WHISTLER MOUNTAIN AVALANCHE CONTROL PROGRAMME

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Introduction

Whistler Mountain is located at about 50° North latitude by 123° longitude, in the Pacific Coast Range of British Columbia, about 115 km north of Vancouver. The Peak of Whistler is at 2200 m and the base altitude is 640 m with the top lift terminal at 1950 m. Although the skiing terrain at Whistler is at a relatively low elevation, treeline is about 1800-2000 m, and the upper portion of the area is alpine. Most of the ski slopes, and virtually all of the slopes controlled for avalanches, have aspects facing between northeast and northwest.

Climate

In British Columbia there are two basic climatic zones: coastal, which is distinguished by moderate temperatures and abundant precipitation, and interior, where temperatures are generally more extreme, and there is less precipitation, with much of the interior being semi-arid. Whistler is situated 50 km from the end of Howe Sound, a long inlet of the Pacific Ocean, and also about 50 km from the dividing line between the coastal and interior climatic zones. Whistler Mountain itself has two climate zones. The lower mountain, from 640 m to 1280 m, has a coastal climate. It is similar to the classic West Coast ski areas of Washington State. Temperatures are usually just about the freezing level. There is a moist air flow in from the ocean, and commonly a damp fog layer hangs around the 1280 m level. Rain is not infrequent, especially in the late spring. Avalanche danger on the lower mountain is quite rare, occurring only on very steep slopes immediately after a very heavy snowfall (greater than 30 cm in the previous 12 hours).

The upper mountain, from 1280 m to 2200, has a rather interior type of climate with colder temperatures, dry snow, and frequent strong winds. Rain is quite rare. Obviously, there is considerable overlap between the upper and lower mountain zones, but the only times they act as a unit are during lengthy periods of clear, high pressure weather, especially if there is a north wind, when the air temperatures become isothermal from valley floor to mountain peak.

There are two basic storm patterns: from the southwest over the mountains directly from the ocean, and from the southeast from storm tracks moving inland from the ocean and up the northwest southeast oriented valleys to the east of Whistler. These southeast storms generally bring more snow. The storms often go for five days and may run back-to-back for up to two months without a break.

It must be emphasized that Whistler is a West Coast area and thus gets considerable snowfall (1200 cm-1900 cm at 1650 m) and moderate winter temperatures (temperatures below -20°C were experienced only on four occasions during the season of 1975/76). Temperature gradient snow is therefore not usually a factor in slab instability.

Types of Avalanches

At a rough estimate, 97% of the slides on Whistler consist of the most recent layers of snow. These are not necessarily small slides - especially if there has been no control in an area during three-five days of continuous storm. Although the terrain at Whistler is sufficiently steep for severe avalanche problems, the snow is actually quite stable. Given the possibility of two-three days settlement time after a storm has ended, most unstable situations would become stable. It is really skier traffic that forces artificial control. As soon as they are opened after the control work, the steep alpine slopes are cut up by the skiers. These most recent layer-type slides are usually soft slab, and may descend a few hundred meters.

Some 2% of the slides involve more than the most recent layer of snow. These can be large slides with deep fracture lines, 1 m is common, and over 2 m has been recorded - and are frequently hard slabs. They are generally associated with crusts in the snowpack, but accurately diagnosing these layers in snow pits has so far proved to be very difficult.

The remaining 1% of the avalanches are of a type that seems peculiar to Whistler. Early in the season, usually late November and early December, the early season snow accumulation will slide on the permanent snow fields. The surface of the fields is invariably suncupped and rock hard. Obviously there is a poor bond between the new snow and the old. The problem is to diagnose whether the condition exists, and when the snow will release. This situation does not arise every year and we do not compile an accurate record of early season weather and snow accumulation. The best solution has been awareness of the problem and constant blasting over a period of weeks of the permanent snow field areas until a slide results or we feel confident there is no more danger. In the past, these slides have been giant hard slabs, with fracture lines from 1 m to 4 m deep and up to 0.5 km wide.

Methods of Explosive Control

Hand-Charges - The basic unit is a 1 kg cartridge of Submagel 95%, a nitroglycerin explosive with a detonation rate of approximately 7300 m/s. This is combined with a 1 m shunted safety fuse using a No. 6 cap. Usually these charges are used singly. However they may be occasionally combined into doubles and triples in special circumstances.

Approximately 55 single hand-charges are used on the upper mountain on a full control day, distributed over seven routes.

Avalaunchers - The avalauncher payload consists of 1 kg Penolite booster utilizing a mechanical impact detonation system. The projectile is propelled from the gun by a "quick release" of compressed nitrogen. Maximum target range is approximately 2000 m.

We use three avalaunchers firing over ranges of 300-1200 m. The system depends upon a skilled operator who can make corrections according to wind, air density and the mechanical state of his equipment. We have approximately 31 avalauncher targets on a full control day.

Coordination

Experienced patrolmen utilizing area knowledge and radio communications work in two-man teams to cover the mountain which is divided into three zones (A, B and C).

At 0700 hours, 10 to 12 patrolmen depart the Valley Station by ski lift. Weather data is collected en route at Mid-Whistler. Readings of temperature, new snowfall and wind are taken, as well as observations of snowfall intensity. At approximately 0740 hours, the patrol arrives at the Alpine Office (1850 m). One man immediately takes weather readings, while others begin to prepare charges. The patrol leader examines the chart of the recording anemometer as wind and wind transportation are key factors in slab formation in our area. The patrol leader makes an initial evaluation of the avalanche hazard and decides on the intensity of control measures to be employed.

By 0800 hours, the first control teams depart. On an average day, the patrol leader will send out three hand-charge teams and one gun team to cover Zone A. In exceptional situations, up to two other teams are sent to cover lower mountain areas. At approximately 0815 hours, a second gun team departs the Alpine Office. Their job is to clear the more inaccessible high alpine slopes of Zones B and C, many of which threaten routes that are later taken by hand-charge control teams.

Within one hour of arrival in the alpine area, feedback starts to come in from the Zone A control teams. Special attention is paid to reports from indicator slopes. A team also reports snowfall measurements taken at a lower study plot (1610 m). Upon receiving this feedback, combined with the initial results of Gun #2, the patrol leader may revise his hazard evaluation and adjust the intensity of control planned for Zones B and C. If all goes well, Zone A will be cleared for skiing by 0845 hours, the time at which the public begins to arrive in the upper mountain area. Zones B and C will be opened later in accordance with visibility, control results, weather forecasts, etc.

Helicopter Control

Under certain circumstances, specifically good visibility, significant new snowfalls and the prospect of large crowds, helicopter control may be utilized. Using this method, eight men are used to control Zone A by conventional means, while three men control Zones B and C from the helicopter with takeoff typically planned for 0845 to 0900 hrs. By 1000 hrs., control of Zones B and C will be completed and the areas may be opened to the skiing public.

Helicopter control does, however, have shortcomings. Firstly, it is severely limited by weather--good visibility and low wind being necessary factors. Secondly, the "feel" for the snow that control teams experience while hiking is eliminated. Instability in coastal weather patterns and long storm cycles tend to make this method unreliable for much of the year.

Cornice Control

Many methods have been used in our area to place cornice charges. Generally, a buried charge is implanted into drilled or shovelled holes. Spacing and depths are a very subjective variable. One overall observation we have made shows that slower speed powder in the neighbourhood of 4000 m/s is superior to high speed powder for cornice control. Slow speed powder seems to produce the desired clean shearing effect, while high speed powder seems to produce a messy shattering effect.

Clean shearing is, of course, desired for safe, efficient opening of corniced areas. Through the early season, we will periodically hand-charge corniced areas and, in the latter parts of the year, as instability increases, we will drill and blast corniced areas. Typically, several hundred meters of cornices are blasted each spring.

Discussion

KANZLER: What are your manpower requirements for an average day?

STETHEM: From 10 to 12 patrolmen. We control 60 to 80 days each season, using 1000 avalancher rounds and 2000 hand-charges.

WEYGANDT: What type of hand-charges do you use?

STETHEM: 95% Submagel, manufactured by C.I.L. The weight of each charge is just over 1 kg.

KINGERY: How does the ski patrol feel about going under avalanche slopes that have been controlled in a whiteout, when it is not clear that the slopes have been stabilized?

STETHEM: We over-control when we are not sure of results. Often, we fire twice on each target.

KINGERY: Is the explosive content of your Avalauncher projectiles sufficient to protect control teams? We feel that the 75 mm Howitzer or recoilless round is undersized.

STETHEM: We would also like to use larger charges, but we cannot afford the expense. Avalauncher rounds with the present explosive charge of about 1 kg cost $11/round.

LACHAPELLE: What is your dud-rate with the Avalauncher?

STETHEM: From 3% to 3½%, i.e., about 30 duds each season. We tried searching for our duds in the winter, but this proved impossible since they penetrate quite deeply. Instead, we search for duds from June to October.

ANDERSON: Is the Avalauncher dud unstable?

STETHEM: We experimented and found that an armed Avalauncher round will detonate when dropped on its nose from a height of over 1 m.

KANZLER: What are your maximum target ranges with the Avalauncher?

STETHEM: With a 1 kg payload, we can fire to about 1200 m. But we cannot reach 1200 m with a 1 kg payload if the target is a considerable elevation rise above the gun.

KINGERY: How do you drill holes for cornice blasting?

STETHEM: At first we tried using an auger, but that was too time-consuming. Now we either shovel a shallow hole or form a hole pounding in an aluminum pipe. We increase the amount of explosives if we cannot drill a deep hole.