AVALANCHE NEWS

FALL 2001 **Volume 62**

canadianavalancheassociation

*** It's new**

*** It's fresh**

*** It's the CAA**

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MARKETING GUY

New Marketing Guy in Town

After spending the last two years managing an outdoor centre in New Zealand, I figured I would have a hard time finding a new home that could match up… I was wrong. I am more than “stoked” to be living in Revelstoke, a friendly community where climbing, paddling, mountain biking and ski touring exists in my backyard. There’s even a job here for me!

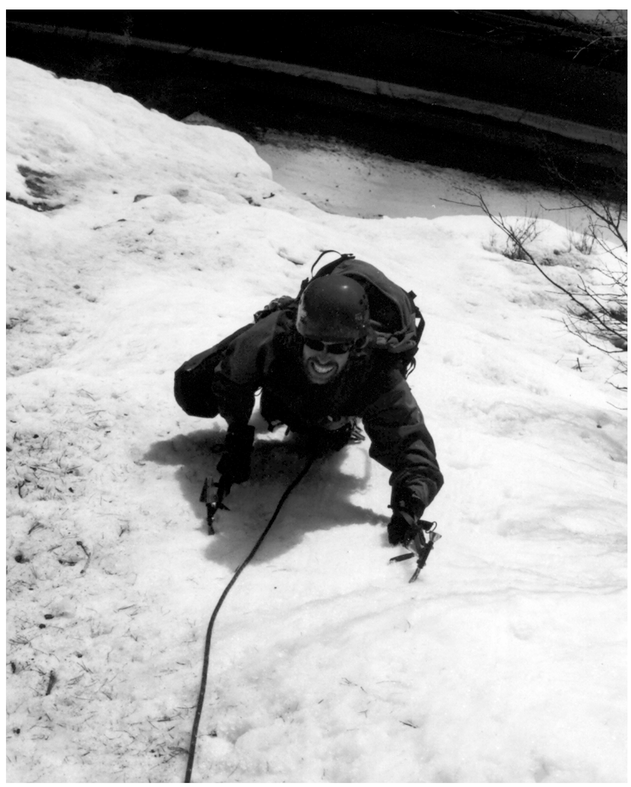
People seem to be surprised when they hear I am the new marketing guy for the Canadian Avalanche Association? “ So…you sell avalanches?” tends to be a common response.

Not exactly…

The CAA relies on corporate sponsors to fund the Bulletin and public awareness events. Campaigning and servicing these generous organizations, organizing public events, and raising our public profile are all challenges that fall under my umbrella.

It’s an exciting time to come on board with the CAA! If you have any leads on potential sponsors or want to share your marketing ideas, please get in touch with me. I look forward to crossing your path, either in the office or the mountains.

Philip Johnston
Marketing/Sponsorship



IN MEMORY OF MARK KINGSBURY

Trusted and respected professional.

Outstanding father and family man.

Considered a friend by all who knew him.

Mark Kingsbury's tragic death has touched us all.

He was a privilege to know in this industry,
and he will not be forgotten!

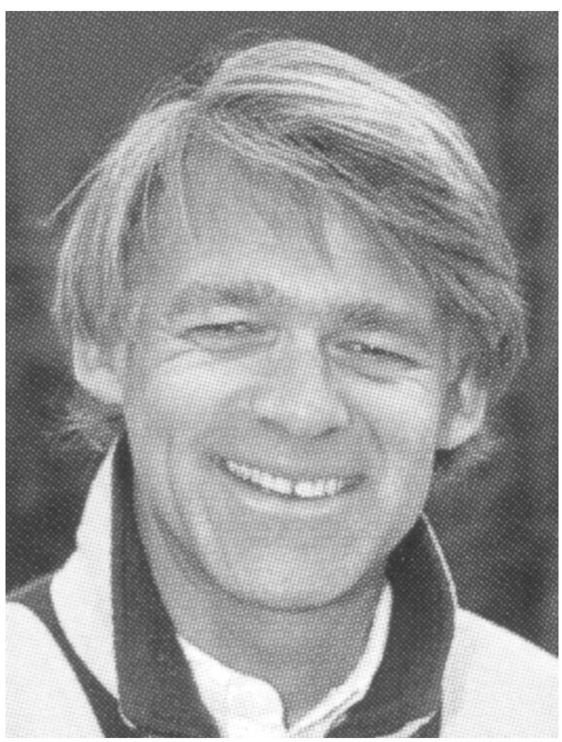


Photo courtesy: Canadian Mountain Holidays

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Revised September 2000

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www.avalanche.ca

CANADIAN AVALANCHE ASSOCIATION 2002 ANNUAL GENERAL MEETING

The dates have been set for next years
Annual General Meeting. May 6th - 10th at the:
Ramada Courtyard Inn
1050 Eckhardt Avenue West
Penticton, BC
V2A 2C3
Reservations: 1-800-665-4966
Ask for Canadian Avalanche Association discount rate.

Participate in the ISSW 2002!

The forum for the exchange of expertise in your field!
The International Snow Science Workshop 2002
Penticton, British Columbia, Canada,
September 29 - October 4, 2002

The ISSW is a biennial workshop dedicated to providing a forum for the exchange of current research and practical applications for snow avalanche hazard management. The theme, "A Merging of Theory and Practice", reflects the partnership of snow scientists and avalanche practitioners.

These workshops began in Canada in 1974. Since that time they have been hosted alternately in either Canada or the USA, held in Canada once every six years. The ISSW has become firmly established as the venue to learn about cutting edge avalanche research and practice. For many years it has attracted worldwide participation. We invite all our colleagues from around the globe to join us in this unique forum.

We encourage you to:
- Register and Attend
- Provide a Poster Presentation
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- Submit a Paper
- Participate in Sponsorship
- Enjoy the Field Trip and Activities Day

For further information see our brochure in this mail-out, and visit our web-site at, www.ISSWorkshop.org

Quebec Collaborative Avalanche Project (QCAP) Status Report :

A meeting took place June 1, 2001 in Quebec city between the CAA (Marc Deschenes, Susan Hairsine and John Kelly) and approximately 25 Quebec stakeholders. The meeting addressed the organization and structure necessary to achieve QCAP goals in a manner that best meets the needs of Quebec stakeholders. Out of this meeting came the creation of a 6 member Facilitation Team and the selection of the Federation Quebecoise de la Montagne et de l'Escalade (FQME) as the storefront to provide Quebec based services to the QCAP.

Marc Deschênes and Susan Hairsine were in Quebec October 19 – 29th to meet with the Quebec Facilitation Team and other stakeholders and to scope potential sites for teaching the series of winter avalanche safety courses.

We explored potential course sites in the Chic-Chocs mountains of Gaspésie with Dominic Boucher, which appears to offer the best avalanche terrain. If the wind doesn't blow the instructors away, the courses will go over well! We also explored sites around the Charlevoix and Saguenay regions for possibly teaching a couple of 2-day RAC's.
Our Quebec guides Alain Couture (Jonquiere), Stephane Gagnon (Montreal) as well as our own Environment Canada meteorologist Alain Bergeron (Rimouski), provided invaluable local knowledge for good course site selection. We then had two days of lengthy meetings with the Quebec Facilitation Team and other stakeholders, and produced a detailed project implementation plan. Details of the Quebec avalanche occurrences and weather project were finalized as was the agreement for course registration and storefront services with the FQME.

CAA professional members Sylvain Hébert, Marc Ledwidge, and Val Visotzky will be helping Marc Deschênes with the RAC, ARAC and SAR course instruction this winter in Quebec. Colani Bezzola is scheduled to provide one week of mentoring for the Gaspe Avalanche Forecasting Center.

The Quebec gang is enthusiastic about the upcoming winter courses. For more information or questions about the QCAP please contact Marc (mdeschenes@telus.net) or Susan (mtnmgmt@monarch.net).

2002 AVALANCHE AWARENESS DAYS

AVALANCHE AWARENESS DAYS BIG SUCCESS!

Thanks to everyone who found time in their busy schedule to help out with our 4th annual "Avalanche Awareness Days"!

This year was bigger than ever! On January 11-13th, twenty-four mountain communities across Western Canada offered free avalanche awareness activities.

Thanks to you, hundreds of recreational skiers, boarders, and sledders gained a new respect for "out of bounds" terrain. Your efforts and commitment to public safety will have prevented accidents and saved lives!

Special thanks to Dave Iles and his snow safety crew for hosting the national Media Day. Our public safety message received excellent media exposure at a national and regional level.

Fundraising events at Fernie, Revelstoke, Shames Mountain, Big White, Kicking Horse and Banff generated a combined total of $2500. These funds will be put directly towards keeping the Public Avalanche Bulletin alive!

Make sure you mark next year's dates on your calendar, January 10-12, 2003.

Thanks to Columbia Brewery, we were able to supply each venue with a new banner and posters. Their continued commitment to public avalanche awareness programs was reinforced this weekend with a generous donation of $11,000 to the Canadian Avalanche Foundation.

FACETED SNOW

STRENGTH CHANGES OF LAYERS OF FACETED SNOW CRYSTALS IN THE COLUMBIA AND ROCKY MOUNTAIN SNOWPACK CLIMATES IN SOUTHWESTERN CANADA

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ABSTRACT: The strength of layers of faceted crystals is important for forecasting snow stability. During the winters of 1993-2000, in the intermountain snowpack climate of the Columbia Mountains and the continental snowpack climate of the Rocky Mountains of southwestern Canada, over 100 strength measurements of 16 layers of faceted crystals were made. Rank correlations are used to relate the strength of layers of faceted crystals with measured snowpack properties and calculated snowpack variables. Additionally, the contrast in snowpack properties between snowpack climates allows comparison between shear strength and snowpack factors. Factors showing the greatest potential for predicting shear strength include load and slab thickness.

KEYWORDS

snow crystals, faceted crystals, snow strength, snow climate, avalanche, avalanche forecasting

1. INTRODUCTION

In southwest Montana 59 % of investigated avalanches between 1990 and 1996 (Birkeland et. al.,1998) and in Canada 26 % of the fatal avalanche accidents between 1972 and 1992 (Jamieson and Johnston, 1992) were a result of failures of layers of faceted crystals. Statistics for Canada show the number of avalanche fatalities is greatest in the continental snowpack climate of the Rocky Mountains and least in the coastal snowpack climate of the Coastal Mountains (Jamieson and Geldsetzer, 1996). To prevent avalanche accidents, avalanche forecasters rely on snowpack data, weather forecasts, and previous avalanche activity. Often weather, snowpack conditions, and time restrict data collection, increasing reliance on snowpack evolution models. However, the shear strength of layers of faceted crystals is often poorly predicted by such models (Fierz, 1998).

Various snowpack variables influence the strength of layers of faceted crystals, but these variables have not been widely studied. In this study, snowpack variables and shear strength of layers of faceted crystals were measured in the continental climate of the Rocky Mountains and the intermountain climate of the Columbia Mountains of southwestern Canada. Relationships between shear strength and snowpack variables are established by using physical arguments and Spearman rank correlations.

2. LITERATURE REVIEW

In a recent study, Stock et al. (1998) observed numerous layers of faceted crystals at Red Mountain Pass, Colorado from December to March. He measured stuffblock scores (Johnson and Birkeland, 1994), and hand hardnesses on valley bottoms and north and south-facing slopes. The study found faceted crystals were larger on north-facing slopes and slower to gain stability and strength.

Jamieson and Johnston (1999) used Kendall-Tau correlations and ranked variables associated with the rate of shear strength change for surface hoar layers. They found the predictor variables that most significantly affect shear strength are height of the snowpack, the maximum crystal size, and slab thickness.

3. SNOWPACK CLIMATES

In southwestern Canada there are three snowpack climate zones: coastal, intermountain, and continental (Fitzharris, 1981; Mock, 1995). Each of these climate zones (Figure 1) has different weather and snowpack conditions. The coastal climate of the Coast Mountains produces relatively warm temperatures and heavy snowfall. The Rocky Mountains have a continental climate associated with cold temperatures and shallow snowpacks. The intermountain climate of the Columbia Mountains is due to an overlap between the coastal and continental weather systems. As a result the intermountain climate has less snowfall than the Coast Mountains, but more than the Rocky Mountains (Armstrong and Armstrong 1987). Typical mid-winter snowpack depths at tree line are 2 m to 4 m in the Columbia Mountains and 1 m to 1.5 m in the Rocky Mountains.

In southwestern Canada there has not been a comprehensive study defining different snowpack climates. Average snowpack and weather data collected from two sites in the Rocky Mountains of Canada and three sites from the Columbia Mountains are similar to Armstrong and Armstrong's (1987) and Mock and Birkeland's (1999) results for the western United States.

The continental snowpack of the Canadian Rockies is known for its layers of faceted crystals and depth hoar. Typically the temperature gradient averaged over the snowpack is greater than the faceting threshold of 10^{o}C/m (Akitaya, 1974) from the first snowfall until the end of February (Figure 2) (Johnson, 2000). The result is layers of depth hoar and faceted crystals. By March, facets and depth hoar deep in the snowpack are warm, under a low temperature gradient, and start to round. However, near-surface faceting still occurs due to localized temperature gradients caused by diurnal fluctuations of air temperature and radiation.

In general, the snowpack temperature gradient never reaches the threshold value of 10^{o}C/m for faceting in the Columbia Mountains (Figure 2). Most of the faceting occurs due to near-surface temperature gradients (Birkeland, 1998). After layers of facets are buried, a thick snowpack promotes low temperature gradients that are associated with rounding of grains and strengthening of layers.

Despite clear divisions between inter-continental and continental snowpack climates, variability of snowpack depth within each climate is common (Mock, 1995). Typically the western slopes of the Columbia and Rocky Mountains have thicker snowpacks and are slightly warmer than the eastern slopes. The eastern slopes of the Columbia Mountains have a transitional snowpack climate between the intermountain and continental climates. As a result the snowpack structure includes more layers of faceted crystals on the eastern slopes than on the western slopes.

4. FIELD WORK

During the winters of 1993-2000, in the Columbia Mountains and the Rocky Mountains of southwestern Canada, over 100 strength measurements of 16 layers of faceted crystals were made. The shear strength of layers of faceted crystals was measured with the shear frame. If the faceted layer was deeper than 75 cm and older than two weeks it was only tested once per week, otherwise twice a week. Measurement procedures for air temperature, layer thickness, layer hardness, snowpack depth, crystal type, crystal size, and water content are described in CAA (1995).

4.1 *Shear frame test*

The shear frame test was used to measure the shear strength of the facet layers. The shear strength of the facet layer was calculated by dividing the recorded minimum force by the area of the frame. The shear strength is then adjusted for the size effects of the shear frame (Sommerfield 1980, Föhn 1987). For a detailed description of the shear frame test see Jamieson and Johnston (In press).

4.2 Slab load

The slab weight per unit area is often referred to as the load on weak layers. Each time shear frame tests were performed, slab loads were measured by two methods. The first method requires all snowpack layers above faceted layers be identified. A cylindrical 100 cm^3 sample of snow from each layer is taken. The slab load is calculated by taking the product of gravity and the sum of layer thickness and densities.

Load = $g\ (r_1h_1+r_2h_2+\ldots..)$

where r is density and h is the layer thickness.

The second method is known as a “core load”. Vertical core samples of snow to the depth of a desired layer are extracted from the snowpack and weighed. A cylinder with a cross sectional area of 28 cm^2 is inserted down into the snowpack until it reached the faceted layer or is full. The load is calculated by dividing the weight of the samples by the cylinder area and the number of cores.

4.3 Snowpack temperatures

The temperature profile of the snowpack was measured with digital thermometers in 10 cm intervals. Temperatures were also measured 5 cm above, below, and in the faceted layers.

5 RESULTS AND DISCUSSION

5.1 Rank correlations

The shear strengths of layers of faceted crystals are a result of the interaction with various snowpack variables. These are termed predictor variables because they might be useful for predicting shear strength (Table 1).

The response variable is the shear strength S. To assess snowpack factors that are associated with changes in shear strength the data were rank correlated in three climatic categories:

continental snowpack climate

intermountain snowpack climate

both snowpack climates.

The response variable S_{cont} represents shear strength in continental snowpacks, S_{inter} for intermountain snowpacks, and S for shear strength in both climates.

The distribution of all shear strength measurements shown in Figure 3 failed the Kologorov-Smornov test of normality (d = 0.258, $p < 0.01$). Since the response variable is not normally distributed, Spearman rank correlations are used. This correlation technique only requires the data to be at least on an ordinal scale. The Spearman statistic R ranges from –1 to 1, with –1 and 1 being a perfect correlation and 0 indicating no correlation. The significance level *p* represents the reliability of a correlation. A *p*-level of 0.05 indicates there is a 5% probability of the analysis revealing a correlation in uncorrelated data (Statistica, 1999). Serial correlations are a measure of the relationship between past observations and present observations of a variable (Chatfield, 1980, pg 23-32). They are present in the data and cause overestimates of significance levels for correlations between response and predictor variables.

5.2 Results of rank correlations

Snowpack properties that correlated with shear strength of faceted snowpack layers are listed in terms of their statistical significance in Table 2 and cross-correlations between the predictors are listed in Table 3. In continental snowpack climates shear strength S_{cont} significantly correlated with 6 snowpack variables ($p < 0.05$). In intermountain climates shear strength S_{inter} significantly correlated with 9 snowpack properties. When the data were not partitioned into a climatic region, shear strength S correlated with 10 snowpack properties. The variables that positively correlated with shear strength in all three categories are load, age, thickness of the slab, density of the slab, and hand hardness. In addition to these properties the maximum crystal size correlated with shear strength in the continental S_{cont} and intermountain S_{inter} climates.

5.3 Age

Age positively correlated with shear strength in all three correlation categories (Table 2). However, when strength is plotted over time it reaches maximum values that depend on snowpack climate (Figure 4).

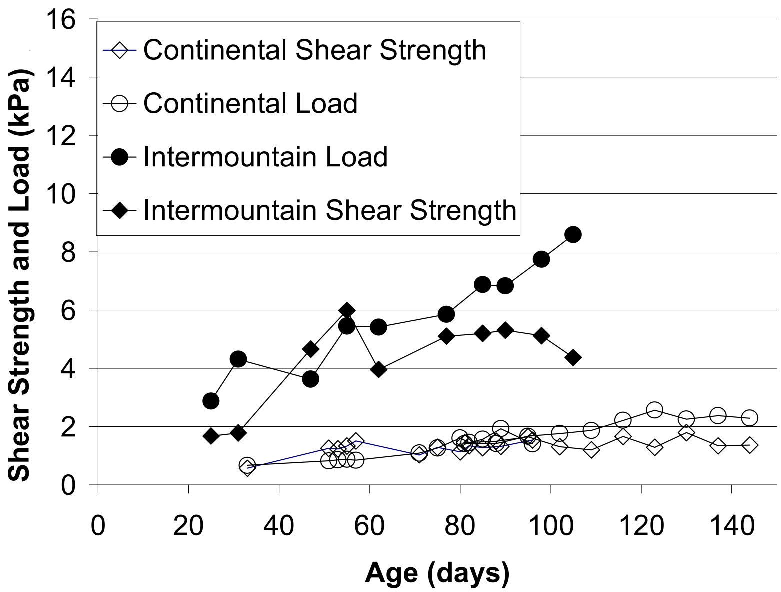

Figure 4. Shear strength and load over time in the continental and intermountain snowpack climates.

5.4 Load

Load positively correlated with the shear strength of facet layers Σ_{inter} in the intermountain snowpack (*p = 2.1E-11*, Table 2) more significantly than the continental snowpack Σ_{cont} (*p = 1.9E-3*, Table 2). Load is also more significantly correlated (*p = 7.5E-17,* Table 2) to shear strength Σ than any other snowpack property. These three correlations show the strong dependence of shear strength on load, until maximum shear strength was reached.

In each climate, maximum shear strengths were reached after different periods of time. Maximum shear strength was reached after approximately 90 days within the continental climate and approximately 60 days within the intermountain climate (Figure 4). After 60 days the load in the intermountain climate averaged approximately 5.25 kPa. After 90 days the load in continental climates averaged approximately 1.75 kPa (Figure 4). Beyond these points, loads continued to increase, but other factors (such as layer temperature, previous temperature gradient and crystal size) may prevent further increases in strength.

5.5 Slab thickness (H)

Slab thickness strongly correlated with strength Σ_{inter} for intermountain (*p = 1.0E-12,* Table 2) and for continental snowpacks Σ_{cont} (*p = 1.3E-2*). Slab thickness is expected to affect strength because thicker slabs are associated with larger loads (*p = 1E-27,* Table 3), warmer temperatures (*p = 1.2E-4*), and low temperature gradients (p = *5.0E -9*).

5.6 Slab density (r_{slab})

Shear strength positively correlated with slab density r_{slab} (Table 2) in all three strength categories. This is not surprising since slab density is a function of slab thickness (*p = 1.6E -12*, Table 3) and load (*p = 1.5E-22*).

5.7 Hand hardness (R_{wl})

Hand hardness roughly measures the resistance to penetration. It is an index of strength. The positive correlation (*p = 4.8E-11*, Table 2) between hand hardness and shear strength Σ is expected.

In this study faceted crystals in continental snowpacks reached maximum hand hardnesses of approximately 1F+, but rounding facets in intermountain snowpacks sometimes reached P+. The difference in hand hardnesses for each snowpack climate is primarily due to load (p = *6.2E-8*, Table 3); load is associated with bond formation and growth.

5.8 Temperature of the weak layer (Twl)

The temperature of the weak layer (Twl) positively correlated (*p = 1.3E-7*, Table 2) with shear strength in intermountain snowpacks, but did not for continental snowpacks. In the deep snowpacks of the Columbia Mountains, temperatures gradually increase over the winter, promoting rounding of the faceted crystals and bond growth. The temperature of the weak layer correlated with slab thickness (*p = 1.2E-4*, Table 3) and age (*p = 4.8E-15*) suggesting as layers age they are buriedly deep and well insulated from cold air.

In continental climate of the Rocky Mountains the temperatures of weak layers slowly warm throughout the winter. However, thin overlying slabs reduce insulation from cold air. As a result the temperature of weak layers undergo fluctuations that may reduce correlations.

5.9 Temperature gradient (TG)

The temperature gradient weakly but positively correlated ($p = 2.1E\text{-}2$, Table 2) with the shear strength S_{inter} of layers of faceted crystals in the intermountain snowpack of the Columbia Mountains. However, an effect of temperature gradient on shear strength is not expected since most of the temperature gradient data has magnitudes less than 10^{o}C/m.

The temperature gradient did not correlate with shear strength in continental snowpacks Σ_{cont}. Temperature gradients in continental climates fluctuate and may remain greater than 10^{o}C/m for months. As a result, weak layers of well developed faceted crystals form. After temperature gradients dissipate weak faceted layers are slow to gain strength because the crystals are large and they are under little load.

5.10 Maximum Crystal Size (Emax)

The maximum crystal size weakly correlated ($p = 3.2E\text{-}2$, Table 2) with strength in both snowpack climates, but field workers regard it as an important property that affects shear strength. The positive correlation indicates that larger crystals have higher strengths. Both field and cold laboratory observations show increases in crystal sizes when faceted crystals are rounding (Johnson In preparation). This suggests growth of rounding faceted crystals is associated with strengthening.

5.11 Faceted crystal type

Faceted crystals are classified as solid faceted particles (4a) or faceted particles with rounding of facets (4c) based on the appearance of rounding (Colbeck et al., 1990). Field workers usually expect increases in strength when faceted crystals show signs of rounding (4c), not further faceting (4a). In each of the layers of faceted crystals from the Columbia Mountains, rounding was observed from mid-December throughout the winter. The layers from continental snowpack areas were not reported as rounding faceted crystals until mid-to-late March.

6.0 CONCLUSIONS

Load and thickness of the slab correlated most significantly with shear strength of layers of faceted crystals in intermountain and continental snowpack climates. These snowpack climates provide contrasts in load and thickness of slabs.

The slab thickness is associated with strengthening of layers of faceted crystals through its association with load and low temperature gradients. Thick slabs insulate weak layers of faceted crystals from cold air temperatures, causing warm weak layer temperatures and low temperature gradients.

Load had a greater correlation with shear strength in the intermountain climate than in the continental climate. The difference in correlations (Figure 4) shows that large loads cause faceted layers to gain strength quickly. Physically, more load pushes faceted crystals closer together resulting in increased density, number of contacts, and bond size.

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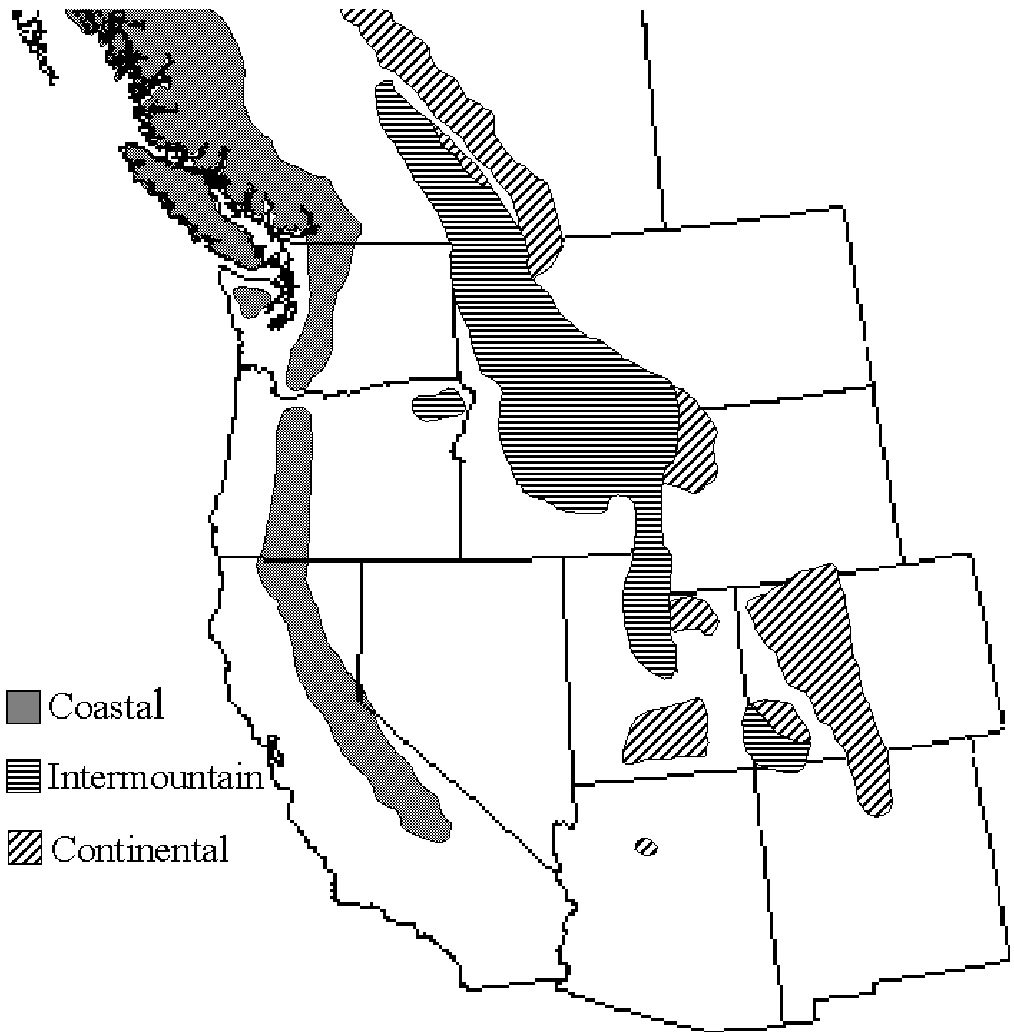


Figure 1. Snowpack climates of the western United States and southwestern Canada. (After Mock, 1995)

Table 1. List of predictor factors and response variables.

PREDICTOR VARIABLES	
Load	Weight of the overlying snow per unit horizontal area (kPa)
ρ_{slab}	Averaged slab density of snow above layer of faceted crystals (kg/m^3)
H	Thickness of the slab, the depth of snow over the layer of faceted crystals (cm)
R_{wl}	Hardness of the faceted layers measured with the hand hardness test (CAA, 1995)
HS	Depth of snowpack (cm)
Age	Number of days since the layer of faceted crystals formed
TG	Temperature gradient measured across layers of faceted crystals. Measurements are taken 5 cm above and 5 cm below the layer (^{o}C/m)
Twl	Temperature of the layer of faceted crystals (^{o}C)
L	Thickness of the layer of faceted crystals (cm)
TA/HS	Temperature gradient averaged over the snowpack (^{o}C/m)
Emax	Maximum length of faceted crystals (mm)
Emin	Minimum length of faceted crystals (mm)
TA	Air temperature (^{o}C)
RESPONSE VARIABLES	
Σ	Shear strength of layers of faceted crystals measured with the shear frame (kPa)
Σ_{inter}	Shear strength of layers of faceted crystals measured with the shear frame in inter-continental snowpack climates (kPa)
Σ_{cont}	Shear strength of layers of faceted crystals measured with the shear frame in continental snowpack climates (kPa)

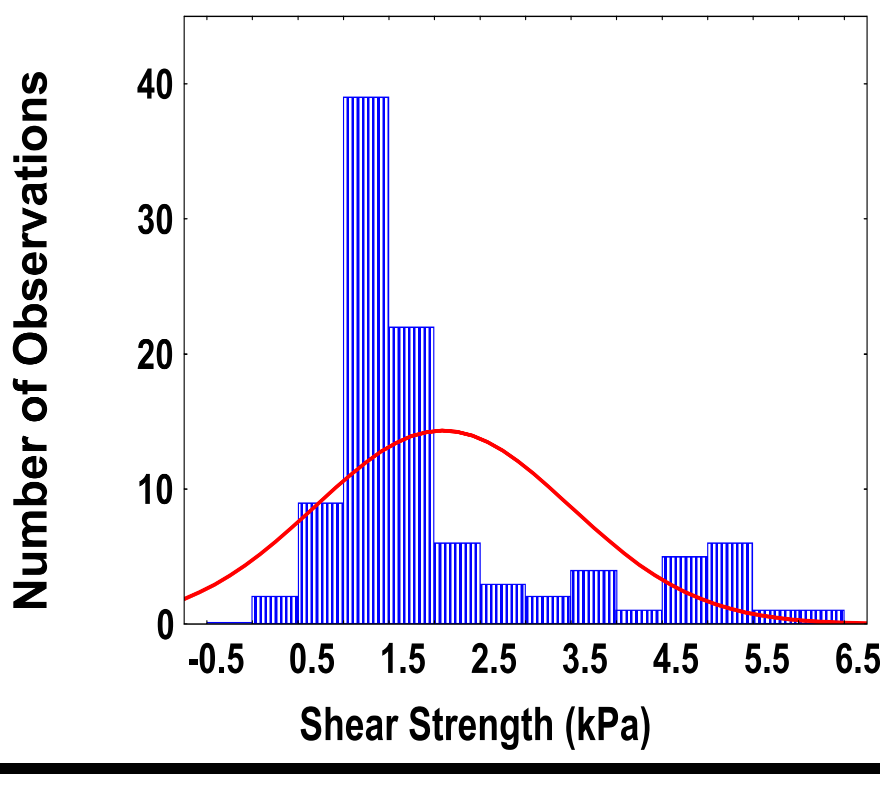


Figure 3. Distribution of shear strength and expected normal curve.

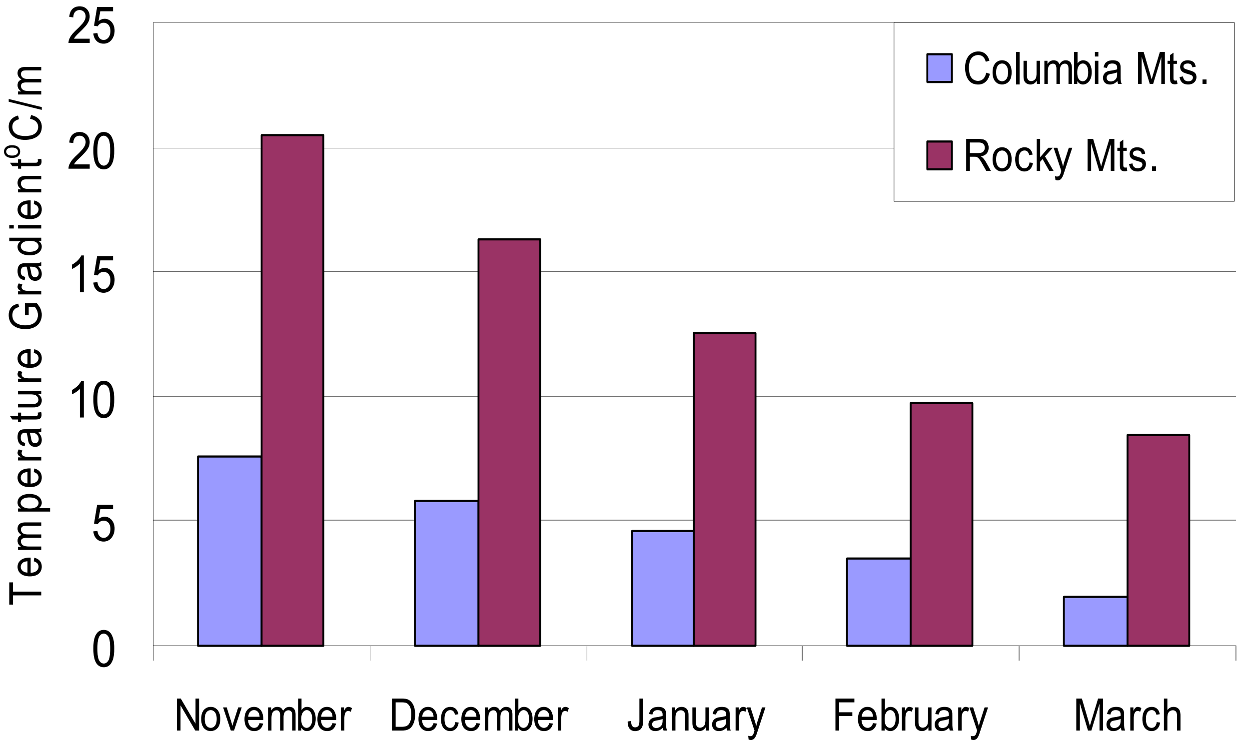


Figure 2. Snowpack temperature gradients in the Columbia and Rocky Mountains clearly show each snowpack climate. (Johnson, 2000).

Table 2 Spearman rank correlations between strength and snowpack variables. Correlations are significant if p , 5.0E-2

Correlations with shear strength (Σ) for faceted layers within both continental and intermountain snowpacks.				Correlations with shear strength (Σ_{inter}) for faceted layers within intermountain snowpacks.				Correlations with shear strength (Σ_{cont}) for faceted layers within continental snowpacks.			
	N	R	*p-level*		N	R	*p-level*		N	R	*p-level*
Load	**101**	**0.71**	**7.5E-17**	**H**	**48**	**0.82**	**1.0E-12**	**ρ_{slab}**	**53**	**0.52**	**5.7E-05**
ρ_{slab}	**101**	**0.68**	**3.7E-15**	**Load**	**48**	**0.79**	**2.1E-11**	**Load**	**53**	**0.42**	**1.9E-03**
H	**101**	**0.68**	**6.5E-15**	**Age**	**48**	**0.76**	**2.8E-10**	**R_{wl}**	**52**	**0.40**	**3.2E-03**
R_{wl}	**97**	**0.61**	**4.8E-11**	**ρ_{slab}**	**48**	**0.71**	**2.2E-08**	**H**	**53**	**0.34**	**1.3E-02**
HS	**101**	**0.57**	**4.7E-10**	**Twl**	**47**	**0.68**	**1.3E-07**	**Age**	**53**	**0.32**	**2.1E-02**
Age	**101**	**0.44**	**5.0E-06**	**HS**	**48**	**0.64**	**1.2E-06**	**Emax**	**53**	**0.29**	**3.5E-02**
TG	**101**	**0.39**	**5.8E-05**	**R_{wl}**	**45**	**0.64**	**1.8E-06**	TA	53	0.25	7.2E-02
Twl	**99**	**0.28**	**4.9E-03**	**TG**	**48**	**0.33**	**2.2E-02**	HS	53	0.23	9.8E-02
L	**92**	**-0.23**	**3.0E-02**	**Emax**	**46**	**0.32**	**3.2E-02**	TA/HS	45	0.24	1.1E-01
TA/HS	**80**	**0.23**	**3.7E-02**	Emin	46	0.27	6.6E-02	L	49	-0.16	2.6E-01
Emax	99	0.17	9.4E-02	L	43	-0.27	7.6E-02	TG	53	0.16	2.6E-01
Emin	99	0.05	5.9E-01	TA	45	-0.10	5.1E-01	Twl	52	0.12	3.8E-01
TA	98	-0.05	6.1E-01	TA/HS	35	0.03	8.5E-01	Emin	53	0.02	8.7E-01

Table 3 p-values for cross-correlations between snowpack factors. Correlations are considered significant if p < 5.0E-2

	Age	HS	Load	H	Rwl_l	TG	Twl	Emax
HS	3.1E-01	-	-	-	-	-	-	-
Load	**8.9E-12**	**3.1E-14**	-	-	-	-	-	-
H	**2.7E-07**	**6.1E-20**	**1.0E-27**	-	-	-	-	-
R	**1.9E-02**	**2.0E-06**	**6.2E-08**	**3.9E-07**	-	-	-	-
TG	**8.2E-04**	**1.3E-05**	**2.1E-08**	**5.0E-09**	**9.0E-03**	-	-	-
Twl	**4.8E-15**	5.9E-01	**3.5E-06**	**1.2E-04**	2.9E-01	**4.7E-05**	-	-
Emax	**8.0E-14**	7.4E-01	**9.7E-04**	**9.6E-03**	3.1E-01	4.5E-01	**2.1E-04**	**-**
ρ_{slab}	**9.8E-19**	**2.0E-04**	**1.5E-22**	**1.6E-12**	**3.9E-06**	**1.8E-03**	**1.7E-07**	**1.1E-04**

TRANSCEIVERS AND CELL PHONES

Avalanche transceivers and cell phones

Just yesterday I was forwarded a posting from a backcountry skiing newsgroup. It detailed an accident at a European ski hill where a skier was buried by an avalanche. He was carrying a digital beacon and his partner, alone, began an immediate search using his beacon, but the victim could not be located. Later investigation revealed that the lone searcher was carrying a mobile phone and that the phone was turned on. It interfered with the function of the digital beacon he was carrying and gave false readings, directing the searcher to an area approximately fifty metres away from where the victim was buried. The victim's body was later found using an analogue beacon, though the article is not clear as to whether or not the phone was still on and nearby. A group of manufacturers and distributors conducted tests afterward and found that analogue and digital beacons are both somewhat affected by mobile phones. They recommend that all mobile phones and other electronic devices be turned off while carrying an avalanche transceiver. Please consider these facts when using avalanche transceivers.

Regards, Mike
Quality Assurance Manager -
Mountain Equipment Co-op

Digital Avalanche Transceivers affected by mobile phones

A manufacturer's investigation has revealed that the search some avalanche transceivers can be affected by mobile phones. A pisteur died at Pra-Loup on the 25th of December. He was caught and buried in an avalanche while securing the ski area. His colleague tried to find him using a digital avalanche transceiver. The beacon indicated a direction and distance that were completely incorrect. 50 meters away from where the pisteur was buried. He was later found with a classic analogue beacon but too late. Inquiries revealed that the searcher's portable phone was turned on. The search facility of some beacons can be affected by mobile phones that are not turned off. After testing this problem has been confirmed by the manufacturers. It would also seem that there is some affect on analogue transceivers. It is recommended that all mobile phones are switched off when a search is made and it is advisable to turn off all mobiles while carrying an avalanche transceiver.

CAF Toulouse/Bureaux des Guides Bourg St
Maurice via dD
Rich Vandervoort
Boeing Intellectual Property Engineering

FUSE NEWS

International Society of Explosives Engineers
30325 Bainbridge Road - Cleveland, Ohio 44139-2295
Tel (440) 349-4400 - Fax (440) 349-3788

Date: October 3, 2001
To: ISEE Members in the U.S.
From: Jeff Dean

In the wake of the attacks on September 11, ATF has informed us that the agency intends to immediately commence non-routine visits to persons and/or companies licensed to store or transfer explosives within a 50 mile radius of any major populated area.

The purpose of these visits is to check security including Table of Distance requirements, record keeping, and obvious violations of ATF regulations.
They will be checking internal controls, closely checking inventories,
establishing the date of and verifying the annual inventory, and ensuring that magazine owners have copies of ATF advisories.

ATF also wants to be sure that any unusual anomalies or suspicious
activities dealing with missing explosives have been reported and check on how they were reported. That includes suspicious job applicants, hiring or firings.

In September, ISEE advised all magazine owners to check and recheck your inventories and all persons in the explosives industry to place into effect emergency security measures throughout your operations to minimize the possibility of any unauthorized possession of explosive materials.

The ATF Advisory Notice that was issued in September is being sent again with this message as a reminder.

Jeffrey L. Dean, CAE
Executive Director and General Counsel
International Society of Explosives Engineers
dean@en.com =80 www.isee.org

Please feel free to contact us

with any feedback...

BOMB TRAMS ON BLACKCOMB

Introduction

Bomb trams in various form have been in use on Blackcomb mountain for about ten years and have proven to be a beneficial addition to the avalanche control program. At present the fleet totals 16 and counting. The benefits are in worker safety (elimination of Avalauncher and sketchy hand charge or ski cut routes) operational simplicity (potentially anyone with basic training can operate a control mission) and of course public safety due to the vastly more efficient air blast. But as they say nothing of value comes without a bit of heartache and anguish.

A Short History of Design and Trouble Shooting

Generally speaking we are constantly amazed at how easily such a simple machine can be utterly snookered by the alpine environment (I'm sure MOTH Coquihalla could add to that!) Riming and winds are the two big enemies (some would argue that we should be added to that list). Even the mechanics are a bit puzzling at times as described below. Nevertheless at this stage in the game most of the kinks have been chased out and without a doubt bomb trams have proven to be well worth whatever headaches were (and still are) involved.

Our first trams evolved quickly from simple rope and snatch block affairs to short 2.5 inch pipe towers, bike wheel drives, ¼ inch poly rope haul lines and hardware store style clothesline pulleys return sheaves. These were very cheap to build and actually worked surprisingly well except for one fatal flaw. The poly rope continuously stretched and required constant tensioning which became a maintenance nightmare as our fleet of trams expanded. Under infrequent riming events and regular high wind events the lines would stretch further and often snagged on terrain in some locations. Otherwise the rope proved plenty strong enough. Even after 2 or more seasons of UV exposure under load and the occasional serious riming event the lines only seemed to break when snagged and abraded on rocks. We quickly discovered that the bomb hangers needed to have a low profile weight to resist the bomb blast sending the thing up and around the haul line. The solution proved to be a short length of chain (MOTH Coquihalla used a lead splitting wedge on their trams for similar purpose). The bike wheels worked fine and one unit used a whole ten speed frame (complete with ten speeds) delivering 5 shots over 220 meters of span!

Single strand zip lines which traversed start zones in a down sloping manner were also installed but are gradually falling out of favor as operation and equipment storage is such a hassle compared to a simple tram set up.

Another significant flaw was a propensity for operator error (read derail). An attempt to correct this tendency through staff training met with limited success. Clearly the situation needed a little rethinking and a fair bit of cash.

In 1999 we decided to upgraded the haul lines to steel cable. Everything else needed to be redesigned To handle the increased load and drag. Generally the upgrading provided a far superior product at a still reasonable capital cost. The beefier units weighed in at about 10 or 12,000$ cdn The smaller units (which essentially means no concrete or big towers but still big spans) weigh in at about 500 to 1200$ cdn. Operations are much cleaner and smoother, and maintenance absorbs far less of our time. All the same as you may have guessed the systems are hardly problem free as outlined below.

Enemies of the Tram

Riming

Most seasons present little riming issues but given the right environmental conditions we have had widespread riming or icing on at least three occasions over ten years. When this happens the systems become hopelessly seized and inoperable until the lines can be deiced by warm conditions (preferable) or lowering the lines to manually de ice (much less preferable!) .   Most alarming are the huge loads applied to the whole system by a 2 inch water ice layer across 200 meters, especially if you throw a little wind into the mix. Amazingly enough only on one occasion has a cable broken. One tram is located at a ridge top high riming site so not surprisingly it rimes up more often. Interestingly, As the line traverses into leeward terrain below the ridge crest the riming tapers away significantly. This ridge top site gives us the usual riming common at ridge top. Worse yet and effecting our lower sites is rising freezing levels with storm conditions resulting in dense water icing layers

Wind

Lesser line loading effect compared to riming but of course much more frequent. The only damage so far has been a buckled bracket at the drive sheave prompting a upgraded design from channel to square tubing steel.

Line Stretch, Line Bounce / Line Cluster

It appears to be advisable to retention the line after a couple of months to account for line stretch. A loose line appears to be linked to some poorly understood (by us) dynamic effects upon the system when a bomb goes off. The looser haul line bounces and twists up and over the upper strand resulting in what is technically termed as " a cluster".   This effect may also have something to do with only one bomb being on the line and occasionally the bomb hanger mysteriously winds up wrapping up and over the whole shooting match (known as a " total cluster"). Introducing an extra block at the return station to spread the two lines apart seems to help along with maintaining proper line tension. Other ideas (unproven) are introducing an extra bit of weight at the bomb hanger / haul line junction. Heavier haul cable may also help but heavier line requires heavier everything else. There is distinctly more effort required to drive 3/16 inch cable compared to 1/8 inch.

Operator Error

A touchy subject at patrol meetings. Perhaps we should leave it at that but suffice to say that at least a little bit of training is in order on an ongoing basis. The most common errors are tying any old piece of rope on as a bomb hanger (total cluster), side loading the haul line (derail) and attaching the bomb hanger clip to a eye on the haul line (winding of the hanger around the haul line as delivery is made).

Components

It has been our experience that if you want the thing to survive and function then implement as much design improvement as possible, no matter how seemingly trivial. For instance thimble all cable eyes in the haul line and if possible use sheaves grooved to accept 1/8 or 3/16 inch cable. If the cables is going to break anywhere you can be sure it will be at a bend over an edge so improve cable strength by properly supporting the cable at the bends. High lines and tower tie backs that bend over shackles or other links should be treated similarly.

Cable

We use mostly !/8 inch 7x19 strand galvanized control cable with a breaking strain of 2000 lbs. Some spans have 3/16 inch cable (breaking strain of 4200 lbs) We tension to about 800 to 1000 lbs so the safety factor is o.k. however we are just guessing how the wind factors in. Wind plus rime has to be putting the cable close to the breaking point. 3 /16 inch cable may prove to be the best bet over the long run.

Towers and Sheave Assemblies

Towers range from big beefy 20 foot by 12 inch pipe bolted to concrete piers to little 2.5 inch schedule 40 pipe sections bolted to rock. The little guys are certainly less obtrusive and expensive but the big ones are sometimes required due to terrain. Drive wheels are old Dopylmyer sheaves with either a 1:1 hand crank or a 3:1 chain speed gear. The return sheaves are .5 inch by 3 or 4 inch yarding blocks (Jet brand is best) The haul line is 1/8 to 3/16 cable with line length up to 220 meters between stations. It is recommended that all sheaves be modified with a 1/8 or 3/16 inch groove for better support and tracking of the cable in the sheave.   Most drive towers have been fitted with boat winches positioned for haul line and aviation line tensioning.

Bomb Hangers
We have settled on 4 to 8 meter sections of 1/8 inch cable with a 12 inch section of 3/8 inch chain at the bomb end. A 2 foot length of number 12 R90 electrical wire links the bottom of the chain to the bomb. The top of the hanger assembly has a spring loaded clip designed for the commercial troll fishing industry for clipping leaders onto downrigger lines. Up to 5 different shots are hung per haul line. Positioning is predetermined and marked on the haul line with dog tags if necessary. Stops on the cable keep the hangers in place.

Bombs
We use 1 kg charges almost exclusively for the typical surface new snow instability. Our targets are typically small size 2 pockets. Occasionally larger shots are used but no big AMEX bombs. We have found that often 2 separate pockets can be effected by splitting the difference in positioning the shot.
Occasionally if the instability is particularly tender a single shot can trigger numerous targets, something to consider in relation to the safety of other control teams. The bombs are connected to the hanger wire by a length of 3/16 inch bunji cord tied securely to the shot (do not tie over fuse!). Double priming is recommended.

Aviation Markers
Almost all trams are equipped with aviation marker balls either hung on the tram line itself or scattered along an adjoining separate highline. The balls are 12 inch floats designed for the commercial trawl fishery (way cheaper and just as good as standard aviation marker balls). The local pilots really appreciate these things. If at all possible keep these high lines a reasonable height above and preferably off to the side of the tram lines to avoid any chance of tangling.

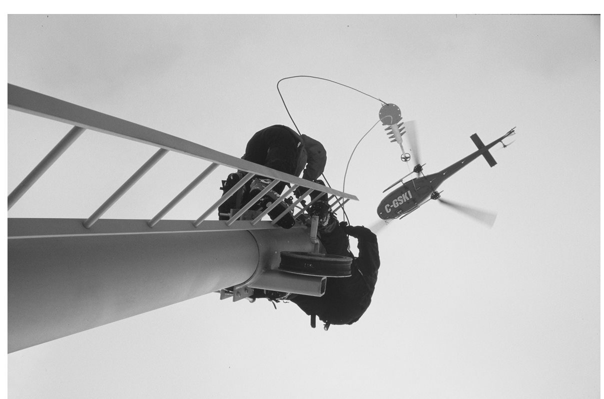
Operations
For one or two shots the operation is pretty straight forward. If you want to deliver 5 shots all at once you better have all your ducks in a row. Before you pull the first pullwire make sure everything is totally organized neatly and all required tasks completed. The following is a brief outline of a typical bomb run.

Drive operator (route leader) calls commands, operates drive and connects bomb hangers to haul line.

Bomb handler (route second) on command ignites fuses and times first fuse lit.

Procedure
1) Derime and test run
2) Attach all bombs to hangers
3) Attach # 1 bomb hanger to haul line
4) Ignite, start timer and deliver
5) Attach # 2 etc….

It takes about 2 minutes to deliver 5 shots across 200 meters. As the fuses these days take at least 3 minutes to burn this is ample time, if you have your act together. Of course dud pullwires can give you grief (double prime!) as can snagging terrain during delivery. Duds are handled easily by simply returning shot after appropriate wait time until able to place another shot next to dud.



RAC Programs Update

October 31, 2001

Over the past eighteen months the CAA's Board of Directors, CAC staff, Education Committee, RACPAG (RAC Programs Advisory Group) and many individual RAC providers have worked diligently to advance the management and delivery of the RAC program. This update is intended to bring everyone up to speed on some of the key results of these efforts.

1. Fall 2001 RAC Instructor Training

In September, the CAA's Board of Directors approved a grant of $2000 to the RACPAG for the design and organization of a RAC Instructor Training program for this fall. There was a strong consensus that the focus for this training should be terrain evaluation, group management, and rescue beacon instruction and use.

I am pleased to report that there will be two RAC instructor training sessions this fall. I urge all RAC instructors to take advantage of these opportunities for skills development.

- ***The 2001 Winter Professional Development Workshop***, Dec. 1-2 in Golden, BC. Please see the enclosed information sheet for more details. Please register early as spaces will be limited.

- ***The University of Calgary Outdoor Pursuits Program Staff Training***, Nov. 26-27. RACPAG Chair Albi Sole has generously offered to open this training to RAC instructors.

  At: The Kananaskis Field Station, Alberta
  Cost: $20 buys you a nights accommodation at the Centre.

  Agenda:
  Day 1 Classroom sessions
  Day 2 Field day at Fortress.

  For details please contact Albi at asole@ucalgary.ca Phone 403-220-8638;
  Fax 403-210-8134 before November 15th.

2. RAC Risk Management Initiatives

The Cloutier Risk Management Report identified several RAC program management and delivery issues that, in his opinion, had "risk of drawing the CAA into litigation". These issues were discussed at the RAC Providers meeting at the CAA AGM last May. Since then, in compliance with strategic direction from our Board of Directors, and following consultation with the CAA's legal counsel, management consultant, Education Committee, RACPAG, and many others, we are implementing the following initiatives.

CAA Web Site Revisions
The original text has been revised to more clearly specify the roles and responsibilities of the CAA and the RAC providers. These changes are intended to ensure that RAC students understand that this training is supported and promoted by the CAA, and that RAC instructors deliver these courses as either small business or public service offerings in their local communities.

RAC Instructor's Agreement Revisions
These agreements have been revised to more clearly identify the roles, responsibilities and expectations of the CAA and RAC providers. RAC Instructor's Agreements will be revised as and when required, and renewed annually.

RAC Course Waivers
A waiver is currently being developed by Mr. Robert Kennedy, the CAA's legal counsel. This waiver is intended to help protect both RAC course instructors and the CAA from liability in the event of an accident. All RAC instructors will agree to have all of their RAC students sign these waivers, as a condition of their Instructor's Agreement. ***You will be notified when these waivers become available.***

Permitted Advertising For RAC
In the absence of clear guidance for advertising RAC courses, and as might be expected when there may be competing RAC providers in the same geographical area, there has been controversy surrounding RAC advertising, and the affiliation between those courses and course instructors and the CAA. To help us all provide accurate and fair information to the public, the CAA is developing standards for "Permitted Advertising" for your use. All RAC instructors will agree to comply with these standards, as a condition of their Instructor's Agreement. ***You will be notified when these "Permitted Advertising" standards become available.***

RAC Instructor Standards and Training
The CAA feels ethically obliged to promote RAC training as a broad based avalanche accident prevention program across Canada. The RAC program was funded and developed under this premise, and to this end the CAA's Board of Directors has affirmed that CAA Affiliate Members with CAATS Level 1 Ski Operations training will continue to instruct the introductory RAC program. To do anything else would deny the benefits of RAC training to thousands of Canadians.

At the same time, the "industry standard" for winter back country leaders continues to evolve, and it could be argued that CAATS Level 1 training needs to be supplemented with additional training to be commensurate with that "industry standard". The CAA's Board of Directors has recently approved policy to deal with this issue. The RACPAG has offered to consult with RAC instructors, and generate a proposal for revising the RAC instructor standards to better meet current "industry standards". As a parallel initiative, the RACPAG will also propose a training program to help RAC instructors meet those revised standards. The attached policy document CAA Support to RAC / ARAC Program Delivery and it's appendices contain additional detail regarding these developments.

3. CAC Support To RAC

The CAC will to continue to offer support and promotion for you and your RAC courses. ***Please visit our website at www.avalanche.ca; go to the Recreational Avalanche Course Providers List, and ensure your contact information is accurate and up to date.*** Please contact Audrey Defant audrey@avalanche.ca Phone 250-837-2435; Fax 250-837-4624 for instructional supplies, handbooks, website changes, waivers, or anything else that you need from the CAC. For anyone interested, the minutes of the May 2001 RAC Providers meeting are available through Audrey.

Audrey has been working hard on your behalf for several years now; if you have the opportunity, let her know that her efforts are appreciated….

As specified in the CAA's policy documents, the CAA is committed to continuing periodic renewal of all RAC materials, through the CAA's Intellectual Property Renewal Fund.

In addition, the CAA is working to find an appropriate corporate partner for RAC who, in return for branding and promotional considerations, would be willing to offer multi-year financial support for RAC program improvements, and other CAA public safety services. The details of how this would all work are not determined, as these details would have to be negotiated with the partner. However, benefits to both the CAA and individual RAC instructors could be substantial. Stay tuned for updates as progress is made on this initiative.

4. RAC Programs in Quebec

The Quebec Collaborative Avalanche Project (QCAP) is now in full swing. Marc Deschenes has taken on the project management task, and I believe he may still be looking for instructors to teach RAC in Quebec during the next two winter seasons. If you are a fully bilingual RAC instructor with reasonable teaching experience, and are interested in getting involved, please contact Marc at mdeschenes@telus.net.

5. RACPAG Contacts

During the RAC Providers meeting at the CAA's AGM in Penticton last May, the following CAA members generously volunteered to represent the constituency of RAC providers, and to work with the Managing Director and others for the advancement and good governance of RAC issues. I encourage you to work with these representatives to ensure your voice is heard. They are:

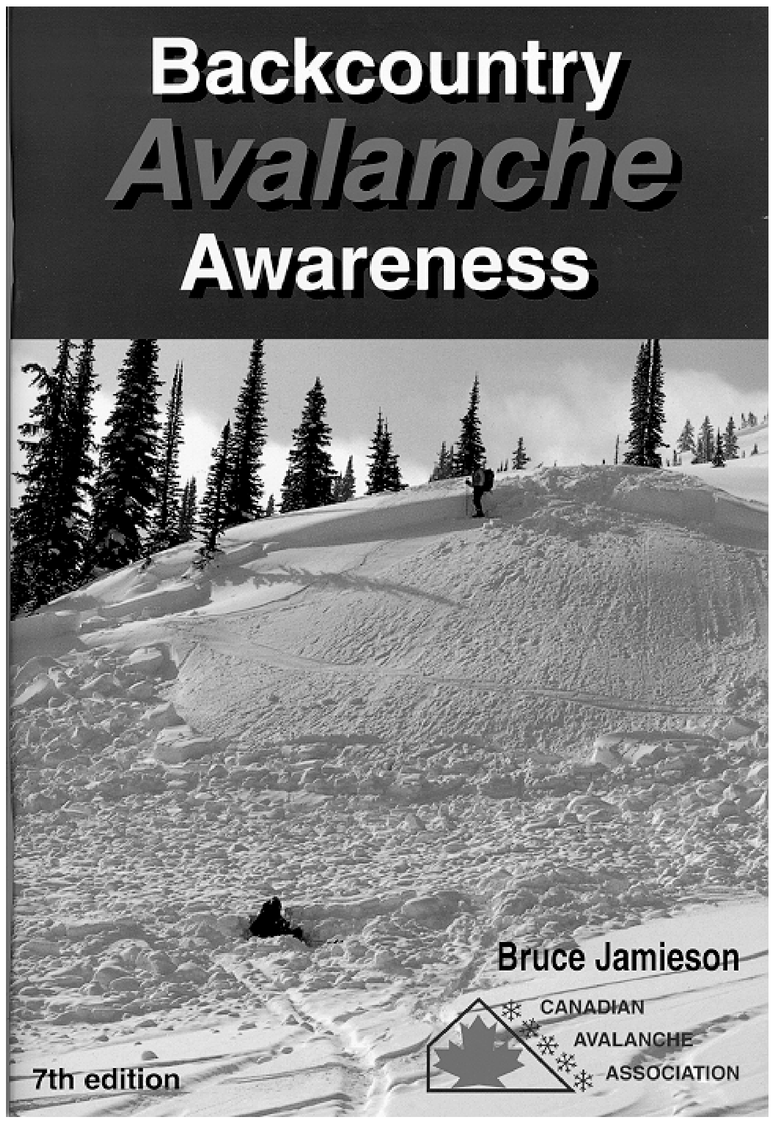
Albi Sole-Chair	asole@ucalgary.ca	(403) 220-8638
Daniel Krmpotich	dank@norlight.org	(208) 267-8875
Greg McAuley	storm@snowavalanche.com	(250) 564-9786
Kirstie Simpson	simpsonk@inac.gc.ca	(867) 633-2199
Christoph Dietzfelbinger	info@bearmountaineering.bc.ca	(250) 847-2854
Darcy Svederus	snowtec@telusplanet.net	(403) 773-3795
Eric Vezeau	vezeaue@hotmail.com	(604) 938-0044
Charles Wood	cwsnowpro@yahoo.ca	(250) 494-8688
Lori Zacaruk	zacs@cadvision.com	(403) 938-5811

I extend a sincere "Thank You" to these CAA Members who have stepped up and offered their services to help advance the RAC programs.

I also wish to thank the CAA's Board of Directors, and the Education Committee for their countless hours of hard work on RAC related issues over the past couple of years. Their commitment helps to ensure that these programs continue to grow in a positive and responsible manner.

Best wishes for a safe and productive winter!

Clair Israelson
Managing Director



Canadian Avalanche Association

CAA Board of Directors Approved INTERIM Policy

CAA Support to RAC / ARAC Program Delivery

1. The CAA's Relationship to RAC / ARAC

1.1 The RAC / ARAC programs support the CAA's mandate, as the stated goals for these programs include:
- Improving avalanche safety education in Canada.
- Maintaining a nationally recognized recreational avalanche course standard.

1.2 The CAA owns and holds copyright to the RAC / ARAC instructor materials package and advanced student manual. In addition, the CAA holds exclusive right to publish and distribute the three avalanche awareness handbooks authored by Bruce Jamieson, that serve as the student manual for all RAC courses.

1.3 Through the Canadian Avalanche Centre (CAC), the CAA supports RAC / ARAC delivery by providing materials and other services to instructors. The CAA's Managing Director is responsible to manage all CAA initiatives in support of the RAC / ARAC providers and programs.

1.4 The RAC Programs Advisory Group (RACPAG) is mandated to represent the interests of all RAC / ARAC providers. Appendix 1 to this document contains the approved Mandate and Terms of Reference for the RACPAG.

1.5 The CAA Education Committee is mandated "To support public avalanche safety awareness education." The Education Committee will have ongoing input into RAC / ARAC program developments through liaison with the CAA's Managing Director.

1.6 The RAC / ARAC programs will exist within the CAA domain, according to policies set by the CAA Board of Directors from time to time. The Managing Director is responsible to administer the CAA's component of these programs, integrating strategies and recommendations of the CAA's risk management, legal, and operational management consultants into the CAA's program delivery.

2. Relationship with Providers

2.1 RAC / ARAC courses will only be delivered by CAA Members in good standing, as either small business or public service ventures within their communities, using nationally recognized curriculum, instructional materials and student hand-books copyrighted and/or published and supplied by the CAA. All RAC / ARAC instructors will conduct their activities within the terms and conditions of a valid Providers Agreement with the CAA. Providers' Agreements may be reviewed annually, and may be revised or cancelled at the discretion of the CAA.

2.2 The CAA's Board of Directors affirms the principle that both Affiliate Members and Professional Members should continue to contribute to public avalanche awareness education by instructing RAC's. ARAC's will be delivered by Professional Members only.

2.3 RAC / ARAC providers are key stakeholders in these programs, and individually hold full responsibility for all aspects of RAC / ARAC delivery. However the CAA retains ownership of the course materials specified in 1.2 above, and any other RAC / ARAC program support services as may be developed from time to time.

2.4 Through the RACPAG and providers meetings, RAC / ARAC providers contribute to the strategic co-management of these programs. In cooperation with the Managing Director, and liaison with the CAA Education Committee, they will have strong input into RAC / ARAC program direction and developments.

2.5 RAC providers, through the RACPAG, should recommend standards for RAC / ARAC programs, and instructor qualifications and training.

<u>3. CAA – RAC Funding</u>

3.1 The RAC ARAC programs will be financially self sustaining.

3.2 The CAA will develop and manage funding mechanisms to provide for renewal of the RAC / ARAC course materials supplied by the CAA, and other CAA support to these programs. Funding will be based on surplus generated as a result of past and future RAC / ARAC program revenues, and appropriate third party sources.

3.3 Surplus generated through the RAC / ARAC programs may be used to pay for:

- RAC / ARAC programs administration at the CAC
- Ongoing RAC / ARAC materials development and renewal
- Development / design of CAA approved RAC / ARAC instructor training programs

3.4 The RACPAG should have input to help set priorities for the CAA's RAC / ARAC programs expenditures.

3.5 RAC / ARAC providers will be responsible for the costs of program services that are of direct benefit to each individual instructor. Examples include delivery of RAC / ARAC instructor training programs, and any other support services to their activities that they may collectively deem to be required: e.g; paid services of RAC / ARAC Coordinator?.

4. RAC Program Goals, 2001 / 02

The CAA suggests RAC / ARAC program management initiatives that are listed below, in order of priority.

4.1 CAA to implement Cloutier risk management report recommendations, as per legal and operational management consultants' suggestions.

4.2 In collaboration with the RACPAG, develop a funding strategy and 2001/02 budget for CAA support to the RAC / ARAC programs.

4.3 Request RACPAG to propose consensus based instructor standards and a training program for Affiliate Members, to promote improved safety and decision making during the field trip component of RAC courses.

4.4 When satisfactory standards and training programs are proposed by the RACPAG, the CAA will fund the design, but not the delivery, of this training program. The CAA would like to see this training conducted during the fall of 2001, under the coordination of the RACPAG.

4.5 Design and delivery of a public advertising program promoting RAC / ARAC training.

4.6 Development of an instructional techniques training program for RAC / ARAC instructors.

4.7 RAC / ARAC materials review and update.

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APPROVED INTERIM MANDATE AND TERMS OF REFERENCE
For the
<u>RAC / ARAC Programs Advisory Group (RACPAG)</u>

Mandate
The RAC / ARAC Programs Advisory Group is comprised of CAA Professional and Affiliate Members who have volunteered to represent the interests and issues of all RAC / ARAC providers while they assist the CAA in development of structures, processes and procedures to foster delivery of RAC / ARAC training in a manner that respects the needs and aspirations of the CAA, the RAC providers, and the public.

Terms of Reference
1. The Chair of the RACPAG will report to the CAA's Managing Director.

2. Either the Chair of the RACPAG or the Managing Director may identify issues for deliberation by the RACPAG. They will collaborate to develop clear and specific tasking instructions, and when these tasking instructions are negotiated to their mutual satisfaction, the Advisory Group will work within the terms of that written guidance.

3. Recommendations and positions developed by the RACPAG should be unanimous, and signed off by all members. In the event that unanimity cannot be achieved, a minority report should be prepared to represent the alternative perspectives. In developing recommendations and positions on issues, the Advisory Group will strive to represent the entire constituency of RAC providers.

4. Any work that requires expenditure of CAA funds must be supported by a work plan and budget that is authorized in advance by the Managing Director. All work must stay within the terms of those documents.

5. The origins and history of the RAC program reside largely with the CAA's Education Committee. Both the RAC Advisory Group and the Managing Director may liaise with the Education Committee for advice or perspective regarding any issues or discussions that may arise.

6. It is acknowledged that this Advisory Group has volunteered for a one year period, and it is the stated intention of all parties that at the 2002 AGM of the CAA, when structures and terms of reference are developed, RAC providers will be elected to represent this group for the future good governance of the CAA's activities relating to the RAC programs.

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APPENDIX 2.

SUGGESTED ROLES AND RESPONSIBILITIES
For the
RAC Providers Advisory Group (RACPAG)

This document contains the suggested roles and responsibilities for the advisory group formed by the volunteers from the floor of the RAC Providers Meeting in Penticton, May 9th, 2001.

The Advisory Group sees its role as to assist the CAA in what ever way possible to implement the 'Interim Strategic Direction for the RAC Program' as outlined at the RAC Providers meeting in Penticton.

In this role The RACPAG will work with, and under the leadership of the CAA to:
- define the nature of the relationship between the CAA and RAC providers
- provide a mechanism to ensure the continued growth and development of the RAC program
- facilitate the professional development of the RAC Providers through development and delivery of instructor training programs.

Our initial expectation is that these goals will be achieved through instituting the following objectives

1) The development of terms of reference for a volunteer body that shall succeed the RACPAG and be created out of RAC providers elected from the floor of the 2002 RAC Providers Annual meeting.

2) To consider the existing standards for RAC providers, and make recommendations for revisions to the RAC Providers Agreements.

3) To assist in organizing a 'RAC Providers meeting' to be held in conjunction with the CAA Annual General Meetings to be held in 2002.

4) To assist in developing a process to ensure that RAC courses are delivered in a consistent and quality manner by all RAC providers.

5) To assist in organizing one or more seminars in the Fall of 2001. These seminars will be devoted to helping all RAC providers develop their skills in delivering the existing RAC Curriculum.

6) The RACPAG will investigate the CAA's suggestion that a paid, part time RAC Coordinator's position be created and make recommendations to the CAA as to whether:

a) such a position needs to be created
b) develop the profile for such a position in terms of:
   i) The relationship between the position holder and RACPAG or any body that might succeed the RACPAG
   ii) The qualifications of such a office holder
   iii) The selection process for such an office holder
   iv) The job description of position holder. *In order to do this work the RACPAG will need*

- An accounting of the RAC program expenses and revenues to date
- A report from Randy Stevens that gives an estimate of the time requirements for fulfilling the role of the paid 'RAC Program Coordinator' proposed by the CAA Education committee.
- A copy of that portion of the Cloutier Risk Assessment Report that pertains to RAC issues

In identifying the areas where the RACPAG can assist the CAA the RACPAG wishes to make the following comments.

- All the members are enthusiastic supporters of the need to leave the CAA as the owner of all RAC materials and as the leader in the development or revision of those materials and all other aspects of the educational content of the RAC Courses
- All members have expressed their desire to see continued development of the RAC program, including setting some higher standards for The Providers, to ensure that program delivery is of the highest quality possible. In particular, that the course delivery standards are consistently met; and that courses are delivered safely.
- RAC Providers recognize that the original objective of this program was to provide a broad based and consistent public safety program that ensured students were receiving the same high quality of educational material. In addition, we agree with the CAA, that restricting delivery to professional members only will restrict access to the RAC courses. At the same time we want to ensure that the courses are delivered by experienced and knowledgeable providers capable of delivering a high quality safe program.
- We are aware of the overriding concern that the CAA has at the moment to address the issue of the liability exposure of the CAA. However the RAC Providers have strongly expressed their desire to see seminars in place for this fall. As a group we feel that it is necessary to begin work on arranging these seminars as early as possible. While the CAA must retain control of educational content, we feel that that the RACPAG can assist the CAA by assuming the role of making the necessary arrangements, with the expectation that the other issues will have been settled in time to hold the seminars.

Version Sept 9, 2001

AVALANCHES:
WARNING, RESCUE AND PREVENTION

By: Roland Meister   Translated

Summary: The International Commission for Alpine Rescue (ICAR) has played an important role in accident prevention over the last 50 years. As a result of discussions held between search & rescue organisations and avalanche forecasters, the number of people killed in avalanches did not increase in equivalence to growing use of alpine and recreational areas, despite technology that makes alpine and avalanche terrain more accessible to the general public. In mountainous countries throughout the world, the overall mean of avalanche fatalities each winter is 109; in all countries that are involved with the ICAR, the number of avalanche fatalities combined is 160. A direct correlation can be found between public avalanche warning systems, avalanche prevention programs and the effectiveness of search and rescue operations. This success has been gained through a co-ordinated and co-operative approach within the international community.

INTRODUCTION

The national federations of the mountain emergency are organised in the International Commission for Alpine Rescue. The ICAR was founded approximately 50 years ago during an international meeting of mountain rescue organisations. The ICAR is based on the co-operation of mountain rescue organisations on an international level. Its goals are to make recommendations for the most effective response to alpine emergencies and to work toward the prevention of accidents in the mountains. 33 organisations belong to the ICAR. These organisations represent 21 countries in Europe and North America. The ICAR consists of four sub-commissions: land rescue, air rescue, snow avalanches and alpine medicine.

Early on in development of the ICAR, it was recognised that a need existed for an improvement in the field of avalanche rescue. There is a sense of urgency in avalanche rescue, more so than many other mountain rescue scenarios, in the critical importance of quickly locating the buried victims. Search methods and search technology had to be developed and implemented in a systematic manner. It was known that out of ten recreationists caught by an avalanche, nine of them had triggered the avalanche themselves. These two factors, time and subjectivity, made it apparent that avalanche education is of the utmost importance. The Swiss Federal Institute for Snow and Avalanche Research (SFISAR) joined the ICAR during the 1950's, ANENA of France joined in the 1970's and both AINEVA of Italy and NGI of Norway have been associate members since the 1980's. All are institutions that do not work directly for rescue organisations within their countries, but play an integral role in co-ordination, research and education. In relation to the diminution of avalanche accidents a narrow link consists between rescue and prophylactic measures.

AVALANCE WARNING

The first operational avalanche reports were analysed in Switzerland in the winter of 1945. They covered the whole of the Swiss Alps and consisted of a short text, which gave general information regarding snow conditions and avalanche danger. In 1953 the first reports were published in Austria followed by Tyrol in 1960. After a severe accident in France in 1970 countrywide avalanche forecasts were made available to the public. Italy started providing public bulletins in 1977 and, at about the same time, avalanche reports became common in Czechoslovakia, Scotland, Spain, the USA and Canada.

With strong support from and under direction of the ICAR, these countries agreed in 1993 to a unique avalanche danger, the so-called European avalanche danger scale. The scale was adopted by the US and Canada 2 years later. The avalanche hazard is defined and generically described in one of the following categories: low, moderate, considerable, high and extreme. The degree of hazard is defined through analysis of existing snow stability and the probability of release. In addition, some countries give recommendations regarding the behaviour of people going backcountry skiing. There has been detailed interpretation of this subject (Meister, 1998). Prohibitions are not a part of the avalanche bulletins. But the reports provide general hints as to high-risk areas such as elevation, aspect and slope incline. Ultimately, though, the decision to cross a steep slope still has to be made by the recreationist.

To verify the effectiveness of the text in the avalanche bulletin and the published degree of hazard, a detailed questionnaire was provided after an avalanche accident. Over a 30 year period, the mean number of avalanche fatalities was 109 (Switzerland 27, Austria 27, Italy 20, France 30, Germany 3, Slovenia 2, Liechtenstein less than 1). In all ICAR countries put together, the long-term mean number of avalanche fatalities per winter amounted to about 160.

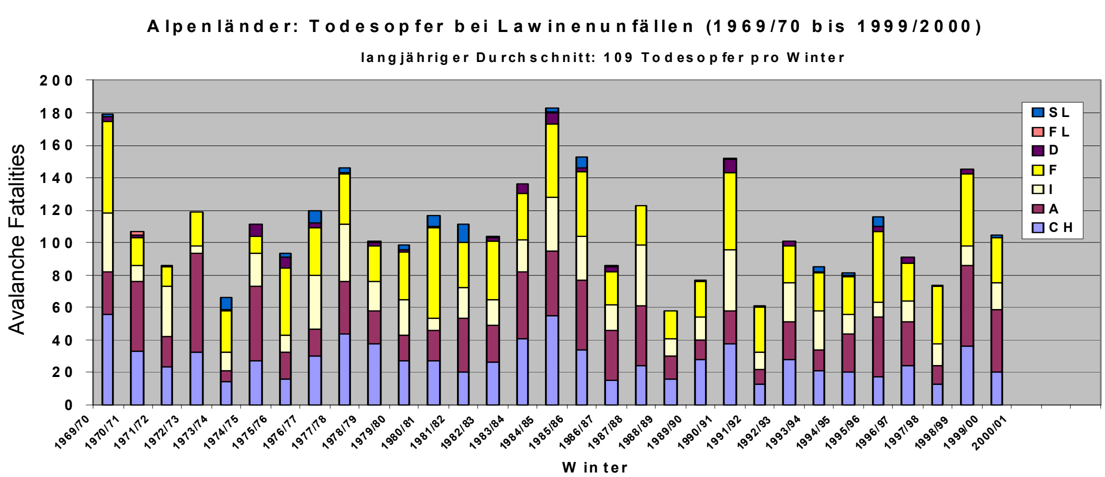

Figure 1: Number of avalanche fatalities per year in: Switzerland (SW), Austria (A), Italy (I), France incl. Pyrenees (F), Germany (G), Liechtenstein (L) and Slovenia (SL)

The differences from one year to the next are striking. Also worth mentioning is the fact that the progression is nearly the same in each country, which points to similar weather and climatological conditions. Comparable data exists in the USA (Atkins and Williams, 2000), Canada (Jamieson and Geldsetzer, 1996) and Norway (Kristensen, 1998). Detailed accident analysis is also available from Japan (Shinji and others, 2000).

Inspite of a remarkable increase in both mountain traffic and recreationists mobility in general (about 80 percent within the past 30 years) the number of avalanche fatalities did not increase. There appears to be no direct correlation.

To properly estimate the actual avalanche hazard, one needs a good understanding of the following parameters: snowfall, temperatures, wind and snow cover conditions. These relationships are very complex. As a long-term mean, every third day is an avalanche day. Winters with heavy snowfalls are not necessarily those with the most avalanche fatalities. For example, avalanche accidents in the winters of 1974/75 and 1981/82, with large amounts of snow, were rare events. And, in spite of small levels of snowfall in the winters of 1984/85, 1990/91 and 1995/96, there were many accidents, most with fatal consequences; however, the fact that the snowpack was quite shallow, with many unstable layers, cannot be overlooked.

Some of the more disastrous winters with a large number of severe accidents in the Alps were: 1969/70 (avalanches hit housed regions in Val d'Isère in France and Reckingen in Switzerland), 1981/82 (there was a large accident in the tourist region of Werfenweng, Austria with a total of 13 fatalities), 1984/85 (there were many small isolated accidents and a large highway accident, with 11 fatalities on a road near Täsch in Switzerland), 1985/86 (avalanches were predominantly in the south parts of the Alps, but there was also a large avalanche with 16 fatalities in Norway), 1990/91 (a tremendous avalanche killed 12 people in Courmayeur, Italy), 1999/2000 (two large events involving backcountry skiers in the regions of Galtür and Kaprun in Austria killed 21 people).

Interestingly enough, when related to specific snow conditions, on unique days nearly at the same time, in all regions of the Alps, there is a condensed occurrence of avalanche accidents. Such days were, for example, the 17^{th} of January 1977, the 21^{st} of March 1987, the 17^{th} of February 1991 or the 15^{th} /16^{th} of February 1997. The preceding weeks of all these days were predominantly cold and dry with minimal snow coverage. Relatively small amounts of precipitation afterwards lead to these accidents.

The sequence of periods with large amounts of precipitation during January and February were practically the same in France (Savoya), Switzerland and Austria, which lead to an increase in avalanche activity in the catastrophic winter of 1999.

This past winter (2000/2001) was characterised by seven heavy precipitation systems between October 2000 and the beginning of February 2001 with nearly uninterrupted snowfalls. In those southern regions, between the Valley of Aosta, the Mountains of canton Tessin in Switzerland and the Engadine and Dolomites region, snow depths reached a fifty-year high with a dramatic increase in avalanche activity. But provisional analysis points to no extraordinarily high number of accidents.

All these and similar analysis can be gathered also for other important snowpack and meteorological characteristics like wind and air temperature. Other factors must also be considered; during periods of stormy weather and in times of heavy snowfall, fewer people venture into the mountains therefore limiting the number of avalanches involving people.

AVALANCHE PREVENTION

Avalanche prevention first deals with the sheltering of housed regions and their inhabitants. Buildings should be planned and constructed in terrain that is safe from avalanches only. Permanent safety measures include construction in avalanche start zones and in run out zones using diversions and barriers. About 15 percent of all avalanche fatalities involve people in buildings. These accidents, however, are becoming less common; but the potential for such occurrences remains as was demonstrated in a sad manner in the winter of 1998/99.

For the security of the road and highway routes (including ski area access), on which 20 percent of all fatal avalanche accidents occur, temporary protective measures are common. In countries which allow it by law, avalanche control through the use of explosives has proven to be effective from a safety point of view and in reducing closure times. Specialists and technicians are employed and are educated through certification programs and mentorship and are responsible for local and regional hazard management. Often these technicians are affiliated with or work with local rescue teams. For the ICAR, the question of professionalism arises in regards to mountain rescue personnel. Also the fact that, in performing this dangerous work, about one person dies in an avalanche per year in Switzerland must not be overlooked.

The greatest potential for avalanche accidents exists in off-piste, out of bounds or backcountry terrain. It is here that 65 percent of avalanche fatalities occur; this percentage is on the rise. The best preventative measures are linked with public education and awareness campaigns. More specifically, young off-piste skiers and freeriders should be targeted in courses and at ski areas, as this group seems to be high risk. This responsibility lies with avalanche instructors, ski instructors and mountain guides.

The use of safety equipment, such as avalanche transceivers, probes and shovels has gained widespread acceptance in the international community.

In 1989, the ICAR published a recommendation that avalanche transceiver frequency should be internationally standardised to 457 kHz. After years of discussions with several manufacturers and through assistance from the ICAR foundation ‘Vanni Eigenmann’ (Italy) an agreement could be found for the fix sending frequency of 457 kHz. After a widespread comparison test with the latest digital beacons, (Krüsi and others, 1998) the ICAR found that the new digital technology was unsatisfactory in some key areas. Since then, many of these beacons have been improved. Even now, however, the use of the new technology requires knowledge and practice. Similar results were confirmed in the latest tests in France (Sivardière, 2000). It is our opinion there must be an optimum between reliability and maximum search width. Some new statistics (Schweizer and Lütschg, 2000) concerning geographical characteristics (length, width, induction lines, etc.) could lead to more effective strategies in search methods. Speed, however, remains the most important factor; one has to be very fast to find a buried victim alive.

Developments with materials like RECCO, ABS, LVS and life vests forced the ICAR, in 1999, to react with a new resolution in regards to public awareness??: consult the avalanche bulletin, avoid triggering an avalanche, ski with someone with experience and understand that using avalanche safety equipment requires skill and practical training. It is also important for the manufacturer to convey to the user a basic understanding of the theory involved (Kern, 2000) in search techniques.

AVALANCHE RESCUE

Because every minute counts in a rescue scenario, it is important to have an efficient and highly organised rescue team. In modern-day rescue, helicopters, radios, modern equipment, avalanche rescue dogs and extensively trained rescuers are integral to an effective rescue.

Rescue organisations developed in a variety of ways in different countries. Usually they went out as voluntary rescue groups. Alpine Clubs, the Red Cross, the armed forces and, later, local clubs and organisations participated in the rescue of avalanche victims.

Rescue methods have adapted with the continued development of modern techniques. The organisation, hierarchy and efficiency of search and rescue command style rescues have become the standard. There has been a trend from voluntary groups to professional rescue organisations that work in conjunction with police forces. A mixture of specially trained personnel is used in specific situations and weather conditions. The ICAR performed pioneering work with the ground rescue teams in the winter mountain environment. The first live recovery with a trained avalanche search dog dates occurred in 1954. Specific rescue practices were evaluated and documented and avalanche rescue began to learn from experience. This led to larger successes within the rescue industry.

Generally accepted techniques and guidelines are continuously challenged through accident analysis. Precise questions and evaluation of rescues forms the basis of this comparison. Not only should quantitative and qualitative data be analysed, both also rescue successes and failures. From this research and analysis, the ICAR is able to make recommendations, as was the case in 1995 in regard to avalanche rescue dogs. An ICAR research group has published an extensive multilingual dictionary (Segula, 1995).

According to the latest accident statistics - researched by Frank Tschirky of the SLF (Tschirky and others, 2000) – there has been a greater success rate with more live recoveries over the past few years. This can be attributed to both effective self-rescue and organised rescue teams. Table 1 points to a 50% success rate with organised rescue and self-rescue seems to be 4 times as effective. (??)

Table 1: Number of people recovered alive and corresponding chance of survival of people completely buried. Values are listed according to the location method using all 689 reported rescues

Location method	Self rescue (333 completely buried people)	Organised rescue (356 completely buried people)	Total (689 completely buried people)
Last known point	32 (100%)	5 (100 %)	37 (100%)
Transponder??	-	1 (100%)	1 (100%)
Visible clues	125 (84%)	11 (26%)	136 (71%)
Probing	10 (71%)	10 (19%)	20 (29%)
Rescue dog	-	30 (18%)	30 (18%)
Transceiver	70 (51%)	6 (11%)	76 (39%)
Arbitrary digging	-	0 (0%)	0 (0%)
Total	237 (71%)	63 (18%)	300 (44%)

in Switzerland for the period of 1980-1999 (20 years).

Of essential importance is clear information and smooth transition from self-rescue to organised rescue. Also, new avalanche rescue technology is being tested for effectiveness (Kern and others, 2001).

In central mountain regions, it is possible to access most areas within 15 minutes when safe flying conditions are present. When “no-fly” conditions exist and in less accessible mountainous countries, the helicopter is not used as a rescue tool.

From a medical point of view it is worth considering, that accordance to new statistics, (Weymann, 1999) 25% of fatalities are due to ??mechanical violations?? Furthermore, it is worth mentioning there has been some research on survival rates of victims who are able to breath in air pockets or in debris of varying density, moisture, etc. (Brugger and others, 1997).

OUTLOOK

A successful avalanche rescue depends upon a combination of public avalanche bulletins, prevention and education and organised rescue techniques.

In the future, more effective public avalanche bulletins will require better weather forecasts and research data. Collaboration and clarification of hazard ratings are also required internationally. Warning and awareness of other mountain hazards should be intensified. To accomplish these goals, the avalanche forecasters and professionals need assistance of the avalanche rescue teams.

In regards to prevention and education, more work is needed to target youth and high-risk groups who venture into the mountains. Instructional films, slide shows, manuals and information leaflets should be made more available nationally and internationally. Education is also needed on the effective use of avalanche technology, such as avalanche transceivers; a greater awareness of the risks associated with mountain travel will greatly benefit both individuals and groups of people recreating in avalanche terrain.

Reports from rescuers regarding specific avalanche characteristics help can help with additional analysis and research; for example, what was the size of the avalanche? Where was the initial search started? Where and when was the main search started? What were the burial depths and burial times? In what condition were the buried victims found? Was first aid required? From this information, search methods and rescue methods may be improved assist with avalanche prevention programs. It is imperative to ensure the safety of rescue personnel; in Switzerland alone, 18 rescuers have died in the last 65 years in avalanche rescues.

There are very few limitations placed upon the flow of information due to advancements in communication technologies. Information should be made available throughout the rescue effort with analysis of events and conditions preceding the accident. All these factors, coupled with the benefit of experience, can help guarantee that incident and fatality rates can stabilise and, in the long term, decrease.

In the ICAR sees a need for a common dialogue internationally. It would also be beneficial to attract more countries, such as Japan, South America and Australia, to the organisation.

The organisational structure of the ICAR also plays a minor role. Most important is the continued co-operation between rescue specialists and avalanche professionals. The exchange of ideas between manufacturers and researchers should also be maintained. This can pave the way towards landmark prevention and education.

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DRY SNOW DENSITY

ESTIMATING DRY SNOW DENSITY FROM GRAIN FORM AND HAND HARDNESS

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ABSTRACT: Snow density has many applications in avalanche forecasting, including calculations of load over weak layers. However, density measurements of snowpack layers are often incomplete because of problems sampling thin layers or time constraints on fieldwork. This paper summarizes over 5000 density measurements of dry snow from the Columbia and Rocky Mountains of Western Canada between 1993 and 2000. The density values are regressed on hand hardness to yield a method for estimating density of snow layers with known grain form and hand hardness. Standard errors give an indication of the quality of the estimate.

KEYWORDS: snow density; density estimation; hand hardness; grain form; avalanche forecasting

1. INTRODUCTION

Occasionally it may be necessary to estimate the density of a snow layer. Density measurements in the field may not be done due to time constraints or because a layer is too thin for the sampler. Having a complete set of density values is important for calculations of load over a weak layer, or for determining the water-equivalent of the snowpack.

Hand hardness measurements (Colbeck and others, 1990; CAA, 1995) are widely used and are quickly and consistently done during snow profiles. Likewise, snow grain forms are also usually recorded. This paper explores a method for estimating snow density from hand hardness and grain form. In an effort to increase the precision of the density estimates, this study differentiates between snow grain types.

2. METHODS

Densities were measured using a 100 cm^3 sampling tube and either a portable electronic scale or a Strong Stitch mechanical scale. Samples were taken vertically for layers at least as thick as the length of the sampling tube (10 cm) and horizontally for thinner layers. Layers thinner than the diameter of the sampling tube (4 cm) were not sampled or used in this study. Corresponding snow grain type and hand hardness values were recorded for each layer with a density measurement. The snow types were recorded by either their major or minor classification (Colbeck and others, 1990). Hand hardness classes F, 4F, 1F, P, K and I (CAA, 1995) were subclassified using the 16 levels: F-, F, F+, 4F-, 4F, 4F+, 1F-, 1F, 1F+, P-, P, P+, K-, K, K+, I, where the + and – subclasses require slightly less or slightly more force than the respective main class.

The hand hardness classes were assigned a corresponding hand hardness index. Fist (F) is assigned an index value of 1 and each major class is incremented by 1, with intermediate values for the subclasses. The hand hardness index is described in more detail later in this paper.

The data presented in this paper are from measurements of 5411 snow layers taken in the Purcell, Selkirk, Monashee and Rocky Mountain Ranges of western Canada between 1993 and 2000. Measurements were done by at least 27 different people.

Table 1: Measured density (kg/m^3) of common snow types grouped by hand hardness and grain type.
N - number of layers measured, SD - standard deviation, SE - standard error.

Hand Hardness	Hand hardness index	Precipitation particles (PP) 1abcde				Graupel (gp) 1f				Decomposing and Fragmented precipitation particles (DF) 2ab				Rounded grains (RG) 3ab				Rounded mixed forms (RGmx) 3c			
		N	**Mean**	SD	SE	N	**Mean**	SD	SE	N	**Mean**	SD	SE	N	**Mean**	SD	SE	N	**Mean**	SD	SE
F-	0.67	89	**64**	22	2	2	**91**	32	23	54	**81**	23	3	~	**~**	~	~	1	**81**	~	~
F	1.00	206	**83**	29	2	13	**133**	29	8	352	**103**	26	1	17	**167**	40	10	4	**155**	40	20
F+	1.33	24	**102**	25	5	~	**~**	~	~	84	**115**	30	3	4	**169**	13	6	3	**160**	31	18
4F-	1.67	6	**118**	25	10	1	**164**	~	~	73	**121**	28	3	12	**147**	23	7	3	**163**	26	15
4F	2.00	31	**113**	28	5	6	**138**	37	15	344	**135**	30	2	91	**169**	40	4	7	**175**	18	7
4F+	2.33	5	**114**	14	~	2	**157**	33	~	110	**143**	31	3	51	**174**	33	5	3	**196**	15	9
1F-	2.67	2	**138**	29	~	2	**203**	74	53	73	**156**	31	4	73	**185**	36	4	5	**230**	56	25
1F	3.00	6	**154**	50	20	11	**169**	45	14	235	**169**	32	2	451	**204**	40	2	22	**205**	23	5
1F+	3.33	~	**~**	~	~	~	**~**	~	~	53	**189**	36	5	204	**219**	42	3	21	**215**	38	8
P-	3.67	~	**~**	~	~	~	**~**	~	~	27	**215**	32	6	256	**243**	41	3	16	**250**	29	7
P	4.00	1	**178**	~	~	5	**267**	39	17	40	**210**	39	6	740	**272**	47	2	19	**266**	28	6
P+	4.33	~	**~**	~	~	~	**~**	~	~	4	**237**	74	37	266	**310**	51	3	3	**299**	12	7
K-	4.67	~	**~**	~	~	~	**~**	~	~	~	**~**	~	~	46	**365**	48	7	~	**~**	~	~
K	5.00	~	**~**	~	~	~	**~**	~	~	~	**~**	~	~	28	**377**	60	11	~	**~**	~	~
K+	5.33	~	**~**	~	~	~	**~**	~	~	~	**~**	~	~	5	**418**	38	17	~	**~**	~	~

Hand Hardness	Hand hardness index	Faceted crystals (FC) 4ab				Faceted mixed forms (FCmx) 4c				Depth hoar (DH) 5abc				Wet Grains (WG) 6ab				Melt-freeze crust (mfc) 9e			
		N	**Mean**	SD	SE	N	**Mean**	SD	SE	N	**Mean**	SD	SE	N	**Mean**	SD	SE	N	**Mean**	SD	SE
F-	0.67	3	**125**	10	~	~	**~**	~	~	~	**~**	~	~	1	**45**	~	~	~	**~**	~	~
F	1.00	46	**143**	36	5	2	**165**	16	~	7	**202**	40	15	2	**216**	141	100	~	**~**	~	~
F+	1.33	7	**149**	23	9	1	**155**	~	~	~	**~**	~	~	1	**220**		~	~	**~**	~	~
4F-	1.67	2	**159**	11	~	1	**134**	~	~	~	**~**	~	~	2	**189**	86	61	~	**~**	~	~
4F	2.00	88	**215**	41	4	13	**222**	59	16	17	**241**	30	7	16	**231**	86	21	~	**~**	~	~
4F+	2.33	19	**218**	42	10	8	**208**	24	8	6	**258**	42	17	1	**126**	~	~	~	**~**	~	~
1F-	2.67	28	**244**	39	7	19	**222**	30	7	5	**243**	27	12	4	**200**	70	35	~	**~**	~	~
1F	3.00	154	**255**	45	4	60	**248**	37	5	18	**256**	56	13	15	**266**	100	26	3	**332**	16	~
1F+	3.33	38	**268**	40	6	32	**252**	53	9	2	**283**	46	33	5	**319**	17	7	1	**284**	~	~
P-	3.67	38	**282**	37	6	68	**285**	36	4	~	**~**	~	~	3	**319**	47	27	3	**278**	27	16
P	4.00	122	**289**	47	4	121	**308**	44	4	8	**297**	31	11	8	**278**	54	19	16	**286**	42	10
P+	4.33	16	**331**	45	11	49	**348**	43	6	1	**268**	~	~	5	**311**	68	~	8	**282**	75	26
K-	4.67	5	**314**	45	20	12	**386**	32	9	1	**320**	~	~	~	**~**	~	~	6	**304**	68	28
K	5.00	~	**~**	~	~	6	**368**	49	20	1	**270**	~	~	~	**~**	~	~	17	**296**	64	16
K+	5.33	~	**~**	~	~	2	**446**	8	6	~	**~**	~	~	~	**~**	~	~	1	**276**	~	~

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Hand hardness classes (Colbeck and others, 1990; CAA, 1995) were determined by pushing into the snow with a fist in glove (F), four fingers in glove (4F), one finger in glove (1F), blunt end of pencil (P) or knife blade (K) with a constant manual force. The specified force is 10-15 N (1.0-1.5 kg force) but field workers rarely check their “standard” force with a force gauge.

3. OBSERVATIONS

Grain forms are grouped or broken down into subsets (Table 1) as follows: Precipitation particles (PP) include all subclasses except graupel, hail and ice pellets. Graupel (PPgp) is given its own category due to its significantly different form and properties. Hail and ice pellets are excluded because only one data value is available for each. Decomposing and fragmented precipitation particles (DF) include both subclasses. The mixed forms of rounded grains (RGmx) and facets (FCmx) are not included under their major classes; each is given their own category. Depth hoar (DH) and wet grains (WG) include all of their subclasses. Surface hoar layers were too thin for the sampling tube and are therefore omitted. Data for ice masses are limited to four layers and also excluded. For surface deposits and crusts only melt-freeze crusts (mfc) are included in this study; no data are available for the other subclasses.

Table 1 shows that for a given hardness, more mature grain types are typically denser than less mature forms. Consider layers of 4F hardness: New snow (PP) layers have a mean density of about 117 kg/m^3 whereas layers of decomposed and fragmented particles have a mean density of about 138 kg/m^3. Further, 4F layers of rounded grains have a mean density of about 169 kg/m^3.

4. ANALYSIS

While Table 1 can be used to estimate density from grain type and hand hardness, better estimates are probably possible based on a regression that reflects the monotonic effect of densification on hardness for a particular grain type. For a regression we need a measure of hardness with interval properties.

Similar work in this area (Gold, 1956; Kinosita, 1960) established relationships between hardness and density, with the hardness of snow defined as penetrating force over area of a blunt penetrometer (Kinosita 1960). Using the specified force of 10 to 15 N (1.0 to 1.5 kg force), and average measurements of area for the major hand hardness classes as shown in Table 2, it is possible to arrive at approximate hardness values for the hand hardness classes. The areas of the major hand hardness classes were determined by averaging the two reasonable extremes of a large hand with a bulky glove and a small hand with a thin glove. The parts that would come into contact with the snow were measured with a ruler.

Table 2: Average area measurements and approximate hardness for the major hand hardness classes.

Hand hardness class	Hand hardness index	Area cm^2	Hardness (kN/m^2)
F	1	82	1.5
4F	2	22.5	5.6
1F	3	5	25
P	4	0.64	195
K	5	0.15	833

The values in Table 2 corroborate Brown's (1995, personal communication) suggestion that for the hand hardness test, the area of the penetrometer (fist, fingers, etc.) decreases step-wise by a factor of four (roughly) for the classes F, 4F, 1F, P and K.

Jamieson (1995) used a factor of two for a hand hardness index, in an analysis of an earlier and smaller version of our data set. However, those results, as well as trials with a factor of four, did not fit our data as well as the hand hardness index.

For our analysis, we let the hand hardness H (with units of force over area) increase step-wise by a factor M (corresponding to a decrease in area of 1/M). Using Fist resistance as base

$$H = (F_{CONSTANT}/A_{FIST})\, M^{h-1} \qquad (1)$$

where $F_{CONSTANT}$ is the approximately constant force applied manually, A_{FIST} is the area of a gloved fist, and h = 1, 2, 3, 4, 5 is the hand hardness index in Tables 1 and 2 for classes F, 4F, 1F, P and K, respectively.

Kinosita (1960) found a linear relationship between log hardness and density. Similarly, Gold (1956) found a linear relationship for low density snow between log hardness and density.

$$\text{Log } H = C_1 + C_2\, \rho \qquad (2)$$

Combining Equation 1 and Equation 2, we obtain a linear relation between h and ρ

$$\text{Log } (F_{CONSTANT}/A_{FIST}) + (h\text{-}1) \text{ Log } M = C_1 + C_2\, \rho \qquad (3)$$

For each grain type, the density is regressed on the hardness index h for groups of grain types using the following simplification of Equation 3

$$\rho = A + B\, h \qquad (4)$$

Of course, the test of this linear relationship will be how well it fits real data. The empirical constants, A and B, the coefficient of determination, R^2, and the standard error of estimation, s, and the significance level, p, are given in Table 3.

Wet grains, due to their dependence on liquid water content, and melt-freeze crusts exhibit unacceptably large error values and are not included in further tables or figures.

Using the empirical constants, A and B, from Table 3 the estimated density values are plotted (Figure1a and 1b) along with the measured means from Table 1.

Rounded grains do not conform well to a linear regression. Instead, we used a non-linear regression of the form.

$$\rho = A + B\, h^x \qquad (5)$$

This yields a better fit (R^2 = 0.54) and the empirical constants: A = 154, B = 1.51, and x = 3.15.

Table 3: Linear regressions of density on hardness index h by groups of grain types

Class	No. of Layers	A	B	R^2	p	s
PP	370	45	36	0.30	< 10E-16	27
PPgp	42	83	37	0.47	4.63E-07	42
DF	1449	65	36	0.52	< 10E-16	30
RG	2244	0.79	69	0.50	< 10E-16	46
RGmx	107	91	42	0.55	< 10E-16	32
FC	566	112	46	0.51	< 10E-16	43
FCmx	394	56	64	0.51	< 10E-16	43
DH	66	185	25	0.26	1.287E-05	41

In Figures 1a and 1b, estimated values are only given to the extent of the measured means.

Except for rounded grains, the linear regression lines show a reasonable fit to the data, implying a linear relationship between density and the hardness index *h*. The linear relationships support the assumptions behind Equations 1 to 4, including the interval property assumed for *h*.

Note that the lines, especially those in Figure 1a, do not represent densification, since during densification grains may change form. For example, under conditions of low temperature gradient, new snow particles (PP) become decomposed particles (DF) which in time become rounded grains (RG).

Although there is a dependency on temperature (Gold, 1956; Kinosita, 1960) for hardness, the effect is much less significant than the density/hardness relationship. Considering the relatively low accuracy of hand hardness measurements, temperature effects would not be readily apparent and are not covered in this paper.

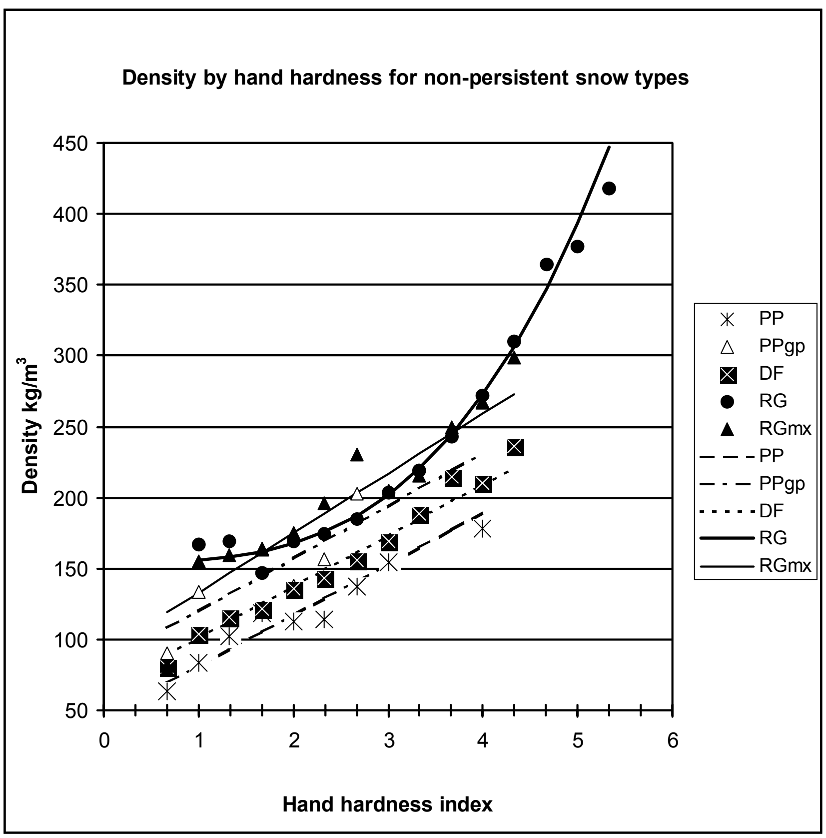

Figure 1a: Density by hand hardness for non-persistent snow types. Points represent measured means, lines represent estimated values from regressions.

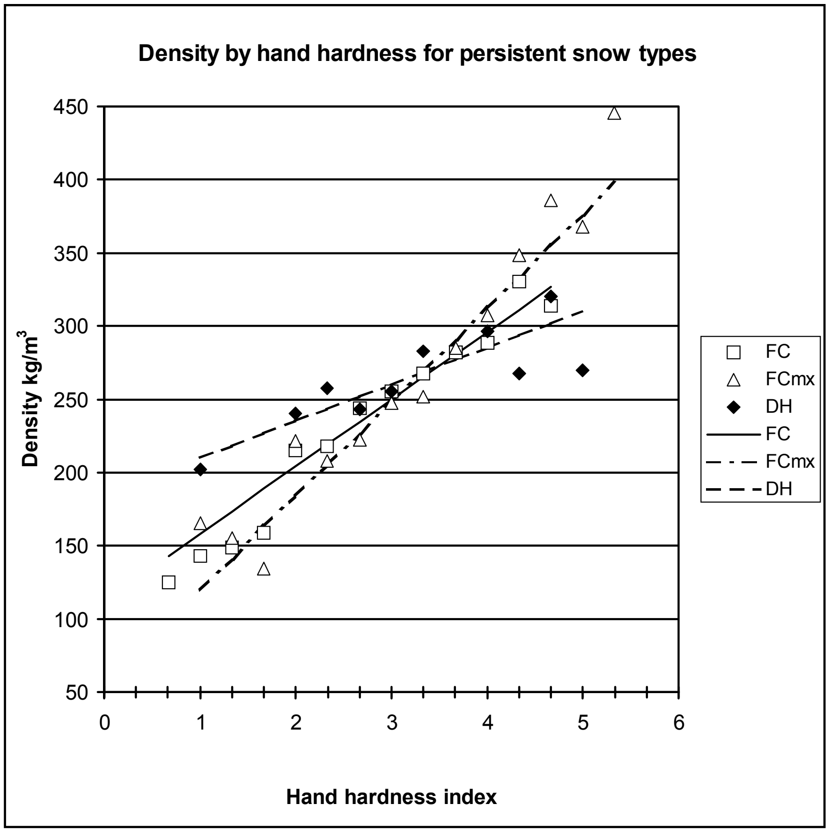

Figure 1b: Density by hand hardness for persistent snow types. Points represent measured means, lines represent estimated values from regressions.

Table 4: Calculated densities (kg/m^3) using the regressions from Table 3, except for rounded grains (RG) which are derived from the non-linear Equation 5.

Hand hardness	Hand hardness index	PP	PPgp	DF	RG	RGmx	FC	FCmx	DH
F-	0.67	69	108	89		119	143		
F	1.00	81	120	101	156	133	158	120	210
F+	1.33	93	132	113	158	147	173	141	218
4F-	1.67	105	145	125	162	161	189	163	227
4F	2.00	117	157	137	167	175	204	184	235
4F+	2.33	129	169	149	176	189	219	205	243
1F-	2.67	141	182	161	187	203	235	227	252
1F	3.00	153	194	173	202	217	250	248	260
1F+	3.33	165	206	185	221	231	265	269	268
P-	3.67	177	219	197	244	245	281	291	277
P	4.00	189	231	209	273	259	296	312	285
P+	4.33			221	306	273	311	333	293
K-	4.67				347		327	355	302
K	5.00				393			376	310
K+	5.33				447			397	

5. APPLICATION

Table 4 presents the estimated densities from the regression lines in Figures 1a and 1b. These values can be used to estimate a density for a given hand hardness and snow type, keeping in mind the accuracy of the estimates indicated by *s* in Table 3. We use the non-linear Equation 5 for rounded grains (RG) and the linear Equation 4 for other grain types. For estimation of load due to particular layers, the accuracy of the estimate decreases with an increase in the thickness of the layer.

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KOKANEE GLACIER CAMPAIGN

March 9, 2001

To our Community Partners:

We would like to thank you for all your effort in support of the Kokanee Glacier Alpine Celebration held in Nelson February 2-4. Without your help, the Celebration would not have been such a huge success. It is organisations like yours that make events like this work.

The Celebration raised national awareness about the campaign's vital safety messages as well over $10,000 towards the campaign's goal of $900,000. We are confident that the Kokanee Glacier Alpine Campaign will be a beneficial endeavour for all Canadians. We are truly honoured by your support and commitment. Thank you for caring!

Sincerely yours,

District Manager

BC Parks Kootenay District

Mary Krupa

Project Director

MINUTES OF THE PUBLIC AND TECHNICAL MEETING

Wednesday May 9th - 1:00 pm **Gord Ritchie ~ Meeting Chair**

Research Progress Report ~ Bruce Jamieson:

Bruce gave research project highlights. His research program has been ongoing for twelve years, he is currently at the end of a three year project. Fieldwork has focused at Rogers Pass with cooperation from Parks Canada and the Blue River area with cooperation from Mike Wiegele Heli Skiing.

In the winter of 2000-01, field work included 330 person days in the field, 170 profiles, 350 compression tests, 164 sets of shear frame tests including over 95 strength changes and measurements at 33 slab avalanches. Bruce listed the graduate students, research technicians and collaborators on the project. The project has made practical contributions to knowledge on remote triggering, formation and stabilization of facets on crusts, forecasting for deep slabs, and stabilization of buried surface hoar layers.

The knowledge transfer from this work into the avalanche industry includes:
14 seminars to 300+ avalanche professionals (winter 2000/01), a mail out of research results, 6 presentations at ISSW, 20 papers on the web site, 4 presentations to the CAA (May 2001), stability tables on Infoex, 5 previous research staff now guiding and 6 doing other avalanche work. For further details contact: www.eng.ucalgary.ca/Civil/Avalanche.

Supporters include Canada West Ski Areas Association, B.C. Helicopter and Snowcat Skiing Operators Association, B.C. Ministry of Transportation and Highways, Parks Canada, the CAA, the University of Calgary, Natural Sciences and Engineering Research Council, Intrawest Corporation, Mike Wiegele Helicopter Skiing and CMH.

Predicting the Strength of Buried Surface Hoar Layers: Tom Chalmers, Graduate Student ~ University of Calgary

Tom reported on results from his research. The strength of a buried surface hoar layer is directly related to the stability of a buried surface hoar layer. The project took lots of snowpack observations and many shear frame measurements of buried surface hoar.

He tried to determine how snowpack factors relate to the strength of the surface hoar layers and the stability of a buried surface hoar layer.

Most skier-triggered avalanches occur in the first 21 days the layer is buried and this is when most strength gain occurs as well. Tom discussed the modeling strength of these first 21 days. He stated that more load is leads to greater strength of the weak layer and that surface hoar layers with larger grains tend to be weaker.

Model Results show that current strength is associated with:

(Continued on page 54)

(Continued from page 53)
load (+) layer thickness (-), days since burial, (+) height of snowpack (+) and temperature of layer (+).

Tom indicated that you could take a set of observations around a buried surface hoar layer in the Columbia Mountains, do an easy calculation and get a great estimate of the current shear strength of the layer which would not require a shear frame. An important consideration is it requires measurement thickness of surface hoar layers to the nearest millimeter. Tom showed various graphs of strength change over time to verify his model.

Work is still required on forecasting stability indices, and forecasting skier-triggered avalanche activity.

Tom concluded by thanking Bruce Jamieson and NSERC as well as other field staff and supporters.

Stability Indices ~ Bruce Jamieson:

Bruce discussed extrapolating stability ratios from a study plot (concepts and data). He thanked his collaborator Dave Skjonsberg (Parks Canada.)

Stability ratio = shear strength (100 cm2 frame)

load

Bruce's data showed that there is more avalanche activity when the stability ratio is low. He showed a slide discussing hypothetical change over time and field data indicating that the strength of a weak layer tends to adjust to overlying load.

Bruce argued that stability indices/ratios determined in study plots should extrapolate better for naturals than for human-triggered avalanches. Highway programs that forecast mostly for naturals tend to use study plots more than backcountry programs that forecast mostly for human-triggered avalanches.

He summarized by stating that the strength of weak layers adjust to overlying loads; strength/load ratios can be useful for forecasting avalanches within 10+ km but they are expected to work best for naturals. The study plot must be located so that it develops weak layers and loads similar to the starting zones.

Bruce acknowledged field staff that helped on the project as well as his sponsors.

Spatial Variations of Stability in Avalanche Start Zones ~ Kyle Stewart:

Kyle presented his first year of data for his MSc thesis. He reviewed his objectives to document spatial variability in weak layers, determine the scale of variability in start zones, and causes of variability in start zones.

He explained the research methods used to measure weak layer stability. The drop hammer test was explained and demonstrated. Kyle discussed his field methods of utilizing the drop hammer and the array of 40-80 tests that are conducted per day.

(Continued on page 55)

He stated that site selection was important and that an undisturbed avalanche start zone is selected for spatial array, if safe conditions permit. Otherwise a similar spot is selected. Selection is based on aspect, ground cover, slab thickness and slope angle. Kyle showed examples of data collected.

Conclusions: He developed a method for studying spatial variability in start zones; observed 5-10 m clusters of low stability for surface hoar; and thin areas are sometimes associated with low stability.

Applications include causes of variability, site selection for strength and stability tests and explosive placements, as well as increasing the high margin of safety for conditions associated with high variability.

Next year his research will include different spacing for the arrays, correlation with compression tests, and influences of rocks on stability.

Kyle thanked the ASARC research team and the project supporters.

Gord Ritchie stated that these research projects are a significant contribution to the avalanche industry in Canada. He thanked Bruce and his researchers, who have done such a large amount of work to help further our knowledge of avalanches.

Advances in Fuse Design ~ Everett Clauson:

Everett discussed the advances they are seeing in fuse design. Three years ago fuse assemblies with high reliability were hard to come by. During the last year they have come up with an option for fuse design. Their goal to supply the forecasters a "toolbox" where they chose the best tool specific to their application.

The system requires high reliability, cannot be too expensive, should duplicate what you are doing now so retraining wouldn't be required, and be safe and free from misfires.

He drew a diagram and proposed a box with a timer to count down the 2 minute ignition time.

Everett introduced Paul from Magic Fire. This is company is involved in engineering and manufacturing of precision electronic pyrotechnic initiators. They have with a variety of customers including Disney, US Army, Aerospace, Film and special effects, and CIL/Orion. Paul reviewed their technology in initiators and firing control systems.

The design objective for the avalanche project was reviewed including safety precautions that were to be incorporated into the design, reliability factors, cost effectiveness, and simplicity. The two components, the control panel and precision electronic initiator, were shown.

The system was demonstrated and the members asked a variety of questions about the design to Everett and Paul including timing multiple charges, product costs, etc.

First CARDA Live Find – Robin Siggers

Robin Siggers, Vice President of the CAA, Education Committee representative, and Fernie ski area employee is also a CARDA dog handler who had the first live find in Canada.

Robin reviewed the sequence of events that lead to this live find. The day before the ski area opened to the public one of their staff was buried in an avalanche. He was not wearing a beacon. Patrollers doing avalanche control work saw the avalanche and notified the ski area that a person was buried. As per their avalanche rescue plan, Robin's trained CARDA dog (Keno) was transported from the base area to the site. Robin arrived in about 15 minutes and 13 patrollers were on site within 20 minutes. The dog successfully indicated the victim in 24 minutes and he recovered fully within 30 minutes.

Accolades piled in and it became a media event. Robin showed footage from "Animal Miracles" which documented the event.

Robin closed by discussing CARDA. It was founded in 1978 in collaboration with the RCMP and Parks Canada and the goal was to form a recognized civilian avalanche dog rescue group. There are now 32 validated dog handler teams to respond to avalanches from a variety of locales and eight new teams are in training this year. The CARDA mandate is to rescue avalanche victims. The event has been very inspirational to the CARDA handlers. For more information on CARDA, their website is: www.carda.ca

Robin an Keno were presented with a plaque by Anton Horvarth on behalf of CARDA in recognition of their remarkable achievement.

Multi Burial Recreational Incident – Gordon Ohm

Gordon discussed the February 13th incident in the backcountry near Fernie involving two parties (a group of 5 triggered an avalanche above the party of 13 below.) Six people were in the gully at the time of the avalanche and it fully buried two, partially buried four and the other seven extricated the partially buried persons. The fully buried victims were dug out in 30 minutes but both were fatalities.

PEP contacted Gordon at Island Lake late in the day advising of the two fatalities. Two of the party were flown out before dark. A party of four skinned in from Island Lake bringing food and tarps for the party, and the rest of the survivors flew out the next morning.

Gordon added that both victims were found with beacons. The first victim who died from trauma, had to have her beacon turned off before they found the second victim who died from asphyxiation.

Gordon stated that the local PEP group and Fernie Search and Rescue did a great job. He emphasized the importance of having a competent media spokesperson available early in an avalanche event. The initial press reports were horribly inaccurate, because in the absence of answers, the media made them up.

Mapping Search Patterns – Steve Conger

Steve Conger works for the Utah Department of Transportation and is on the Board of the American Avalanche Association.

Two years ago at the American Avalanche Association meeting, Steve challenged the beacon manufacturers to develop teaching materials for the avalanche courses.

Steve carried out beacon research in mapping search patterns. All beacons had fresh batteries the day of his experiment. He found a location in Little Cottonwood Canyon where other people would not influence the study results. He used a GPS unit to log the times and locations and showed the strip search widths. He conducted two searches with each of the beacons. He added that a GPS unit buried in snow cannot see space, so it cannot do constellation readings.

He buried his beacons 1.5 meters deep. He will be trying this experiment with multiple units this year. He was most surprised with the false signals; when you picked up the signal and stopped and then moved once again, the signal was lost. He stated you had to be within 20 meters on the flux line. Steve wants to incorporate survey grade accuracy in this study.

Canadian Avalanche Foundation ~ Chris Stethem:

Chris is the President of the Canadian Avalanche Foundation. He gave a brief overview of the idea of the Foundation and explained that it is meant to compliment the activities of the CAA.

The CAF is a federally registered charity to raise funds in support of avalanche safety initiatives. Chris Stethem, Jack Bennetto, Gord Ritche, Hans Gmoser, Peter Fuhrman, Peter Schaerer, and Margaret Kemper Trudeau were on the Board of Directors last year. Justin Trudeau will be taking his mother's place on the Board. A minimum of two board members must be CAA members.

The goals of the CAF is to raise and grant funds in support of:
- public avalanche bulletins (7 days a week service over a wide geographical area is their main focus)
- public awareness and education
- research

Chris discussed the relationship to the CAA. He then gave a financial overview of the CAF over the past year. Donations included $22K corporate membership, $3K individual membership, and $67K in memory of others that included monies earned at the Bryan Adams benefit concert, Whistler auction, and donations in memory of Karl Nagy, Pierre Trudeau, and Dave White.

Grants in 2000/01 included $20K to fund the public avalanche bulletin and $500 to the Nelson area Snowsmart pilot project for materials.

Future Initiatives of the CAF include:
- A commitment to support an increase in the frequency and coverage in the public avalanche forecast in 2001/02
- A continued donor/membership drive in the mountain community
- Striking partnerships within the mountain community
- A drive to reach the non-traditional mountain community
- Establishment of an Alberta Chapter and office in Canmore

Avalanche Progress In Newfoundland ~ Keith Nicol:

Keith Nicol is a professor at Memorial University in Newfoundland and is a key stakeholder in the Eastern Canada Avalanche Project (ECAP).

Keith reviewed the weather patterns this winter in Newfoundland. St John's had continuous snow (over

600 cm) and broke their winter record of 1881/82. At this time, they still have snow and are driving through snow tunnels. He added that the winter snowpack around Cornerbrook was close to their usual average.

The ECAP aimed to reach recreationists in the province. Keith showed slides of the avalanche terrain in Newfoundland. As well, he showed weather data for the past winter and correlating avalanche events. Six snowmobilers were caught in avalanches and one was partially buried this year. Another avalanche involved 5 people on 4 snowmobilers, triggered by high marking. Everyone in that accident was partially buried. The snow-mobiles were damaged but there were no injuries to people.

Keith added that they need a reporting system in Newfoundland to better track avalanche events.

He ran one RAC course through Memorial University this year. The snowmobile community is not interested in avalanche training at present. He will try to contact local sledders again next year.

Gord Ritchie indicated it was a diverse slate today and he thanked the afternoon speakers. The meeting adjourned at 4:50 p.m.

<u>Thursday May 10th ~ 8:30 a.m.</u> Rob Whelan ~ Meeting Chair

Rob welcomed the participants and introduced the morning sessions. They focused on research being done by the University of Calgary, the University of B.C. and work in the United States.

<u>Recent Avalanche Research Results at UBC ~ Dave McClung:</u>
<u>Risk and Bayesian Techniques for Snow Avalanche Risk Mapping in Canada:</u>

Dave followed the lead of colleagues in the landslide sector where everything is risk based. He attended rockfall and landslide sessions in France that reconfirmed this, and added that this is the way his group has been going for a long time.

His session presented ideas of avalanche mapping and risk concepts including:

- Risk acceptability for land use planning and zoning
- Swiss standard and Canadian mapping standards
- Applications for other things besides residential things
- Bayesian approach to probable consequences

Dave explained the definitions of risk (probability or chance of death or losses as well as frequency and probable consequences). The size classification enters under probable consequences whereby risk = frequency x probable consequences.

The risk acceptability for land use zoning is proportional to the inverse of the return interval. In Europe they use the concept of impact pressure and return period at a given location.

Different plots of impact pressures, return periods and curves were discussed. In comparing the linear theory to the Swiss standard shown, linear theory is comparable but more conservative than the Swiss standard. At the highest frequency of events, the Swiss would accept more risk than the linear theory.

Other applications for this work is forestry and transportation use.

We have two measures of destructive pressures; impact pressures and the Canadian size classification (a way to record the destructive consequences of events).

The Bayesian approach to probable consequence and the Bayes rule were discussed. Bayes rule allows one to combine judgmental probabilities with calculated probabilities.

There is often not enough data for site specific information when linear risk mapping for highways is done. Prior probability is substituted for the probable consequences in the risk equation.

Dave discussed an application with the return period in Galtür Austria. In February 1999, 31 people were killed when an avalanche entered the town. Dave showed slides and discussed the return interval model he used. Based on everything Dave learned at this site, this avalanche has a return interval of one to two hundred years.

He summarized by stating that risk-mapping parameters can be formulated as the intersection (product) of probabilities. Swiss and Canadian zoning standards are compatible with a risk-based approach. The Canadian requirements are diverse with two measures of consequences and impact pressures of the Canadian size system. Probable consequences are expanded using Bayes rule.

The risk-based approach breaks the mapping problem into easily identifiable parts and shows how to combine them.

He closed with these final thoughts on probability:

- The odds against a bomb on a plane are a million to one;
- The odds against two bombs ; a million times a million to one;
- So - Next time you fly – cut the odds and take a bomb!

Dave McClung thanked the research supporters for the UBC avalanche group. These supporters include Canadian Mountain Holidays, Natural Sciences and Engineering Research Council, Forest Renewal B.C., Vice President Research, UBC, and in kind support from BC Ministry of Transportation and Highways and Intrawest.

Snow Stability Patterns in British Columbia ~ Pascal Haegeli:

Pascal is a PHD student working at UBC in the Department of Geography. He is working on computer modeling for snow stability patterns.

Pascal explained that the goal of his research is to develop a new avalanche forecasting computer model for heli ski operations. Heli ski operations have different needs than ski areas of highway operations, where models have been used.

Pascal's work included the examination of forecast objectives in order to create an appropriate model: scale problem. He gave examples of stability scale domains in avalanche applications. Factors influencing his model include individual weak spots, adjacent avalanche paths, avalanche cycles etc. His research is to determine which pattern is dominant.

Pascal showed a slide of a stability cycle in CMH operations. He requires geographical information from the group including study sites, zones and where exactly their operations are. He wants to come up with a scale definition of avalanche phenomenon and all contributing factors. This would give information on how to improve the monitoring network, and transferability of model.

The benefits of this research to the avalanche industry would be a better understanding of avalanche activity in B.C. and the beginning of a more user-friendly display of Infoex data. He added that the Infoex data set is unique and much can be done if they have this geographical information. This would be very important in increasing the understanding of stability patterns.

Verification of Fine Grid Weather Forecasts with Input into Numerical Avalanche Prediction ~ Claudia Roeger

Claudia's research involved creating a 24 hour avalanche forecast by combining weather prediction output with numerical avalanche prediction as one more tool for avalanche forecasters to help with their decision making process. She defined the two steps used in her models and the verification of numerical weather prediction output.

Her conclusions about weather predictability are that 24 hour forecasts were generally more accurate than 48 hour forecasts. The higher resolution grids (2 km/3.3 km) gave better predictions than the 10 km grid.

She explained the new snow density analysis and added that new snow density does not depend on wind speed at the study plot at Kootenay Pass. New snow density depends significantly on air temperature.

Claudia showed a graph detailing avalanche forecast verification methods. This included verification with observed avalanche data and comparison of model output statistics.

Her avalanche forecasting results were that the avalanche forecast model output for the model runs with numerically predicated weather data, is very similar to the run with observed weather data.

She concluded that the combination of numerical weather predication and numerical avalanche forecasting looks very promising. The 24 hour avalanche forecast with high resolution numerical weather predication as input gives results comparable to the nowcast (12 hr forecast) with observed weather data as input.

Claudia's ideas for future work include:

- using the Kalman predictor correction method for MC2 forecasts at Kootenay Pass in daily operations
- testing the combination of the MC2 weather forecast on a daily basis at Kootenay Pass
- determination of effects on increasing grid resolution of weather models
- sensitivity tests for input variables of the avalanche forecasting models

She thanked the B.C. MoT Snow Avalanche Program and Whistler Blackcomb Ski Patrol for their assistance in the project.

Study Plot Variability ~ Chris Landry - Montana State University:

Chris discussed avalanche prediction by spatial extrapolation of study plot stability.
Last winter he completed six trials in Montana and one at Rogers Pass (Round Hill)
He used a quantified load column test (bench mode or surface mode).

Variability was evaluated:
- in shear strength within a pit
- in shear strength within a plot
- in shear stress within a plot
- in shear strength between plots

The pit layout of stability tests cells (plan view) was shown and variations in stability within pits was discussed.

At Round Hill there was relatively low variation within the pits but wide variation within the plot. He showed a variety of plot wide and pit coefficients of variation at the other six plots as well.

Variability in strength was shown in terms of critical load/water equivalency. He stated that it was hard to pick out any clear pattern regarding whether variations in the slab correlated to the variations in strength. Chris looked at the ability of a single study pit to reliability predict study plot stability. Overall, reliability was low.

Plot to plot comparisons were tested with the same hypothesis for equal mean strengths, but the hypothesis was still rejected.

Chris closed by thanking his research crews and supporting organizations, including the CAA and the Rogers Pass crew.

Runout Estimation for Short Slopes ~ Bruce Jamieson:

Bruce reported on Alan Jones' work for his MSc thesis.

There is a history of residential avalanche problems with short slopes. Bruce showed some examples of this with slides. Existing models underestimate runout for short slopes. Since 1935, 56% of residential fatalities in Canada have occurred from slopes less than 150 meters high.

Alan did his first summer of research on short avalanche slopes. Twenty-eight paths have been surveyed to date in the Rockies, Quebec, the Columbias and Coast Mountains.

Alan's slope profile included a survey of the entire path from the top of start zone to the runout using tight chain and clinometer.

Bruce displayed some preliminary results of data showing the non-exceedance probability versus runout distance. Path profiles were completed at each of the 28 paths surveyed, and extreme runouts were determined from vegetation and historical records. Preliminary results involve developing regression equations for short slopes using the runout ratio method.

Future work includes surveying extra sites in the summer of 2001 to expand the data set. Alan will try to get additional sites based on suggestions from the avalanche community and use data from other countries. Alan will examine climatilogical variations as possible predictors for runout on short slopes. He expects this to be complete by December 2001. On behalf of Alan, Bruce thanked the field staff and organizations that supported this project.

He closed by saying if you know any short slopes that could be added to this project this summer or have any other ideas or questions about the project this summer please contact Alan Jones (alanjones@netidea.com) or Bruce (jbjamies@ucalgary.ca).

Digital Guideline Development ~ Evan Manners:

Evan discussed the obvious benefits of data sharing across large geographical regions. Having this data in a similar data format has a lot of efficiencies.

The OGRS project was postponed due to the ADAPT project, however the Technical Committee has now started the review. The current Terms of Reference includes adding field comments, correction of minor errors, French and English versions and publishing in digital format by the fall of 2001.

Basic avalanche observations need to be in a common system that OGRS provides, but developing standards for communication of this data would also be beneficial.

The data needs some common geographical relationship to make it more meaningful.

Roger Aikins demonstrated the CMH software currently under development. "Snowbase" is used in all eleven areas of CMH. Roger explained the history of the software and how the information is communicated between the guides, areas, and the central office in Banff.

The main focus of the software is a visual access of information. He added that it is an operational tool and not a research or modeling tool. The data is entered in a user - friendly way and greatly augments communication within the guiding team.

Roger gave a demonstration of the CMH Snowbase program and showed the various reports that can be generated. Digital cameras are used to capture images and these are later shown at guides meetings for discussion of avalanche events. These events can be archived and discussed throughout the season.

Dave Smith demonstrated the BC MoT software and explained it was more specific to a GIS application. They want to link the data organization and use it for GIS. B.C. MoT is looking at the possibility of using this application on a broader scale in two or three years.

Dave showed how he can connect to real time weather data, and also other operational components that can be customized for his program (i.e. inventory of bomb caches, etc.).

Evan discussed the history of the XML data standards. He had surveyed principle stakeholders within the avalanche industry to determine if they wanted to participate. He added that this was an important initiative to work on, and should include GIS terrain links, but we should continue to support the efforts of the U.S. to collect data in a unified method.

The Board of Directors has agreed to proceed with the XML data standards. Torsten has estimated the cost to the CAA in developing a digital storage standard to facilitate development exchange in the future. This work would add $10K to the OGRS revision.

In the future, if we develop ways to improve data exchange we cannot diverge too widely in how we store the data. Data conversion is expensive and we should try to avoid that by having a unified way of storing data.

Thursday May 10th - 1:15 p.m. **Bill Mark ~ Meeting Chair**

Bill introduced himself as the President of the CAA Board of Directors. He thanked the rest of the Board for all their commitment over the past year and introduced them.

Presidents Report ~ Bill Mark:

The new CAA Managing Director (Clair Israelson) was hired Aug 1, 2000. Diny Harrison resigned as President to avoid a conflict of interest. Bill was the Vice President and assumed the role of President. Robin Siggers became the Vice President and Rob Whelan was appointed as a Director at Large. Bruce Allen agreed to stay on as Past President to provide continuity with the new Board.

In an April 2000 visioning session, the BOD and Past Presidents met to focus the direction of the CAA. Michael Laub prepared a report based on this visioning session that would help guide the BOD and CAC managing director.

His report stressed organizational structures, reporting responsibilities including committee Terms of References and job descriptions, enhanced financial planning and management, and development of policy documentation.

Based on his recommendations, Committees Terms of Reference are being approved, a RAC management strategy is in progress.

Communications: Bill stated that the Board is continually working to improve communications within CAA. All committees now receive BOD meeting minutes and there is a Board member on all committees. Other communication initiatives implemented this year include a "member only" newsletter supplement, and website improvements. Bill added that members should let the CAC know if they have any other ideas to improve communications.

CPD Program: The membership unanimously adopted the continuing professional development concept (CPD) in 1998. It is the third year of operation. The Board strongly affirms support for CPD continuation but are looking for feedback to improve it.
There will be random audits undertaken by the Membership Committee this year.

We need to more clearly define the criteria for avalanche “activities” as per the CPD document. If you have any other ideas, please contact Niko, (Professionalism and Ethics Committee).

Professional Registry: Bill stated that there is an average of five inquiries per year and these queries generate inappropriate results. It is a major workload for the CAC to maintain the registry in its present form. At present, it is not working well for members or clients.

The Board made the following recommendations at their recent meeting for the CAA website:

- all members will listed by category with contact information unless they choose to be "unlisted"
- refine the categories in the Registry listing
- a "yellow pages" concept be made available for members of all categories with optional paid advertising of services
- this website would serve as a "shop window" for the CAA and professional ethics would be showcased

Bill showed examples of the proposed web page for member listings and the paid advertising, "yellow page" concept for industry information/services.

Relationship Between the CAF and CAA: The CAA and CAF need to have better cooperation, and a joint marketing strategy will be developed to assist in this regard. The CAA has hired a strategic marketing person to develop plans to procure sustainable corporate funding. Jane Mitchell will also work on how we can better present ourselves to current and potential sponsors. She will work on our "branding". Bill indicated the CAA logo may require some updating because it is looking dated and is not in both French and English. This has been recommended by marketing experts and key sponsors.

The CAA will work on a sponsorship plan that gives value to sponsors. The web site, CAA materials and events are all areas that will see change as we work to improve our corporate image.

CAA Issues on the Horizon: Bill discussed membership participation and committee representation. The Board would like to investigate keeping participation up in committees, especially membership activities east of the Rockies. Bill stated that the Board recommends a constitutional change that can be voted on next year to make this a truly national organization.

Board of Directors Priorities for 2001/02 include:

- financial management policies
- marketing plan
- engaging the snowmobile community more
- continuing to improve CAA member services
- forming strategic alliances (ACC, CWSAA, BCFS, BCHSSCOA, ACMG, CSGA, etc.)
- ongoing Laub report implementation
- CAATS export issues
- PEP training and Coroners recommendations

Financial Report: Due to the absence of Secretary/Treasurer John Kelly, Gord Ritchie discussed the financial statements for the Association. Gord introduced Ken McLean, who is the accountant for the CAC and CAF. Ken was in attendance to answer any questions.

Gord reviewed the CAA Financial History ~ "A Turn Around Story:"

1998/99 – Financial Hard Times:

- $67 k operating loss with a $55 k year end cash balance (before project funds of $75K)

1999 – 2000 – Tough Measures:

- CAATS cutbacks, extra students on courses
- part time Infoex staff eliminated

- Board visioning meeting and Laub report
- $45K operating surplus
- $138K year end cash balance

2000 – 2001 – Consolidation:
- project funds isolated from Operations
- IPR (intellectual property renewal) fund established
- Well managed operations with tracking mechanisms established
- $49k operating surplus
- $202k additional project funds
- $357k year end cash balance

2001 – 2003 – A Return to "Hard Times" or Building for the Future?
This concept was discussed and financial statements and balance sheets were reviewed. Anyone requesting the detailed budget information can obtain a copy from the CAC.

Ken explained the difference between project funds as liabilities and being shown as an asset. These funds are given in advance, but are listed now because work commitments are being carried out. He defined "future project money" as money that is received in different fiscal years. Ken added that the budget now reflects more tracking on dollars and allocating costs fairly against activity elements. Asset depreciation is included in each of the operating areas.

Bruce Allen made a motion to accept the financial statement. Bob Sayer seconded the motion. The motion was carried with all in favor.

Education Committee ~ Colani Bezzola:

Colani summarized the work of the Education Committee, and indicated there had been more lengthy reports in some of the other meetings (i.e. CAATS, RAC, etc.). The committee is comprised of Laura Adams, Dave Smith, Randy Stevens, Phil Hein, Robin Siggers and Colani Bezzola. They held meetings Sept 10 2000, Nov 9 2000 Jan 30 2000, and April 17, 2001.

Their Terms of Reference/Mandate are nearly complete. Their current workload involves CAATS (Phil Hein), ADAPT Project, RAC, CPD (annual workshop), SNOWSMART, JIBC/PEP: Review of the "Organized Avalanche Rescue Response" Course, Kokanee Hut initiative and "A discussion – Future Formal Training for Avalanche Professionals in Canada."

Colani closed by thanking all the members of the Education Committee and especially Randy Stevens for his commitment to the RAC program.

There was concern expressed that there was no RAC representative on the Educational Committee. Colani indicated that Laura will be the contact person for RAC.

Action: A RAC Advisory Group was formed at the RAC meeting and they will work with Laura and Clair to have a TOR for this group including a reporting structure.

Explosives Committee ~ Mike Boissonneault:

The Explosives Committee is comprised of Mike Boissonneault (chair) Bernie Protsch, Colani Bezzola, Brian Johnson, and Bruce Allen who is the Board contact.

The mandate for the Explosives Committee was reviewed. They have held regular meetings and other communication throughout the year.

The International Society of Explosives Engineers hosted an avalanche task force meeting last year in Salt Lake. Some of the issues discussed included:

1. Fuse length (in US minimum fuse length is a 90 second fuse, or 66cm – in Canada minimum fuse length is 100cm or approx 150 seconds);
2. Relights (one re-light allowed within 20 seconds of original attempt in US);
3. Single fusing Vs double fusing (Explosive manufacturers want double fusing to reduce probability of duds, however cost, especially in Canada, becomes an issue);
4. Hand made fuse Vs manufactured fuse (most US programs make their own fuse assemblies with hand or bench crimpers. In Canada we must use manufactured fuse, by law);
5. Training - was not given much discussion at the meeting.

Explosives Committee Initiatives:

The CAA is developing generic avalanche control procedures. This document is in draft form only at the present time.

The Explosives Committee worked with WCB last summer to create a more applicable written exam. They met with Dick Shaw and Steve Duffy and revised the entire exam. There are now 60 questions regarding transportation, handling and storage including questions to test for knowledge of snow and avalanche phenomenon. Once a candidate writes these sections they write the section(s) they wish to get an endorsement in (Handcharge, Helibombing, Cornice, Avalauncher).

There is a CAA proposal to raise the existing qualification necessary to obtain an Avalanche Control Blasting Ticket (CAA Level 1 or Guides' ticket). The Committee wrote a letter to WCB, who are not in a position to give an official response but agree in principle. This may not occur until they revise their regulations.

The CAA is seeking funds from WCB to support explosives training. They are now in a position where they may receive $20K to go towards an avalanche control training course. A course could be available by 2001.

Mike Boissonneault showed the participants a draft of an avalanche blaster's log book they had created. The blasting log is a way of recording all blasting activities and can be easily and quickly filled out after each mission. This proposed blasting log would be specific for avalanche control missions. According to WCB regulations, all blasting activities should be recorded in a personal log book.

Everett Clausen indicated that CIL/Orion has diverted 3% of sales to CAA training program. This program will continue next year. Bruce thanked Everett and CIL/Orion for their contribution.

Technical Committee ~ Bruce Jamieson:

The members of the Technical Committee are Dave McClung, Bob Sayer, Simon Walker and Rob Whalen. They read their completed mandate to the meeting participants.

Work carried out by the Technical Committee included:

- forestry handbook - feedback was completed
- OGRS – they are working on compiling comments that have been received and forwarding these to

Torsten who is defining scope for the project

- Rob Whalen and Bruce Jamieson will volunteer to work on the OGRS committee and Bob Sayer, Simon Walker and Dave McClung will review document
- Reviewing the form for stability evaluation work
- Providing a review of the advanced glossary of the CAA web site

Bruce closed by stating they have an interim Terms of Reference in place and will give this some more attention in the near future.

Awards:

Dominic Boucher was given the "New Member Award" in recognition of all his hard work in Quebec. He was presented with a plaque and pack, and an ice ax.

Anton Horvath ~ Membership Committee:

The membership committee is comprised of Anton Horvath (chair) George Field, and Jill Hughes. Their new initiatives have included developing a mandate and Terms of Reference. This is the third year of the CPD program and a random audit of members will occur this year. Anton thanked Audrey at the CAC for all her hard work with the membership.

The total membership is 468 persons (257 professional, 129 affiliate, 81 associate and 5 honorary). The trend is an increase in affiliate members largely because of new RAC providers.

Anton showed the new member lists, welcomed these new members on board and looked forward to their continued involvement in the CAA. He added that when we have 500 members, there is a new source of funding in Alberta available to us.

Professionalism & Ethics Committee ~ Niko Weiss:

Nic Seaton and John Buffery and Niko Weiss make up the Professionalism and Ethics Committee. They worked on the Scope of Practices document this year. After input from Peter Schaerer, the committee drafted a position paper that is currently with the Board Work on this initiative, including a formalization of definitions of professional members, will be ongoing.

The P&E Committee will continue their efforts to streamline CPD reporting and improve member participation. Niko added that the committee is open to ideas for improving the CPD reporting mechanisms and urged members to contact him at ams@ark.com with suggestions.

They will be submitting their Terms of Reference to the Board for approval soon.

Associate Members and Affiliate Members Report ~ Gord Burns:

Gord Ritchie (Affiliate Members) and Gord Burns (Associate Members) were elected to be their committee representatives for another year. Gord Burns indicated he was surprised by the amount of

Board work that is required. He added that there are no major issues from either of these sections.

They appreciate the email communication in the CAA's effort to save trees. Gord thanked the CAC staff for their hard work and the associate members that attended the meetings.

Managing Directors Report ~ Clair Israelson:

Bill Mark introduced Clair and indicated how happy he was to have him at the helm given his background in the avalanche industry and organizational knowledge.

Clair stressed how proud he was to work with this organization. As Managing Director, his duties include working with the CAA Board of Directors, Committees, staff and stakeholders and the public to prudently manage and advance the work of the CAA in a manner that reflects the structures, history and values. He has been working towards implementing the Board's Strategic Direction for the Association. He has developed operating policy documents for Board approval currently "approved as interim". These include: conflict of interest, intellectual properties management, CAA product pricing, contractor selection, etc.

Clair discussed the Cloutier Risk Management audit which scope includes CAA operations, website, insurance (not finance), CAATS, RAC, public information bulletin etc. In all 35 issues were identified and the highest priority issues were dealt with immediately with the remainder to be addressed this summer and fall.

Clair briefly explained the changes to the CAC Financial Systems. They are now able to track committed costs against the various budget items. This will allow better reporting to the Board, and track expenditures more effectively. Some financial system changes include:

- intellectual and materials properties maintenance now an annual budgeted cost
- cost centre elements, funding streams and OH cost allocation criteria rationalized
- committed expenditures are now tracked
- operations are separate from projects
- multi year financial tracking systems for projects developed and implemented

A CAA Financial Policies document will be developed in 2001/02.

CAA Projects for 2000/01 include:

- Avalanche Hazard Mapping Project $291.2k, ADAPT Project $281.9K
- CAA/CAF marketing plan – $20k+. Jane Mitchell was introduced (Marketing person) and Clair urged members with business links, etc. to talk to Jane
- QCAP – $455.4k – 30 months duration
- OGRS revision – $6k +
- Cloutier report implementation – $10k
- Explosives Course Development – $22k +

Other CAC activities included Avalanche Awareness Day at Whistler, creation of a "Members only" website and newsletter supplement. Feedback is welcomed.

The CAATS registrations have increased. There is improved customer support. Phil Hein became a CAC employee in 2001/02.

The Infoex format has been upgraded and improvements will continue for 2001/02. The public safety services bulletin access continues to grow (250,000 hits to 480,000 hits). It broke even financially this year, which was a milestone.

Reported avalanche involvements this year included 64 reports involving 111 people and 13 fatalities. It was a tough winter though and we did very well to get through it with so few accidents.

He acknowledged the hard work of the CAC staff. These people include: Evan Manners (Operations Manager), Phil Hein (CAATS Coordinator), Audrey Defant (Association Member Services) , Heather Buerge (CAATS Administration) , Pat Cota (Accounting) , Brent Strand (Reception, Technical Support and Infoex) , and Wanda Hill (Infoex).

American Avalanche Association ~ Steve Conger:

The American Avalanche Association has seen a lot of growth and changes in the past year. They have similar numbers of members in the U.S. (400) but very meager funding. The AAA has a paid staff of one. They are strictly a "member organization". Their governing Board decided to make a concerted effort to become a more umbrella organization within the U.S. They have dropped the "P" from their name. Steve added that the greatest threats to the avalanche community in the U.S. is sustainable funding for regional avalanche forecast centres, and continued concern over explosives (i.e. the ability to use explosives for avalanche control work).

Members want the association to ensure quality avalanche education in the U.S. The association's education committee has developed a plan for the certification of avalanche instructors which will be presented to the general membership this fall for approval. A description of the program will be in the Spring issue of the Avalanche Review. The U.S. does not certify schools or curriculum but proposes certifying instructors and has in place recommended curriculum guidelines.

With the help of an advisory board they examined how to help the avalanche forecasting centres with their funding crises. They partnered with Forest Service National Avalanche Centre to form a conduit for donations to the smaller centres. The AAA has been promised seed money to get a development director to obtain sustainable funding. The job posting is currently on their website.

The association is currently seeking a new executive director as well as editor for the Avalanche Review. Don Bachman has stepped in as interim director.

Steve discussed qualifications and CPD proposed for the certified avalanche instructors. He added that they wish to support the quality and intent of the Canadian materials and do not want to see this diluted south of the border. Their development seminar this fall, will be an Olympic and weather theme and held at the Canyons. There will be a technical component (data logger programming).

For more information please see their web site at: www.americanavalancheassociation.org or www.avalanche.org, or contact Don directly (406) 587-3830.

Elections:

Directors are elected for a maximum of five years. If persons are elected as president in their final year, they can stay in that position for an additional three years (8 years in total). The role of "Past President" is transitional and helps bring continuity to the Board. The Membership Committee is elected from the floor. The Audit committee includes all the past presidents, and Alberta Auditors.

When a governing board was instituted, the goal was to get a range of geographical locations and disciplines. In future there is going to be more of a business/management focus in the Board. The membership committee should have a higher profile.

The Board members' time span serving as a Director is as follows:

President – Bill Mark (3)	Vice President – Robin Siggers (2)
Secretary/Treasurer – John Kelly (2)	Director - Membership – Anton Horvath (1)
Direct at Large – Simon Walker (1)	Director at Large - Rob Whalen (<1)
Director – Associates – Gord Burns (1)	Director – Affiliates – Gord Ritchie (3)
Past President - Bruce Allen	

Gord Burns and Gord Ritchie had been re-elected to their positions earlier in the morning.

None of the meeting participants nominated anyone else to run for the Board.

Motion: Dave McClung made a motion to re-elect the current Board of Directors by acclimation. Colani Bezzola seconded the motion. The motion was carried with all in favor.

All Directors were re-elected by acclimation for another year term.

Three new members were nominated to serve on the Membership Committee. They are Brad White, Helene Steiner, and Johan Slam, and replace George Field and Jill Hughes.

Motion: Bruce Allen made a motion to close the nominations to the Membership Committee. This was seconded by John Forth. The motion was carried with all in favor.

Brad White, Helene Steiner and Johan Slam were elected to serve on the Membership Committee.

The new Alberta Auditors are Mark Klassen and Rowan Harper

Bill showed the participants the Approved Interim CAA Reporting Structure diagram. The Board will focus on policy and strategy.

NEW BUSINESS:

2002 AGM Location: ***Motion by Dave McClung to hold the 2001 AGM in Penticton. Seconded by Bruce Jamieson.***

Discussion: The ISSW will be held in the fall of 2001 in Penticton and this would give organizers an opportunity to finalize facility details, etc.

The motion was carried with all in favor.

Quorum: ***Motion by Bob Sayer that the Board of Directors send out notice for voting at the next***

meeting that the number of people required as a quorum be changed to 10% from 20%. Bruce Jamieson seconded the motion.

Discussion: With the increase in membership, we may be in the position of not having sufficient members at the next AGM to reach a quorum of 20%.

The motion was carried with one opposed.

CAA Membership Handbook: Dave McClung made a motion that the CAA produce a handbook that is free to members, available in paper copy as a booklet, and would include name, address, affiliation, phone, fax, email, membership facts, code of ethics, procedures for complaint, CAA Constitution, etc.

Discussion: Privacy issues for members, data changes.

Jack Bennetto modified the motion: That the CAA membership list be made available in electronic format and on paper by request for the membership. The CAA Code of Ethics, Constitution, and other data could also be included. Bob Sayer seconded the motion.

The motion was carried.

Bruce Allen made a motion to adjourn the meeting. Bob Sayer seconded the motion. The motion was carried with all in favor. Bill Mark adjourned the meeting at 4:35 pm.

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