Transceiver Tests: laboratory measurements

by François SIVARDIÈRE, Director of ANENA

Article published in "Snow and Avalanches" the review of ANENA, N° 95 - September 2001

In the autumn of 2000, ANENA field-tested several different avalanche transceivers available on the French market. During first months of 2001, it supplemented these with measurements taken in a laboratory. Presentation of the results.

Operating conditions

From a practical point of view, the transceivers which were tested in a laboratory environment were those which have been most popular in France: Tracker DTS, Ortovox M1 and F1, Barryvox Mammut and Arva 9000. Measurements were made on four apparatuses of each model (total of 20).

The standard which relates to transceivers is published by the European Institute of standardization of telecommunications (ETSI). It was revised during the first half of 2001 and a new version (from now on called IN 300 718) was adopted in May. However, that which was used as reference for the tests and their interpretation goes back to March 1997 (ETS 300 718), which was in force at the time of the tests and at the time of the design and the manufacture of the transceivers tested.

It specifies in particular the conditions under which measurements must be taken. A strict respect of the totality of these conditions would have made these tests impossible because of their high cost for ANENA. Thus, with regard to the conditions of battery strength, the products were tested only with new batteries for all the tests. In addition, the precise standard requires that the norms be respected in a range of temperatures from -30°C to +45°C. However, measurements were taken at only four different temperatures. The temperatures chosen by ANENA correspond to temperatures representative of typical transceiver use: 25°C, 10°C, -5°C and -20°C. They were also selected to highlight, if necessary, a variation of the parameter studied according to the temperature.

Finally, specific tests not envisaged by the standard were requested from the laboratory in order to control certain more practical characteristics for the field use and to really judge performances of the products.

The objective of the field tests carried out during the autumn of 2000 was to better understand the practical characteristics of avalanche transceivers present on the French market. The results were published in Neige and Avalanches n° 92 (December 2000) and were discussed in Neige and Avalanches n° 93 (March 2001). The approach of the field tests was empirical. ANENA tried, by multiplying measurements and the number of "testers", to make them as objective as possible. However, taking into account the means of ANENA but also of the statistical laws, the results could only give indications and orders of magnitude. It was thus

necessary to take more objective measurements, independent of the people handling the transceivers.

In addition, transceivers are electromagnetic instruments which must respect a standard of compatibility**.** But laboratory measurements made in the past showed that the manufacturers always do not respect this standard. It was thus advisable also to make sure, in all independence, of the conformity of beacons to the standard.

The ANENA thus appointed a consulting and engineering firm from Lyon, specializing in electromagnetic, radio compatibility and in electric security (RF Consulting), to carry out certain radio operator tests on transceivers. The required tests had for a goal to measure independently, and without the possibility of subjective interpretation, certain fundamental characteristics of transceivers. The results, which are presented hereafter, were interpreted along two axes:
- the checking of conformity to the standard of certain electromagnetic characteristics of transceivers;
- the comparison, if necessary, with the results obtained in the field tests of November 2000.

• Transmit frequency
The standardized transmit frequency of avalanche transceivers is 457 Khz ± 100 Hz. Measurements show that for two Ortovox F1 Focus and two Ortovox M1 out of the four tested for each model, the deviation of the frequency is higher than -100 Hz (from -105 to -117 Hz) at -20°C. In the case of the M1, such values had already been obtained in 1998 transceiver tests under the aegis of Cisa-ikar. It thus seems that nothing was done to modify this problem! It should be wished that the Ortovox company be seriously worried about this characteristic on all its apparatuses. Indeed, with respect to the new standard (maximum deviation of ± 80 Hz), the nonconformity of its beacons would be even larger: it appears according to the same proportions' (two out of four) as of -5°C, and with -20°C, only the M1 would be in conformity of eight beacons. How to say then for -30°C where it would seem that all Ortovox are not in conformity!

Generally, the deviations in frequency are -34 to -117 Hz for Ortovox and -10 to +21 Hz for the three other models. Except for Ortovox (the variation increases when the temperature decreases), there was no linear deviation in frequency according to the temperature.

• Cycle of operation
Two Ortovox F1 Focus (of four) are not in conformity with the standard at 25°C. At the other temperatures, these two apparatuses approach the limit, but on the good side. According to the conclusions of the test report, "the variations with the requirements of the standard are weak, but illustrate that the transmit oscillator is too sensitive to temperature, making it possible to consider for the maximum extreme temperature envisaged by the standard (+ 45 °C) a possibility of nonconformity of the whole F1 product line". From a practical point of view, this

remark must be brought closer to the real conditions of transceivers, which never reach such temperatures (especially under snow).

• Transmit power
The tests were carried out at only one temperature (+6,5°C). The ETS 300 718 standard requires a minimal value and a maximum value for the power of the signal emitted by transceivers.

With regard to the maximum value, the apparatuses all tested are in conformity with the regulations of the standard. The values measured for the Arva 9000 are higher than the maximum value authorized by the standard. But the standard envisaged a possibility of uncertainty of measurement for these tests, thanks to which they are not in fact completely out of conformity. These same measurements thus confirm the measurements of maximum range taken in the autumn 2000 field tests, which indicated the Arva 9000 has a transmit power higher than the other models (in the "maximum field" configuration). On the other hand, no apparatus tested is in conformity with the standard concerning minimal transmit power! One must wonder why the manufacturers do not respect this basic specification guaranteeing a minimum level of transmit power (i.e. a minimal range!).

The new version of the standard does not envisage any more a minimal value of transmit power, which will reassure the manufacturers, but not the users.

Lastly, the measurements showed that the temperature did not have a great influence on the transmit power of the transceivers tested.

• Spurious emissions
The report concludes on this point: "all the products are in conformity with the regulations of standard ETS 300 718 with regard to the maximum value of the field radiated on the first two harmonics of the frequency of emission of 457 Khz".

• Sensitivity of the receiver
In this case, measurements were taken at only one temperature: 12°C. Moreover, this test being very long, it was decided to make measurements on only one product per model instead of four.

The apparatuses tested are in conformity with the standard.

In addition, complementary measurements (on four products per model) were carried out at other temperatures under particular conditions. This made it possible to compare transceivers of the same model, and highlighted a rather significant dispersion of the sensitivity of the apparatuses of the same model according to the temperature. Except in the case of Tracker, the sensitivity of beacons improves when the temperature is low (what is an asset considering the most frequent conditions of

temperature during a rescue). These measurements of sensitivity of the receiver confirm in any point the observations which could have been made during the field tests, and particularly the fact that the two models of Ortovox have a sensitivity definitely higher than those of the other models. This is consistent with the useable ranges calculated in the field tests (Ortovox: approximately 20 m, other marks: approximately 10 m).

Lastly, the laboratory test report concludes this part with two remarks which confirm once again the results of the field tests:
- the range (calculated theoretically) varies according to the various models by a factor of two (10 and 20 m, for example);
- the standard authorizes under certain conditions, ranges "largely lower than 30 meters"!

• Receiver bandwidth

This parameter characterizes the selectivity of the receiver.
The broader the bandwidth, the less selective the receiver is (and the less sensitive it is). The standard does not specify anything on this subject.

Insofar as the standard authorizes an emission between 456,900 Khz and 457,100 Khz, it would seem logical that the receivers are able to collect with the same sensitivity all the waves whose frequency is in this range, which is not the case. It is the case for only the Tracker DTS.

For the other models (except M1 to a lesser extent), their sensitivity in particular is very degraded (from -5 to -10 dB) for the waves of frequencies ranging between 456,900 Khz and 456,950 (even 456,960) Khz (range of emission of the two types of Ortovox at 10°C and less).

• Operation life

The operation lives of beacons were calculated starting from measurements of consumption of an apparatus of each model. The very long costs and times for this type of measurements prevented ANENA from making tests on a larger number of apparatuses. However, for this type of parameter, one can consider that that is sufficient.

All the models are in conformity with the standard: they all ow operation in transmit for at least 200 hours (from 250 hours up to 400 hours for one of them at ambient temperature). At the end of 200 hours of emission, enough power remains to function in reception mode for at least an hour (as the new version of the standard envisages). Tests were also carried out to check that autonomy remains sufficient when the products are used in the cold (-10 °C on average).

In addition, the time at which it is advised to change batteries varies for each transceiver (for Ortovox F1 Focus measurements were, however, impossible for technical reasons). In the case of the Arva 9000, the indication for changing batteries is even rather premature, which goes however in the direction of safety.

- **Conclusions**

Supplementing a series of field tests carried out in November 2000, the tests carried out by an independent laboratory on five types of beacons allowed:
- to highlight the non-observance of the standard by all the manufacturers on a parameter (minimum transmit capacity) and by one of them on other parameters (in particular the frequency of the transmit signal);
- to confirm the measurements made in the field.

Thus, the conclusions of the comparative studies of the characteristics of the various models tested are the same ones, whether they come from the field observations and measurements or from the radio operator tests in laboratory.
In particular, if any beacon in reception is able to receive any beacon in transmit, the range can vary according to the model of the transmitter and the model of receiver, by a factor of two.