USER-FRIENDLY AVALANCHE BEACONS

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ABSTRACT

Avalanche rescue beacons, used efficiently, are well known to be the best means of effecting rapid recovery of buried avalanche victims. It is also well known that considerable practice is required for proficient use of avalanche beacons. This paper presents two new beacon functions that accelerate the beacon learning curve and reduce the potential for confusion and dangerous mistakes. Also presented are several additional features that allow for easier use and improved efficiency.

Unique features of the RAMER AvaLRT avalanche locator/rescue transceiver

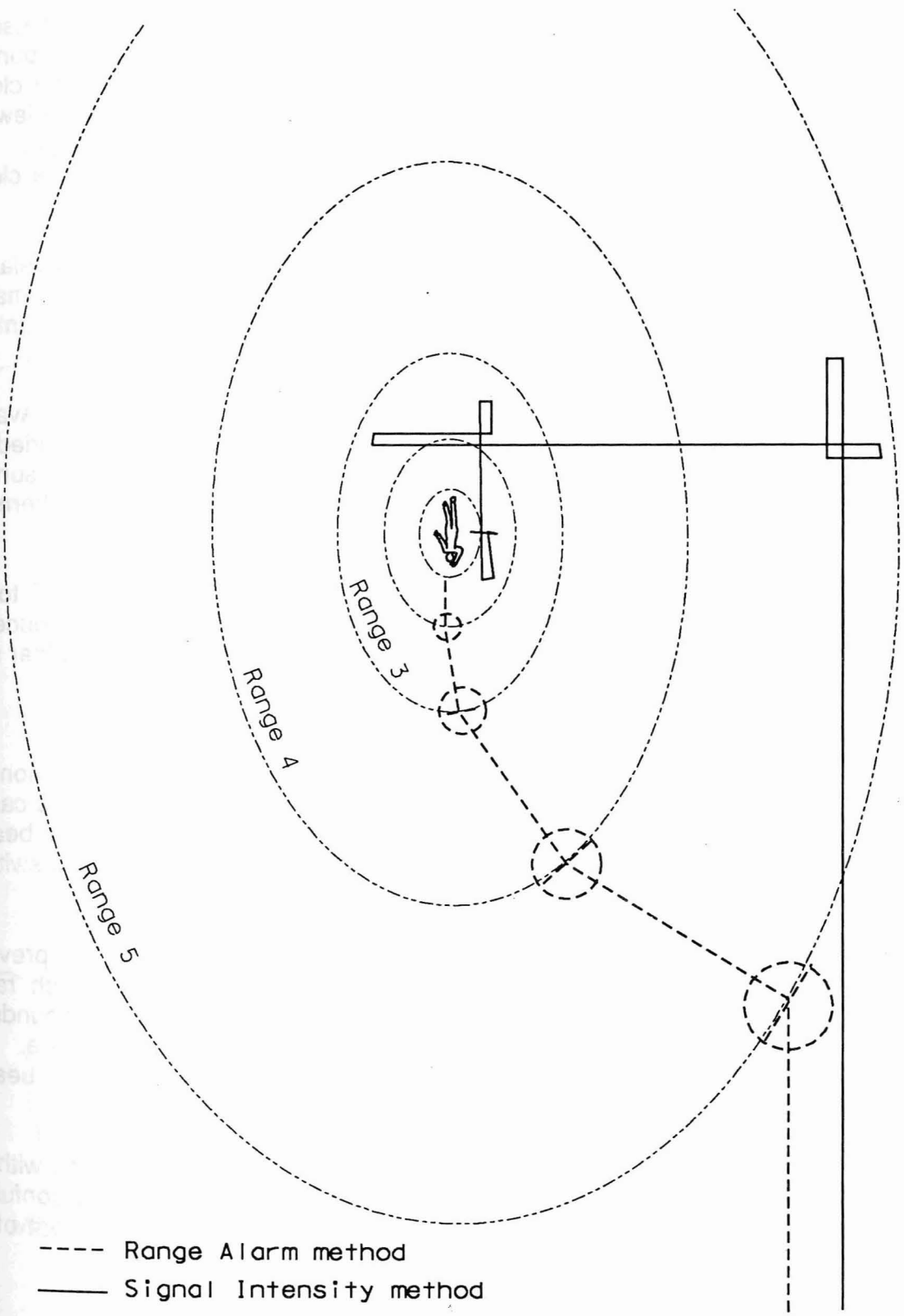
Range Alarm System

All beacons sold today have multiple receiver settings. The rescuer begins searching on the longest range setting, switching to progressively lower range settings according to his subjective evaluation of the received signal. Learning when to switch to a closer range setting requires much practice.

Several new beacons use a visual and/or audio alarm to indicate the point at which the range should be reduced. The Ortovox F1 (single frequency) uses a conventional LED that starts to illuminate well before range saturation and becomes progressively brighter as the signal amplitude increases. The audio tone also changes as the range saturates. The Ramer AvaLRT (dual frequency) uses a high-intensity LED that illuminates at full brightness just before range saturation, and also adds an additional tone. In comparing these two beacons, it is obvious that the use of any range saturation signal reduces the learning curve and increases certainty. It also obvious that the "off/on" characteristic of the AvaLRT Range Alarm is much easier to use and provides more certainty than the gradual nature of the Ortovox range indicator.

The precision of the AvaLRT Range Alarm permits surprisingly accurate directional location of the buried beacon. When the first Range Alarm is heard (at about 100 feet on high frequency, 50 feet on low frequency) the searcher backs off slightly until the alarm stops (about 6 inches). He/she then moves the AvaLRT (being careful not to rotate it) about 4 feet or so to one side or the other of the search line and again acquires the alarm. By moving perpendicular to the line between the two alarm points, the searcher will be going fairly directly toward the buried beacon. This procedure is illustrated in Diagram 1 on the following page.

Diagram 1: Search Method Comparison
Note that the distance traveled by the searcher using the Range Alarm method is approximately 50% of the distance traveled using the conventional Signal Intensity method.



The Range Alarm has proven to be much more intuitive than other location techniques. Users have described the alarm point as "the Wall", and it does give one a sense of having run into something. Once inside the first "Wall" there is no confusion as to the general location of the buried beacon. Each closer "Wall" increases the certainty level.

Once the searcher has reached the burial location, the Range Alarm can be used to pinpoint the buried beacon with remarkable accuracy. Instead of crawling around on the snow, the searcher will instead look for the outer activation point of the closest alarm "Wall" to the buried beacon. This can provide a location accuracy of a few feet with a 10-foot burial, as is illustrated in Diagram 2 on the following page. Also illustrated is the increased effectiveness of this system in finding two or more closely buried beacons.

Because of the intuitive nature of the AvaLRT Range Alarm, people with no avalanche beacon experience can become proficient very quickly. We tell them to simply imagine a series of concentric circles around the buried beacon, and that the Range Alarm will come on as each circle is penetrated.

Note: Since the closest Range Alarm position is 6 feet on high frequency, the AvaLRT must be moved away from a shallow burial location. For instance, a beacon buried one foot below the surface must be pinpointed from a distance of 5 feet above the surface. This is actually easier and takes less time than conventional methods. Furthermore, extremely shallow burials are common only during practice sessions.

It is possible to reduce the minimum alarm range by rotating the AvaLRT to the minimum signal position (90° to the maximum signal orientation). This will reduce the range to 2 or 3 feet, but will also result in a dead spot with peaks signals at either side. This technique should only be used by searchers who are proficient at it.

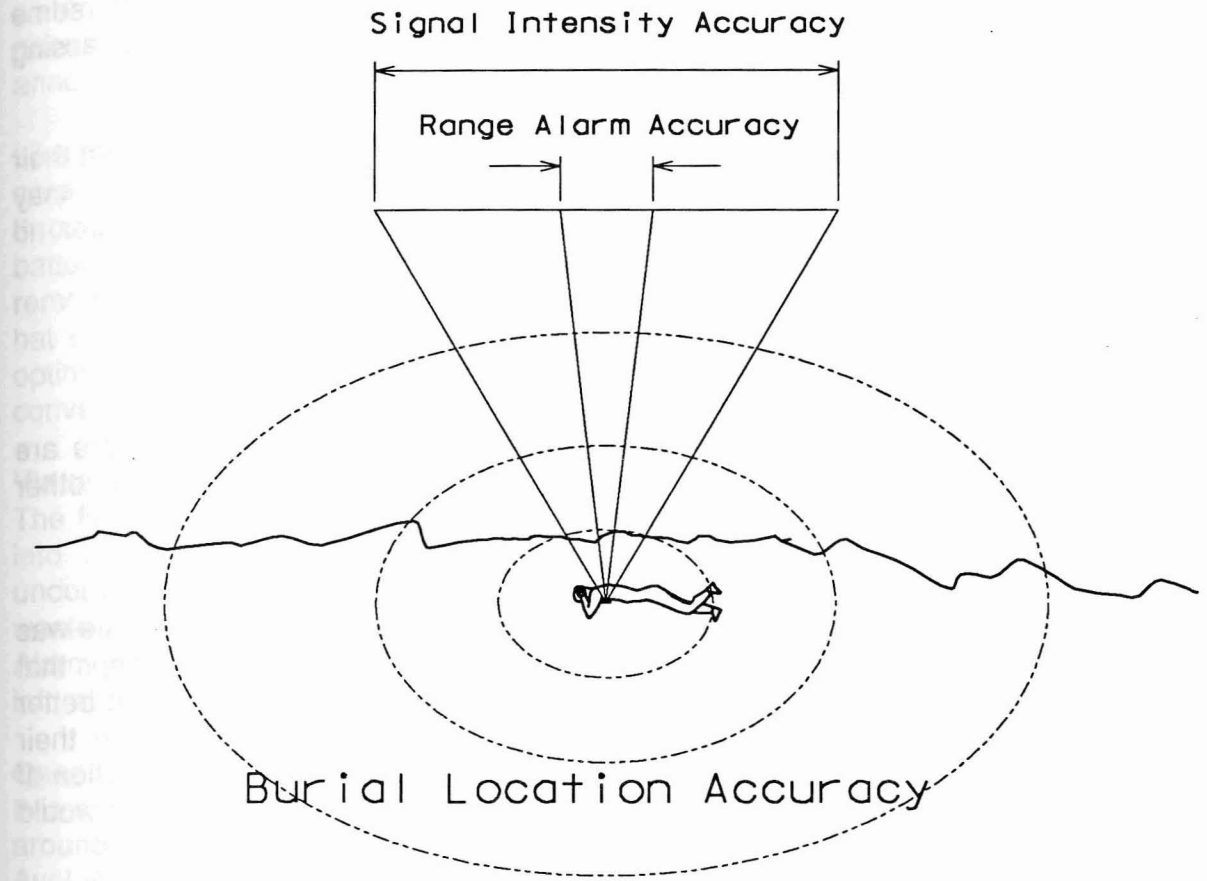
Fail-Safe System

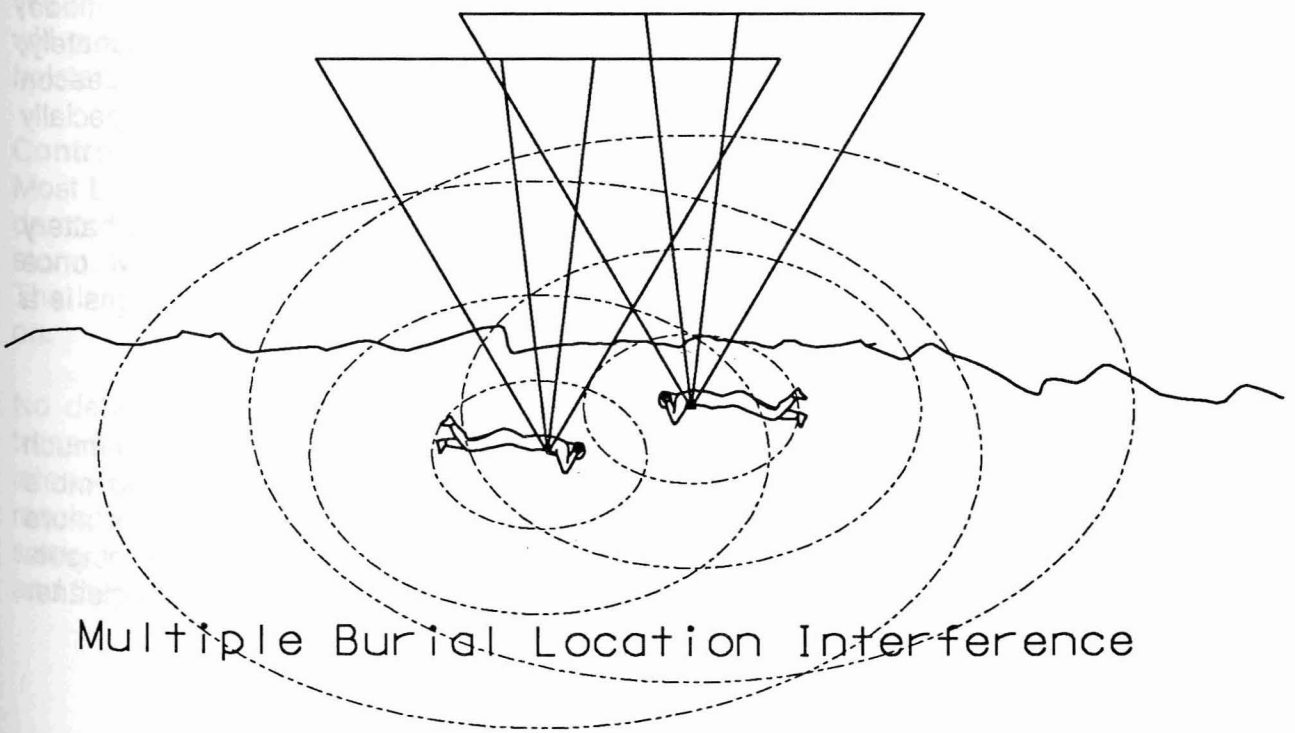
After the excitement of an actual avalanche rescue it is not uncommon for inexperienced rescuers to forget to switch their beacons back to transmit. This can be a fatal mistake. It is also not uncommon for a rescuer to accidentally drop his beacon in deep snow and lose it, or bury a beacon for a practice rescue and forget to switch it to transmit.

The Ramer AvaLRT incorporates an automatic return-to-transmit function that prevents accidental non-transmission. Two minutes of searching is allowed in each range position. If the control lever has not been moved in that time, a loud alarm sounds. If the control lever is still not moved, the AvaLRT returns to the transmit mode. Any movement of the control lever overrides the Fail-Safe function and returns the beacon to the receive mode.

Although some concern has been voiced about the Fail-Safe alarm interfering with the search, this has not been the case in practice. Other searchers are not confused, because they can also hear the alarm. Of course, they will inform the culprit of his

Diagram 2: Location Accuracy Comparison





misdeed in case he doesn't know what is going on. This may be why some professional ski patrollers are not 100% convinced. After all, it might be embarrassing for other rescuers to know that you have allowed your Fail-Safe to time out.

There is, however, valid concern on the part of helicopter and snow cat guides that their clients might not understand how the Fail-Safe system works. Future designs may incorporate an adjustable Fail-Safe delay that can reduce that problem. Under no circumstances can the Fail-Safe function be entirely deactivated.

Other user-friendly features of the RAMER AvaLRT

While not as revolutionary as the Range Alarm and the Fail-Safe system, there are other features incorporated in the AvaLRT that make it easier to use than other beacons.

Low Battery Indication

The Echo was the first beacon to offer a built-in battery tester. When the earphone was plugged in (switching it to receive) the first sound heard would be a series of beeps that indicated the battery condition. The more beeps, the weaker the battery. While better than licking the battery terminals with your tongue, this led to people thinking their beacon was stuck on transmit, when what was actually happening was an indication of a very weak battery. This is not as strange as it sounds - one model of Echo II would transmit for five minutes after the battery was removed.

Since then other manufacturers have incorporated visual and audio battery testers. These usually are activated when the beacon is first turned on in the transmit mode, and consist of a series of LED flashes and rapid transmit beeps. Unfortunately, batteries tend to rejuvenate after a rest period, so testing the battery when the beacon is first turned on is not a good indication of the real battery condition later on, especially in cold weather.

The AvaLRT uses a low battery indicator similar to a smoke alarm. When the battery voltage drops below the minimum level, the AvaLRT will output a loud squawk once every four minutes until the battery is changed. This can be rather annoying (as is a smoke alarm) but it is hard to ignore.

Speaker Output

It has been demonstrated conclusively that a loudspeaker receive output is much easier to deal with than the conventional earphone. Not only is it faster and more comfortable (no cord to deploy or slippery thing to stick in your ear), it is much more easily heard by people with high-frequency hearing loss. The speaker outputs overtones and harmonics that can be heard by a person who cannot hear the cleaner tone of an earphone.

Other speaker-output beacons use small magnet-driven loudspeakers housed in a waterproof envelope. The AvaLRT uses a piezoelectrically-driven metal disk that needs no waterproofing. It is similar to the speakers in smoke alarms and other annoying security devices.

Like other speaker-output beacons, the AvaLRT provides a jack for an auxiliary earphone. Unlike the others, the AvaLRT has an earphone compartment, accessible through a sliding door on the side of the beacon which also provides access to the battery. And instead of using a conventional in-your-ear earphone, the AvaLRT uses a remote speaker. The hook Velcro on the back of the remote speaker will stick to your hat or collar of your pile jacket, and does not need to go in your ear. It provides optimum performance in high noise situations or for hearing-impaired users. A conventional earphone can also be used.

Visual Output Display

The first visual output display, the Visovox, consisted of a VU meter that was plugged into the earphone jack of the Ortovox F2 beacon. While it's performance was undoubtedly excellent, it was expensive and cumbersome, and setting it up for a search wasted precious seconds. The AvaLRT uses a high-intensity LED to indicate Range Alarm positions. It also flashes on transmit. The visual Range Alarm provides as much information as a meter with much less hassle.

Case and Harness

It is a dangerous nuisance to have to undo straps, unzip cases, and otherwise mess around with small items when confronted by a life-or-death avalanche rescue. The AvaLRT holster is designed to remain on the user, and the AvaLRT simply pops out when the locking latch is released. The AvaLRT is also equipped with a wrist lanyard. We strongly suggest attaching the lanyard to your wrist so that the Fail-Safe function will protect you, not just your beacon. The lanyard can also be looped through the holster strap when additional security is required.

Controls

Most beacons have rather small control knobs for switching ranges. This is fine when demonstrating a beacon indoors, but awkward when wearing thick gloves in a raging storm. The AvaLRT uses a large control lever that can easily be operated with gloves. The large size of the display also makes it easier to see what range position you are on.

No detent or lock-out is required to prevent the AvaLRT from being switched from transmit to receive, since it will transmit in all receive positions. There is a small interlock button that prevents return to the OFF position. All other beacons have a mechanical interlock to prevent accidental switching to receive from transmit. How some of these interlocks function is not immediately obvious to the inexperienced user, and they may be difficult to operate while wearing gloves.

Advanced features that have nothing to do with user-friendliness

The AvaLRT includes other features that give it certain advantages over other beacons, even though they don't necessarily make it easier to use.

Reliability

Experience has shown that most beacon failures come from three elements: the earphone, the battery connection, and the range switch contacts. The earphone problem has been eliminated by speakers. The AvaLRT reduces battery connection problems by using a snap-on 9-volt battery clip that is considered to be the most positive form of battery connection (short of soldering).

Most beacons use rotating range switches with electro-mechanical switch contacts. Eventually these contacts can wear or corrode, causing intermittent contact or complete failure. The AvaLRT uses a non-contact magnetic reed-relay switching system that cannot wear or corrode. The reed-relays are part of the circuit board, and the magnet is contained inside the back switch lever. Even if the front switch lever (the one that is used to move the switch) is somehow broken or ripped off, the switch will still function.

Electronics

Some beacons still use discrete components and transistors. These are susceptible to corrosion and vibration. The AvaLRT uses state-of-the-art miniaturized surface-mount technology that allows the electronics to be fully encapsulated in epoxy and virtually impervious to water and mechanical damage.

Frequency Switching

Most of the world has accepted the high frequency (457 kHz) as standard. There are still a lot of low frequency (2275 Hz) beacons in the United States, and only dual-frequency beacons can be sold until 1996. The disadvantage of a dual-frequency beacon is that the range on high frequency must be compromised by the low frequency range.

The AvaLRT eliminates this problem by providing a switch to select high or low frequency. This allows the searcher to take advantage of the longer range on high frequency if it is known that the buried beacon is compatible. If the frequency of the buried beacon is unknown, low frequency will be used for the primary search. The AvaLRT has a range of 100 feet on low frequency, essentially the same as other low frequency beacons. On high frequency, the AvaLRT will detect signals up to 200 feet. The first range alarm comes on at 100 feet.

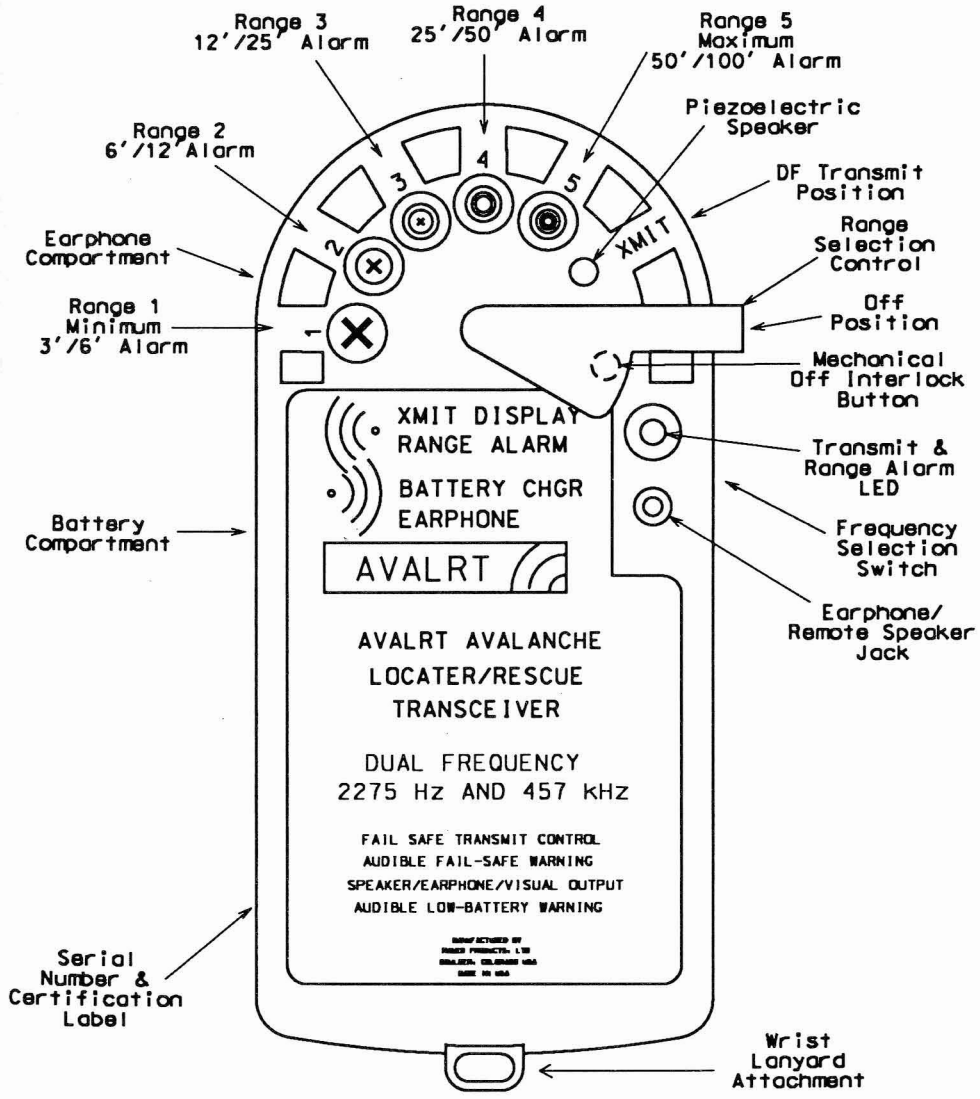
Being able to switch receive frequencies cuts receive power consumption in half, and also allows independent testing of the high and low transmit functions of other beacons. Without this feature it is difficult to detect a failure of one channel of a dual-frequency beacon. Once low frequency beacons become extinct, the AvaLRT can be permanently switched to high frequency. **Note:** The AvaLRT transmits simultaneously on both frequencies, as required of a dual-frequency beacon.

Transmit Rate

The world standard for transmit rate is one pulse per second. Many U.S. ski patrols favor a more rapid transmit rate. While a faster transmit rate does consume batteries faster, it also can speed recovery. The AvaLRT is available with either a standard transmit rate or a twice per second professional transmit rate. The professional AvaLRT is not available to the general public.

CONCLUSION

The Ramer AvaLRT offers unique features that will make avalanche beacons more acceptable to the general public and may even save some lives. The downside of such technological wonders is the length of time it has taken to bring it to market. Being first with breakthrough technology is also very expensive.



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