  c. Reducing the groundspeed with flight into the wind.
  d. Making the touchdown at the minimum airspeed.

  Make a normal landing onto the "runway" at your pretend international airport. It is important to avoid a stall where the airplane is dropped down through the trees.

  - Even after the airplane has made contact with the trees, the rudder can be used to avoid direct contact with heavy tree trunks (even if the wings have been peeled off).
  - Avoid areas with tall trees and thin tops. These can allow the airplane to drop to the ground. A free-fall from 75 feet beginning at zero speed will result in an impact at 40 knots, generating about 4,000 feet per minute rate of descent. Instead, find trees with lots of branches, especially those that are low.
  - The ideal landing means wing contact should be symmetrical to prevent the loss of one wing that leads to a spinning descent.
  - If the airplane is on the ground and contact with trees is unavoidable, try to make contact with both wings at the same time.

- MOUNTAINOUS TERRAIN

  Mountainous terrain with its irregularity prohibits rules for a forced landing that are cast in stone. Altitude provides more time and options when choosing an emergency landing area. The pilot at a needlessly low altitude over rugged terrain has few options available during an emergency.

  The emergency landing when flying in a "V-shaped" canyon means you must land on a slope. Slope landings are always made upslope. Sufficient speed must be obtained to allow the transition from the glide attitude to the landing attitude, and then a normal landing. The importance of airspeed can be seen by examining the performance of a gliding airplane at 50 knots with a 500 feet per minute rate of descent. Such condition results in a 6-degree glide path. If the upslope landing area is 19 degrees, the aircraft's attitude must be changed 25 degrees just to parallel the slope.

  This will require a glide speed of 20 knots or more above normal. Remember, another 5-degrees to 10-degrees of pitch is required to complete the flare. Once the airplane is on the ground, and before its momentum runs out, use full rudder to turn the airplane parallel to the mountain side to prevent sliding backwards.

- WATER (DITCHING)

Water landings can be inviting when compared to a poor tree landing or landing in extremely rough terrain. Some pilots may be reluctant to make a water landing because the airplane will be lost and there is the possibility of becoming trapped inside. The only valid reason to pick a very poor landing area over water is when the water temperature is near freezing (or you see schools of sharks).

Factor in the following considerations before making the decision to ditching airplane:

a. The water temperature and the estimated time to be spent in the water. The survival time in water with a temperature of 33°F is less than one hour for the average person.
b. The proximity to land.
c. The physical condition of the occupants and their ability to swim.
d. The availability of life vests and other water-survival equipment.
e. The number of occupants and the number of usable exits.

Float-plane pilots learn a method for glassy water landings. As the term implies, a large area of water is smooth and provides no visual reference for depth perception. It usually leads to one of two problems for the uninitiated, either the plane is flown into the water, hitting in a nose-low attitude, or the air-plane is stalled from a high altitude. To avoid the consequences of lack of depth perception, establish a constant rate of descent and maintain that minimum descent until water impact.

2. FLIGHT CREW REQUIREMENT AND QUALIFICATION

2.1. Minimum Flight Crew.

The basic flight crew complement is the minimum number of flight crew required to handle the aircraft controls during flight.
The following are minimum crew composition of aircrafts operated by Smart Cakrawala Aviation:

Aircraft Type	Type of Operations	Minimum Flight Crew
C208/C208B	Mountainous	1 Pilot Incommand and 1 First Officer

2.2. Crew Qualification Requirements

2.2.1. Flight Crew Member Instructor.

The qualification requirement for flight crew member instructor are:

1. He/she Has satisfactorily completed PT. Smart Cakrawala Aviation training program to be able to act as Instructor in the Operation Manual Part D Section 4;
2. Is appropriately qualified as an instructor; and
3. He/she Has completed the initial and recurrent training requirements applicable to the instruction to be carried out.

<table>
<tr><th>NO</th><th>QUALIFICATION</th><th>LIC</th><th>GI</th><th>FI</th><th>CCP</th></tr>
<tr><td>1</td><td>1 year experience</td><td rowspan="5">CPL/
OR
ATPL</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2</td><td>50 hours flying in a recognized mountainous environment</td><td></td><td>X</td><td>X</td></tr>
<tr><td>3</td><td>Minimum 700 hours total time in appropriate category including 100 hours instructional experience</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>4</td><td>Mountain Flying Course</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>5</td><td>Have demonstrated competence to an appropriately qualified flight examiner and on successful completion have had their logbook endorsed</td><td></td><td>X</td><td>X</td></tr>
</table>

2.2.2. Pilot In Command

The minimum qualification requirements for C208/C208B pilots to act as PIC of a commercial air transportation flight in Smart Cakrawala Aviation are:

NO	QUALIFICATION	LIC	MOUT 1	MOUT 2	MOUT 3	MOUT 4
1	"MOUNTAINOUS TERAIN FLYING OPERATION TRAINING"	CPL/ OR ATPL	X	X	X	X
2	20 hours of Line Training		X	X	X	X
3	Release the Additional Route / Airport Qualification by Instructor			X	X	X
4	500 hours experience on type					X
5	Undersupervision minimum 50 hours					X

2.2.3. First Officer (FO)

The minimum qualification requirements for C208/C208B pilots to act as PIC of a commercial air transportation flight in Smart Cakrawala Aviation are:

NO	QUALIFICATION	LIC	MOUT 1	MOUT 2	MOUT 3	MOUT 4
1	"MOUNTAINOUS TERAIN FLYING OPERATION TRAINING"	CPL	X	X	X	X
2	20 hours of Line Training		X	X	X	X
3	Release the Additional Route / Airport Qualification by Instructor			X	X	X
4	100 hours experience on type				X	X

3. TRAINING PROGRAM

This manual is intended to serve as guidance material for pilots ground and/or flight training program to ensure that each pilot become qualified and remain adequately trained for mountainous operations, duty position and kind of operation in which the pilot serves.
All pilots personal will receive training, testing and check according to the appropriate category of training.

3.1 Objective

This Segment is the final segment of each training curriculum as outlined in this SOP and is composed of specific Testing and Checking.
After completion of formal training, pilot must successfully complete this segment before being qualified to serve unsupervised as a required PT. Smart Cakrawala Aviation pilot.

3.2 Ground Training.

Time ………14.0 Hours

(A) Horizon

- define horizon
- identification of real or imaginary horizon
- superimposing a useable horizon on any variable background ie. visualizing where real horizon sits as if terrain or obstacles were transparent
- illusions associated with inaccurate horizon definition
- hazard potential associated with these illusions and poor horizon definition.

(B) Wind Awareness

- forecast conditions including synoptic
- ‘fluid flow’ concept of air between, over, and around terrain
- significance of direction relative to terrain
- wind patterns less than 15kts
- wind patterns greater than 15kts
- local patterns and effects
- upper winds compared to lower winds ie. comparison of wind in valley with wind at altitude
- indication of wind velocity at altitude i.e. snow, drift, lift/sink patterns, VSI indications, wave, cloud movement
- lift, sink, rotor, wave, turbulence, gusts
- cloud types as indicators of potential flying conditions
- indicators of lower level wind, for example:
  - tussocks

  - water ripples / lanes on stationary water and wind shadows on water
  - poplars
  - willows
  - crop
  - smoke / dust
  - drift, and drift indicators
  - G/S versus A/S
  - cloud shadows as indicator of upper wind and its influence on lower level wind
- applicability of Va and Vnokatabatic / anabatic winds in a valley
- choice of flying low versus flying high

(C) Situational Awareness

- threats
- space
- inertia
- drift
- altitude, including pressure and density altitude
- gaining or losing height
- turning radius and effects of speed, configurations, wind, turbulence, weight, visibility
- weather patterns
- sun/shadow
- scale – GA aircraft is but a dot on the landscape
- merging terrain
- clear air effect
- legal requirements
- recognition of height above terrain
- appreciation of the need for anticipation versus reaction
- moral responsibilities – consideration of people & stock
- appropriate clothing & footwear
- passenger safety & comfort
- potential landing options
- distances for position reports
- traffic
- illusions, especially terrain gradient
- fuel remaining
- daylight remaining
- potential for stalling in the turn

- effect of poor visibility configuration on fuel management
- potential dehydration effects
- white water content in rivers as indicator of valley gradient

(D) Contour/constant altitude flying

- horizon identification / appropriate nose attitude
- awareness of space and position
- appreciation of inertia
- appreciation of available escape options
- right of way
- lookout - high wing versus low wing, left versus right, blind corners, colour schemes
- recognizing lift / sink
- Groundspeed versus Airspeed relationship
- flying constant altitude to recognise any changing gradient of valley floor

(E) Valley Turns

- use of full width anticipating need for 360° turn
- minimize angle of bank to minimize Vs increase
- lower airspeed to reduce turn radius
- use of poor visibility configuration
- reduced flap to maintain performance i.e. 10° flap as opposed to 20°
- need for power to combat drag
- check turns before valley narrows
- large valley – position anywhere right of center
- confined valley – any need to move over to make turn means one is not correctly positioned (Human Factors 5 – 7.5 seconds reaction time)
- effect of sudden shadow / sun effects
- clear screen
- steep gliding turns and effects of changing horizon, narrowing valley
- roll out position – never in middle of valley
- always positioned to anticipate not react
- if on wrong side...easy decision to change sides, if in middle potential for indecision and lack of space
- if airspeed decays with full power lower nose to convert height to airspeed
- emphasis “caution flying up a valley haven't previously flown down" philosophy.

(F) Saddle Crossings

- concept of saddle, pass, spur, ridge
- compromise of many variables
- anticipation/assessment of lift and sink
- VSI indications
- appreciation of wind direction relative to terrain
- approach 45° with escape route downhill, downstream
- desirable approach left to right
- escape option 'obstacle free' to use minimum bank angle
- knife edge saddle versus prolonged commitment area saddle
- level attitude - maintain airspeed with regard to Va
- not in climb attitude - airspeed and lookout are compromised
- not in descent – airspeed and control limited by Va
- anticipate turbulence
- use of parallax to assess sink and safe height to cross ie. more terrain visible behind as approaching saddle therefore higher than saddle; less terrain visible therefore lower and turn away early; including technique for assessment of 500' clearance
- decision making including:
  - planning of initial flight path to a mountain range or ridge
  - options
  - approaches to the saddle/pass/ridge/spur
  - commitment point
  - escape routes
  - position and options after crossing
  - position reports for traffic information
  - proximity to cloud including potential for lift

(G) Route Finding

- water only flows downhill
- identify flow and follow to larger river, lake, sea, roads, town etc.
- awareness of valley alignment relative to compass
- awareness of sun position
- map folding; hold in one hand thumb on moving position whilst holding control– column/stick to facilitate peripheral vision
- effective pre-flight planning

(H) Difficult Conditions

- cloud, showers, white out, bright out - effects on visibility, disorientation, illusion, work load
- merging terrain – foreground with distant
- dirty windscreen versus clean
- precipitation on screen affecting judgement
- gradient of snow covered areas, depth perception
- sun/shadow effects
- effects of difficult conditions on aircraft management including:
  - distractions
  - fuel
  - icing
  - visual reference
  - attitude control
  - altitude / hypoxia
  - aviate, navigate, communicate
  - below VHF radio coverage levels
  - SARTIME management
  - orientation
  - decision making, including pilot attitudes
  - temperature extremes, temperature factors
  - turbulence
  - air movements including significant up or down flow
  - wires and obstacles e.g. wind farms

(I) Cautions and Emergencies

- Performance comparisons including:
  - utility category versus MAUW
  - effects on turn radius
  - rates of climb
  - handling of sink
  - altitude/power considerations
- New aircraft rating differences including:
  - often faster/heavier
  - greater turn radius required
  - more anticipation needed
  - higher workload (e.g. extra controls and instruments)
- CFIT accidents – most occur by:
  - loss of visual reference (horizon)
  - stall in turn

  - attempting to out-climb terrain
  - poor decision making, resulting in reaction instead of anticipation
  - lack of decision making resulting in inaction
- Forced Landing and Precautionary Landing considerations including:
  - limited options
  - priority ~ make a plan; confined spaces may affect the ideal
  - tendency to crowd landing area
  - consider climatic/seasonal wind effects for calculated gamble on wind ie. Anabatic versus Katabatic
  - consider valley gradient
  - awareness of mind sets and illusions
  - consider early Mayday or Pan call
  - habitation in remote area; look for airstrip/fertiliser bins
  - consider elevation
  - use of lift conditions to glide down valley closer to potentially more suitable option and habitation
  - river beds - consider landing downstream; surface may be smoother
  - beaches
    - ❖ stoney patches usually indicate firm sand
    - ❖ steep indicates soft sand
    - ❖ flat, damp sand usually means firm sand
    - ❖ debris, especially following period of poor weather
    - ❖ no lagoon area above high tide line
    - ❖ x/w potential
    - ❖ sand type; quartz, iron, coal etc
    - ❖ always a gamble

(J) Consider survival kits, their use and contents relative to basic principles of survival and to the area of operations including:

- Location
- Water
- Food
- Shelter
- Will to survive
- Survival principles after unplanned landing, including basic first aid principles and skills

(K) Use of survival equipment:

Location

- Have items that will facilitate being found, that enhance your visibility compared to the surroundings ie:
  - bright ground sheet / tent fly / clothing
  - condys crystals, food colouring
  - flares
  - mirrors / reflection items
  - torch
  - ability to ignite fuel / oil as smoke producer
  - candle
  - fire axe to break pattern of vegetation for searchers
  - lightweight camp shovel (snow ops)
  - whistle

Water

- Survival kit container as receptical
- Ability to heat and provide warm drink

Food

- Basic dry freeze type food and means of providing warm food more from principle of preventing hypothermia than satiating hunger.

Shelter

- Items that will facilitate use of resources available to shelter from the elements including parts of aircraft:
  - Ground sheet / tent fly
  - survival blankets
  - duct tape
  - light rope / string

Will to survive

- Awareness that if each survivor retains the will to survive their chances are greater regardless of the availability of the other principles. This alone will make the most difference.
- Have available Mountain Survival guidance material

(L) Flight following/ELT

- Options for flight following in a mountainous environment
- Limitations and uses of ELT in a mountainous environment

REVIEW……………………………………………………………………………………………02.0 Hours

3.3 Line Training.

Time ……………………………………………………………………………………………………20.0 Hours

1. Crew Briefing, FLOPS Briefing, Performance, Manifest
2. Fuel Calculation and Flight Plan
3. Coordination (cockpit crew, Engineer)
4. Aircraft preflight and set up
5. How to used G1000 for mountainous.
6. Aircraft Handling
7. Descent:
   - Approach Briefing,
   - Rates of Descent,
   - Considerations,
   - overflight
8. Landing
   - Information sources,
   - Performance Calculations (MLW),
   - Short-field landings,
   - Runway slope,
   - Key Points and commitment points,
   - Go-arounds
9. Examples from Airports we fly to commonly:
   - Ilaga special procedures
   - Beoga left base turn
   - Bilogai RWY 09 approach
10. High Altitude Take-off:
    - Performance Calculations / take-off weight
    - Speeds
    - Departure brief,
    - Technique (rotation)
    - Emergency Options
    - Departure procedures from TMK
11. Climb:
    - Climb Power and performance
    - Inertial Separator

12. Emergencies

Exercise:

To experience simulated forced landings and precautionary landings in mountainous areas.

Aim:

To practice emergencies where options may be limited, where terrain and or weather are intrusive to the ideal.

Technique:

- In real or simulated circumstances provide as much variety from the ideal simulated forced landing or precautionary landing as local resources permit, where the selected landing site means descent below the ridge line is required i.e. real horizon reference is unavailable.

Principles to experience:

- Lack of real horizon
- Variables:
  - height available
  - distance from options/gliding distance
  - option types eg. strips, paddocks, clearings, beaches, sand bars, roads, etc.
  - conditions of wind, turbulence, and precipitation
  - conditions of load and performance
  - conditions of visibility including light/sun/shadow effects
- priority - make plan - confined spaces may affect
- climatic / seasonal wind effects eg. for a calculated gamble use anabatic / katabatic?
- use of lift conditions/avoidance of sink for glide range considerations
- valley gradient
- illusions and mind sets
- need for early mayday - what frequency, consider 121.5, ELT/tracking system activation
- habitation in remote areas - look for airstrip/fertiliser bins
- consider elevation
- consider wires

contents of survival kit and uses relative to principles of survival

3.4 Course ware

1. Operations Manual Part A, B, and C

2. SOP Mountainous Manual
3. MEL
4. Pilot Operating Handbook (POH)
5. Flight Plan, AIP, Indoavis ONC Chart and Approach Chart.

3.5 Training Environment

Aircraft on revenue or non-revenue operation.

3.6 Testing / Checking

Testing and checking pertaining to duties will be done by Flight Instructor or Check Airmen.

3.7 Record Keeping.

Certificate Ground Training Mountainous

Flight Training Form (form Operations Manual Part D)

- SCA-OPS-OMD 005 ATTANDANCE REGISTER
- SCA-OPS-OMD 007 FLIGHT TRAINING RECORD
- SCA-OPS-OMD 006 LINE CHECK

APPENDIX A CATEGORY MOUNTAINOUS AIRPORTS/AIRSTRIPS AT PAPUA AREA

No.	Criteria
1.	Elevation
2.	Runway Length
3.	Runway Available
4.	Runway Surface
5.	Airspace Control
6.	Navigasi Aids
7.	Airports/Airstrips

No.	Mountain 1	Mountain 2	Mountain 3	Mountain 4
1.	WAKDE 1. 3 m 2. 1640 x 30 m 3. – 4. Grass 5. – 6. – 7. Airstrip	WAKT 1. 86.40 ft 2. 1056 x 23 m 3. – 4. Asphalt 5. ATC 6. NDB 7. Airport	SINAK 1. 7292.36 ft 2. 641 x 13 m 3. – 4. Asphalt 5. – 6. – Airstrip	ILLAGA III 1. 2164 2. 550 X 24 m 3. – 4. Grass 5. – 6. – Airstrip
2.	WASF 1. 511 ft 2. 1200 x 31 m 3. – 4. Asphalt 5. AFIS 6. NDB 7.	WABI 1. 40 ft 2. 1399 x 29 m 3. – 4. Asphalt Concrete 5. ATC 6. NDB, VOR 7. Airport	POGAPA 1. 5951.73 ft 2. 600 x 20 m 3. – 4. Grass 5. – 6. – 7. Airstrip	BEOGA 1. 5600.67 ft 2. 488 x 24 m 3. – 4. Grass 5. – 6. – 7. Airstrip
3.	WASO 1. 46 ft 2. 1300 x 30 3. – 4. Asphalt 5. ATC 6. NDB 7. Airport	RANSIKI 1. 131.24 ft 2. 1050 x 30 m 3. – 4. Grass 5. – 6. – 7. Airstrip	MULIA 1. 5887.34 ft 2. 797 x 19 m] 3. – 4. Asphalt 5. – 6. NDB 7. Airstrip	
4.	KAMBUAYA 1. 1406 ft 2. 1100 x 30 m 3. – 4. Asphalt 5. – 6. – 7.	WAJO 1. 4263.82 ft 2. 1354 x 30 m 3. – 4. Asphalt 5. ATC 6. NDB 7. Airport	ILLAGA I 1. 7975 ft 2. 600 x 18 m 3. – 4. Asphalt 5. – 6. ATS 7. Airport	
5.	WASN 1. 98 ft 2. 1340 x 30 m 3. – 4. Asphalt 5. AFIS 6. NDB 7.	KARAS 1. 3 m 2. 1000 x 20 m 3. – 4. Grass 5. – 6. – 7. Airstrip	ENAROTALI 1. 1750 m 2. 990 x 18 m 3. – 4. Grass 5. – 6. – 7. Airstrip	
6.			BILORAI 1. 7312.35 ft 2. 600 x 18 m 3. – 4. Asphalt 5. – 6. – 7. Airstrip	