

RED PINE CHUTES AVALANCHE ACCIDENT – CASE STUDY

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ABSTRACT: On December 23, 2007, an in-bounds avalanche occurred in open terrain in Red Pine Chute at Canyons Ski Resort, in Park City, Utah. The avalanche was classified as HS-ASu-D2.5-R2-o and caught four people, resulting in one fatality from trauma and one full burial with subsequent rescue by ski patrol.

Red Pine Chute is a 38°, 40-foot-wide, NNE-facing slide path that descends from 9600' elevation along the Wasatch crest. Late October 2007 brought a storm followed by a month of dry weather, forming faceted snow that was then buried in mid-December by 80" of snow with 5.5" SWE. Following very thorough control work, the chute was opened for the season the day prior to the accident and saw moderate ski traffic, including at least four work runs by Patrollers. The victim's party triggered the slide, with the crown located lower on the slope than any slides recorded during the previous 10 years of control work. Rescue efforts resulted in the successful location and resuscitation of an 11-year-old victim following a burial of forty minutes.

The family of the deceased subsequently sued the Canyons for negligence and the 2013 trial resulted in a unanimous jury verdict in favor of the resort. The litigation process was instructive and the accident prompted procedural changes at Canyons, including improvements to internal snow safety manuals, improved warnings to skiers, and better overall awareness of the inherent risk of inbounds avalanches. We will share improvements made to documentation, policy and procedure in hopes of industry advances.

KEYWORDS: Avalanche accident, avalanche rescue, lawsuit, Avalanche mitigation

1. INTRODUCTION

A significant mid-October 2007 snow storm in Utah's Wasatch Mountains followed by a cool, dry November combined to create a significant weak layer on most North and East facing aspects above 9000 feet. The first three weeks of December brought a series of storms that began to overload this layer in a series of avalanche cycles both within the ski areas and in the backcountry. Repeated avalanche mitigation missions produced large avalanches at most ski areas. On December 23rd, nearly 24 hours after being opened to the public, an in-bounds avalanche occurred in the Red Pine Chutes at Canyons Resort. The avalanche caught and carried at least four people with one full burial and one fatality due to trauma. This paper documents the snowpack development, mitigation measures and decision to open the terrain, the specifics of the avalanche and subsequent rescue, as well as some key points from the jury trial, which occurred six years after the accident

and resulted in a unanimous jury verdict in favor of the ski resort.

2. TERRAIN

Canyons Resort is located three miles North Northwest of the town of Park City, UT on the Wasatch Back. The base elevation is 6800 feet ASL with a summit elevation of 9990 ASL. It encompasses over 4000 acres of primarily East facing terrain (North thru South on the compass with negligible West facing terrain.) A series of very steep and short (approximately 1000 vertical feet) glacial cirques dominate the upper mountain where the accident occurred. The resort averages 355 inches of snow a year, leading to a shallower snow pack than its neighbors on the Wasatch Front. The resort is on the leeward side of the prevailing storm track, leading to significant wind events on persistent weak layers – closer to a continental snowpack than is seen on the Wasatch Front. The Ninety-Nine 90 Express chairlift serves the 9990 peak with short steep and rocky north and east faces.

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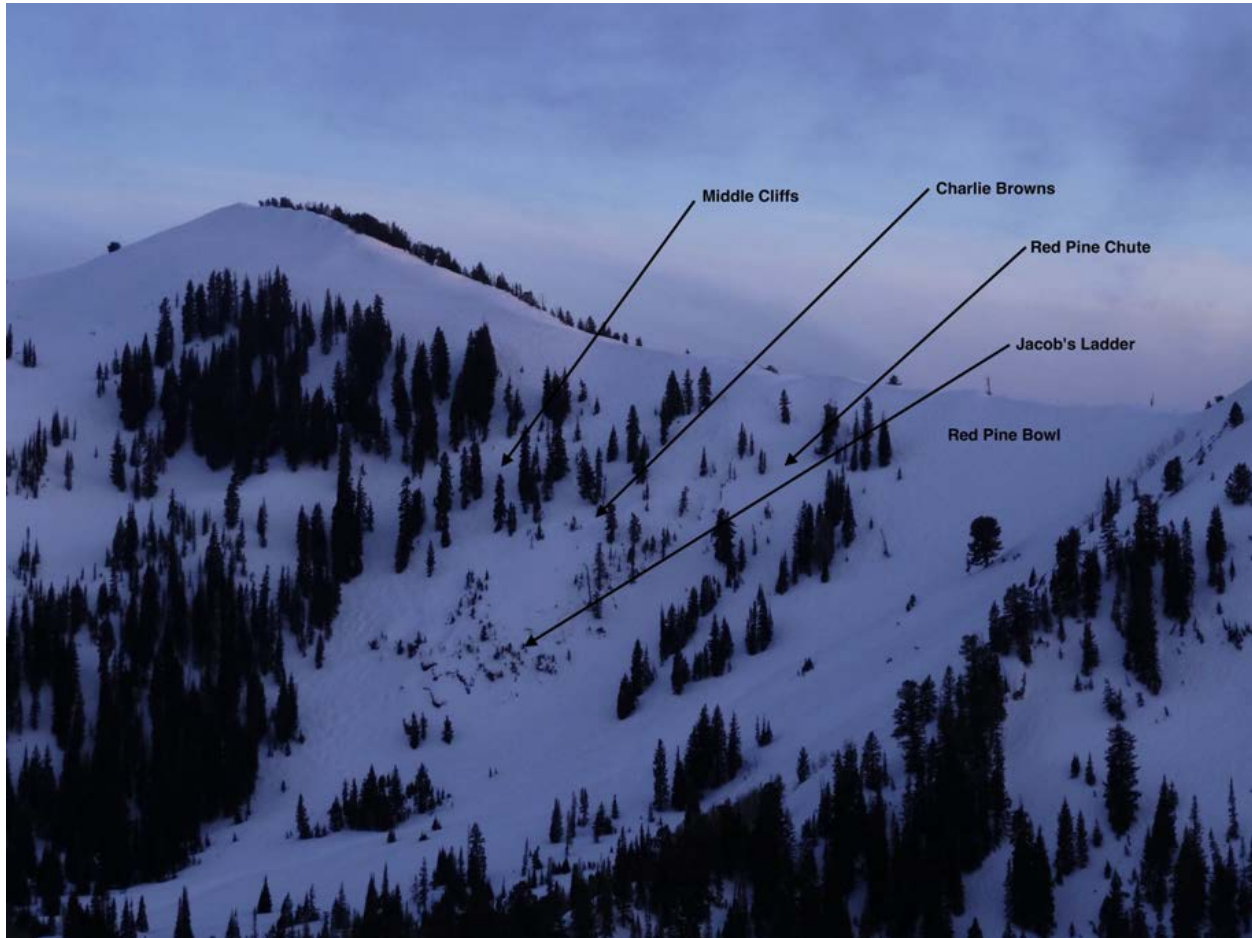


Fig. 1 North side of Ninety-nine 90

The North face of Ninety-nine 90 is complex divided by three diagonally sloping rock bands which create mid slope convexities and steep breakovers as you descend. The Main Red Pine chute is east facing with a top elevation of 9600 and a bottom elevation of 8600. It is an average slope angle of 38 degrees with short portions exceeding 45 degrees. The chute is flanked by rock outcroppings on each side and is heavily wind loaded by west, northwest and southwest winds, with a large untreed slope on the west side as a fetch. The slope itself is mostly devoid of vegetation in the upper 1/3 with only a few small shrubs and some sub-alpine fir along the chute's periphery. The ground itself is mostly decomposing slab bedrock, with little or no dirt, making travel in this area without snow cover very challenging and dangerous (Fig. 1)

3. SNOWPACK HISTORY AND AVALANCHE HAZARD MITIGATION

October 16th brought the season's first significant storm and first significant avalanche to the upper elevations of the Wasatch Range. With 10-20 inches of snow falling over a 24-hour period, powder fever hit the Wasatch and locals triggered a large avalanche on the West Face of Mt Baldy. No one was caught. This snow would become the weak layer that failed in a large number of 2007-08 season's large avalanches, as it lingered throughout October on shady aspects above 9000 feet. The remainder of October would stay stormy but little or no additional accumulation was measured.

November was clear and mild. All solar aspects melted off and the snow on the shady upper elevations continued to facet. A small storm on November 11th was the only measurable precipitation until November 30th. A scheduled opening on Thanksgiving 2007 was delayed due to lack of snow. Snowpits from late November showed the entire snow pack to be mostly loose, 2-4 mm well developed facets in the early stages of devel-

oping into cups and chains. The storm on November 30th delivered 3 inches of dense snow with some significant wind prior to and during the storm. A few small new snow and wind slab avalanches occurred from this storm.

The first week of December was cold and dry, with the first significant storm event since October arriving on December 4th. This storm would deposit 8-10 inches of light density snow and relatively mild winds. There was a short break in the weather on the 6th before a larger storm arrived on the afternoon of the 7th. This storm would last through December 9th and deliver 33 inches of snow and 1.70" water at Canyons study plot. This storm had light winds but effectively "capped" the basal facet/depth hoar layer. December 9th thru the 17th would see small showers and flurries with the 3 inches of snow occurring on the 13th being the only real accumulation during this period.

Snow Safety went to Ninety-nine 90 on Dec 11th and 12th to perform explosive testing and snow profiles and tests. Over two days, multiple shots were placed in all major starting zones including Red Pine Chutes with no results. Snow pits revealed approximately 25-30 inches of total snow exhibiting poor structure and moderate strength scores in a variety of snow pits. The overlying slab just wasn't enough to cause the weak facets at the ground to fail even with explosives. It was agreed that skier compaction would be the ideal way to manage the snowpack but the rocky talus nature of ninety-nine 90's lower slopes required significantly more snow to safely open to public.

Winds were variable during this time with a few major wind events wreaking havoc on the snow surface. Snowpits revealed a slab sitting on a weakening depth hoar layer, as well as surface hoar growth noted in multiple locations along the Park City Ridgeline. Also of note, were 15 unintentional human triggered avalanches reported to the Utah Avalanche Center between December 1st and the 15th. One was a very close call on December 13th outside Brighton Resort with two snowboarders almost completely buried after being caught and carried on a nasty ride through trees and rocks.

On December 14th 4.5" of snow containing .20" of water (4.5% Density) fell. This was followed by a brief clear and very cold weather period through December 16th. This created a layer of weak surface hoar and faceted snow at the top of the snowpack.

On December 17th, Canyons Snow Safety took their Ski Patrol Level 1 Avalanche Class to Ninety-nine 90, where they dug snow pits in the Broken Tree area with the same aspect and elevation as Red Pine Chute and approximately 200' from the top of Red Pine Chute. Two weak layers were noted. One was 5" from the top of the snowpack and yielded an average compression test score of 14 (moderately strong) with a poor quality (Q3) shear. This weakness was thought to be a light density layer or hardness change within the new snow enhanced by near-surface faceting. The other weakness was at the top of the October snow, now buried 25" down, and yielded an average compression test score of 25 (quite strong) with a high quality (Q1) shear. This is the weakness that caused concern and would be the focus of testing and monitoring over the coming week. The class of twelve skied down Red Pine Bowl and Charlie Brown's, but did not enter Red Pine Chute due to thin cover.

The night of Dec 18th it began snowing again. By 4:15 am on Dec 19th, 11" @ 0.55" water snow (5% density) had fallen, and the ski patrol ran lower mountain routes, with extensive sloughing and sensitive very soft slab avalanches within the new snow. We did no mitigation work on Ninety-Nine 90 that day.

By 4:30 AM on Dec 20th, an additional 5" @ 0.5" water (10% density) had fallen, creating a density inversion in the upper layers of snow. The buried lighter snow included both the light density new snow of Dec 19 and the sugary, faceted snow developed at the top of the snowpack in the previous days. Explosive testing and mitigation teams were sent to Ninety-Nine 90 that day getting very unpredictable and varied results on the east side (Fright Face route) and frequent collapsing of the snowpack (a sign of instability). One patroller had a soft slab 18" deep, the depth of the new snow, break out above him, after explosive testing. Later, on the Middle Cliffs on the North Face, this patroller threw a 2lb cast hand charge with negative results and walked 40 feet away, where the snowpack collapsed and released a slide, taking out the crater from his previous shot.

Snow fell all day. Jeff Lonn, Snow Safety Coordinator, took a team and ran the Charlie Brown's and South Square routes, which includes upper Red Pine Chute, in the afternoon, placing numerous 2 and 4 pound pentolite charges using air blasts and surface shots along the ridge. Only some small, 8-10" deep slabs released including a

slide in Red Pine Chute 8-10" deep and 40' wide, running full length of the chute to the lower angle apron below. The team ran out of shots and left the area feeling that it was not yet safe. In his afternoon report to the Utah Avalanche Center, Jeff described the avalanche conditions as "spooky". His primary concern was the instability associated with the light density snow buried 12-18" down, as these were the only significant slides released by control teams on Dec 20th. Secondary concern was one of these smaller slides stepping down into the October facets and releasing full depth avalanches.

Dec 21st brought more snow: At 4:15 am the 24hr stake read 17" @ 1.6" water (9.5% Density). Winds overnight averaged close to 20 mph with gusts of 44 out of the Southwest initially and turning to the Northwest near morning. The storm total was now at 33" @ 2.65" water. This represented a considerable amount of weight added to the snowpack. The density inversion was very pronounced and Snow Safety prepared for high avalanche hazard by assigning a heavy shot count to all mitigation routes. The Utah Avalanche Center issued a high danger rating that morning. Lower mountain routes yielded no significant avalanche activity. Teams then advanced to Ninety-nine 90 and did East Side routes also with no significant activity. Teams exited via the East Side but placed 3 shots on the North Side (Triangle Tram, Woodstock, and Upper East Face far left), again with negative results.

Dec 22nd, 2007 dawned clear, with HN24 of 2" @ .13" water. Winds had mellowed considerably during the day averaging in the upper teens overnight. The storm total was now 35" @ 2.78" water. Mitigation teams were dispatched to the North Side of Ninety-nine 90, armed with significantly more explosives than usual due to the high hazard we expected, although the Utah Avalanche Center had dropped the danger to "considerable" on 12/22/07.

Jeff again took his team and ran the Charlie Brown's and South Square route that includes Red Pine Chute. Notably, a 4 lb. surface shot was placed in Red Pine Chute approximately 30 feet from the future crown, which released a 12" deep soft slab, that ran the length of the chute. The team then proceeded to Red Pine Bowl and South Square Chute to do ski cuts and drop cornice. They elected not to use explosives in those places because they had done so 2 days before on 12/20, after the bulk of the new snow, with no

results and 12/20 had seen much more active avalanche activity than 12/21 or 12/22. While on South Square, they observed a very large avalanche released by the Middle Cliffs mitigation team with a 4 lb. hand charge. This slide released at the top of the faceted October snow. The crown was very near several bomb craters that had produced negative results suggesting that the releasing shot had found a "sweet spot", usually a thin spot around rocks or cliffs. The Charlie Brown's route follows a cliff band similar to that of the Middle Cliffs, with a similar aspect, and so it was thought that there was a possibility of releasing a similar slide there. The debris from the Middle Cliffs slide overran the lower portion of the Charlie Brown's cliff band, Jacob's Ladder. Because of this, the team was able to use the shots allotted for Jacob's Ladder higher on the route, throwing a closely spaced succession of shots, trying to find any trigger spots. They used 6 2 lb. shots along the left flank of Red Pine Chute between the top of the slope and Jacob's ladder. Teams usually use 3 shots for this area. Two shot placements of note are the Red Pine Chute, right fork shot crater, which was about 5 feet from the crown of the fatal slide, and the Charlie Brown's nose crater, which was about 20 feet from the crown. The entire cliff band was ski cut, and no more releases occurred. The team noted no further collapsing of the snowpack. Jeff called off route and felt the Charlie Brown's and Red Pine Chutes' control work had been done more thoroughly than had ever been done before and there was nothing more they could do.

4. DECISION TO OPEN NINETY-NINE 90

Jeff conferred with Paul Santana, the Snow Safety Tech who would be taking over avalanche forecasting duties on Dec 23rd. The decision was made to first open the East Side of Ninety-nine 90 and after that was thoroughly tracked, to open the north side. A significant ridge divides the two faces and access is controlled by a series of "Avalanche Control Area" gates. Both Paul and Jeff had been running routes on Ninety-nine 90 in the previous days and felt that control work was thorough and skier compaction would be the best thing we could do to mitigate future avalanche hazard. Some rope and sign line maintenance was required prior to opening. Paul called Jake Hutchinson, Ski Patrol Director at the time, to discuss the opening plan. Jake had been running routes and managing teams on Murdock Peak during the storm cycle

so hadn't been directly involved in mitigation on Ninety-nine 90. Paul asked that Jake come take a look at, and photograph, the Middle Cliff's avalanche and then give the entire face a once over on the mitigation work that had been done to see if anything had been missed. Jake agreed went to Ninety-nine 90 to have a look. Prior to riding the chair, Jake was contacted by marketing, hoping to get their videographer into place to film people skiing powder on the North side for its opening day that season, Jake agreed and allowed them to stage via the summer road below the North face to film. Jake checked in with the patrol at the top of Ninety-nine 90 and then proceeded out the North face alone. Jake performed a quick crown profile on the middle cliffs and then a test-plus pit immediately above and adjacent to the crown in undisturbed snow. The crown profile gave a test result of CT26Q2 down 91 CM failing on well-formed facets between two crusts. An adjacent pit also revealed an ECTN29 and RB5 on facets between the two crusts. Jake then traversed to Red Pine Chute observing ski-cuts and shot craters from mitigation teams as he went. He entered Red Pine Chute via the right fork at almost the same elevation, as the Dec 23rd crown would be. He performed a few quick snow tests with hand and poles and then skied the main chute. Unbeknownst to him, the videographer had started filming just as he started his traverse. This footage would later be key evidence at trial. He then called Paul on the radio, identified some rope and sign work to be done and gave the OK to open the North side once that work was complete. Two patrollers went out and stood up signs and bamboo, essentially sidestepping down the slope within a few feet of the eventual trigger point.

We opened the North Side of Ninety-nine 90 at approximately 1:30 pm on Dec 22nd and it was skied without incident until closing at 3:15 pm. At 3:15 pm, Jeff toured through the North Side to see how tracked out the slide paths were. Jeff traversed across Charlie Brown's nose, crossed the future crown, and entered Red Pine Chute about 30 feet below the future crown. Red Pine Chute had a number of tracks in it; He then skied down the left side of the chute a few feet from the rope line, down the path of the future avalanche, without noting any collapsing or hollow snow.

5. ACCIDENT AND SUBSEQUENT RESCUE

Dec 23rd dawned cool and clear with no new snow and negligible winds recorded at Canyons Study

plot and upper mountain weather stations. A team led by Eric Lonn (Assistant Snow Safety Coordinator) was dispatched to check for any potential new wind loading along Desolation Ridge. The ridge allows ski cuts of most major starting zones along the north face of Ninety-nine 90. They observed no new snow, minimal wind-loading and unfilled tracks from the previous day in all areas, including Red Pine Chute. They then proceeded down the Charlie Browns route giving good visual and physical access to Red Pine if needed. They saw nothing of concern and gave ski patrol clearance to open at its scheduled time.

At approximately 11:30 AM, Jake received a phone call from Canyons dispatch while riding the Peak 5 chair. They had a call from 911 Dispatch reporting an avalanche near Ninety-nine 90 with at least one person missing. The information was unclear as to whether the slide was in or out-of-bounds. Jake made a general radio call on the patrol channel to start scanning terrain and instructed Patrollers to return to station if not involved in patient care or a safety critical task. The slide was quickly located in Red Pine Chute by Eric L. scanning with binoculars from the top of Tombstone lift. Patroller Eric S. was working the rope line above Red Pine and quickly descended to check it out. Upon arrival he reported at least one person missing and presumed buried and one person partially buried who was unresponsive with no vital signs. He requested help and began life saving measures on the unresponsive person.

Ninety-nine 90 chair was immediately closed to the public and guests on the chair were sent down the East side. All patrollers from Ninety-nine 90 were dispatched to the scene and each Patrol Hill Captain was asked to send all available patrollers and equipment to stage at the top of Ninety-nine 90 chair.

Paul and Jake arrived simultaneously at the bottom of the chair and rode together making various phone and radio calls for internal and external resources as well as formulate a plan of attack. From the top of the chair, Jake took some rescue gear and a few locals the patrol knew via the low road to the debris field. Jake then took over as Accident Site Commander. Paul went high to the ridge to assess any remaining avalanche hazard. At this time, a small squall began to move in with increasing winds and reduced visibility, which impacted helicopter availability.

After a quick assessment of the scene, Jake realized multiple bystanders had left gear

and equipment all over the debris field. Jake assigned two additional patrollers to assist Eric S. with his patient and began to assign column and probe line leaders amongst remaining patrollers. At this time, Brian Z. approached Jake distraught and angry about his missing son Max. He provided key information about the Last Seen Area (LSA) - where they had been standing and resting after skiing Red Pine Chute. Patroller Bryan S. arrived at that time with a bundle of probes. He was assigned a small group of bystanders and a probe line area beginning at the toe of the debris (probe line 1), with the LSA as the center anchor for the probe line. Patroller Mike C. was assigned to Brian Z. to manage the witness. Eric L. arrived shortly thereafter with additional probes and was assigned a second probe line beginning at the LSA. Search dogs were also in route at this time. With the second move uphill, probe line 1 made a positive strike. Multiple patrollers quickly began excavation and we carefully excavated around his face observing no ice lens or air pocket. Extrication from the snow required digging to his feet, as he was buried in a standing position with his skis still attached. The patient had no vital signs. Rob and Bryan started makeshift CPR while extrication and digging continued. A toboggan arrived within a few minutes of extrication and Rob continued CPR while in transport to a waiting Air Med air ambulance. The patient regained a heartbeat and began breathing on his own during transport to the helicopter but remained unconscious and combative throughout transport to Primary Children's Medical Center.

The search continued with RECCO, two search dogs and transceiver searches, all clearing the site of additional victims. At this time, after phone communication with a doctor, the Medical Examiner and a paramedic near the scene, life saving measures were ceased on the first patient and he was transported via toboggan to the Medical Examiner. With no additional missing person reports. The site cleared by dogs, RECCO and transceivers and the search was called complete by the Summit County Sheriff and the Accident Site Commander.

Examination of the avalanche found it to be 10" to 5' in depth with an average depth of 3' and approximately 125' wide and running 600 vertical feet. The slab was fist/four finger hard and compression tests in the flank revealed a CT 36Q2, failing on 2-3mm facets between two crusts. This then stepped below the crust and entrained

all snow, essentially running through the October facets on the ground. Figs. 2,3,4,5

After 5 days in a chemically induced coma, Max was brought out and made a full recovery. From dispatch logs, 39 minutes elapsed between the original 911 call to Canyons Dispatch and the time his head was exposed. We estimate an actual burial time closer to 45 or 50 minutes.



Fig. 2 Crown close up from near trigger point



Fig. 3 Looking up track from top of debris

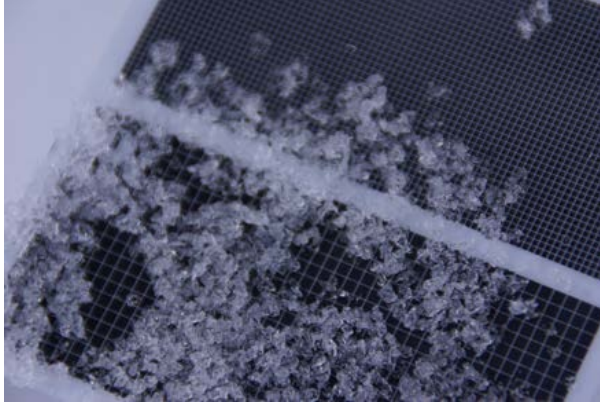


Fig. 4 October facets shown during accident investigation on 12/24/07

6. LAWSUIT

In the spring of 2008 the family of the deceased skier, Jesse Williams, filed a wrongful death lawsuit. Plaintiffs alleged negligence and gross negligence on the part of the Canyons; amongst the claims in original complaint were that The Canyons "Defendants failed to properly and adequately train personnel responsible for avalanche forecasting and avalanche control" and "Defendants owed the duty to deny public access to the ski run if the run was unsafe for skiing". Canyons attorneys moved for Judgment stating that avalanches are an inherent risk of skiing that can never be fully mitigated, due to the unpredictable forces of nature and constantly changing weather and snow pack. The summary judgment was denied, and after several years of legal wrangling, a jury trial was finally commenced on November 7th, 2013.

There were four key points the plaintiffs' attorneys focused on over the eight day trial attempting to prove the Canyons negligence in opening the Red Pine Chutes terrain on Dec 23rd. First, they questioned the decision not to boot pack Red Pine Chutes. The Canyons Snow Safety plan in 2007 said, "Boot packing will be performed..." Second, they questioned the lack of Air Blasts or larger explosives in the Red Pine Chute area following the results of the middle cliffs shot. Third, they questioned the lack of documented snow pits in the Red Pine Chute. Finally, they questioned the decision to open the terrain on Dec 23rd without performing explosive mitigation.

The decision not to boot pack was dictated by the weather. Due to the nature of the terrain, it is very difficult to move safely on this slope without adequate snow cover. It is a fine line between

enough and too much snow. The storm that started on Dec 5th quickly changed the mentality from boot packing to mitigation work. By the time the storm ended, the snow was too deep to effectively boot pack so snow safety and the patrol director made the decision to shift to mitigation.

The lack of air blasts or bigger shots was a repeated theme. Trying to impress upon the jury the power of a two-pound cast primer was key. The area of affect in a small, confined area such as Red Pine Chute and the cumulative effect of multiple shots, targeting multiple trigger points were key to the defense. Other key defense points were photos showing multiple layers of explosive ash and debris in the crown, showing the thoroughness of explosive work and the likelihood that the trigger point had likely been impacted by explosives multiple times.

We felt that we had adequate knowledge of the snowpack structure from the variety of formal, documented snow pits and informal snow pits. We didn't doubt the snowpack structure, but also believed that based on experience, the four pound surface blasts in Red Pine chute, releasing the smaller slabs over the previous days were a highly effective tool. All large avalanches previously observed on this path had been triggered by this shot, or a much larger avalanche encompassing all the North Side starting zones.

The decision not to do mitigation work on the 23rd was an easy one. There had been no new snow and no evidence of wind loading. The slope had been open the previous day without incident so we had no reason to believe additional explosive work was necessary.

Another key defense point was The Canyons signage alerting skiers to potential avalanche hazard beyond the "Avalanche Control Area" gate and the fact that the deceased was a ski patroller himself and likely understood what that meant.

On November 15th after 45 minutes of deliberation, the jury returned a unanimous verdict in The Canyons favor.

7. CONCLUSIONS

This event had a tremendous impact on many lives and has potential to impact a variety of pending ski area related avalanche accidents. It is the first in-bounds accident involving a fatality to go to jury trial. While not precedent setting in that a supreme court hasn't heard it, it will certainly be cited by attorney's in future cases.

As practitioners, Canyons snow safety personnel learned much from this incident. . . Sitting on a witness stand for two days is an incredibly taxing process. Every moment, every decision, every document is scrutinized and questioned. Plaintiff's attorneys will twist words, repeat questions, and generally try to confuse the witness (and the jury) in attempts to discredit experience and sound decisions..

The first important thing is to tell the truth. Believe in what you did and did not do. It's hard to not beat yourself up and question your actions when on the stand being questioned about things that occurred six years prior.

Listen to your attorneys and make sure you understand the ways that depositions, written statements, snow profiles, and photos may be interpreted. Plaintiff's council will jump on every minor slip. Don't let them get under your skin.

At the end of the day, the jury felt we had performed our duty to the best of our ability given the information we had. We weren't unduly pressured by management to open terrain, nor did we ignore or disregard obvious clues. We kept meticulous records regarding snow pack development, weather and mitigation work performed. We discussed openly within the Patrol and Snow Safety Department when or if we could open the terrain and allowed everyone a voice if they had concerns based on what they had seen, and none did. Finally, good signage that is clear and concise, and well maintained is important. Avalanches will always be a hazard when you put snow on steep mountains and none of us possess the ability to forecast every possible outcome or if/when particular slope will slide. We put ourselves in harm's way every day we go out there, so that people can enjoy the snow.

Lastly, we learned its ok to celebrate saving a life without taking away from the sadness of someone losing his or her life. You can second guess yourself for the rest of your life, but ski resorts, highways or towns employ us to make hard decisions based on years of experience and hours in the snow without the benefit of hindsight.

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Fig 5. Looking down to debris field from mid-slope, photo taken 12/24/07