THE EFFECT OF EXTERNAL INTERFERENCE ON AVALANCHE TRANSCEIVER FUNCTIONALITY

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ABSTRACT: For over 40 years, avalanche transceivers have been helping searchers locate and rescue victims buried in avalanches. They rely on internal electronics receiving and interpreting radio waves being transmitted by the victim's avalanche transceiver, and their success and usefulness is measured by how quickly and effectively they can follow that signal to the buried victim. Up until now, little has been done to understand the effect that external interference has on this signal, and therefore the effectiveness of the beacon itself. In this study, personal electronic devices were held near a searching beacon to see if they had any influence on the beacon's ability to follow a signal. This was done by finding both the normal and affected ranges and comparing the two values. In the end, there was clear evidence that electronic devices, when held close enough to a searching beacon, had a negative effect on that beacons functionality.

KEYWORDS: Avalanche Transceiver, Interference, Functionality

1. BACKGROUND:

An avalanche transceiver's functionality is based upon whether or not it can effectively find a buried and transmitting beacon. It does this by following a flux line that is created by the near field electromagnetic signal that is being produced by that transmitting transceiver (Hereford, Edgerly 2000). This signal runs at a frequency of 457 KHz, and the searching beacon is attempting to pick up a signal at that exact frequency.

There is little affect on this signal from external objects such as snow, a human body, metal, trees or rocks (Hereford, Edgerly 2000), but little is known what affect other objects, such as personal electronics, have on this signal and therefore the functionality of the searching beacon.

It is known that signals that stray from 457 KHz do in fact impede the effective range of avalanche beacons (Achelis). In fact, there is a European standard that states that all beacons must produce a signal that falls within 80 Hz of 457 KHz. There is no such standard in North America.

Also, there is anecdotal evidence that electronic devices have an adverse affect on the functionality of a "searching" beacon. One such story, published in the Journal of Wilderness and Environmental Medicine (2005), is a first-hand account of a pacemaker producing enough interference that the operator, and author of the letter, believed to be receiving a signal more than 80m away from the transmitting beacon. Carol Darwin, the author, went on to say that "when held at three-quarters arms length, there was no interference."

This raises the question of what other objects have an effect on the functionality of a searching and beacon, and from how far away will those objects have an effect? It is the goal of this study to begin to answer those questions, and to come up with a recommendation as to what practitioners and rescue professionals can do to optimize the functionality of their avalanche transceiver.

2. METHODS:

First, objects that could possibly create interference with a searching beacon were chosen. Seven items were chosen to be used in the test, based on popularity, usefulness in the backcountry, and imagined effect (Table 1). All but one object, the RFID chip Alyeska lift ticket, run on batteries, and were therefore turned on and running while the tests were completed. A number of different beacons were used in both tests.

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Two tests were performed to determine the effect that an interfering object might have on the functionality of a "searching" beacon. One determined range and the other presented a visual of the beacon's track.

GPS Unit	**Small, 2-Way Radio**
SPOT Geo-Locator	**RFID Chip (Alyeska Lift Ticket)**
Digital Camera	**iPod**
Cell Phone	

Table 1: List of objects used to cause interference.

2.1 Range

Schweizer (2007) outlines a straightforward and typical test that determines the effective range of a beacon. A searching beacon moves towards a transmitting beacon from outside of its known effective range. When a signal is picked up, the distance away from the transmitting beacon is recorded.

In the testing for this study, the known effective range was determined for each beacon by performing a number of "control" range tests, both before all other tests and throughout the testing to ensure that there were no permanent negative effects on the searching beacon. Also, the location where the very first signal was received was not always where the range measurement was taken. To ensure consistent results, and because many of the interfering objects caused the occasional transmission to be picked up, the tester waited until there were a number of clear signals being received.

In each test, the interfering object was held at 0, 10, 20, 30 and 40cm away from the searching beacon. Initially, tests were also done where the interfering objects were placed near the transmitting beacon, but there were no noticeable changes from the control, so those tests were stopped and their results will not be shown here. Both the actual distance to the transmitting beacon and the distance displayed on the searching transceiver were recorded, along with occasional battery levels of both beacons.

2.2 Track

Using an advanced GPS unit, visual representations of a number of beacon searches were recorded. These were done before the range tests, and helped in determining what effect the interfering objects had on the beacons. There is little quantifiable data that can be gained from the images created in this study, but they were a great tool in the progression of this research.

A transmitting beacon was placed on the ground, and a suitable starting position for the searches was found, by following a flux line away from the beacon until the signal was lost. A marker was placed at that starting position for consistent tests. Two operators then conducted the tests. One would follow the searching beacon's instructions (directional arrows), moving slowly so as to follow the beacon's instructions as closely as possible, and the other operator followed, within half of a meter, the other "searcher" and held and operated the GPS device. This was done to ensure no interference between the recording GPS unit and the searching beacon.

The tests were run through with the same interfering objects, each test being done three times to ensure consistency. When a signal was not picked up at the starting position, or was lost while completing the search, the "searcher" would walk slowly straight towards the transmitting beacon. This was done, as compared to a normal "zig-zag" search pattern, to simplify the resulting image. Again, controls were done to determine the "normal" track.

3. RESULTS

3.1 Range

There was a noticeable difference in range when a number of interfering objects were tested. This was the case for all three beacons tested; Pieps DSP, Tracker DTS, and Mammut Pulse; although the specific amount of interference, and which objects interfered more, varied between the different beacons.

Figures 2, 3, and 4 show the resultant ranges by object, and show the progression of effect from holding the interfering object at 0, 10, 20, 30, and 40cm away from the searching beacon. The control is shown at the top of the chart, and it can be seen that some ranges are actually greater than the control. This shows the inherent inconsistencies from one test to the next, so a deviation of ±3m should be applied to the results shown.

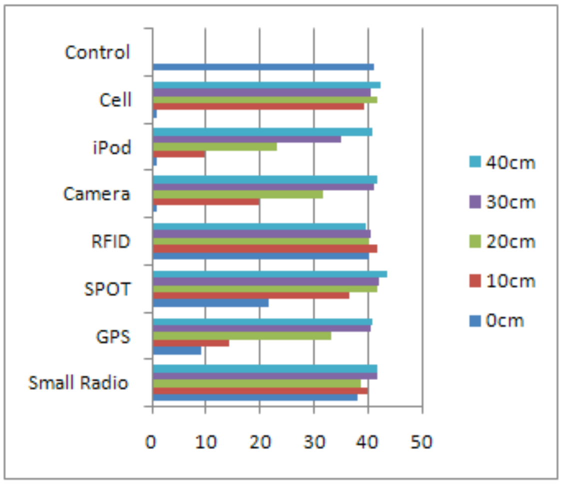

Figure 2: Tested ranges for BCA Tracker.

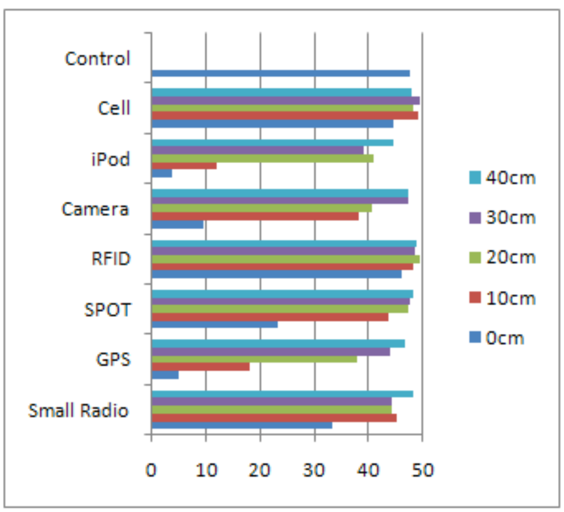

Figure 3: Tested ranges for the Mammut Pulse.

Figure 5 combines all of the data, and shows a comparison between all three beacons, each of the interfering objects and their distance away from the searching beacon. Since the control range, or effective range, for each beacon is different, the formula $r^E - r^I = \theta$, where r^E is the determined effective range, r^I is the determined range with the interfered object, and θ is the difference between the two. Essentially, figure 5 displays the magnitude of the interference.

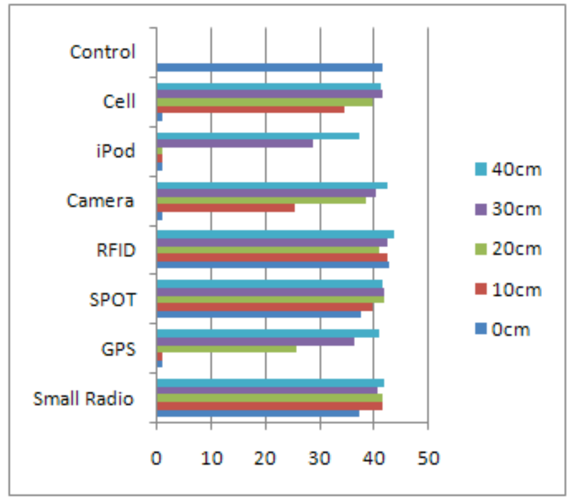

Figure 4: Tested ranges for the Pieps DSP

3.2 Track

The advanced GPS tracks, while producing no quantifiable data, did generate a few striking images which demonstrate the effect of interference on a searching beacon. Figure 6 is an example of one of these images. It illustrates both the control route (in red) and the resultant route when a handheld GPS device was held 0cm from the searching beacon.

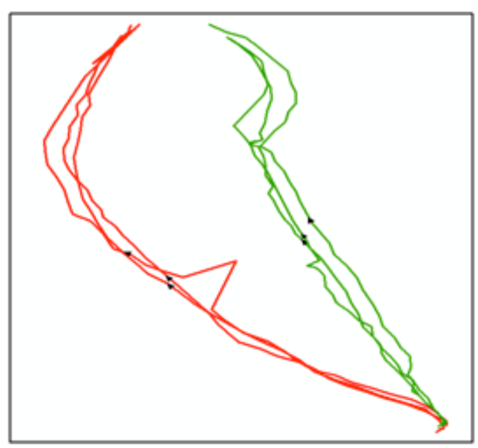

Figure 6: Image created by the advanced GPS; BCA Tracker transmitting and searching, interfering object is GPS unit and held directly under searching beacon.

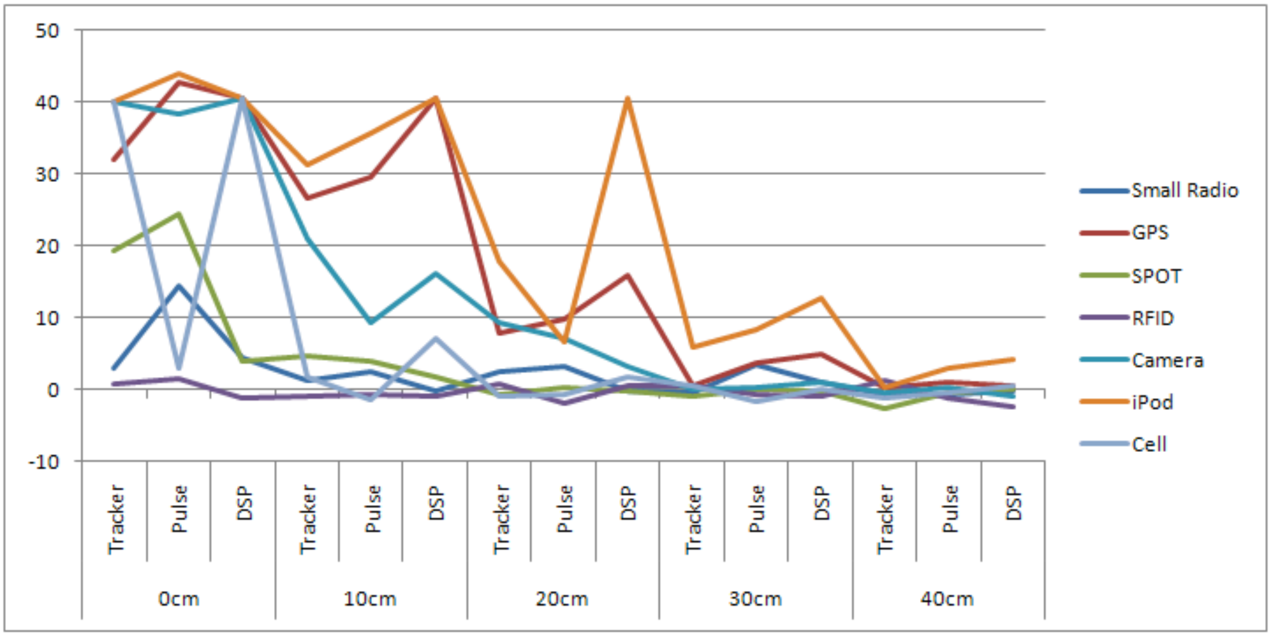

Figure 5: θ values of each test

4. ANALYSIS

The range test produced the greatest amount of usable data, all of which showed that numerous electronic devices have a large impact on the functionality of a searching beacon. Specifically, the iPod, digital camera, GPS device, SPOT geo-locator, and cell phone all produced concerning test results.

The small radio seemed to affect the functionality only slightly. The RFID chip, Alyeska lift ticket did not seem to have any effect on the searching beacons functionality.

Figure 6 shows an example of how, once the actual signal is received and the searcher beacon begins to follow it towards the transmitting beacon, that it follows the flux line fairly normally, and seems to function correctly.

The distance away from the searching beacon seems to be the largest determining factor in how the functionality of the beacon is affected. Hereford and Edergly (2000) describe how objects held very close to a beacon will affect the "Quality of the antenna circuitry," and since it is very unlikely that any of these objects will be held up against a searching beacon during an actual search, it seems to make sense to look primarily at the results when the interfering object is held at 10cm or farther from the searching beacon. Even still, there are concerning results.

5. RECOMMENDATIONS

The effective range of a beacon greatly affects its search strip width. This value is the lateral distance between two rescuers, or between one rescuer and the edge of a debris field (Schweizer 2008). Rescuers assume a search strip width based on their personal beacons normal effective range. If the actual effective range during a rescue scenario is much less than the normal effective range, altered by possible interference, then there will be large gaps in the area of rescue that can go unsearched.

Based on the results of this study, it is recommended that all electronic devices be turned off while attempting to search with an avalanche transceiver. This includes electronic devices that were not tested in this study. If items must remain on during a search, then the searching beacon should be held more than 40cm away from that object. As a broader rule, having all electronic devices, besides for avalanche transceivers, turned off while traveling in avalanche terrain is recommended, especially in this era of increasing technological use.

Finally, it is recommended that more testing be done. There are more types of beacons that need to be tested, as well as many more possible interfering objects.

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