AVALANCHE NEWS

SUMMER 1997 VOLUME 52

CANADIAN AVALANCHE ASSOCIATION

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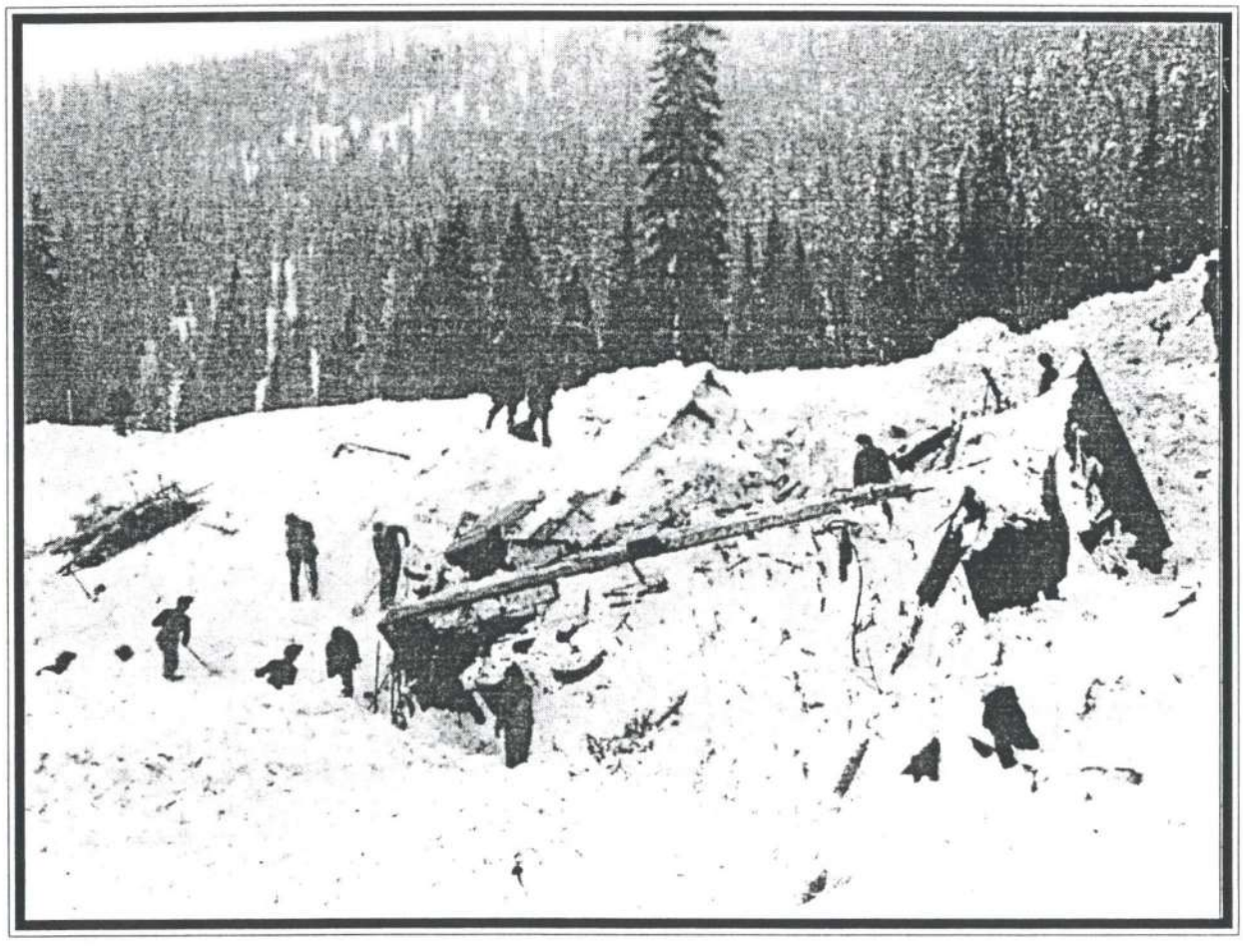


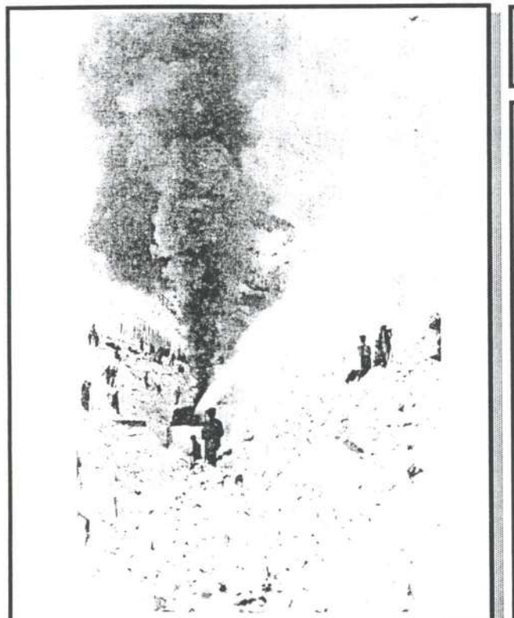
The worst avalanche in Canadian History: Rogers Pass, March 4th, 1910. 62 people were killed.

WEIS WORDS FROM THE PRESIDENT

BY NIKO WEIS

I choose to invest time in the Avalanche Industry and in particular with the C.A.A. because I find the most inspirational and constructive people, in the highest concentration, here. It is my goal to continue to attract and maintain these kind of people in ever increasing concentrations, to work within our Association and Industry. People have made us what we are, great people make a great Organization. As a member of the Board of Directors of the C.A.A. for 6 years I have witnessed the Association reach a very strong position, through the genius and dedication of many individuals and the harmony of many. I am very pleased to have this opportunity to work more closley with the people and challenges that are the C.A.A.

Sincerely, Niko Weis
President
Canadian Avalanche Association



1910 Avalanche photos by
Byron Harmon from Banff, Alberta

FROM THE EDITOR'S DESK

BY LYNN FREELAND

Welcome to the 1997 summer issue of Avalanche News. This is my first ever publication and I hope you can bear with me as I learn to produce a newsletter that everyone will enjoy and look forward to receiving. Our front cover depicts the worst avalanche in Canadian history and also provides the introduction to a series that we are hoping to include in future issues of the Avalanche News. With the help of our reading audience and some other closely involved people, we will give you the details of the History of the Canadian Avalanche Association. We will welcome all input pertaining to this project, which can be mailed, faxed, phoned, or e-mailed to us at the Canadian Avalanche Centre. The input of our members is particularly important....
If there are other ideas that any of you might have for articles please feel free to contact me at the Centre. As you will note the deadline for the next issue is October 1,1997.
I think you will find this an interesting newsletter. I know that I found it very interesting to put together.
I hope all of you have made the transition from winter to summer and are taking advantage of the warm weather. I know I'll be enjoying the sun and all the fine things that go along with summer.

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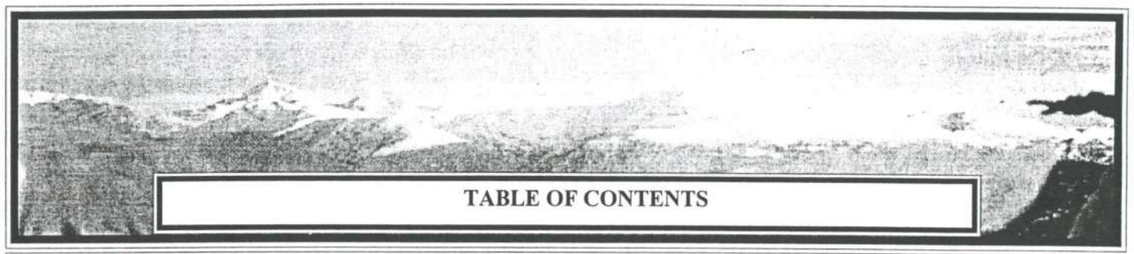

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MINISTRY OF TRANSPORTATION AND HIGHWAYS SNOW AVALANCHE PROGRAMS

1996-1997 YEAR END SUMMARY

Introduction

This winter was "a big one" compared to average conditions experienced for avalanche areas which affect public highways, particularly in the southern part of the province. Although the northern avalanche areas experienced some unusual conditions, they did not have an extraordinary season.

The challenge to monitor conditions throughout the province, where there are 70 avalanche areas with over 1,600 avalanche paths, is at times monumental. There are 21 technical field staff located at the prime avalanche areas throughout the province. They are supported by 8 head quarters staff based out of Victoria.

The winter of 96-97 will be remembered for two significant events; the November 11th layer and the late December-early January storm (Storm of 96). The November 11th layer was responsible for many large avalanches throughout the winter and early spring and was unfortunately the cause of some backcountry fatalities as well. The Storm of 96 caused extensive road closures throughout the southern part of the province. One closure in the Fraser Canyon lasted over a week in duration.

Weather

Winter weather arrived early in November with below average temperatures throughout most of the province. Precipitation amounts in the south exceeded normal amounts while in the north they were about average or slightly below.

The most significant effect the weather had on the snowpack was the development of the November 11th layer. This layer of faceted crystals formed on a crust which developed as a result of rain falling at high elevations between November 8-12. On November 13 temperatures dropped significantly, forming a widespread crust. Unseasonably cold temperatures persisted for the next 10-13 days throughout the province, in addition to variable amounts of precipitation (20cm at Whistler, 90cm at Duffey Lake, 121cm at Kootenay Pass). The weak snowpack structure which developed due to these weather conditions resulted in avalanche failures for the next 3-4 months throughout much of the Rocky Mountains, Columbia Mountains and Coast Mountain ranges. The most recent area to be affected by the November layer occurred on May 8th (almost 6 months after the layer formed) in the Duffey Lake area (size 4.0 natural).

This unique sequence of weather conditions and subsequent effects on the snowpack prompted a research paper by Dr. Bruce Jamieson titled The Facet Layer of November 1996. In this paper Dr. Jamieson indicates that "dense layers such as crusts tend to increase the temperature gradient just above and below the crust." The combination of a wet dense crust, almost two weeks of very cold temperatures with cold dry snow above it resulted in a temperature gradient which supported the formation of a persistent "micro layer" of facets.

The Storm of 96 began on December 28 and raged on until January 3. This storm was responsible for 54 separate road closures during this time, mostly in the southern half of the province. At one point during this storm there were 26 highways closed, resulting in massive restrictions of travel. The area most adversely affected was the Fraser Canyon, Allison Pass and Coquihalla avalanche areas where the length of road closure for the Fraser Canyon alone exceeded 200 hours.

Based on historical weather and avalanche occurrence records, this storm ranks as one of the most severe experienced so far this century.

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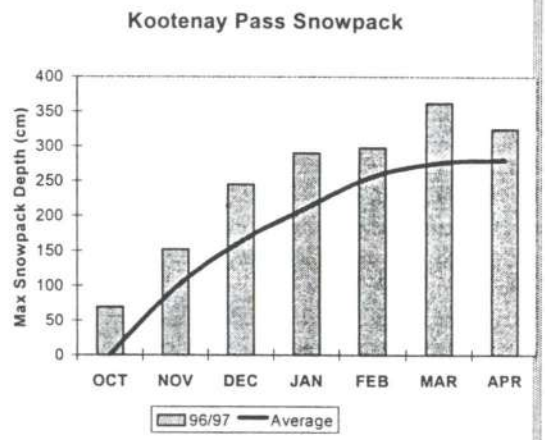
Snowpack

For the months of November and December most of the southern half of the province experienced colder temperatures than normal along with above average precipitation amounts. Many areas reached snowpack levels that were above average throughout the winter and well into the spring.

In the north the snowpack during the early part of the winter was shallow. Uunseasonably cool temperatures developed a facet layer, which contributed to significant avalanche occurrences later on in the winter.

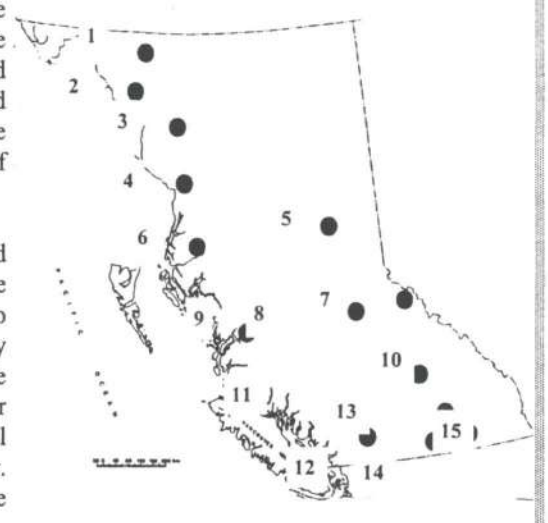
The November 11th layer did not see any boundaries and could be found in avalanche areas throughout the southern portions of the province to as far north as the Bear Pass (Stewart).



Avalanche Activity

The weather and snowpack conditions which developed early in the winter was a contributing factor to the extensive avalanche activity which occurred throughout the early to middle part of the winter. Locations such as Kootenay Pass, Revelstoke and the Nelson areas saw almost continuous avalanche cycles throughout the months of November, December and January. By late December avalanche hazard levels became critical for many areas in the south with the onslaught of the "Storm of 96". The number of avalanches recorded during this 9 day period exceeded 1,150. Of this amount, 870 affected the highway.In the northern avalanche areas two of the more active avalanche cycles occurred in late January and early April. Both of these cycles produced numerous large avalanches.

One of the extra levels of responsibility for the Stewart based avalanche crew was to manage the avalanche hazard situation above the community of Stewart. Mount Rainey poses a significant threat to this community with start zone elevations over 2,000 meters directly above both the townsite and harbour. In addition to managing the hazard in the Bear Pass, closures of municipal roads and the harbour must now be co-ordinated in order to ensure their protection. Several closures were necessary in areas affected by Mount Rainey this winter. One of the more memorable events dusted the eastern portion of the townsite from a size 4.0 and left a deposit which measured 13 meters in depth.



MOTH has15 locations providing avalanche info.

The total number of avalanches recorded above provincial highways this winter was 4,153. Many areas exceeded their average number of avalanche occurrences, especially the Fraser Canyon.

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Road Closures

As can be expected, the duration of road closure times exceeded average amounts this winter. The total length of time provincial highways were closed due to high avalanche hazard was 1,600 hours. Most of this occurred in the southern avalanche areas. Closure times for avalanche areas in the north was about or slightly less than average.

Summary

It becomes clearly evident that active winters like the one we just experienced can be reasonably managed with the existence of well designed safety measures. For many who have taken the annual avalanche awareness course, reviewed the Avalanche Search and Rescue Plan or participated in yet another probe line and beacon practice,... it all made sense this winter. Hopefully, in subsequent winters, those who questioned the value of avalanche safety training and related safety measures will remember the "winter of 96-97" and participate with heightened awareness and enthusiasm.

For the avalanche technicians and their crews, a good part of this winter was wildly exciting. For parts of the winter, it was also tiresome and frustrating to deal with almost continuous storms, the lurking November facet layer and the additional work load and stresses of "a big winter". However, like any difficult task that has been successfully dealt with, the sense of accomplishment and pride of doing a good job is also there (not to mention a few grey hairs - you should be so lucky to have some, hair I mean - any colour will do).

It may take a few weeks for avalanche crews to work this one out of their system, but one thing is for sure, they will all be ready to do it again next season. A little older perhaps, but also a little wiser, for having been a part of the winter of 96-97.

Mike Boissonneault
Senior Avalanche Officer
Snow Avalanche Programs

ANNUAL GENERAL MEETING 1997

The Annual General Meeting was held in Penticton B.C. on May 08, 1997. Members and other interested people enjoyed the warm and sunny weather that prevailed over the entire week of meetings. Many took advantage of this and managed to do some climbing or a round or two on the golf course.

Jack Bennetto opened the meeting and welcomed everyone. In his report he discussed the extensive 96-97 avalanche activity; the helicopter accident of Jan 11,1997; the Public Avalanche Workshop in Vancouver on November 23, 1996; the programs for professional development; and the development of a workshop for CAA members.
The results of the mail in questionnaire were discussed and listed in order of preference:

- advanced avalanche forecasting
- hazard mapping
- use of computers
- new developments in the field
- calculation of runnout distances
- weather forecasting

Other presented topics were the member support registry, improving membership processing, the joint CAA/CSPS recreational avalanche course project and the completion of the book, *Avalanche Accidents in Canada Volume 4*.
Also discussed were the reorganization of the Canadian Avalanche Center, with the proposal to create the positions, using existing staff, of an Executive Director and a CAC Manager. The Executive Director would deal with member business, public relations and fund raising, while the CAC Manager's duties would include Infoex, administration of schools and the business of the Center.

Bruce Allen provided the Treasurer's Report, with the Association still in a strong financial position (complete financial statements can be obtained at the Center). Alan Dennis talked about the Public Safety Services and expanding our programs into Eastern Canada.

New statistics were provided for the membership with 20 new active members, 5 new associate members and 1 new affiliate member. One member resigned. The totals are now 212 active members, 52 associate members, and 4 affiliate members for a grand total of 264 members. Niko Weis then outlined the problems of record keeping in the past and proposed that anyone having a dispute with the records that state they owe back dues will not be required to pay. He also asked that the members be honest in this regard and pay them if they know they are in arrears. The dues of 1998 (due January 1, 1998), will be assessed a late dues penalty of $25.00, which will be charged if dues are not paid by the finish of the 1998 Annual General Meeting.

Peter Schaerer gave the Education Committee Report, with an increase in students to 348. The Level I courses had 280 participants while the Level II had 43 participants. Seventeen people took part in the Transportation And Industry Course and new for this year was the Snowmobile Course which had an enrollment of 8 very enthusiastic participants. Phil Hein coordinated the courses this past winter. A second educational project underway is the Recreational Avalanche Course being organized by Randy Stevens. The next educational project will be the Professional Development Courses for the membership.

Mike Boissonneault gave the Explosives Committee report. Resolution of the safety fuse situation was the main project of the committee. The Ensign Bickford Company will supply a safety fuse product next winter. There will be ISO plant production with x-ray quality control, an information sheet with the product will be a type of waiver and a mandatory training program will be

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implemented. The committee wrote a letter to Energy Mines and Resources re: fuse concerns. The letter, which was sent under WCB's signature, requested complete and thorough testing and then approval for the new product. The time line for availability is next season.

Dave McClung gave the Technical Committee Report and the revision sheet to guidelines stating that Torsten Geldsetzer and Colanni Bezzola had helped extensively. Corrections and revisions will not occur again until 2001, but the committee will accept suggestions until that time. Please send these suggestions to the CAC. This Committee is also reviewing the Doug Abermite video in relation to it's Technical Standards.

Jack Bennetto gave the APEGBC committee report. They held a meeting June 14, 1996. A fall presentation to APEGBC was canceled. Jack spoke of a APEGBC's support for a Memorandum of Understanding that is now in the works. However, the progress of negotiations is slow. He also discussed the Forest Practices Code Act that comes into effect June 15, 1997. A letter is being sent out to the Provincial Land Managers outlining the purpose of our Association and the resources available through our Association. Jack proposed that committee remain but become the professional development committee.

Dan MacDonald provided the Associate Member Report. The membership decided they would like to have contact with purchasing clientele; access to information and contacts; and training benefits. Membership dues were made to equal Active member dues.

Don Bachman gave the American Association Avalanche Professionals report. Don introduced Steve Conger of the Utah Department of Transport, who was also in attendance. The AAAP has 256 professional members, and 35 affiliate members out of total of 494 members. An Executive Director position for the AAAP was established. The AAAP Centre is in Boiseman, Montana. Don outlined the structure of the AAAP. He then discussed the WestWide Network that has 85 subscribers with 110 having access. He highlighted the association's publication *The Avalanche Review* and the association's support of the National Explosives Committee which was formed after the Big Sky accident.

Chris Stetham coordinated the elections. Chris then outlined the proposed executive board of Niko Weis for President, Marc Ledwidge for Vice President, Bruce Allen for Secretary/Treasurer, Diny Harrison for Membership Director, and Bob Sayer for Director at Large. Chris asked for nominations from the floor. Bill March was nominated for Director at Large. All were elected. Dan MacDonald was elected by the Associate members at their meeting as Associate Director. The Membership committee of George Field, Rod Gee were elected. Alberta Auditors Peter Ahman and George Field were elected.

A presentation was made to outgoing President Jack Bennetto, a Tina Turner Poster, and new skis for his wife Diana.

Scotty Morrisin did a Workers Compensation Board presentation re: the new policy of Due Diligence. (See article in this issue.)

New business for the 1997 executive began with discussions on membership and professional development.

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UNDERSTANDING DUE DILIGENCE

submitted by S. Morrison, affiliate member.

In spite of high profile prosecutions and fines, many employers still don't understand the concept of due diligence. This article will explore the misconceptions, with a view to clarifying for employers the true meaning of due diligence and it's proper use in the courts.

Quite simply, due diligence means taking care. In the workplace, that means taking all reasonable care in the circumstances to protect the health and safety of the workers. Due diligence must be part of the behavioral attitudes in the workplace and cannot be made up after the fact.

The duties of employers are spelled out in the Act and include:

- providing equipment, materials and protective devices as prescribed by the regulations;
- seeing that this equipment is maintained in good condition;
- seeing that the equipment, materials and protective devices that are provided are used as prescribed;
- providing information, instruction and supervision to workers to protect their health and safety;
- appointing a competent supervisor;
- aquainting the worker with any hazards in the workplace;
- carrying out the measures and procedures required by the Act and regulations;
- providing assistance and cooperation to a joint health and safety committee; and
- taking every precaution reasonable in the circumstances to protect workers.

If an employer and it's managers don't understand their duties under the Act, attempts at being duly diligent will simply be hit or miss. Employers often do a poor job of assessing potential hazards in the workplace. The various regulations of the Act specify the risks or hazards in the workplace that should be guarded against. Other dangerous circumstances in the workplace include: incompetence of supervisors, ignorance of workplace dangers, poorly maintained equipment and inadequate instructions and supervision.

The key to understanding the concept of due diligence is understanding the words duty and risk.In any prosecution under the Act, the Crown must show a breach of duty by the employer, and hence should be able to show the employer failed to guard against risk. The defense must show that despite the occurrence of contravention of the Act, all due care was taken in the circumstances.

How does one show all due care? Just as duty and risk can be used to establish negligent conduct, so too can they be used to demonstrate that all reasonable care was taken to prevent the alleged prohibited act.

Understanding not only how the prohibited act occurred, but also why it occurred, is pivotal to the defense. That's because when you answer the question " why did this omission occur?", you will automatically know whether the duty was breached. The duty is tied directly to the prohibited risk.

The law does not stipulate a certain standard for training or supervision; it's up to the employer to set these standards. Often in prosecution, however, employers have no standards to show the court.

To successfully maintain a defence of due diligence, an employer must have performed all of it's duties with respect to the specified risk set out in the charge before the court. The court is not interested in what you did generally to be safety conscious. Due diligence as a defense requires evidence that specific steps were taken .

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The Facet Layer of November 1996 In Western Canada

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Introduction

In November 1996, a layer of faceted crystals formed on a crust throughout much of the Rocky Mountains, Columbia Mountains and Coast Mountains of Western Canada. Unfortunately, the "November facets" formed the failure planes for avalanche accidents in all three ranges. This faceted layer stabilized in many areas by early January 1997—except in a few areas such as the North Columbia Mountains where it released numerous large and often destructive slab avalanches throughout the winter.

In this paper, we summarize the November weather in two areas of the Coast Mountains near Whistler and in the North and South Columbia Mountains. Based on the weather records, we propose that the facets were weaker and slower to stabilize in areas that had less snow on the crust during the cold period from November 13 to 23rd. Also, we outline two ways in which a underlying crust can contribute to the formation of facets and instability.

Based on the shear strength, load, temperature and temperature gradient of the facets at Mt. St. Anne in the North Columbia Mountains, we discuss strength changes and two shear frame stability indices.

Weather of November 1996 in the Coast Mountains near Whistler

From November 8th to 12th air temperatures at the Blowdown Mid weather station at 1890 m in the Cayoosh Mountains along the Duffy lake Road reached well above freezing (Fig. 1). Rain fell to ridgetops. With the advancing arctic air, temperatures dropped on November 13th forming a widespread crust. Temperatures remained well below normal until November 23rd. At 1550 m on Blackcomb Mountain, temperatures were 2-3 degrees higher during the 10-day cold period than at Blowdown.

During this cold period from November 13 to 23, an estimated 90 cm of snow fell at 1550 m on Blackcomb Mountain, while only 28 mm of precipitation fell at Blowdown Mid. Although temperatures at the two sites were similar, more faceting occurred in the thinner layer of dry snow above the crust at Blowdown than further west near the where the snow above the crust was roughly twice as thick (S. Aitken, personal communication).

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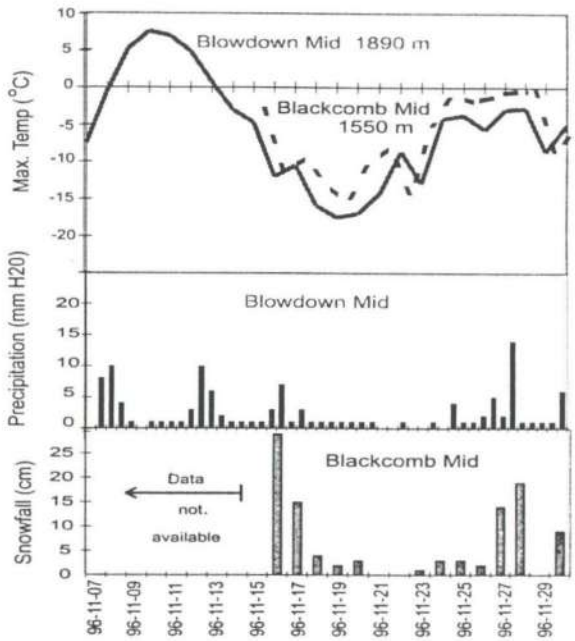

Figure 1. November 1996 weather from Blowdown Mid station in the Cayoosh Mountains and Blackcomb Mid station in the Outer Coast Range.

Stability of the November Facets in the Coast Mountains near Whistler

In the Cayoosh Mountains along the Duffy Lake Road, a major avalanche cycle on December 8th removed the facets from many slide paths. However, the November facets remained unstable in shallower areas not affected by this cycle. Subsequently, occasional dry slab avalanches ran on the November facets as late as March 10th.

In the heavier snowfall area of the Outer Coast Range near Blackcomb where the facets on the crust were less developed, the faceted layer stabilized by the middle of January 1997.

Two factors probably contributed to the November facets stabilizing faster near in the Outer Coast Range near Blackcomb than in the Cayoosh Mountains along the Duffy Lake Road:

- In the Outer Coast Range, the thicker layer of dry snow above the crust resulted in less temperature gradient and less faceting compared to the Cayoosh Mountains where less snow was on the crust during the 10-day cold period.
- The Outer Coast Range usually receives more snow than the Cayoosh Mountains and greater load usually contributes to gradual strengthening of buried weak layers.

Weather of November 1996 in the Columbia Mountains

For November 7 to 30th, maximum air temperatures from two weather stations in the South Columbia mountains (Stagleap, 1780 m, at Kootenay Pass and Galena Pass, 1570 m) and two in the North Columbia Mountains (Fred Laing, 1080 m, near Mica Creek and Mt. St. Anne, 1900 m near Blue River) are plotted in Figure 2 along with precipitation data from Fred Laing and Galena stations.

The temperature reached above 0°C at Stagleap and Fred Laing during heavy precipitation on November 8th, although Kootenay Pass below the Stagleap station received snow rather than rain. From November 9th to the morning of the 13th all stations reported maximum temperatures above freezing, with 5-10 mm of precipitation per day. Rain fell in many areas of the Columbia and Mountains.

Maximum temperatures dropped below freezing at all four stations on the 13th or 14th as arctic air spread over BC. This cold air mass kept temperatures below normal for 10 days. From November 17th to 19th the Fred Laing station in the North Columbia Mountains was several degrees colder than Stagleap and Galena in the South Columbia Mountains. Mt. St. Anne in the North Columbia Mountains was often 5-8 degrees colder than the two stations in the South Columbia Mountains from November 16th to 22nd.

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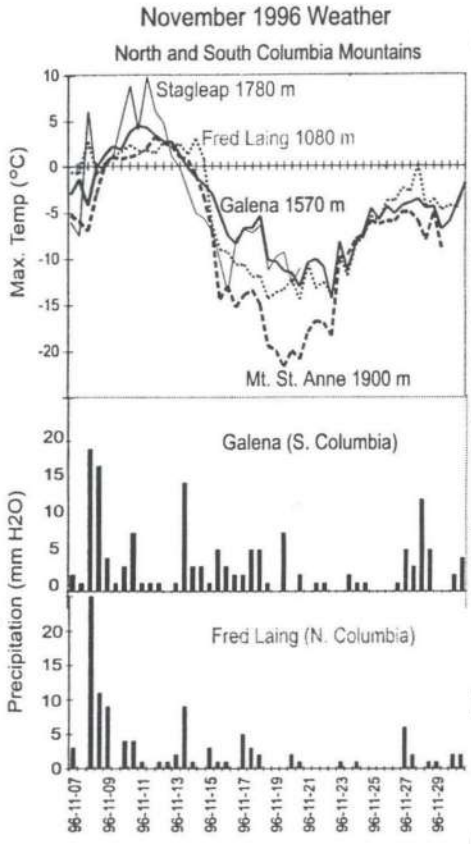

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During the cold weather from November 13th to 26, the North and South Columbia Mountains received different amounts of precipitation. Fred Laing and Mt. St. Anne in the North Columbia Mountains received 32 and approximately 40 mm of precipitation, while Galena and Stagleap in the South Columbia Mountains received approximately twice as much, 60 and 87 mm, respectively. In particular, Kootenay Pass received 121 cm of snow! Clearly, there was substantially more snow on top of the crust in the South Columbias than farther north. Consequently, the temperature gradient in the snow above the crust would have been roughly twice as high in the North Columbias than farther south. As a result of the greater temperature gradient in the North Columbia Mountains, the snow above the crust became more faceted than in the South Columbia Mountains.

Figure 2. Weather from November 1996 at Stagleap and Galena stations in the South Columbia Mountains and Fred Laing and Mt. St. Anne in the North Columbia Mountains.

Effects of Crusts on Faceting

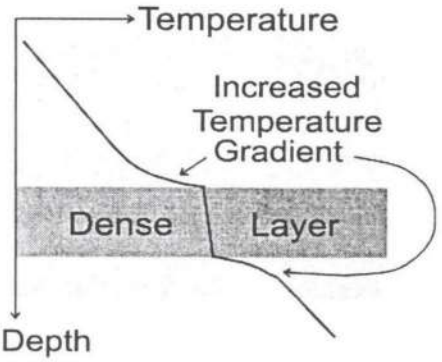

Figure 3 Effect of dense layers such as crusts on temperature gradient (after Colbeck, 1991)

Dense layers such as crusts tend to increase the temperature gradient (Fig. 3) just above and below the crust (Colbeck, 1991). Although this increase in the temperature gradient is often too close to the crust to be easily measured, it explains the observations of facets just above and below crusts when the major layers above and below the crust show no evidence of faceting (Moore, 1982).

As a result of rain or air temperatures above freezing from November 9th to 13th, a surface layer of wet snow formed. Due to warmer temperatures at lower elevations, this layer of wet snow was thicker at, and below, tree line than at higher elevations. This layer of wet snow was buried by cold dry snow on about November 13th, 1996 and froze over time to form a crust. In many areas, cold temperatures in the following 10 days caused faceting in the snow above the crust.

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In the following months, many guides and avalanche workers reported that the facets on the crust were more developed and weaker at, and below, tree line. This is likely a consequence of three factors:

- During the cold weather, there was less snow above the crust at lower elevations and consequently a stronger temperature gradient.
- Cold air may have pooled in valleys causing stronger temperature gradients at lower elevations.
- The layer of wet snow would be thicker—and perhaps wetter—at lower elevations. Because of its stored heat and latent heat, the thicker layer of wet snow at lower elevations would remain at 0°C longer when the arctic air arrived and be slower to cool after it froze. Consequently, the temperature gradient would be greater and faceting would be increased compared to higher elevations where the layer of wet snow/crust would likely be thinner (Fig. 4).

Changes in Layer of Facets at Mt. St. Anne over Winter of 1996

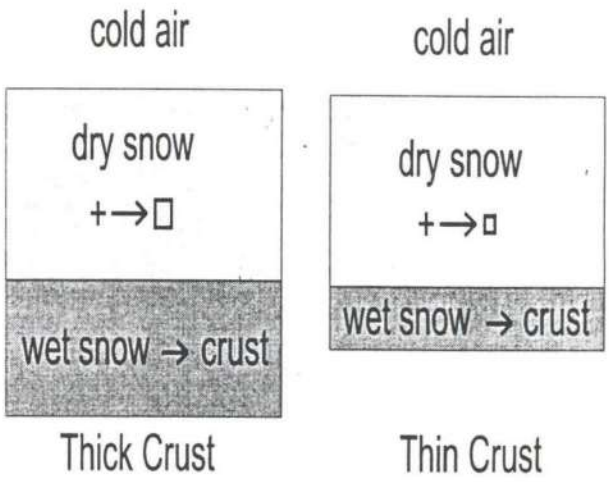

Figure 4. When dry snow and cold air overlie a layer of wet snow, the dry snow is likely to become faceted. The dry snow above the thicker layer of wet snow on the left is likely to become more faceted than the dry snow above the thinner layer of wet snow on the right.

At 1900 m on Mt. St. Anne, the shear strength of the November facets was measured with a 250 cm2 shear frame about once a week from Dec. 11, 1996 to March 21, 1997. As shown in Figure 5, the shear strength increased from 1.5 to 8.4 kPa while the load increased from 160 to 910 mm of water, the temperature of the facets increased from -3.5 to -2.0°C and the temperature gradient decreased from 0.8°C/10 cm to 0.1°C/10 cm. The relatively warm temperature of the facets (> -5deg C), the low temperature gradient (< 1°C/10 cm) and the heavy and increasing load all favour strengthening of the facets, which we measured.

While the November facets gained considerable strength during the winter, the large natural avalanches that slid on the November crust in the North Columbia mountains (most of which occurred during warming or snowstorms) indicates the facets never fully stabilized. In comparison to many other layers of facets in the Columbia Mountains, the 2 mm facets from November 1996 were well developed in the North Columbia Mountains, a factor which may have slowed stabilization. Also, shear due to creep would have been concentrated where the facets met the harder crust. Clearly, the avalanche activity indicates that the layer did not gain strength fast enough to support the increasing load and resist the changes in creep caused by warming. Our current understanding of snow metamorphism and field techniques for measuring snowpack properties do not allow us to quantitatively explain why the layer did not stabilize.

From the shear frame measurements, we calculated two stability indices: the Stability Ratio, SF, (Schleiss and Schleiss, 1970; CAA, 1995) and RBcalc. However, neither index has, to our knowledge, been used for slabs as deep as those that failed in the November facets in the North Columbia mountains—many of which were more than 2 m thick. Schleiss and Schleiss (1970) proposed SF for "new" snow, and our experience with the shear frame stability index, RBcalc, is primarily within the top 1 m of the snowpack. Nevertheless we plot SF and RBcalc in Figure 6 to assess the suitability of such indices for deep weak layers.

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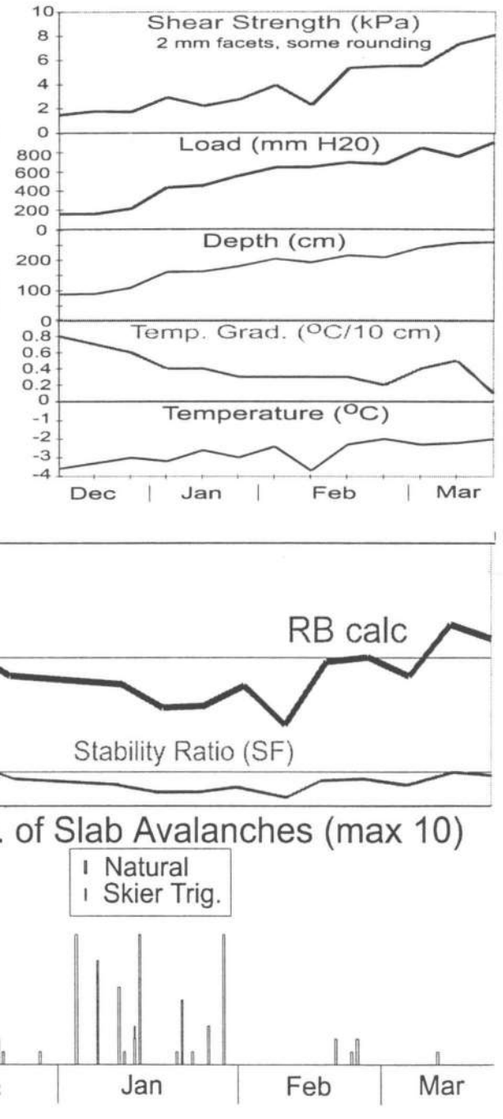

Figure 5. Measurements of the November facets at Mt. St. Anne in the North Columbia Mountains during the winter of 1996-97.

For new (storm) snow, SF < 1, suggests instability and values between 1 and 1.5 suggest transitional stability. Most avalanches occurred while SF < 1. However, there are many days in which SF < 1 and no avalanches failed on the November facets indicating the index underestimates the stability.

For skier triggered slabs within the top metre of the snowpack, RBcalc < 4 suggests instability and values between 4 and 6 suggest transitional stability. While the November facets were being tested with the shear frame, most of the avalanches were naturals and occurred while RBcalc < 4. However, there are many days in which RBcalc < 4 and no avalanches failed on the November facets indicating the index underestimates the stability and may not prove useful for such deep weak layers.

Yet avalanche activity decreased in February and March when the indices approached their transitional values. This suggests that shear frame indices might be modified for such deep weak layers. Such a refined index could be occasionally useful since the November 1996 facet/crust combination was, like the November 1985 facet/crust combination, difficult to forecast (C. Israelson, personal communication).

Figure 6. Stability indices for the November facets at Mt. St. Anne in the Cariboo Mountains and number of dry slab avalanches that slid on the November facets in the surrounding Cariboos and Monashees.

(Continued on page 15)

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Summary

The November facets were slower to stabilize in areas such as the North Columbia Mountains, where less dry snow lay on the crust during the cold period from November 13th to 23rd. We expect the facets were more developed in such areas.

A dense layer such as a crust increases the temperature gradient just above and below the crust, sometimes causing facets to form next to the crust.

Cold snow on top of a thick layer of wet snow is more likely to become faceted than a similar amount of cold snow on top of a thinner wet layer. This probably contributed to the November facets being better developed and weaker at lower elevations than in the alpine.

The stiffness of a crust tends to concentrate shear at the top of the crust. In combination with a weak layer such as facets above the crust, this shear concentration contributes to instability.

Present shear frame stability indices do not appear well suited to a deep instability such as the November facets in the North Columbia Mountains. However, the indices were consistent with the lingering instability of the November facets..

Acknowledgements

For providing weather data on short notice, we are grateful to Jack Bennetto, Ted Weick, and John Tweedy of BC Ministry of Transportation and Highways, to Mike Wiegele and Ken Black of Mike Wiegele Helicopter Skiing and to Graham Tutt of Blackcomb Mountain. Our thanks to Scott Aitken and Graham Tutt for discussing the stability of the November facets in the Coast Mountains with us. For their many deep pits and shear frame tests at Mt. St. Anne, we thank Jill Hughes, Ken Black and Steve Lovenuik.

Our thanks to Chris Stethem, Clair Israelson, Juris Krisjanson, Alan Dennis, Colani Bezzola, and Bob Sayer for ongoing advice and stimulating discussions on deep slabs, and to Ken France for prompting us to look at the weather that formed the facet/crust combination.

For financial support provided we are grateful to Canada's Natural Science and Engineering Research Council and the BC Helicopter and Snowcat Skiing Operators Association consisting of Canadian Mountain Holidays, Cat Powder Skiing, Crescent Spur Helicopter Skiing, Great Canadian Heliskiing, Great Northern Snow Cat Skiing, Island Lake Mountain Tours, Island Sauvage Airmobile Outdoor Adventures, Klondike Heli-Skiing, Kootenay Cat Skiing, Kootenay Heli-Skiing, Mike Wiegele Heli-Skiing, Mountain Heli-Sports, Purcell Helicopter Skiing, R.K. Heli-Skiing, Robson Helimagic, Selkirk Tangiers Heli-Skiing, Selkirk Wilderness Skiing, Sno Much Fun Cat Skiing, Tyax Heli-Skiing, Tyax Lodge Heli-Skiing, Whistler Heli-Skiing, BC Ministry of Environment, Lands & Parks, Canada West Ski Areas Association, Marsh & McLennan and Zurich Canada

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VISIBLE CHANGES IN BURIED SURFACE HOAR OVER TIME

Torsten Geldsetzer, Bruce Jamieson and Colin Johnston
Department of Civil Engineering, University of Calgary

Introduction: As surface hoar builds, its growth rate and shape are determined by the microclimate at the snow surface (Colbeck, 1987; Hachikubo and Akitaya, 1996). The structure that develops is likely to impact on the strength of the layer as it is buried and how it changes over time. For example, surface hoar crystals that grow outwards faster than they grow upwards will intersect with their neighbours and create an umbrella effect, leaving air pockets between the crystals (Davis et al., 1996).

In hopes of being able to visually determine something about the strength of surface hoar layers, we took microphotographs to observe changes over time. Our main study area was in the Bobbie Burns area of the Purcell Mountains. We took pictures about once a week from the beginning of February to mid-March, 1997. Our basic equipment was a normal 35mm camera with a 1:1 macro lens and 100 ASA slide film. With all techniques we used as small an aperture as practical to maximise the depth of field.

Disaggregated crystals were photographed on a 10mm grid etched into the back of a normal black screen. To get a steady shot we used a custom made support (designed by R. Davis of CRREL) with a focusing rail.

In-situ shots were done either back-lit or with a black screen as a background. The latter was done by pushing a crystal screen into the snow about 1 cm behind the front of the wall and then carefully removed the disturbed crystals from the front. With back-lighting, it involved cutting a thin wall perpendicular to the sun and taking the picture on the shaded side. We found that we could get good sharp photographs by just bracing the camera with our elbows in the snow.

What we found: We were able to collect a time series of pictures for the January 17th and February 11th surface hoar layers during the 1996/97 winter. We compared both the in-situ and disaggregated images with the strength changes that occurred over the same time frame.

Initially the settlement of the overlying layer onto the surface hoar crystals caused the layer to thin quickly. This corresponds to a strength increase. Subsequently, the layer maintained its thickness with only slight further thinning. A drastic exception to this occurs when the layer collapses as in a whumpf where the standing crystals fracture and are compacted. Even though the layer is thinner immediately after compaction, it is actually weaker compared to a neighbouring portion of the snowpack in which the crystals are still standing. However, the increased possibility for bond development will cause the strength of the compacted layer to increase more quickly.

Whereas the layers above and below became more dense over time, the undisturbed surface hoar layers retained their relatively low density. We also observed that the amount of lean, from perpendicular to the slope, in the individual surface hoar crystals was not very pronounced even after 5 weeks of burial on a 26+ degree slope, so differential creep between the layers above and below seems minimal.

The bonds at the top of the surface hoar crystals are large and their development over time can be observed fairly easily. However, the bonds at the bottom of the crystals are much smaller and are difficult to see, even with a 1:1 macro lens. Nevertheless it was possible to see differences in bond widths ranging from 1 mm to about 3 mm when comparing images of different surface hoar layers.

(Continued on page 17)

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Disaggregated photography still proved the best method for observing changes in individual crystals. The large surface hoar crystals retained much of their size and shape even after two months of burial. Rounding at the edges did occur and fine striations seen in earlier images disappeared leaving only the larger striations. Clustering of smaller grains seemed to increase with time as did the bonding of surface hoar crystals to one another - both seemed to correspond to strength increases.

The crystal density differed from location to location and layer to layer. Although we only have a small sample number, they do suggest that higher densities have higher strengths. How can this be applied: Large surface hoar crystals change very little, even over numerous weeks. When observing surface hoar crystals on your crystal screen, signs of rounding may relate to strengthening more than any change in crystal size and more emphasis should be placed on strength test results for the layer. Also, the appearance of the surface hoar crystals in the pit wall is relevant. Are they standing or lying, how thick is the layer in relation to their size, are they closely packed or are there lots of air pockets between them.

Acknowledgements: This study is part of a Collaborative Research and Development Project funded by the BC Helicopter and Snowcat Skiing Operators Association and Canada's Natural Sciences and Engineering Research Council. In addition to financial support, Canadian Mountain Holidays and Mike Wiegele Helicopter Skiing also provide logistical support and a productive environment for field studies.

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Hachikubo, A. and E. Akitaya. 1996. Surface hoar growing for several days. Proceedings of the International Snow Science Workshop in Banff, October 1996.

AVALANCHE NEWS

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FIRST EVER CAATS LEVEL I COURSE FOR SNOWMOBILERS

This winter the first technical avalanche course for snowmobilers was put on in Revelstoke. It took a long time coming but was much appreciated by the eight participants, some of whom had been waiting a couple of years to start. Darcy Svederus of the Alberta Snowmobile Association and Ron Niesner of the BC Snowmobile Federation really worked hard on behalf of their organizations for the course. The other students came from Revelstoke, Alberta and Idaho. The course leader was Rob Whelan who has taught numerous recreational snowmobile avalanche courses.

Snowmobile course at morning weather plot.

After the first morning with rain to sub-alpine elevations, the course had a week of clear weather (see photo). The areas of Boulder Mountain, Mt Mackenzie and Keystone were used for field work. The Revelstoke Snowmobile Club set up a weather station at Boulder, taking up all the equipment on the groomer(thanks Jim Pecora) and bringing it down at the end of the course. Even in the first week of April, the Columbias snowpack held some interesting characteristics including the February surface hoar that showed up in all three field areas. We had a super keen group of students. Rob remarked that the best snow profiles, by Level 1 students, were done on this course. Congratulations. It was obvious that the group had a lot of experience in mountain snowmobiling terrain, we covered a lot of distance and observed much.

The requirement for this course for anyone considering leading snowmobile tours is obvious. Although this course does not make a snowmobile guide, it certainly goes a long way in their apprenticeship. As Rob and I learnt during the course the snowmobile guide has some interesting challenges in group management as enthusiasm to travel the terrain can put big distances between the group members. This was an excellent course with very experienced riders. Finally a big thanks to YAMAHA who supplied the machines for the instructors.

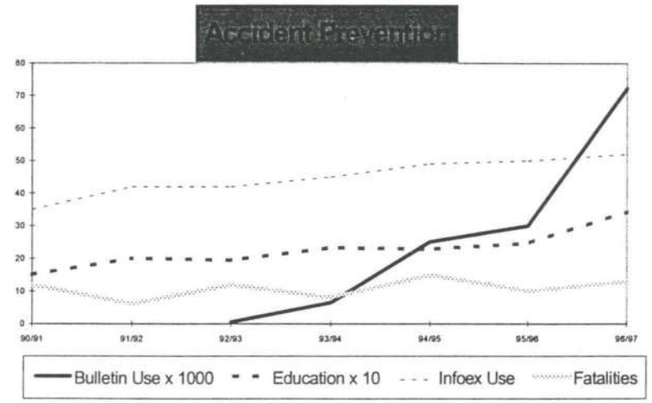
DEADLINE FOR FALL ISSUE
IS
OCTOBER 1st, 1997

Winter 1996-97

PUBLIC SAFETY SERVICES

This was the sixth winter that the Avalanche Bulletin has been distributed from the CAC. The attached graph shows the increase in use counted from direct hits to our 800number, the Vancouver & Calgary cell message locations and the internet. It is getting more difficult to count direct hits because many web and internet users have their own distribution and forward the Bulletin to other users. The graph shows 70 000 direct hits. This does not include the fax network which goes out twice a week from Revelstoke or the tv and radio distribution, particularly during times of High and Extreme Danger. Conservative industry estimates say that 250 000 indirect hits is not unreasonably high.

From information that comes back to the Centre it is interesting to note the increased use of the service by snowmobilers and the general increase in avalanche awareness by all snowmobilers. The most remarkable live recoveries from avalanche accidents this winter were by snowmobilers who were found because they were wearing a transceiver. Five years ago this would not have been possible because hardly anyone riding a snowmobile wore a transceiver or had friends who knew how to use one. Some of this success can be attributed to the development of more avalanche awareness courses for snowmobilers and, for example, innovative sales promotions that include avalanche safety equipment in snowmobiles. Increases in the number of people going into the mountains doing all activities will always challenge our ability to provide the best possible public safety services.



A recent new development in public safety work is the Recreational Avalanche Course project. The National Search and Rescue Secretariat have provided funding under their mandate of prevention to assist the CAA develop a standard for teaching avalanche awareness in Canada. Partners in this project are the Canadian Ski Patrol System, who gave the first avalanche awareness courses in Canada over 30 years ago. With a number of organizations and companies giving avalanche courses in Canada the need for a standard is obvious, particularly for people who go on to professional and technical avalanche courses. At the CAA spring meetings in Penticton all the interested parties discussed the development of this project which should be ready for next winter. If you have any interest or comments about this, contact the Centre.

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Due Diligence
to prevent the alleged contravention.
Due diligence does not mean accidents will not happen. Due diligence means doing reasonable things to try to prevent harm to workers. If an employer cannot demonstrate that it has fulfilled all of its statutory duties, then it can never establish due diligence.
Another aspect of due diligence that employers generally have difficulty with is the idea of foreseeability, which simply means determining the risks in advance. It is now foreseeable that trained workers can inadvertently make a mistake. There are many other risks which are not covered by regulations, instead, it's up to the employer to foresee them and guard against them. Employers will still argue that the failure of an experienced and trained worker is not foreseeable, however that argument doesn't take into consideration that people will take short cuts and run risks. These things are foreseeable and the employer is responsible for ensuring through adequate supervision and enforcement that they do not take such risks.

Once an accurate assessment of the risks and dangers in the workplace has been done, a decision can be made with respect to the employer's duties. The assessment of risks must be an ongoing process. Due diligence is dependent on the present condition of the workplace; not those that existed last year.

Training is another important element in carrying out due diligence. Supervisors must be able to accurately evaluate the abilities of the workers to ensure that training has been absorbed.

When assessing whether or not your company has achieved due diligence, start by understanding the duties imposed on employers. Assess the risks and hazards associated with your type of business. Then look to see whether the risks in the workplace are being addressed by examining your list of statutory duties for each.
Due diligence means taking reasonable care. You can't take care if you don't know the risks around you.

This is a condensed version of an article written for May/June 1994 issue of Accident Prevention by Mark Alchuk, LL.B,Crown Counsel with the Ministry of the Attorney General for the Ontario Ministry of Labour.

(Continued from page 19)

Public Safety Services

Finally, for this report, some explanation of the graph which shows some interesting trends. Attendance at the CAATS continues to grow. As reported elsewhere in this issue there were 344 students this winter. The other one of the three main operations at the Centre is the INFOEX which shows on the graph with an increased number of subscribers. The Avalanche Bulletin relies on InfoEx for its technical information base. The contribution of all the subscribers in gathering this valuable and expensive data is acknowledged with thanks. And still the cycle of avalanches with human involvement will never go away completely but the trend in number of fatalities is not rising as much as the use by all activities, whether ski touring, helicopter skiing, snowmobiling, ice & mountain climbing or highways and industry in the mountains.

JOB OPPORTUNITY

KLONDIKE HELISKIING, operating out of Atlin, northwestern B.C. is looking for:

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Canadian Avalanche Association Training Schools / **CAATS**

WINTER 96-97
TRAINING SCHOOLS REPORT

BY PHIL HEIN

The **1996-97Avalanche Season,** witnessed the same growth trend the **Technical Training Schools** have experienced during the past five years. From an average of 150 students per year through the late 1980's, and 200 during 1990 to 1992, current participation has increased substantially to 343 students this past season, with a total of 17 Level 1 & 2 courses being held in Alberta and BC.

Overall, this represents significant growth of the Schools, with the ensuing organizational challenges for the program. More than fifty instructors are now on the CAATS roster, with 35 instructors involved with this past winters courses. The Centre, which coordinates and provides support for the program, has experienced changes in location, staffing, and organization during the past two years. It is anticipated that with many of these changes leveling off, that the Centre will provide better service and consistent facilitation of the program.

Currently, the most significant area of avalanche safety training, interest and growth, is that of **recreationist's**. The CAA, in a joint project with the Canadian Ski Patrol System, are involved in developing new standard course outlines and materials for independent providers and instructors of **recreational avalanche safety courses (RAC)**.

This initiative, it is anticipated, will better provide the content and emphasis best suited to recreational participants. The RAC courses will in time lessen the demands on the technical training schools, which will continue to provide and focus on skills for persons engaged in industry, or intending on entering the operational avalanche safety field.

The Canadian Avalanche Association and Centre strive to meet the demands growing from people's energetic interest in the mountain environment. In Canada, avalanche professionals, industry/operations and many recreationist's throughout the country, look to the CAA Schools for their primary formative knowledge base. At this time, this keen interest is not leveling off, and initiatives to best suit the various needs for avalanche safety knowledge and training are being pursued.

The brochure for the 1997-98 technical training school courses will be available from the

Centre in August. Persons interested in the program can call and ask to have their name put on the mailing list. **Recreationist's** interested in specific introductory and advanced recreational courses for next winter, can call the Centre in the late fall for a list of independent organizations and instructors who will be providing the updated RAC programs.

AVALANCHE INVOLVEMENTS 1996/97

BY EVAN MANNERS

The winter of 1996/97 was an exceptional winter in many ways. Several persistent snowpack weaknesses developed, and in more than one instance, significant storm occurences swept over the western mountains and triggered avalanche cycles so large they were observed from the Coast all the way east to the Rockies. In many ways, the most exceptional thing about the winter is that so few serious incidents did occur, given the potential for disaster that existed.

Although reports are still trickling in to the CACentre, 108 avalanche involvements have been reported in detail. These incidents affected a total of 152 people and resulted in 13 fatalities. 70 people involved were backcountry skiers, 17 were skiing inside a ski area (usually avalanche control personnel), 12 were skiing in an out of bounds area, 27 were snowmobilers, 2 were in a vehicle, 9 were climbers, and 15 were a variety of other activities. Geographically, 20 incidents were in the Coast range, 53 in the Interior, and 35 in the Rockies.

Of the reports containing enough information (14 unknown), it was determined 76 people were caught only, 50 were partly buried, and 12 were completely buried. Some of the fatalities involved people only partially buried. The following is a brief description of the fatalities:

Yoho National Park, BC
On December 12, a skier in the McArthur Pass area of Yoho National Park was caught by an avalanche he triggered. As the skier climbed a south facing slope, the entire slope propagated from a shallow area trigger at the skier. The slope angle averaged 30 degrees, and failed on the November 11 layer, which was on average 70 cm down in the snowpack. The class 2 slide partly buried the solo skier, who was found later that day when companions reported he did not return.

Whistler, British Columbia
On December 16, a group of 70 skiers, including a German group, were heliskiing in the Spearhead Mountain Range near Whistler, BC. At 2.45pm an avalanche was triggered, partly burying one skier. A sympathetic avalanche caught 4 others from the same group. Of the five skiers caught in the avalanches, two were recovered alive. The three others, two males and one female, were flown to the Whistler Health Care Centre and pronounced dead on arrival. They had been buried for between 30 and 40 minutes. All five persons were located through the use of avalanche transceivers. The original trigger occurred in an area much shallower than the main snowpack, and propagated on the November 11th layer.

Blue River, BC
On January 13, an avalanche occurred in the Monashee Mts. of BC, catching two guests and one guide of a group of heliskiers. At 15:35 a radio call for help was received, and five helicopters of guides and rescue equipment responded. By 16:04 all three persons had been located and first aid had been administered. The victims were then flown by helicopter to an ambulance waiting in Blue River.

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One male was pronounced dead at 17:25 in hospital in Blue River. A second male was transferred to hospital in Kamloops, BC and recovered. The guide was also transferred to hospital in Kamloops, and later died from injuries suffered during the avalanche. The avalanche carried the victims through extreme terrain, and burial depth was approximately 2 metres.

Coquihalla Summit, BC
A party of three young persons were snowboarding in the backcountry near the Coquihalla Summit area of southern BC. One boarder had made part of run and was waiting for other two. They skied together and triggered the slope as they came down. One escaped to the side. The other was caught and carried into a gully below by the slide. The deposit missed the observer waiting below. Avalanche was size 2.5, crown 50m wide by 45cm deep. Deposit 150 meters long by 10 wide by 3+ meters deep, in lower angled portion of gully. Slope angle at start zone 30-35 degrees, aspect SE. Start zone was a classic shaped bowl and was triggered at a convexity in the slope, near the top of the bowl.

The group carried no rescue gear, but located the person after some time searching randomly. After an unsucessful attempt to revive the victim, the group went for help. Local avalanche professionals responded once word reached them, and brought the body to the trailhead.

Nelson, BC
On March 22, an avalanche caught two heliskiers in the Galena area of Interior BC. The two were swept downslope and over a cliff. The persons were located quickly by transceiver, but burial depth was over 2 metres. Neither survived the accident. No further details available.

Golden, BC
On Feb 2, a group of 4 snowmobilers were in Lange Creek, approx 10 km NW Golden, BC. One member of the party was noticed missing, and the other members of the group found a large avalanche when they investigated. The missing person's snowmobile was found on the surface along one edge of the deposit, and tracks of the snowmobile could be seen above the fracture line, climbing up the slope, turning and coming back down.

The missing person did not carry a beacon. He was located 1 hr and 45 minutes later, 35 metres above his snowmobile, in a direct line between it and his tracks above the avalanche, using random probing. He was buried 1.5m in depth, and had not survived the incident.

The avalanche was class 4, 300m wide, and fracture crown varied from 1 to 3 metres. The failure layer was the November 11th layer.

Golden, BC
A group of snowmobilers were riding in the Lange Creek drainage on March 30. Four were taking turns high pointing on a slope, going one at a time. One person triggered a slab, which buried the person and partly buried the snowmobile. His three companions waiting at the bottom of the slope managed to run on foot out of the way of the avalanche, which hit and damaged their snowmobiles parked in the path. None of the people carried any self rescue equipment, but a nearby group were well equipped and quickly organized a coarse probe line to search for the missing person.

(Continued on page 24)

(Continued from page 23)
One of the well equipped group had an emergency radio, and contacted rescue authorities. A trained search dog

and rescue professionals began to arrive by helicopter. The person was found by search dog 3 hours and 10 minutes after he was buried under more than two metres of very dense avalanche debris. He was found 40 metres from his snowmobile, and did not survive the burial.

The avalanche was a class 3.0 dry slab, West aspect, start zone at 2560 metres elevation, with a slope angle of 35-40 degrees, 300 metres wide, and running 300 metres downslope. The slide began on a rain crust under storm snow which fell March 20, and stepped down into lower snowpack instabilities as it ran. Failure depth averaged 2 metres for the majority of the slide.

Rescue teams had responded to an avalanche involving a snowmobiler in the same general area the day before, although that time the person was only partly buried and survived.

Atlin, BC
On March 31, a group were heliskiing near Atlin, BC. The guide and one client had already skied down. When the third client began to ski, a slide propegated on the slope, carrying the person down and completely burying him. A second sympathetic slide began to runt. This slide hit the guide and client waiting at the bottom.

The guide and client were together when hit. The client was found only partly buried in the toe of the deposit, and was dug up within 7 minutes. The guide was found a few metres away, buried 3.5 metres deep. Rescuers had to locate him by transceiver, then shovel part way down before probing was successful, due to the extreme depth. The person in the first avalanche was located by transceiver also, very near the other two. He was buried approximately two metres. He and the guide did not survive, while the partly buried victim regained consuousness at the scene and recovered in hospital.

The two avalanches joined during flow, to form a class 3.5 slab avalanche, from SE to NE aspects in a bowl, running approximately 350 vertical metres. Initial failure was in faceted shallow snow, which propegated over a large area.

(Continued from page 8)
Annual General Meeting

Changes to membership criteria will be voted on next year after the membership has been informed of the proposed changes. Jack will be mailing out Quinton Law's Report from the May 7, 1997.
A motion was carried that the CAA executive pursue a strategy to separate the Public and Professional aspects and activities of the organization to facilitate Charitable status for the former and Professional recognition for the latter.
The 1998 Annual General Meeting and Association Meetings will be held on May 6,7, and 8th 1998 in Penticton B.C. See you all there.

NEW ADVENTURE TOURISM TRAINING MATERIALS AVAILABLE

B.C. adventure tourism operators now have a wonderful new set of industry developed training reaources to use. The Adventure Tourism Series is a set of three workbooks and two videos that have been developed by key industry proffessionals.

The Pacific Rim Institute of Tourism (PRIT), as the official coordinating agency for tourism human resource developement in the province, was pleased to be able to respond to an industry request to help coordinate this project.

The Open Learning Agency developed these resources with input from proffessional guides from around the province. PRIT worked to make sure the materials were formally endorsed by the 15 Associations (and 5 Adventure tpurism programs) involved in the developement. Since that time an additional 6 adventutre associations have become involved in informal discussions to look at a common approach to adventure tourism workforce developement. A successful forum was held last year and discussions are now underway to continue this effort.

If you don't have a set of these great training resources make sure you call for your copies today. They are designed to work for your business.

A special price has been given to all your association members of $105.00 for the complete package (GST and shipping extra). You can order your set from Marlene Morris at PRIT (604) 682-8000

FUSE NEWS

The CAA Explosive Committee has been actively working with representatives from ICI Explosives Ltd in the hopes that a new safety fuse assembly will be made availible by next winter. The poor quality of safety fuse has been the primary area of concern for the Explosive Committee for the past three winters. Since the demise of the CXA plant (which used to supply the industry with safety fuse assemblies) there have been numerous problems with fuses. In this time we have been required, due to manufactures recommendation, to use two fuses for all avalanche control blasting operations. The new safety fuse which ICI expects to supply next year will be made at an ISO (International Standards Organization) plant in Mexico (ISO represents a high standard of quality). The fuse material will be supplied by Ensign Bickford which is very similar in quality to the CXA fuse material previously used by ICI. The fuse will include a 12 grain detonator and a copper thermolite connector. This fuse should be availible in either 1,2 or 3 meter lengths. The Explosive Committee is currently negotiating with ICI to determine conditions of sale. Due to legal concerns on behalf of the US based Ensign Bickford, it may be necessary to meet specific training requirement and signing of a waiver type document prior to qualifying for purchase of the new fuse product. The Explosive Committee will continue to pursue reasonable acquisition of this product on behalf of the CAA. Watch for further updates in the next Newsletter.

Mike Boissonneault Chair,
Explosive Committee
Bernie Protsch
Colani Bezzola
Explosive Committee Members

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