United States Military Artillery For Avalanche Control Program:
A Short History In Time

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ABSTRACT: The U.S. Forest Service initiated avalanche control and forecasting in the United States. The Forest Service manages large tracts of publicly owned land called National Forests and they permit certain activities and businesses on those lands. The Forest Service began permitting ski areas on National Forests in 1938 when they issued a special use permit to Alta Ski Area in Little Cottonwood Canyon near Salt Lake City, Utah.

Almost immediately the Forest Service realized that avalanches threatened the public both while they traveled the Little Cottonwood Canyon Road to reach Alta Ski Area and while they actually skied. The Forest Service hired Douglass Wadsworth to help mitigate the threat and he became the first Forest Service Snow Ranger.

The Forest Service Snow Ranger Program grew to become one of the most effective and innovative avalanche control and forecasting programs in the world. Forest Service Snow Rangers pioneered the use explosives for avalanche control in the US, developed the first effective avalanche forecasting programs in the US, and initiated the use of military artillery for avalanche control in the US.

My paper will trace the development of the Military Artillery for Avalanche Control Program in the United States from its inception to today. It will explain how military artillery work, examine alternatives to military artillery, discuss three 106mm RR accidents and discuss the future of military artillery for avalanche control in the U.S.

KEYWORDS: military artillery, avalanche control, recoilless rifle, Howitzer, Forest Service

1. Introduction

The U.S. Forest Service initiated the first large scale avalanche control and forecasting program in the United States. The Forest Service manages large tracts of publicly owned land called National Forests and they permit certain activities and businesses on those lands. The Forest Service began permitting ski areas on National Forests in 1938 when they issued a permit to Alta Ski Area. Alta Ski Area is adjacent to the Town of Alta in the upper end of Little Cottonwood Canyon near Salt Lake City, Utah.

Figure 1: Buildings within the Town of Alta that were damaged and destroyed by an avalanche (historic photo, circa 1915).

Almost immediately the Forest Service realized that avalanches threatened the public both while they traveled the Little Cottonwood Canyon Road to reach Alta Ski Area and while they actually skied. The Forest Service hired Douglass Wadsworth in 1939 as the first Forest Service Snow Ranger and directed him to minimize the avalanche danger.

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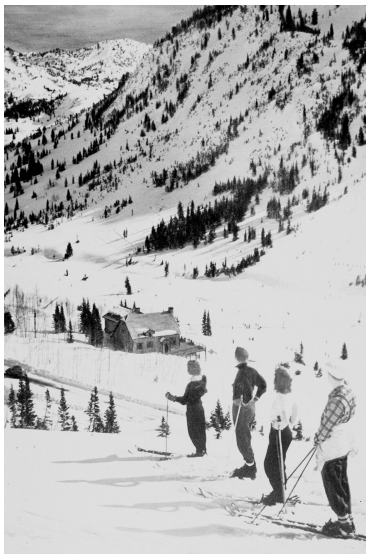

Figure 2. Four skiers look down onto Alta Ski Area (historic photo, circa early 1950s).

In response, Wadsworth developed one of the first recorded sets of avalanche safety rules for travelers and skiers.

1. Keep out of the Canyon (Little Cottonwood) during periods of storm and from one to three or four days afterward.
2. Following a storm, keep off steep, un-timbered slopes for a period of two or three days.
3. Do not park or stop in the pathway of previously occurring slides.

Shortly after issuing the rules Wadsworth and a colleague used dynamite and tried to artificially trigger an avalanche on Mount Superior, a very dramatic peak directly across canyon from Alta Ski Area. This was the first recorded use of explosives for avalanche control in the United States and luckily it did not trigger an avalanche. The following day a natural slide with a crown line almost six kilometers long ran from Mount Superior east along a steep ridge and completely destroyed the band of trees Wadsworth and his colleague had been hiding in the day before. Had the previous day's explosives had the same result, Wadsworth and his colleague would not have survived.

2. First Use of Military Artillery

Undaunted, the Forest Service continued experimenting with explosives for avalanche control, albeit with limited success, until 1946 when they hired Monty Atwater as the Alta Snow Ranger. Atwater had served with the US Army Tenth Mountain Division in Europe during World War II and he had seen explosives including military artillery used to trigger avalanches. Atwater began working with explosives almost immediately; he tried drilling holes in cornices, placing explosives in the holes and detonating them electronically and he tried lowering explosives in a coffee can onto a slope. Interestingly, Atwater also hung explosives from a tree branch and positioned them a few feet above a slope to see if an air concussion could trigger an avalanche. Unfortunately he gave up this technique after one try and it was years later before the industry realized how much more effective air concussions could be than concussions within the snow-pack.

Atwater continued experimenting with explosives for avalanche control and then, at the urging of visiting Swiss snow scientist Andre Roche, he began looking into using military artillery for avalanche control. He contacted the Utah National Guard in 1949 and arranged for them to fire 15 rounds from a 75mm French Howitzer into several slopes above Alta. This was the first use of military artillery for avalanche control in the United States. Atwater picked out the target points and a National Guard soldier shot the French Howitzer.

Figure 3. Monty Atwater, Utah National Guard soldier, and Forest Supervisor Felix Koziol examine a French Howitzer (historic photo, circa 1949).

Based on the positive results from the 75mm French Howitzer, the Forest Service decided to permanently station military artillery at Alta but declared that only Army National Guard personnel could shoot the weapons. Since the Guard was stationed 1000 meters below and 50 kilometers away in the Salt Lake Valley it was

often difficult for them to get to Alta during a storm to shoot the weapon. Predictably, the time came when a storm prevented the Guard from getting up Little Cottonwood Canyon to Alta and so Atwater shot the weapon without authorization from the Forest Service. In fact, this happened several times, but eventually Atwater's Forest Service boss caught on and threatened to discipline him for not following procedures. Luckily for Atwater and for the Military Artillery Program a high ranking Forest Service official intervened and changed the policy so Atwater and other Forest Service Snow Rangers could legally fire military artillery.

Atwater and other Snow Rangers experimented with several types of military artillery and finally settled on 75mm and 105mm Recoilless Rifles (RR) as the best choices. The US Army had developed new weapons such as the 106 RR by the early 1950s and had placed the 75mm and 105mm RR on their surplus weapons list. This designation allowed the Forest Service to easily and inexpensively obtain the weapons and ordnance.

Recoilless rifles are ideal for avalanche work. Recoilless rifle ordnance consists of a perforated cartridge case containing propellant that is attached to the actual explosive projectile or bullet. The projectile fits snuggly into the barrel of a recoilless rifle; however, the inside diameter of the chamber of a recoilless rifle is considerably larger than the cartridge case so the case itself is suspended in the chamber. When ordnance is detonated, propellant gases push the projectile out the barrel and simultaneously escape out the back of the rifle through vents. Since roughly an equal amount of energy escapes out the rear of the barrel as pushes the projectile out the front, the weapons do not recoil.

Figure 4. Energy escaping from the front and rear of a 105mm RR.

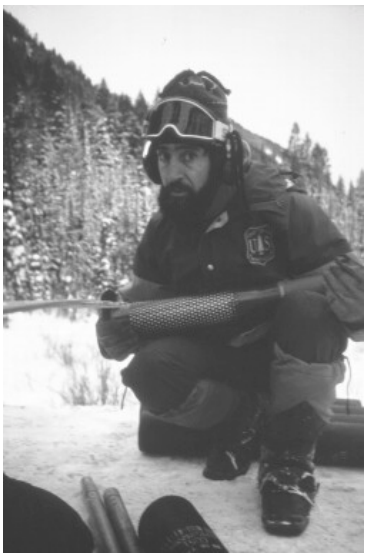

Figure 5: 105mm RR round with perforated cartridge case on the left end and explosive projectile on the right end.

Recoilless rifles are light and easy to use and they had a stellar reliability and safety record in World War II. The Forest Service developed agreements whereby the Army would supply the weapons and the ordnance at a small fraction of their actual costs and that the Forest Service would use them to control avalanches within their permitted ski areas. Military artillery worked so effectively that the Forest Service expanded the program to eventually include over 20 ski areas. State departments of transportation also developed agreements with the Army and began using military artillery to control the avalanche threat above mountain highways.

Recoilless rifles were specifically designed to be mobile artillery pieces and to be shot from vehicles such as Jeeps. The Forest Service also occasionally shot their recoilless rifles from the back of pickup trucks; however, in the late 1970s Forest Service snow rangers performing avalanche control in the mountains above Ogden, Utah miscalculated and overshot a ridge and the round landed in and partially destroyed a house being constructed in an Ogden suburb. Following that incident, the Forest Service prohibited the use of mobile mounts and required that all shooting be done from permanent locations.

Occasionally artillery ordnance does not explode upon impact. Unexploded ordnance or duds occur infrequently but they do pose a potential

risk to hikers and others that might stumble upon them after the snow melts. Consequently, all artillery users keep meticulous records of the occurrence and location of duds so they can be located and destroyed.

Figure 6: Recovered artillery dud with detonation cord lying on top of it

From the beginning, Monty Atwater and other Forest Service Snow Rangers continued perfecting the use of hand delivered explosives and looking for methods to supplement and perhaps replace military artillery. Atwater and the others realized early on that because surplus military ordnance was no longer manufactured that it was a finite resource and that a substitute would have to be found sooner or later.

In the late 1950s Atwater worked with an inventor and developed the first Avalauncher. The Avalauncher, patterned after baseball-pitching machines, uses bottled, pressurized nitrogen to propel a projectile with about one kilogram of explosives through a smooth barrel to avalanche starting zones up to a few hundred meters away. The Avalauncher does not have the accuracy, the range or the punch of military artillery but it is an important avalanche control device.

In fact, no one has developed a device that can totally take the place of military artillery. Military artillery can deliver up to 3.5 kilograms of explosives to distant and inaccessible starting zones and they have enabled ski areas like Alta, Snowbird, Jackson Hole and Mammoth Mountain and highway departments in Colorado, Utah, Washington, California, Alaska and Wyoming to effectively minimize avalanche danger and safeguard the public.

Figure 7. Snow Rangers inspect an early version of the Avalauncher (circa 1960).

3. Avalanche Artillery Users Group

The Military Artillery for Avalanche Control Program proceeded more or less without incident until 1986. In October of 1986 a massive explosion occurred in a bunker in Kentucky that housed 75mm RR ordnance. The Army immediately issued a moratorium that suspended use of all recoilless rifle ordnance including all use of military artillery for avalanche control. The moratorium threw the Forest Service, the ski areas and the highway departments into near panic.

Luckily, the Army quickly investigated the incident and determined that the explosion had been caused by very poor storage conditions. The Army issued a revised set of strident ordnance storage requirements to prevent a similar occurrence and lifted the moratorium in mid-November 1986.

While the moratorium only affected the Program temporarily, it did illustrate that external problems could negatively impact the Program with little or no warning. It further illustrated that the many users within the Program rarely communicated and they did not have a unified voice or a single point of contact for the U.S. Army.

To rectify the situation, Doug Abromeit and John Anderson of the Forest Service contacted all

military artillery for avalanche control users and proposed meeting in Anaheim, California in 1987 to form a military artillery users group. Nearly every user in North America attended the meeting and together they established an organization called the Avalanche Artillery Users of North America Committee (AAUNAC). They decided that AAUNAC would function as the professional organization and as the single point of contact for all military artillery for avalanche control users.

AAUNAC now works very closely with the U.S. Army, has developed training manuals for all calibers of artillery used for avalanche control, provides training for users, distributes technical information, facilitates the development of alternatives to military artillery, communicates electronically on a regular basis and meets at least one time per year to discuss issues germane to all users.

As stated earlier, the Military Artillery for Avalanche Control Program relies exclusively upon weapons and ordnance no longer manufactured by the U.S. Army or anyone else in the USA. In the early 1990's, the Army was out of surplus 75mm and 105mm Recoilless Rifle HE ordnance (HE rounds are the best avalanche control rounds). As a result, the Forest Service and AAUNAC worked arranged for the Army to replace many of the existing 75mm and 105mm RR systems with 106mm recoilless rifles. At about the same time, the Washington Department of Transportation obtained an armored tank from the Army and installed it on Stevens Pass, one of the mountain thoroughfares for Seattle, to replace its 105mm RR system.
Both the tank and the 106mm RR seemed to be viable alternatives to 75mm and 105mm recoilless rifles. The tank worked and continues to work well but because of its technical nature, limited availability, high cost and rather sinister appearance its use has been limited to Stevens Pass in Washington.

The 106mm RR, basically an updated, lighter version of the 105mm RR, was used during the Korean and Viet Nam Wars. Because of the similarity between the 105mm RR and 106mm RR, very little additional gunner training was necessary and the system seemed to be performing quite well. That was until 1995 when a tragic in-bore explosion occurred at Alpine Meadows Ski Resort, California.

4. 106mm RR In-Bore Explosions

Five gunners were standing on the mount next to the weapon during a training exercise. The weapon was fired and a low order detonation occurred while the projectile was traveling out of the barrel. The detonation partially shredded and peeled back about one third of the muzzle end of the barrel. The explosion sent shrapnel from the weapon barrel and the projectile flying in all directions; two chunks of shrapnel struck and killed one of the gunners.

Figure 8: Gun mount site of fatal 1995 accident.

The Army, the Forest Service and other Federal and state agencies conducted a thorough investigation of the accident that found that the most likely cause of the explosion was a manufacturing defect in the projectile's base plate. Base plates are located on the bottom of the projectile where they form the protective interface between the propellant in the cartridge case and the projectile.

Ordinarily when a round is fired the propellant in the cartridge case ignites and forms extremely hot gases that push the projectile through the artillery barrel and into flight. The base plate shields the explosives in the projectile from the hot propellant gases. However, in this case, Army munitions experts concluded a hairline fracture caused by a manufacturing defect in the base plate allowed the hot propellant gases to penetrate the base plate and partially detonate the explosive in the projectile as the round traveled out the barrel.

The resulting explosion was a partial or low-level detonation; had it been a high level or complete detonation the devastation would have been much greater. The Army immediately suspended

use of the ordnance “lot” and the Forest Service National Avalanche Center required that all 106mm RR be fired from behind protective barriers.

Figure 9: Shrapnel embedded in a cardboard storage tube containing a live 106mm RR round. The tube was lying on the mount.

Following the accident, several 106mm RR users decided they did not want to continue using the 106mm RR. The Army replaced these 106mm RR with 105 Howitzers. The remaining 106mm RR users elected to erect safety barriers and to shoot the weapons remotely from behind the barriers.

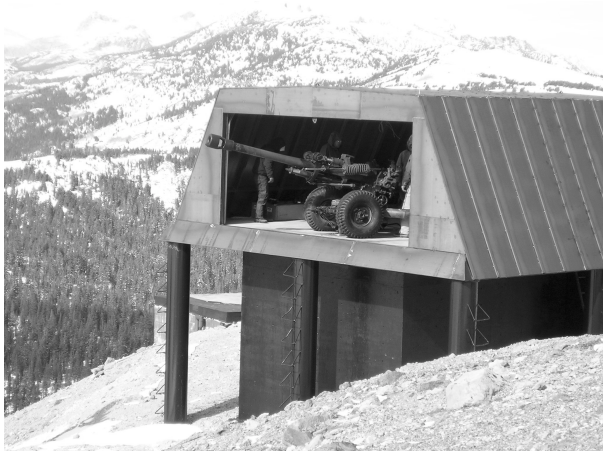

Figure 10: 105 Howitzer inside a protective shelter.

And luckily they did, in December 2002 two massive 106mm RR in-bore explosions (both much bigger than the 1995 in-bore) occurred within 13 days of each other at Mammoth Mountain, California. During both incidents, the gunner crews were behind protective barriers and were unharmed. The Forest Service allowed the program to continue until spring since it was virtually impossible to install an alternative system in the deep December snow. The Forest Service National Avalanche Center permanently suspended the program in May 2003 and all remaining 106mm RR users converted to 105 Howitzers.

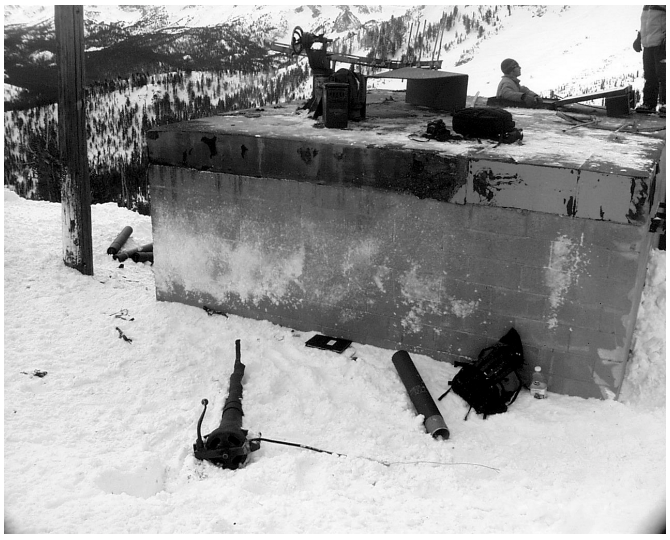

Figure 11: 106 mm RR Mammoth Mountain Gun Mount after in-bore explosion. Note weapon lying in the snow in front of the mount.

Figure 12: 106mm RR gunners demonstrating where they stood beneath the protective barrier when the accident occurred.

Figure 13: Severe damage to the protective box that contained live rounds when the in-bore explosion occurred.

One hundred five millimeter Howitzers shoot basically the same projectile as a 105mm RR; however, 105 Howitzers are much heavier and have over twice the range of a 105mm RR and, unlike the 105mm RR, Howitzers have a recoil mechanism. Howitzers have performed very well as avalanche control weapons and their users tend to be very enthusiastic about their capabilities. They do not have a dangerous back blast, they are much less loud, and users can fire them from beneath a covered structure, protected from harsh winter elements.

While 105 Howitzers unquestionably work quite well, like their recoilless rifle predecessors, they are no longer manufactured and therefore exist in finite quantities. And, while highly unlikely, they are not immune to malfunctions such as those that occurred with the 106mm RR. Obviously, a similar incident would almost certainly disqualify them as viable avalanche control devices. So, while users currently embrace their use, they realize the Program could end without warning.

And to further complicate the situation, there does not seem to be an heir apparent to the 105mm Howitzer in the Army's surplus arsenal. The US military has long since converted to sophisticated and expensive systems that are not suitable for avalanche control.

5. Possible Alternatives

Several innovative companies have developed remote explosive delivery systems such as the gas powered LOCAT and Avalauncher systems and on-site systems such as Gaz-Ex Exploders, Wyssen Towers, and Doppelmeyr Bomb Trams and Exploder Boxes. All of these systems work quite well and are used throughout the world.

Figure 14: LOCAT gas powered launcher.

Figure 15: Gaz-Ex Exploder in a starting zone.

However, military artillery has a unique niche. It alone allows avalanche control workers to fire rounds from a single fixed accessible location and trigger avalanches in distant inaccessible starting zones. Other remote delivery systems are typically less accurate, have less range, and deliver less explosive power than military artillery.

The on-site systems require installation either in or adjacent to a starting zone. This installation requirement can be cost prohibitive when there are multiple starting zones and the installation can be impractical or nearly impossible in particularly roughed terrain or when land use policies prohibit construction such as in officially designated Wilderness Areas within the United States.

Representatives of the munitions industry have proposed manufacturing ordnance to replace the dwindling supplies of military ordnance. The new ordnance could be fired from existing military artillery pieces or new delivery devices could be

developed. The ordnance would be designed specifically for avalanche control and could be fitted with

- Proximity fuses that would detonate the projectile above the snow surface
- Warheads that would not produce shrapnel and
- A timing device that would destroy the warhead in the event that the projectile did not detonate upon impact.

Ordnance designed specifically for avalanche control would have many advantages over existing military rounds that were designed for warfare. However, the cost per round would most likely increase dramatically and perhaps as much as twenty fold or more. Currently, military artillery rounds cost about $50 per round including initial price, transportation and storage. Munitions industry spokespersons have estimated that avalanche specific rounds would cost anywhere from $700 to $1000 per round depending upon features. This would obviously be a very dramatic and potentially prohibitive price increase for ski areas and departments of transportation that depend upon military artillery for avalanche control.

However, the potential cost of not having an effective alternative to military artillery is also very high. If the use of artillery were suddenly no longer an option, several ski areas could not safely operate and, more importantly, several state departments of transportation could not safely keep vital transportation corridors open.
The cost to states and to ski areas to develop and to utilize an alternative system would undoubtedly be in the millions of U.S. dollars. However, the State of Washington estimates lost revenues of $xxxxx each day Stevens and Snoqualmie Passes are closed and commercial trucks and private vehicles are diverted and not able to reach Seattle over the Cascade Mountains. If the military artillery program suddenly ended, commercial losses similar to those in the State of Washington would significantly and negatively impact the economies of other states including Alaska, California and Colorado.

6. Conclusion

Because the current limited use of 75mm and 105mm recoilless rifles and the more wide spread use of 105mm Howitzers works quite well and budgets are limited, government officials and resort owners have a difficult time justifying spending money to develop a new system. However, not developing a back-up/replacement system for military artillery is a calculated risk based on the very uncertain premise that the current system will continue to operate smoothly and without incident.

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