wyssen avalanche control

• Artificial Avalanche Release Systems
• Avalanche Detection Systems
• Weather Stations
• Avalanche Control Consulting & Contracting
wyssen avalanche control AG

The pressure is high to keep transport routes open and people safe, and effective avalanche control is the key to protect roads, railways, power plants and ski resorts in a reliable and cost-effective way. wyssen avalanche control offers a wide range of products and solutions for avalanche control, the main method being artificial avalanche release. Construction measures such as avalanche barriers, protective tunnels and galleries lead to very high investments and running costs. Our range of modern, environmentally friendly systems is unrivalled in terms of reliability and effectiveness. As a Swiss based company and native mountain people and alpinists, we are familiar with the alpine particularities and have a deep understanding of the problematic nature of avalanches.

This allows us to offer you optimal solutions starting from the project planning phase to the delivery and running of installations with the proverbial Swiss Quality in terms of effectiveness, reliability and support.

wyssen avalanche control is the market leader in Switzerland and has more than 190 towers in total installed in Europe as of 2011.

Reference Project Zermatt

Zermatt Valley, Switzerland

In the valley of Zermatt there are more than 30 avalanche paths endangering the traffic lines to Zermatt. During high season in winter up to 30’000 people are moving in and out of Zermatt per day.

Before 2004, the avalanche control in Zermatt Valley was mainly conducted by delivering explosive charges into the avalanche starting zones by helicopter. But this method only works during good weather conditions and daylight. During snow storms one has to wait for good weather, and with the old system this often caused situations where the snow accumulation was too big by the time the helicopter could fly and they were not able to do avalanche control due to the danger of destroying the railroad and other installations in the valley.

Since the terrain at the avalanche starting zones are extremely rough and inaccessible, the avalanche control team in Zermatt Valley was looking for a very reliable and remote controlled system with high efficiency (allowing the release of small portions of snow) and no susceptible supply lines in the terrain. In 2004 the first Wyssen Avalanche Tower was installed for a pilot project. A couple of years later, the evaluation process concluded that it is a highly effective way of securing the important roads and railways in the area.

Wyssen Avalanche Towers are used for more than road protection in Zermatt. In 2011 there are in total 30 towers that protects the ski resort and the people in the slopes.

And there are already plans to install even more towers to protect both the ski resort and the traffic lines. Zermatt is the most famous ski resort, and the one generating the largest turnover in Switzerland. Within this region only best quality and most reliable products for avalanche protection are accepted by the responsible authorities.

According to Bruno Jelk, Director of Avalanche Control Organisation of Zermatt Valley, Wyssen Avalanche Towers provide a unique possibility of releasing critical snow masses in even very inaccessible areas:

- Using avalanche towers has proven to be the most effective way of releasing small, controlled avalanches because the Wyssen towers provides explosives being detonated above the snow cover, which has a significantly higher effect than explosives being detonated on or under the snow surface.

In 2004 the first Samnaun Ski Resort began to install Wyssen Avalanche Towers. Later the community of Samnaun also decided to go for avalanche towers to optimize their avalanche safety concept for the roads and exposed parts of the villages. The state government of this region also decided to install Wyssen Avalanche Towers to protect a state highway and railroad by controlling the recognized Gonda Avalanche. This project was financially supported by the federal government and a scientific case study was done to document all important aspects of the project. The conclusions thereof led to the county deciding to install Wyssen Avalanche Towers to protect more avalanche zones in eastern Switzerland.

By January 2011, there are 67 Wyssen Avalanche Towers protecting the risk areas in the Silvretta Mountains for the safety of the people in ski resorts and on traffic lines.

Sarah Siegels, Head of the Avalanche Control Team in Ischgl, Austria, is very pleased with the results:

- For several years we used another system for remote triggering of avalanches, but the concept of the Wyssen Avalanche Towers as well as the service agreements they offer, convinced me choose their solution for the systems afterwards. The reliability and the effect of the avalanche towers as well as the high service level measured against the low operation costs, makes Wyssen Avalanche Towers the optimal choice for us.

Reference Project Silvretta Arena

Ischgl-Samnaun-Galtür, Switzerland/Austria

The ski resorts in the Silvretta Arena are endangered by avalanches at such a high level that the avalanche control staff used up to 20 tons of explosives per season to make sure that the people on ski slopes or in the tramways were safe from avalanches.

The charges were mainly delivered manually by the control staff. They had to ski to the danger areas and throw charges in the snow. This means high risk for the personnel, too long delay before the ski resort could be reopened and a very low effectiveness due to explosion inside the snow cover, which is not very effective.

In 2001 the Samnaun Ski Resort began to install Wyssen Avalanche Towers. Later the community of Samnaun also decided to go for avalanche towers to optimize their avalanche safety concept for the roads and exposed parts of the villages. The state government of this region also decided to install Wyssen Avalanche Towers to protect a state highway and railroad by controlling the recognized Gonda Avalanche. This project was financially supported by the federal government and a scientific case study was done to document all important aspects of the project. The conclusions thereof led to the county deciding to install Wyssen Avalanche Towers to protect more avalanche zones in eastern Switzerland.

By January 2011, there are 67 Wyssen Avalanche Towers protecting the risk areas in the Silvretta Mountains for the safety of the people in ski resorts and on traffic lines.
Wyssen Avalanche Towers work very well for large-area avalanche starting zones due to the big effective range produced by the use of big explosive charges detonated above the snow. This way of releasing avalanches is known for best results compared to other methods; it creates a high-frequency N-shaped shock wave which is important for big effective ranges.

The flexibility when it comes to location and installation makes it possible to install towers even on ridges or to build a higher tower in order to have the charge hanging higher in the air, and this makes it possible to reach even more of the potential avalanche starting zone. Thanks to the remote control of this systems they are very quickly available for fast interaction even during snow storms or in the middle of the night.

But the biggest advantage is that no personnel has to approach the danger zones to perform avalanche control. The charges can be prepared inside weather protected buildings without having to do tricky and dangerous handwork in cold and stormy weather.

For inaccessible and remote areas, which most often is the case for avalanches endangering roads, railroads, power lines, etc. the Wyssen Avalanche Tower LS12-5 is the best solution. For avalanches with easy and safely accessible starting zones, the Mini Tower LS4-5 is an ideal alternative.

Wyssen Avalanche Towers

Avalanche Tower LS12-5

Construction and function
- The tower is permanently installed in the avalanche starting zone
- A magazine with 12 explosive charges of up to 5 kg each is placed on top of the tower
- The helicopter pilot can put the magazine on the tower or lift it off without needing a flight assistant, using the special helicopter link and the guiding device on the magazine
- The operation is carried out with software on a PC via coded radio connection
- A charge is dropped by means of a triggering mechanism and remains hanging on its retaining line above the snow
- During the drop, dual ignition is pyrotechnically activated and the detonation takes place after a time delay
- The magazine is brought back to the station by helicopter for reloading, servicing and safe storage during the summer

Advantages
- Blasting above the snow with larger charges creates the maximum effective range (Up to 260 m in diameter)
- Weather independent and rapid release
- No personnel in the avalanche danger zone
- Comparatively low investment and low impact on nature
- No vulnerable feed lines are necessary; energy is supplied by solar cells on the magazine
- Compact and tightly sealed magazine: All critical and moving parts are well protected
- Safe and simple preparation of the charges
- System integration possible with measuring stations for decision-making assistance

Weight 680 Kg
The Wyssen product range covers these requirements with either the Wyssen Mini Tower, Charge Carrier for explosive cable ways or the Avalancheur Cannon.

The best way to determine which system to use for a specific area is an inspection visit by our avalanche control team. With the range of products available in the Wyssen portfolio we will find the solution that best fit the terrain and conditions in the area you want to protect from avalanches.

Other Products for Avalanche Control

Mini Avalanche Tower LS4-5

- The tower is permanently installed in the avalanche starting zone
- A magazine with 4 explosive charges of up to 5 kg each is permanently installed on top of the tower
- Reloading is done manually
- The electric power is supplied by cable
- For start-up of the system a key locked switch has to be activated
- The deployment of a charge is performed by radio signal of a walkie talkie
- During the fall of the charge two igniters are activated for triggering of the charge
- The explosion takes place above the snow when the charge is hanging on the cord
- The height above the snow is variable by adjusting the length of the cord

Advantages
- Blasting above the snow with larger charges creates the maximum effective range (up to 260 m in diameter)
- Simple and less costly alternative to the Avalanche Tower LS12-5
- Remote controlled release allows weather independent and fast interaction
- No personnel in the avalanche danger zone

Avalancheur

A canon to propel explosives into the avalanche zone.

- The Avalancheur is installed in a central safe and accessible location
- The 1.8 m long projectile is loaded with 2.2 kg of liquid explosives
- Pressurised nitrogen is used for the propulsion of the projectile
- By directing the canon and adjusting the gas pressure, the projectile can be shot without visibility into the desired avalanche zone
- The explosive will be initiated as soon as the projectile hits the snow cover and leads to a detonation above the snow

Advantages
- Detonation above the snow cover
- Reach of up to 1.5 km
- The 2-component explosive is safe to use since it doesn’t detonate until the two components are mixed
- In case of a dust the explosive will be inert after some hours
- Weather independent interaction
- Arbitrary amount of targets to supply
- No personnel in the avalanche danger zone

Lacroix

Simple and proven technology serving avalanche protection.

- manually or electrically driven
- optional fully automatic control system
- charge can be fixet either on the suspension or on the charge dropper
- triggering after a time delay or by activation of the charge carrier

Advantages
- Blasting above the snow with larger charges creates the maximum sphere of action (up to 260 m in diameter)
- With one installation several fracture zones can be embraced
- Triggering is independent of weather conditions
- No personnel in the danger zone
- Low investment costs for short lengths of cableway
- Detonation point can be chosen at any point along the cable route

Charging Carrier for Cableways

The charge carrier can take 2 or 4 charges and improves the efficiency for explosive cable ways.

- The carrier is installed on the connection device of the explosive cableway
- Up to 4 charges of 10 kg can be transported at the same time
- The power is supplied by battery
- The carrier is transported to the desired point for avalanche release by the cableway
- The release of a charge is initiated by radio signal from walkie talkie
- During the fall of the charge two igniters are activated
- The charge will detonate after a time delay at the desired height above the snow

Advantages
- Air blast with big charge
- Considerable saving of time
- Weather independent releasing
- One device can be used for different cableways
- Low weight of 11 or 16 kg without charges
- Low investment for a big improvement of an existing system
We would like to point out that radar radiation is completely harmless. The low weight of the radar device enables it to be operated in either means of PC software. Furthermore the monitoring area can be partitioned into different sectors, Avalanche radar can detect speeds from 1 km/h up to 300 km/h. If the signal exceeds a pre-determined threshold value, an alarm signal which can detect avalanche activity up to a distance of two kilometres. Additionally avalanche radar makes it possible to detect spontaneous avalanche activity and in combination with a traffic light switch, it can be used for operating road closures. Moreover the information about spontaneous avalanche activity is very important when estimating local avalanche risk.

Advantages of Radar

- New innovative radar technology specially developed for detecting avalanches
- Robust and compact design developed for the harsh Alpine climate
- Low energy consumption that enables power to be supplied by solar panels
- Remote maintenance and data transfer using the mobile phone network
- Wide area of applications, since debris flow and rock falls can also be detected
- No time-consuming and cost intensive installation in the avalanche slope necessary

Basic Principles of Artificial Release of Avalanches

For a successful artificial release of an avalanche, or respectively to be able to exclude the possibility of an occurrence of an uncontrolled avalanche to the highest degree of certainty, some basic rules must be observed at all costs. These rules are based on theoretical considerations that have been substantiated by measurements in the terrain. They also are in accordance with the practical experience of the users in the terrain.

The objective of artificial avalanche release is to create a sufficiently high additional stress in the snow cover, so that either a potential avalanche is released or in the case of a negative blasting result, no subsequent uncontrolled spontaneous avalanche or avalanche released by a skier can be expected. The most important criteria for this objective are the snow slab danger in deep winter conditions is the rate of pressure rise of the additional stress on the snow. It follows from this that the maximum pressure above a certain level is no longer relevant. The maximum required additional stress at a distance of 100 m and more will only be attained if this rise in pressure is rapid enough.

It is of the utmost importance to attain a justifiably effective range around the detonation point, so that all possible weak points (hot spots) in the potential avalanche fracture zone are covered. In March/April 2011 and 2012 and under the guidance of Dr. H.U. Gubler, we carried out measurements of the blasting efficiency of different explosives and gas mixtures. It became apparent that only pressure waves created by explosives could create the necessary rapid increase in pressure, so that at distances of more than 70 m, if there were a negative blasting result, it could be assumed that no further uncontrolled avalanche has to be expected. With explosives optimised for avalanche release, effective radius of up to 140 m could be measured with charges of 5 kg. Detailed information concerning this: Gonda Case Study, may be ordered from avalanche@wyssen.com

Wyssen - a Network of Specialists

In the sector of avalanche protection measures, know-how from various disciplines is in demand. Mostly at the start it requires an avalanche expertise that taking into account the local features and protection targets, includes possible solutions protocols and also an avalanche protection concept. A well-equipped and efficient avalanche commission not only needs optimal installation of measuring stations for wind, temperature, snow depth and snow drifts as aids for decision-making. We are pleased to offer you a sound concept, the construction and installation of our systems.

Due to the fact that cornices can hardly be released by detonations above the snow, we now offer planning and installation of Kolskofen (turbulence generators), jet roofs or snow fences.

Avalanche Control Contracting

Since the consequences of an uncontrolled avalanche can be so devastating, it is of utmost importance that avalanche control is carried out in a professional way.

We offer general consulting and can help with any aspect related to avalanches control, from risk analysis, solution definition and general planning to installing and running of most suitable measurement and releasing systems as well as all service and maintenance needed.

Our experienced avalanche control team works closely with local avalanche experts, local and regional authorities, external meteorologists and geologists.

There are many advantages to outsourcing avalanche control projects:

- No investments needed - we provide the necessary equipment
- No in-house expertise or training of personnel needed
- You get access to international expertise on the field
- Reliable protection of roads and railways
- Risk analysis, operation and service & maintenance is included

Avalanche Radar

The radar device permanently monitors a pre-defined area of the avalanche fracture zone and can thus reliably detect when an avalanche has been set off. In combination with the Wyssen avalanche towers, radar enables successful blasting to be verified. The information about whether an avalanche has been released together with a rough estimation of its size can significantly reduce the residual risk when carrying out avalanche protection work.

Endangered areas are scanned with a so-called “Pulsed Doppler Radar”, which can detect avalanches activity up to a distance of two kilometres. If the signal exceeds a pre-determined threshold value, an alarm signal is set off. This alarm signal can be given on location (e.g. a warning tone, warning light) and/or it can be sent as a text message or by email.

Avalanche radar can detect speeds from 1 km/h up to 300 km/h. Furthermore the monitoring area can be partitioned into different sectors, the so-called “Range Gates”. This technology permits certain areas to be excluded, should these be the cause of false alarms.

In addition to the alarm signal, the radar data can also be visualised by means of PC software. Its low energy requirements enable the avalanche radar to be powered by solar panels and thus be positioned anywhere in the terrain.

The low weight of the radar device enables it to be operated in either stationary or mobile modes. We would like to point out that radar radiation is completely harmless.

Basic Principles of Artificial Release of Avalanches

The avalanche radar in combination with the Wyssen avalanche towers is in operation for protecting the B158 Silvretta road in Paznaunait (Ischgl, Tirol). For protecting the road, avalanches are artificially released with five avalanche towers. The radar is installed in the valley on the opposite side and monitors the avalanche release zone (distance approx. 1,800m).

Experiences gained from the winter 2011/12 have demonstrated that the radar detects small artificially released avalanches, as well as spontaneous avalanches and thus supplies important information to the avalanche commission.

Avalanche Detection

In the last decade the artificial release of avalanches has increasingly gained in importance. Avalanche towers are today put into operation mainly in ski areas in order to safeguard the ski slopes, but also are utilised for safeguarding traffic infrastructure. Up to recently, in poor visibility conditions, it could not be checked, or only to a limited degree, whether blasting had been successful. For the persons responsible for safety it is extremely important to know whether or not an avalanche has been released after a detonation. It is also important that the local safety personnel and the regional and national avalanche warning services receive information about spontaneous avalanche activity. For this reason we have decided to expand our range of products and now offer radar on our avalanche towers for detecting avalanches.

We are pleased to offer you a sound concept, the construction and installation of our systems.

With this we have convinced the Tyrolean State Commission for Natural Disaster Protection (Katastrofenschutzkommision Tirol). For protecting the road, avalanches are artificially released with five avalanche towers. The radar is installed in the valley on the opposite side and monitors the avalanche release zone (distance approx. 1,800m).

Experiences gained from the winter 2011/12 have demonstrated that the radar detects small artificially released avalanches, as well as spontaneous avalanches and thus supplies important information to the avalanche commission.

Reference Project Ischgl

The avalanche radar in combination with the Wyssen avalanche towers is in operation for protecting the B158 Silvretta road in Paznaunait (Ischgl, Tirol). For protecting the road, avalanches are artificially released with five avalanche towers. The radar is installed in the valley on the opposite side and monitors the avalanche release zone (distance approx. 1,800m).

Experiences gained from the winter 2011/12 have demonstrated that the radar detects small artificially released avalanches, as well as spontaneous avalanches and thus supplies important information to the avalanche commission.
Weather Stations

Reliable and exact weather data are important basics for a well-organised avalanche control service. However, for each of these applications completely individual boundary conditions exist. Thus for measuring these data there are no standard solutions, and flexible systems which are optimised for the specific requirements are required. From the development of a suitable measurement concept to the choice of optimal components from a wide range of sensor technology, communication solutions and well-conceived and flexible mechanical structures down to fully configurable, powerful station programming (upgradable at any time) and data evaluation, our automatic weather stations are totally aligned to these requirements.

The powerful solar power kit and the diverse modes of communications allow an autonomous operation and thus the widest possible flexibility in the choice of an optimal location. The various types of well-conceived, robust mechanical carrier systems and the whole station concept are designed for efficient installation and low-maintenance operation. The completely remote controlled maintenance work, numerous built-in control functions and the high quality of the components and materials used guarantee high availability of the measurement data. Thus they can serve as a valuable foundation for successful projects in a wide variety of applications in science, research or operational services.

**General tech. Specifications**

Manufacturer: Sensalpin GmbH, Davos
Data acquisition: Campbell Datalogger
Communication:
- addressable UHF radio connection with repeater-function
- short distance broadband radio network
- GSM / GPRS
- Ethernet

Solar power kit:
- Battery capacity for long station autonomy
- Optimised charging control and low discharge protection
- Configurable energy saving function

Programming:
Flexible, freely configurable programming with complete remote control maintenance, self-tests and monitoring of all important components.

Mechanical construction:
Can be placed on any substrate without a concrete base, is simple to install, robust and durable

and too...
- Optimised for simple installation and maintenance and long-term operation under the harshest environmental conditions
- Modular construction and flexible design

**Snow Monitoring Station**
Reliable current weather and snow depth data from potential avalanche fracture zones are fundamentally indispensable for avalanche warning.

**Typical measurement parameters**

<table>
<thead>
<tr>
<th>Measurement parameter</th>
<th>Standard-Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow depth</td>
<td>Campbell SR50A with optimised measurement algorithm</td>
</tr>
<tr>
<td>Snow surface temperature</td>
<td>IR AlpG contactless infrared measurement</td>
</tr>
<tr>
<td>Snow and ground temperatures</td>
<td>Campbell T107 NTC Thermistor</td>
</tr>
<tr>
<td>Wind</td>
<td>Young 05103 specially reinforced and optimised High mountain version</td>
</tr>
<tr>
<td>Air temperature</td>
<td>Campbell T107 thermally isolated assembly in radiation shield</td>
</tr>
<tr>
<td>Relative air humidity</td>
<td>Rotronic Hygroclip HC2</td>
</tr>
<tr>
<td>Air pressure</td>
<td>Setra CS100</td>
</tr>
<tr>
<td>Other sensors and parameters on request</td>
<td></td>
</tr>
</tbody>
</table>

**Snow Measuring Station**

Drifting of snow by the wind is an important factor for the formation of avalanches. Good wind measurements thus form an important basis for assessment of the current avalanche situation.

**Typical measurement parameters**

<table>
<thead>
<tr>
<th>Measurement parameter</th>
<th>Standard-Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>Young 05103 specially reinforced and optimised High mountain version</td>
</tr>
<tr>
<td>Air temperature</td>
<td>Campbell T107 thermally isolated assembly in radiation shield</td>
</tr>
<tr>
<td>Relative air humidity</td>
<td>Rotronic Hygroclip HC2</td>
</tr>
<tr>
<td>Air pressure</td>
<td>Setra CS100</td>
</tr>
<tr>
<td>Other sensors and parameters on request</td>
<td></td>
</tr>
</tbody>
</table>

**Wind-Measuring Station**

The wind is often called the architect of avalanches. Good wind measurements thus form an important basis for assessment of the current avalanche situation.

**Typical measurement parameters**

<table>
<thead>
<tr>
<th>Measurement parameter</th>
<th>Standard-Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>Young 05103 specially reinforced and optimised High mountain version</td>
</tr>
<tr>
<td>Air temperature</td>
<td>Campbell T107 thermally isolated assembly in radiation shield</td>
</tr>
<tr>
<td>Relative air humidity</td>
<td>Rotronic Hygroclip HC2</td>
</tr>
<tr>
<td>Air pressure</td>
<td>Setra CS100</td>
</tr>
<tr>
<td>Other sensors and parameters on request</td>
<td></td>
</tr>
</tbody>
</table>

**Snow Drift Station**

Drifting of snow by the wind is an important factor for the formation of avalanches and thus for the assessment of the current avalanche danger. For measuring snowdrifts the acoustic drift sensor "FlowCapt" is used. This worldwide unique instrument from the Swiss company IAV Engineering develops and supplies a good quantitative index about the drifted snow quantity and after periods of precipitation accompanied by strong winds.

**Typical measurement parameters**

<table>
<thead>
<tr>
<th>Measurement parameter</th>
<th>Standard-Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>Young 05103 specially reinforced and optimised High mountain version</td>
</tr>
<tr>
<td>Relative air humidity</td>
<td>Rotronic Hygroclip HC2</td>
</tr>
<tr>
<td>Air pressure</td>
<td>Setra CS100</td>
</tr>
<tr>
<td>Other sensors and parameters on request</td>
<td></td>
</tr>
</tbody>
</table>

**General technical specifications**

No-obligation consultation
We will be pleased to advise you about your concept and offer you optimal information for a well-functioning avalanche service.
Contact: avalanche@wyssen.com