Interference Issues Concerning Avalanche Rescue Transceivers

Story by Manuel Genswein

Metal parts, magnets, and any kind of passive or active electronics potentially cause interference for a transceiver. This may lead to the following effects:

- detuning of the antennas (TX *transmit*, RX *receive*)
- persistent magnetization of the antennas (TX, RX)
- increased power consumption (TX)
- reduction of transmitted field strength (TX)
- inability for proper signal detection in digital search modes (RX)
- reduction of receive range due to receive filters opening up to a broader frequency range (RX)
- increase of noise in analog sound (RX)

Whereas metal parts may detune the antennas and shield the signal, active electronic devices are likely to cause interference resulting in a higher noise floor and/or arbitrary distance and direction indications. The mass, dimension, and characteristics of metals and the amplitude and frequency spectrum of the electronic and electromagnetic interference influence the extent of problems created for the transceiver. It is important to understand that for many sources of interference, the amplitude of the harmful interference increases with proximity by a power of three to distance, i.e., if a certain electronic device causes an interference ring amplitude of level 2 to the transceiver at 20cm distance, the interference reaches an amplitude of level 8 at 10cm distance.

Concept of Interference and Consequences for Transceiver Technology

When speaking about electronic and electromagnetic interference, it is important to understand that an interfering signal may directly influence the electronic circuits of the transceiver and/or be picked up by the antennas of the transceiver. The frequency spectrum of interference often includes frequencies exactly on or close to 457'000Hz, in particular when taking into account that multitudes of harmonics may be in this spectrum. Therefore the interference is in the avalanche rescue transceiver frequency range and can make exactly the same impression to the receiver as the signal of a buried subject. Electronic and electromagnetic interference with different characteristics influence the transceiver in different ways; however, it is crucial to understand that an incoming interfering signal may look to the receiver exactly the same as a "real" signal transmitted by a buried subject. Therefore, the transceiver may show arbitrary distance and direction indications caused by interference in an area where there is no buried subject or the distance to the buried subject is much greater than the maximum range of the receiver (signal search phase). The difference in amplitude of interference compared to the amplitude of the real transmit signal of a buried subject is an important factor that influences to what extent the search may be compromised (SNR = signal-to-noise ratio).

Therefore, we may conclude: 1) the weaker the signal of the buried subject, the lower the tolerance for interference; and 2) a transceiver with high sensitivity has the capability to pick up very weak signals from far-distant (long range) buried subjects – however, this equally means low tolerance for interference.

- The longer the range of a device, the more it is susceptible to interference.
- The shorter the range, the lower the sensitivity of the device for "real" signals as well as for interference.
- Long range and high interference tolerance are antagonists.
- Long range leads to shorter burial times and therefore increased survival chances.[1]
- Users have to know that their degree of compliance to the rules on avoidance of interference directly influences the efficiency of the rescue actions.

In cases where rescuers experience strong interference despite full compliance to the rules of avoiding interference – such as proximity to high-voltage power lines, antenna masts, cableways, buildings, etc. – where the source of interference cannot be removed or turned off, switching the device to analog mode with manual volume control may be the only option to allow a search for the buried subject. Often this measure needs to be combined with a reduction of search-strip width. Devices targeting advanced recreational or professional user groups that aim to provide a solution for 100% of potential rescue situations – such as an Ortovox S1, ARVA Link, or Pulse Barryvox – offer such analog search options. The reason behind the much higher tolerance for interference in an analog search compared to a digital search is human hearing's enhanced ability to detect a "real" signal when a lot of interference is present and when the signal-to-noise ratio is bad.

Lastly, interference degrading the performance and efficiency of the transmit function should be discussed: Transmit mode is less sensitive to interference than receive mode, therefore acceptance of interference is higher, and most gadgets can be used with only minor restrictions, such as keeping a minimum distance of 20cm between metal parts, electronics (active or passive), and the transceiver in transmit mode. If the recommended safety distance is compromised because equipment and clothing get displaced on the body during the course of the avalanche, the transmitted field strength within the nominal transmit frequency range may be reduced leading to a shorter range in which the buried subject can be received. However, range reductions of more than 30% are rare and would require detuning of the antenna and/or shielding of the signal by a large metal object. In particularly negative cases, the weaker signal of the buried subject may not be picked up when applying the search-strip width recommended by the manufacturer. The appropriate rescue tactical measure in such cases is to cut the search-strip width in half, which in practice means you would search on the middle lines of the signal-search pattern (i.e., if a 50m search strip width was applied without success in the first phase, the signal search strip width pattern is shifted by 25m in the second phase.

Recommendations for Professional Users

General Rules

Clothing: Avoid wearing clothes with magnetic buttons or larger metallic and/or conductive parts (e.g., heated gloves).

Storage: Do not store the transceiver close to strong magnetic fields as they can magnetize the antennas with a long-term effect.

Magnets and electromagnetic fields: Some transceivers of several brands have a magnetic ON/OFF or OFF/SEND/SEARCH switch, so magnets in close proximity can randomly turn the unit off, to search, or to send. Some transceivers of several brands contain an electronic compass that is, especially during search, highly sensitive to magnets and electromagnetic fields.

Transmit Mode

In transmit mode a minimum distance of 20cm should be kept between an avalanche rescue transceiver and metallic objects or electronic devices. The expected distance for serious transmit-mode interference is considerably shorter (<3cm) for many objects and devices, but the likely displacement of a carrying system, clothing, and potentially interfering objects due to mechanical impact during an avalanche has to be taken into account. Therefore the recommended distance should include some margin of safety.

Search Mode

In search mode, a minimum distance of 50cm should be kept between the beacon and objects that can be used with a transceiver *(specified next)*.

Equipment That Can Be Used With Transceivers

Objects and equipment often used with a transceiver include rescue or operationally critical equipment and equipment integral to mountain excursions. Specific examples that require more restrictive rules than the 20cm safety distance in transmit mode and 50cm safety distance in receive mode are outlined as follows:

- Camping equipment: metallic backpack frames, metallic camping and cooking equipment, metallic vacuum bottles
- Non engine-driven snow sport equipment: skis, snowboards, snowshoes
- Climbing gear: carabineers, ice axes, crampons
- Electric headlamps, excluding headlamps with switching power voltage regulators
- Snow study kits, including metallic snow saws
- Improvised repair equipment, pocket knives, and pocket multi-purpose repair tools
- Writing tools
- Wristwatches without radio functions *(may stay on wrist)*
- Any food, candy or cigarette box with metal foil wrapping
- Avalanche survival equipment: flotation devices *(including remote-release devices)*, AvaLungs, avalanche balls
- Avalanche rescue transceivers providing backup transmit function in case of secondary avalanche
- RECCO search devices *(Keep at 3m distance and do not point directly at another rescuer.)*
- RECCO reflectors *(May be placed at any distance without any risk of interference.)*
- Avalanche probes and shovels *(Metallic and carbon probes should not be placed parallel to the snow surface during fine and pinpoint search.)*
- High-performance lights and generators for night searches *(Strong interference may affect a larger zone around the equipment. Interference should be checked with an analog receiver on the highest sensitivity setting and appropriate measures taken accordingly.)*
- Vehicles: snowmobiles, snow-grooming machines, cars, snowplows, snowblowers *(A search from these vehicles can be strongly affected by interference from a running engine, metal plates, and vehicle electronics. In transmit mode, range reduction is possible depending on proximity to metal vehicle parts. In close proximity to a vehicle, search accuracy might be compromised.)*
- Helicopters *(A search from a helicopter is only efficient with specialized transceivers.)*
- Medical equipment: pacemakers *(Users are advised to carry the device on their right side, so adjust length of carrying straps. Consult the pacemaker manufacturer's instructions regarding interference impact.)*, portable heart-rate monitors *(need to be switched off during search or 50cm away from the receiver)*, first aid equipment *(such as metallic splints)*, toboggans, immobilization equipment, stretchers
- Analog VHF and UHF radios up to 5W transmit power *(Interference may occur during transmit mode. Radio loudspeakers produce strong electromagnetic fields and should not point directly at the transceiver.)*
- Digital VHF and UHF radios up to 5W transmit power *(Interference may occur during transmit mode, so radios need to be turned off during search.)*
- Cell phones, PLBs (personal locator beacons), satellite phones *(Inference may occur during use, including network synchronization, text messaging, and data transmission. Devices need to be turned off during search for all searching rescuers. While the search is in progress, use of these devices on the entire avalanche should be restricted to brief emergency calls at a minimum distance of 25m to the closest searching rescuer. Cell phones in "airplane mode" may stay on at a 50cm distance.)*
- Orientation equipment: electronic and mechanical altimeters, electronic and mechanical compasses, hand-held GPS receivers *(except devices with radio transmit functions)*
- Equipment for armed forces and law enforcing agencies: guns and pistols, ammunition, weapons including optics but excluding electronic systems *(If weapon is carried diagonally on the front of the body, the transceiver must be carried sideways.)*, body-armor *(carry transceiver sideways)*

Non Rescue, Mountain, or Operationally Relevant Equipment

The variety of electronic equipment (entertainment, video, photo, remote controls, etc.) that rescuers have been using in combination with their avalanche rescue transceiver has grown tremendously. Some of these items may not cause an interference problem with a particular transceiver, but may interfere with other transceivers. It is therefore impossible to make a recommendation for every device and transceiver. In recent years, several reports from failed or severely disturbed and delayed rescue actions have shown that electronic equipment can have an unpredictable and strong influence on avalanche rescue transceivers. Therefore, while a search is in progress on the avalanche, all non-critical equipment must be turned off and remain off on the entire avalanche for the duration of the search.

High-voltage power lines and radio towers may also dramatically reduce the performance of an avalanche rescue transceiver. Digital search mode often completely fails, and it is necessary to carry out an analog search by applying signal search strips with a very limited width.

Recommendations for Recreational Users (Short Version)

Avoid wearing clothes with magnetic buttons or larger metallic and/or conductive parts (i.e., heated gloves). Be aware that food, candy, or cigarette box wrapping often includes thin metallic foil! In transmit mode a minimum distance of 20cm must be kept between avalanche rescue transceivers and any metallic object or electronic device. In search mode, keep a minimum distance of 50cm.

All equipment on searching rescuers needs to be turned OFF, except radios, cell phones in airplane mode, headlamps without switch power voltage regulator *(usually found in high-power devices with external battery packs)*, wristwatches without radio functions on the wrist, and devices providing backup transmit function in case of a secondary avalanche.

All equipment on non-searching rescuers on the avalanche needs to be turned OFF, except cell phones, satellite phones, and PLBs. While a search is in progress, equipment use is restricted to brief emergency calls/messages at a minimum of 25m to the closest searching rescuer, devices providing a backup transmit function in case of a secondary avalanche, and headlamps.

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[1] Genswein, M., Reiweger, I. and Schweizer, J., 2009. Survival chance optimized search strip width in avalanche rescue. *Cold Regions Science and Technology*, 59(2-3): 259-266.

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LANGUAGE MATTERS

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the guidelines as established by the American Avalanche Association for awareness, level 1, level 2.

However, if the prospective course provider or instructor is considering using such language to describe or promote their course, the AAA Education Committee recommends that you carefully review that your course seeks to achieve a course design which is appropriate for the audience and available terrain to achieve:

- Student outcomes
- Recommended course content
- Prerequisites for the training level
- Course format
- Performance measures
- Instructor qualifications

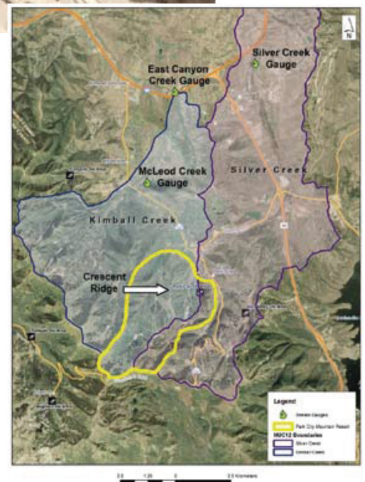
For reference go to: www.avalanche.org/guidelines.php

Finally, it is important to realize that concepts in avalanche education are constantly in a state of change with frequent updates to fresh ideas and thinking as professionals in student learning and instructor strategies. The AAA Education Committee recommends that course providers and instructors maintain continued professional development (CPD), attend regional snow and avalanche workshops offered through avalanche centers, and embrace avalanche education standards by joining programs that offer avalanche training. Strive to network with other course providers or avalanche-based resources for your CPD. There are many ways to satisfy your professionalism and currency with avalanche education, and we hope everyone out there in this field exposes themselves to fresh ideas and thinking each season.

The study area.

left: Crescent Ridge with Gobbler's Knob and Rocky Point (l-r). *Photo courtesy Eric Hoffman*

Below: PCMR boundaries with stream basins and gauge locations. *GIS courtesy Karen Lannom*



Stream Flow and Wet Avalanches

Story by Mark Saurer

When the snow has melted from the valley floors, peak flow levels in our local streams may help predict the onset of annual wet-avalanche events. Park City Mountain Resort (PCMR), located on the Wasatch Back of Utah, is unique geographically when compared to neighboring resorts in the Cottonwood Canyons. With several east-facing, low-elevation starting zones, PCMR tends to see the first wet-avalanche activity each spring. Additionally, the streams in the surrounding basin begin to flow early allowing for stream-flow monitoring and forecasting while upper-elevation drainages are still covered in ice and snow. Preliminary observations at PCMR show a relationship between the first stream-flow peaks and wet-avalanche activity.

First a disclaimer: I present this project/study as a work in progress. My data sets are not very extensive, and at this time I draw no solid conclusions, just noting my observations.

I am certainly not the first to consider comparing stream flows with wet-slab (WS) activity. In the wake of a May 2005 inbounds WS avalanche fatality at Arapaho Basin, Hal Hartman and Leif Borgeson looked into better ways to forecast these events. Leif was working to find a solution other than just closing terrain, perhaps closing too early or, worst-case scenario, closing too late. Notable in their findings was the observation that "[during] an extraordinary warm-up…stream discharge climbed above the wintertime flow rate for the first time. Two days later, May 20, a wet-slab avalanche…claimed the life of a skier."

While forecasting for the spring opening of the Going to the Sun Road in Glacier National Park, Blase Reardon also has observed increased in stream flow prior to the onset of wet-avalanche activity. In his *Conceptual Model for Wet Slab Forecasting*, Reardon looks for "evidence that meltwater is flowing through the snowpack, such as water running across the road and rising streams."

Review of Study Area

PCMR lies in north-central Utah along the east side of the central Wasatch Range, 20 miles east of the Salt Lake Valley. The resort area covers 3300 acres and ranges in elevation from 6900' at the base to 10,000' along the summit ridgeline. Among the six neighboring resorts of the Wasatch, PCMR is unique in that there are several relatively low-elevation (below 8500') avalanche starting zones. In seasons with weather and snowpack conditions conducive to wet-avalanche activity, these paths are often among the earliest to avalanche and have proven to be accurate predictors of activity on upper-elevation slopes. Indeed, forecasters from other areas claimed that when our paths start to go off, they begin to be suspicious of their terrain.

For this study, I primarily focus on one specific area: Crescent Ridge. With starting-zone elevations below 8500' and primarily east aspects, the avalanche paths on Crescent Ridge are typically first to be active in the spring. The two paths highlighted in the top photo have a history of particularly dangerous and deadly avalanches.

River Basins and Stream Data

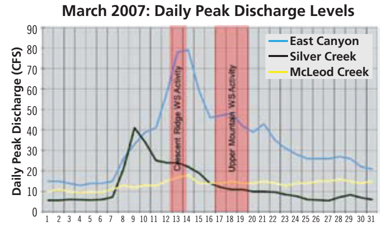
PCMR is located on the headwaters of East Canyon Creek and Silver Creek, tributaries of the Upper Weber River Basin. Crescent Ridge lies in the southeast corner of Kimball Creek's basin, a tributary of East Canyon Creek. The automated stream gauges used for this study *(shown in the map, above)* are managed by the United States Geological Survey (USGS) Salt Lake City field office and can be read remotely via interactive maps on the Colorado Basin River Forecast Center (CBRFC) or USGS Water Data Web sites.

Review of Wet Cycles and Stream Data

I reviewed several years of avalanche cycles and stream-flow data as far back as the 1985 fatality on Gobbler's. In the interest of space, I'll review only the spring of 2007 here.

A substantial warm up started on March 12, 2007. Average 24-hour high/low temps for a week starting on the 12th of 54°/34° respectively were recorded at PCMR's summit weather station (9250'). From March 13-21, 26 large wet slabs and wet loose avalanches, both natural and artificially released, were reported to the Utah Avalanche Center, including several size 2-3, full-depth WS at PCMR.

March 2007: Daily Peak Discharge Levels



The graph above displays daily peak discharge levels from the gauges near PCMR. The first steep increase started mid-day on March 7. Full-depth WS released from Gobbler's on the 12th and from Rocky Point on the 13th. The peak in Silver and East Canyon Creeks occurred 72 hours prior. A second increase started the 11th for East Canyon and McLeod Creeks and peaked

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