Federal Aviation Administration

Topic of the Month
April 2015

Mountain Flying

Presented to: Salem Area Pilots
By: Thomas Gorski CFI
Date: April 4, 2015

2014/12/21-069 (I) PP Original Author, FAASTeam; POC Kevin Clover, AFS-850 Operations Lead, Office 562-888-2020; reviewed by John Steuernagle 12/18/2014 Modified by Thomas Gorski CFI 503.551.1700 FAASTeam presentation, KSLE April 4th, 2015

(Next Slide)

Set the Tone- warm and welcoming. My style is getting you comfortable with asking relevant questions frequently. It is important to address your concerns and your questions. We can learn much from each other. Questions and answers are very important, so frequent Q/A interaction is encouraged.

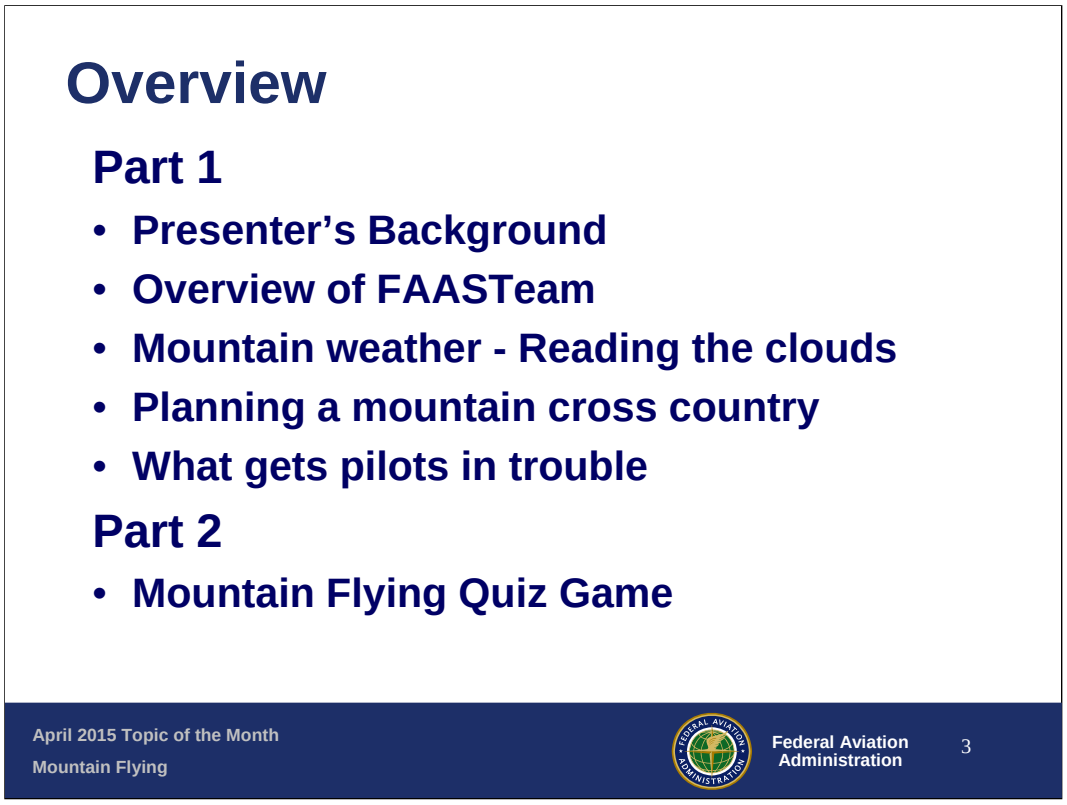
Restrooms, exits, evacuation.

Acknowledge Sponsors.

Seminar / Webinar engineering with priority on Seminar. Webinar is running in the background.

10 Min break.

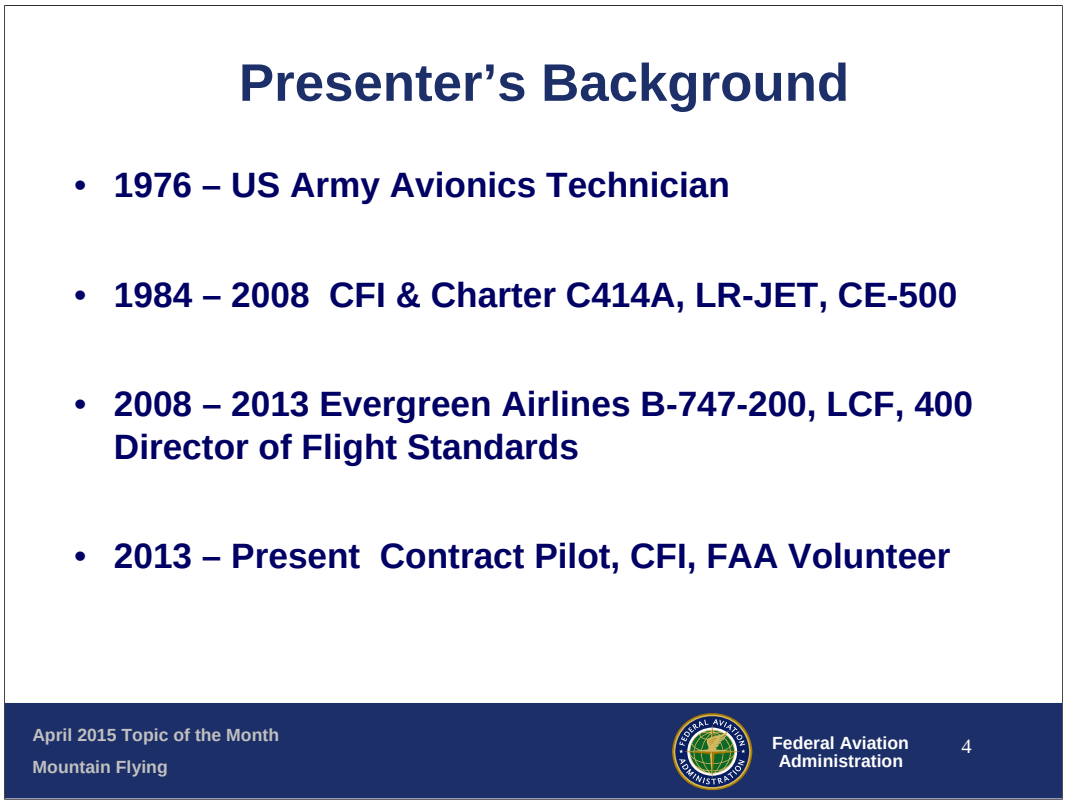
(Next Slide)



During this first part I am going to speak a bit about my background, and give you an overview of the FAASTeam.
Then I want to talk Mountain Flying, and have specific discussions about reading the clouds, planning a mountain cross-country trip, and talk about the kinds of things that gets pilots in trouble.

During the second part we will play an interactive audience response quiz game, where we all participate with the help of a wireless responder system.

Next Slide



Discussion of my background.

1976 – US Army Avionics Technician

1984 – 2008 CFI & Charter

2008 – 2013 Evergreen Airlines - Director of Flight Standards

2013 – Present Contract Pilot, CFI, FAA Volunteer

(Next Slide)

Activities of the FAASTeam are organized and indexed through the Website FAASAFETY.GOV

Faasafety.gov is a portal between the FAA Safety Team and the aviation community.

(Next Slide)

The mission of the FAASTeam is:

Improve the Nation's aviation accident rate

by conveying safety principles and practices

through training, outreach, and education;
while establishing partnerships

and encouraging the continual growth

of a positive safety culture

within the aviation community.

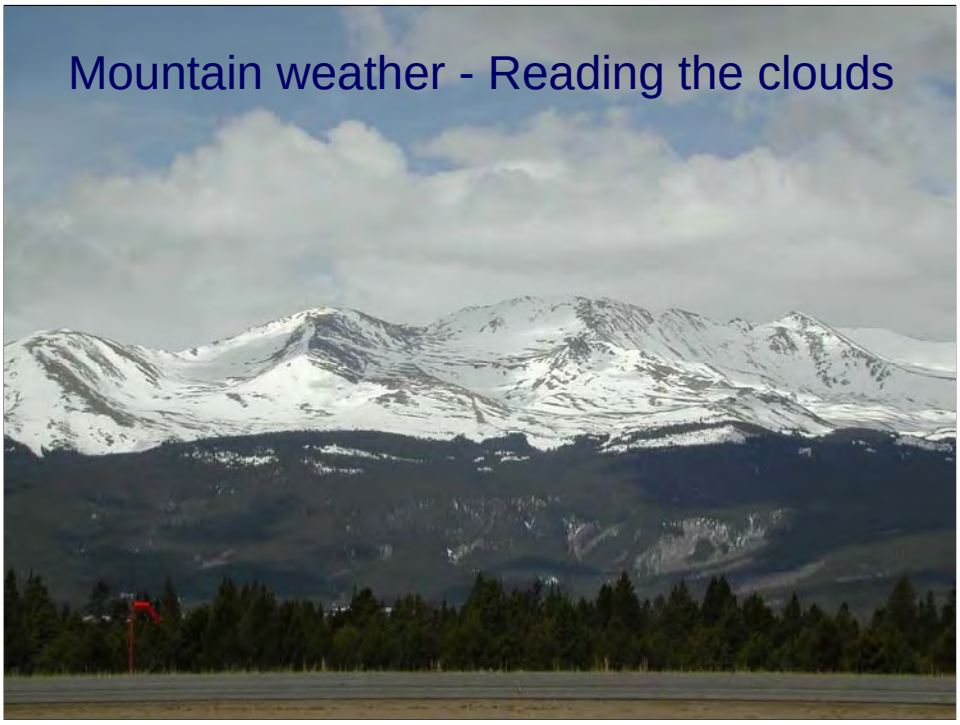
(Next Slide)

A Safety Culture is made up of individuals making a conscious effort to promote aviation safety.
By virtue of their conversations, those individuals share knowledge and experience, and serve to facilitate a shift in the way we think about safety.
I am talking about Pilots who participate in the WINGS Pilot Proficiency Program.

Mechanics who participate in the AMT awards program, and everyone who attends Safety Seminars.

On behalf of the FAA Safety Team I want to thank each and every one of you, for being here today. Thank you!

(Next Slide)

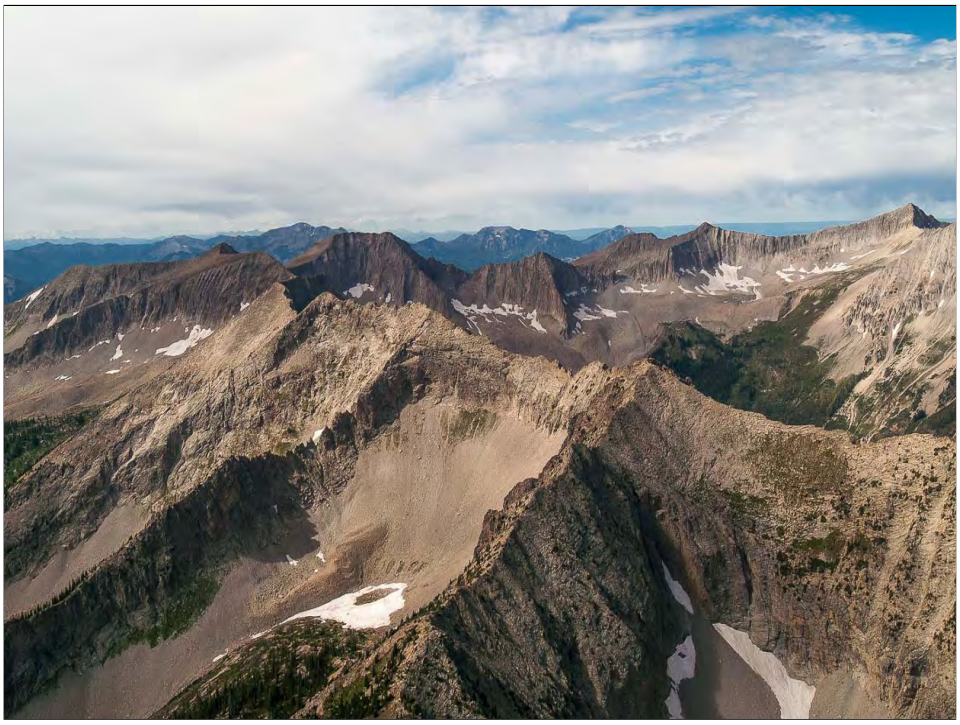


The next series of slides are taken from a briefing given by the Colorado Pilot's Association, where the important aspects about mountain flying are highlighted. The Colorado Pilot's Association briefing does ***not*** represent a complete mountain flying course, but instead it provides a reminder about how important it is to get quality training before going flying in the mountains. I want to express my gratitude to the Colorado Pilot's Association for providing many of the following slides, upon which this presentation is based.

(Next Slide)

Flying in the in the mountains offers beautiful scenery and views you can't get from the ground. It doesn't matter whether it's the Rockies, the Andies, or the Alps, there are scenes that are unforgettable.

(Next Slide)



However, the mountains' beautiful scenery also involves more risks than flying over the flatlands.

In this presentation, we will focus on operating in the Rockies of the western US, but the principles are the same for flying in any mountainous areas.

Every mountainous area is different and familiarity with one doesn't mean you are prepared for some others.

Local training will help you apply what you've learned elsewhere, in a new environment where you will be better prepared to mitigate any unexpected hazards.

(Next Slide)

Some good advice at the Leadville airport…

This picture used to grace the entrance to the FBO at Leadville, Colorado. It tells a story. In many cases in the mountains, especially the Colorado Rockies, pilots are confronted with very high terrain that will press the limits of most GA aircraft. For example, Colorado has 54 peaks over 14,000' and over 600 peaks above 13,000'.

(Next Slide)

It is very important that you get a solid understanding of how the weather interacts with the terrain and how that might affect your ability to fly safely in the mountains.

(Next Slide)

Weather Requirements for Mountain Cross-country

- **Winds aloft forecast, at 9,000 and 12,000 feet is a maximum of 25 knots**
- **Ceiling at least 2,000 feet above all ridges and passes along the route**
- **Visibility of at least 10 miles along the route**

For pilots with little or no experience flying in the mountains, the winds at mountaintop level should be no more than 25 knots. Above that level, the turbulence and up and down drafts could be uncomfortable at best and often dangerous for GA aircraft.

A ceiling of at least 2000' above all ridges on the route will help reduce exposure to hazardous turbulence in most cases. This ceiling should be increased as the wind speed increases.

Good visibility, well above the basic VFR requirements, is needed since you will generally be using pilotage for navigating.
GPS is an excellent tool, but there are times when picking out a particular pass or valley will need to be done visually.

Good visibility is the only way to do that safely.

If any of these requirements are not met, consider looking for a suitable alternate route, delaying the flight, or canceling the flight and driving.

(Next Slide)

Mountain Wave

- **Can occur in any season, but very common in the winter**
- **Stable atmosphere**
- **Wind at least 15 knots within 30 degrees of perpendicular of the barrier (mountain range, etc.)**

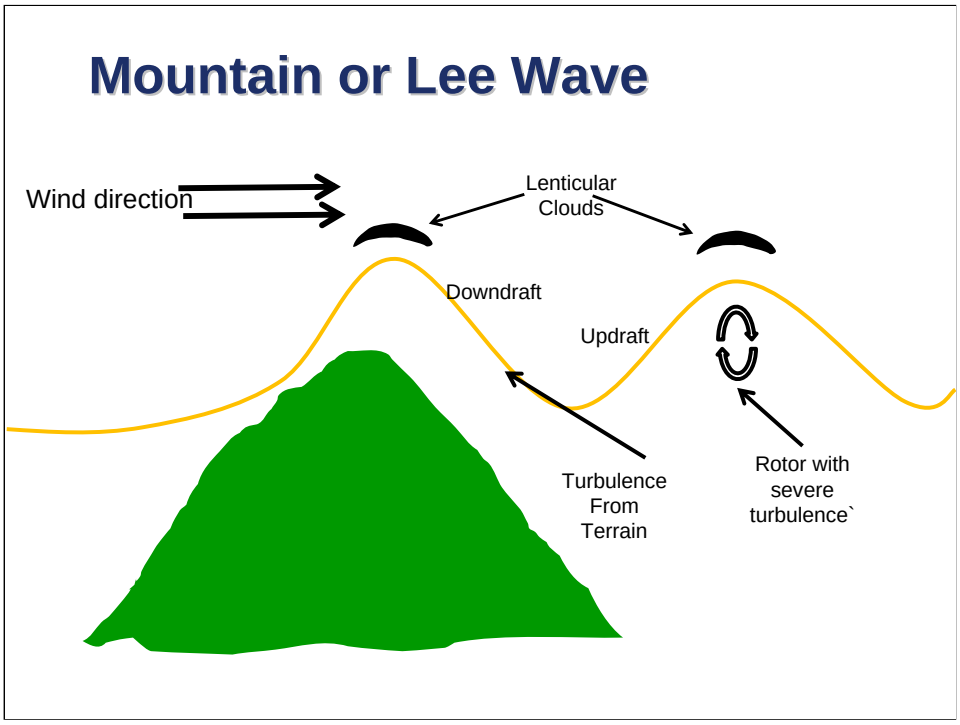
Mountain waves can occur in any season, but very common in the winter. They are associated with a stable atmosphere, and require a moderate wind.

Mountain waves require a wind of at least 15 knots within 30 degrees of the range. Just a 15 knot wind may be sufficient enough to set up a mountain wave!

Waves can cause very strong up and down drafts that will easily exceed the capability of almost any GA aircraft.

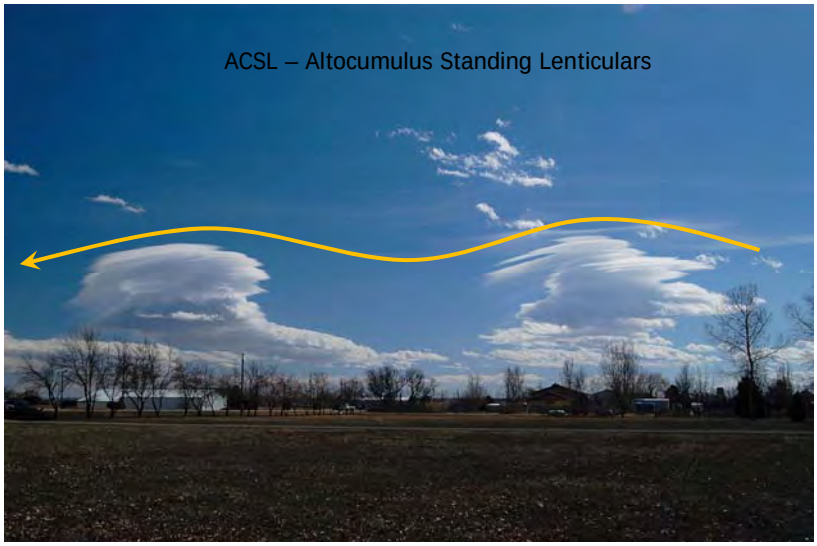
There is also severe or extreme turbulence associated with rotors in mountain waves.

(Next Slide)



During a mountain wave event, there are strong up and down drafts downwind from the ridges. The downdrafts in even moderate mountain waves exceed 1000 feet per minute, making it difficult or impossible to cross the ridge. Rotors are caused by the wind shear and rotating moment underneath the crest of a mountain wave. The rotors will cause severe or greater turbulence and must be avoided.

(Next Slide)



This image was taken looking south from Fort Collins. It shows two crests of a mountain wave.
There are also a few rotor clouds in the picture.
With conditions such as these, you are provided with what you might call signposts in the sky! You should be able to pick out the places where you want to fly and places you want to avoid.

(Next Slide)

What's the Wind Doing?

- **Where are the updrafts and downdrafts?**
  - Updrafts on the windward side of ridges, downdrafts on the leeward side.
  - Picture in your mind what the wind is doing, but leave yourself an out in case you're wrong.
  - When operating parallel with a valley, fly over the updraft side in order to take advantage of any updrafts which may be present.

One of the most important things you can do when learning to fly in the mountains is to learn how to visualize what the wind is doing as it interacts with the terrain. Make an educated guess about where the updrafts and downdrafts are, then leave yourself a good out as you test your theory. When operating parallel with a valley, it is usually best to fly over the updraft side in order to take advantage of any updrafts which may be present

(Next Slide)

Failure to take density altitude into consideration has led many pilots into situations their aircraft couldn't handle. This image was taken at Centennial Airport at 5885 MSL, just before sunset one summer evening. You can see that, even in the early evening, the density altitude is quite high and can present problems if you are not properly prepared.

A Rule of Thumb – 85º on a Colorado Front Range airport

gives DA approximately 8500

(Next Slide)

Effects of Density Altitude on Aircraft Performance

Standard temperatures at different altitudes

Sea Level	5,000’	10,000’
59° F (15° C)	41° F (5° C)	23° F (-5° C)

The elevation at Leadville is 9,927 feet. At 63° F, (40° higher than standard) the density altitude would be 12,500’.

Assuming a standard altimeter setting, anything above standard temperature at your elevation means your density altitude is above the field elevation.

When the snow is melting at Leadville, the density altitude is already above the field elevation.

(Next Slide)

Effects of High Altitudes on Aircraft Performance

- **Normally-aspirated engines develop approximately 3% less power for each thousand feet above sea level.**
- **At Leadville (9,927 feet) *on a Standard Day (23° F)*, a normally-aspirated engine can develop only 70% of its rated horsepower.**

  Think of this as taking off at a cruise power setting!

In order to attain the normal indicated airspeed required for rotation at Leadville, the airplane's true airspeed will be 20% greater than at sea level. A normally aspirated engine, is putting out 30% less horsepower than at sea level, and you have two factors working against you.

The airplane will be going faster over the ground than what you are used to. You may have a tendency to rotate early, trying to make the aircraft fly before it is ready.

Many pilots have said about an airstrip, "If I can get the airplane into there, I can get it out!" In high density altitudes, that will often not be the case.

(Next Slide)

Leaning for High Density Altitudes

- **Why lean?**
  - To ensure maximum power output from the engine at higher elevations.
  - To reduce sparkplug fouling during idle and taxi operations at *any* airport.
- **When to lean?**
  - When taxiing.
  - Anytime the engine is operating above approximately 3,500 feet MSL.

Why lean? At sea level or the low levels of the Midwest, takeoffs with full rich mixture are required. However, at higher density altitudes, even those found at airports along the Front Range of the Rockies from New Mexico to Wyoming, leaning for takeoff is the only way to get the expected performance from a normally aspirated engine.

Lean to ensure maximum power output from the engine at higher elevations. Lean to reduce sparkplug fouling during idle and taxi operations at *any* airport.

Lean when taxiing, and anytime the engine is operating above approximately 3,500 feet MSL.

(Next Slide)

Effects of Higher Altitude on Aircraft Performance

- **TAS is approximately 2% higher than IAS for every thousand feet of altitude**
- **Turn radius proportional to square of TAS**
  - Greater at high altitude for any given IAS and bank angle because TAS is greater
- **Takeoff and landing distances are significantly increased**
  - ✈ Reducing an aircraft's weight to no more than *90% of the maximum gross weight*, will significantly increase its performance and flight safety

An indicated airspeed of 80 knots would be approximately 96 knots true airspeed at 10,000 feet above sea level.

For a given bank angle, a greater speed results in a greater turn radius. So even though you may be flying at 80 knots indicated, you true airspeed is 96 knots and your turn radius for the same bank angle is significantly greater.

The higher true airspeed translates into a longer landing roll as the aircraft touchdown has 20% more speed than it would at sea level. The effect is similar to landing with a tailwind!

This higher than normal speed also causes a visual illusion during landing. As you get close to touchdown, the ground appears to be rushing by faster than what you are accustomed to at lower elevation. You must override your intuition and fly the airplane based on its indicated airspeed.

Reducing an aircraft's weight to no more than *90% of the maximum gross weight*, will significantly increase its performance and flight safety

(Next Slide)

Takeoff calculations

- **Density altitude**
  - Fixed pitch add 15% per 1000 feet DA to 8000 ft.
  - Constant speed add 12% per 1000 feet DA to 6000 ft.
- **50/70 Rule – no obstruction**
  - 60 x .7 = 42
- **30/70 Rule - obstruction**

Here are some rules of thumb when making takeoff calculations.

If you have a fixed pitch prop, for each 1000 foot increase in density altitude up to 8000 feet add 15% to your calculated takeoff distance.

For constant speed props add 12% per 1000 feet of density altitude up to 6000 feet.

When planning takeoff from short unobstructed runways establish a landmark at 50% of your calculated takeoff distance.

When on the take off roll you should have 70% of your rotation speed at that point. If you don't – the safest thing is to abort the takeoff and reduce weight or wait for more favorable wind and temperature conditions. In this example we're assuming a rotation speed of 60 knots or MPH. 70% of 60 is 42. The number you'll want to see at the halfway point

If you must clear obstructions on takeoff you'll need to have 70% of your rotation speed by the time you've travelled 30% of your available takeoff distance.

(Next Slide)

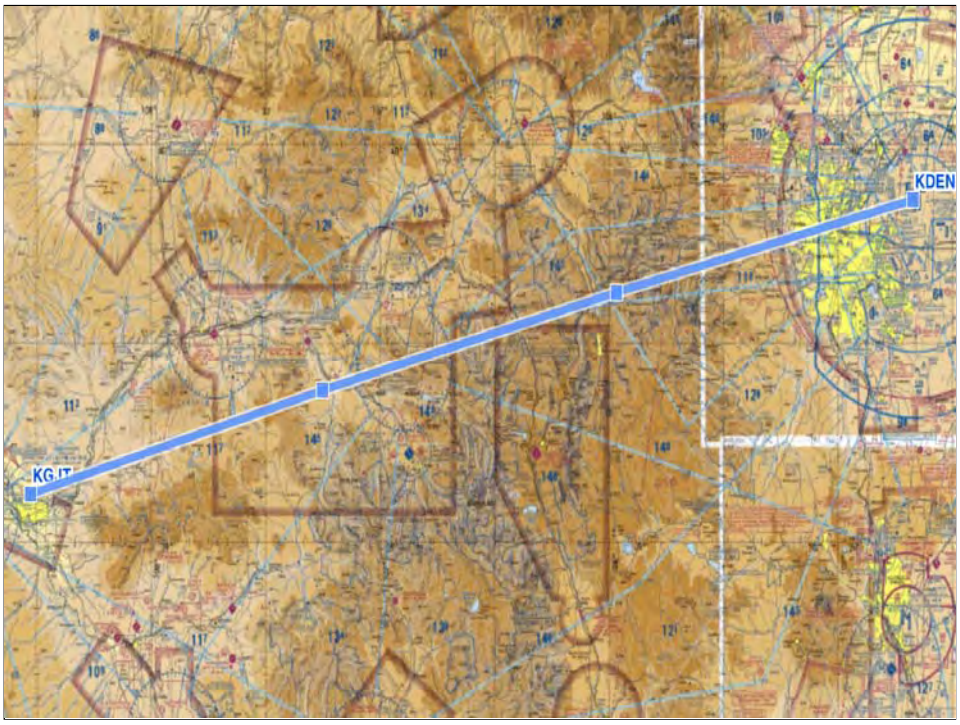
(Next Slide)

Planning the Route

- **Mountain flight planning involves points in space, not predefined intersections, etc.**
- **GPS direct usually isn't a good idea.**
  - DEN direct GJT is over the highest mountains in Colorado
- **Plan the route over passes, along drainages, etc.**
- **Use user defined waypoints for common waypoints, such as passes.**

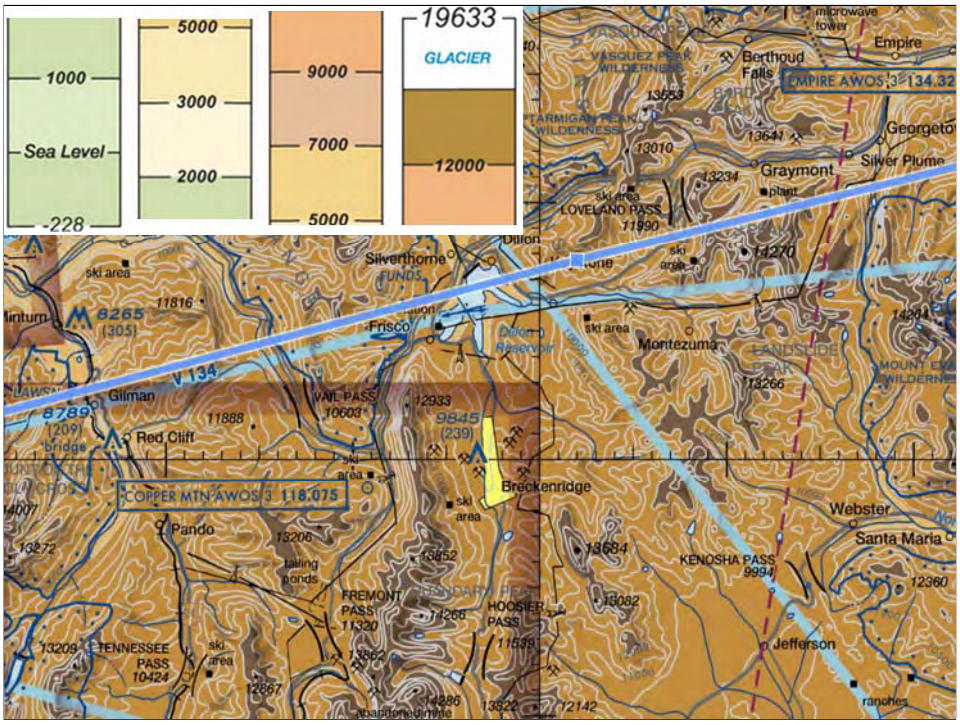
Planning a mountain flight involves finding points in space, not predefined intersections. Look for terrain features, such as passes and drainages. Use your GPS in conjunction with a mapping application on your tablet device to establish waypoints. Mapping your own way through high terrain is a good way to maintain situational awareness and avoid getting lost in unfamiliar terrain. An example why DEN direct GJT is not always the best idea: Because that route takes you over some of the highest mountains in Colorado.

(Next Slide)



Here is the route showing a direct route between DEN and GJT.

(Next Slide)



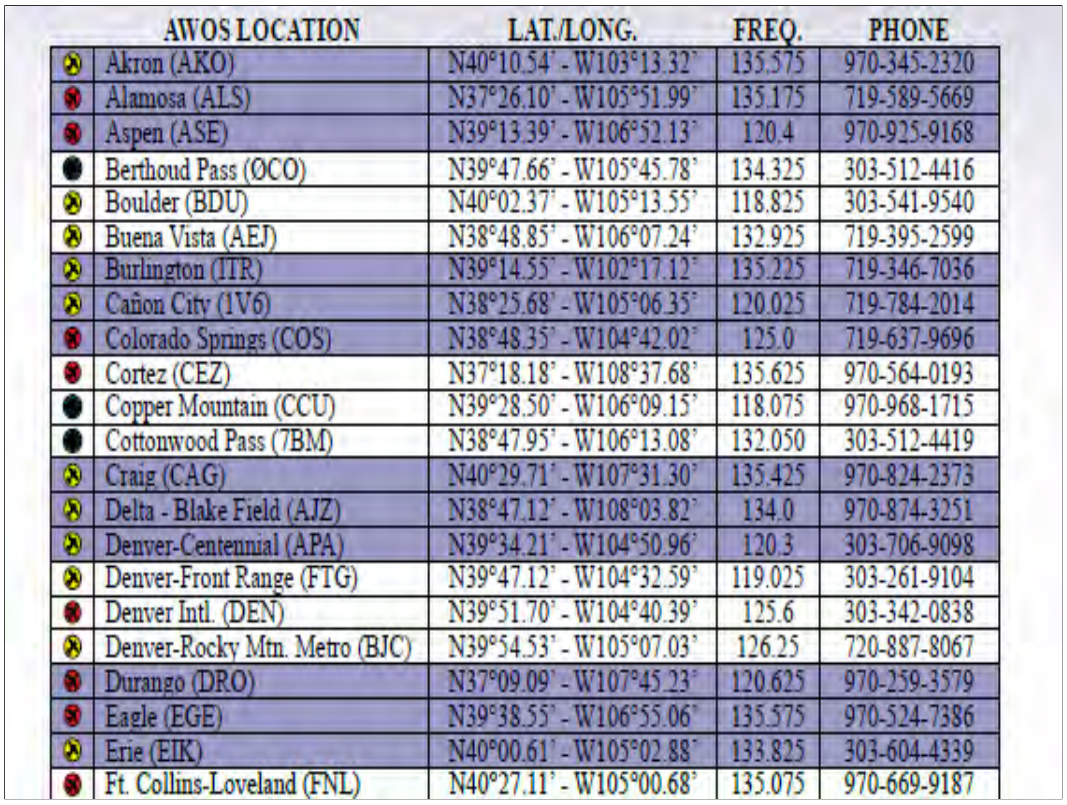
Here is a close-up of the same route. **(Click)** Terrain elevation is shown with specific colors on the sectional chart.

(Next Slide)

Weather Planning Tools

Some states produce tools to help pilots navigate their mountains safely. **(Click)** This example is produced by the Colorado Aeronautical Division and shows all of the AWOS locations in the state, including those on mountain ridges.

(Next Slide)

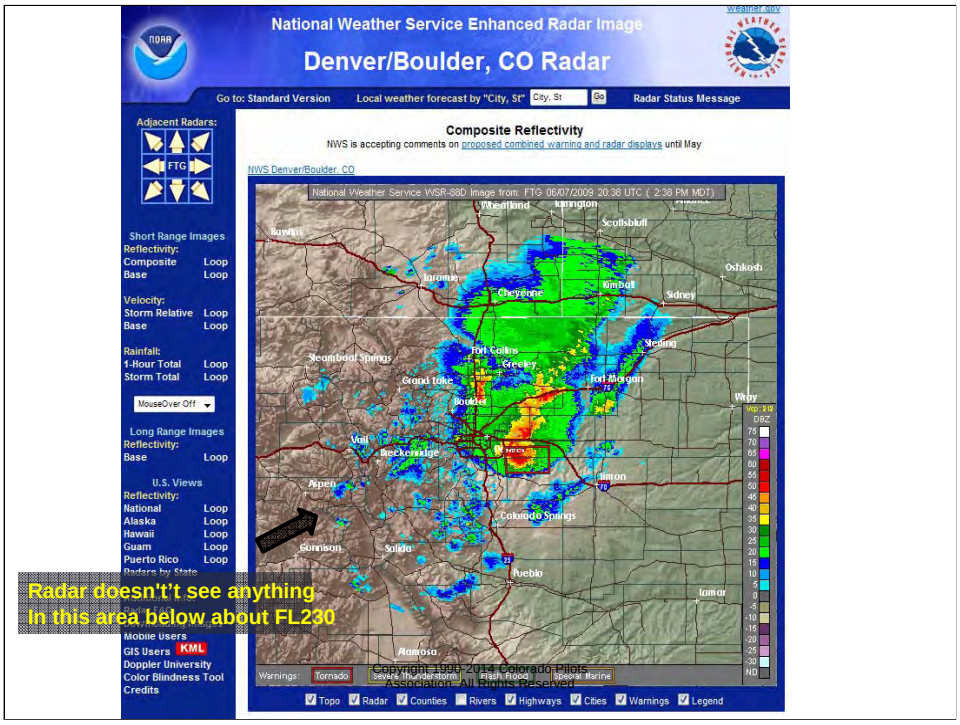


AWOS LOCATION	LAT./LONG.	FREQ.	PHONE
Akron (AKO)	N40°10.54' - W103°13.32'	135.575	970-345-2320
Alamosa (ALS)	N37°26.10' - W105°51.99'	135.175	719-589-5669
Aspen (ASE)	N39°13.39' - W106°52.13'	120.4	970-925-9168
Berthoud Pass (ØCO)	N39°47.66' - W105°45.78'	134.325	303-512-4416
Boulder (BDU)	N40°02.37' - W105°13.55'	118.825	303-541-9540
Buena Vista (AEJ)	N38°48.85' - W106°07.24'	132.925	719-395-2599
Burlington (ITR)	N39°14.55' - W102°17.12'	135.225	719-346-7036
Cañon City (1V6)	N38°25.68' - W105°06.35'	120.025	719-784-2014
Colorado Springs (COS)	N38°48.35' - W104°42.02'	125.0	719-637-9696
Cortez (CEZ)	N37°18.18' - W108°37.68'	135.625	970-564-0193
Copper Mountain (CCU)	N39°28.50' - W106°09.15'	118.075	970-968-1715
Cottonwood Pass (7BM)	N38°47.95' - W106°13.08'	132.050	303-512-4419
Craig (CAG)	N40°29.71' - W107°31.30'	135.425	970-824-2373
Delta - Blake Field (AJZ)	N38°47.12' - W108°03.82'	134.0	970-874-3251
Denver-Centennial (APA)	N39°34.21' - W104°50.96'	120.3	303-706-9098
Denver-Front Range (FTG)	N39°47.12' - W104°32.59'	119.025	303-261-9104
Denver Intl. (DEN)	N39°51.70' - W104°40.39'	125.6	303-342-0838
Denver-Rocky Mtn. Metro (BJC)	N39°54.53' - W105°07.03'	126.25	720-887-8067
Durango (DRO)	N37°09.09' - W107°45.23'	120.625	970-259-3579
Eagle (EGE)	N39°38.55' - W106°55.06'	135.575	970-524-7386
Erie (EIK)	N40°00.61' - W105°02.88'	133.825	303-604-4339
Ft. Collins-Loveland (FNL)	N40°27.11' - W105°00.68'	135.075	970-669-9187

The page has the frequency and phone numbers of each of the AWOS locations so you can call directly while planning your flight and get real time updates before you launch.

You can view the current version at colorado-aeronautics.org

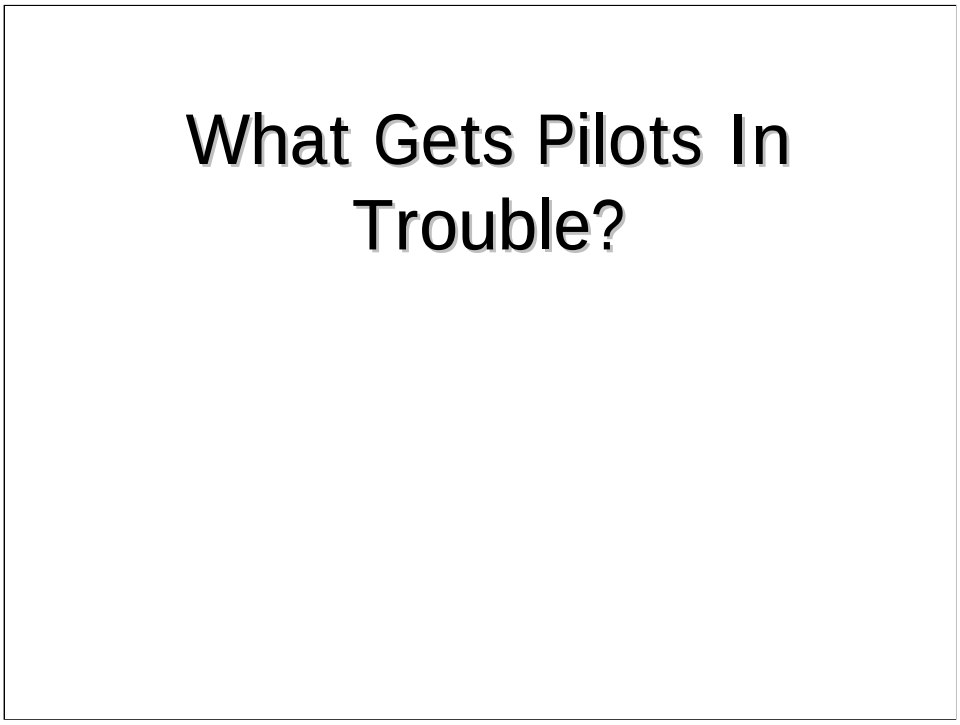
(Next Slide)



Many of us are now using radar on our tablet device while in flight. However, radar and mountains don't mix very well. For example, the Denver NEXRAD system can't see anything below about FL230 over the central part of the state. You may not be seeing the complete picture because of these limitations.

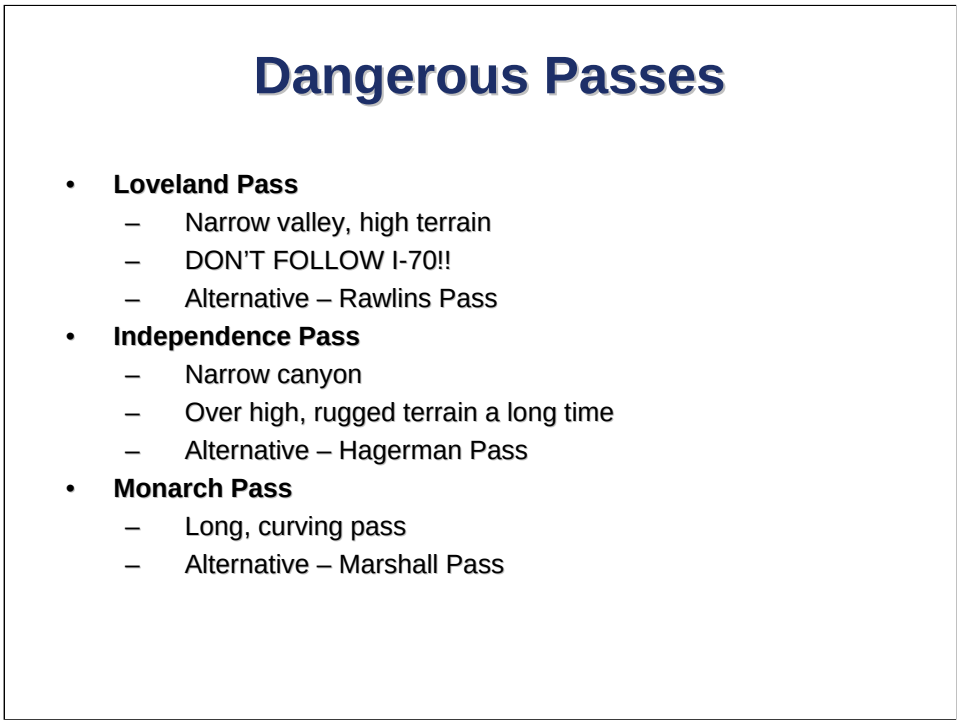
This image is from noaa.gov

(Next Slide)



What Gets Pilots In Trouble?

Next Slide)



Picking the wrong route has claimed many pilots who didn't have local knowledge of issues that might be associated with some passes. For example, in Colorado, three passes: Loveland, Independence and Monarch - have historically more aircraft accidents than any other passes in the state. Under the right conditions, you could, of course, use these passes, but most local instructors will recommend avoiding them in favor of nearby alternates.

(Next Slide)

Before descending into a mountain airport, look at what your options are for go-arounds and takeoff routes. On this approach to the Glenwood Springs airport, if you had not surveyed the area before descending, you might get here on final and wonder it that really is a box canyon ahead.

(Next Slide)

Box Canyon

A canyon with steep sides and possibly a zigzag course, that is closed upstream.

A box canyon is a canyon with steep sides and possibly a zigzag course, that is closed upstream. Never fly up a canyon that you haven't already flown down so you know if there is room to turn around. **(Click)** NEVER try to out climb the terrain in ANY airplane.

(Next Slide)

Flying up a Valley or Canyon

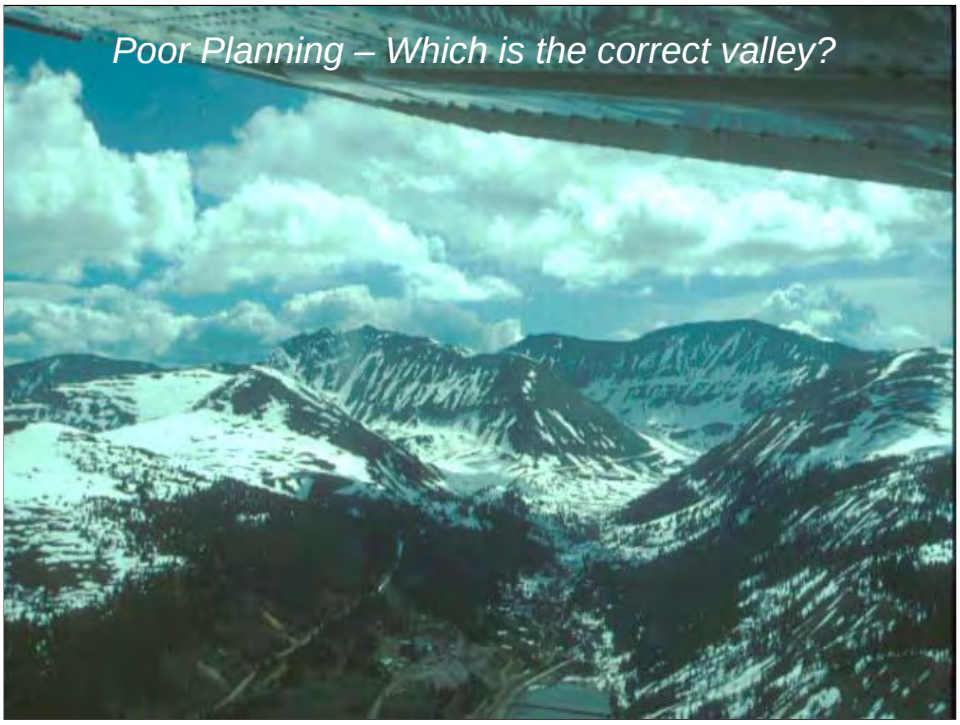
- **Before entering a valley or canyon, have sufficient altitude to safely clear the highest terrain.**
- **Don’t try to out climb the terrain.**
- **This is a major cause of fatal accidents in the mountains.**

Many pilots have lost the bet that their airplane can out-climb terrain that leads to a box canyon. Careful route planning will help avoid this.
Before entering a valley or canyon, have sufficient altitude to safely clear the highest terrain to be encountered, a pass or ridge.

Don’t try to out climb the terrain.

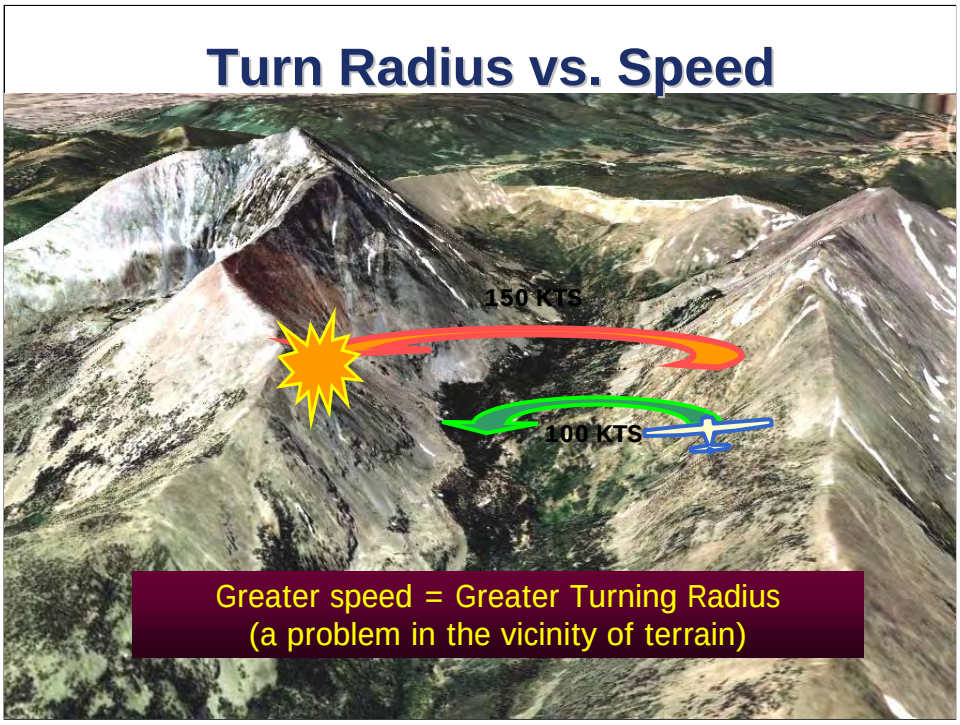
Trying to out climb terrain is a major cause of fatal accidents in the mountains

(Next Slide)



Doing adequate preflight planning will give you the correct heading to expect when picking the right valley to fly through. Making the wrong choice could get you into a position from which you can't escape. In this case, there are at least four valleys you might take, but only one is correct. The other three quickly become box canyons with rapidly rising terrain that you wouldn't be able to out-climb or turn around in.

(Next Slide)

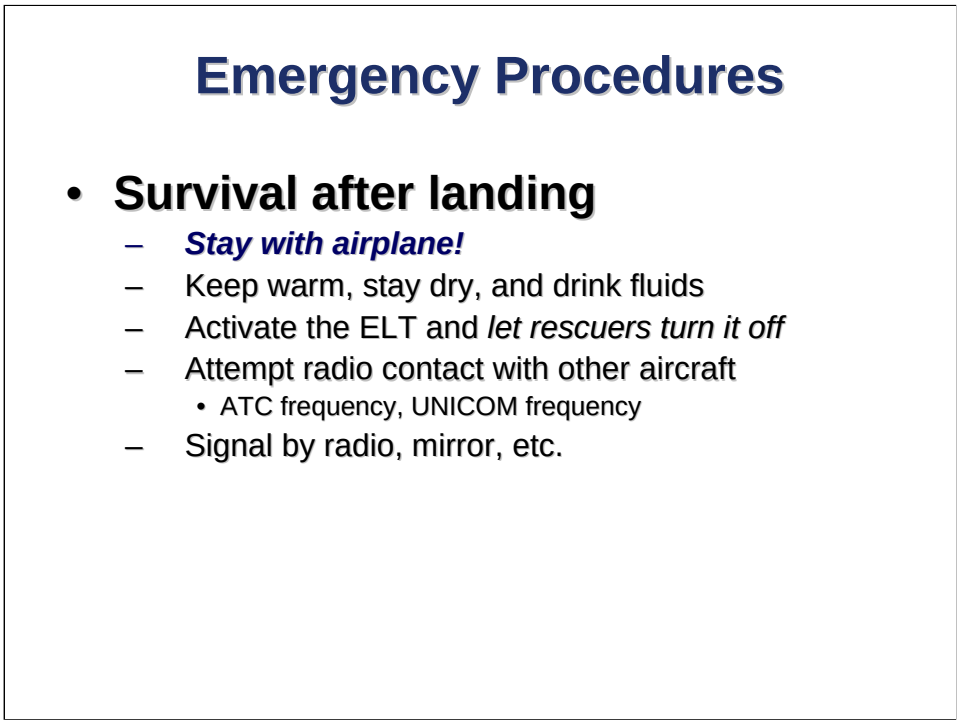


PLANNING YOUR ESCAPE: Always leave plenty of room for turns in canyons.

- Do NOT enter a canyon which will not allow a 180 degree turn plus a descent.

- Remember that turn radius increases as the square of true airspeed. It will be dramatically wider with even small increases in TAS.

(Next Slide)



It is extremely important to stay with the airplane after an accident. Individual people are very difficult to see from a search airplane. If you survived the crash, that means that the cabin is probably intact enough to be used as a shelter until you are rescued.

After the crash, remove the ELT from the aircraft, turn it on, and ***let your rescuers turn it off***.

(Next Slide)

What Kind of ELT?

- **406 Mhz ELTs**
  - Becoming much more affordable
  - Provide the satellites a much more precise location
- **Personal Locator Beacons (PLBs) are good backups**
- **SPOT, Spidertracks, etc. have signaling features and leave breadcrumb tracks**
- **Satellite phones, especially in places like Alaska**

Satellites no longer monitor 121.5 Mhz, so you have to depend on some ground station or other aircraft to hear it. 406 Mhz is monitored now and the higher frequency gives a much more precise location for searchers. Some units also have the ability to transmit your GPS coordinates.

PLBs can be good backups and can be carried in your pocket in case the aircraft's ELT is damaged in the crash.

SPOT, Spidertracks, and other similar locators also have a way to signal that you need help.

They also transmit your position back to a monitoring facility, so searchers can narrow down the search area and find you much quicker.

Satellite phones work anywhere you have a clear line of sight with the sky.

(Next Slide)

Questions?

Portland FSDO
3180 NW 229th Avenue
Hillsboro, Oregon 97124

Phone: (503) 615-3200 or
(800) 847-3806 Fax: (503) 615-3300

Office Hours: 7:30 a.m. to 4:00 p.m.,
Monday - Friday

Office visits appointments only
recommended

Tom Gorski
503.551.1700