



slopeangel.com

AVALANCHE SAFETY ESSENTIALS

BASIC AVALANCHE SAFETY EDUCATION FOR
BACKCOUNTRY SKIERS, WINTER CLIMBERS AND WALKERS



INTRODUCTION

In 85 - 90% of avalanche accidents worldwide, the avalanche was triggered by the victim or their party (Temper, 2008).

This means that the majority of our focus and care when travelling over snow-covered backcountry terrain should be on the slopes; and making sure they are safe to ski, climb or walk on.

This guidebook gives you an introduction to the fundamentals of avalanche safety, setting the pathway for you to undertake your first avalanche safety course, or perhaps refreshing your mind on some of the essential avalanche safety practices.

We also introduce the Slope Angel Halo which is a small portable electronic device that provides easy access to information that will help with your decision-making.

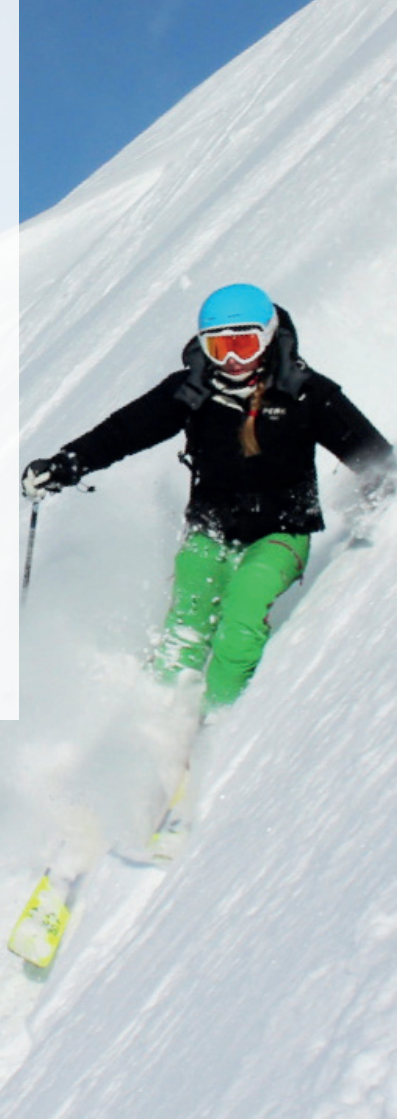
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MECHANICS OF AN AVALANCHE

An avalanche is a mass that can be a mix of snow, ice, rocks and debris that travels down a mountain. Avalanches occur due to a number of triggers such as overloading, temperature change, slope angle and snowpack conditions.

This guidebook describes three of the main types of avalanche to consider when travelling on snow covered slopes, especially un-patrolled backcountry terrain: slab, surface and wet snow avalanches, each of which have their own unique characteristics to consider.



- Accelerate to speeds of 30km/hr in three seconds & 130km/hr in just six seconds.
- Slabs can vary in thickness from a few centimetres to three metres.
- Can fracture above or below a party, depending on a host of factors.
- The odds of a slab being triggered by an external element are much smaller.

Slab Avalanches

Slab avalanches are the deadliest type of avalanche. You should be extremely vigilant of the potential for a slab release above or below you and your party when travelling on snow covered slopes, especially un-patrolled backcountry terrain.

A slab avalanche is a compact snow layer that can detach and slide on top of a weaker layer underneath. The slab breaks off in a single section before breaking into more pieces, which is where you see the classic jigsaw puzzle pieces of snow break around the victim. As stated in the introductory paragraph, 85 - 90% of worldwide avalanche incidents are triggered by a human.

Surface Avalanches

Surface avalanches often start from a single point and accumulate snow whilst sliding on or near the surface of the snowpack. Surface avalanches usually occur after a very heavy fall of snow and can travel at incredibly fast speeds whilst constantly gathering momentum as they collect more snow off the surface.



Wet Snow Avalanches

Direct sun on the snow, or warmer air temperatures caused by indirect sun or rain, lead to the snow melting and the water percolating through the snowpack decreasing the strength of the layers below. Once initiated, wet snow avalanches tend to travel much more slowly than dry snow avalanches, similar to custard running down a plate when you tip the plate on an angle. Wet snow avalanches are harder to initiate compared to slab or surface avalanches, but care must be taken to avoid certain slopes at certain times. Check out the **Weather Influence** section for more information.



Weather Influence

Weather plays a huge role in the strengthening and weakening of the layers within the snowpack. It can also load the snowpack with a firm slab of snow at an alarming rate, so the current, previous and future weather conditions must always be checked before heading out in to the backcountry, to understand what snowpack conditions you're likely to find.



Consistently Cold Temperature

A temperature drop in a winter snowpack can be dangerous. The bottom of the snowpack usually remains at zero degrees Celsius, if the temperature within the snowpack differs more than one degree Celsius per ten centimetres of snow depth, a strong temperature gradient is present. These conditions cause grains to become angular and faceted due to the moisture being drawn from the individual crystals. Faceted crystals can form extremely weak layers after a constant low temperature that may persist deep within the snowpack for long periods of time.

Fast Temperature Rise

A significant rise in temperature increases the avalanche hazard quickly. When the temperature of the ambient air rises more than 10 degrees, the snow on top of the snowpack, logically, gets heated up first. The layers on top become heavier, resulting in more stress on the snowpack. Wet snow instabilities due to sun, warm temperatures and/or rainfall saturating the snowpack produces deep and heavy snow avalanches, especially when rain falls at summit levels.

Wind Transportation

Snow begins to drift when wind speeds reach about ten mph. The wind scours snow from the windward side of terrain features such as ridges, open bowls and gullies. The snow is broken into smaller fragments and deposited on the downwind (lee) side of the terrain features. The deposited snow can form thick, cohesive slabs. The stronger the wind the harder the 'windslab'.

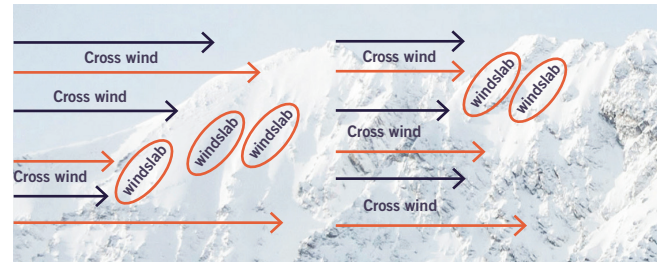
The direction that the slope faces with respect to the wind is important to note. Wind erodes from the upwind side of a feature such as a ridge and it deposits

on the downwind (lee) side, wind can deposit snow ten times more rapidly than precipitation.

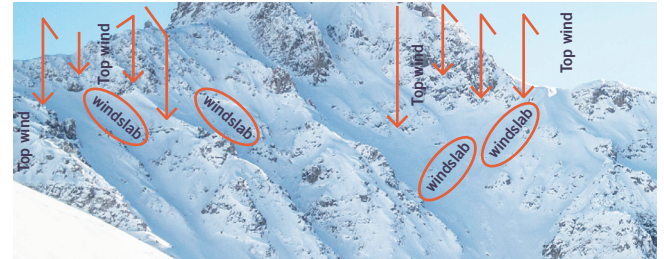
Wind deposits snow most commonly on the lee side of upper elevation prominent terrain features such as ridges, peaks and passes. We call this *top loading*. Wind can also blow across a slope which we call *cross loading*; this is particularly common when the wind whips across a slope, taking snow off ridges and shoulders, and depositing on the lee face of a couloir.



Cross Loading Formation



Top Loading Formation



Terrain Influence



Valleys/bowls

A bowl is a deadly terrain trap. When an avalanche starts on the run above and slides into a bowl, avalanche debris will pile up deeply whilst pushing the victim deeper. Shovelling takes a large portion of the already critically short time frame to dig out a victim and very few victims live from burials deeper than about 3m. Always consider the consequence of being swept into the bowl or valley below.



Trees

During an avalanche, tree-covered slopes change from being great terrain to ski, to a wall of immovable obstacles that will replicate a giant sieve that can cause serious trauma to anyone who finds themselves being carried through it. The presence of trees does not lower the risk of avalanches. When the avalanche starts on an open slope and surges into the trees, the trees form a dangerous terrain trap.



Cliffs

This type of terrain trap can make surface avalanches deadly as the consequences of being swept over a steep cliff are very severe no matter the size of the cliff. It's very unlikely that you'll be able to halt your progress in time if caught in an avalanche on steep terrain above cliffs.



Snow Stability

Each time fresh snow falls it forms a cohesive layer with the older snow below it. The bonding interface between two layers of snow is how we can predict and forecast snow stability, taking into consideration the strength or weakness of the layers buried below and examining weather forecasts for the day(s) ahead and how a change (or no change) in weather could preserve the strengths/weaknesses of the layers buried within the snowpack.

In the words of Bruce Tremper: “Snow is a lot like people. It doesn’t like rapid change”.

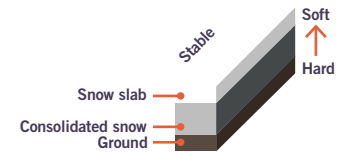
In 85-90% of all avalanche accidents, the avalanche is triggered by the victim or someone in the victim’s party and 90% of the time this involves a dry slope avalanche.

Snow is very sensitive and does not like rapid change – it needs time to adapt to change. Snowpacks can behave in very different ways depending on the types of change and stress they are subjected to. Dry slab avalanches occur when a relatively weak layer beneath the slab fractures, usually because there has been too much weight added to the surface at too fast a rate. Light snowfall over a period of a few weeks is not so much of a problem but heavy snowfall over a short period can be a huge problem – for example drifting can easily cause a metre of snow to fall in three hours. Suddenly adding the weight of a person on top of an already unstable weak snowpack causes an instant change adding tremendous stress and causing the weak layer to fracture.

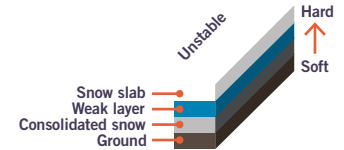
Testing Snow Stability



Light snowpack



Heavy snowpack



Compression Test

Compression tests paired with snow crystal examination give you an indication of the strength/weakness of the snowpack in a specific area. These tests should be performed in several locations and the results used in conjunction with other observed clues such as slope angle, temperature, altitude, time of day as well as local knowledge and weather information. As many factors as possible should be taken in to consideration when assessing the situation and deciding whether to ride.

Basic Compression Test

To perform a snow stability test:

- Isolate a small column 30cm x 30cm using either a para-cord or a saw to ensure the block is isolated from the snowpack
- Take the blade of the shovel and lay it flat on top
- Start with ten taps by articulating from your wrist
- Ten more taps by articulating from your elbow
- Ten more taps from your shoulder using the full weight of your arm



Early failures of the block indicate weak stability.



Extended Column Test (ECT)

The advantage of the extended column test is that you can observe the potential energy stored within the snowpack, this is referred to as propagation potential and can be observed when a fracture occurs across the entire column. Notes can be made on how easily the column sheared showing how much or little weight it would take to release a weak layer on a slope of similar angle and aspect to where the test is performed.

- Isolate a block 90cm wide x 30cm deep
- Tap on one side of the top of the isolated block
- Tap as previously, from the wrist, elbow and arm
- Observe the number of taps required for the targeted layer to fail.

If the column failure propagates across the entire 90cm block, then this is a strong red flag showing the potential energy within the snowpack that could produce a deadly slab release if triggered.

Stability is judged relative to the amount and rate of stress exerted on the snowpack. (i.e. the weight of your wrist, forearm, or whole arm on the isolated block). The more force required to make a layer fail, the better the stability. The location and quality of the weak layers that have failed is also important. For example, an 'easy' fracture 60cm deep in your pit indicates a much more dangerous situation than a fracture ten centimetres deep.





Testing Snow Stability

The chart below is taken from the Snow, Weather and Avalanche Guidelines (SWAG) published by the American Avalanche Association. This chart can be used to quantify the ECT results and analyse the potential energy stored within the snowpack.

Fracture time	Code	Fracture characteristics	Shear quality
Sudden planar	SP	Thin, straight fracture that suddenly crosses the column in one loading tap and column slides easily off the layer.	Q1
Sudden collapse	SC	Fracture crosses entire column from one loading tap and is associated with a significant weak layer in the snowpack.	Q1
Progressive compression	PC	Fracture of noticeable depth that crosses across the column from additional compression of the layer with subsequent loading taps.	Q2/Q3
Resistant planar	RP	Fracture requires one or more loading tap to cross the column and the column does not slide easily on the layer.	Q3
No fracture	NF	No fracture.	-






Quality 1 (Q1) shear shows poor bonding and often very poor stability and is typically indicative of much more dangerous conditions than a Q2 shear and certainly a Q3 shear.

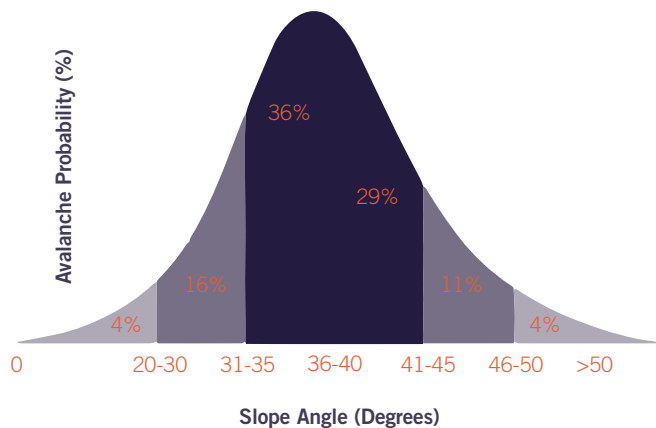
Snow Crystal Observation

Snow is made up of an infinite number of crystals of differing shapes and sizes; it is the shape of these crystals which has a huge effect on how layers of snow bond together. Changes in temperature can alter the shape of these crystals and it is this that has an effect on the cohesion of the snow. A rise in temperature weakens the bonds, whilst a fall in temperature increases the brittleness and tension within the slab.

Depending on the temperature, humidity and other atmospheric conditions, snow crystals can have a variety of shapes, but all

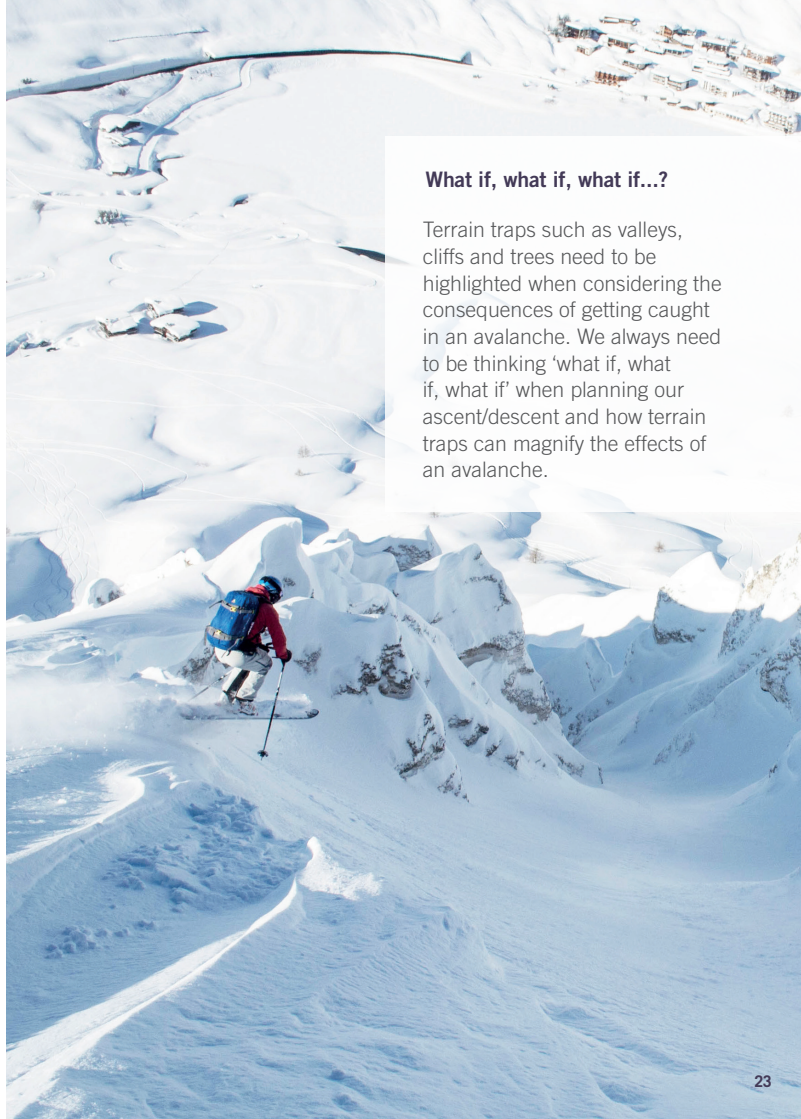
are generally hexagonal or six-pointed. In areas that get a lot of snow, the snow on the ground forms a snowpack. The layers within the snowpack have different qualities due to the shapes of the crystals in the layer. For example, six-pointed crystals can interlock more easily than needle-shaped crystals, so they create a stronger layer. On the other hand, when super-cooled water comes into contact with snow crystals in the air, it creates rime. Heavy rime deposits can cause pellet-like snow called graupel, which creates a very unstable sugary layer.

	Type	Also called	Looks like	Where found	How it's formed
	New snow	Powder, rime, graupel, etc.	No two are alike	On the snow surface	Falls from the sky
	Rounded snow	Equilibrium snow Old snow	Fine-grained, chalky	Old layers of snow	Low temperature gradient conditions (typically less than 1 deg C per 10cm)
	Faceted Snow	Sugar snow Kinetic snow Depth hoar	Sparkly, large-grained	Anywhere in the snowpack	Large temperature gradient conditions within the snowpack (typically more than 1 deg C per 10cm)
	Surface Hoar	Frost, feathers	Sparkly, large-grained	Snow surface or buried by more recent layers	Winter equivalent of dew (frozen water vapour) on the snow surface
	Melt-Freeze Snow	Corn snow Spring snow Wet snow	Corn snow, Spring snow, Wet snow	Snow surface or buried by more recent layers	Repeated melting and freezing of the snowpack



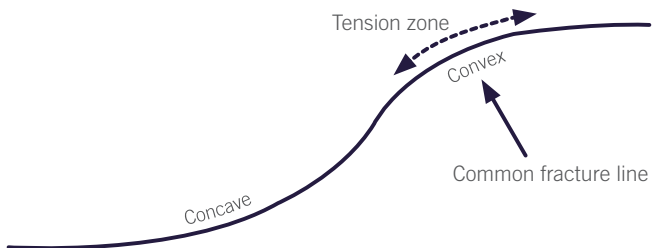
Slope Angle

Slope angle is one of the most important factors when assessing avalanche probability as it is the defining feature that allows snow to become pulled down the slope by gravity. 76% of all avalanches occur between 34° to 45°, with surface avalanches becoming more popular over this degree of steepness. 38° is the perfect angle for creating slab avalanches, whilst less than 3% of slabs occur on slopes less than 30°.



What if, what if, what if...?

Terrain traps such as valleys, cliffs and trees need to be highlighted when considering the consequences of getting caught in an avalanche. We always need to be thinking 'what if, what if, what if' when planning our ascent/descent and how terrain traps can magnify the effects of an avalanche.



A concave slope is much less likely to avalanche than a convex slope. Convex slopes create tension and cause weakness and fracture points.

Overloading occurs when the amount of falling snow or a group of skiers/mountaineers place too much weight on the slope – this puts pressure on the snowpack and destabilises its structure.



PLANNING YOUR DAY

Good planning is the best way to stay safe. It is more than checking the weather, snow conditions and your route. There are many human factors that should be considered as well.



The Human Factor

Human factors can sway the otherwise rational thought process of backcountry skiers and other winter mountain goers against making informed and conservative decisions. These may include the quality of snow en-route, the dynamics and ability of the group, and the familiarity of the terrain to be crossed.

You can possess the strongest avalanche safety knowledge in the world, but it means nothing if you are convincing your group that the potentially hazardous slope is safe to ski for all the wrong reasons.

Heuristic Traps

Humans frequently fall into a potentially fatal flaw wired into our brains - a 'Heuristic Trap'. Analysing avalanche danger includes juggling a wide range of variables such as wind speed and direction, fresh snow, temperature history, slope gradient and steepness. A 'Heuristic Trap' is when a human ignores the information that is presented in front of themselves and incorrectly applies a rule of thumb to make their decision.

FACETS

Ian McCammon (2004) developed a set of human factors, labelled FACETS, to help backcountry users to assess their own conscious or unconscious motivations. Each letter in the FACETS mnemonic corresponds with a human factor that can bias our otherwise excellent judgement. Learn to always be mindful of these 'Heuristic Traps' and how they could be affecting your judgment in the backcountry.

F

Familiarity

"I've skied this slope thousands of times before and it hasn't avalanched, thus it must be stable this time round."

E

Expert Halo

"I am concerned about the slope stability, but since my ski partner has his Avalanche 2 certification, I'll rely on him."

A

Acceptance

"I need to ski this face in these conditions right now to get everyone's approval in resort."

T

Tracks (first)

"The powder is so good today, I'm going to ski this slope because it's awesome, even though I have concerns in the back of my head."

C

Consistency

"I must ski on the north face of the Grande Motte today as I told my friends that was the plan."

S

Social Facilitation

"I'm happy to follow the crowd as I don't want to appear like I'm afraid in front of my friends, I'll stick with their decisions!"



Check the forecasts

An in-depth study is required before you make any route choices. Read page 15.

Plan your timings and ascent/descent path, accounting for the terrain

300 - 400m/h is a realistic pace to plan your touring speed. Allow extra time - the reality in the mountains is usually different from how you imagined it. Study the map for obvious features to avoid/aim for.

Group dynamics

Never go alone. Groups of 3 - 4 are the safest to travel in backcountry terrain. Discuss your thoughts of the snow conditions at the start of the day and keep chatting about the snow conditions throughout the day.

Plan A, B, C, D, E...

It's imperative to have back-up plans scheduled in case avalanche conditions don't allow for Plan A. Don't just ignore Red Flags because you don't have any other options.

Recommended single day ski tour kit list







This is a recommended kit list for a single day, traversing and skiing simple, non-glacial terrain:

- METAL snow shovel
- 3m Avalanche probe
- Modern 3 antenna transceiver
- Mobile phone + charger
- Slope Angel Halo
- GPS device
- Local OS, IGN etc map
- Compass
- Insulating spare layer
- Personal medications
- First aid kit
- Blizzard blanket
- Helmet
- Goggles
- Cat 3-4 sunglasses
- 1 litre water bottle
- Food + extra spares left over
- SPF 30 sun & lip cream
- Ski Strap
- Climbing skins cut for your skis
- Ski crampons
- 30m confidence rope
- Multi-tool including knife
- Whistle








Forecasted Avalanche Conditions

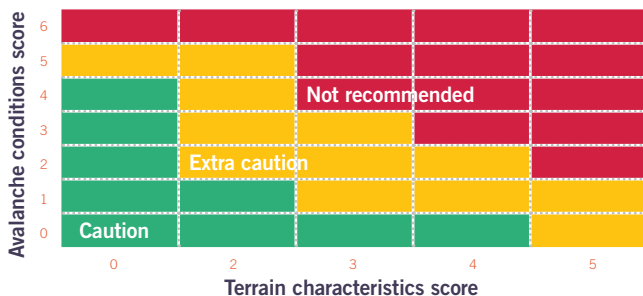
The local avalanche safety forecasts are the first thing you should check when you begin to collate the information together in order to make your informed choice on where or what to ski. Each forecast tells you the previous weather and avalanche history in the region and their report on the avalanche danger for the next days via five danger ratings explained below:

 5 Very high		<p>Avoid all avalanche terrain. Natural and human-triggered avalanches certain.</p>
4 High		<p>Very dangerous avalanche conditions. Travel in avalanche terrain not recommended. Natural avalanches likely; human-triggered avalanches very likely.</p>
3 Considerable		<p>Dangerous avalanche conditions. Careful snowpack evaluation, route-finding and conservative decision-making essential. Natural avalanches possible; human-triggered avalanches likely.</p>
2 Moderate		<p>Moderate avalanche conditions. Natural avalanches unlikely; human triggered avalanches possible.</p>
1 Low		<p>Generally safe from avalanches. Natural and human-triggered avalanches unlikely.</p>



					
Avalanche Risk	Very High	High	Considerable	Moderate	Low
France	[Checkerboard]	[Checkerboard]	[Checkerboard]	[Solid Yellow]	[Solid Yellow]
North America	[Checkerboard]	[Solid Red]	[Solid Orange]	[Solid Yellow]	[Solid Green]

The Avaluator



Avalanche conditions	
Is the avalanche danger 'considerable' (3) or higher?	1
Is there a persistent or deep persistent slab problem in the snowpack?	1
Are there signs of slab avalanches in the area from today or yesterday?	1
Are there signs of snowpack instability? Whoomphs, shooting cracks or drum-like sounds?	1
Has there been loading in the past 48 hours including roughly 30cm + of new snow, significant wind transportation or rain?	1
Avalanche conditions score	<input type="text"/>

Terrain Characteristics

The Avaluator, developed by the Canadian Avalanche Association is a basic aid to help the user make an informed decision. The Avaluator covers key warning signs and terrain factors to predict avalanche danger.

The Avaluator shown opposite is just an example of an avalanche decision-making tool which helps you decide on the level of risk you are willing to accept depending on your avalanche-related experience.

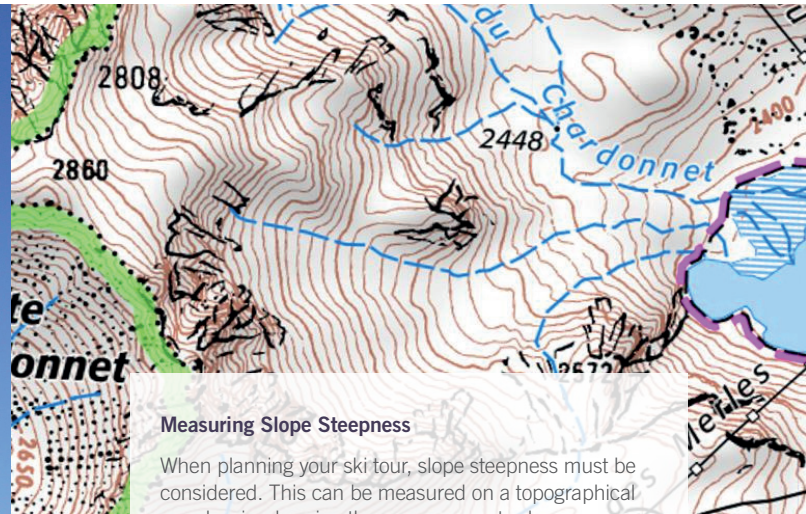
Add up the numbers that have affected the avalanche conditions in your location in the 'Avalanche Conditions' table and combine that with the terrain characteristics table total based on the terrain you plan on travelling within. Please take a look at our **Recommended Reading, Training and Classes** section of this guidebook for links to where you can buy these decision-making tools online.



Terrain characteristics	
Is the slope steepness between 30 and 35 degrees? OR, is the slope steeper than 35 degrees?	1
Are there gullies, trees or cliffs that increase the consequences of being caught in an avalanche?	1
Is the slope convex or unsupported?	1
Is the slope in the alpine, in a sparsely treed area or in open forest?	1
Terrain characteristics score	<input type="text"/>

Here are some points to consider when using decision-making tools when planning your day;

- Decision-making tools cannot predict the stability of a specific slope.
- Just because you are in the 'green' area of the Avaluator doesn't mean you are completely safe. You still need to be constantly aware of the terrain to avoid straying onto isolated slabs.
- The Avaluator is a good learning tool but you've got to be more prepared than the information that an Avaluator equips you with, so back this tool up with experience or an avalanche safety course.
- You can see that in complex terrain, for example on high alpine glaciers – there are no safe days when the bulletin says that the situation is level 3 or more.



Measuring Slope Steepness

When planning your ski tour, slope steepness must be considered. This can be measured on a topographical map by simply using the measurement ruler on your compass. Place the ruler at right angles to the contour lines on the topographical map and measure the space between each contour.



200m contours, 1 :50,000 maps									
Contour spacing (mm)	10.0	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0
Slope angle (degrees)	22	23	24	25	27	28	30	32	34

200m contours, 1 :50,000 maps								
Contour spacing (mm)	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0
Slope angle (degrees)	36	39	42	45	49	53	58	63

Safe Travel Practices (Ascent)

Weather conditions can often differ to those expected. Make sure you are continually monitoring the weather in your immediate area to ensure you don't miss any potential surprises. For example, the wind is clearly blowing off the summits when there wasn't a strong wind forecast?

Go around fresh snowdrifts and wind compacted accumulations of snow that look opaque to the eye.

Be aware of obvious 'clues' shown to you by the snowpack. For example, recent avalanche activity on slopes that you are approaching, or shooting cracks forming in the snow with blocks breaking off at your feet. If there's been a dump of fresh snow overnight you should know what all this fresh snow is sitting on, dig down in a safe place to investigate.



Slope crack

Ridges and shoulders offer a safer ascent option, where you are unsure of the large face ahead of you.

Space your group out in any steep sections to reduce your weight on the specific area of the snow - travel uphill at a similar speed to avoid bunching together.

Keep an eye on the air temperature for the day and monitor your progress on the ascent keeping in consideration the time you plan on descending and how the temperatures may have affected the snow.

Safe Travel Practices (Descent)

If skiing straight from the lifts, start out on low angle slopes whilst you look for clues. Then, if there is not a lot of recent avalanche activity around, you do not see or hear any other clues of instability and you have understood the bulletins, you can think about exploring steeper and more varied terrain.

Ski steep slopes one by one at all times.

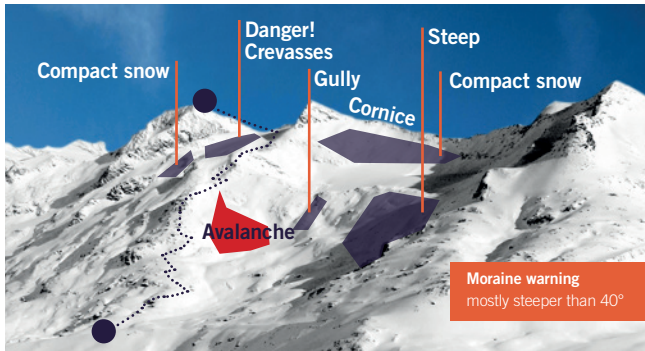
Only ever stop where you are protected from potential risks, such as under a rock, on a ridge and not below a potentially loaded slope.

Keep your group away from any terrain traps throughout the day by constantly thinking of the consequences of an avalanche at any point of your day.

Always keep an eye on each other as you descend one by one. When possible, try to make sure to stop in clear eyesight of your group, whilst also making sure you're not putting yourself in danger of being in the path of an avalanche.

Have fun, but always be considerate of your safety and that of your party.





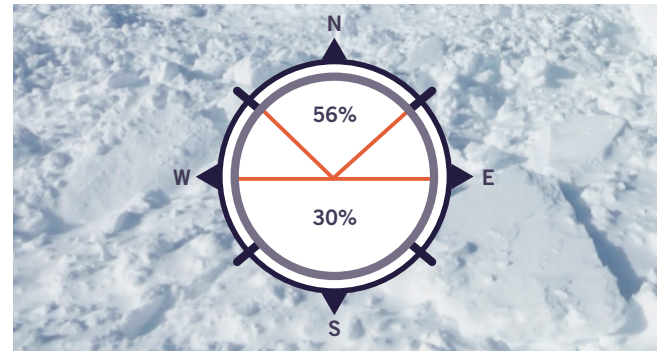
Terrain – Slope Shape

Make use of terrain shapes to ensure the best route:

- **Ribs** – snowdrifts don't often accumulate here as the snow gets blown off.
- **Road Ridges** – also difficult for snowdrifts to form due to wind.
- **Humps** – the snowpack here is supported by small slope shapes.

Avoid certain areas to ensure the best route:

- **Steep Slopes** – a riskier avalanche area, also maintain appropriately safe distances.
- **Bowls and gullies** – snowdrifts can easily accumulate here, making it a riskier area.
- **Cornices** – prone to breaking off unpredictably. Snowdrifts can also accumulate on the leeward side, underneath the cornice.



Terrain – Slope Direction

North-facing slopes make up 70% of where all avalanche accidents happen (N to E) with 56% of these taking place in the pure north sector (NW to NE).

In the Southern Hemisphere the reverse is true that south facing slopes are more prevalent to avalanche.

This is because there is less sunshine in these areas which causes the snowpack to set more slowly. This in turn means that the powder remains in place much longer and therefore so does the danger.

The prolonged exposure to sunlight on south-facing slopes in the winter mean their snowpack structure is more stable. However, during Spring, the avalanche risk does increase as the sun warms the snow, especially on east and south facing slopes.

30% of avalanches do still take place on a southern aspect. Always remember, there are risks in all aspects.

EQUIPMENT

When travelling in backcountry terrain, the bare minimum every member of the group should carry is a Transceiver, Shovel and Probe (TSP). Research has shown that by carrying a TSP, backcountry skiers stand a 66% higher survivability rate when avalanched.

Although it's very well carrying the equipment, get out there and practice with the it! Don't have snow where you live prior to travelling out to your ski destination? Bury a friend's transceiver in a heap of leaves and practice locating it with the three-stage method shown later in this guidebook.



Transceiver

First produced and developed by John Lawton in 1968, under the brand name 'Skadi', this simple transmitter and receiver worked at 2.275kHz and converted the 2.275kHz signals that it received into an audio tone which allowed the user to 'track' the location of the wearer. Modern day avalanche transceivers now work on the universal frequency of 457 kHz (Dawson, 2013).

Digital transceivers followed and improved upon this system which led to larger signal ranges and reduced burial times for the victims; this evolution of transceiver technology has led to digital transceivers becoming the norm for snow sports enthusiasts, with the percentage of snow sports users that are equipped with a transceiver, increasing from 29% to 74% from the period 1970 - 1999 (Brugger & Falk, 2002)

The best avalanche transceiver is the one you are most practiced with. Many of them sell themselves with fancy settings,



but it's fundamentally important to be effective and efficient in using whatever modern transceiver you choose to purchase.

Avalanche transceivers do two things: they broadcast or 'send' a signal, and search for a radio wave we call a 'flux line'.

Avalanche Airbag System

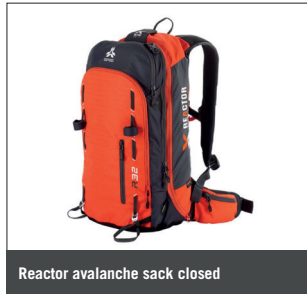
ABS Backpacks are able to keep users 'afloat' and on the top of a sliding avalanche as a result of the structure an avalanche forms whilst it is moving down a slope due to the granular properties of an avalanche; 'Inverse Segregation' (Kern, M. 2000).

Inverse Segregation is the term used to describe the movement of snow within the avalanche best described by shaking a bag of crisps, the smaller crisps fall to the bottom, whilst the larger crisps remain on the top (Kern, et al., 2005)

- ABS should be used with a transceiver, shovel and probe at all times
- It is essential that users practice deploying their pack
- Airbags are expensive and heavy



Reactor avalanche sack open



Reactor avalanche sack closed

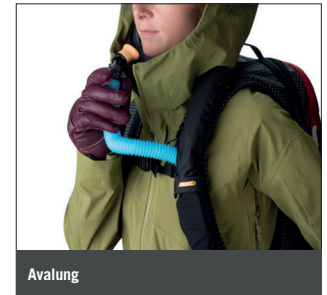


Slope Angel Halo



AvaLung System

The Artificial Air Pocket Device, 'AvaLung' is a device designed by Thomas Crowley and manufactured by Black Diamond Equipment Ltd (McClung & Schaerer, 2006); enables the user to extract and inhale 'clean' air from the surrounding snowpack, whilst exhaling the dangerous CO₂ behind the user to prevent further potentially lethal CO₂ inhalation in the event of a full body burial (Brugger & Falk, 2002).




Avalung


A Transceiver, Shovel and Probe must also be carried by the wearer of the AvaLung as the AvaLung is designed to only prolong the length of survival within a full burial avalanche with reports showing a prolonged 60 minutes breathing time under the snowpack, compared to the average 5 to 14 minutes without an AvaLung (Radwin, & Grissom, 2002).


Slope Angel Halo (SAH)


Slope Angel develops tough and compact devices that help assess avalanche risk, all designed and tested in the French Alps by real skiers, mountaineers, hikers and rescue teams. The Halo helps evaluate five of the main avalanche risk factors. This information should be used together with snow compression tests, weather forecasts and other information as outlined in this guidebook.




 **Transceiver Checker** – SAH confirms that a transceiver is switched on and working using a sound and visual display. By holding down both function keys within 10cm of a transceiver, self and group checks can take place in close proximity without the need to spread team members metres apart. Transceivers both transmit and receive a signal, so ensuring your transceiver is working is one of the most important safety checks. The signal is vital to being found quickly or to search for a buried skier, boarder or climber after an avalanche.

 **Slope Angle** – Using an in-built inclinometer SAH gives you a quick and accurate reading of the slope angle. Place the device either directly onto the slope or onto a ski pole (or similar) with the screen facing upwards. Notoriously hard to estimate, slope angle is essential to know when it comes to avalanche risk assessment. Research has shown that 70% of avalanches occur on slopes greater than 30° and up to 50°.

 **Altimeter** – SAH identifies your altitude in metres when you scroll through the display. Weather forecasts give information on snowpack conditions at specific heights. Knowing your altitude will allow you to quickly match this information. The altimeter feature will also help you to determine your location, assist with route planning and enable you to calculate height gained and lost during ascents and descents, which all aids decision-making and assessment of avalanche risk when combined with SAH's other functions.

 **Thermometer** – SAH quickly measures ambient air in Celsius and Fahrenheit when you scroll through the display. Temperature, like slope angle is difficult to accurately guess. A rapid change in temperature is a big warning sign. A rise of more than 8°C in 12hrs significantly increases the risk of an avalanche. When the temperature drops beneath -25°C weak layers frequently develop. Snowpack stability and avalanche risk are hugely influenced by changes in temperature caused by warm air, cold air, rain, snow and sunshine.

 **24hr Clock** – SAH shows the time in 24hr mode when you scroll through the display allowing you to see the time without having to remove gloves or find your watch/mobile phone under layers of clothing. Time awareness in terms of backcountry planning and safety is critical and is an additional factor/consideration when it comes to decision-making.



RESCUE

You and your group need to be as efficient as possible in the event where one or more of your party (or someone from a different party) are caught in a full burial (i.e. their head is buried under the snow). 'If completely buried, a victim has a greater than 90% survival rate if they are found and extricated within about 15 minutes, but only a 30% survival rate if the rescue time stretches to 30 minutes.'

In most cases death occurs between 15-30 minutes from time of burial. The cause of death is asphyxiation probably due to one of the mechanisms that produce asphyxia in avalanche burial victims; position asphyxia, airway obstruction or carbon dioxide displacement asphyxia. Death also is caused from the trauma of hitting trees and rocks on the way down.



Rescue Scenario

Determine who is missing from your group. Ensure you do not leave anybody unaccounted for and you have every able person searching.

If possible, call 112 (European Emergency Number) to mobilise the rescue services. Also save the local Piste Patrol contact details and call direct as this may be quicker.

Keep yourself and your group safe by assessing whether additional avalanches could occur. These may come from different parts of a bowl or release zones. Do not move out into the avalanche path if another seems likely.

Go only when safe. Reassess conditions continually.

Turn all avalanche transceivers to 'receive' mode. Critical time can be wasted if a searcher's transceiver is leading everyone else away from the victim's transceiver.

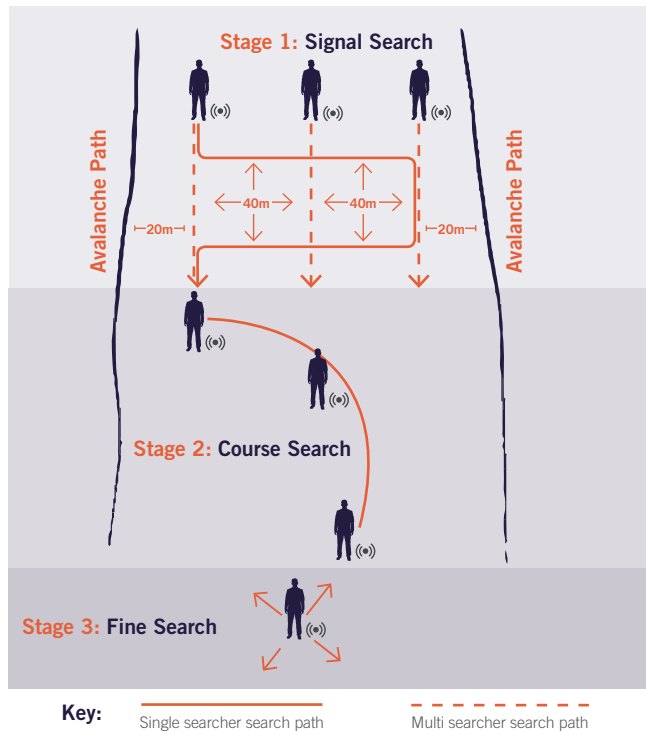
Determine where the avalanche victim(s) or their gear was last seen. If you're 100% sure there was only one victim and can see an arm or leg above the surface, immediately head down to them to uncover them and clear their airway.

**Mountain rescue - call 112 (in Europe)
Be prepared to supply the following information:**

- Who is calling: name, phone number, location?
- What happened?
- Where did the accident happen?
- When did the accident happen?
- How many completely buried victims?
- Weather in the area?
- Avalanche beacons worn?

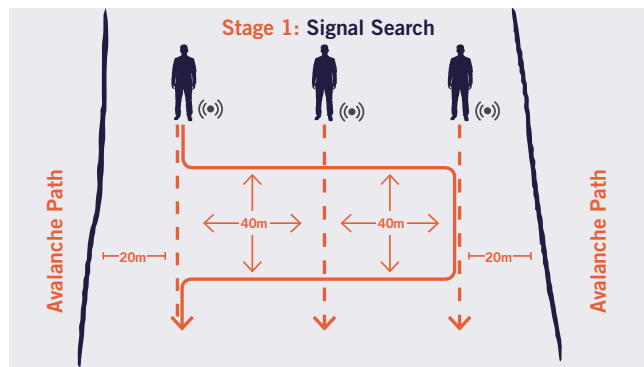
Companion Rescue

Once you and your party have followed the five steps overleaf, it is then vital to mobilise and start to perform the three stages of companion rescue. It is imperative that all members of the group have turned their transceiver to receive in order to avoid confusing the searchers.



Stage 1: Signal Search

If you managed to determine where the victim(s) were last seen, you are able to start the Signal Search from that position. If this is not the case, you are required to cover the whole of the avalanche path with your signal search, as shown below. The two diagrams show how to perform this search, being careful not to rush too much and drop below the victim, yet with enough haste to free the victim(s) in time.



Keep your eyes and ears peeled when performing all 3 stages of the companion rescue to hear/see any signs of life.

- Depending on how many are in your group, you must cover the entire avalanche path in a maximum width of 20m or the entire width of the avalanche if alone.
- Your aim here is to keep descending as the above diagram shows with transceiver at belly button height. You are aiming to get a consistent 'beep' on your transceiver, showing that it's latched on to the victim's transceiver's flux rings.

Stage 2: Coarse Search

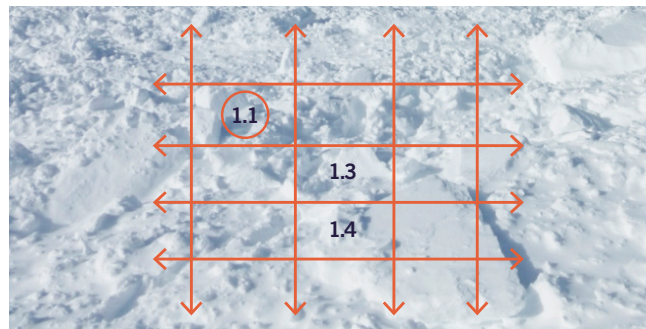
- This is the stage of the search where you begin to hone into the buried victim. We do this by starting to follow our transceiver a little more and not stick to regimented search patterns, like with the Signal Search.
- As you get closer to the victim, the pitch of the sound that the transceiver makes will get higher.
- Modern, digital 3-antenna transceivers will point you to the direction you are required to go in. Start to follow these direction arrows to be drawn into the buried victim's transceiver. Keep an eye on the distance numbers, as if they begin to get larger, this is indicating that you have skied past the buried victim.
- If you do end up skiing past the victim, shout up to another member of your party to say what has happened and for them to slowly come down to you until they get the lowest number they can. If alone then it's usually best for skiers to sidestep up. Snowboarders will be required to take their snowboard off their feet and walk uphill.



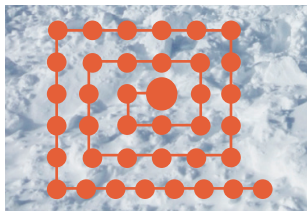
Stage 3: Fine Search

- When you get 2-3m away (depending on burial depth) from the victim or your avalanche stops showing direction arrows, you can stop and take your skis off to get as close to the snow as possible.
- Whilst on your hands and knees, hold the device as close to the surface of the snow as possible, keeping it flat to the snow.
- Do not move the transceiver sporadically in random directions. Only move the transceiver in a vertical or horizontal motion until you find the lowest number possible on the readout. For example, if you move it to your left and the number goes up from 1.4 to 1.5, you know they're not to your left, so move the transceiver right until you get the lowest number.
- Mark the area with a ski pole, shovel or spare probe to make sure you don't lose the position.

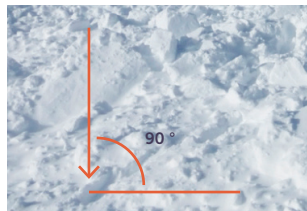
Mark Lowest Number!



Keep 25cm distance between each probe strike



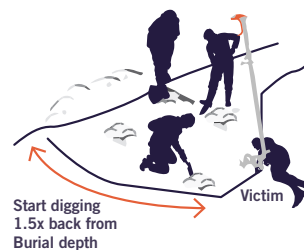
Keep probe perpendicular to snow surface



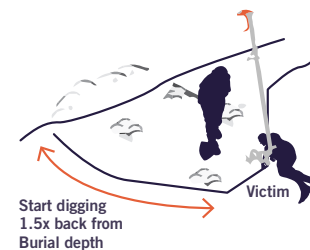
Probing Techniques

- Practice deploying your probe when you work on your companion rescue stages to ensure efficient deployment - particularly if you're performing the rescue alone.
- Probe from the area where you left your ski pole, spare probe or shovel. Push your probe as far as it can go. The feeling of a human body is very distinctive with a squishy feel to it, if you are striking flesh. It's also clear if you are hitting the ground below, rock or tree.
- If you do not strike from your first probe strike, start probing in a spiral pattern around your first probe strike, with each probe 25cm apart, just like the diagram above.
- Always keep your probe perpendicular (90 degrees) to the slope.

Multi-person extraction techniques



Single-person extraction techniques



Extraction Techniques

- Although easily overlooked, shovelling consumes most of the time of an avalanche rescue.
- Avalanche debris sets a little like concrete, so chop the snow into little blocks and scrape the snow away, don't lift the snow with every scoop as that will consume too much energy.
- Excavate immediately downhill of your probe strike. Take a look at your probe measurement markings to see how buried the victim is - in burials more than one metre, start shovelling downhill 1.5 times the burial depth of the victim.
- Helpers behind the lead excavator should just be scraping the snow downhill, not lifting large chunks of snow.
- With multiple rescuers, the lead excavator should spend one minute at the front, and rotate roles to avoid fatigue.
- Plastic shovels are not recommended, always choose a metal shovel.
- Once extricated, snow should immediately be cleared from the mouth with first aid treatment administered depending on condition of victim - Danger, Response, Airway, Breathless, Circulation (DRABC).
- Do not move the victim more than necessary - if waiting for rescue, keep them warm with spare layer.

Recommended Further Reading, Websites and Courses

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Websites

- henryavalanchetalk.com
- avalanchegeeks.com
- www.avalancheassociation.ca
- slf.ch/en.html



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