

# CAUTION – AVALANCHES!



## Edited by:

Swiss Federal Institute for Snow and Avalanche Research SLF, Davos • Federal Office of Sports Magglingen (BASPO) • Swiss Alpine Club SAC • Swiss Army (Cen exce A mtn tng) • Swiss Ski

## With support of:

MeteoSwiss • Friends of Nature Switzerland (FNS) • Swiss Council for Accident Prevention bfu • Swiss Commission for the Prevention of Accidents on Snowsport Runs SKUS • Swiss Air Rescue (Rega) • Swiss Foundation for Alpine Research (SFAR) • Association of Swiss Mountain Guides (ASMG) • Swiss Cableways (SCW) • Swiss Snowboard Association (SSBA) • Swiss Snowsports • Swiss Association of Mountaineering Schools (SAMS) • Rescue Organisation of the Canton of Valais (KWRO/OCVS)

To be obtained from: the Editors

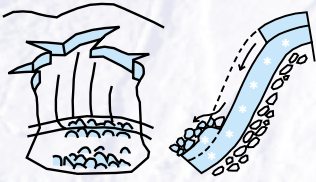
Fifth edition: 2005

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# Avalanche formation

## Types of avalanches (dry or wet)



Snow slab avalanche



Loose snow avalanche

### Terrain

critical steepness:  
(steepest part of  
starting zone)

30° for dry snow slab avalanches  
(less than 30° for wet snow avalanches)

Beware of runout zones!

- ▶ **Avalanche release (spontaneously or artificially) by either an increase in stress (e.g. by a skier) and/or a decrease in strength (e.g. by warming or rain).**

The **first sunny day** after a snowfall period is particularly dangerous.



### Snow slab avalanches

Cohesive snow on top of a weak layer: The slab breaks away as a unit. Dry snow slabs are the most dangerous avalanches for winter recreationists. They are also possible when the surface layers seem to consist of cohesionless powder snow.

### Avalanche danger prevails above all with:

- new snow combined with wind
- rapidly and distinctly rising temperatures
- weak layers within the snow cover

### Wet snow avalanches

Towards spring the snow cover loses its strength due to gradual soaking: increasing danger of wet snow avalanches. If the snow surface is distinctly refrozen, following a clear night, mostly favourable conditions prevail before midday. Pay attention after midday and generally at any time when the sky is overcast.

- ▶ **Pay attention to daily evolution!**

# Avalanche hazard evaluation: «3x3»-method

	Conditions: Weather and Snow	Terrain	Human factors
<b>1. Trip planning</b> ▶ <b>Trip with alternatives and time-schedule</b> «Which tour is possible?»	<ul style="list-style-type: none"> <li>• Avalanche bulletin</li> <li>• Weather forecast</li> <li>• Additional information: from hut warden etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Map</li> <li>• Guide book</li> <li>• Photographs</li> <li>• Key passages</li> <li>• Measure steepness (map 1:25'000)</li> <li>• Alternatives</li> <li>• Time-schedule</li> </ul>	<ul style="list-style-type: none"> <li>• Who will participate?</li> <li>• Group size</li> <li>• Technique and fitness</li> <li>• Equipment</li> <li>• Responsibility</li> </ul>
<b>2. Assessing the local hazard</b> ▶ <b>Route selection and alternatives</b> «Is anything unexpected?»	<ul style="list-style-type: none"> <li>• Precipitation, critical new snow depth</li> <li>• Alarm signals</li> <li>• Wind, wind-driven snow</li> <li>• Air temperature</li> <li>• Visibility</li> <li>• Clouds</li> <li>• Weather trend</li> <li>• Snow cover conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Is my perception correct?</li> <li>• Steepness</li> <li>• Aspect</li> <li>• What is above/below?</li> <li>• Near ridge?</li> <li>• Topography/relief</li> <li>• Forest</li> </ul>	<ul style="list-style-type: none"> <li>• Who is in my group?</li> <li>• Check of equipment and transceivers</li> <li>• Who else is travelling?</li> <li>• Frequently check the physical condition of members and the time-schedule</li> </ul>
<b>3. Assessing specific slopes, key passage</b> ▶ <b>Trail selection</b> ▶ <b>Safety measures, turning back</b> «To go or not to go?»	<ul style="list-style-type: none"> <li>• Critical new snow depth</li> <li>• Snow quality</li> <li>• Recent accumulations of wind-driven snow</li> <li>• Radiation, temperature</li> <li>• Visibility</li> <li>• Frequency and extent of previous skiing activity</li> </ul>	<ul style="list-style-type: none"> <li>• Steepness, shape, location (e.g. distance to ridge), size of slope</li> <li>• Rocky outcrops</li> <li>• Elevation and aspect</li> <li>• Danger of fall and of burial</li> <li>• Detour possibilities</li> </ul>	<ul style="list-style-type: none"> <li>• Physical and mental fitness</li> <li>• Technical ability</li> <li>• Group size</li> <li>• Discipline</li> <li>• Leadership</li> </ul>



# Avalanche hazard evaluation



**Recent accumulations of wind-driven snow are often particularly dangerous.**

## General snow conditions, snow cover

A thick snow cover is generally more stable than a thin snow cover. Danger assessment may be supplemented by field tests (e.g. shovel shear test, rutschblock test, column or compression test) to gain additional useful information. Are there weak layers or interfaces (e.g. surface hoar)? Each layer boundary is a possible weakness, in particular in case of a significant difference in hardness or grain size.

### Tip: Column Test

To find weak layers: cut a column of snow about 30 cm x 30 cm. Induce a fracture by gradually loading the top of the column (tapping, hitting). If it does not fail, break it over your leg or let it drop.

## Conditions

### New snow + Wind = Danger of slab avalanches

#### Critical new snow depth ► at least «considerable» avalanche danger

- 10-20 cm when conditions are unfavourable
- 20-30 cm when conditions are fair or mixed
- 30-50 cm when conditions are favourable

Favourable: low to moderate winds, air temperature close to 0°C, strongly irregular old snow surface, frequently skied slope

Unfavourable: high rate of precipitation, strong winds (>50 km/h, roaring wind), low temperature (below -5 to -10°C), smooth old snow surface, rarely skied slope

#### Alarm signals ► typical for «considerable» avalanche danger

Recent, natural and remotely triggered slab avalanches. Whumpfs and shooting cracks.

## Temperature

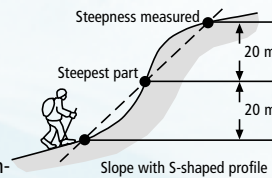
Take into account previous and expected evolution. Cold temperatures preserve the danger. Warm temperatures have a long term stabilizing effect, in particular repeated warm-cold cycles. Rapid, distinct warming towards 0°C favours instability. Solar radiation significantly warms up the surface layers, thereby promoting instability.



## Terrain

### Steepness

- **Measure** the slope angle with an inclination scale on the map (1:25'000). Pay attention to S-shaped terrain profiles: in fact always steeper.



- During the trip, **estimate** the inclination of the steepest part of the slope (ca. 20m x 20m) or **measure** it using the poles (or the snowboard).

### Tip: rule of thumb for steepness

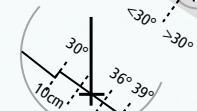
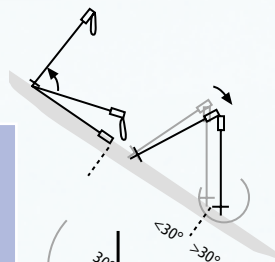
- if zig-zags (kick turns) are necessary:
- > about 30 degrees
- steep terrain with rocky outcrops:
- > about 40 degrees

- Also consider steep slopes above and below the route, in particular if 'considerable' danger prevails.

### Shape of slope and type of terrain

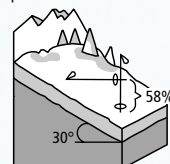
- Most accidents happen on steep shady slopes, near the ridge top.
- Hilly ground allows better selection of a safe route.
- Sparse woods do not protect from slab avalanches.
- Ridges are safer than bowls. Ridges are often wind scoured, also offering a favourable old snow surface. Gullies and bowls are often loaded with wind-driven snow, also offering a rather unfavourable old snow surface.

Measuring steepness with poles: triangle or pendulum method.



If the suspended pole hits the snow surface below the mark, the slope is steeper than 30 degrees, otherwise it is less steep. The further from the mark, the steeper: 10 cm corresponds to about 3 degrees.

Measuring steepness with marked poles:



30° corresponds to 58%,  
35° corresponds to 70%,  
40° corresponds to 84%  
of the length of the pole.

## Aspect

- Shady slopes are more hazardous than sunny slopes.

## Size of slope

- How large is the slope? Is the run-out gradual?
- Terrain trap? Risk of deep burial in hole-type terrain features and stream gullies?

## Human factors

Many avalanche accidents occurred not because the hazard could not be recognized, but due to subjective elements such as poor judgement and according behaviour. **Perception, decision making and behaviour** are processes strongly influenced by mental and social factors.

Pay attention to (examples):

- **Illusions/Limits of perception:** in fog or diffuse light we cannot assess the terrain properly. In stormy weather we cannot hear «whumpfs»
- **Emotionally distorted perception/wishful thinking:** we often only see what we expect to see. We tend to filter information in favour of our plan.
- **Positive reinforcement/over-confidence:** so far it has always turned out well. Accidents happen to others. I have everything under control.
- **Group:** Tendency of groups to take higher risks (risky shift effect), group/peer pressure, competition within and between groups. Presence of other groups, or skiing tracks.
- **Poor communication** within a group, e.g. about keeping distances or descent routes. Did everybody understand the instructions? Can I rely on the other group members following the instructions?

Always take a bad feeling seriously. Continuously test a good feeling against new observations and facts: do not be led astray.

Class of steepness

30° 35° 40°

Steepness averaged over 100m vertical

20° 25° 30° 35° 40° 45° 50° 55° 60°

# Avalanche bulletin

The degree of avalanche danger depends on: the release probability (the natural stability of the snow cover and the effects of human activities), the distribution and frequency of dangerous slopes, the size and type of avalanches (including the thickness of the sliding snow layers).

## National bulletin

Structure: General situation, short-term development, forecast of avalanche danger for the following day (degrees of danger, incl. aspect and altitude of the dangerous slopes), tendency for the subsequent days.

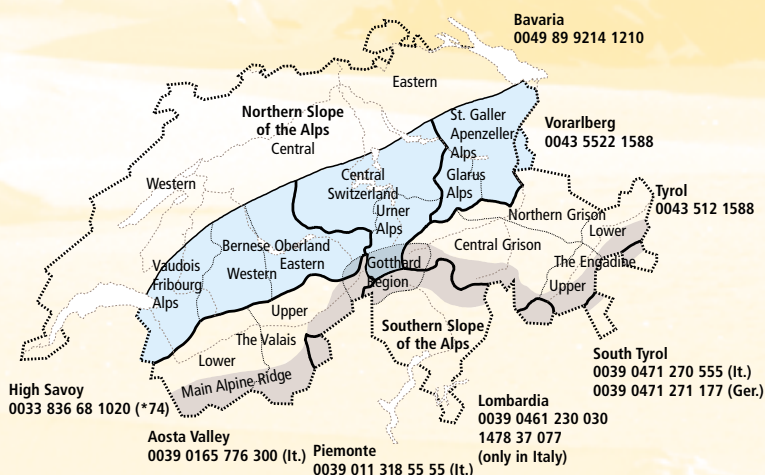
Content: Information about snow conditions, and regional avalanche danger for all regions of the Swiss Alps (regional indication, local divergence is possible, transitions are smooth!).

Issue and distribution: Daily after 17.00. Phone: 187 (from outside Switzerland: +41 848 800 187), Fax: 0900 59 20 21 (in German), 0900 59 20 22 (in French), teletext: page 782, wap.slf.ch and with much additional information on the web: <http://www.slf.ch>

## Regional bulletins

For most regions, daily after 08.00, a regional bulletin in graphical form is issued (Fax: 0900 59 20 20, wap.slf.ch, <http://www.slf.ch>)

Information on the avalanche conditions in adjacent countries: [www.lawinen.org](http://www.lawinen.org)



## Avalanche danger scale (abbreviated)

Degree of danger	Characteristics (release probability, distribution and frequency of dangerous slopes, type of avalanches)	Consequences and recommendations for recreationists outside of controlled ski areas
<b>1</b> low gering faible debole	Triggering is generally possible only with high additional loads (e.g. groups without intervals) and on very few locations in steep extreme terrain. Only a few sluffs and small natural avalanches are possible. Forecasted for about 20% of the winter season. About 7% of the recreational fatalities.	Generally favourable conditions. Ski one by one on extremely steep slopes. If possible avoid recent accumulations of wind-driven snow on extreme slopes. Beware of the danger of falling and of possibly unfavourable conditions in high alpine terrain.
<b>2</b> moderate mässig limité moderato	Triggering possible in particular with high additional loads, particularly on the steep slopes indicated in the bulletin. Large natural avalanches not likely. Forecasted for nearly 50% of the winter season. About 34% of the recreational fatalities.	Favourable conditions, for the most part. Routes should be selected with care, in particular on steep slopes of the aspect and altitude indicated in the bulletin. Avoid all extremely steep slopes of the aspect and altitude indicated in the bulletin and recent accumulations of wind-driven snow. Ski one by one and with caution on very steep slopes.
<b>3</b> considerable erheblich marqué marcato	Triggering possible even with low additional loads (e.g. single person), particularly on the steep slopes indicated in the bulletin. In some conditions, medium and occasionally large natural avalanches may occur. Frequently alarm signals exist (whumpfs, natural releases). Forecasted for nearly 33% of the winter season. About 47% of the recreational fatalities.	Partly unfavourable conditions. <b>Critical situation.</b> Experience in avalanche hazard assessment and in selecting good routes required. Avoid very steep slopes of the aspect and altitude indicated in the bulletin if possible. Pay attention to remotely triggered avalanches. Proceed with caution on traverses or when travelling into unknown terrain.
<b>4</b> high gross fort forte	Triggering probable even with low additional loads on many steep slopes of all aspect. In some conditions, many medium and several large natural avalanches are likely. Forecasted for a few days only of the winter season. About 12% of the recreational fatalities.	Unfavourable conditions. <b>Acute Situation.</b> Lines of transport might be endangered. Sound experience in avalanche hazard assessment required. Stay in moderately steep terrain; beware of runout zones. Remotely triggered avalanches are typical, even over large distances.
<b>5</b> very high sehr gross très fort molto forte	Numerous large natural avalanches are likely, even in moderately steep terrain. Avalanches run to the valley bottom. Rarely forecasted, on average for one day of the winter season. No recreational fatalities.	Very unfavourable conditions. <b>Catastrophic situation.</b> Parts of villages endangered, evacuations might be necessary. Travel in avalanche terrain not recommended.

# Decision strategy to assess and reduce the avalanche risk

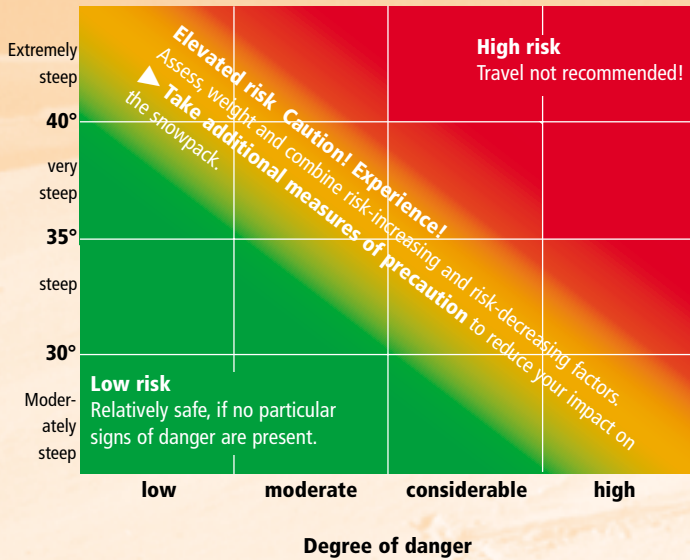
## Connect the degree of avalanche danger with terrain: slope inclination and aspect

Depending on the degree of danger, it is recommended to avoid slopes of a certain steepness and with unfavourable aspect.

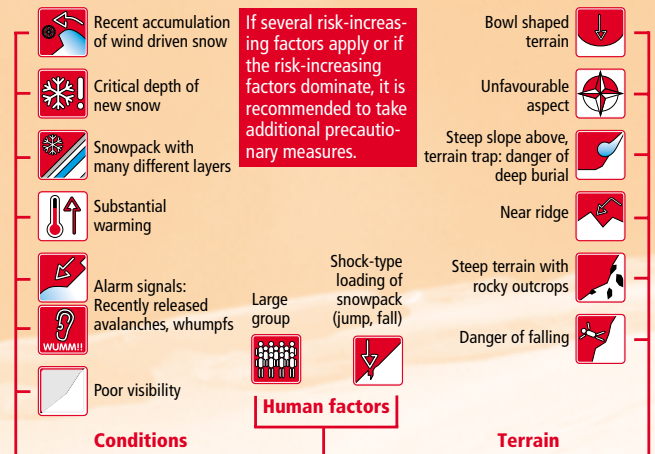
The unfavourable aspects are generally shady slopes (change with season!) and/or lee slopes. Aspect and elevation of these particularly unfavourable slopes are usually described in the avalanche bulletin.

If we do not know the conditions, if we can't make observations, or if the unfavourable slopes are not specified in the bulletin, we assume all slope aspects to be unfavourable. If there is a difference, we may assume a lower danger for the slopes of favourable aspects (typically about one degree lower).

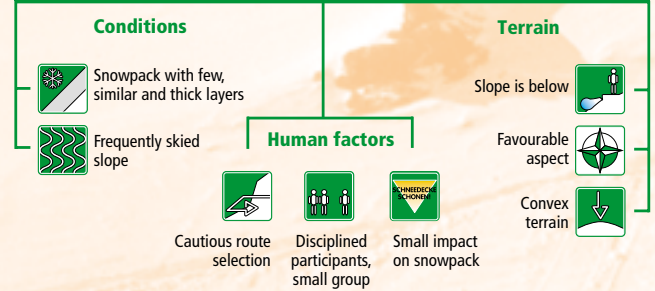
For the slopes of unfavourable aspects, the following is recommended:



## Factors increasing the risk



## Avalanche risk



## Factors decreasing the risk

### Example:

If «moderate» danger is prevailing, it is recommended to avoid extremely steep (>40°) slopes of unfavourable aspects, and to take additional precautionary measures on very steep (35°-40°) slopes.

### To determine the slope inclination, the degree of avalanche danger needs to be considered:

- If «low» or «moderate» danger is prevailing, the steepness in the surroundings of the tracks (20m) is relevant. Keep in mind that terrain steeper than 30° in the green domain is still potential avalanche terrain.
- If «considerable» danger is prevailing, the whole slope needs to be considered and its steepest part is relevant.
- If «high» danger is prevailing, we keep away from steep slopes (>30°).

In frequently skied terrain, exceptions from the above recommendations might be acceptable.



### Elementary safety measures (to apply in general)

- Be informed about weather and avalanche conditions, trip planning.
- Inform others about planned route.
- Always set transceiver (rescue beacon) to TRANSMIT (check functioning), carry an avalanche shovel and a probe.
- Constant reassessment of: weather, snow, terrain, human factors, time schedule
- Circumvent recent accumulations of wind-driven snow.
- Consider the variations in temperature depending on the time of the day and the impact of radiation (also on the way to the hut).
- Ski down extremely steep slopes one at a time.

### Additional precautionary measures (to apply in particular if alarm signs are present)

- Avoid steep terrain with rocky outcrops and gullies.
- Keep distances between each other (while climbing up at least 10 m, while skiing down keep further apart), or ski down one at a time.
- Define a descent route, ski gently, avoid falls.
- Avoid the steepest part of the slope.
- Stop and regroup on islands of safety.
- In case of fog or bad visibility in steep, unknown terrain: turn back!

About 90% of all avalanche victims have triggered the fatal avalanche themselves.



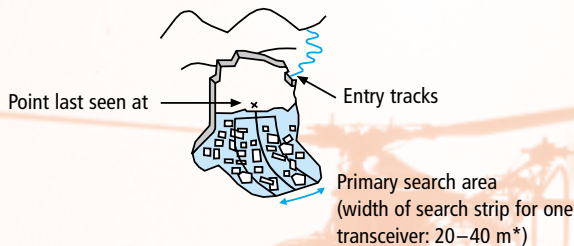
# Avalanche accident – Rescue

## If caught

Try to escape out of the avalanche area (rarely possible); let go of ski poles, try to open bindings, pull your knees toward your chest and hold your arms in front of your face.

## If not buried

### Keep calm – Fight



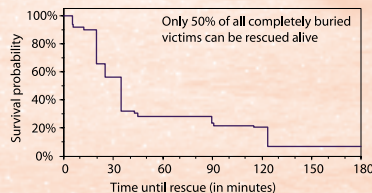
- Watch the avalanche flow and the persons caught (note the point last seen at).
- Gain an overview – think – act. Assess your own safety, avoid further accidents.
- Determine primary search area (in the flowing direction below point last seen at).
- Begin searching immediately with transceiver (turn off transceivers that are not in use) and at the same time search with eyes and ears.
- Alert rescue service.

If transceivers are not available:

- Search with eyes and ears.
- Alert rescue service.
- Systematic repeated improvised probing

(\*: Width of search strip and search according to specific transceiver manual)

### Avalanche danger = Danger of death



## First aid for avalanche victims

- Dig methodically, make a large hole.
- Uncover head and chest as fast as possible, clear the breathing passages, check if there is a breathing cavity in the snow.
- Start artificial respiration (mouth-to-nose), if circulation has stopped, start cardiopulmonary resuscitation simultaneously; continue resuscitation until a medical doctor takes over.
- Prevent further cooling.
- Position the victim according to injury.
- Watch and take care of the victim very carefully.
- Careful evacuation by helicopter

## Alarm

### Phone

Swiss air rescue (Rega): 1414 (all of Switzerland, except in Valais)  
KWRO/OCVS: 144 (Valais)  
Police: 117

### Radio

161.300 MHz (E-channel)  
158.625 MHz (K-channel, police)

## Accident report

**Who** is calling (Name, phone number, location)?

**What** happened?

**Where** is the accident location?

**When** did the accident happen?

**How** many completely buried victims, helpers?

**Weather** in the area?



### Concise report = Effective help

## Air rescue

Do not approach the helicopter before the rotor has stopped. While the rotor is running, only get in and out in the company of a crew member and always stay in eye contact with the pilot.

