On the practical use of avalanche beacons – the Austrian Transceiver Test 2001

P. Höller* and F. Gibler**
*Federal Office and Research Centre for Forests, Institute for Avalanche Research, Innsbruck, Austria
**Austrian Consumer's Association, Vienna, Austria

Abstract: The development of new avalanche beacons in the last years was the motive to initiate a test of electronic transceivers by the Austrian Institute for Avalanche Research. The project was carried out in 2001 in cooperation with the Austrian Consumer's Association (VKI) and the Austrian Institute for Home and Leisuretime Safety. Seven different types of beacons were tested under comparable conditions in the laboratory as well as in the field. Goal of the project was to provide relevant information for backcountry skiers, off-piste skiers and snowboarders; moreover a folder was printed to help people when buying a new transceiver.

The investigations in the lab were concentrated not only on technical measurements (including measurements on the energy consumption of the different transceivers) but also on practical tests (e.g. how is the battery capacity indicated, how can the beacons be used with gloves...).

For the field work a standardized test was developed, which had to be comprehensible and objective on the one hand, and as efficient as possible on the other hand. The search tests were carried out with three different groups of individuals (1. skiers without knowledge on avalanche beacons, 2. backcountry skiers with a basic knowledge and 3. professionals). In total about 130 persons took part in the search tests. The participants were also asked to fill out a questionnaire. So it was possible to get additional information on operation instructions and handling of the transceivers.

The results were described with marks ranging from 1 (very good) to 5 (not sufficient). All beacons passed the tests. However, only one beacon got a "1" in the technical as well as in the practical test, two beacons got a "1" in the technical test and a "2" in the practical test; the marks of the other transceivers were between "2" und "3".

Keywords: avalanche accidents, avalanche rescue, avalanche beacons

1. Introduction

1992 Brugger and Falk presented their first results on survival probability of avalanche victims. From this investigation we know that the survival probality is relativley high within the first 15 minutes of burial (93%), but decreases to about 25% if the burial time is more than 45 minutes.

* Federal Office and Research Centre for Forests, Institute for Avalanche Research, Rennweg 1, A-6020 Innsbruck; tel: +43 512 573933 5106; fax: +43 512 573933 5250; e-mail: Peter.Hoeller@uibk.ac.at
** Austrian Consumer's Association, Mariahilferstrasse 81, A-1060 Vienna; tel: +43 1 58877 239; fax: +43 1 58877 73 e-mail: fgibler@vki.or.at

That implies that the survival probability can be improved only when the burial time by fast transceiver search can be reduced.
Brugger (1997) analysed data from 1981 to 1994 and found that the burial time of people rescued by companion transceiver search was only 35 minutes in average whereas the burial time was 120 minutes without use of a beacon. However, from the statistical point of view their effects on the mortality rate was only marginal signifcant (Brugger, 1997). Recent investigations by Tschirky et al. (2000) show that in the last 5 years transceiver search was more successful. The probability of being recovered alive by companions using transceiver devices has increased from 30% to 75%, the burial time of people located alive by companions using beacons was 15 minutes (Tschirky et al., 2000). From this it can be assumed that the state of the training of transceiver-users has probably been improved.
But also new types of transceivers could contribute to reduce the burial time in the near future.

These new devices with digital technology have shown enourmous benefits in several key areas of avalanche rescue like search speed, ease uf use and ease of learning (Edgerly and Hereford, 1998). And these transceivers have some advantages (determination of the direction, distance calculation...) which may lead to shorten the search time.

2. The transceiver test 2001

The development of new transceivers and the fact that the last important test on avalanche beacons was done in 1998 (Krüsi et al. 1998) was the motive to initiate a new test on electronic transceivers by the Austrian Institute for Avalanche Research.
The investigations were carried out in 2001 in cooperation with the Austrian Consumer's Association (VKI) and the Austrian Institute for Home and Leisuretime Safety.
Seven different types of beacons (Pieps 457, Tracker DTS, Ortovox F1 classic, Ortovox F1 focus, Mammut Barryvox, Ortovox m2, Arva 9000) were tested under comparable conditions in the laboratory as well as in the field. (see fig. 1)

Figure 1: Beacons included in the Austrian test. l.t.r.: Pieps 457, Tracker DTS, Ortovox F1 classic, Ortovox F1 focus, Mammut Barryvox, Ortovox m2, Arva 9000.

Goal of the project was to provide relevant information for backcountry skiers, off-piste skiers and snowboarders; moreover a folder was printed to help people when buying a new transceiver.

3. Methods of tests

3.1. Practical and field tests

The search tests were carried out with three different groups of individuals (1.skiers without knowledge on avalanche beacons, 2.backcountry skiers with a basic knowledge and 3. professionals). In total about 130 persons took part in the search tests.
The investigations were done in January and March 2001 in Maria Alm (Federal province of Salzburg) as well as in July and August 2001 in the glacier areas of Hintertux and Neustift/Stubai (Federal province of Tyrol).
For the search tests (fine search) a standardized method was developed, which was comprehensible and objective on the one hand, and as efficient as possible on the other hand:
1. To avoid effects due to different conditions of the test persons a relatively flat slope (15 - 18% which coresponds to 8.5° - 10°) was selected.
2. Two transceivers (turned into the transmitting mode) were buried in a distance of 20 m from the starting point (the first in a vertical position, the second in a horizontal position). The starting point was marked with a pole; as transmitting beacons two Ortovox F1 were used.
3. The position of the beacons was aligned (from the pole at the starting point to a well known point in a certain distance). So it was easy to find out (without entering the test area) whether the test person has located the buried transceiver or not (the person was succesfull when he/she was within of $1m^2$ of the buried beacon).
4. The test area was prepared in a way, that possible tracks could not be seen by the test persons.
5. Start with the search tests: only one person was allowed to be at the test area at each time. The following instructions and information were given to the test persons:
- to move with normal walking-speed.
- to be prepared that two beacons are buried.
- to define the position ($1m^2$) of the transceiver; therefore the test persons had to mark the closest area ($1m^2$) with four pennants.
- to let the beacon in the snow.

6. The following parameters were recorded respectively noticed: 1.The time which was needed by the test persons from the starting point to the closest area of the transceiver ($1m^2$). 2. The distance (measured with a laser rangefinder) and the direction from the starting point to the pennants (this was necessary to check if the test persons have located the beacons on the right place). Additionaly we assessed the statements of the test persons concerning cleareness of the acoustical and optical

signals as well as clereness of the signals in case of multiple burial.
Moreover the test persons were asked to fill out a questionnaire. Thus it was possible to get additional information on operation instructions and handling of the transceivers.
The questions were grouped into the following topics:
-operating instructions
-short instructions on the transceivers
-handling (operating, how to put the beacon on)
-optical and acoustical indicators

3.2. Laboratory tests

The laboratory tests were divided into a technical test and into the pinpoint search. The technical test included the following checks:
-operating elements (clarity and comprehensibility of operating elements, use of switches with gloves)
-battery capacity control (clearness of the capacity control)
-polarity test (effects on the transceivers if batteries are inserted in the wrong way)
-humidity test (the beacons were tested one week under 99% rel. humidity).
-energy consumption (the power consumption was measured both in the transmitting mode and in the search mode).
To be as effective as possible it was decided to have the pinpoint search test in the lab. Fig. 2. gives an overview on the test site.

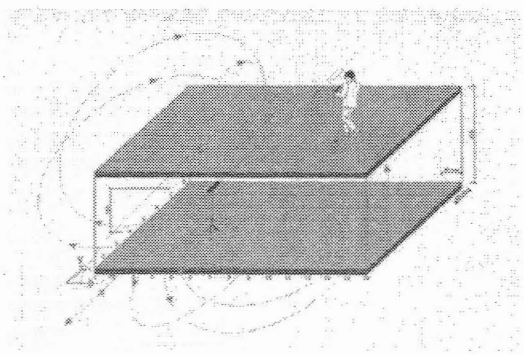

Figure 2: The laboratory test for the pinpoint search

The idea was to investigate the pinpoint search independently from snow conditions.
Under avoidance of electric installations two floors were set in the laboratory of the VKI; the distance was 2.75 m. On the ground of each floor a grid was marked, so that the x-axis as well as the y-axis lay one on top of the other. The size of the grid was 50 to 50 cm, in total 98 grids (7*14) were marked on each floor. So it was possible to place the transmitting beacons not only in different depths (with a maximum burial depth of 2.75 m) but also in different positions (vertical, horizontal).
The tests were done similar to the field tests. Only one person was allowed to be on the upper floor at each time. The following instructions and information were given to the test persons:
- to move with with normal walking-speed.
- to mark the exact position of the transmitting transceiver on the floor.

We recorded the time which was needed by the test persons to locate the beacon as well as the acurracy of the locating (the accuracy was determined by using the grids on the ground). The following scheme was used to assess the results: 1. locating within 50 cm (very good), 2. locating within 75 cm (good) and 3. locating within 100 cm (sufficient).

4. Results

Table 1 gives an overview on the results of the practical and fied tests; in table 2 further information on the laboratory tests can be found.
In general all transceivers passed the test.
It can be seen that all beacons got a good in the category "search" (tab.1). Taking into account only those persons who were able to define the position of the beacon (area of $1m^2$), it can be shown that 75 % of these persons needed less than 3 min. (average 2 min) to reach this area; the fastest person was within 1 min (with a Tracker TDS). However, there was no significant difference between new (with digital technology) and old beacons (with analogous technology).
In the category "locating" (pin point search in the lab) the results varied between good and sufficient. Better results were obtained by those beacons with good optical indicators (LEDs etc..). It can be assumed that this is connected with the fact that most people are visual types.
The "operating instructions" were judged with very good to good. However, the "short instructions" on the transceivers regulary did not reach the good marks of the general instructions (see tab. 1).
The category "handling" was divided into "operating" and "how to put the beacon on and out". While in the category "operating" none of the transceivers got a very good (the operating with gloves, especially during low temperatures was

	Barryvox	Tracker	Arva 9000	Ortovox m2	Ortovox F1	Pieps 457	Ortovox F1 focus
search	good	good	good	good	good	good	good
locating	good	very good	very good	good	sufficient	sufficient	good
instructions	very good	good	very good	good	good	good	good
short instr.	very good	sufficient	good	sufficient	good	less suff.	good
operating	good	good	good	sufficient	less suff.	sufficient	less suff.
straps	very good	sufficient	less suff.	good	sufficient	good	sufficient
indicators	very good	very good	very good	sufficient	less suff.	less suff.	sufficient
SUMMARY	very good	good	good	good	sufficient	sufficient	good

Table 1: Results of the practical test

	Mammut	Tracker	Arva 9000	Ortovox m2	Ortovox F1	Pieps 457	Ortovox F1 focus
switches etc..	good	good	very good	good	sufficient	sufficient	sufficient
capacity control	very good	very good	very good	good	less suff.	not suff.	less suff.
polarity test	very good	very good	sufficient	less suff.	very good	very good	less suff.
humidity test	passed	passed	passed	passed	passed	passed	passed
transmit (mA)	3.2	8	8.1	5	5.4	8	6
search (mA)	90	144	54	50	58	110	63
SUMMARY	very good	very good	very good	sufficient	sufficient	sufficient	less suff.

Table 2: Results of the technical tests

difficult), the assessment in the category "how to put the beacon on and out" (straps) varied between very good and less sufficient. Those beacons which require a complete opening of the straps when starting with the search procedure got the lower marks. Especially in the case of an accident it is very important that the search procedure can be started as fast as possible. In the category "indicators" the new beacons (with digital technology) had better rankings than the analogous transceivers. This can be explained with the fact that the optical indicators of the new transceivers are relatively easy to understand, especially for non-professionals.
To summarize the field test we can say that the better the level of the training the better the search results. However, when people from the third group (professionals) had to operate a transceiver which they are not used, their search time increased significantly.
In tab. 2 the results of the technical tests are presented. The "battery capacity control" was judged from very good to not sufficient. The better marks were given to the beacons with a direct symbol of the battery capacity on the display. On the other hand there are some beacons which are equiped with only one LED; to check the capacity of the batteries it is necessary to count the number of lightning. Since this system is less comfortable (and also inaccurate), it got a lower ranking (less sufficient to not sufficient) in our test.
In the category "polarity test" we had two less sufficient.
The "humidity test" was passed by all beacons.

5. Conclusion

Electronic transceivers can help to reduce the search time in the case of an avalanche accident and will contribute to increase the survival probability of buried people. Moreover beacons are an imperative tool for companion rescue.
It seems that optical indicators can be better

understood by the users than acoustic signals (because most of the people are visual types). However, it is absolutely necessary to train the handling with avalanche transceivers regularly. The best beacon does not help when the user is not able to operate the device.

6. References

Brugger H. and M.Falk,1992. Neue Perspektiven der Lawinenverschüttung. In: Wien. Klin. Wochenschr. 104, 6, 167-173.

Brugger H.,1997.Überlebenswahrscheinlichkeiten beim Lawinenunfall: Die technischen Möglichkeiten der Selbst- und Kameradenrettung und ihre natürliche Grenzen. In: Sicherheit im Bergland, Jahrbuch 1997 d. Öst. Kuratorium f. Alpine Sicherheit, 53- 62.

Edgerly B. H. and J.Hereford,1998. Digital Transceiving Systems: The Next Generation of Avalanche Beacons. In: Proc. Int. Snow Science Workshop, Sunriver, Oregon, USA, 27 Sept. - 1. Oct. 1998, 120 - 127.

Krüsi G., Weilenman P. und F. Tschirky,1998. Lawinenverschütteten-Suchgeräte Vergleichstest „LVS-98". In: Mitt. Eidgenöss. Inst. Schnee- Lawinenforsch. 57, 131 S.

Tschirky F., Brabec B. and M. Kern, 2000. Avalanche Rescue Systems in Switzerland: Experience and Limitations. In: Proc. Int. Snow Science Workshop, Big Sky, Montana, USA, 1. Oct - 6. Oct. 2000, 369 - 376.