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Avalanche Mitigation-Certified Study Guide

Preface: During our last Certified Exam in March of 13 we had an observer from the Intermountain Certified Program. His only criticism of our avalanche module was that we didn't cover anything on avalanche mitigation. I related to him that we don't really have mitigation issues in the Midwest with hills reaching a staggering 1200 feet of vertical. That was not entirely truthful. We have had avalanches such as the glide avalanche at Perfect North Slopes and the spontaneous slides on the sand dunes on the eastern and southeastern corners of Lake Michigan. We will address these avalanches in this section. It is likely that you will get a question about mitigation in the avalanche module as either an oral or a written question. The answers to those questions follow in this short document.

Introduction: Mitigation by definition is to make less dangerous. That does not mean safe. What it does imply is that it should be safer. The snowpacks that we ski on many times are bombed and skied into submission. Another way of looking at that is that the slope was so weakened by explosive assault that it now borders on the brink of total collapse. Is the glass half full or half empty? Always be wary and always be looking for more information.

In the remainder of this document we will discuss different forms of mitigation.

Urban Mitigation and Zoning: I'm part of the WW2 boomer crowd. The ski fanatics of my generation sought out land to place their ski chalets on once they had the financial where-with-all to afford such an endeavor. Some got there sooner than others. Many were disappointed to find out that the land that they

purchased was no longer classified as residential land and they were not permitted to build on it. Naturally the litigation followed. Sometimes solutions were found and sometimes not. What happened here? What happened was that the local municipality learned of the avalanche peril and the financial implications of allowing building in avalanche slide paths. Today mountainous communities seek out information on avalanche paths based on the 100 year avalanche. That would be the worst slide possible based on the history of the area and the information garnered from avalanche forecasters and civil engineers. Zoning policies followed based on these studies.

Sometimes the mountainous community is late in discovering that a developed community is in a potential avalanche path. Negotiations then have to begin with the endangered property owners to create some level of safety. What usually happens is that a barrier solution is agreed upon and the cost is shared.

Avalanche Starting Zone Mitigation:

Mountain Top Barrier Systems: These are structures built at the top of mountains to support the accumulation of large quantities of snow. These structures look like cyclone fences that are embedded in the rock and supported by cables. They are modular units and are extensively used in Switzerland. TECCO Avalanche Barriers, a division of Geobrugg of Switzerland, and TRUMER have had tremendous success in providing avalanche protection for many villages in avalanche paths in Germany, France, Italy, Switzerland and Austria. TRUMER is a major supplier of down mountain systems designed to retain rock and stabilize scree areas. You have probably seen these applications near highways when driving through mountainous terrain. The limitation to these cornice entrainment systems is that they have to be maintained and sometimes the snow accumulation is so great that the arrest and anchor systems are overcome with snow to become useless.

Gazex Systems: There are two types of systems; one fixed and the other mobile. The fixed unit is very common in many U.S. ski areas. The fixed unit has three parts, the shelter where the gas is stored and mixed, the pipelines that transfer the gas to the exploder and the exploder that you see on the slopes. The exploder looks like a huge elephant trunk. The communication with the gas shelter is via computer with a discrete radio frequency to start the gas mix that transfers to the exploder via polyethylene pipes. The exploder has a pressure manifold, an electronic ignition box and two spark plugs for ignition. The exploder comes in several sizes to match the thump required to release snow.

The concept here is that the exploder thumps the pack from above causing a small release as apposed to a huge release. The advantages here are that no human is exposed to any danger while mitigating. The disadvantages are that the slope is always thumped in the same spot and the system is expensive. If you're interested you can get more information at www.groupemnd.com. then select T.A.S. for pictures of all this really cool stuff.

On the web site above you will see the GAZEX Daisybell that is suspended from a helicopter. This mobile unit is designed to mitigate areas that threaten communities or recreation areas below. The Daisybell looks like a space capsule with two gas cylinders strapped to the side. The control unit is in the helicopter for ignition. The helicopter swings the unit into position before ignition. The advantage here is that it is not necessary to send a patroller into a hazardous winter mountain climbing exercise with explosives.

Rocket Mitigation: Outdoor Engineers developed a remote rocket launching cache that could be pre-aimed at the start zones of avalanches where human mitigation was not practical. These rockets of various sizes would be loaded into a secure box

mounted on a tower. The box opening and secure launching is controlled from a secure computer. At the time I first read about this the first test firing failed because the tower solar panel had rimed over and power wasn't available to open the secure door. It gave no such information to the controller and the rocket was fired and it resulted in the entire rocket box and tower being destroyed. I'm not sure if this system is available today.

Avalaunchers: Avalaunchers are nothing more than long barreled potato guns. They have become quite sophisticated but are dedicated to short range mitigation. The projectile does not have a ballistic or rotation to enhance accuracy. This limits the reach of the projectile. The tremendous advantages are that as much as a 3 lbs. charge can be sent reasonable distances without endangering a patroller and the cost is cheap in the world of avalanche mitigation (about $30 per shot). Check out the Falcon GT at www.avalanchemitigationservices.com.

Recoilless Rifles: The most common rifle is the 105mm. Ski areas use these weapons to target starting zone collection sites during and immediately afterwards snowfalls that severely stress the snowpack by simple loading. The concept is to trigger the release in small increments. They will do this during the storm so make sure you didn't decide to do a winter campout for "freshies" in the morning. If you do that make sure you tell the local mitigating patrol about your intentions so they don't shell your position. They shoot these positions in the blind (known position settings).

The 106mm. rifle has issues. A 106 barrel exploded 2 years ago killing 1 patroller and injuring another. The ammunition also has a high defect rate. 106's are no longer used.

Tanks: Glory Bowl overlooks Hwy 22 that goes through the Teton Pass and carries commuters who service the Jackson Hole Ski Resort and the community of Jackson, WY. Over 8000 skiers ski

in Glory Bowl each year. Glory Bowl avalanches frequently. Glory Bowl is not part of the Jackson Hole Ski Resort and is not mitigated by the resort. Because GB is the most popular backcountry site in the U.S. the Forest Service has taken it upon themselves to mitigate GB. The Forest Service asked the military for some kind of mitigation device to protect the highway and skiers. They got a Desert Storm tank. It's old but effective. The military trained the Forest Service how to drive it and how to fire the gun. The tank is an addition to the GAZEX units the forest service placed at the cornice line in Glory Bowl.

A Jackson Hole Historical Note: A bridge was constructed over the Glory Bowl slide zone for Hwy 22. The day before the bridge was to open a very large avalanche took out the bridge. It may have been the 100 yr. avalanche.

Mortar Mitigation: At Telluride I saw a small mortar (mini avalauncher) that launched 2 lb. bombs onto a slope convexity that constantly avalanches and is dangerous to patroller intrusion. Patrollers had to go so far out to get to the convexity that they were often sucked into the release. This was a unique local solution.

Detachable Front Compressors: A large drum compactor has been designed for the front of a Piston Bully or a Bombardier snow cat. Instead of a front blade a drum roller (looks like an earth compactor) is detached and lowered by cable in areas that are considered to hazardous for personnel. The concept here is to crush the dangerous depth hoar.

Patroller Mitigation:

Ski Cutting: Ski cutting should never be done where you may suspect large hard slab avalanches. Ski cutting is used to <u>frequently</u> mitigate soft slab avalanche potential. Patrollers should

always plan for an escape route and should use a belay system if the conditions are considered suspect.

Bamboo Bomb Placement: Patrollers on belay ropes place hand bombs on bamboo poles to enhance the explosion. Bombs above the snow pack are more affective than explosions on the snow surface.

Trolley Cranks: Many ski areas have trolleys that provide the patroller the opportunity to fasten a bomb to the cable and to hand crank it over the desired spot. These are permanent fixtures that take the charges to known "sweet spots".

Helicopter Bomb Drops: In each western state the respective state Department of Transportation controls explosive licensing with oversight from the Transportation Safety Administration. UDOT (Utah Dept. of Trans.) authorizes Diamond Peaks Heli Services, owned by Craig Olson, to mitigate avalanches from a helicopter. He must submit operation specifications and procedures plus a training program to be approved before he receives certification.

Hand Charges: Most patrols have bomb routes with at least two patrollers assigned to each route. The Snow Safety Director produces maps for each route with demarcations for shot placement. It is desirable to keep the same patrollers on each route since patrollers gain experience on precise shot placement for maximum results.

Access Control: In the event that an area of the resort has not been mitigated at the time of opening then that area remains closed to the public until mitigation can be achieved. Those members of the public that jump the closures then may serve as human triggers to the ensuing avalanche. Heli-Guides do the same thing. They know where it's safer to ski and they control the situation with time. They wait for the stability.

Transportation Mitigation:

Highway Mitigation: Mountainous states have mobile artillery units and helicopter avalanche mitigation contracts. It is also common that states hire avalanche forecasters to follow the snowpack trends along the most precarious highway stretches. On those highway stretches that frequently avalanche it is not uncommon to see GAZEX units in place.

Avalanche Sheds for Highways and Railroads: In areas that have frequent and large avalanches both the state highway departments and the railroads have invested in building avalanche sheds over the byways. This saves considerable time, money and disruption of service for these byways.

What About Those Midwestern Avalanches?

The Sand Dunes:

On the eastern and southeastern shores of Lake Michigan there are sand dunes. Sand dunes by definition are always remodeling based on the wind and weather. Sand is easily moved by the wind and eroded by water. When you grab a handful of sand it has no cohesion. Sand particles look and act like facets in the snowpack. When lake effect snow dumps snow onto these sand dunes there is instant instability. Lots of snow will show you that with spontaneous avalanches much like that of the Pacific Northwest maritime environment. Furthermore, water drainage channels will penetrate the snowpack and the sand below only to be eroded away by wind and water. That means that the snowpack is supported by something akin to stemware. There may be vertical strength to the snowpack but horizontal (shear strength) strength is almost nonexistent. This is the reason lakeside parks are closed in the

winter season and prevalent signs are everywhere advising people to stay off of snow covered dunes.

The Scree Piles:

The Keweenaw Peninsula is a small piece of land sticking into Lake Superior from Upper Michigan. There is a geologic ridgeline that goes the length of the peninsula. There are rich deposits of copper that have been extensively mined in the last century. The railroads have closed now and the tracks removed but the byways are extensively used by snowmobilers. The vastness of the railroad network and the plentiful lake effect snow have made this area a snowmobile paradise.

Surrounding the closed mines are large scree piles. These piles are conical in shape and have slopes around 35 to 40 degrees. The area also gets around 300 inches of snow each season. As you can imagine, the unstable scree with ample snow on top makes for an interesting land feature that snowmobilers can't resist.

Man Made Snow In the Wrong Place:

Perfect North Slopes (PNS) is a ski resort much like all the other ski areas located in the central part of the United States. Located in southern Indiana in a maturely dissected plateau, Perfect North must contend with the moderating temperatures of the Ohio River and the temperature inversions inherent in the geology. To meet the challenges Perfect North realized the need to capitalize on the narrow windows of opportunity to make snow by purchasing over 200 high capacity snow guns.

It is not uncommon for PNS to produce monster size piles of snow (snow whales). As the weather moderates this is considered storage snow. To keep this snow in place you must have slab cohesion, anchoring and sufficient snow to support it. If the snow

whale is high enough on the slope and the weight of the snow exceeds the supportive capacity the snow may slide. PNS has a slope averaging 28 degrees with long grass underneath the snowpack. With extensive rain the grass becomes wet and the differential thawing causes a downslope stress failure that causes the entire slab to move (glide avalanche). If it moves fast enough it will fracture into large pieces capable of human harm and physical damage to the ski resort. This did happen after hours and two chairlifts were damaged.

The mitigating solution was for the patrol and management to keep an eye on any convexity failures (cracks) and any change from the previous situation during rain storms. Management improved the integrity of the slope by providing undulations to increase slope surface area (increase friction) and improved the water drainage.

This cooperation and education with patrol and management personnel has greatly increased the knowledge of low terrain-large slab glide avalanches.

The Practical Exam Changes:

Everything in Practical Exam is the same except you will be required to find two (2) transceivers in five (5) minutes. All the other parameters are the same. This requires you to be more proficient with your personal transceiver.

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