FIELD TESTS OF AVALANCHE BEACONS AT 2275 HZ AND 457 KHZ

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ABSTRACT

The transmission frequency for avalanche beacons used almost universally within the U.S. is 2275 Hz, whereas the European community has standardized on 457 kHz. To evaluate whether the U.S. avalanche community should switch to the higher frequency, we have carried out our own tests on a comparison of two beacons: the *Skadi* manufactured by John Lawton, the best quality beacon among those operating at 2275 Hz, and the *Barryvox* manufactured by Autophon, operating at 457 kHz. Two types of experiments were conducted. The first was to simply establish the distance range at which a searcher can hear the beacon; the second evaluated how quickly a searcher can locate a buried beacon. Because of its greater range, the Barryvox could be detected at a greater distance by all testers, and, thus, the primary search, to first detect the signal, with this beacon is faster. However, most of the tests were carried out in small areas, 50×100 m at the largest. Thus the shorter primary search did not necessarily contribute to a significantly shorter total search time. The secondary search, i.e. the search for the victim after the signal is detected, consumes the largest fraction of the total search time in small avalanches.

INTRODUCTION

The transmission frequency for avalanche beacons used almost universally within the U. S. is 2275 Hz, whereas the European community has adopted 457 kHz as a standard. The major advantage claimed by advocates of the higher frequency is its longer transmission range, resulting in faster searches for buried victims (Meier, 1986).1 On the other hand, some experts assert that most North American avalanches that involve burials are smaller than their European counterparts, and that the longer range of the 457 kHz beacons is thus largely unused on this continent. If this is true, switching to this higher frequency would impose needless expense on many ski areas, who would have to replace their current supply of beacons.

Should the U.S. follow the Europeans and adopt the higher frequency, 457 kHz, as the standard? To thoughtfully decide, the U. S. avalanche community requires information about the comparative

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performance of the two frequencies. We have, therefore, carried out own unbiased tests on two beacons: the *Skadi* manufactured by John Lawton, the best quality beacon among those operating at 2275 Hz, and the *Barryvox* manufactured by Autophon, operating at 457 kHz. The tests were conducted by the Alpine Meadows and Mammoth Mountain Ski Patrols, as part of their regular monthly testing and training in the use of avalanche beacons.

We emphasize that the tests were designed only to compare the two beacons, and in this paper we avoid the political, practical, and economic issues involved in the question about changing the standard U.S. frequency.

TYPES OF TESTS

Two types of experiments were conducted. The first was to simply establish the distance range at which a searcher can hear the beacon; the second evaluated how quickly a searcher can locate a buried beacon. Thus, two types of searches are defined: the *primary search* is the effort to first detect a signal; the *secondary search* is the effort to locate a buried beacon, once a signal has been heard.

Range Experiments

Because the ability to detect the signal from an avalance beacon varies with individuals, we needed to establish for each person tested the maximum range at which he/she could first hear a buried beacon. The collections of these results, for the two different types of beacons, allowed us to statistically characterize the detectable range and the variation among individuals. Such results are also useful to each ski patrolman, in that thos with exceptionally good hearing can design more efficient search paths, while those with hearing deficiencies will know they have to use a tighter net in the primary search.

The test was conducted as follows (see Figure 1): A beacon was concealed beneath the snow surface, and the searcher was given the correct direction toward the beacon and would walk steadily toward it from 150 to 200 m away. When the searcher first heard the beacon, the distance to it was measured. He would then continue to walk forward along the search path until directed to leave by the test supervisor, so that subsequent searchers could not infer the beacon location from the tracks on the path. Each searcher undertook this comparison of the two types of beacons at least once.

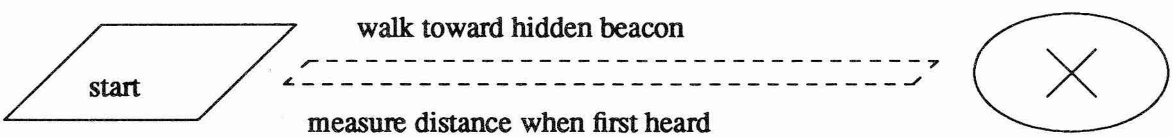

Figure 1. Range Test

Timed Searches for a Single Buried Beacon

These tests were similar to those already conducted by the ski patrols as part of their period training in beacon use. The method of searching was the same as that used in the regular periodic training, except that searchers alternatively used different types of beacons.

A searcher would enter an area known to contain a buried beacon, and would search until deciding on a correct location above it (see Figure 2). Two times were recorded: (1) T_p is the time required for the primary search, i.e. until the first perceptible tone from the buried beacon; (2) T_s is the time required for the secondary search, i.e. from the first perceptible tone to the searcher's decsion about location. For searches of small areas T_p would be zero.

Burial depths ranged from 30 cm to 2 m, but because of the low snow depths in the seasons in which the tests were conducted, most burial depths were small. For many of the observations, we also recorded

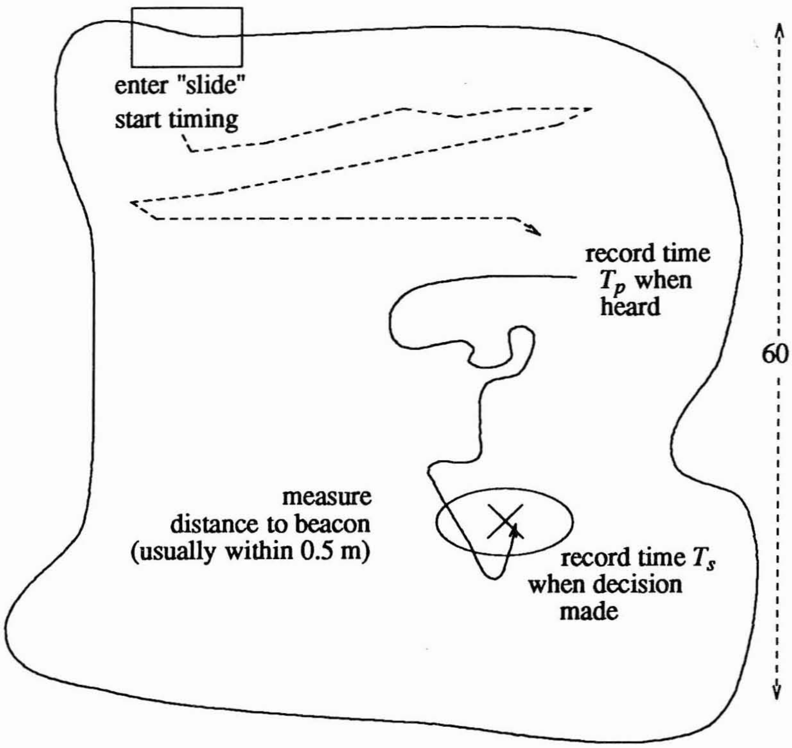

Figure 2. Timed Search for Hidden Beacon

the time to probe for the buried beacon, which was inside a stuffed burlap bag.

Beacon and Battery Variation

The specific beacons used for receiving and tranmitting were varied. This was particularly important with the Barryvox, because each ski patrol had only two beacons. Similarly in tests with the Skadis, beacons were used both for transmission and reception. All tests with the Barryvox were conducted with fresh batteries, and each patrolman made sure his/her Skadi was well charged for the tests.

RESULTS

Range Comparsion

Every test subject could detect the Barryvox at much greater distance (Figure 3). Ranges at which each could be detected were as follows:

Table 1. Distances (meters) at Which Beacons Could be Heard

	mean	std dev	min	max
Skadi	28.8	6.1	18.3	39.6
Barryvox	72.6	15.0	44.5	94.5

Not only is the mean for the Barryvox much higher, but the minimum distance at which any subject could hear it was greater than the maximum distance at which any subject could hear the Skadi. The average subject heard the Barryvox 44 m before he/she heard the Skadi.

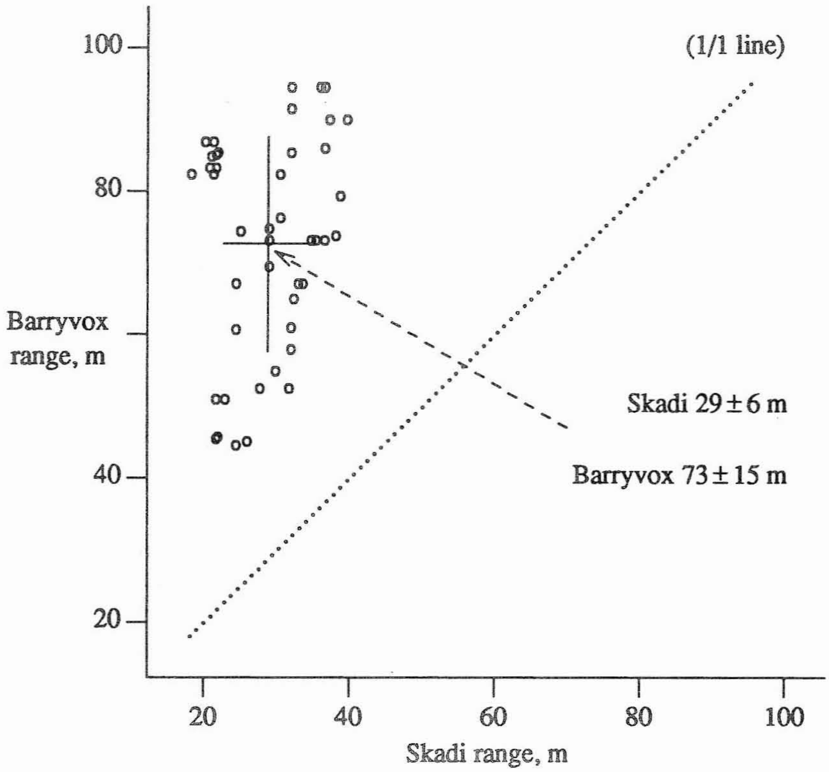

Figure 3. Range Comparison

Timed Search for Hidden Beacon

In the timed search for the hidden beacon, two times were recorded: T_p, the time required for the primary search to first detect a signal from the buried beacon, and T_s, the time required for the secondary search to locate the hidden beacon after first detecting the signal. We also recorded the time for probing before a final decision was made.

Because of its greater range, every subject found the Barryvox faster for the primary search. However, in an "avalanche" of this small size, 60×60 m, the primary search is a much smaller part of the total search time than the secondary search. For the two probes, there differences in the times for the secondary search were not statistically significant (Figure 4). As a result, neither were the differences in total search time statistically significant (Figure 5).

Table 2. Times (minutes) for Primary, Secondary, and Total Searches

	Primary Search		Secondary Search		Total Search	
	mean	std dev	mean	std dev	mean	std dev
Skadi	0.47	0.38	2.64	1.44	3.11	1.64
Barryvox	0.15	0.18	2.74	1.47	2.90	1.57

SUMMARY

The Barryvox, operating at 457 kHz, can be detected at greater distances than the Skadi, operating at 2275 Hz. The mean distances of detection were 79 vs. 29 m.

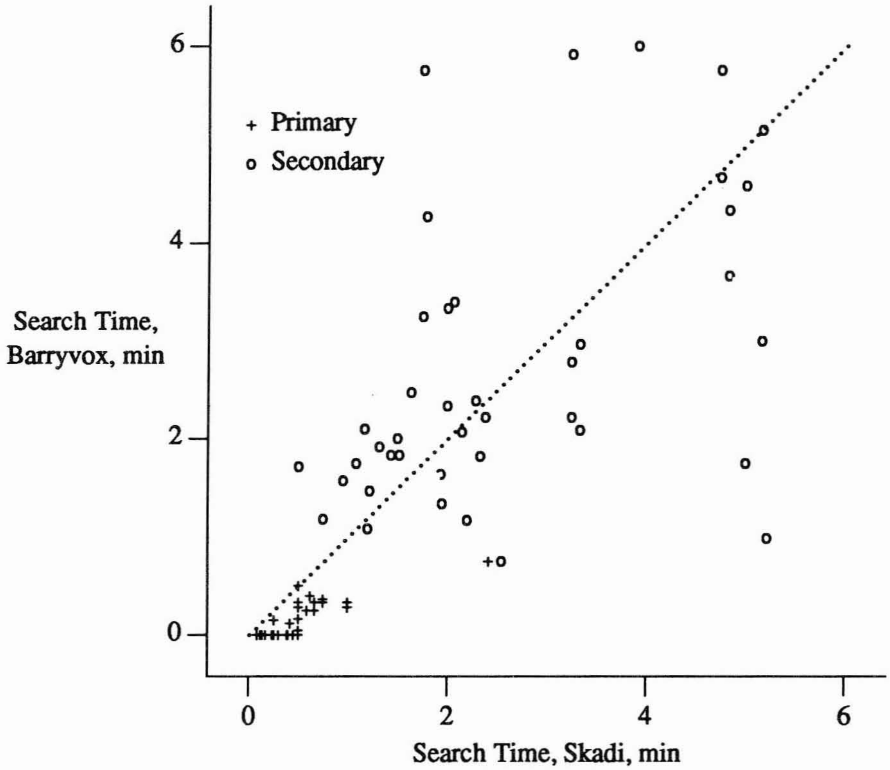

Figure 4. Timed Search for Hidden Beacon

The Barryvox was significantly faster for the primary search.

There were no significant differences between the two types of beacons in the secondary search, despite the greater distance at which the Barryvox was detected.

There were no significant differences between the two types of beacons in the total search time in this experiment with search areas of $60 \times 60\,\mathrm{m}^2$.

CAVEATS AND SUBJECTIVE EVALUATIONS

In a large avalance, where the search area is larger, the faster primary search with the Barryvox could contribute significantly to a faster total search.

Search times reported are optimistic, because they were carried out on smooth slopes. Times in avalanche debris would be longer.

Efficiency depends on correctly manipulating the amplifier.

Most, but not all, testers preferred the loudspeaker (available only on Barryvox) over the earphone, because of lack of wires. However, when background noise is loud, for example in wind, earphone is preferred.

The Barryvox beeps too slowly.

We detect no disadvantage to the Barryvox, in comparison to the Skadi. Thus, we see no reason to resist the European recommendation to standardize on the 457 kHz frequency for avalanche beacons.

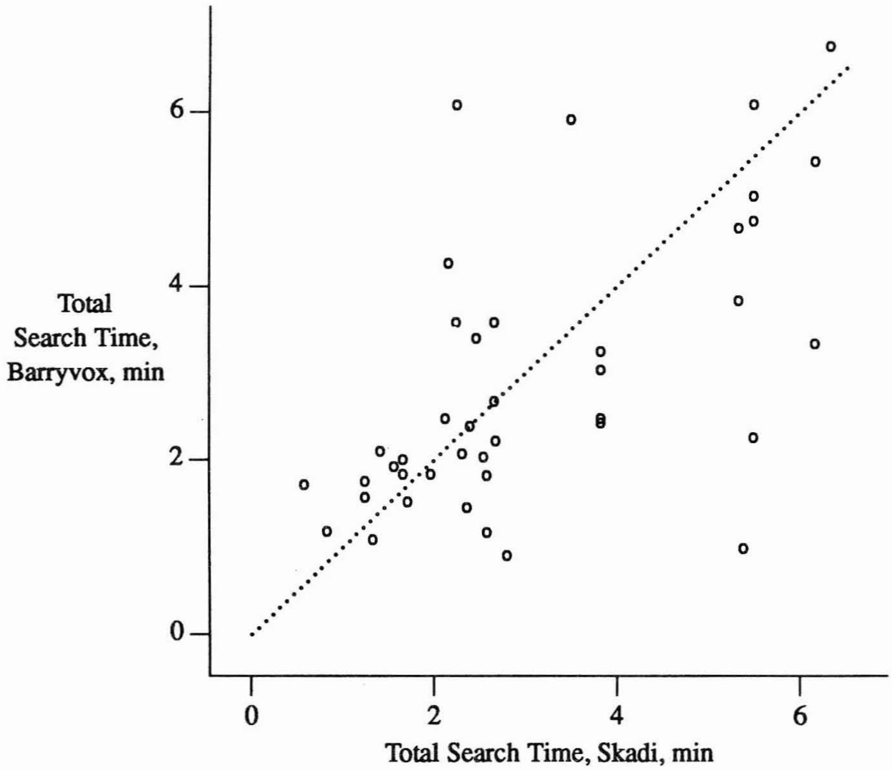

Figure 5. Total Search Time for Hidden Beacon

Acknowledgements

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