Mountain Flying

Note: *This Safety Advisor gives practical advice for managing the risks of mountain flying. It is NOT intended to replace a mountain flying course that includes flight training with a qualified instructor.*

Mountain flying allows pilots to reach new and exciting destinations while providing adventures and challenges that most flatlanders will never know. As with any new flying adventure, there are also unique risks, most associated with either unforgiving terrain or high density altitude.

There are additional risks when flying in the mountains. Actively manage those risks for a safe flight.

Density Altitude

Higher density altitude means thinner air. For pilots, the bottom line is that high density altitude means seriously degraded aircraft performance. Technically speaking, density altitude is true altitude adjusted for non-standard temperature and pressure. At high density altitudes, it is common for non-turbocharged airplanes to climb at only 200 or 300 feet-per-minute. Would you be comfortable taking off toward rising terrain with that kind of performance?

There are many ways to determine density altitude. It is often included on automated weather recordings (ASOS or AWOS) and shown on “density altitude thermometers” at airports. You can also calculate density altitude with your flight computer, or even with simple math: density altitude increases approximately 120 feet for every one degree Celsius the temperature is above standard.

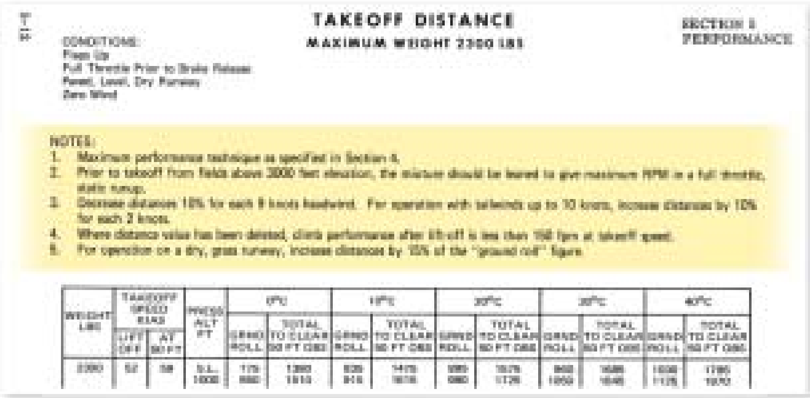
Run the Numbers

Remember that standard temperature at sea level is 15˚C and air cools an average of 2˚C per 1,000 feet. For example, the standard temperature at 6,000 feet msl is 3˚C (12˚ cooler than sea level). If the temperature at 6,000 feet were actually 23˚C, the density altitude would be approximately 2,400 feet *higher* than the mean sea level (msl) altitude (120 X 20˚C above standard). The aircraft would perform as if it were at *8,400* feet.

Higher density altitudes also require a longer takeoff roll. When calculating the required takeoff distance, be sure to read the notes in the pilot's operating handbook (POH) that refer to items like tailwind conditions and runway surface, and leave yourself a margin of safety. It's also good to always have an abort point so you can stop on the remaining runway if the airplane is not accelerating properly.

Rule of Thumb

If the airplane is at less than 75% of liftoff speed by the midpoint of the runway, then abort the takeoff. You'll have to try again with a lighter load or maybe when it's cooler.



TAKEOFF DISTANCE
MAXIMUM WEIGHT 2300 LBS

SECTION 5
PERFORMANCE

CONDITIONS:
Flaps Up
Full Throttle Prior to Brake Release
Paved, Level, Dry Runway
Zero Wind

NOTES:
1. Maximum performance technique as specified in Section 4.
2. Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.
3. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
4. Where distance value has been deleted, climb performance after lift-off is less than 150 fpm at takeoff speed.
5. For operation on a dry, grass runway, increase distances by 15% of the "ground roll" figure.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	0°C		10°C		20°C		30°C		40°C	
	LIFT OFF	AT 50 FT		GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
2300	52	58	S.L. 1000	775 860	1390 1510	835 915	1475 1615	895 980	1575 1725	960 1050	1685 1845	1030 1125	1795 1970

Make sure you read the NOTES before calculating takeoff distance.

Flying at higher density altitudes requires attention to detail. Most pilots are good at calculating takeoff and landing distances, but many get into serious trouble by forgetting to calculate the climb performance they will experience *after* takeoff. At a respectable climb rate of 300 feet-per-minute, for instance, it will take more than three minutes just to climb to the common traffic

Remember to calculate after takeoff climb rate.

pattern altitude of 1,000 feet agl. Around mountain airports, this climb rate may not be enough to clear the terrain.

Terrain and obstacle clearance is a function of both vertical speed *and* groundspeed. Over a specified distance, the faster an aircraft's groundspeed, the greater the rate of climb needed to avoid obstacles. Just because an airplane can go fast doesn't mean it can out-climb a mountain. Always calculate rate of climb in *feet per nautical mile* given your estimated ground speed and vertical speed. Map this out on a chart before you depart to ensure you can out climb all terrain and obstacles.

When rising terrain is an issue, one solution is to perform several climbing circuits near the airport to gain altitude before departing the area.

Run the Numbers

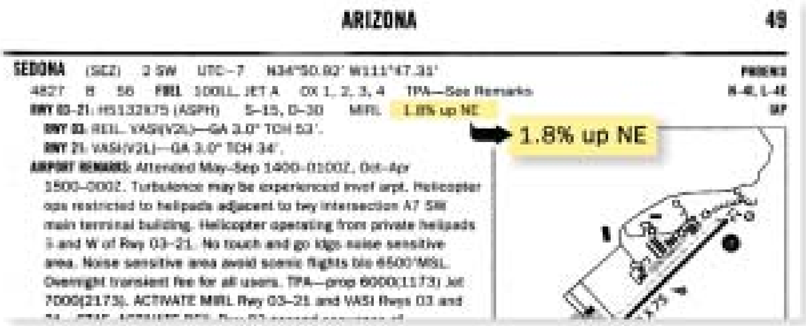
To figure out the feet-per-nautical-mile climb rate that an aircraft is capable of delivering, multiply the vertical speed by 60 and then divide by the groundspeed. For example, if the vertical speed is 500 feet-per-minute and your groundspeed is 120 knots, the feet-per-nautical-mile climb would be 250 feet: [(500 X 60)/ 120]. This formula works for both knots and miles per hour.

Weight and Balance

Mountain pilots routinely operate well below the aircraft's maximum gross weight, since extra weight robs precious performance needed in high-density-altitude situations. As a rule of thumb, try to stay at least 10 percent lighter than the maximum takeoff weight. It's also good to fly with reduced fuel when able, even if it means refueling at a nearby *lower* elevation airport before proceeding on course. This is a new concept for most flatland pilots. Just remember – don't use your fuel reserves unless caught in a true emergency.

Mountain Airports

Sloping runways are common in mountainous areas. One example is Sedona, Arizona. This popular tourist destination offers a well-maintained airport and breathtaking scenery, but the Airport/Facility Directory (A/FD) points out that Sedona's 5,132 foot runway has a 1.8% slope. That may not sound like much, but do the math. This runway slopes more than 92 feet from one end to the other! By comparison, most control towers are only about 75 feet tall.


ARIZONA 49

SEDONA (SEZ) 2 SW UTC–7 N34°50.92' W111°47.31' PHOENIX
4827 B S6 FUEL 100LL, JET A OX 1, 2, 3, 4 TPA—See Remarks H-4E, L-4E
RWY 03-21: H5132X75 (ASPH) S-15, D-30 MIRL 1.8% up NE IAP
RWY 03: REIL. VASI(V2L)—GA 3.0° TCH 53'.
RWY 21: VASI(V2L)—GA 3.0° TCH 34'.
AIRPORT REMARKS: Attended May–Sep 1400–0100Z, Oct–Apr 1500–0002. Turbulence may be experienced invof arpt. Helicopter ops restricted to helipads adjacent to twy intersection A7 SW main terminal building. Helicopter operating from private helipads S and W of Rwy 03–21. No touch and go ldgs noise sensitive area. Noise sensitive area avoid scenic flights blo 6500'MSL. Overnight transient fee for all users. TPA—prop 6000(1173) Jet 7000(2173). ACTIVATE MIRL Rwy 03–21 and VASI Rwys 03 and

Be familiar with airport "must-know" information, like runway slope.

Taking off downhill can decrease the required takeoff roll when departing an airport with a sloping runway. If you are taking off downhill with a light tailwind, keep in mind that landing traffic will most likely be arriving in the opposite direction. Accepted takeoff and landing procedures will differ from one airport to another, so it's best to talk to a local pilot before venturing out on your own.

Airplane turning final for an "unimproved" mountain runway.

Approach to a grass runway.

Many mountain airstrips are "unimproved," which is a nice way of saying they have dirt, grass or gravel runways, and/or are sloped. These airports offer challenges above mere aircraft limitations. Be sure to get flight training for unimproved airport operations, and become familiar with each particular airstrip before attempting to use it.

Mixture Magic

Another new procedure for flatlanders is taking off with the mixture leaned. Most pilots are accustomed to taking off with the mixture full rich, but this can lead to disaster in high-density-altitude situations because the engine will be running much too rich.

Follow the aircraft's POH for specific recommendations on leaning. If your POH does not give specific guidance, the usual procedure for non-turbocharged piston engines is:

1. Ensure the run-up area is clear of rocks and other debris (to protect the propeller).
2. Hold the yoke full back to keep the prop high and minimize pressure on the nose wheel strut.
3. Set the throttle to full power.
4. Lean the mixture until there is a slight drop in power.
5. Enrichen the mixture slightly rich of the maximum power setting.

It is also important to set the mixture as lean as possible for all taxi operations. Doing so prevents the spark plugs from fouling.

Mountain weather can change quickly.

Mountain Weather

Most pilots have heard horror stories of mountain winds or other high-country weather phenomena, but there's really nothing to fear – when you're armed with the proper education. Imagine water flowing through a fast moving stream or river. As rocks or other obstacles disrupt flowing water, it curves and moves in a predictable pattern. Mountain winds are no different. As the wind blows past mountain peaks, it also moves in a predictable manner. With experience you'll know where areas of dangerous turbulence, downdrafts, and useful updrafts can be found.

Obtaining the latest weather information is especially critical, since weather in the mountains can change quickly. Reported conditions can easily change by the time you get there.

Automated weather reporting stations, many accessible by telephone, are available at some airports to give pilots current conditions at those locations. What these reports don't reveal are the weather conditions over the next ridge or in the nearby valley, where the weather may be completely different. Some of these weather "reporting holes" can be filled in by using off-airport automated weather stations that are located on ridge summits or in mountain passes.

Another resource to help fill in the weather picture is the weather camera. Most of the weather cameras now operational are in Alaska, but more airports throughout the country are adding weather cameras to their Web sites. See dozens of these cameras in action in Alaska at http://akweathercams.faa.gov.

Even with automated weather facilities and weather cameras, it's still difficult to paint a complete weather picture of current conditions in the mountains. In many areas, pilot reports (pireps) are the only source of weather information. If it's been a while since you've given a pirep, visit the AOPA Online Safety Center (www.aopa.org/safetycenter) and take the free interactive SkySpotter online course to get up to speed.

SkySpotter®

A free interactive online course that teaches pilots about pireps.

VFR or IFR?

Lowland pilots accustomed to flying straight-as-an-arrow routes will likely require an attitude adjustment before tackling the mountains. Especially in the summer, with higher density altitudes, GA aircraft are sometimes unable to fly at the high altitudes required to clear rugged terrain in the mountains, much less meet minimum enroute altitudes (MEAs) for IFR flight. Beyond that, a straight-line route frequently takes pilots over some of the most inhospitable terrain imaginable, making a safe emergency landing questionable and a timely rescue improbable. Experienced mountain pilots much prefer staying VFR and in valleys, where the terrain is not only lower, but more conducive to survival in the event of an emergency landing.

Definition

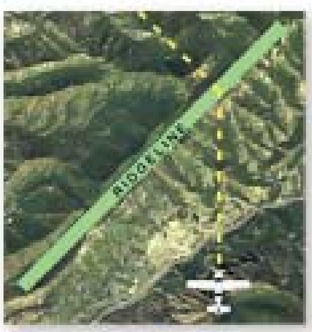
The MEA is the lowest published altitude between radio fixes that assures both navigational signal coverage and obstacle clearance.

If flying in the mountains at night, consider going IFR.

Nighttime in the mountains can be especially unnerving. Most mountainous areas are sparsely populated, and it can get very dark very quickly. Scarcity of lights on the ground, particularly without a full, bright moon, can bring on spatial disorientation. Experienced pilots always treat night flights as instrument flights. VFR-only pilots should seriously consider postponing a night mountain flight until daylight hours, even in good weather.

Flight Planning

Since flying direct to your destination is usually not feasible, preflight planning must include a careful evaluation of routes and altitudes.



Recommended procedure for crossing a ridge.

Around large mountains and ridgelines, it is usually best to plan a flight path that will follow lower terrain around the upwind side of the mountain. Going over the mountain may be feasible if your aircraft has the capability to fly high enough.

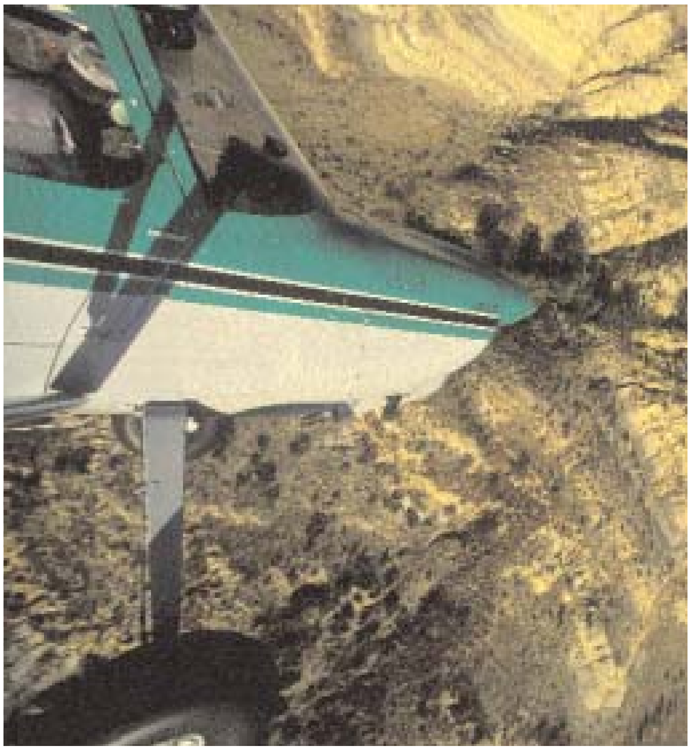
When the winds aloft are 20 knots or greater, it's best to fly at least 1,000 feet higher than the mountain peak you are crossing. Be prepared for updrafts on the upslope side and downdrafts on the downslope side (remember the flowing water). It is also a good practice to cross mountain ridges at a 45-degree angle. Doing so allows you to turn back with less than a 180-degree turn if unexpected turbulence or downdrafts are encountered. Once you've crossed the ridge, turn 90-degrees to the ridge to depart the area of potential turbulence as quickly as possible.

When in flight, you should always ask important questions like: Are the winds aloft what they were forecast to be? Do I have enough fuel to make it to my destination with proper reserves? Basic time/speed/distance calculations will help identify changes that could signal potential hazards. If you have a GPS on board, compare its data on estimated time enroute and course bearing information with your preflight calculations. Has anything changed? If so, what has changed and why? Continuously asking these simple questions can help you predict and take control of potential problems before they become significant.

Pilot comfort is another serious issue on hot summer days. Careful calculations with performance charts will provide pilots a good idea of whether a flight is even possible, but no performance chart can prepare pilots and passengers for the bone-shaking turbulence common on summer afternoons, particularly over the torrid landscape of the desert southwest. Experienced mountain pilots make it a point to fly early in the morning when the temperature is cooler.

Alternatives

What if you can't make it to your destination safely? Are you willing to go to an alternate airport or return to the departure airport? Every time you fly, be *mentally* prepared to divert, especially when flying in the mountains. This is easier said than done, since we often feel pressure to satisfy our passengers or those waiting at the destination. The best way to disarm this hazardous tendency is to talk to the other people who are involved before takeoff. Are they OK with *not* making it to the planned destination? If not, it's time to manage their expectations. Sometimes just talking about it before the flight will give you the ammunition you need to divert without hesitation when the need arises. Remember: if you absolutely have to get there on time, go by car.



Don't forget about emergency planning. Could you make this off-airport landing?

Canyon Flying

Flying in canyons, with steep rock walls on either side, is one of the most thrilling parts of mountain flying. But some canyons can come to an abrupt end, as do the pilots who mistakenly choose to fly in them. Should you accidentally fly into a so-called "blind" canyon, will you be able to perform a course reversal and get out? Remember, true airspeed increases with altitude, and so does your turn radius. This means that it will take more room to make a 180-degree turn at high altitudes than at sea level. In a pinch, if you must make that turn, remember to slow down first to decrease your turn radius. Lowering the flaps or landing gear may help decrease your speed.

In most canyon flying accidents, the pilot did not even realize the terrain was rising faster than the airplane was climbing until it was too late. The result is often a desperate turn that leads to a stall/spin with fatal consequences. Pilots who want to fly canyons should receive specialized instruction from an experienced flight instructor who is familiar with the local area and with canyon flying procedures.

Signal Reception

Radio and radar coverage, something usually taken for granted in flat parts of the country, isn't always available in mountainous areas since VHF radios and radar must have line-of-sight to work properly. Pilots who have become accustomed to being able to open a flight plan, receive ATC flight following, or even tune a VOR virtually anywhere may be surprised when none of these are available. Always remember to take full advantage of preflight weather briefings and information from nearby automated weather stations when able. The lack of ground based navigation signals may make GPS even more enticing.

Mountain flying is one of the most rewarding and challenging adventures a pilot can experience. Before exploring the mountains on your own, be sure to get hands-on flight training with a mountain flying instructor so that you can put the concepts discussed in this Safety Advisor into practice.

Enjoy your flight!

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