THE AK BLOCK, A SIZED NON-CUTBACK SNOW TEST

Bill Glude[1] and Randall Mullen[2]

[1]Alaska Avalanche Specialists, Juneau, AK

[2]Crazy Mountain Research, Bozeman, MT

ABSTRACT: The AK Block is a large block snow test sized to the tester's weight and their ski or snowboard contact length, dug out on three sides, and loaded by a person on skis or snowboard. It was developed to maximize the large block advantages of simulating human triggering, identifying the most-critical weaknesses, error tolerance, propagation testing, numerical score plus direct sensory feedback, and minimizing the effects of spatial variability. The AK Block takes less time than other large blocks, and avoids, the back cut that is difficult to do properly. It accounts for tester weight, and tests the slab and weak layer as an integrated system. The AK Block is simple to set up, using the skis or snowboard to provide crack initiation. Earlier analysis of 357 blocks over 120 field days indicated that the AK Block is a valid predictor of avalanche days. This new statistical analysis follows the methodology used in evaluating the Extended Column Test and Propagation Saw Test, allowing better comparison of the AK Block with other tests. Results suggest that the AK Block is more accurate at detecting unstable days than the Rutschblock, and has a lower rate of false stable results. Its predictive performance is comparable to that of the Propagation Saw Test, but less accurate, and with a higher false stable rate, than the Extended Column Test.

KEYWORDS: avalanche, snow stability tests, block tests, sized-block, AK Block, Rutschblock

1. INTRODUCTION

A variety of tests are used to help evaluate snow stability. Though their usefulness is limited by the spatial variability of the snowpack, these tests are valuable tools for both professionals and recreational users. They work best when combined with other observations as part of a targeted search for instability, as noted by Landry (2002) and McClung (2002).

Tests may use small or large blocks. Small block tests are generally 30 by 30 to 30 by 90 cm, isolated on all sides, and loaded by hand or by dropping a small weight, usually applying force through a shovel. Large block tests are big enough for a person on skis or a snowboard to load them by jumping on the block.

The large block tests have the advantage of a greater sample area that helps average out small-scale spatial variability as noted in Schweizer (2004) and Johnson and Birkeland (1998). There is also evidence, as noted in Glude and Mullen (2008) that large block test results more effectively influence human decision-making.

The AK Block grew out of an effort to improve on the good qualities of the widely-accepted Rutschblock test. The history, procedure, and prior statistical analysis are described in detail in Glude and Mullen (2008). An updated paper for peer review is also in the works, so this conference paper will focus on the most recent statistical analysis.

The Glude and Mullen (2008) paper can be found in the Proceedings for the ISSW 2008 conference, and on the Research page of the Alaska Avalanche Specialists website, at http://www.akavalanches.com/research.html, along with updated information and additional material.

2. SUMMARY - USING THE AK BLOCK

The first step in using the AK Block is determining your block size, which depends on the contact length of the skis or snowboard you are using, and your weight.

Since your skis or board initiate the crack, it is critical that they span the entire block. A small amount of rocker or early rise does not affect results, so long as there is good contact with the snow when jumping on the block. Measure the contact length and pick out your block width from the contact

* *Corresponding author address:*
Bill Glude, Alaska Avalanche Specialists,
Juneau, AK 99802;
tel: 907-523-8900
email: aas07@mac.com

length row on the sizing table, to the nearest 5cm. There is a sizing table in Section 8 of this paper.

Tester weight is without clothing and gear. Look for the closest column. If between weights, go heavier if you ride heavy gear; lighter if you prefer ultra-light. Do not try to adjust your weight with a rucksack; you will jump differently from a heavier person.

We considered having a correction factor for tester weight instead of sizing the block, but rejected that idea because it is already necessary to size the width to contact length; and smaller people get to dig a smaller block, while we assume that bigger people have the strength to dig a larger block.

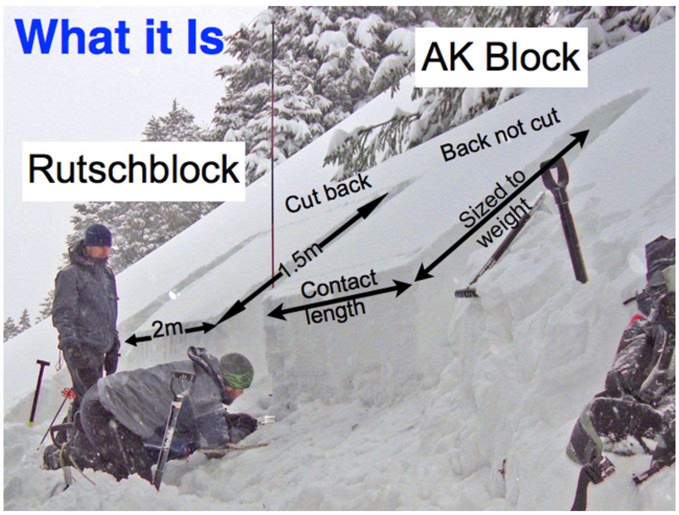

Fig. 1: Rutschblock and AK Block side by side, showing layout, with John Bressette and Mike Janes, Juneau, Alaska 2005, photo © Bill Glude.

The block is laid out, then dug on the front and two sides to a little beyond the depth of the layers to be tested. The side trenches can be narrow, and the last bit can be cut with a snow saw or shovel, rather than excavated. The back is not cut.

The tester approaches on skis or snowboard and stands right on the upper edge of the block, with tip and tail hanging free over the side trenches. Loading steps are:

1. Fractures during setup.
2. On approach or first gentle load.
3. On knee flex.
4. On first, moderate jump.
5. On second, hard jump.
6. On three hard vertical jumps.

6.5 Three hard “shear kick” jumps.

7. No fracture.

On skis in step 2, give a one-legged downslope push to apply shear force to the top layer of snow before stepping the other foot onto the block. Otherwise, skis can sink through soft weak layers near the surface without giving them a good test. Snowboards give the same downslope surface layer push while sliding slowly onto the block.

For step 6.5, jump with a “shear kick” downslope to transmit shear force to any weak layer.

Fig. 2: Proper positioning at the top edge of the AK Block, with tips and tails over the side trenches, photo © Bill Glude.

Record the numerical score, the slope angle, the shear quality (and fracture character if desired), and the percentage of the block that released. Example: AK4 on 38° Q2/RP 100%.

3. DATA SET

This new analysis uses the same data set as that in Glude and Mullen (2008).

Field testing locations were primarily in the Chugach and Coast Ranges of Alaska, supplemented by sites in the Kenai Mountains of Alaska, the Teton Range of Wyoming, and the Northern Alps, in Nagano Prefecture, Japan.

The Alaskan ranges and Japanese Alps all have cold maritime climates that grade inland to continental. That means they get virtually all kinds of snow every season, over a wide range from very dry to wet snow or rain; from thin windslab over depth hoar snowpacks to ones over 5m thick; with a winter temperature range typically -20° to +7°C.

The sample size and diversity was robust, with 357 large blocks and 120 field days.

Slope angles ranged from 28° to 48, with median and average of 39°.

Weak layer depths covered a range from 0.05 to 0.98 m, with a median of 0.35 m, and an average of 0.40 m.

Weak layer types were varied: 42% faceted, 20% frozen melt layers, 17% unidentifiable interfaces (usually density differences within storm snow), 9% thawed melt layers, 6% surface hoar, 3% graupel, 3% rounded, and 1% ground.

Tester weight ranged from 50 to 110 Kg for the AK Blocks, but was held to 80 to 90 Kg for Rutschblocks, to test the sizing of AK Blocks against standardized Rutschblocks.

Experimental controls included: no testing if spatial variability was high; sites chosen for uniform slope angle, snowpack, and loading; blocks shared common edges to minimize spatial variability; tests alternated sides to eliminate aspect effects; and blocks were discarded if compromised.

Blocks were laid out with graduated probes, sawn first, then dug at least 0.10 m beyond the weak layer.

Recording and observations followed the American Avalanche Association (AAA) observation guidelines, as outlined in American Avalanche Association (2004).

4. SUMMARY - RESULTS OF 2008 ANALYSIS

In these earlier studies, we considered stable days as those tested by skiers and explosives without avalanches, and unstable days as those with actual avalanches that day, or on the weak layer detected in the test, within the next 24 hours.

The AK Block and Rutschblock were compared using logistic regression analysis. The Akaike Information Criteria (AIC) value (Akaike 1974) was calculated for each case, and Receiver Operating Characteristic (ROC) curves were used to compare the Stability Wheel with AK Block tests.

We found no significant difference in AIC values between the Rutschblock and AK Block, both performed equally well.

The difference in AIC values and ROC curves showed that the Stability Wheel decision-making tool better predicted avalanche activity than the Rutschblock or AK Block alone. This is to be expected, as the Stability Wheel is a tool that incorporates a broader range of observations. The AK Block by itself had acceptable discrimination.

AK Blocks were compared with adjacent identical blocks with a back cut added to determine the effect of cut versus non-cut backs. Bootstrap t-test results showed no significant difference.

These results were surprising to us, but were similar to those for the ski-block (Rutschblock without the cutback), in Jamieson and Johnston (1992). Their ski-block scores were a marginally significant one-half step higher when median Rutschblock scores were 2 or 3. but showed no significant difference when Rutschblock scores were in the more-critical decision-making range of 4 or higher.

The Cutback AK Block scores averaged a statistically insignificant 0.014 step lower than uncut AK Block scores, and there was no significant difference for any particular range of AK Block values.

The low 10% rate of fracture at the back cut in our Rutschblock sample underscores the lack of difference.

5. METHODS - CURRENT ANALYSIS

To allow better comparison with other snow tests, we re-analyzed the original data set, following the methodology detailed in Simenhois and Birkeland (2009) in their evaluation of the Extended Column Test (ECT) and Propagation Saw Test (PST) using contingency tables and the Hanssen–Kuipers discriminant as in Hanssen and Kuipers, (1965), and as applied to snow in Purves et al. (2003).

The Hanssen–Kuipers discriminant is also called the True Skills Score (TSS). It compares the test's accuracy against random, unbiased results. TSS = 1 is a perfect predictor; TSS = 0 for random predictions, and TSS = < 0 is worse than random.

We followed the Simenhois and Birkeland (2009) procedures for calculating Probability of Detection (POD), Probability of False Detection (POFD), False Stability Rate (FSR), and True Skills Score (TSS).

We applied the Simenhois and Birkeland (2009) criteria for stable and unstable days. Stable days were those tested by skiers and explosives without producing avalanches, and unstable days were those with avalanches, shooting cracks, or whumpfing.

The only difference in methodology is that we took each day's average test scores as one piece of data, rather than each individual test. Our initial analysis was done that way so a large number of tests on an anomalous day would not skew the results. Rather than re-scoring each day here, we continued using that more-stringent criterion.

Average AK and RB test scores of less than 5.0 were considered as indicators of instability; 5.0 and higher scores as indicators of stability.

6. RESULTS AND DISCUSSION

The contingency tables compare observed stable or unstable slope conditions with the tests' predictions, with cases as set out in Table 1, following Simenhois and Birkeland (2009).

Tbl. 1: Contingency Table for Assessing Stability Test Performance

Test Result	Observed Slope Conditions	
	Stable	Unstable
Stable	a: correct stables	b: misses (false stables)
Unstable	c:false alarms (false unstables)	d: hits (correct unstables)

Tbl. 2: AK Contingency Table

Stable	57	12
Unstable	18	34

Tbl. 3: RB Contingency Table

Stable	38	10
Unstable	16	8

Tables 2 and 3 are contingency tables showing the values for AK Block (AK) and Rutschblock (RB) tests in our data set in the same format as Table 1.

Table 4 compares our results for the AK and RB tests with the ECT and PST results from Simenhois and Birkeland (2009).

Tbl. 4: Test Comparison

Test Type	POD	POFD	FSR	TSS
AK	0.74	0.24	0.26	0.50
RB	0.44	0.30	0.56	0.14
ECT			0.00-0.06	0.91
PST			0.30-0.44	0.56

TSS is a good evaluator of prediction in general, but FSR is particularly important for avalanche test evaluation because false stable results can contribute to fatal decision-making.

On True Skill Score, where a higher number is better, the AK Block rates higher than the Rutschblock, marginally lower than the PST; and they all score much lower than the ECT.

On False Stable Rate, where a lower number is better, the RB scores the highest, the AK Block is a little lower than the PST, and the ECT has a much lower score than any of the others.

7. CONCLUSIONS

The AK Block would appear to be a good predictor for avalanche testing. In this analysis, it outperforms the longtime standard Rutschblock, and performs comparably to the PST, but does not equal the low False Stable Rate or True Skills Score of the ECT.

The reasons for the AK Block outperforming the Rutschblock are not clear. Sizing the block to tester weight is a key difference, but our RB testers were kept to a narrow weight range. Perhaps the absence of the back cut reduces the edge effects discussed for ECT tests in Bair, E., et al., 2013, or perhaps it better simulates actual fracture initiation and propagation in the snowpack.

The effectiveness of propagation tests as predictors of avalanche days suggests that it would be useful to do the same analysis of propagation values for AK Blocks. Guidelines for AK Block procedure since 2008 include recording the percentage of the block that released, as well as the shear quality, and optionally the shear character; but this data set predates those improvements that came with the development of the propagation tests.

8. AK BLOCK SIZING TABLE

Dec	Wt lbs	264	253	242	231	220	209	198	187	176	165	154	143	132	121	110	99
2010	**Wt kg**	**120**	**115**	**110**	**105**	**100**	**95**	**90**	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**45**
	Area m²	3.30	3.17	3.03	2.89	2.75	2.62	2.48	2.34	2.20	2.06	1.93	1.79	1.65	1.51	1.38	1.24
AK Block Width in meters, same as contact length. Move decimal 2 places right for cm.	**1.00**	3.3	3.2	3.0	2.9	2.8	2.6	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.5	1.4	1.2
	1.10	3.0	2.9	2.8	2.6	2.5	2.4	2.3	2.1	2.0	1.9	1.8	1.6	1.5	1.4	1.3	1.1
	1.20	2.8	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.8	1.7	1.6	1.5	1.4	1.3	1.1	1.0
	1.25	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1.0
	1.30	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0
	1.35	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9
	1.40	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9
	1.45	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.9
	1.50	2.2	2.1	2.0	1.9	1.8	1.7	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.8
	1.55	2.1	2.0	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.8
	1.60	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.2	1.1	1.0	0.9	0.9	0.8
	1.65	2.0	1.9	1.8	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1.0	0.9	0.8	0.8
	1.70	1.9	1.9	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.7
	1.75	1.9	1.8	1.7	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1.0	0.9	0.9	0.8	0.7
	1.80	1.8	1.8	1.7	1.6	1.5	1.5	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.8	0.7
	1.85	1.8	1.7	1.6	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.7	0.7
	1.90	1.7	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.7	0.7
	1.95	1.7	1.6	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.8	0.7	0.6
	2.00	1.7	1.6	1.5	1.4	1.4	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.6
	2.05	1.6	1.5	1.5	1.4	1.3	1.3	1.2	1.1	1.1	1.0	0.9	0.9	0.8	0.7	0.7	0.6
	2.10	1.6	1.5	1.4	1.4	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8	0.7	0.7	0.6

AK Block height in m, choose from closest weight column. Weight is without gear or clothing.
Move decimal 2 places right for cm.

9. REFERENCES

Akaike, H.,1974, A New Look at the Statistical Model Identification. *IEEE Transactions on Automatic Control AC*, Vol. 19, 716-723.

American Avalanche Association, 2004. *Snow, Weather, and Avalanches: Observational Guidelines for Snow Avalanche Programs in the United States,* American Avalanche Association.

Bair, E., Simenhois, R., van Herwijnen, A., and Birkeland, K., 2013, Edge Effects in Propagation Tests,, *Proceedings of the 2013 International Snow Science Workshop,*

Birkeland, K. and Chabot, D., 2006, Minimizing “false stable” stability test results: why digging more snowpits is a good idea. *Gleason, A. (Ed.), Proceedings of the 2006 International Snow Science Workshop, Telluride, Colorado*, 498–504.

Birkeland, K. and Johnson, R., 1999, The stuffblock snow stability test: comparability with the rutschblock, usefulness in different snow climates, and repeatability between observers, *Cold Reg. Sci.ence and Technology*. 30 (1–3), 115–123.

Birkeland, K. and Simenhois, R., 2008. The extended column test: test effectiveness, spatial variability, and comparison with the propagation saw test, *Campbell, C., Conger, S., Haegeli, P. (Eds.), Proceedings of the 2008 International Snow Science Workshop, Whistler, B.C.*, 401–407.

Birkeland, K., Simenhois, R., and Heierli, J., 2010, The Effect of Changing Slope Angle on Extended Column Test Results: Can We Dig Pits in Safer Locations?, *Proceedings of the 2010 International Snow Science Workshop, Squaw Valley, CA*, 55-60.

Campbell, C. and Jamieson, J., 2007, Spatial variability of slab stability and fracture characteristics within avalanche start zones.,*Cold Region Science and Technology* 47 (1–2), 134–147.

Canadian Avalanche Association. 2001, *Observation Guidelines and Recording Standards for Weather, Snowpack, and Avalanches,* Canadian Avalanche Association.

Efron, B. And Tibshirani, R.J. 1993. *An Introduction to the Bootstrap,* Chapman and Hall, Inc., NY.

Föhn, P., 1989, The “Rutschblock” as a Practical Tool for Slope Stability Evaluation. *The Avalanche Review*, March 1989, Vol. 7, No. 6.

Fredston, J. and Fesler, D. 2011, *Snow Sense - A Guide to Evaluating Snow Avalanche Hazard,* Alaska Mountain Safety Center, Inc., 9140 Brewsters Drive, Anchorage, AK 99516.

Gauthier, D. and Jamieson, J., 2006a, Evaluating a prototype field test for weak layer fracture and failure propagation, *Gleason, A. (Ed.), Proceedings of the 2006 International Snow Science Workshop, Telluride, Colorado*, 107–116.

Gauther, D. and Jamieson, J.B., 2006b, Understanding the propagation of fractures and failures leading to large and destructive snow avalanches: recent developments, *Proceedings of the 2006 Annual Conference of the Canadian Society for Civil Engineering, First Specialty Conference on Disaster Mitigation*, 23/05/2006, Calgary, Alberta.

Gauthier, D. and Jamieson, J., 2008, Fracture propagation propensity in relation to snow slab avalanche release: validating the propagation saw test. *Geophysical Research Letters* 35 (L13501). doi:10.1029/2008GL034245.

Glude, B. 2004, The AK Block, A Sized-Block Snow Test, *ISSW 2004 Proceedings, Jackson Hole, Wyoming*, 153-160.

Glude, B. 2006, A Roadmap for Teaching Stability Evaluation, *The Avalanche Review*, April 2006, Vol. 24, No.4.

Glude, B. and Mullen, R. 2006, Evaluating the AK Block, a Sized Non-Cutback Snow Test, *ISSW 2004 Proceedings, Telluride, Colorado*, 630-639.

Glude, B. and Mullen, R. 2006, AK Block Project Status Update 2008, *ISSW 2008 Proceedings, Whistler, British Columbia,* 1043-1052.

Hanssen, A., Kuipers, W., 1965, On the relationship between the frequency of rain and various meteorological parameters, *Koninklijk Netherlands Meteorologisch Institus, Meded. Verhand*. 81, 2–15.

Hendrikx, J. and Birkeland, K., 2008, Slope scale spatial variability across time and space: comparison of results from continental and maritime climates, *Campbell, C. (Ed.), Proceedings of the 2008 International Snow Science Workshop, Whistler, B.C.*, 155–162.

Hosmer, D. W. and Lemeshow, S. 2000, A*pplied Logistic Regression*, 2nd Edition, John WIley and Sons, New York.

Jamieson, J.B. And Johnston, C.D., 1993. Experience with Rutschblocks, *Proceedings of the International Snow Science Workshop, Breckenridge, Colorado, October 1992*, 150-159.

Johnson, R. And Birkeland, K., 1998, Effectively Using and Interpreting Stability Tests, *ISSW ’98 Proceedings, Bend, OR*, 562-565.

LaChapelle, E., 1980, The fundamental process in conventional avalanche forecasting, *Journal of Glaciology.* 26 (94), 75–84.

Landry, C., K. Birkeland, K. Hansen, J. Borkowski, R. Brown, and R. Aspinall. 2002, Snow stability on uniform slopes: Implications for extrapolation, *Proceedings of the 2002 International Snow Science Workshop , Penticton, BC, Canada*, 532-539.

Landry, C., et al., 2004.,Variations in snow strength and stability on uniform slopes, *Cold Region Science and Technology* 39 (2–3), 205–218.

McCammon, I. and Sharaf, D., 2005, Integrating Strength, Energy, & Structure Into Stability Decisions, *The Avalanche Review*, February 2005, Vol. 23, No. 3.

McClung, D.M. 2002, The elements of applied avalanche forecasting Part I: the human issues, *Natural Hazards*, Vol. 25, p. 111-119.

Purves, R, Morrison, K., Moss, G., and Wright, D., 2003, Nearest neighbours for avalanche forecasting in Scotland — development, verification and optimization of a model *Cold Regions Science and Technology* 37 (3), 343–355.

Ross, C. and Jamieson, J., 2008, Comparing fracture propagation tests and relating test results to snowpack characteristics. *Campbell, C. (Ed.), Proceedings of the 2008 International Snow Science Workshop, Whistler, B.C.*, 376–385.

Schweizer, J., 2002. The Rutschblock Test, *The Avalanche Review*, August 2002, Vol. 26, No. 5.

Schweizer, J.and Jamieson, J., Schneebeli, M., 2003. Snow Avalanche Formation, *Review of Geophysics* 41 (4). doi:10.1029/2002RG000123.

Schweizer, J. and Jamieson, J.B., 2004, Snow stability measurements. In: M. Naaim and F. Naaim Bouvet (Editors), *Proceedings of the International Seminar on Snow and Avalanche Test Sites, Grenoble, France, 22-23 November 2001*, Cemagref editions, Antony (Hauts-de-Seine), France: pp. 317-331

Simenhois, R.and Birkeland, K., 2006, The extended column test: a field test for fracture initiation and propagation, *Gleason, A. (Ed.), Proceedings of the 2006 International Snow Science Workshop, Telluride, Colorado*, 79–85.

Simenhois, R. and Birkeland, K., 2007, An update on the Extended Column Test: new recording standards and additional data analyses, *The Avalanche Review* 26 (2), 17–18.

Simenhois, R. and Birkeland, K., 2008a, The effect of changing slab thickness on fracture propagation, *Campbell, C. (Ed.), Proceedings of the 2008 International Snow Science Workshop, Whistler, B.C.*, 755–760.

Simenhois, R. and Birkeland, K., 2008b, Extended column test results during surface warming: does surface warming affect fracture propagation potential?, *Campbell, C. (Ed.), Proceedings of the 2008 International Snow Science Workshop, Whistler, B.C.*, pp. 26–35.

Simenhois, R. and Birkeland, K, 2009, The Extended Column Test: Test effectiveness, spatial variability, and comparison with the Propagation Saw Test, *Cold Regions Science and Technology* 59 (2009) 210–216.

Simenhois, R. and Birkeland, K., 2010, The effect of additional snow load on Extended Column Test and Propagation Saw Test Results, *Proceedings of the 2010 International Snow Science Workshop, Squaw Valley, CA*, 214-220.

Simenhois, R., Birkeland, K., and van Herwijnen, A., 2012, Measurements of ECT Scores and Crack Face Friction in Non-persistent Weak Layers: What are the Implications for Practitioners?, *Proceedings of the 2012 International Snow Science Workshop, Anchorage, AK*, 104-110.

Tremper, B. 2001. *Staying Alive in Avalanche Terrain,* The Mountaineers Books, Seattle, WA.