Avalanche Probing Revisited

Tim Auger[1] and Bruce Jamieson[2]
[1]Banff Park Warden Service
Box 900, Banff, Alberta T0L 0M0, Canada
[2]Dept. of Civil Engineering, University of Calgary, Calgary, Alberta
Phone 403-220-7479, Fax 403-282-7026, e-mail jbjamies@acs.ucalgary.ca

Avalanche probing is still required to search avalanche deposits when other rescue means such as transceivers are unavailable. For many years the most common method employed by organized rescue teams in western Canada has been the technique known as coarse probing. In coarse probing the rescuers line up elbow to elbow and probe the snowpack once per step as the line of probers advance. This technique produces a pattern of probe holes on a 75 x 70 cm grid. The probability of detection ranges from 20% for a vertically oriented victim to 95% for a prone or supine victim and is considered to average 76% (Schild, 1963, 1974).

The idea behind coarse probe spacing recognizes the need to sacrifice some thoroughness to improve the speed of probing and thus maximize the chances of recovering a victim alive. The decision to employ coarse probing reflects the sort of trade-offs or risk-management familiar to the modern incident commander. In avalanche searches requiring manual probing the problem, in simple terms, is how to get as many holes into the snow as fast as possible.

This paper examines two possible means to improve the speed and efficiency of probing in rescues where there is still a possibility for live recovery. Limiting the depth of probing is discussed and several alternative probing techniques are compared.

LIMITING DEPTH OF PROBING

The concept of restricting the depth of probing is not new. Lacking sufficient burial statistics, Perla (1967) assumed that avalanche victims were distributed uniformly in the top 3 m of an avalanche deposit, and concluded that limiting probing depth would not increase the probability of finding avalanche victims alive. However, recent Swiss and US statistics on burial depth (Figure 1) represent adequate samples for re-consideration of optimum probing depths.

It is clear that survival is related to depth of burial. Deeper burial likely means more restricted respiration and denser snow deposition containing less air. Deeper burial often results from larger and thus more violent events. Since deeper burial is more likely to mean the victim has already succumbed, it makes sense to consider limiting the depth of probing if it improves the odds of finding the victim who is more likely to still be alive because of shallower burial.

If the depth of probing is limited, the speed of probing should increase because the probe does not travel as far. Speed is further improved if the probe itself can actually be shortened making it easier for the rescuer to manage.

Is there an optimum depth of probing? Both sets of statistics show the total number of victims buried in avalanches decreases at depths below 1.5 to 2.0 m. Perhaps more significant is the sharp decline in the proportion of survivors at depths greater than 1.5 to 2.0 m.

If the rescue leader is faced with searching a vast area, he may opt for a shallower probe depth not only to speed up the rate of probing, but to focus the search on that part of the debris most likely to contain a victim who is still alive.

We chose 1.5 meters (close to 5 feet) as the test depth for limiting probing. This depth would reach approximately 68% of the total victims in the US database and 88% of those recovered alive. Using the Swiss statistics, 85% of the victims, or 95% of those recovered alive, were found at depths less than 1.5 m.

The effect of shortening the probes, and limiting the depth to 1.5 m is discussed in detail in the next section.

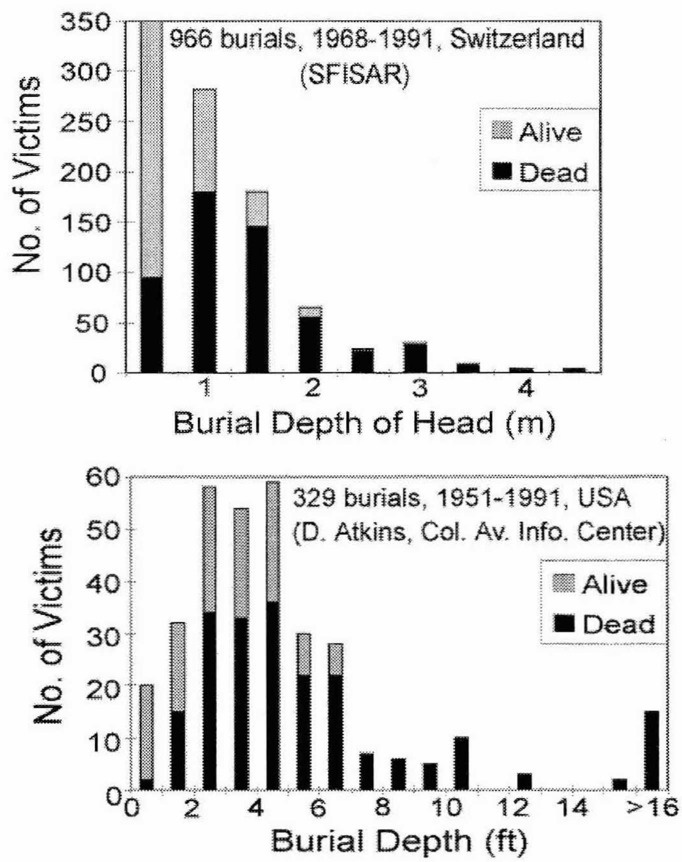

Figure 1 Number of avalanche victims found alive and dead by burial depth. Swiss burial depths (in metres) and US depths (in feet) are scaled for comparison.

FIELD TESTS

Field tests of various techniques were conducted at Roger's Pass, B.C. on March 29, 1996. An undisturbed snowpack over a large flat paved parking area was chosen as a test site and found to contain consistent one finger resistance snow over a uniform 2.1 m depth throughout the entire area. Foot penetration was about 2-3 cm. The force required to penetrate the snow with a probe was consistent and typical of an avalanche deposit.

The area was divided into a series of identical corridors the width of a 9 member probe line and 50 m in length. The probers were instructed to probe at a realistic rate which they felt they could maintain for an extended period ("at least an hour non-stop"). The number of steps was controlled and recorded and thus the exact number of probe holes could be determined. The time for the team to complete each 50 metre stretch was recorded.

Four different sets of tests were conducted, each employing a variation of probing technique. Each 50 metre plot was repeated four times and the probing times were averaged.

Two basic techniques were compared. Two tests employed 9 probers in the traditional coarse probe spacing. The alternative technique employed 3 probers spaced openly to cover the same area as above however each prober placed 3 holes per step. This is a variation of the open-spaced technique described in Perla and Martinelli (1976, p. 192) and McClung and Schaerer (1993, p. 191).

Bilgiri probes were used. Full depth probes employed 4 sections (3.25 m). The probes were shortened to 3 sections (2.45 m) for three of the tests. One test was full depth (to ground) 2.1 m. The remainder were to a depth of 1.5 m. The probes were marked with tape to indicate 1.5 m.

The usual probemaster was employed to direct the 9 member probe line. In one of the open spaced tests the team was instructed to proceed at their own individual paces.

FIELD TEST RESULTS

Times were averaged for each technique and the rates of probing were calculated (table 1).

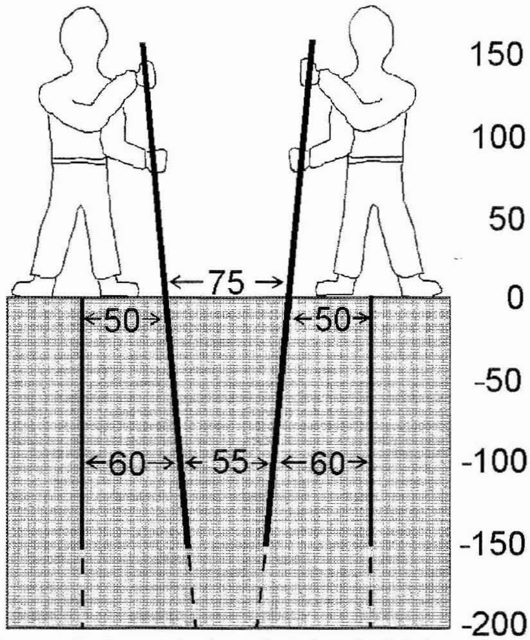

Figure 2 Probe spacing in vertical plane for 3-hole-per-step probing. Optimal spacing occurs approximately 1 m below surface. All dimensions in cm.

THREE-HOLE-PER-STEP PROBING

The open-spaced technique illustrated in McClung and Schaerer (1993, p. 191) shows each rescuer probing twice per step. In the technique employed in these tests, each person probed three times each step, to the left, in center, and then right.

In reality if the prober reaches to the side, the probe will usually enter the snow at an angle. If he tries to maintain the 75 cm spacing the angle may be 10-15 degrees from vertical. However if the probers space themselves finger-tip to finger-tip apart (~175 cm) the resulting lateral spacing of probe holes is reduced to about 60 cm at a depth of 1 m and the angles of the probe holes on each side are slight.

Figure 2 illustrates the resulting probe coverage for this technique in a vertical plane through the snow.

TEST SET #1	COARSE PROBE - FULL DEPTH	PROBE RATE (holes/person/minute)
	- with probe master - 4-section probes	7.42
TEST SET #2	COARSE PROBE - 1.5 M. DEPTH	
	- with probemaster - 3-section probes	8.03
TEST SET #3	THREE HOLE PER STEP - 1.5 M. DEPTH -with probe master -3-section probes	13.21
TEST SET #4	THREE HOLE PER STEP - 1.5 M. DEPTH - individually paced -3-section probes	12.06

Table 1: Probe patterns and rates.

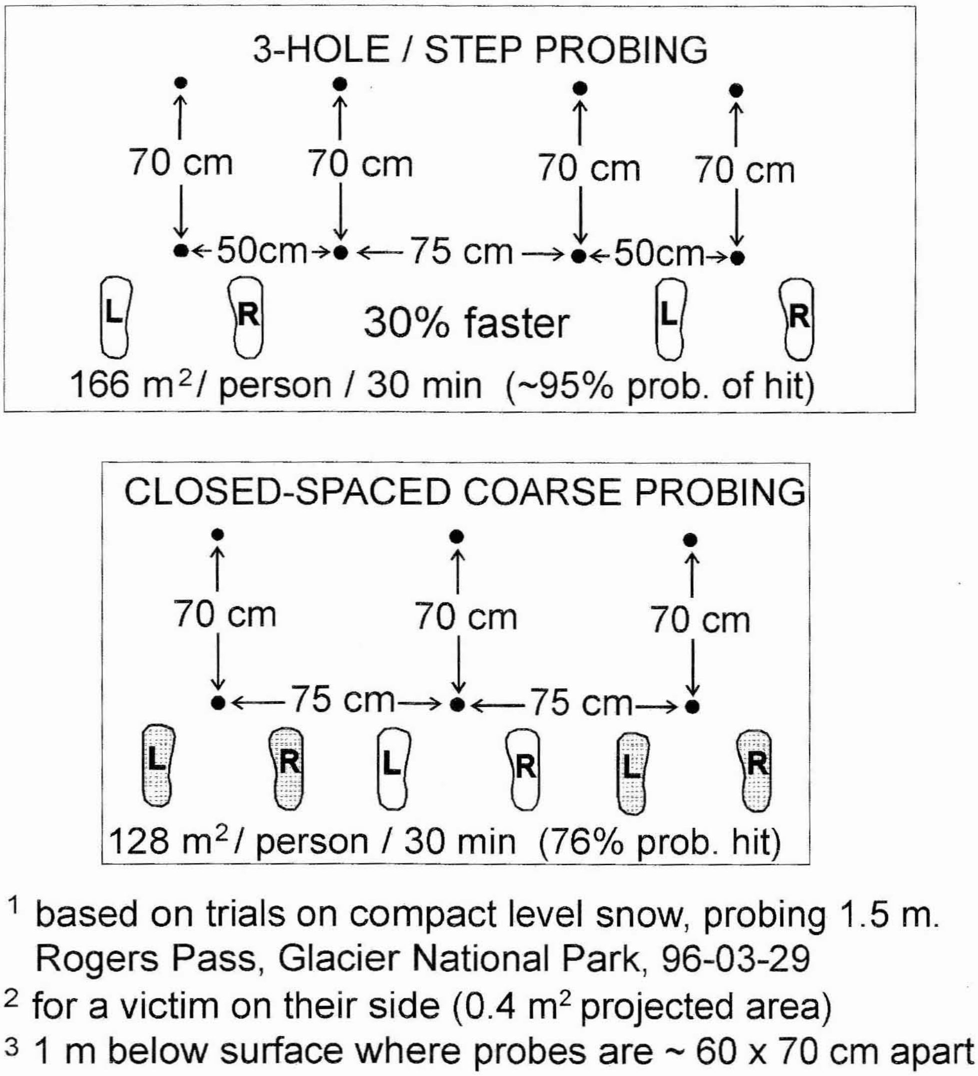

Figure 3 Comparison of 3-hole-per-step probing and open-spaced probing showing position of holes in snow surface relative to prober's feet. Based on trials in compact level snow, probing 1.5 m depth, 3-hole-per-step probing is 30% faster. For a victim of average size and orientation, 3-hole-per-step probing increases the probability of detection from 76% to approximately 95%.

DISCUSSION

Times within each test set were consistent and snow conditions were ideal so it is possible to compare the various techniques.

Test sets #1 and #2 both employed the classic coarse-probe technique but varied the probe length. Using shortened probes and limiting the depth was marginally faster however, since the 'full depth' (test #1) was only to 2.1 m. the results of this comparison are not strongly conclusive.

The only difference in technique between test set #3 and #4 was that the team members in #4 each proceeded at their own pace. We were interested to observe that the group with a designated person calling the pace (set #3) produced a higher rate than the individually paced group.

From these tests it appears that the three-hole-per-step method is significantly faster than the traditional coarse-probing method. The reason must relate to the stepping part of the probe sequence. Multi-hole probing requires less walking per unit area. Less steps reduces the delays due to waiting for the slowest prober. It also reduces the absolute amount of walking each rescuer must do. In the test site the walking conditions were ideal. In a normal avalanche site where walking is often difficult, the amount of energy saved, and the improvement of work productivity should be even greater than in this test.

The finger-tip to finger-tip spacing between the probers in the three-hole-per-step method results in a finer grid pattern, 60 x 70 cm compared to 75 x 70 cm for coarse probing. Even with this reduced area coverage factored in, the three hole per step technique is still 30% faster than coarse probing. In Figure 3, the area of the respective rectangles compares the productivity of a rescuer using each of the techniques. Furthermore, the denser probe pattern actually improves the theoretical average probability of detection from 76% (for coarse probing) to approximately 95% (calculated for vertical probes hitting an area of 0.4 m^2).

SUMMARY

In avalanche search where time is critical the rescue leader must focus available resources to achieve the highest probability of success. We are taught to priorize the area of the search to try to reach the victim more quickly. The extensive historical data now available on burial depths permit the rescue leader to consider focusing the search even further by limiting the depth of probing. Recent statistics indicate that the majority of victims are buried within 2 m of the surface and that the proportion of victims found alive decreases with depth of burial and decreases markedly around 1.5 m.

It is our proposal that if the rescue leader is faced with probe-searching while live recovery is still a possibility, he should consider limiting the depth of probing in the interests of speeding the search.

Our field tests indicate that 3-hole-per-step probing also significantly improves the speed of searching. Setting up the probe line for this technique is easy using finger-tip-to-finger-tip spacing. The effectiveness of traditional coarse-probing is dependent on a high degree of discipline of the search party where maintaining correct spacing is important. However, with the three-hole-per-step technique described here, if the searchers happen to wander slightly off line they will still be putting down a higher density of holes than traditional coarse probing.

With the three hole per step technique, 2 probers cover a width almost equal to 5 coarse probers. This deployment may have the added psychological effect of encouraging small parties (self-rescue situations) to energetically pursue probing because the spacing of the probers does not appear so hopelessly inadequate in comparison to the area to be searched.

Some searchers and search leaders may already be employing these principals. These data and tests should supply a greater confidence in choosing to vary from the traditional techniques.

REFERENCES

McClung, D.M. and P.A. Schaerer. 1993. The Avalanche Handbook. The Mountaineers, Seattle, 271 pp.

Perla, R.I. 1967. Optimal probing for avalanche victims. USDA Forest Service Miscellaneous Report 13.

Perla, R.I. and M. Martinelli, Jr., 1976. Avalanche Handbook, U.S. Dept. of Agriculture, Agriculture Handbook 489, 238 pp

Schild, M. 1963. Absuchen und Sondieren. Symposium über Dringliche Massnahmen zur Rettung von Lawinenverschütteten, Vanni Eigenmann Foundation, p. 30-32.

Schild, M. 1974. Previous experience in the practice of avalanche rescue. Avalanche Protection, Location and Rescue. Vanni Eigenmann Foundation, p. 51-75.

ACKNOWLEDGEMENTS

We would like to gratefully acknowledge the generous assistance of Knox Williams and Dale Atkins for providing the U.S. data, Dr. Walter Good and Hansjörg Etter of the Swiss Federal Institute for Snow and Avalanche Research for the Swiss data, Dr. Ron Perla for his help in obtaining the rescue data and for his continuing interest in avalanche safety, and Dr. Jürg Schweizer and Peter Schaerer for advice and translations from German.

Special thanks to the probe team who participated in the field tests including: Allison Amero, Perry Davis, Jeff Goodrich, Dennis Herman, Jim Mammalis, Thea Mitchell, Murray Peterson, Dave Rutherford, Percy Woods, Chris Worobets, and to Dave Skjönsberg and Gordon Peyto for setting up the site at Roger's Pass.