Avalanche Safety Guidelines

This guideline is intended as a general introduction to this topic.

Introduction

Worldwide, avalanches kill more than 150 people annually and thousands more are partly buried or injured. Although highway motorists and others can be involved in an avalanche, climbers, backcountry skiers, and snowmobilers are by far the most likely to be involved in one. All that is necessary for an avalanche is an accumulation of snow and a slope for it to slide down. Slab avalanches, where layers of a snow pack fail and slide down the slope, are the most common and most deadly. There are two types of slab avalanches, hard slab, where large blocks of snow and debris slide down a slope and soft slab, where the snow breaks up in smaller blocks as it falls.

Avalanches can occur on almost any slope given the right conditions. In the United States certain times of the year and certain locations are naturally more dangerous than others. Most avalanches will occur between December and April, however, avalanche fatalities have been recorded for every month of the year, with the highest number of fatalities occurring in January, February and March (generally the months of highest snowfall in most mountain areas). Western states account for the majority of fatalities. A significant number of deaths occur in May and June, due to the hidden danger spring snows and the melting season poses for outdoor recreationists. During the summer months, it is often climbers who are caught in avalanches.

Anatomy of an avalanche

An avalanche has three main parts.

- **Starting zone**--The most volatile area of a slope where unstable snow can fracture from the surrounding snow cover and begin to slide. Typical starting zones are higher up on slopes, including the areas beneath cornices and in "bowls" on mountainsides. However, given the right conditions, snow can fracture at almost any point on the slope.

- **Avalanche track--**The path or channel an avalanche follows as it goes downhill. When crossing terrain, be aware of any slopes that look like avalanche "chutes." Large vertical swaths of trees missing from a slope or chute-like clearings are often signs that large avalanches occur there. There may also be a large pile-up of snow and debris at the bottom of the slope, indicating previous avalanches.

- **Run out zone--**Where the snow and debris finally come to a stop, this is also the deposition zone, where the snow and debris pile the highest. Although underlying terrain variations, such as gullies or small boulders, can create conditions that will bury a person further up the slope during an avalanche, the deposition zone is where a victim will most likely be buried.

What conditions cause an avalanche?

Factors affecting the likelihood of an avalanche include weather, temperature, slope steepness, slope orientation, wind direction, terrain, vegetation or other natural anchors, snow pack history and general snow pack conditions. Different combinations of these factors can create low, moderate or extreme avalanche conditions. Some of these conditions, such as temperature and snow pack can change on a daily or even hourly basis, which necessitates constant vigilance of the immediate surroundings during wintertime backcountry travel. This means evaluating the snow pack and its potential to slide is not an event but an ongoing process of answering questions and observing past and current conditions. You must also be aware of the history of the snow pack formation and the present conditions. The time to start a running knowledge of the snow pack is at the beginning of the snowfall season as it is temperature changes and trends that affect the stability of the snow pack.

The following is a brief synopsis of the conditions to consider. More detailed information can be found on the EH&S external links page at http://www.dri.edu/ehs-links#avalanche.

Weather - Avalanches are most likely to happen during or immediately after a storm of significant snowfall. (One inch per hour or more should raise a red flag, with the twenty four hours following a heavy snowstorm as the most critical period). Temperature, wind, and snowfall amount during storms can contribute to avalanche conditions.

Snowfall - Recent snowfall puts extra stress on the existing snow pack, especially if it does not adequately bond to the pre-existing surface layer. The extra weight of new snow alone can cause a slab to break. Snowfall amounts of one foot or more (frequent in mountainous areas) create the most hazardous situations. Six to twelve inches pose some threat, particularly to skiers and backcountry recreationists, while amounts of less than six inches seldom produce avalanches unless there has been some wind loading. The underlying layers can also fail, creating an even bigger threat.

Temperature - Snow is a good insulator, so brief changes in temperature do not have as much of an effect on snow pack as larger or longer changes do. Temperature increases that last several hours or days may lead to melting within the snow pack, which can seriously weaken some of the upper layers of snow, creating increased avalanche potential. When temperatures rise above freezing during the daytime and drop back down again at night (common in the spring) the melting and re-freezing can actually stabilize the snow pack. However, when temperatures stay below freezing, especially below zero degrees Fahrenheit, the snow pack may remain relatively unstable. (Note: if a storm comes in warm and then cools as it passes through, that condition will help bong the new snow to the exiting layer.)

Wind direction - Wind usually blows up one side (the windward side) and down the other (the leeward side) of a mountain. This can result in scouring of snow off the surface of the windward side and deposition on the leeward side, making the leeward side more prone to avalanche. A cornice or icy overhang at the top of a mountain or ridge is a telltale sign of wind scouring. Generally speaking it is safer to travel on the windward side of such a slope, where the snow layer is thinner and wind-packed.

Snow Pack Conditions – How the snow pack develops over a season is critical to understanding the potential for failure because each layer of snow falls under different weather conditions, resulting in a difference in bonding between the layers. If it rains between snows, percolation of water through the snow pack can stop at an ice layer and then

travel down the slope, creating a slick surface that can develop into weaker bonds between snow layers. A deposition of **depth hoar** (course, grainy snow crystal) creates a very weak layer and is often the cause for avalanche.

Slope Angle - Avalanches can occur on almost any slope angle under the right conditions, but are most common on slopes between 30 and 45 degrees.

Slope Orientation – Avalanches can occur on slopes facing any direction, but most in the Northern Hemisphere run on slopes facing north[1], east, and northeast.

Terrain – It is important to pay attention and to be aware of the terrain and any changes in it. Keep an eye out for obvious avalanche zones and do not forget key terrain features which may indicate a greater potential for avalanche conditions, such as bowls and gullies, which can fill with deep snow quickly; terrain traps (smaller depressions or shallow gullies), which can serve as accumulation points for snow and debris trapping a victim during a run; and avalanche chutes, where avalanches occur more frequently; and any evidence of previous slides.

Vegetation – Generally speaking on snow-covered slopes a heavily forested area is safer than open space. However it is not safe to assume the presence of any vegetation will be protective. Lone trees, bushes, or large rocks on a mountainside can weaken the stability of the snow pack and can serve as a catch point for debris causing excessive snow pile-up. These objects can serve as an obstacle for anyone caught in an avalanche and may cause blunt force trauma.

Many avalanches start above the tree line, making high-elevation work especially risky. If an avalanche starts above the tree line, it can cut a path through the trees below. A swath of missing trees indicates a possible avalanche prone area. If you can make observations during the summer and there are obvious run out paths or recovery type vegetation present (aspens are a good indicator of this), these areas should be avoided during winter operations.

During the spring smooth surfaces, such as rock faces and grassy slopes may cause avalanches. Low lying vegetation beneath the snow is relatively ineffective at anchoring the upper layers of the snow pack.

Evaluating Avalanche Potential

The process of evaluating avalanche potential begins with knowledge of the conditions above followed with the question "When are the conditions sufficient to cause a mass of snow to slide down a slope?"

Begin with Gathering Data (answer with a YES, MAYBE or NO)

Terrain

- Can the terrain produce avalanches?
- Is the slope steeper than 25-30 degrees?
- Are there any visible signs of recent releases?

[1] Remember that in the Southern Hemisphere it's just the opposite because south facing slopes are colder than north facing ones.

- Are there run out areas on your route?
- Is there an absence of natural anchors?

Snow pack

- Is the snow pack unstable?
- Are there any recognizable patterns of instability related to elevation or aspect?
- Is there a weak bonding layer?
- Has an avalanche warning been issued recently?
- Is there a force (natural or man made) available to cause a release to happen?

Every time you have answered YES to the Terrain and Snow Pack questions you need to look at the Weather and Involvement to help you take the subjectivity out of your decision to go into the backcountry.

Weather

- How has or is the weather affecting snow stability in the area?
- What kind of loading has taken place and at what rate?
- What may trigger a slide (Weight, cornice breaks, solar warming, wind loading, recent storm, etc)?
- Typical Weather Patterns to watch for
  1 Heavy snow accumulation in a short period (1" of more per hour).
  2 High winds.
  3 Heavy rain.
  4 Long, cold, clear, calm period followed by heavy precip and/or wind loading.
  5 Storms that start out cold and end up warm.
  6 Temperature rise to near or above freezing after a long period of cold weather.
  7 Intense solar radiation, particularly with a thin layer of clouds above.

Human involvement

- Is the route safe?
- Does a safer alternate route exist?
- Should you wait for the snow pack to stabilize?
- With only one immediate rescuer available, is it worth the risk?
- What is the experience level of the rescue team?

Two YES' are always a NO GO. Any combination of YES and MAYBE requires you to evaluate whether it is due to uncertainty or to the fact that conditions are changing for the worst. If you are uncertain, gather more data to change a YES or MAYBE to a NO. If the conditions are changing, monitor the rate of change, be conservative and leave a margin of error.

Constantly evaluate the situation. Quick checks you can make throughout the day include:

- What have the weather conditions been over the past few days? Recent heavy snows?
- Can you observe any wind loading on the slopes?
- Do you have a good sense of the snow pack? Have you performed any snow pit or shear tests?
- Have you noticed many fracture lines, heard "whumping" or cracking sounds, or hollow noises in the snow pack?
- Are you keeping an eye on the orientation and steepness of the slopes as you cross them?

- Are you traveling across gullies, bowls, or valleys? (These can be deposition zones, which can lure you into a false sense of safety.)
- On your trip did you notice any recent avalanche activity on other slopes similar to the one you are on?
- If a slope looks suspect, are there alternative routes?

Extra precautions to take:

- If there is no alternative to crossing a suspect slope, do so one person at a time to minimize risk.
- When descending or ascending a slope, try to stay as far to the sides of a potential avalanche chute as possible to decrease your chances of being caught if an avalanche happens.
- Be aware of the condition of those in your party. If someone is tired, hungry, or cold they may not be using their best judgment. A team member in this condition is considered to be the weakest link and the whole team must go at their pace.
- Remain constantly aware of changing weather or temperature conditions, particularly if your outing will last more than a few hours.
- Require the basic avalanche rescue equipment, such as beacons, ski-pole probes, and collapsible shovels, as a necessary part of your backcountry gear.

Equipment to Carry:

- **Portable shovels** made of aluminum[2] are lightweight and compact enough that they can be carried in a pack. They can significantly decrease the time to dig out a person.
- **Collapsible probes or ski-pole probes** are easy to carry along and are essential to finding a buried victim when there are no visible clues on the surface.
- **Avalanche beacons (transceivers)** are the most commonly used rescue device and when properly used, except for a trained canine, will provide the fastest way of locating a victim. It is critical to have the transceiver set to "transmit" during your outing. Remember that more than one transceiver unit is required on every outing so the victim can transmit to a unit in receiving mode. Make sure everyone in the party is carrying their own transceiver and knows how to use it. You should check this when doing your pre-trip check.

Travel Smart:

- Before leaving for the backcountry, review available information about avalanche potential in the area of work. This information is updated frequently during the winter months and can be found on a number of Internet sites[3].
- Prepare for the worst. Minimize your exposure to suspect areas. Think of the consequences of your actions. Is it worth it?
- Check your survival gear. Know where your safety equipment is and how to use it.
- Do a pre-trip check right before hitting the trail to verify the range and proper modes of your avalanche beacons. The range check will give you the information needed to do a properly spaced hasty search.
- Use the terrain to your advantage and always have an escape route in mind.

[2] Note: Plastic shovels do not hold up to extreme conditions that will be encountered after an avalanche has stopped and hardened.
[3] Some examples are available at http://www.dri.edu/ehs-links#avalanche.

- When crossing a suspect slope,
  - fasten all your clothing securely to keep out snow;
  - loosen your pack so that you can slip out of it with ease and remove your ski pole straps and any ski retention devices;
  - make sure that your avalanche beacon is on and switched to "transmit";
  - cross one at a time within view of your team members and proceed to a “safe” area;
  - then keep an eye on the next team member until s/he has reached a safe area. Continue until all members of the team have reached safety.

If you are caught in a slide:

- Initially yell, ditch any equipment possible and get away any large equipment, such as snowmobiles, ATV, samplers, etc.
- Grab any anchor you can to stop
- Try to swim to the surface and side of the slide.
- Before the snow stops moving, make an air pocket with your hands and thrust an arm up towards the surface before the snow stops moving.
- One of the most critical things, if at all possible, is to take a deep breath[4] to expand the chest and hold it. This will help create some extra space between you and the surrounding snow, so you will have an easier time breathing once the snow sets.
- Try not to not panic. Remain calm to preserve air space and conserve energy.
- Refrain from yelling unless you hear rescuers nearby as the snow will muffle your calls and the energy expelled will rapidly use up the airspace.

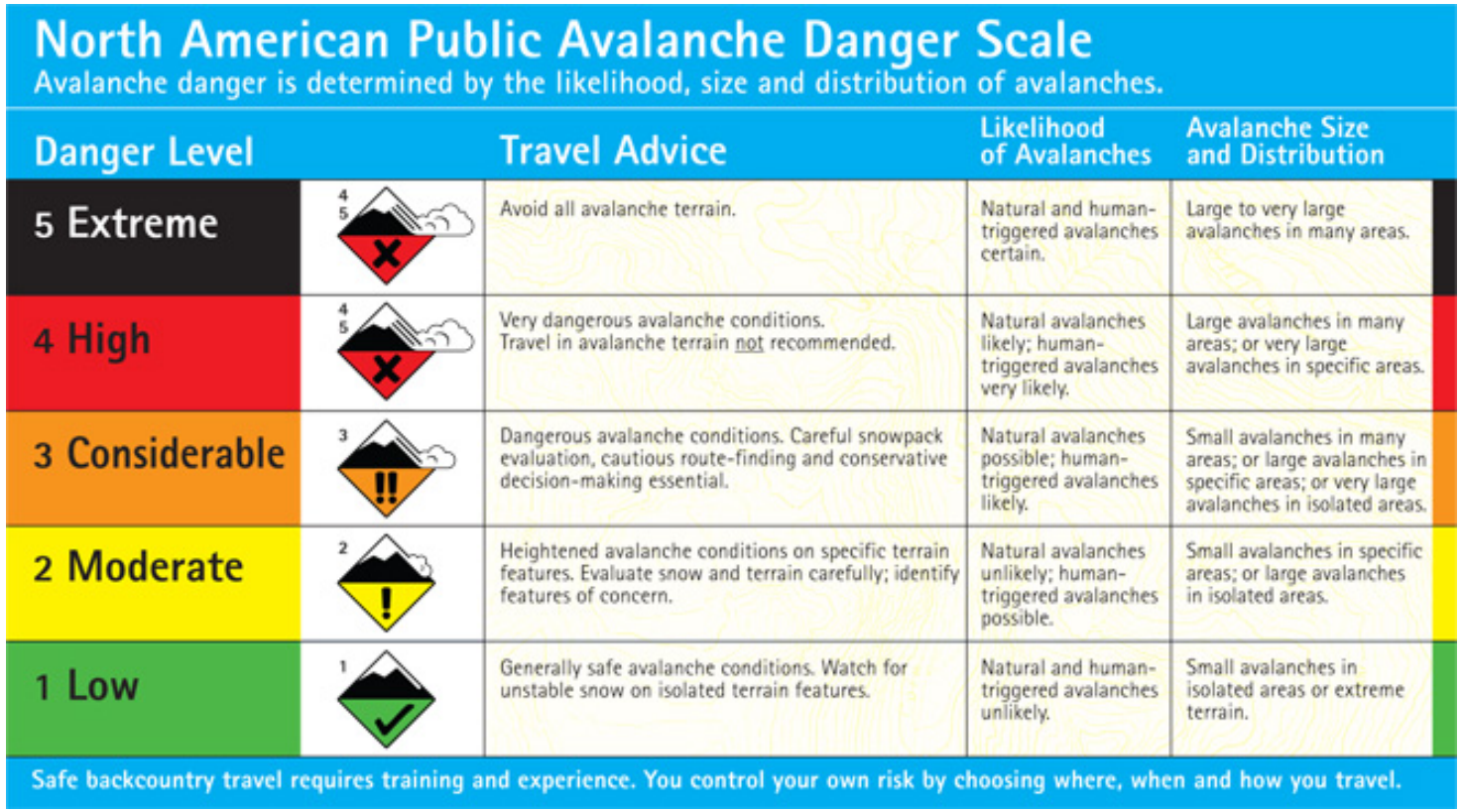
If you witness a slide:

- In order to have a 50% chance of saving someone’s life they must be found and dug out within the first 30 minutes
- Watch the victim, mark the last seen point, assess further hazard before proceeding into the area. DO NO HARM[5]. If it is not safe, do not go into the slide area.
- **Call immediately for assistance if possible, but go get help only after hours of intense searching**.
- Use your transceiver and focus your search starting at the last seen point, weaving from there down to the deposition area.
- Locate clues and investigate using your probe. Leave any clues in place be careful not to contaminate the area.
- **How long should you search?** Search for the victim until all hope is lost, a more experienced team replaces you or until the hazard to you is too great due to, hypothermia, exhaustion, or increased avalanche danger.

[4] Be careful not to inhale snow in the process
[5] ‘Do No Harm’ is a phrase widely used in rescue, recovery, EMS, first responder and medical situations that means “evaluate the situation before going in, because if it is not safe you may risk your life and/or make a bad situation worse.”

North American Avalanche Danger Scale[6]

from www.avalanche.org



[6] International (European and Canadian scales may have minor description differences and colors associated with each level.

This Attachment updated 12/2013.