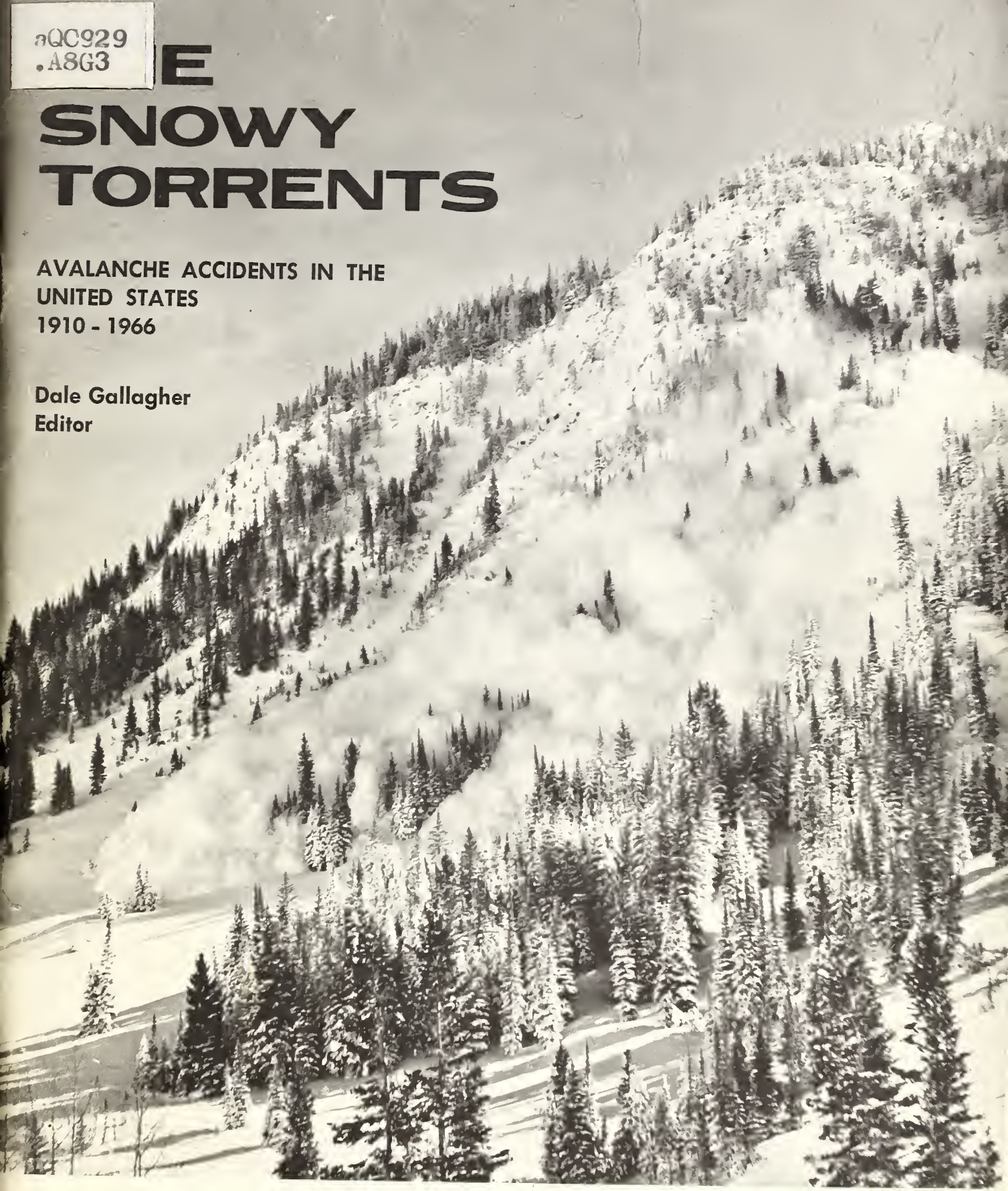
E SNOWY TORRENTS

AVALANCHE ACCIDENTS IN THE UNITED STATES 1910 - 1966

Dale Gallagher
Editor



U. S. Department of Agriculture
Forest Service

Wasatch National Forest
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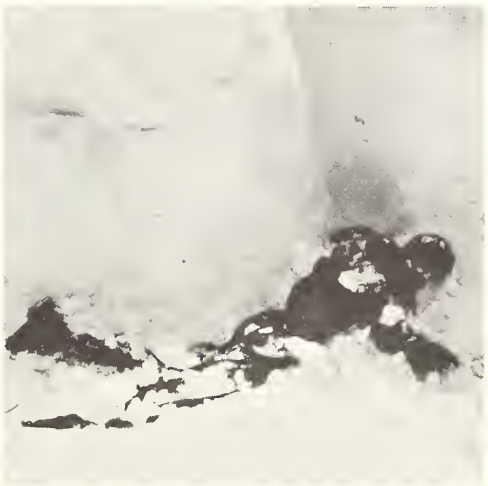
ALTA AVALANCHE STUDY CENTER

The Alta Avalanche Study Center was discontinued in 1972.

Requests for copies of this publication should be sent to:

Rocky Mountain Forest and Range Experiment Station
240 West Prospect, Fort Collins, Colorado 80521

"THE SNOWY TORRENTS ARE LIKE THE DEEP SEA: THEY SELDOM RETURN THEIR VICTIMS ALIVE."



INTRODUCTION

Each winter many snow avalanches fall in the mountains. Some bring destruction to property and terror to those unfortunate enough to be caught in the sliding snow. Reports of some of these reach the Alta Avalanche Study Center on the Wasatch National Forest in Utah. The following summaries are drawn from this master file for avalanche data maintained at Alta by the U. S. Forest Service.

The reason for compiling these accident summaries is to analyze both the causes which led to the accidents and the rescue efforts which followed. By studying these, we can learn some of the factors that caused the accidents and, hopefully, prevent similar ones in the future. Each accident summary is followed by our commentary. We point out the mistakes as lessons for us all, not as criticism of the individuals involved. Compliments are bestowed where they are due. We play no favorites; snow rangers as well as novice skiers receive their fair share of recognition for setting examples, both good and bad.

The general skier is usually not familiar with the complex circumstances which can lead to snow avalanche formation. But it is hoped that, by reading reports such as this one, the skiing public will be more aware of avalanche hazard and will gain some knowledge of the proper rescue procedures should someone be caught. Public education about the avalanche hazard is difficult because of the number of people involved. This report is part of the Forest Service program in snow safety education which is designed to meet this difficulty.

This compilation may give a misleading impression that some areas have a high concentration of avalanche accidents, but our study is necessarily biased by the reporting system. Not all accidents come to our attention. Others are so poorly reported that a summary cannot be prepared. The ones which achieve the status of publication are those for which we received accurate reports. There is also a strong bias toward accidents which led to injury, death or extensive damage. These accidents are the ones for which someone takes the trouble to write and submit a report. The narrow escapes and accidents closely averted often go unmentioned.

We request that anyone having information about avalanche accidents send it to the Alta Avalanche Study Center, Alta via Sandy, Utah, 84070. Newspaper stories, first-hand accounts, official reports, no matter when or where the accident happened, are all wanted. We would like to have reports on any avalanches that caused destruction, that someone was caught in, or narrowly escaped, or that were unusual in size, quantity or behavior. From a study of these reports we establish and update our snow safety procedures.

In the appendix will be found an explanation of the abbreviations, conversion tables, and an outline of the contents of a complete avalanche accident report.

Edward R. LaChapelle, Avalanche Hazard Forecaster, helped prepare this report. He shares responsibility for the comments. Others who helped prepare the summaries are Molly Radke and Vivienne Hull, Writers, from the Snoqualmie National Forest.

We plan to publish additional summaries from time to time, as more accident reports become available. We hope they will be few.

Dale G. Gallagher, Editor
Medicine Bow National Forest

WEATHER FACTORS

The Stevens Pass area had experienced a siege of storms that left one of the heaviest snowfalls ever recorded in the Cascade Mountains so late in the season. The storm progressed as follows:

February 21 - Storm started with sudden fury, depositing a foot of snow per hour. Storm continued all night.

February 22 - Wind and snow continued in blizzard proportions. Maintenance crews were just able to keep the railroad open.

February 23 - Continued high winds and cold temperatures. Some avalanche activity and a few scattered fatalities in the Cascades.

February 24 - Gale force winds and very cold. Slides becoming more numerous hourly.

February 25 - Cold, grey blizzard. Eleven (11) feet of new snow at Wellington.

February 26 - Snowfall, at times, reached 12 inches per hour, and drifts were 20 feet deep in places. Ominous roar of occasional avalanches made passengers jumpy. During the night, the wind increased in intensity.

February 27 - Storm grew worse, in a final blast of fury. Later in the day, the snowfall dwindled into a thin sleet.

February 28 - Sleet continued during the day and into the night. Around midnight, sleet quit, and a warm, moist southwest chinook set in; later rain began falling.

March 1 - At 0120 hours, the slope above the trains avalanched, killing 96 persons.

ACCIDENT SUMMARY

The Great Northern Railroad, on its route from Spokane to Seattle, traverses the Cascade Mountains in the State of Washington. On 23 February, 1910, train number 25, with 5 passenger cars, was stopped in Leavenworth, Washington. Because of the winter storm, both train 25 and mail train number 27 spent several hours in Leavenworth, waiting for the slides to be cleared. Later that same Wednesday, they were stopped again at the east portal of the Cascade Tunnel (snowshed). Gale force winds had drifted the tunnel portals closed, and disrupted electrical service in the tunnel.

It took a day to clear the portals and several hours more to dig out the trains which by now were locked in deep drifts. Finally, around 2000 hours on Thursday night, 24 February, both trains proceeded through the tunnel. They passed the little town of Wellington (about 1/4 mile from the west portal) and were put on parallel sidings approximately 400 yards beyond the town. The drifts were now so deep that only the tops of the telegraph poles protruded. The main line had again been closed by a large avalanche at Windy Point, covering the tracks for 900 feet to a depth of up to 25 feet. During Thursday night, a small avalanche 50 feet wide had released from the bank above Cascade, crossed the tracks where the trains had been parked hours before, and swept away the cook shack into a ravine. Two men were killed. The 55 train passengers had eaten all three meals at this cook shack on the 24th.

On Friday, 25 February, passengers waded through the snow for breakfast at the hotel at Wellington. Some stopped at the depot and sent telegrams to their relatives. The delay not only irritated the healthy passengers, but the several ill people on board suffered increasingly as each hour of snowfall passed. Mothers were at wits end to contain the children who now had been cooped up three days. Late in the afternoon, the rotary crew reported they were sure they could have the slide cleared by Saturday morning. The conductor passed the word through the train. Passengers asked why the train couldn't be moved back into the tunnel, but the conductor calmed them, stating the train was now at the safest place on the mountain.

The trains had not moved on Saturday, 26 February, and the storm continued to rage. The avalanche at Cascade and those at Windy Point had the trains blocked in both directions. New avalanches hampered efforts to clear the tracks, and one of the double rotary snowplows was now disabled between two slides. Some of the passengers again urged that the train be backed into the tunnel where it would be safe from an avalanche. However, others objected because they were afraid drifting snow would block up the portals. Also, coal smoke would foul the air in the tunnel. During the afternoon, the telegraph lines went dead, ending communications both east and west. For five days the crews had worked to the point of collapse, clearing and re-clearing the slides under the personal direction of the railroad's superintendent for this division. But now the line was blocked tighter than before.

Saturday night a "committee" from the passengers met with the railroad superintendent, urging him to move the train into the tunnel or onto other spur tracks closer to the tunnel. The superintendent refused, citing that the tunnel was cold and damp and the smoke and fumes would be unbearable. The passengers couldn't walk to the hotel to eat because the tunnel had water running on both sides of the track and there was no way to get food from the hotel to the train. He also pointed out that the hill above the spur tracks was even steeper than the one above where the train was now parked. He assured them that the train was in the best possible place, and that relief rotaries were on the way.

On Sunday, 27 February, the storm grew even worse. Passengers on the train held a church service, led by a minister on board, which somewhat eased the tension and silent dread of the passengers. During the morning, the division superintendent and two other workers began to hike westward to Scenic, a small railroad town $8\frac{1}{2}$ miles away.

A little later five men from the train decided they too would walk out. All arrived at Scenic, but during the trip one railroad man was caught in an avalanche and carried 1000 feet into a ravine, miraculously escaping death. The five passengers were near collapse when they arrived. It was obvious the remaining passengers could not walk out. Back at Wellington, a number of railroad laborers quit because their demand for higher wages was refused. They began walking out with their bedrolls on their backs. A rotary crew from the east had walked 10 miles back to Wellington to report their equipment was stalled between two slides, and they found a number of slides had run all along the way. In addition to these alarming facts, that afternoon the passengers heard the roar of avalanches more frequently and closer than before.

One of the passengers was fascinated by the mountainside above the train. When they first had arrived, a number of stumps and snags could be seen. (The slope had been burned off a number of years before.) Now there were no blemishes - just an "immense quilt of pure white snow." * This passenger went to the hotel to replenish his tobacco, and on the way observed a "part of a hill simply fold up and start sliding with a roar." * This slide did no damage, but was an ominous warning and shook the observer. Late Sunday, the snowfall dwindled into a thin sleet.

Monday marked the fourth day the trains had been on the siding. The tension was electric - all were a bundle of nerves. The slightest unusual noise startled everyone. Around midnight, the sleet quit, and a warm, moist southwest chinook wind set in. By this time, some of the drifts had reached 20 feet in depth. During the day Monday, more men set out for Scenic - seven passengers and four railroad men.

At 0120 hours, on Tuesday, 1 March, the white death made its call. The avalanche that many had feared swept everything in its path 150 feet down into the Tye River Canyon. Buried under the snow lay two trains, three steam locomotives, four electric locomotives, a rotary snowplow, several boxcars, an engine shed, a water tower, and telegraph poles and wires!

Some of the few survivors described the avalanche as follows:

> "The coach lifted and went hurtling through the air. It kept falling, falling, with many grinding noises. I was catapulted forward and found myself lying in my pajamas in the snow."

* - See end of report for source of these quotes.

"The car was tossed up as though it were a juggler's ball, turning over and over. We were thrown from the top to the bottom and from the bottom to the top. The coach seemed to strike something and burst open like an eggshell."

"The sleeper soared upward. It struck another object and seemed to veer and whirl. Then it began to fall down.... down...until it landed with a jolt that rendered me senseless. When I recovered, I was lying face down and a heavy object pressed into my back, pinning me so I could not move. The nightmare of pain began as the weight kept increasing steadily. I was sometimes conscious, often unconscious, yet always aware of the back-breaking weight as it settled heavier - increasing the suffering.

I had no sense of time - only that eternities of agony had passed. Then, with dazed disbelief, I heard voices and the clink of shovels above me. Summoning all my courage, I called a weak and feeble 'help'." After 11 hours in an icy tomb, this victim was rescued.

The town of Wellington had been spared, but the avalanche had cut a swath 1400 feet wide and over 2000 feet long. Rescuers found only one end of a coach, the side and blades of a rotary plow, and the roof of a shack exposed on the surface. All else was buried in a white grave. The men worked desperately in the wind driven rain. This precipitation made the threat of additional avalanches a real hazard, and packed the snow from the avalanche even harder, making digging more difficult. The grisly rescue continued, yielding an occasional survivor as well as many bodies. After six hours, 14 people had been found alive. Suddenly the rescuers heard new cries, and found three more railroad men alive.

Around 0830, seven hours after the accident, a shovel crew heard faint tapping noises and uncovered the end of a popped-open mail car. Four more railroad men were found only slightly injured in a corner that had not been crushed.

As they continued digging, they uncovered only twisted wreckage and bodies. Eleven hours had passed since the fatal avalanche, and all hope had been given up of finding anyone alive. Around 1230 hours, as some of the men paused to rest, they heard a faint sound, almost like the mew of a kitten. Digging down they found a large tree trunk, and under it was a woman, just barely alive. This was the last of the survivors, 22 in all. The main rescue party from Scenic arrived around 1300 hours. It took until 8 or 9 March to recover the remainder of the bodies. During the spring melt, one more body was found, bringing the final death toll to 96 - the largest avalanche tragedy in the United States. The record still holds.

Finally on 9 March, the first train arrived at Wellington, coming from the east. It took until 12 March to open the line westward to Scenic. But the battle was not completely won - fate still had one final blow. On the morning of the 13th another avalanche fell just west of Windy Point, sweeping a rotary train into the canyon below, killing one man. The route was soon cleared again, and then remained open.

TERRAIN

The slope above the trains was about 2,000 feet in length. It was another 150 feet from the tracks down to the river. The slope had been burned over by a forest fire, leaving very weak anchors for the snow.

COMMENTS

Since the building of the railroad, a slide had not been known to run in this particular location. As many people sadly find out, a climax avalanche may occur only once in one or two hundred years. Mother Nature had given a number of ominous warnings - a very severe winter storm with excessive snowfall and winds - numerous avalanches occuring along the railway route - and finally a rapid warming of slopes already overloaded. Couple these factors with a sparsely timbered mountain slope, and it is clear the odds were overwhelmingly in favor of an avalanche occuring. But the warnings were ignored, a risk taken, and disaster resulted.

The Cascade Tunnel is now closed, and all remains of the town of Wellington (or Tye as it was later called) are now gone. The summer after the tragedy, the railroad spent $1\frac{1}{2}$ million dollars building an additional mile of snowsheds. In 1929, the Great Northern railroad gave up on this Stevens Pass route, bored an 8-mile tunnel lower in the mountain, and relocated some 40 miles of track.

Note: The most authentic account of this tragedy is the book "Northwest Disaster, Avalanche and Fire" by Ruby El Hult. Her source was personal interviews of those present and newspaper accounts. The above summary is based on her book.

WEATHER CONDITIONS

This storm started on the afternoon of 22 March, 1926, and continued until 2 April, when it partially cleared. During the storm, winds were often severe and blizzard conditions were common.

ACCIDENT SUMMARY

The Black Bear mine is located above the town of Telluride in Southwestern Colorado. The Black Bear was remote - trails led to it, but the quickest communication was by aerial tram which carried ore buckets high over the gorges and down the cliff faces. The portal of the mine was at an elevation of 12,050 feet in a treeless, cup-shaped basin. Next to the mine was the Black Bear avalanche, whose course follows a steep rock chute in the steep sides of the upper basin close to the mine entrance. It occasionally mauled the edges of the surface buildings. When the company erected a new, three-story boardinghouse capable of feeding and sleeping 150 men, they cautiously set it back from the chute near a ribbing of cliffs. Every worker knew that two different slides funneled into the main chute, one from either side of the upper cliffs. In fact, concussion created by the running of the first slide often jarred the other into motion. The second had never yet followed so close on the heels of the first that the chute clogged. It seems not to have occurred to anyone that if a jam-up should occur, the pressures would squeeze the second slide up and out of the normal channel.

When metal prices dropped, the crew at the mine dwindled to 15 men and a cook, wife of the blacksmith. As a mascot they had a shaggy black-brown-and-white shepherd dog named Karhu (Finnish for bear). On 22 March, nine men went down to Telluride for a few days off. Two men, foreman H. J. and E. E. went down as far as the mid-station of the tram. By the time the last of the nine vacationers was on his way down the hill aboard a swaying bucket of ore, the clouds had closed around the peak-tops. The wind fired sprays of snow pellets that stung like B-B's. The two remaining men waited until a telephone call assured them that the nine men had reached the lower tram terminal safely, then they started for the Black Bear. They could not ride the upper tram, for an operator had to be in the station when the cable was moving, so they walked. Their return through the blizzard was harrowing. They lost their way, nearly stumbled over a cliff, and finally were guided to the mine by gunshots fired by their worried companions.

The blizzard howled through the rest of the month. Except for delaying the return of the vacationers, it caused only inconvenience at first since most of the work was underground. Then the telephone line went out and later the power line. Twice they heard the rumble of distant avalanches, but that was to be expected. Finally H. J. decided that instead of huddling together near the kitchen, they should scatter. If an avalanche did

strike, some of them might survive to dig out the others and save some lives. He moved the men to rooms on different floors and in opposite ends of the building.

At two o'clock in the morning on Good Friday, 2 April, one segment of the Black Bear slide roared down its chute. The vibration woke H. J. "Anyhow that's over," he thought in relief. Before he could let out his breath, a second wave squirted sideways out of the channel. It broke the boardinghouse in two. The western piece was hurled almost intact toward the base of the cliffs. The other section, the kitchen end, was crunched into fragments and strewn, together with pieces of other buildings, half a mile down the slope into the basin.

For H. J. the episode began as a splintering crash, a whirl through blackness, then ended in appalling quiet. He felt no pain, but when he tried to move nothing happened. For a moment he dissolved into panic there in the soft, total darkness. Then he took hold of himself and began to reason. He was flat on his back. Deliberately, experimentally, starting with his bare feet, he tried to move some part of himself. He could not bend a joint. He was packed in compressed snow as form-fitting as a concrete mold. Strangely, it did not occur to him at first to try wiggling his neck. Finally, he discovered that he could wag his head sideways an inch or two. After rubbing it back and forth for a while he decided that he was touching a piece of corrugated iron from the wall outside his room.

There was a small air space above his nose. Breathing deeply, he tried to gain room by flexing and relaxing different muscles. But the snow kept settling and he made no gain. After a while he heard a faint crackling sound. He could not analyze what it might be, but he shouted as loudly as he could. The noise ended, and at last Harry began to feel uncomfortable. The heat of his body was melting the snow that touched him, and the wetness made him cold and miserable. Oddly, the touch of the corrugated iron, the one man-made thing left in his constricting world, kept helping him.

RESCUE

Two of the men had been in the unbroken section of the boardinghouse. Shaken but unhurt by the building's wild flight, they crawled out of their beds onto the sloping floor, collected their wits, pulled on their clothes, and made their way outside. Enough of the mine works remained intact for them to orient themselves in the moonlight that seeped through the clouds. They started down the line of debris to see whether anything stirred. No luck. They started back up. In order to cover the area as thoroughly as possible, they separated and zigzagged methodically back and forth.

In a depression tented by splintered timbers they found one man still in his bed. Though not seriously injured, he was painfully bruised and chilled through. They took him to the intact portion of the boardinghouse and put him on the floor between two mattresses. As the two searchers zigzagged down the mat of snow and debris, another man appeared like a genie

through the diffused, eerie light in front of them. His bed in the commissary had been next to a wall whose lower part was of rock. The rock held and the slide swept over the top of it, leaving him in a cave. Clad only in pajamas, he chipped his way out through the packed mass with a board. The effort had exhausted him, and he was stowed between the mattresses with the other man.

At dawn, the wind rose again but the searchers made one more trip. As one of them paused to catch his breath, he thought he heard someone moaning. It was H. J., six feet down. Just as he had been drifting asleep, he had again heard that crackling noise. This time he realized the sound was caused by feet and started not moaning, but yelling at the top of his lungs. The searchers dug through six feet of snow with their hands to rescue H. J.

Full daylight had come, but snow was falling heavily. Suddenly the dog Karhu stumbled into sight, no one knows from where. He had been deafened and blinded by the avalanche. After thawing out a little, H. J. insisted that they divide between them such spare clothing as they could find. H.J. tied some gunny-sacks around his own feet, some towels around his body and head, and prayed a little.

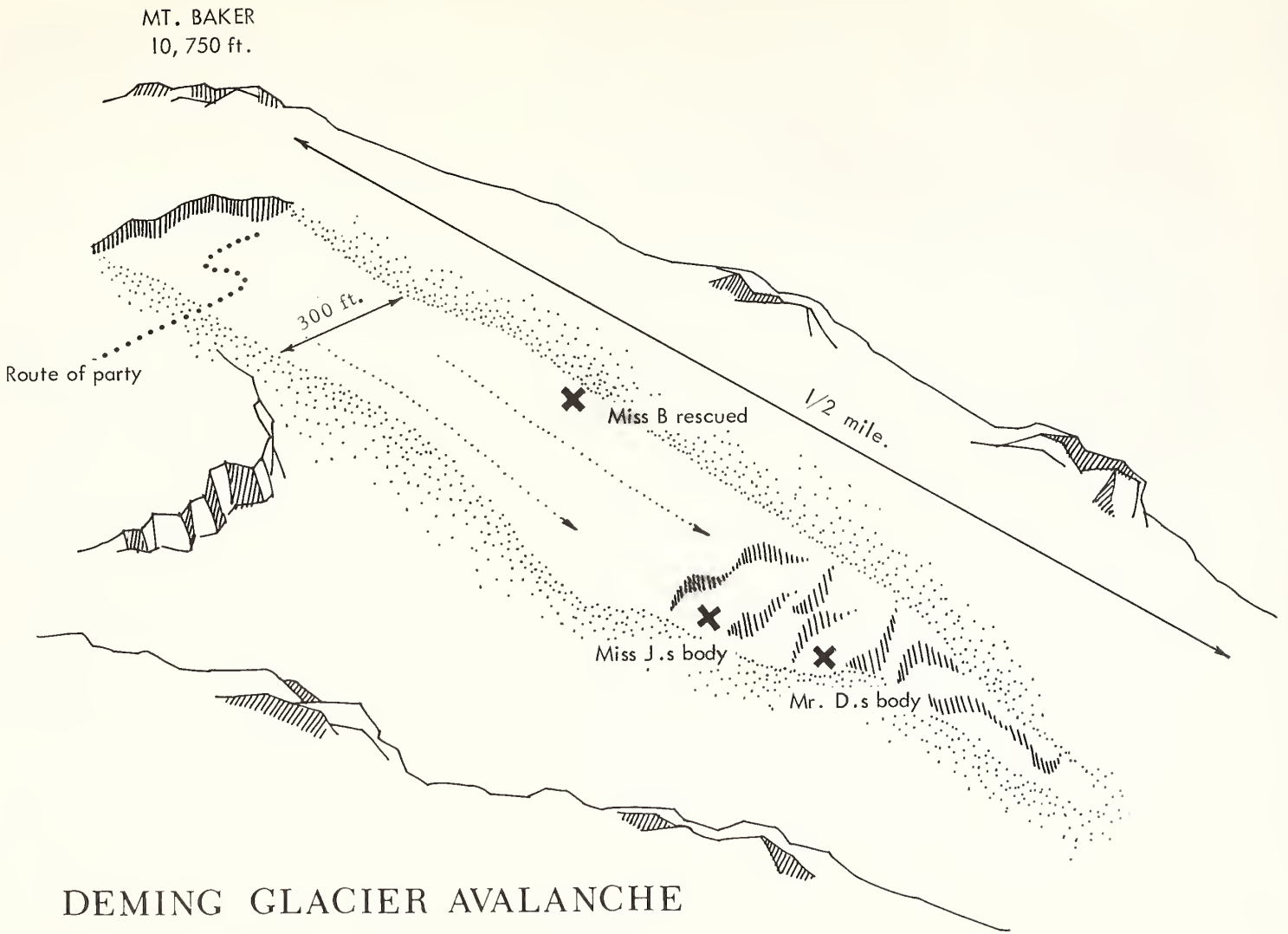
Soon they were all cold and as dazed as the dog. Help was not likely to come; the telephone had been down for several days and they could find no trace of blacksmith and his wife. In their condition, another night at 12,000 feet might be fatal. Giving up, they stumbled in a blurred and forgotten ordeal of exhaustion down the mountain to Telluride.

The first rescue party that started back up to look for the Rajalas failed to reach the Black Bear mine. The searchers in the second party probed four days with long steel rods, finding only debris. Finally someone noticed a strand of green yarn and recalled the cook's knitting. They followed it into the snow and up through a splintered hole in what had been the floor of a room. The bed was there, upright, even the covers undisturbed. Everything looked natural, until the searchers realized that the first thrust of the avalanche must have carried the pair up against the roof, where a broken beam had crushed the tops of their heads.

COMMENTS

This account is based on a magazine article written from a personal interview with foreman H. J. Several interesting points are found in the report, such as the yarn leading the rescuers to the two victims; protection afforded by pieces of the buildings; the vivid description from H. J. of his ordeal while buried; the sound decision of H. J. to scatter the people in the building; and the survival of the dog.

Rescuers should not give up the search until it is certain no hope is left or until conditions make further search impossible. This is especially true when buildings are involved.



DEMING GLACIER AVALANCHE
MT. BAKER, WASHINGTON
22 July, 1939 no. 39-1

ACCIDENT SUMMARY

On this Saturday, a group of 25 college students were ascending Mt. Baker, a glaciated volcano of 10,750 ft. elevation in northern Washington State. At about 1:30 p.m. the party was climbing in zig-zag fashion the steep upper slope of the Deming Glacier, known as the Roman Wall, and were about 15 minutes from the summit. The survivors later reported there was a "sudden swishing sound, and a fine layer of loose snow began to slough off the steep slope." The entire climbing party was within the moving snow, and "found themselves all sliding with it as though standing on a moving carpet." In spite of their efforts to anchor themselves, all 25 climbers were carried with the avalanche. As it gained speed, it descended the long face of the Roman Wall, and crossed ice cliffs and crevasses of the Deming Glacier, travelling a total distance of about $\frac{1}{2}$ mile.

After the moving snow had come to rest, the survivors gathered on a nearby rock ridge, where a check showed five of their number to be missing. (A later check showed the number to be six.) While the shaken survivors were thus occupied, the two men who had been leading the group made a hasty search for the missing victims, probing with ice axe and alpenstock in likely places. They discovered one survivor, Miss B., clinging by her fingers in a chute between two ice cliffs, from where she was rescued. Random probing discovered the body of Miss J. buried under three feet of snow on a bench at the foot of a 100-ft. ice cliff. She was immediately dug out (this occurred about three hours after the accident), but an hour and a half of steady artificial respiration failed to revive her, and she was given up as dead.

RESCUE

The survivors then retired to Kulshan Cabin, a climbing hut below timberline, from where two persons were dispatched to report the accident and seek help from the Forest Service ranger station several miles distant by trail. These persons reached the station at 8:00 p.m., and a rescue party was immediately organized. The rescue group set forth that same evening, reached Kulshan Cabin about 3:00 a.m. on the 23rd, and were able to reach the accident scene after daylight. They discovered Miss J.'s body where the survivors had left it, and proceeded with a search of the area. Shortly the body of Mr. D. was discovered, also buried under three feet of snow, in a large crevasse below Miss J.'s burial point and near the bottom of the slide. No further bodies were discovered.

The search was now organized on a large scale, with the aid of additional manpower, packhorses, supplies and radio communication. A thorough search of the slide debris, including systematic probing and trenching, continued for five more days, but the bodies of the four remaining victims were never located, though various items of clothing and equipment were uncovered.

These bodies have not been recovered to this day, and it is believed they were carried into and buried deeply in crevasses.

COMMENTS

The route of this climbing party is a frequently used one in summer, and avalanches are not a common summer danger here. This accident clearly illustrates that steep slopes and snow are still the only two requirements for avalanche formation, regardless of the season. Even in midsummer a snow storm at high elevations can approximate winter conditions and quickly develop a hazardous situation. This slide occurred in stable weather, but conditions preceding it are not known. From evidence in the detailed report by the Forest Service, plus examination of photos taken by the rescue party, it appears that new snow had fallen recently.

From the photos and the rather imprecise report of the survivors, it seems likely that a shallow soft slab was artificially released by the weight or motion of the climbing party. The slope over which it fell was long and open, and debris deposition was not deep except in crevasses and on ledges among the ice cliffs. This is a clear example of the heightened degree of avalanche hazard on glaciers, where even a shallow and otherwise harmless slide may claim victims by burying them deeply in crevasses or other natural catchment areas in the broken ice.

This fatal avalanche also emphasizes the importance of keeping a party [illegible] out at wide intervals while traversing avalanche terrain. A slide on[illegible]0 ft. wide which is able to trap an entire party of 25 climbers finds a highly favorable situation for creating fatalities. It might be said that here the odds were all in favor of the avalanche, and only by good fortune did so many survive.

No. 41-1 ALTA, UTAH 1 January 1941

ACCIDENT SUMMARY

On New Year's Day, the ski area was operating but the dangerous avalanche paths, including Greeley Hill, were posted closed due to avalanche danger. (Closures were the only protective measures used at Alta at this time.) Two skiers returning from a tour of Albion Basin chose to reach the ski area by traversing across the middle of Greeley Hill. When the lead man started across this slope, a large slab avalanche broke loose and carried him into the Snakepit, the deep, narrow ravine of Little Cottonwood Creek at the foot of Greeley Hill. His companion was outside the fracture line and escaped. The victim was deeply buried under the snow which funnelled into the narrow gulley.

Rescue parties were unable to locate him by probing. His body was finally recovered by trenching 48 hours later, under six feetof snow near the tip of the debris.

AVALANCHE DATA

Reports on this accident are based largely on oral tradition. Several photographs exist which show the fracture line, trail of the victim, and the rescue. From these a medium to large hard slab, HS-AS-3 or 4 is deduced.

COMMENTS

This is a classic example of an ill-chosen touring route. Crossing the middle of the avalanche path offers the greatest prospect of triggering it. This particular path has long been known as a particularly dangerous one, for even a shallow layer of sliding snow will accumulate to great depths in the Snake Pit.

No. 51-1 ARAPAHOE BASIN, COLORADO 18 November 1951

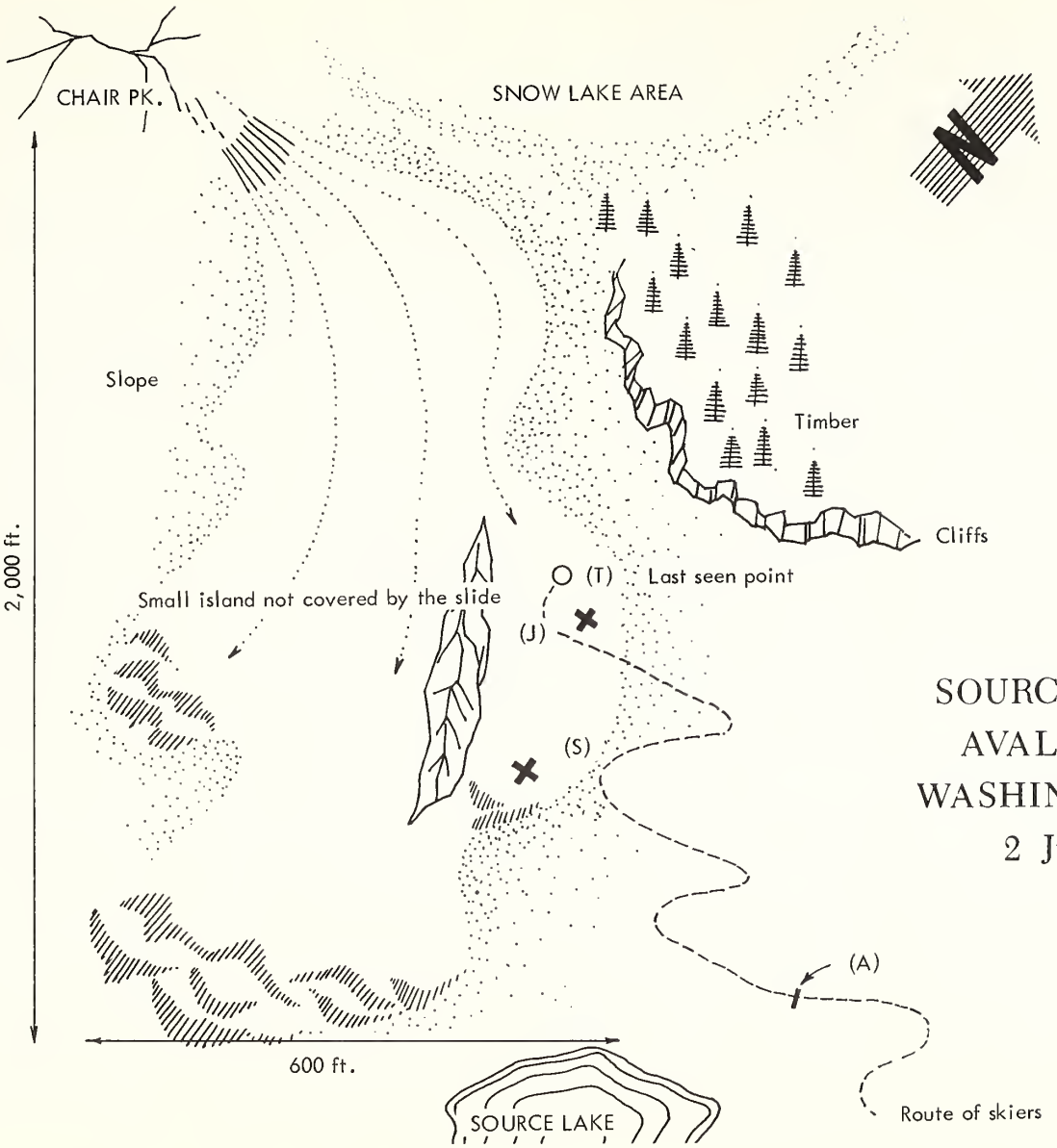
WEATHER FACTORS

A five day storm in mid-November, 1951, had deposited 17 inches of snow at Arapahoe Basin ski area and had been accompanied by high winds. Snow conditions were very unstable, and numerous slides were observed as a result of the storm.

ACCIDENT SUMMARY

As a result of the intense storm, a number of avalanches had run. The Number Two slide of the "Seven Sisters" area on Loveland Pass buried the highway under 6 feet of snow. On Sunday, 18 November, two skiers ignored warning signs at Arapahoe Basin ski area, and skied down the West Wall area. The first skier on the slope made several turns, then traversed into an adjacent slope which avalanched with him. His point of entry was about $\frac{1}{2}$ way down the slide path. He was carried to the bottom, and completely buried except for one hand.

His partner witnessed the slide and, with the help of other skiers who had seen the accident from the lift, dug out the trapped skier.



SOURCE LAKE
AVALANCHE,
WASHINGTON no.53-1
2 July 1953

AVALANCHE DATA

The avalanche was a hard slab, with an 18-inch fracture line, which slid to the ground. From the description in the report, depth hoar was undoubtedly the base layer of snow. Code - HS-AS-2 or 3.

COMMENTS

A very fortunate skier! The sketch map is not accurate enough to determine the exact location of the accident, except somewhere along the west wall. No names are given, nor are any dimensions of the slide.

No. 53-1 SOURCE LAKE, WASHINGTON 7 February 1953

WEATHER FACTORS

This storm had deposited 18 inches of snow, with a 6-inch settlement. On Friday, 6 February, the snow changed to rain and continued intermittently through Saturday morning. Only a few slopes had stabilized by sliding.

ACCIDENT SUMMARY

On morning of Saturday, 7 February, three young men, all 17, started out from Snoqualmie Summit on an overnight ski touring trip to a cabin at Snow Lake. After $4\frac{1}{2}$ miles they would reach Source Lake, where it was necessary to climb out of the canyon to Snow Lake on a bench above. Members of the party were Mr. A., Mr. J., leader of the group, and Mr. S., all with very limited winter mountaineering experience. None of the group had checked out with any authorities, nor had they checked on weather forecasts or avalanche hazards. While skiing up the canyon to Source Lake, they crossed over the debris of several wet snow avalanches that had already run. Around noon, they heard the rumbling of a large avalanche in the distance, but did not see it. A storm the last few days had deposited 18 inches of snow at Snoqualmie Pass, and on Saturday had turned to rain.

Passing Source Lake, they had two choices to reach the bench above. The first was climbing through the timber which is more difficult, but safer from avalanches. The other route was up the easier open slope which was cut by a gulley and overhung by cliffs. They chose the open slope. This slope itself would seldom be dangerous, but above it were high-angle cliffs and couloirs. At approximately 1300 hours, the party was about half way up the slope, with J. leading and S. following about 100 feet below and slightly behind. A. had stopped to remove his ski climbers and was several

hundred feet below and behind S.'s position. A. heard a low rumbling, looked up, and yelled "look out" to his companions. All three turned and tried to ski down and away from the slide. A. was successful, and was not caught. Both J. and S. were enveloped by the snow. A. made a quick search of the slide, and, not locating either of his companions, skied back down the canyon for help. First contact was made with a State Highway Patrolman at 1545 hours, who in turn relayed the alert to the local Snow Ranger at 1555 hours. First party of 5 men was dispatched at 1615 with the eyewitness A. A second party left at 1645 with 6 men, and a third party left at 1655 with 16 men. Three of the rescuers played out and had to return. The Hasty Party arrived at the scene at 2040 hours. They had established the last seen points when the second party arrived at 2125. The Snow Ranger was in this group, and directed the rescuers to make a hasty search below the last seen points. The Snow Ranger found a ski, and in calling to the rescuers for help, he was amazed to hear the victim answering from under the snow. S. was dug out at 2155, cold, but otherwise unhurt, after being buried over 8 hours. He was put in a sleeping bag while the search continued.

Additional follow-up parties were dispatched at 0010 on 8 February with 17 men, and at 0700 with 18 men. In darkness and storm the search continued for J. At 0200 hours, 8 February, the Snow Ranger took stock of his situation. He had two casualties on his hands, the boy dug out of the avalanche and the eyewitness. After three trips through the canyon, the latter was in the final stages of exhaustion. The rescuers were in little better condition. Bad weather, lack of proper equipment, and poor physical condition had choked off the stream of reinforcements. It had now been 13 hours since the accident. The Snow Ranger realized that if he continued the search under the existing conditions, he would be risking the safety of many in the now forlorn hope of rescuing one. He made the painful decision to withdraw to the protection of timber and set up a temporary camp.

The search was resumed at daylight, after one of the follow-up parties had arrived and a thorough review of J.'s route was made. At 0740 hours, a small part of a ski was located under the edge of a large piece of snow. The ski was still attached to J. and he was dug from the snow. The coroner's report listed cause of death as a broken neck.

S. was flown out by helicopter, and J.'s body brought out by sled. Rescue operations ended with all members returning to Snoqualmie Pass at 1620 hours, 8 February.

It was concluded that the actions of the skiers in no way triggered the avalanche. It released naturally above the bench, and the party was in the outer edge of the avalanche path.

The survivor of the accident, S., gave a personal account which is worth repeating here. After A. gave his warning call, S. said he "saw J. turn and start skiing down. I turned and started down, but it was on top of me in an instant. I didn't see the slide take J." S. doesn't remember being

carried down the hill, but "when I came to, I had a heck of a time breathing. I was on my side. My head was about a foot lower than my feet. I still had my skis on. I tried to move. I couldn't. My arm was over my head. That's probably what saved me. It created a little air pocket about twice the size of my head.

"There was enough light getting through so I was aware it was daylight. I was praying and thinking about everything--my folks, A. and S., and I was sure they were caught too. It's a good thing for me they both weren't!" He said he was resigned to the idea that they wouldn't be missed until Monday. He continued, "I didn't hurt anywhere, but I was cold and shaking. My breath was melting the snow, and it was dripping in my ear--it was about driving me out of my mind. It seemed like eternity until they found me. I had been sleeping I guess, when I opened my eyes and saw a flicker of light. I didn't think it could be true. I hollered, and they hollered back. The first one I saw was the Snow Ranger. I couldn't say anything--I just grabbed for him I was so happy."

AVALANCHE DATA

The avalanche started high on the eastern slopes of Chair Peak. The slide ran an estimated 2000 feet, and was 600 feet wide. The victims were caught in a finger of the slide, about 600 feet from the toe. At the point where they were caught, the maximum slope was 30^{o} (58%). The Snow Ranger classified the avalanche as a wet, loose, which would be coded WL-N-4.

COMMENTS

This party of relatively inexperienced winter outdoorsmen violated five of the most important rules of mountaineering, namely:

1. Check both out and in with the proper authorities.
2. Check snow and weather conditions before you start.
3. Heed the warnings you observe en route.
4. Choose routes protected from hazards such as avalanches.
5. In questionable terrain, expose only one member of the party at a time.

All of these basic rules can be applied to either winter or summer mountaineering.

Considering the conditions present and the decisions made by the party, it is very fortunate that any of them survived. Avalanching was frequent during their trip up the canyon. Climbing out of the canyon, they chose a route that flanked an obvious avalanche path. Yet, when fate struck, it only trapped two of the three. Had a witness not been able to go for help, it would have been Monday before rescuers would have reached the scene. One of the men trapped by the slide was buried for eight or nine hours and lived. This is seven to eight hours longer than most victims live under

snow. (Note the value of having his arm next to his face.) In the mountains it is sometimes necessary to take a calculated risk--but to disregard most of the primary rules for survival is to flirt with death. And in this case, death answered.

No. 56-1 TUCKERMAN RAVINE, NEW HAMPSHIRE 18 February 1956

WEATHER FACTORS

Saturday, 18 February - Morning: Weather good. Afternoon: Storm set in, accompanied by high winds. Storm continued during the night, leaving six to eight inches of snow.

Sunday, 19 February - Storm intermittent, but high gusty winds made visibility poor. Weather on Monday unknown.

ACCIDENT SUMMARY

A party of five, ages from 29 to 50, went to Tuckerman Ravine for a weekend of climbing. The party consisted of Mr. F., Mr. L., Mr. Sa., Mr. Sp. and Mr. T., all with limited if any winter mountaineering experience. On Saturday, 18 February, the party attempted to climb to the Summit of Mount Washington via the right-hand gully. A storm began, and the party turned back before reaching the summit. They missed the route they had taken on their ascent, but made it back to the cabin where they had established a base camp. The storm continued most of Saturday night, depositing about six to eight inches of snow, accompanied by high winds.

Late Sunday morning, 19 February, the five again went to Tuckerman Ravine. Enroute they talked to several skiers before noon. One report stated that these skiers warned the party of possible avalanche danger.

The group proceeded along the floor of the bowl, and when they were approximately 200 feet from the foot of the headwall, they decided to turn back. The time was approximately 1400 hours, and high gusty winds made visibility very poor. Mr. L., Mr. Sa., and Mr. T. were in the lead, and Mr. Sp. and Mr. F. followed, perhaps two minutes behind. When they had retraced their steps about 25 yards, the entire party was engulfed by an avalanche.

F. stayed on top of the snow during the "ride." He dug out Sp., who was partially buried. Together they went to the terminus of the debris where they dug out Sa. T. was close by, but buried up to his chin, and it took some 30 minutes to free him. One worked on T. while the other two searched

for L. After T. was freed, the four men spent another ½ hour searching for the remaining man in the party, L., to no avail. At approximately 1500 hours, F. and one other went for help. Six persons were located. One was sent down the trail for more help while five went to the accident scene with F. and his companion. The nine men probed with ski poles until 1630, when the search was called off. Searchers were afraid of another avalanche, and the weather was worsening. A doctor in the party expressed the opinion that the victim was probably dead by now.

On Monday, 25 searchers began searching at 0830 with probes and shovels, systematically covering the area. At 1310 the body of L. was recovered. A doctor on the scene believed he died from suffocation shortly after being buried. Probing was concentrated near the terminus where T. and Sa. were located. T. thought he had been hit by L. as the slide carried them downward. L. was found about 10 feet from where T. was dug out, and about 10 or 15 feet from the edge of the avalanche.

AVALANCHE DATA

The slide was a hard slab. Distance from the fracture line to terminus of the debris is estimated between 800 and 1000 feet. Fracture line was estimated between 1000 - 2000 feet long. Slide would be coded HS-N-3. The slide could have been released by the party if they were in the compression zone of the avalanche. However, from their description and available pictures, it seems more likely it was a natural release.

COMMENT

Signs placed along the trail to Tuckerman Ravine warned of hazards to skiers and climbers. Since use at the area was only light in February, there were no restrictions in force--only warning signs. During the popular spring skiing in March and April, a ski patrol is usually on duty.

The victim's body was in an upright position. Depth below the surface is not recorded. The report states "the systematic probing, carried out in a straight line, did not include the uneven edge of the pile-up. Here, probing was carried on independently by individuals. The nearly upright position of the body probably caused it to be missed during earlier probing there." The body was found within 10 feet of where they thought it might be, yet the searchers probed for over 4½ hours Monday morning before finding it. A good lesson--always begin at the extreme toe or terminus of the debris with systematic probing. Exceptions to this rule will be rare.

The survivors used good judgement in conducting their search for L. However, it is questionable if the first rescue party should have called off the search Sunday afternoon after searching for less than an hour (searching called off at 1630 -- 2½ hours after the accident.) The storm was worsening, and darkness was approaching, but these two conditions are not enough in themselves to call off a rescue. Danger from additional slides had to be considered, but sometimes a calculated risk is necessary. The rescue party may have been unduly influenced by the doctor's statement that

the victim was probably dead. A number of people buried in the snow have lived well over 2½ hours. There is no justification for stopping because the victim might be dead. Rather, the search action must be continued as long as he might be alive.

No. 56-2 LOOKOUT PASS, MONTANA 1 March 1956

WEATHER FACTORS

A two week storm, with prevailing southwest winds, had deposited 6-12 inches of snow each day resulting in numerous avalanches. On 1 March, a strong wind was blowing, and the temperature was estimated to be 35 to 40 degrees. Conditions alternated between a snow blizzard and driving sleet and rain.

ACCIDENT SUMMARY

Several avalanches fell along U.S. Highway 10. This report covers damage done by slides on the Montana (east) side of Lookout Pass. Report No. 56-3 covers damage on the Idaho (west) side of the pass near the small town of Mace.

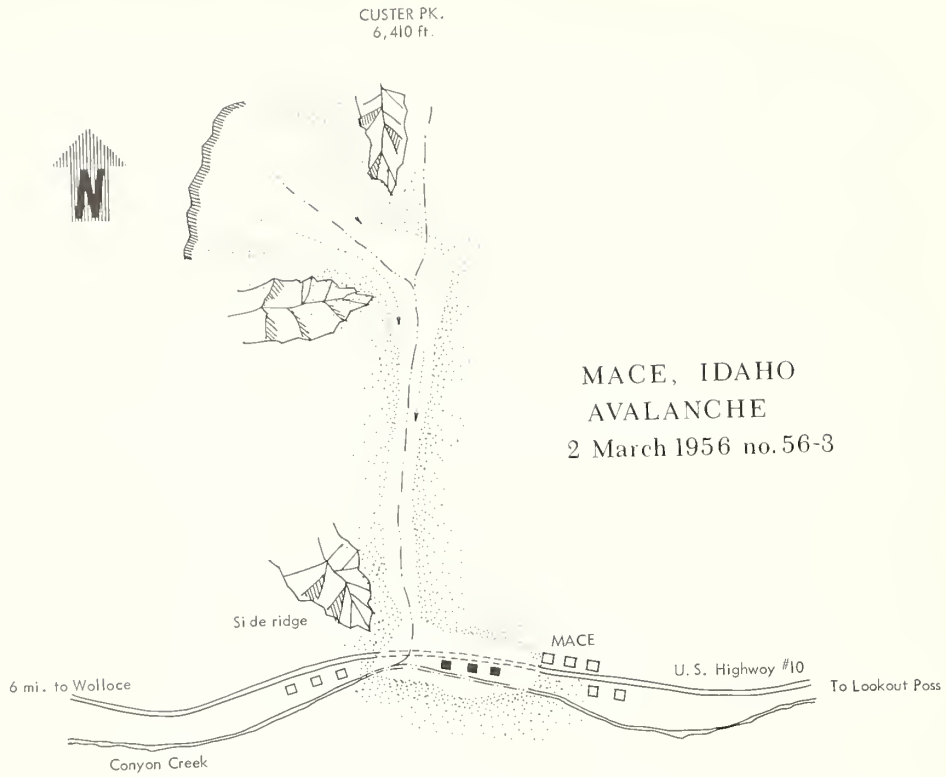
At about 1130 hours, 1 March, 1956, two snowslides ran down adjacent draws about two miles east of the summit of Lookout Pass. These draws are relatively open and steep in the upper half, but the lower portions were planted to white pine 25-30 years ago. These trees were mostly pole size. At the base of the draws is the Northern Pacific railway, and Highway 10 is located across the canyon.

The first avalanche cleared a 200-300 foot path through the plantation, covered the railroad tracks 6-10 feet deep for a distance of 200 feet, filled the creek bottom with 15-20 feet of snow, and continued onto the highway, covering it for 200 feet to a depth of 6-10 feet with snow and trees. At this area the highway is on a fill that is 30 feet above the creek bed. One car was caught and covered by the snow, but remained on the highway. The four or five occupants were able to get out through a window.

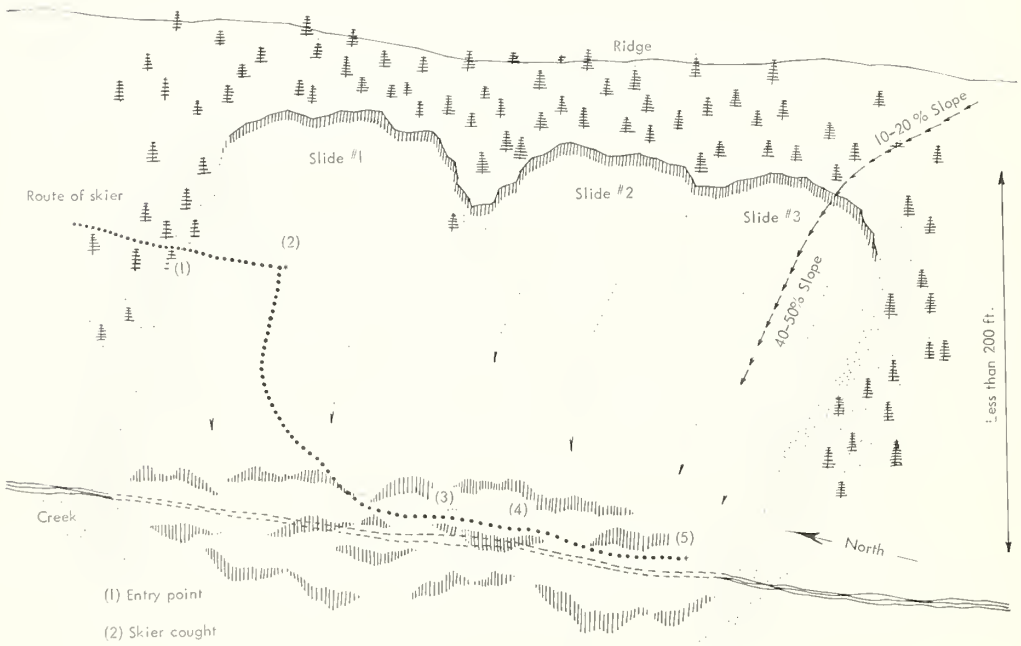
The second slide covered the railroad tracks with six feet of snow for a distance of 600 feet. This avalanche did not reach the highway.

AVALANCHE DATA

The snow depth at Lookout Pass was 12 feet, with approximately 51 inches of water content. Prior to the slides, huge cornices were noted on the ridges.



MACE, IDAHO
AVALANCHE
2 March 1956 no. 56-3



LEEKS CANYON, WYOMING
no. 56-4 5 March, 1956

It was estimated that four or five feet of the new snowpack slid on the older snow surface. Coding is difficult for these slides since data are lacking. Both these slides and those in report 56-3 were probably hard slabs, but lubrication from the rain could have participated in their release. Size is estimated at 3 or 4. Code: HS-N-3 or 4, climax.

COMMENTS

This same area was the scene of an avalanche which caught a train in 1936 and killed two people. It is interesting to note that the first of the two avalanches covered the highway with 6 to 10 feet of snow, even though the road was 30 feet above the creek. Since the creek bed was filled with only 15 to 20 feet of snow, it is evident that a considerable volume of snow and trees was airborn when it reached the bottom of the draw.

The casualty list for this slide follows:

1. 300 - 400 feet of telephone line.
2. A dented fender and cracked windshield on the car that was caught.
3. A number of "growth study" plots that were in the plantation.
4. Several squirrel homes in the plantation. (Immediately after the slide, a number of very confused and disoriented squirrels were seen running around on the uphill side of the road, on the tip of the deposited avalanche snow.)

No. 56-3 2 March 1956

WEATHER FACTORS

A two week storm, with prevailing southwest winds, had deposited 6-12 inches. of snow each day prior to the avalanche. On 1 March, it warmed, and a wet snow fell most of the day. Later, very high winds came up, and were still blowing at the time of the accident.

ACCIDENT SUMMARY

This report covers the destruction caused by an avalanche on the western or Idaho side of Lookout Pass. Two slides on the Montana side (east) also did some damage, and this is covered in report number 56-2.

Approximately 13 hours after the two slides had run on the east side of Lookout Pass, another ran near the small town of Mace, Idaho. At 0115 on 2 March, 1956, a four foot slab released and traveled nearly 5000 feet down a gulch. The snow ricocheted off a side ridge near the mouth of the

gulch, turned a 65° angle up the main creek, and deposited snow for 700 feet up the canyon. In its path was the small mining community of Mace. Eighteen people were caught in their houses, and all survived except a ten year old boy.

As the avalanche came down, it tore out power lines that were 125 feet above the floor of the avalanche path; sheared off 16-20 inch trees; deposited snow on the railroad and highway from 10 to 30 feet deep; knocked down 18 power poles; and destroyed 16 buildings. In addition the air blast (beyond where the snow was deposited)blew over 650 feet of dense polestand on the hillside opposite the gulch and damaged at least 16 other buildings, some of which were 900 feet up the canyon from the last snow deposition. The avalanche knocked one house 35 feet off its foundation into the creek. Others were moved off their foundations, and a number of roofs were dislodged. One survivor said he had been asleep, and "when I woke up the snow was piling on top of my bed." A mother, with her 16 month old baby in her arms, said she heard the rumbling, "then came the shock--it was all black and snow all around us--we couldn't get air."

AVALANCHE DATA

The upper 1/3 of the slide path is 65-75% slope with a southeast aspect. The lower 2/3 of the path is 45-50%, and faces south. The avalanche path drops 1500 feet in elevation, and is about 5000 feet long. The depth of the slab was reported at 4 feet, with a 7-9 foot snow depth in the accumulation (starting) zone. This slide, as well as those in report 56-2, were probably hard slabs, but the added weight from the wet snow undoubtedly assisted in the release. Code for slide: HS-N-5.

COMMENTS

The strength of the air blast that moves in front of the avalanche is graphically illustrated in this accident.

Avalanches have run in this same gulch in 1910 and 1949. The 1910 slide killed 12 people. It is fortunate that more lives were not lost in the 1956 accident. Are 13 deaths incentive enough to move the town to a safer location? If not, it would seem evacuation would be in order during periods of high hazard.

ACCIDENT SUMMARY

At the end of a day's skiing at a regular ski area, Mr. St. and Mr. and Mrs. Sl. decided to finish the day by skiing down a drainage away from the developed area. They made arrangements for a man to meet them with a car at the mouth of the canyon. At approximately 1705 hours, 5 March, the party skied onto a steep side hill, where they stopped for a moment. They were about 150 feet above the creek bed. Mr. St. then skied onto the slope ahead of them. A slab cut loose, carrying St. into the creek bottom. Almost at the same time, a second slide released adjacent to the first one. This, in turn, triggered a third slide adjacent to number two. These slides ran less than 200 feet down the slope, with a combined width of all three of less than 300 feet. However, the avalanche snow was 30 feet deep in some places in the creek bottom.

RESCUE

St. was last seen waist deep in the snow, in the bottom of the canyon, directly below where he had released the slide. He disappeared when the debris from the second slide hit the creek. Mr. Sl. stayed at the scene while Mrs. Sl. skied onto the road, and went by car to report the accident. The report was received at 1730 hours, and the rescue cache and some men were sent to the top of the ski area where they could ski to the scene. The hasty party arrived at 1755, and the search began. By 1830 enough men had arrived to set up a 10-man probing crew. More people arrived, and probing continued with 10-foot probes until 0115 hours, 6 March, when the entire area of highest probability of Slides One and Two had been covered. It was obvious the probes were not long enough, and since the temperatures were below zero, the search was called off for the night. A scintillator and a mine detector were both tried at the scene to no avail. An oxygen resuscitator was brought to the area during the first night's operation.

Probing began again at 0900 on 6 March, with some longer probes added to the operation. In places it was necessary to dig down 5-10 feet, then probe the remaining 20 feet of snow. The alignment of the probing crew was maintained by a string stretched in front of the probers. Probing in 15-25 foot deep snow was found to be a slow process. Often the longer probes would deflect and not follow a "plumb" line course. All unidentified objects were dug out, even though some of these logs or pieces of debris were buried quite deeply.

In the afternoon of 6 March, one of the victims ski poles was located under six feet of snow below where slide Number Two had released. On 7 March the rescuers attempted to move in two bulldozers, but the steepness of the canyon and the snow depth prevented them from reaching the scene. At 1500 hours on 7 March, Mr. St's body was located under eight feet of snow in the lower part of the debris from the Number Three avalanche. Mr. St. had apparently been carried further down the creek by avalanches One and Two

than realized. The terminus of the debris from both slides One and Two were covered by slide Three. Doctors at the scene estimated that the victim died within three minutes after being caught, due to the compactness of the snow in the canyon. Later examination showed no broken bones.

The local Ranger, who participated in the search, estimated that over 50 people worked on the rescue, spending an estimated 1,000 man hours.

AVALANCHE DATA

Mr. St!s ski released a small, 12-18 inch hard slab, which in turn triggered two more avalanches adjacent to the first. The slides occurred on a west exposure, on an estimated 45% slope. Deposition was in a narrow canyon bottom, and flowed down the creek farther than was evident by the debris. These slides would be coded HS-AS-2.

COMMENTS

The victim would have been found more quickly had probing started at the toe of all the debris. However, in this case, the eyewitness account and the debris were misleading. The rescuers were searching in what they believed to be the area of highest probability. This is one of several cases where avalanches have carried objects farther down a canyon than evidence indicates or common sense would believe. This rescue again confirms the uselessness of regular mine detectors or scintilators in searching for objects that are buried several feet under the snow.

The "guide cord," used to keep the probers aligned during this resuce, has now become part of standard rescue procedure.

This avalanche was a very small one, sliding down the hill less than 200 feet; yet it killed a man just as easily as could one that ran for several thousand feet.

No. 57-1 ARAPAHOE BASIN, COLORADO 17-18 January 1957

SUMMARY OF ACCIDENT

On 8 January, an intensive storm had dumped 15 inches of new, unstable snow on the ski area. Two high hazard areas, the "Upper North Glade" and the "Palivacinni" were closed while the more heavily skied areas were checked out. Snow and high winds prevailed for the next five days, until an average of 30 inches had fallen. Prior to the 8th, both of these slopes had been extensively checked out with both High Explosives and protective

skiing. On 15 January, the snow ranger broke several ribs, and it was necessary for local ski instructors to check the slopes. These two instructors had previously worked with the ranger on avalanche control.

On the 17th, the storm had cleared, and after the rest of the area was checked out, a charge was placed high on the Upper North Glade slope. (The shot point may have been slightly higher than it should have been.) Extensive fracturing resulted, but nothing slid. The team traversed across the upper slope and worked their way down, checking several smaller slopes. About 10 minutes after they had crossed the Upper Glade, they looked back up at it, and saw that the western side had slid. The fracture was about 50 feet below the blast point and 45 inches deep. The lower 6-8 inches was depth hoar. The snow slid to the ground and traveled for 250 feet. This same slope had been closed on 21 December, but was skied anyway by two men. On 22 December, one block of C-3 High Explosive brought out the entire slide. The lower 14 inches of the snow pack was depth hoar. Thus in 26 days, this slope had developed 6-8 inches of depth hoar. The Upper North Glade avalanche path averages 30 degrees (58%). This area and the "Pali" were kept closed the remainder of the 17th.

On 18 January, the State Highway gun crew put three shots in the upper area of the "Pali" with their 75 mm howitzer. Two of the shots were too low, and the third was in the lower and stable portion of the cornice at the top of the slide. After the shooting, two employees of the area wanted to ski the "Pali," but the instructors who were checking the area prevailed upon them to wait until they had put some hand placed charges in the proper shot points. This avalanche is 2,700 feet long, with slopes from 45-65%. The instructors made up one charge of seven sticks of 40% dynamite plus one stick of C-3. (Normal charge for this slope is three to five sticks of C-3.) The shot was placed at one of the major shot points. Result? The entire slope avalanched with a 10 foot fracture. The hard slab cleared the snow to the ground and tore up the grass and dirt cover underneath. The debris traveled the entire distance of the slide path, reaching the highway which is across the creek and up the opposite slope.

Considerable pressure had been put on the ranger to open these slopes during 13-17 January.

COMMENTS

Any one of the three examples above could have resulted in a tragic accident. These incidents show the necessity of using adequate charges, and being sure they are detonated in the proper place. This is why a comprehensive "Avalanche Control Plan," complete with picture and diagrams, is a must at any area having even one dangerous avalanche path.

The data on the Upper Glade show how fast depth hoar can build under favorable conditions. A snow ranger must constantly check such slopes to determine the extent of "undermining" from depth hoar.

No. 57-2 Wardner, Idaho February 1957 Stilwell

During the last week of January temperatures ranged from 20 degrees above to 18 degrees below zero. The snow depth for this period remained relatively constant at 29 inches; the continuous sub-freezing temperatures maintained a hard crusted surface on the old frozen snow. January 31 and the first days of February brought a distinct warming trend to the area. By 5 February the daytime temperature ranged around 30 degrees. Snow depths increased some thirty-three inches in this same period, bringing the total accumulation by 5 February to sixty-three inches. Prevailing west and southwest winds during this time created overhanging cornices on the exposed points of spur ridges.

ACCIDENT SUMMARY

The small town of Wardner, Idaho is an old mining settlement, which begins at the southwest boundary of Kellogg, Idaho, and is scattered along Milo Gulch for two miles. Both slopes of the Gulch are steep, several with grades of 60% to 80%. The floor of the gulch is very narrow. Consequently most of the houses had to be built at the toe of the slopes to provide room for the stream and road. Because the area is less than one mile from the lead and zinc smelters of the Bunker Hill Company, the slopes along the gulch have been denuded of most vegetation cover by sulphur fumes and fires.

At 4:00 a.m. 5 February, a massive slide spilled down one of the east-facing slopes, crashing into the home of L. W., killing him and throwing his wife 200 feet out of bed and through a hole in the kitchen roof of a damaged home next door. The residents of that house found their kitchen full of snow, but saw Mrs. W's arm sticking out and rescued the seriously injured woman. The slide was nearly 1200 feet long and almost 200 feet wide at the base. In addition to the destroyed house, several other homes were extensively damaged. Then at 10:00 a.m., a second slide sent tons of snow slamming into homes a half mile further down the canyon. This avalanche demolished two houses, damaged others and buried a young mother and her small daughter for an hour and a half. One hundred volunteers working with shovels and bulldozers began a frantic search for the pair. Finally the assistant fire chief spotted the missing woman's arm amid the debris, and she was pulled free. The woman was discovered under the back door, which had been knocked off its hinges by the force of the slide. Falling over her like a protective covering, it saved her life. The baby was found near by, still in its smashed baby chair. Neither of the two was seriously injured.

That afternoon still another slide struck, sending snow cascading into the living room of another house. A man shoveling snow off the roof of the house when the slide hit was buried up to his neck, although he was able to free himself. Nine houses were destroyed or damaged by the three slides. By afternoon there were reports of minor slides all through the Wallace-Wardner-Kellog area. The only other slide on record in Wardner occured in 1950. Old-timers in the little town couldn't recall a situation like

this one in the history of the area's occupation.

COMMENTS

These houses were right at the foot of steep, open slopes. When the right combination of snow conditions (33 inches new snow on a hard crust) arrived, the inevitable happened. Destruction of vegetation by smelter fumes and fire probably contributed to this disaster, both by clearing the avalanche paths and by facilitating wind-drifting on the ridges.

No. 57-3 LOOKOUT PASS, MONTANA 6 February 1957

WEATHER FACTORS

During the first week of February, 1957, there were several snow slides in the St. Regis Canyon region. For a period of two weeks preceding this slide activity, the temperature ranged from 0^{o} to 30^{o} below zero. In the first few days of February, the temperature rose to a high of 30^{o} to 40^{o} above zero, and heavy wet snow began falling. Early Wednesday morning, 6 February, a Northern Pacific freight train was making its run from Wallace, Idaho, to St. Regis, Montana, through Lookout Pass. By this time the temperature was 30^{o} above and the wind velocity was southeasterly ten to fifteen m.p.h.

ACCIDENT SUMMARY

At approximately 9:00 a.m. the train was passing through an area one mile east of the Pass (elevation 4400 feet) when an avalanche released on a steep (60%) slope three hundred feet above the tracks. The depth of the snow pack at the fracture varied from four to six feet. When the engineer saw the snow rushing down toward the tracks, he opened the throttle and tried to plow through the slide. But it was only seconds before the avalanche picked the lead diesel off the tracks and carried it seventy-five feet downhill. The rest of the train stayed on the tracks and was partially buried by the slide. Luckily, no one was injured. The avalanche had virtually cleaned the hillside of snow; deposition on the tracks was nearly five hundred feet long and varied in depth from ten to twelve feet. After the train had been pulled from the slide, the slide moved again to fill the space that had been occupied by the train.

COMMENTS

This slide came from the same weather pattern that produced the Wardner Idaho, accident. See No. 57-2.

WEATHER FACTORS

The two weeks prior to the accident were clear and warm, producing a sun crust on most slopes. On 2 February, three inches of snow fell along the continental divide, with little wind. Early on the 24th, three more inches fell, but accompanied with high winds. On the 24th, three soft slabs were released at Berthoud Pass (eight miles west of the site) with 12-18 inch fracture lines.

SUMMARY OF ACCIDENT

A group of five young men, ages 15-18, decided to climb a small "glacier above St. Mary's Lake. They missed the regular route to the glacier (where another party was skiing) and instead began climbing up an avalanche path. The five were single file, but close together. L. led the party, followed by Ge., Gy., M. and F. Approximately 300 feet up the slope, the first three emerged from a small chimney they were climbing in. M. and F. were still in the narrow, rocky chimney when the avalanche released, and were carried back down the chimney by the sliding snow. L., Ge., and Gy. were carried down the main slope over very rough terrain of rocks, small cliffs, brush, and stumps. All five were carried to the bottom.

Ge. and F. were not injured seriously, and began rescue of their companions immediately. M. was close to F., with only his right arm exposed. F. dug him out but found him unconscious with a very severe head injury. He was still breathing. Ge. located L., who was also unconcious. (He was later found to have a fractured skull and broken arm.) Ge. also located Gy., who suffered a broken leg, pelvis, and back, but was conscious.

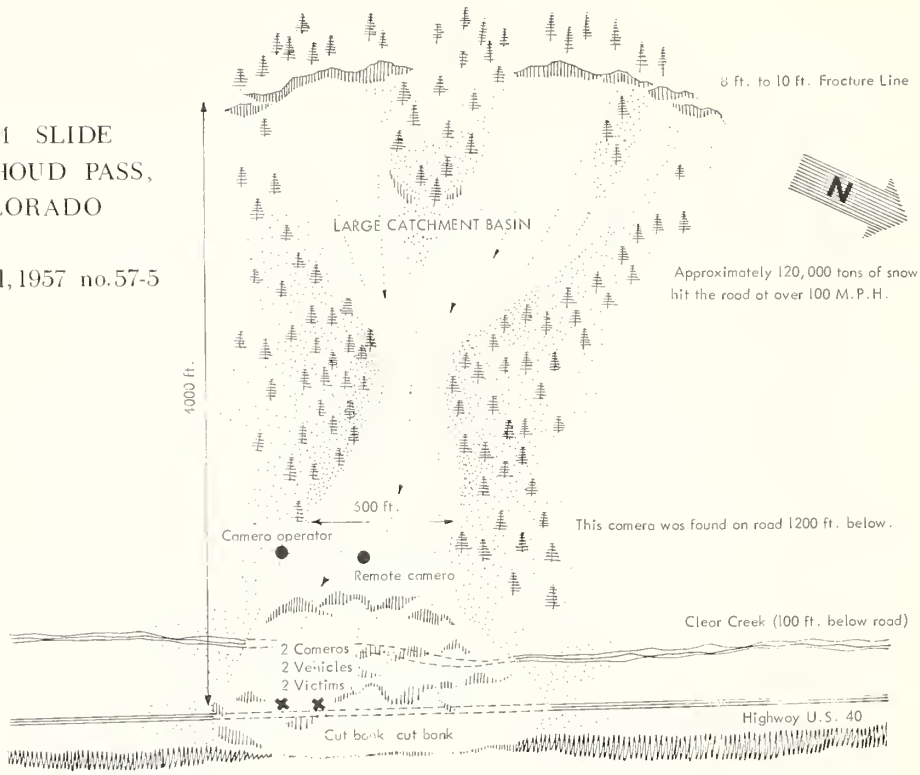
The slide had released at about 1330 hours. At 1400 hours, F. and Ge. spotted Mr. B. who was skiing in the area. Mr. B. administered first aid and sent F. in a car to the nearest phone. An ambulance was driven to the lake. The three seriously injured were evacuated by skiers in the area to the road, where they were taken to Idaho Springs for emergency treatment, and on to a hospital in Denver. M. died the next day of head injuries. L. and Gy. remained on the critical list for some time, but finally recovered.

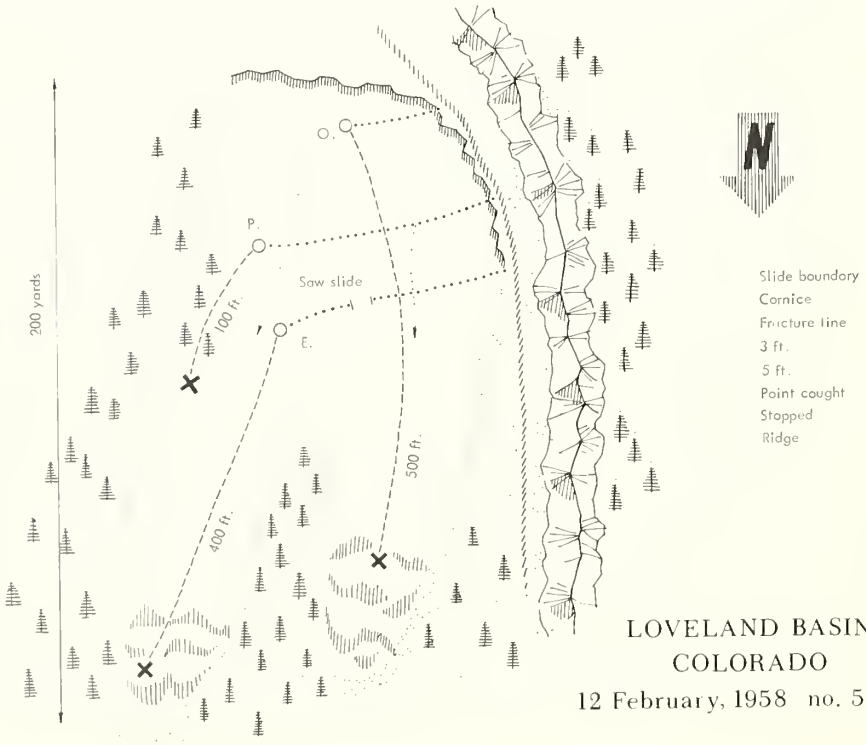
AVALANCHE DATA

The slide was a soft slab (SS-AS-2) with a fracture line 12-18 inches thick. The victims were climbing in an avalanche area that extends for 5/8 mile along this mountain slope. The slide they released was only a small area toward the bottom and in the middle of this vast avalanche area. A hangfire avalanche also released some 400 feet above the victims. Its fracture line was 300 yards wide, but because of a high ridge directly above the victims, the snow from this avalanche was deflected to each side of the victims. Had this snow not been diverted, all five would undoubtedly have been buried under several feet of snow, making survival very doubtful.

DAM SLIDE
BERTHOUD PASS,
COLORADO

8 April, 1957 no. 57-5





LOVELAND BASIN
COLORADO

12 February, 1958 no. 58-1

COMMENTS

This is another classic example of inexperienced, unknowledgable, people venturing into mountainous terrain in the winter. Too frequently such a trip results in tragedy. A strong education program detailing the hazards of the mountains in the winter is needed. These young men could easily have all been killed.

No. 57-5 DAM SLIDE, COLORADO 8 April 1957

WEATHER FACTORS

This avalanche occured after a very intense spring storm. Seventy-nine inches of new snow fell during the seven previous days. Winds ranged from 12-36 m.p.h. from the south and west. Wind was above 30 m.p.h. for 36 hours, and above 20 m.p.h. for 66 hours. Temperatures ranged from a $+2^{o}$ F. to $+25^{o}$ F. Nearly all avalanches ran either during or after this storm, many as climax slides.

SUMMARY OF ACCIDENT

A professional photographer, H., had been assigned to film a story on avalanches and their control. Assisting him was Wy. The state highway department gun team had agreed to allow the photographers to accompany them while they shot slide paths that threatened the highway over Berthoud Pass. A large storm, accompanied with very strong winds, had abated, and on 8 April, 1957, they decided to shoot. They reached the slide path called the "Dam Slide" because of a dam in the creek at its base. The path is 3,600 feet long, including a 1,500 foot transition at its base. Normal deposition is in this transition zone and in the creek. The highway is on the opposite slope, about 40 feet above and 200 feet away from the creek. This slide had not run onto the highway since 1933. H. and his assistant set up three cameras, all encased in waterproof boxes. One was placed in the transition zone, near the eastern edge, one next to the creek, and the third on the highway. Wy. was in the timber on the east side of the avalanche path. H. was on the road, where he could operate that camera and remotely operate the one by the creek. Wy. also operated his camera remotely. A state highway employee Wk.,was standing on the road next to his truck and H.

The 75mm howitzer was placed farther down the road, and traffic was stopped. At approximately 1400 hrs., three shells were fired, the first two yielding nothing. The third shot released the entire 50 acre catchment basin

at once. (Frequently two or three sections will release one after another, which reduces the volume of snow at a given point at a given time.) This produced an estimated 121,500 tons of snow which ran at over 100 m.p.h. The snow not only filled the creek, but buried the highway for 500 feet under 10-12 feet of snow. When the snow cloud settled, nothing was to be seen of the two men on the road, or their truck and station wagon.

Wy. heard H. yell, and Wy. ran for the timber in the snow. Before he reached the trees, "the avalanche hit me like a shock wave, lifting me 10 feet in the air. I could see trees falling around me, then everything went black--or white--it's hard to remember. I was buried, but I managed to claw free of the two feet of snow that covered me." Around 1800 hours, the highway truck was located, windows and cab smashed, and filled with snow. It had been moved 60 feet. About 10 feet away from the truck Wk's. body was located, lying face down. He was under six feet of snow. Later, Mr. H's station wagon was found, crumpled, and with snow packed so solidly inside that it could not be removed except with a board or shovel. At 1045 hours, H.'s body was found in a running position, with his head 16 feet below the surface. Witnesses stated that the highway employee, Wk., was running from the avalanche, but suddenly fell to the highway just before he was covered.

Two cameras were located during the initial search; the other one was found as the snow melted. These films are undoubtedly some of the most spectacular avalanche scenes ever filmed. Trees 60-80 feet tall are flicked into the air like matchsticks. The snow cloud raises several hundred feet into the air and rushes toward the camera at an unbelievable speed, finally enveloping the scene completely.

State highway crews stated they had warned H. that the slide might come over the highway, but he remained in the middle of the path until it was too late.

AVALANCHE DATA

This was a prime example of a climax avalanche. The fracture line was estimated at 8-12 feet, and was a hard slab. (HS-AA-5.) Deposition usually ends in the transition zone or in the creek, but all three of the accumulation zones releasing at the same time, coupled with the heavy build-up, gave more volume at once than usual. The slope of the main avalanche path averages 59%.

COMMENTS

This avalanche has run to the highway level frequently enough to keep an obvious path cleared above and below the road. Since all cameras had remote control capabilities, there seems to be no reason for either man to be in the avalanche path, even though it had not run that extensively for 24 years. The photographer's desire was to obtain as spectacular films as possible. His goal was accomplished.

WEATHER FACTORS

A storm lasting for several days had deposited 12-16 inches of snow in the area. Winds were strong and of sufficient duration to indicate probable avalanche hazard.

SUMMARY OF ACCIDENT

Three professional ski patrolmen decided to stabilize some of the snow fields east of the main ski area. These areas are outside the regular avalanche control area, and beyond posted signs reading "Avalanche Danger, do not ski beyond this sign." The party put a small charge of eight sticks of 50% dynamite at the top of one slope. This area is behind an old snow fence and the snow here was solidly packed from drifting. No settlement or snow movement took place. The group then worked their way downward, crossing over a rocky bench over 100 feet wide and blown nearly clear of snow. The slope below the bench is approximately 600 yards long, and an obvious avalanche path. A cornice had developed along the western ridge of the path.

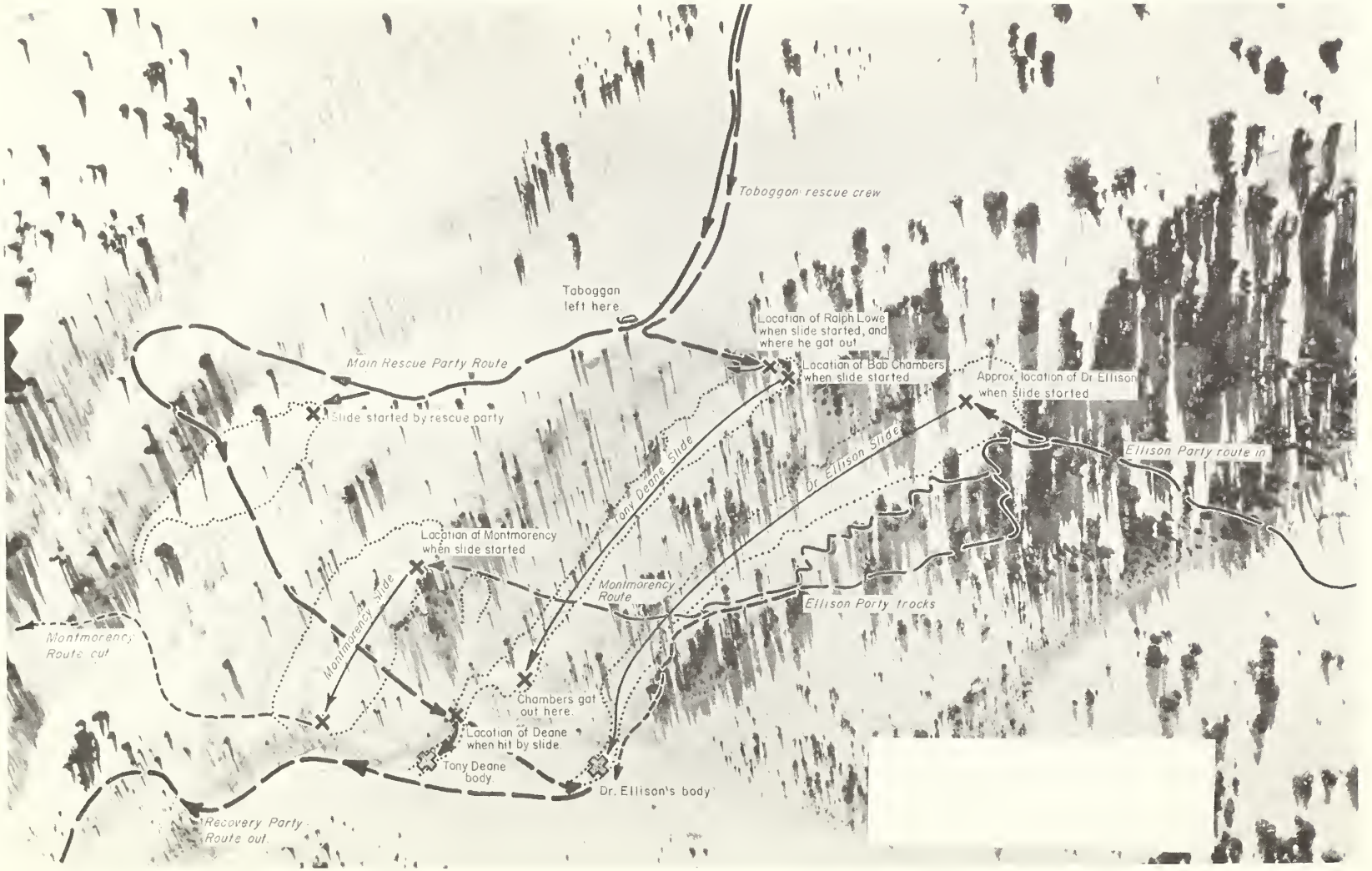
Two of the patrolmen, E. and P., tried to knock off some of the cornice without much success. No high explosives were used. The third man, O. remained at the top of the slide path. P. and E. skied out into the slide path, followed by O.at the top. The avalanche was probably triggered by O. He was caught just below the fracture line, and carried 500 feet down the western edge of the slide. He remained on the surface and suffered no injuries.

P. and E. were about 100 feet below O. P. was carried 100 feet down the slope through small trees. He was partially buried, but dug himself out. His injuries were a broken nose, two broken ribs, abrasions around the face, lips, and nose, torn ligaments in his left knee, eight teeth knocked out and several others loosened, and multiple bruises over his body. One ski remained on--the other came off. Both poles came off. One glove with the pole strap still around it was found hanging in a tree, five feet above the snow surface.

E. saw the avalanche before it hit him, and attempted to ski away from it to the east. He was caught, however, and the impact tore both his skis from his boots. The slide carried him 400 feet and completely buried him in a sitting position. E. was able to extract his own arms and head from the snow, but it was necessary for his companions to dig out his legs.

AVALANCHE DATA

The avalanche was a hard slab, with 8-12 inches of depth hoar under the older snow. Fracture line varied from three to five feet deep, with some larger pieces of the slab (some desk-size remaining intact at the bottom. This slide would be classified as: HS-AS-3. Slope-60%.



No. 58-2 Snow Basin, Utah 9 March 1958 U.S. Forest Service Photo

COMMENTS

The goal of the party was to stabilize some of the slopes east of the regularly controlled ski area. The party succeeded, but not by a recommended method, nor in a way that they expected to. A number of mistakes were made. After such a storm, slopes of this size should never be "test" skied. Explosives are cheaper than false teeth or a funeral.

If necessary to ski such a slope, only one man should be on the path at once, and then belayed. Proper explosives should be used for avalanche control work. These men were very lucky that they were merely battered and bruised.

No. 58-2 SNOW BASIN, UTAH 9 March 1958

WEATHER FACTORS

Between 3 March and 8 March, the weather at Snow Basin was good. No new snow fell in this period, and a hard crust formed on the surface on the old snow. On 8 March a severe storm moved into the area, dropping six inches of new snow at the Forest Service shelter and ten inches on John Paul Jones ridge. High winds accompanying the storm created snow slab conditions on the northerly exposed slopes. An examination of the snow conditions on 10 March indicated that warm temperatures had existed during the first part of the storm and approximately two inches of pellet snow were deposited on the hard crust. As the storm continued, temperatures dropped, bringing an eight-inch layer of powder snow. At the time the first avalanche released, the snow still had not bonded and a hazard persisted.

By the evening of 8 March, the storm subsided; by noon on 9 March, the overcast skies began to clear. Skiers reported that strong winds were blowing at the higher elevations near the summit of Mt. Ogden, but that it was nearly calm in the lower elevations in the vicinity of the chair lift.

ACCIDENT SUMMARY

At approximately 10:30 a.m. on 9 March, four skiers arrived at Snow Basin to begin a one-day ski tour. All of the men in the party had been skiing for many years. They were experienced in touring, having toured in the same general area for years. It was the first time that all four had skied together. Originally the men had intended to tour at Brighton; however, on calling the Alpine Rose Lodge, F.M. learned that heavy new snows made touring in that area hazardous. Consequently the group decided to go to Snow Basin.

Shortly after arriving in the parking lot, the group met the Forest Service snow ranger, who allegedly remarked, "You crazy guys aren't going out today in this wind and snow?" F. M. and Dr. E. talked briefly with the ranger, noting the strong winds and low ceiling near the crest of the mountain range. Although they did not discuss snow conditions, the ranger apparently got the impression that the men had decided against touring. He left the four and went over to Becker Hill where he joined the Ski Patrol in packing the hill.

A short time later the touring party bought lift tickets to the top of both the Wildcat and Porcupine Lifts. At the top of the Wildcat lift, R. P. grew apprehensive about the strong winds in the area, but said nothing to his companions.

The wind speed was about twenty to twenty-five m.p.h.; visibility was approximately three quarters of a mile.

It was probably about 11:00 a.m. when the party arrived at the top of Porcupine lift and prepared to leave on their tour. Dropping off the hill at the snow marker, they congregated under a large fir to put on their climbers. Three of them carried small packs with first aid and other equipment. Dr. E. left his in the car, since the others had duplicate equipment. The snow seemed excellent. Of the snow conditions, R. J., in his statement on the accident, further remarked that, "I must say that many another time I have considered snow conditions much more hazardous than they were this day."

The four chose a northerly route, traveling along ridge lines between the John Paul Jones Ridge and Mt. Ogden, heading for Easter Bowl. The lead position and the task of breaking trail were at first rotated among three of the skiers. R. P. had climber trouble and remained slightly behind. On this part of the ascent, they saw no fracture lines or other indications of unsafe conditions.

On reaching Easter Bowl, they traversed on a line about midway down the Bowl. Snow conditions still seemed good. About halfway through the Bowl, R. P. took the lead. According to his statement, he was about 100 yards from the crest of the ridge when he felt an extensive settling of the snow under his skis, accompanied by an audible "boom." He indicates that this was the first sign of any instability. The party continued on to the ridge top above the Bowl, and briefly checked snow conditions in that area. Some 75 feet down the ridge, they found wind-crusted snow and a marked ripple effect. Avoiding this area, they climbed higher on the ridge to eat lunch, completing the ascent about 12:45 p.m. The four stopped to eat in a shelter of fir trees just below the ridge top, overlooking the last cirque to the north of Mt. Ogden.

During their hasty lunch, the northwest wind, which had been very strong, quieted noticeably. The overcast broke in places, allowing good visibility Following their lunch at about 1:15 p.m., the four began the first part of their descent. It was decided to ski the lower part of the Easter Bowl,

thus avoiding potentially hazardous conditions in the upper part of the Bowl. The lower route would also put them in a position to make a traverse to the top of the prominent east face.

They ran the first slope in good form and regrouped at the lower section. All commented on the ideal powder snow conditions. From there the party crossed a ridge top to pick up the east face run. They ran part of this face, grouping again before the final run. Here the four noted a change in the consistency of the snow. On the final run on the east face, several of them fell. At this point the men decided to traverse through the timber high on the north face of John Paul Jones ridge to return to Chicken Springs Run in the main Ski Area.

Accordingly, after their descent of the east face, the men entered the dense timber and began to traverse parallel to that ridge. By this time they knew conditions were a little unpredictable, but in the timber the snow was deep and there was no evidence of instability. Dr. E. led the party and the other three followed at varying distances. R. P. stopped, and dropped down out of the trail to take a picture, but Dr. E., possibly unaware of this, continued through the trees and rounded the ridge. F. R. and R. J. paused briefly with R. P., and then the three men proceeded, following in Dr. E.'s tracks. As the three approached the east edge of the timber they saw Dr. E.'s tracks lead up to the edge of a large slab avalanche that had released and disappear into its path. There had been no sound or warning of the slide. The fracture line was located about thirty-five feet above his tracks.

The three called, hopefully, but it was obvious that Dr. E. had been caught and probably carried over one thousand feet to the bottom of the slide. Hurriedly the three skied down along the north side of the avalanche, searching intermittently with ski poles on the way down for any sign of the victim. Finally recognizing the danger they were in they paused about halfway down the 1,250 foot avalanche to remove their skis. At this point it was agreed that F. M. would return to the main ski area for help. R. P. and R. J. descended to the fan of the slide, located in a small gully, to begin a systematic search. The deposition area was about two hundred feet long and thirty feet wide. Arriving on the fan about 2:15 p.m., they were forced to exercise great care because of the precarious location of the debris. The two men organized their search, R. J. probing up from the bottom of the slide, and R. P. beginning at the upper part of the slide, and working downward.

F. M., after leaving the other two, crossed the slide path and headed for the shelter back at Snow Basin. He continued on skis to a point where he feared slide danger. Removing his skis, F. M. proceeded on foot. With no warning an avalanche released above him, carrying F. M. 460 feet to the foot of the slope. Fighting continually to stay on the surface, he was slammed against a tree. The left side of his face was bruised, he lost his pack and one ski. Though badly shaken, he continued cross-country to the ridge north of Chicken Springs run. From there he called to skiers that there was a man lost in an avalanche.

Fearful of the consequences should inexperienced skiers go into the area, he refused to tell anyone the slide's location. He insisted they find patrolman B. B., who not only knew the area thoroughly, but who also had had some avalanche training. A doctor in the area immediately notified this patrolman, who met F. M. around 3:00 p.m. in the "Rock Garden" in Chicken Springs. There F. M. gave him the details of the two slides, and stated that only experienced skiers should be included in any rescue party. Then, leaving the details of the rescue to B. B., he went over to the Ski Patrol, who took him by toboggan to the shelter, where a brief examination by a doctor revealed only cuts and bruises. After calling his wife, he notified a friend of Dr. E.'s to tell Mrs. E. of the accident.

RESCUE

In the meantime, other skiers who had heard F. M.'s shouted message notified area officials of the avalanche. S. H., operator of the Snow Basin Ski Area and R. N., head of the Ski Patrol, both learned of the accident from an unidentified skier at the lower terminal of the Wildcat lift. R. N., thinking that the slide had occurred on a particularly steep slope in the Chicken Springs area, left immediately to check that location. R. S., the Snow Ranger, was notified, and he quickly joined S. H., who was already organizing a rescue party. The two conferred briefly about the organization of the party. Because R. S. was still recovering from a recent illness, they decided it would be best if he did not lead the rescue. The Ski Patrol Chief was passed over in favor of B. B., who had had some avalanche training in the army.

On the area operator's orders, the rescue party of thirteen men assembled at the top of Wildcat, where several more joined the group. B. B. returned to the shelter from his meeting with F. M. on Chicken Springs; on his return he was appointed leader of the party by the area operator and joined the main party at the top of the lift. He screened the group, dropping some of the more inexperienced skiers. The final size of the party is uncertain, but probably included between fifteen and twenty people. While the main party left the upper terminal of Wildcat and crossed over to the lower end of the Porcupine rope tow, a smaller group of about four people went to the top of the Porcupine lift to get a toboggan. B. B. apparently was aware of this move and had approved it. This group arrived at the top of Porcupine where they picked up the toboggan and another volunteer. From there, they moved toward John Paul Jones Ridge.

The main party arrived at the bottom of the rope tow, picked up probes and shovels (which had been brought into the area by the patrol chief) and assembled at the top of the tow. R. N. and B. B. disagreed about the safest route to the slide area, but B. B. prevailed, and the party traversed directly across the hill to John Paul Jones Ridge. This phase of the rescue operation remained well organized as the group moved single file with probes and shovels along the ridge. Climbing to the ridge top, they arrived at the section overlooking the avalanche area.

From this vantage point they could see the two men below, searching the avalanche debris for E. At that point the men below caught sight of the rescue party and tried to warn them away from the face by waving and shouting. However, distance separating the two groups thwarted their efforts to communicate. The two patrolmen and another skier moved cautiously up the ridge to check the situation. Deciding that avalanche hazards made it too dangerous to cross the ridge and descend directly to the avalanche, the three men returned to the others to make alternate plans.

Although the second group with the toboggan arrived later, and higher on the ridge than the first group, by this time the toboggan crew had almost caught up. But before the two groups could actually join, B. B. decided to have the main party ski down the ridge through the trees, and proceed from there across to the bottom of the slide. According to one account, the rescue party then became disorganized and separated, as men began skiing down the ridge in whatever way they could. They started down, R. N. shouted for someone to be a lookout to warn the rest of any slides. Whether anyone did so is not known.

Shortly the men with the toboggan appeared on the ridge top and joined stragglers from the main party. The survivors again tried to warn them away but still were unable to communicate. Instead of following the others down the ridge, the smaller party (four or five) parked the toboggan and one of these men, B. C., began to work along the ridge in order to get into a position to work down the slope. Sensing the danger from additional avalanches, another man with mountain climbing experience quickly grabbed a rope off the toboggan. After tying the rope around his waist and taking a shoulder belay from a companion, he tried to reach B.C. with the rope.

Most of the main party had already reached the bottom of the ridge and were starting up the canyon to the main slide. On their way down they narrowly missed being caught by another avalanche, but a warning shout stopped the group just short of the slide's path. As they approached the avalanche debris, the terrain became increasingly dangerous. Just beyond a cluster of pine andalpine trees they encountered a shallow gully. Recognizing it as a potential avalanche path, B. B., unaware of the skiers above him, ordered the group to halt and cross one at a time. He sent one skier across. The man stopped, looked up the steep slope, and then proceeded through the gully. He safely reached a small ledge between two sharp pitches just beyond the gully. The patrolman next sent T. D. into the gully. At that moment, on the ridge above, the avalanche which the roped climber had feared, broke away, carrying B. C. tumbling down the slope in the cascading snow. The climber, near the middle of the slide path, was hurled down the slope and covered. Luckily he was by this time on belay from a large tree and the skier managing the rope was able to hold him. The snow pounded past him, rushing on down the slope and into the gully which those below were trying to cross. Suddenly B. B.'s party heard ominous rumbling of the slide. Both the patrolmen shouted to the first man across the gully to run for safety and told the others to grab a tree. In the fear and excitement, T. D.,exposed in the middle of the gully was

forgotten. As the avalanche slammed through the narrow gully, T. D. was torn from his position and swept away by the rushing snow. He was carried nearly one hundred and fifty feet until the snow finally slowed to a stop and settled over him.

The first man across the gully was safe. Most of the others managed to grab a tree trunk and only their feet were buried. One was snatched from his tree and carried some fifteen feet, but he too remained on the surface. All were unaware that T. D. was buried in the avalanche. B. C. was spewn out of the slide before it entered the gully. As the main party dug themselves out and regrouped, they noticed him, dazed and in shock, higher up on the slope. One of the doctors in the party told him to sit down and wait until he could be checked for possible injuries. The group then continued across the slide, most of them going onto the avalanche were Dr. E. was buried. T. D. still was not missed. At this point, B. B. turned the leadership of the party over to R. N., head of the Ski Patrol, who proceeded to organize the systematic probe.

R. J. (one of the two survivors already probing) and several others began to wonder if someone wasn't missing. They then shortly figured out that T.D. must have been trapped in the slide. About six men went back to start searching the new avalanche area. Realizing that the second accident demanded more men and supplies, including longer probe poles, R. N. sent three members of the party back to the lodge for help.

The men on the top of the ridge, who had escaped the second slide, started down to discover what had happened to B. C. After descending the ridge top they followed the path of the main party to the slides. There they learned that B. C. was safe, but that T. D. was lost. One member of this group posted himself as lookout and the rest immediately joined in the searches. Four or five men began probing at six to eight inch intervals in the main mass of the second slide where T. D. was believed buried. The group working on the earlier slide began probing at one foot intervals, starting at the bottom of the deposition zone.

Meanwhile back at the shelter, the incapacitated snow ranger notified district level personnel and the sheriff's office of the accident. Additional help and avalanche experts were requested from the Supervisor of the Wasatch National Forest. At about 3:30 the Snow Basin operator sent two employees to follow B. B.'s tracks to see if the party needed anything. The two men arrived at the slides and then returned to the lodge with a request for rope. S. H. then dispatched these two and four additional men with a large amount of rope. The group was instructed not to cross any open snow but to stay on the path made by the rescue party.

In the meantime, the three men dispatched by the rescue party after the second slide arrived at the lodge with a request for longer probes. However none were available at Snow Basin, and it would take until the next day to obtain them. The use of a helicopter to aid rescue operations was suggested by one of these men who had connections with the nearby Hill Air Force Base.

Hoping to use it to drop messages to the search party, officials at the lodge requested the helicopter.

The six men sent to aid rescue operations by the area operator arrived at the slide area around 4:30 p.m. just as T.D.'s body was being removed from the second avalanche. A searcher, randomly probing likely areas in the bottom of the slide, had hit something that felt like a body. Digging down, they found T. D. He had been buried about forty minutes, with his head under nearly five feet of snow. His skis, still on his feet, were only about two feet under the surface. He had been bleeding from the mouth and his face was a dark blue color. Although there was no question about his being dead, artificial respiration was administered for a time variously estimated as a half hour to an hour and a half.

The relief party continued on to the other slide to join the search for Dr.E. They were able to provide some relief for the members of the first party and the two men who had been touring with Dr. E. Back at the first avalanche, T. D. was finally given up for dead and his body was wrapped in several parkas. Due to the approaching darkness and hazardous conditions, it was decided to delay removal of the body until the next day.

Worried that, if the searchers remained in the area any later, they would be in great danger, the rescue leader suggested that all personnel in the area return to the lodge and postpone the search for Dr. E. until the next day. One of Dr. E.'s companions urged the group to remain just long enough to complete searching the last thirty feet of the slide area.

Eventually, on B. B.'s suggestion, about ten men left, though all ten did not leave at once, but departed in smaller groups at variously spaced time intervals. Nine men remained to continue searching for Dr. E. The group under B. B. arrived back at the lodge between 5:30 and 5:45 p.m., just as the helicopter and the district ranger arrived. Both B. B. and the district ranger were apprehensive about the helicopter triggering additional slides. Advising against its use, they suggested that the helicopter be returned to the Base. At 7:05 p.m., they learned by flashlight code that the searchers had recovered Dr. E's body.

Disregarding the sheriff's flashlight code message to leave the area, the small group had remained at the avalanche, probing the debris for any sign of Dr. E. One of the men had a miner's light which proved of great value in the search effort. After probing about ten feet more, they discovered Dr. E.'s body, four and one-half feet under the surface. There was no sign of prior movement around the victim, and there was no ice mask over his face. Rescuers dug the body from the snow and examined it carefully for any sign of life. Finding none, they tied the hands and arms across the chest and wrapped the body, planning to recover it the next day. The nine men then numbered off and started back to the lodge where it was thought that only six men had been left at the scene. The group remained together, stopping several times to count off, thus making sure that no one was lost. They returned safely to the shelter around 8:30 p.m.

The bodies were removed without incident on the following day by the Weber County Sheriff's office and experienced Forest Service snow rangers. Adequate precautions were taken to avoid any lingering avalanche hazard.

COMMENTS

Details of this sad day on Mt. Ogden are far from clear. Statements by the participants are well-documented, but do not all agree. This case history represents a systhesis of the best available information.

Ski patrolmen, ski area operators, snow rangers, rescue group leaders - all those who may some day have to assume leadership of an avalanche rescue are invited to contemplate this report. Divided authority, uncertain leadership, loss of discipline or control over a large rescue group, can all lead to sudden disaster. When an avalanche accident occurs, the hazard is high. Firm command, good organization, and exacting care are required to insure that the rescuers do not become rescuees. The same admonition applies to survivors going for help.

In this case, an experienced ski-touring party seriously underestimated the avalanche hazard in spite of some obvious warning signs. The final part of their route took them directly into the fracture line zone of steep avalanche paths on the side of John Paul Jones Ridge, just when they were becoming concerned about avalanche hazard. The accident illustrates once more a recurring theme in these case histories: Snow conditions are difficult to judge, but safe routes need not be. When any doubt about snow stability exists, stay off the avalanche paths and especially out of the release zones.

No. 58-3 SILVER CREEK, WASHINGTON 16 March 1958

WEATHER FACTORS

The weather during the week prior to 15 March had been clear and sunny; the last snowfall was believed to have occurred about 5 March. An inch of light snow fell on the evening of th 15th, but temperatures that evening and on the 16th were relatively high.

ACCIDENT SUMMARY

Silver Creek Valley, today the site of the Crystal Mountain Ski Area, lies just to the east of Mt. Rainier National Park. Formerly it was reached by trail from Silver Creek Lodge on the west side of the Chinook Pass highway. On 15 March a party of nine skiers entered the area to survey a potential

ski area development. All of the members of the party, which included two Forest Service snow rangers and one ski instructor, were experienced skiers. The group completed one day's investigation and then spent the night of 15 March in a miner's cabin located some distance up the valley. The next morning, the party made a tour of the ridges; early in the afternoon they began the descent to their cars.

It was clear that considerable avalanche activity had taken place in the area a week or two before, though most of the debris had been partially buried under subsequent snow fall. On the 16th no other signs of instability had been detected. While the terrain itself was recognized as definite "avalanche country," the experienced members of the party felt that snow conditions were generally safe.

During their descent, the party traversed along a narrow, sloping bench on a 35 degree (70%) slope, which faced east. By 3:00 p.m. they were at a point about one thousand feet above the valley floor, elevation 4,800 feet, on a ridge rising to a height of 6,500 feet. The total snow depth in the area that the party was crossing was no more than four to five feet. One of the skiers cut higher than the rest, above the bench, and released a damp, hard slab avalanche.

Fortunately five of the nine skiers were across, or on the edge of the slide and were involved only in the edge of the tumbling snow. Three of the skiers were directly in the slide's path. As the snow swept by, the three were caught up in the avalanche and carried down the slope. One of the three was carried about one hundred feet and then lodged against a dead tree. The second, F. F., was carried over five hundred feet to within seventy-five feet of the end of the slide. He was alternately buried and brought to the surface, and apparently struck a tree on the way down. The third skier, E. L., was carried almost to the very tip of the slide, and was partially buried several times.

RESCUE

Rescue operations were initiated immediately by the other men. The upper victim was extricated from his position behind the tree. Though he suffered bruised back muscles and was in shock after the accident, he was later able to walk out of the area with some assistance. E. L., the man carried the furthest, was slightly injured with a pulled leg muscle, but was nevertheless able to assist with the rescue work. Both of his skis came through intact and on his feet (he wore non-release cable bindings). F. F. was most seriously injured. He suffered back injuries from striking a tree (later diagnosed as bruised and torn muscles which accentuated the effects of an old injury). One of his skis was completely lost, and the other broke in two. Since he was unable to walk, the others improvised a toboggan from skis and dragged him three miles down the valley to the nearest road. The exhausted party reached Silver Creek Lodge about 10:00 p.m. that night.

COMMENTS

Even experienced snow rangers can't out-guess snow conditions every time. This accident should caution the less experienced who think they have all the answers. The party was spread out for protection, but not nearly far enough.

No. 58-4 BERTHOUD PASS, COLORADO 19 April 1958

WEATHER FACTORS

At about 1530 two unidentified young skiers from Denver were riding the chair lift at Berthoud Pass ski area. Both were fifteen, inexperienced, and this was their first time at the Pass. At that time a heavy ground blizzard with wind speeds averaging twenty-six miles per hour had been drifting the snow for about eight and a half hours. There was no snow falling. In the area where the avalanche occurred, about twelve inches of wind-drifted snow were deposited on a sun crust surface.

AVALANCHE SUMMARY

Just above towers three and four, between the rope barrier and the avalanche release point, the two boys jumped out of the lift. Apparently because of low visibility due to a heavy ground blizzard, the two became lost. They entered the Russell Cliff Area, which is nearly a vertical rock cliff about one hundred feet high and two hundred yards wide. The boy ahead cut loose a twelve inch soft slab. He was carried from the top of the cliff to the bottom, fortunately through the only couloir in the face of the rock. His rate of descent was probably about thirty miles per hour. The fall was cushioned by the snow surrounding the skier. Miraculously, he hit no rocks on his way through the couloir, and escaped injury.

His companion avoided the avalanche, but didn't bother to check on the fate of his partner, nor turn in an alarm. Observers below at the lodge and at the Snow Ranger's headquarters saw the avalanche and could see the boy digging himself out and gathering his equipment. Since he obviously wasn't injured, no rescue operations were organized.

COMMENT

These inexperienced skiers excaped serious injury only by good luck. A similar pair of inexperienced youths in another Colorado ski area were not so fortunate in 1965.

WEATHER FACTORS

A severe storm began the night of 24 January and continued into the morning of 25 January. Precipitation intensity was average with wind velocity at 5-10 m.p.h. Temperature remained around 26-28 degrees. Six inches of new snow fell during the course of the storm. This was the beginning of a storm cycle that lasted until the beginning of February.

ACCIDENT SUMMARY

On 25 January artillery fire and test skiing in the ski area failed to reveal any slide danger. Most of the area was consequently opened for use. Late in the afternoon two skiers traversed the steep slopes above Wildcat Bowl and climbed high under the cornices above Westward Ho. Their path took them about 50 feet higher up the slope than the usual traverse, and above the area which had been test skied earlier in the day. At the steepest part of the slope, just under the cornice, they dislodged a deep climax slab which carried them both a short distance down the hill. They suffered minor bruises and equipment damage. Both were experienced skiers, and one was a trainee in the avalanche school.

Shortly afterwards an Alta Lodge employee and a guest skied through the Eagle's Nest in the area known as High Nowhere. As they did so, they dislodged a climax slab under the steep cliffs of North Rustler. The employee was carried clear to the bottom of the slope, but escaped without injury.

AVALANCHE DATA

The storm occurring on 24-25 January was of little consequence in itself, but provided sufficient load to trigger climax slide conditions, and provided clear warning of impending slide activity as more snow was added by storms on the following days. The highly unstable nature of the base, with at least two good falls of powder resting on a smooth rain crust, had indicated that extensive avalanching was to be expected.

Early on the morning of the 25th a climax slide occurred on Superior, blocking the road. The slides later in the day on Westward Ho and North Rustler indicated that avalanche hazard was high and that danger would increase as storm conditions persisted.

WEATHER FACTORS

By 10 February, the snow stake at Ketchum, Idaho, (elevation 6,700 feet) indicated an accumulation of only fourteen inches. Then between 1:00 p.m., 10 February and 3:00 p.m. on 11 February, a total of thirty-four inches of snow fell at Ketchum. During approximately the same period there was a total fall of nearly forty inches on the top of Bald Mountain (elevation 9,000 feet). As a result of these storm conditions, the ski area on Bald Mountain was closed 11 February, and no skiers were allowed on the mountain.

ACCIDENT SUMMARY

At 9:00 a.m. 11 February, although the storm was still in progress, the Ski Patrol started out to test ski the slopes. By this time, the lift operators were starting to clear the landings at the upper terminal of Lift No. One, and the lower terminal of Lift No. Two, which are situated near each other on a small level area. The Ski Patrol notified the operators that it would take them about thirty minutes to ski back down College Run and begin test skiing in the area above the lifts. At this point, E. S., manager of the area, instructed all the operators to go to the top of Lift No. Two until the Ski Patrol had finished checking the surrounding slopes. Accordingly they gathered at the top of Lift No. Two. Due to the deep snow and storm conditions (the snow continued to fall at the rate of about one inch per hour), it took the Ski Patrol an hour and a half to arrive at the test area.

In the meantime, ski instructor S. E. had requested the operators to start the lifts so that he and another ski instructor could go to the Round House. After returning to the upper terminal of No. One, and the lower terminal of Lift No. Two, the operators did this, but instead of returning to the safe upper terminal of No. Two, they stayed below to clear the lifts' landing and loading areas. S.E. and the instructor went on to Exhibition run, where they intended to test ski the slope.

Then suddenly at about 3:00 p.m., two avalanches broke loose from the area above the two lift terminals. The men below, working on the terminals, heard the avalanches coming, and all but one were able to climb the lift towers to safety. The one man unable to reach the towers was completely covered by the slide. Fortunately he was unhurt, and the other operators, guided by his muffled yells, hastily dug him out. Both of the lift houses were demolished by the avalanche. Moreover, when the lift house was demolished on Lift No. Two, it caused a short circuit in the control and started the lift. Eleven of the chairs, which had been pulled out of line by the slide, ran through the tower, bending part of the tower and destroying the chairs.

The slide started about one hundred feet above the avalanche stabilization benches that had been dozed out a number of years before. Before the snow

settled to a stop, the slides had crossed three avalanche stabilization benches. Although there was speculation that the slides were caused by snow falling from trees, the Ski Patrol had skied the ridge just above the fracture line of both avalanches. They reported that they had not started any other slides during their test ski runs.

Exhibition Run, which has avalanched several times in the past and hit the two lift towers, did not slide during or after the storm. When S.E. and the instructor reached the run, they decided that there was too much snow to test ski it. Consequently, the men were unable to determine conditions in this area. However, Exhibition Run had been skied prior to the storm while the area that slid had not been skied all winter. There was a definite mogul pattern established on Exhibition; after the storm, on 12 February, the mogul pattern was still very apparent. Though Exhibition did not slide, there were avalanches on two other runs in the area that same afternoon.

COMMENT

Lack of coordination during the storm and poor visibility led to a near-disaster. Tight control is required in such circumstances to insure safety. Test-skiing large slopes in poor visibility is a risky procedure at any time. Never hesitate to use High Explosives.

No. 59-3 BRIDGER BOWL, MONTANA 1 March 1959

WEATHER FACTORS

The slide occurred on 1 March, following a week of intermittent snowfall totaling fifteen inches. Five inches of powder had fallen on the night before the slide. Up to the time of the avalanche, this new snow had not reacted nor had it begun to settle. The temperature in this period ranged from 25° during the day to 10° at night; on the first it was 30°.

ACCIDENT SUMMARY

Three members of the Bridger Bowl Ski Patrol team and another skier were members of the party involved in this avalanche. The catwalk entrance to the North Bowl area, some seventy-five yards below the rim of the Bowl, was closed on the first. At about 2:20 p.m. the three members of the Ski Patrol and their companion were traveling along the perimeter of the Bowl, looking for another entrance. Approaching what appeared to be a large slab lying below a small cornice, one of the patrolmen recognized the danger and told the party to climb around the cornice.

Patrolman T.A. took the lead, and the party climbed to a point twenty yards above the cornice. T.A. was nearly ten yards ahead of the rest of the party, when the shearing of his skis caused another slab to avalanche. Unable to ski away from the large slab, T.A. was forced to ride out the slide. The avalanche ran from a point on the rim of the Bowl above the catwalk entrance, over a sixty foot cliff, across the catwalk and onto the floor of the Bowl. Though a skier for six years, T.A. had had no previous avalanche experience. Fortunately, he recalled earlier instructions to try to swim when caught in a slide. He noted that when he started to swim, he felt his feet swing below his head, and the rest of his body popped right out of the slide. As the avalanche ran over the cliff, he was buried again, but by "swimming" he was able to regain the surface. When the slide stopped, his skis were buried under a foot of snow, he had lost his poles, but except for his feet, he was safely on the top of the slide.

The other two patrolmen and the fourth skier were unable to see the end of the slide, as it was out of sight below the rocks. They quickly came down to the catwalk. From there they could see that T.A. was safe. After sending the other skier back to the main hill to report that no one had been injured, the two patrolmen went on into the slidepath to help their companion.

COMMENT

Details of this accident are scanty. The ski patrol group apparently were prudent, but one man was still caught in the middle of a slab when it released and carried over a cliff below. Fortunately the patrolman was at the very top of the avalanche. If he had been farther down, his chances for survival would have been much less.

This is no place for test skiing. Explosives should always be used for avalanche control in such terrain.

It is interesting to note the testimonial to the effectiveness of the "swimming" motion when caught in an avalanche.

No. 59-4 MT. HOOD, OREGON 20 June 1959

ACCIDENT SUMMARY

Early Saturday morning, 20 June, 1959, a party of thirty-two Explorer Scouts and sixteen adults set out to make their scheduled climb of the south side of Mt. Hood. Various other climbing parties were on the mountain at the same time. The weather was good, though about noon the snow began to melt,

making the Chute soft. Crags above the Chute were plastered with snow and ice. Forty-four members of the party arrived on the summit at noon; four of the boys had elected to stay at the upper Hot Rocks. After reaching the top, some immediately started back down, following the same route they had taken on the ascent.

The Scouts and their leaders were divided into nine ropes; the accident involved the next to the last rope to leave the summit. Two of the people on this rope were adults, and the other three were Scouts. The party went straight down the chute to a point above a horizontal crevasse. At that point they traversed diagonally downward to the west to go around the end of the crevasse. From there they made a diagonal traverse downward and east toward the upper Hot Rocks.

While passing under the crags west of the Chute, this roped party of five was caught by an avalanche of snow and ice from the crags. They were warned by a call from the last rope, which was then waiting to follow along behind. Though most of the party were able to dig in, one person was apparently still in motion when the avalanche hit. All were swept down into a crevasse, with a drop of approximately fifteen to twenty feet, and were covered with the falling snow and ice.

RESCUE

Other climbers within the Crater area immediately hurried to the crevasse. Several were lowered into the crevasse and began to dig out those who were buried. The snow and ice which covered the buried climbers had frozen and compacted. Digging was difficult and was accomplished only by the aid of ice axes. More snow and ice fell into the crevasse, piling up on the searchers as they worked. The first three victims were quickly uncovered and hauled out of the crevasse by a straight lift. They were escorted down the mountain until a Forest Service crew met them. It was later learned that one had a fractured vertebra, while the other two received only bruises.

The fourth man was buried deeply in a prone position and was unconscious when first uncovered. One of the rescuers was successful in restoring normal breathing by simply pushing on his chest. The digging out of this victim was completed despite falling snow and ice, after which he was hauled out by use of simple rope slings. The fifth climber, D.D., was the most deeply buried, and by the time he was reached, which was fifteen to twenty minutes later, he was in a serious condition. As soon as he was dug out, he was moved to a point under the North wall of the crevasse, to avoid falling snow and ice. Artificial respiration was applied for about a half hour, while a litter was being improvised from a pack board, ski poles, and climbing rope. By the time the litter was ready, snow and ice falling from above had piled up in the crevasse until they could carry D.D. out by simply walking over the lower lip of the crevasse. Artificial respiration was continued for a total of about three and a half hours.

The accident happened about 1:10 p.m., and word was carried to Timberline Lodge by skiers, who arrived there at approximately 1:45 p.m. The Snowcat left Timberline at 2:15 with Forest Service and Lodge employees. Word of the accident was phoned to the president of the Mountain Rescue and Safety Council of Oregon in Portland at 1:53. The Rescue Chairman was notified and left immediately for the mountain. The telephone call committee began to round up rescue personnel.

Although original messages from the scene did request oxygen, this word was not received. The Snow-cat party had a radio in the cab, but due to a lack of manpower, they were not able to carry it to the scene of the accident. At 4:15 p.m. when the Snow-cat party arrived near the base of Crater Rock, where the cat track ends, they received word of the need for oxygen and relayed the message. Arrangements were made with a Hood River pilot to drop a resuscitator on the mountain. At about 5:10 p.m. the plane was in a position for the drop in the crater; the pilot dropped a message asking if they needed the resuscitator. He received a negative reply and the resuscitator was not dropped.

The rescue party, with D.D., arrived at Timberline Lodge at 7:30. There, Dr. R.C., a visitor at the lodge, attended D.D. for nearly one hour. He was then taken by ambulance to Providence Hospital in Portland. He received oxygen continuously en route to the hospital. He arrived at the hospital at approximately 9:35 p.m. He died at 10:10 p.m. Autopsy determined cause of death as asphyxiation.

COMMENT

See also No. 39-1. The warning can be repeated here: Crevassed glacier terrain is the most dangerous place of all to be caught in an avalanche. Even a small and otherwise harmless slide can carry a man into a crevasse and bury him under many feet of snow.

The many members of this climbing party obviously were not fully aware of the possible avalanche danger from melting snow during a June climb. Dangerous conditions can develop or persist any time of the year at high altitudes.

No. 60-1 SOLITUDE SKI AREA, UTAH 13 January 1960

AVALANCHE SUMMARY

At 4:20 p.m., on 13 January, Dr. and Mrs. T.B., both better than average skiers, were skiing on the eastern slope of the Solitude Ski Area. Due to

avalanche conditions, this slope was closed to skiing, and was adequately posted. As the couple approached a steep slope, Dr. B. apparently sensed the danger in the area and climbed above it. His wife skied across the slope and was caught in a sixty-foot-wide snowslide. Carried nearly one hundred and fifty feet down the hill, she was completely buried when the slide finally stopped. After calling to the top ski lift for help, her husband began searching in the debris.

RESCUE

From the top lift, the call for help was relayed to the lower lift and then to Woodhaus Lodge. Several members of the Solitude Ski Patrol appeared on the scene within minutes after the accident. At Woodhaus Lodge, the Ski Shop owner made an announcement on the public address system, requesting all available ski instructors and Ski Patrol members to assemble at the avalanche cache. Forest Service personnel were then notified of the accident. One forester left immediately to make avalanche cache equipment available to the men, who were rapidly assembling. Additional Forest Service officials were quickly notified of the accident.

Back in the slide area, the first Ski Patrol members to arrive on the scene discovered blood on the snow, and a few minutes later, they found Mrs. B. The blood had come from a cut under the woman's eye. She had been buried for 20-30 minutes. At 5:05 p.m. the Solitude lift phoned Woodhaus that the skier had been found alive and that no additional help was needed. Rescue operations were then halted. After treatment for shock and first aid for her cut, Mrs. B. came off the mountain on foot and by snow-cat by 7:45 p.m.

AVALANCHE DATA

This was a small avalanche, carrying the victim only 150 feet. Probably a soft slab, it would be coded SS-AS-2.

COMMENTS

The philosophy "it will never happen to me" has been proved wrong far too many times. A violation of a closure, a skier completely buried - these are two favorable ingredients for the recipe of death. The bloody snow led to a quick recovery and survival.

WEATHER FACTORS

The scene: 32 inches of new snow during the last 12 days; average wind but not excessive; temperatures below normal with many days in January below zero and a number below zero in February; snow pack less than normal into latter January.

ACCIDENT SUMMARY

A ski patrolman, upon hearing that two men were going touring outside the ski area, talked to them and warned that avalanche danger was high and they should stay within the regular ski area. Warnings against touring were posted on the bulletin boards. The two men, R.D., 34 and R.R., 17, rode to the top of the "T" bar, left the ski area and toured to the south. R.D.'s wife, W.D., drove their car down the south side of the pass to pick up the two men. The men chose to ski the Floral Park area, which is a known avalanche path, and is posted with signs permanently closing it. R.R. later admitted they knew the area slid occasionally.

About 1345 hours, near the bottom of the slope, the slicing action of R.D.'s skis, coupled with the impact of a fall, released an avalanche carrying him 100 yards down the hill and burying him. His companion, R.R., skied on down and stopped about 10 feet from the fracture line facing away from the slide. He did not observe R.D. disappear into the moving snow. Mrs. W.D., waiting on the highway below for the men, saw the avalanche, and drove back up the pass to report the accident to the ski patrol. At that time she thought both men were buried.

RESCUE

At the time of the alarm, the snow ranger and the district ranger had just gotten on the chairlift. By the time they reached the top and skied back down to the patrol room, a small group of patrolmen had already left for the scene. The snow ranger questioned the victim's wife, then left for the accident scene with her, accompanied by a small group with shovels and probes. The district ranger remained behind and led the main party of rescuers a few minutes later. More careful questioning of the witness would have revealed that the easiest access (and the safest also) would have been to drive down the highway and ski about 100 yards to the scene. The first group to arrive had found R.R. unharmed, but so incoherent he could tell them very little. They finally determined the point at which R.D. was last seen. A ski was found about 25 feet from the tip of the slide, and the search centered around the most likely locations along the fall line and at the tip of the debris.

When the main party arrived, an organized probe line was established at the tip of the slide. After probing for about 20 minutes R.D. was found about 20 feet from the tip of the slide. He was lying face down, with his head slightly higher than the rest of his body. He was buried under three feet

of snow, and had been found one hour and forty-five minutes after he was caught. Mouth to mouth resuscitation was started immediately, but with no response. His eyes would not focus, and no pulse could be detected.

Because only a small portion of the avalanche area had slid, and because it began snowing hard, it was decided to evacuate the area before a second avalanche released, trapping the rescuers. R.D. was loaded on a toboggan, and moved to safety. As the rescuers were leaving, another small avalanche was released, but caught no one. Artificial respiration was given continuously until 1640 hours when a doctor arrived and pronounced the victim dead.

AVALANCHE DATA

Avalanche hazard was high. Investigation of the site the next morning revealed about two feet of depth hoar on the bottom of the snow pack. The fracture line varied from one to two feet in depth. On 12 February, a seven foot slab had been shot off the "Roll," one of the ski runs at the Berthoud ski area. Slides occu d in numerous places along the continental divide on the 12th, 13th, and 14th. On Monday, 15 February, the state highway gun crew shot the Floral Park slide with a 75mm howitzer. The entire slope avalanched leaving a fracture line one-half mile long, and closed the highway for three hours. The area where R.D.'s body was located was covered with eight feet of snow.

Both of the victim's skis came off. One was on the surface about five feet above the victim and the other was under the snow near him. His poles were not found.

Of the 19 volunteer ski patrolmen who participated in the rescue, 13 had received avalanche training. The probe line was well organized and worked efficiently. Those who hit the victim with their probes stated they were sure it was a body and not a false clue.

COMMENTS

One of the most important aspects of questioning a witness is determining the accident location as accurately as possible. Entry to the accident scene from below would have been safer and faster.

ACCIDENT SUMMARY

The Fall River Electric Cooperative of Ashton, Idaho, maintains a radio relay station at the head of Superior Creek on the Targhee National Forest, about twelve miles west of Driggs, Idaho. On 9 March, the company sent three men into the station to repair an electric line. The men were able to go part way by snow-cat, but planned to use snow shoes to travel the final distance to the station. By about 1:00 p.m., the men started across an open slope about a quarter of a mile below the relay station. As the three were crossing a slide path, a four-hundred foot wide avalanche released above them. One of the men, R.P., saved himself by catching hold of a tree, but the snow completely engulfed C.H. The third man, B.C., was injured by the crushing force of the snow, but remained on the surface on the half-mile long slide.

RESCUE

R.P., who was uninjured, tried to carry B.C. out of the area. However, after a half mile, he became exhausted and was forced to leave the injured man. Giving B.C. all the clothes he could spare, R.P. went to get help. Men from Driggs rescued B.C. as quickly as possible, but he died a short time later in the Driggs hospital.

The Driggs sheriff notified the district ranger of the accident, and requested help in organizing a search party to rescue the third victim. The ranger responded immediately, but rescue operations were postponed until 6:00 a.m. on the following day, since men coming in from the area reported blizzard conditions. In the meantime the county sheriff, officials of the State Highway Patrol, and the ranger planned the next day's operations. They ordered a snow-cat and weasels from the Highway Department and the telephone company, had probes made from electric conduit, and arranged for transportation, food and snowshoes. An estimate of the number of men needed was made and additional help was requested from the Driggs National Guard. However, they reported that they were under orders not to participate in the search unless the area had been checked for hazards from other slides. The Targhee National Forest Supervisor arranged for an avalanche expert from Jackson Hole to assist in the search.

At 6:00 a.m. the following morning, the search party assembled at the Power Cooperative's office. The searchers were able to drive to within three miles of the slide as the county had plowed the road as far as Horseshoe Canyon. From there the party traveled about two miles by weasel, and went the last mile on foot. They arrived at the slide about 9:00 a.m. with twenty men and immediately radioed back that more help was needed. Since the area appeared safe for working, the National Guard was mobilized. The men were organized into crews and began working at the lower end of the slide, where the ranger laid out guide lines with string. Several people checked behind trees and other places directly below where the men had been caught.

The National Guard began arriving about 10:30 a.m., along with other volunteers, until by noon there were seventy-one men searching the slide area. One of the Highway Patrol officers stayed in the parking area at the bottom, taking care of traffic control and shuttling in men and supplies. The National Guard set up a kitchen there. The Teton Power Company sent additional men and supplies. By noon,two rangers from the Teton National Forest arrived, checked the area for hazards, and assisted with the search. At about 12:30 a snow shoe was found; half an hour later, the body of C.H. was located under five feet of snow. There was a deep gash on his head, and some snow had melted around his mouth, indicating he may have lived a short time. The victim was nearly three hundred feet below where he was when the slide started, and forty feet from the edge of the slide. The snow was piled twenty feet deep at this point.

COMMENTS

The victims were unaware of the danger, chose a poor route, and probably triggered the slide which caught them. If they had been spaced properly, only one would have been exposed to danger at a time. A rescue action timely enough to recover a buried victim alive is almost impossible at inaccessible sites like this.

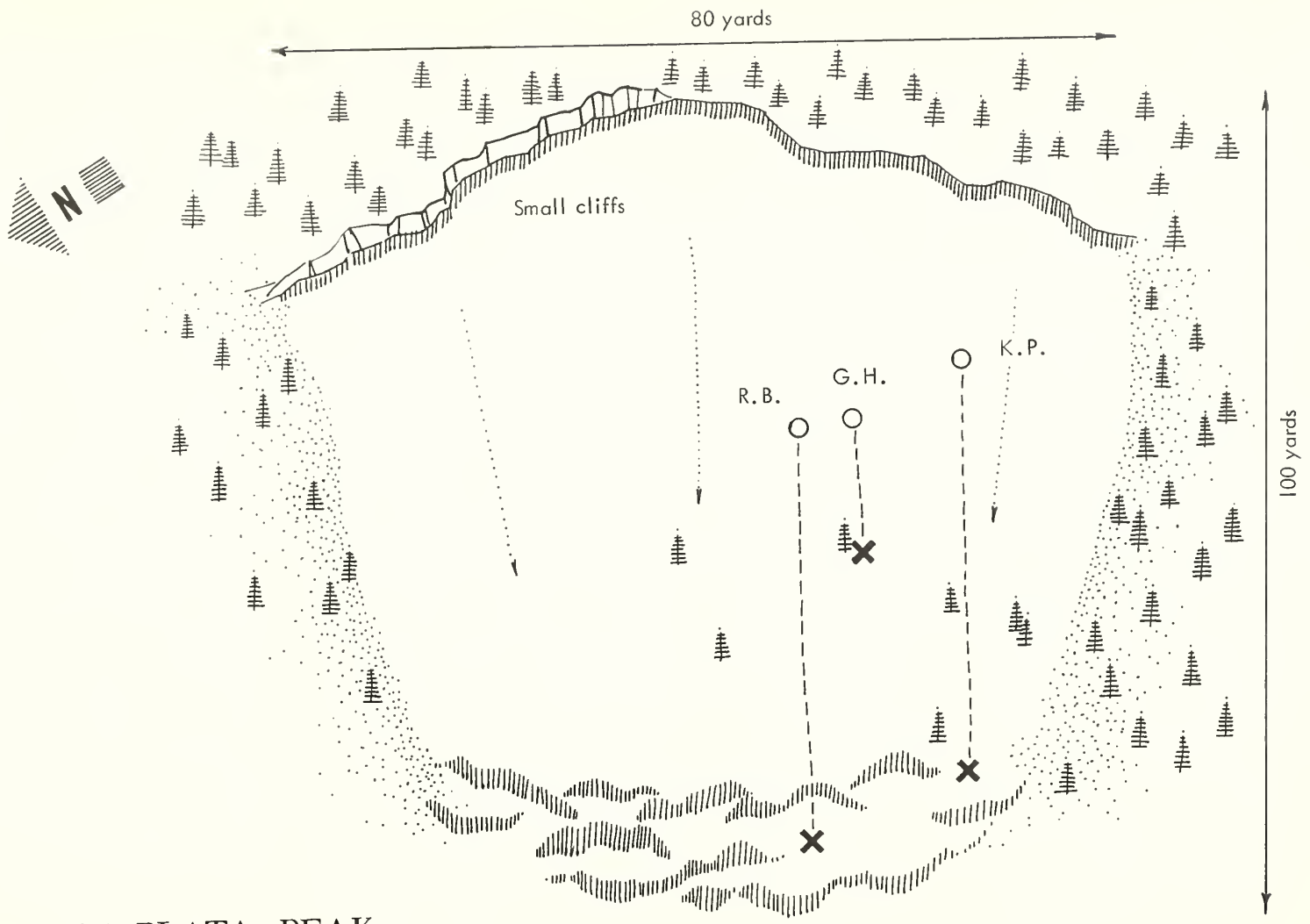
No. 60-4 BRIDGER PEAK, MONTANA February 1960

WEATHER FACTORS

A deep, powder snowfall occurred the day preceding the slide. On the day of the slide the morning had been sunny and warm, but before noon, the sky became overcast, the temperature dropped considerably, and a strong, gusty wind developed.

AVALANCHE DATA

The avalanche occurred at approximately noon on a day in early February, on the north side of the spur one-half mile north of Bridger Peak. A party of five skiers led by D.W., attempting a ski ascent of Bridger Peak, were close to the slide, but not involved in it. The party's proposed route lay up the spur toward the main crest and south along the crest to the summit. Several attempts were made to determine the sensitivity of the snow pack to avalanching. These attempts included probing with a ski pole handle and attempts to kick off slides on steep pitches. These initial probes indicated that the fresh snow was apparently quite stable. Further investigation after the avalanche had occurred, however, revealed that the initial probing had not penetrated deep enough to anticipate slab conditions. After-the-fact probing indicated a firm sub-crust at four and a half feet, beyond



LA PLATA PEAK
LAKE COUNTY,
COLORADO 19 March, 1960

no. 60-5

which the ski pole fell the last foot by its own weight. Hair-trigger slab conditions thus existed next to the ground; the entire thickness of snow was resting almost upon a cushion of air. In spite of the fact that the initial testing had given no warning of hazard conditions, the party leader became increasingly worried about slab avalanches as the party progressed. He later said that he sensed a kind of "hollow feeling" to the snow. Finally, he led the party off the northeast slope and onto the southeast side of the spur. About fifteen seconds later the slide occurred.

The slab avalanche that the party observed involved the entire north side of the spur. As far as could be determined, the whole slope came away as a single slab, almost at the same instant. As it moved, it was split up into blocks by large trees and buried outcrops. Smaller trees were overridden, bent, broken and torn loose. The fracture line ran approximately down the crest of the spur. On the lower, rounded slope, it cut across the crest, involving part of the southeast side of the spur. The snow ran for one-half mile before decreased gradient brought it to a stop. The slab was approximately five and a half feet thick, and swept the slope clean of snow down to grass and bedrock.

COMMENTS

The ski party may have triggered the slide, but a rapid change in temperature or heavy wind gusts could also have been responsible. This particular example illustrates the ineffectiveness of shallow probing in determining the existence of avalanche conditions. Fortunately the party leader, an experienced mountaineer, sensed the possible danger and led the party out of the slide path before the avalanche occurred. We wish more cases like this could be reported in these pages. Unfortunately, the "non-accidents" seldom find their way into the files; usually only the disasters are recorded. (Note: See report 62-8 for similar accident.)

No. 60-5 LAPLATTA PEAK, COLORADO 19 March 1960

WEATHER FACTORS

Temperatures during January, February, and the first part of March had been below normal, setting records in several places. On 13 March the cold arctic air was replaced by a warm wind, and temperatures were above normal on the weekend of the accident. The long cold spell had produced depth hoar on most slopes, and avalanche activity was very much in evidence throughout the mountains on 19 and 20 March. The accident area faced west and was warmed by the afternoon sun, but, because of the elevation (11,500 feet) it cooled to a very low temperature at night.

ACCIDENT SUMMARY

At 0500 hours on 19 March, 1960, K.P., G.H., and R.B. left their car on State Highway 82 west of Twin Lakes to climb LaPlata Peak via Ellingwood Ridge. K.P. had done considerable mountaineering, both winter and summer, during the past four years. Three months prior to this accident he had attended an eight-hour avalanche school taught by Forest Service and Ski Patrol personnel. G.H. had two years of mountaineering experience, and R.B. had five years of experience. All were 25 years old. When the party had reached an elevation of about 13,000 feet, they realized there was insufficient time left to complete the climb. They turned back, deciding to make a second attempt on the 14,340 foot peak the next day. As they reached timberline, they dropped into a small steep basin. All were wearing snowshoes. Suddenly, about 50 feet above the group an avalanche released. The time was approximately 1730 and the sun was still on the slope.

R.B. was carried down the slide about 150 feet to near the toe of the debris. Most of his legs were covered, but he was able to free himself quickly. He climbed up the slide to G.H. who had been carried only 20-30 feet where he was stopped by a clump of trees. He was nearly buried but with R.B.'s help, he was free in about 45 minutes. They made a quick search of the slide but found no trace of K.P. R.B. left for help about 1830 hours, while G.H. remained and continued searching. R.B. reached a resort lodge at 1945.

RESCUE

The owner of the lodge called the Lake County Rescue Unit. Since proper equipment was lacking, a call was made to the Dillon area for probe poles, experienced men, and other rescue equipment. The local District Ranger had received only informal avalanche training, and did not feel qualified to lead such a rescue. A request was made for the Ranger at Dillon, but he was out of town. Eventually, three rescue groups responded--the Lake County group, the Rocky Mountain Rescue Group (Boulder, Colorado), and the National Ski Patrol. Local people also responded as volunteers. The Lake County rescue team arrived at the lodge at 2145. When miners lamps arrived from the Climax Molybdenum Company, the first party left at 2245. It was recognized that the avalanche hazard was very high, so a team of the five most experienced men were dispatched.

In the meantime, when it had become too dark to search further, G.H. followed R.B.'s trail back to the highway. En route he met the first rescue party. The first party arrived at the scene about 0300 on 20 March. Because of the darkness, unfamiliarity of the terrain, and high avalanche hazard, they decided to delay their search until dawn.

A second group of four men was dispatched at 0100 hours on 20 March, and arrived at the accident scene at 0445 hours. Travel was slow and arduous due to the steep slope, deep snow, and dense brush and downed timber. The third party departed at 0407 with nine men. This group chose a more open route and arrived at 0530 carrying sandwiches for the group at the scene.

At 0545 a fourth party of 15 men left the highway for the site. Just after 0600, the dawn began to break and while the rest were eating, the leader of the third rescue party, E.G., went up to look at the slide. At the toe of the slide debris and under a piece of snow, he spotted a piece of snowshoe. He called to the others, and they soon had the body dug out, 11 hours and 35 minutes after the accident. Radio contact was made with the base, and the fourth party was turned back. Permission was received by radio from the coroner to remove the body. K.P. was found under $2\frac{1}{2}$ feet of snow with his arms folded under his chest, face downhill, head deeper than feet, and mouth full of snow. His goggles were down over his face, packsack still on his back, and hat still on his head.

AVALANCHE DATA

The avalanche was 240 feet wide and ran a distance of 300 feet. The fracture was $2\frac{1}{2}$ feet thick, and the slope was 84% (40^{o}). Snow profile from the ground up was 2 feet of depth hoar, sun crust of unknown depth, small layer of depth hoar on top of the crust (these crystals 1/8"-1/4" in diameter), and a $2\frac{1}{2}$ foot hard slab. Blocks of the slab up to 4'x6'x$2\frac{1}{2}$' remained intact. The slope is covered with scattered timber. (HS-AS-3)

COMMENTS

Experience and the recent avalanche classes should have taught K.P. the conditions under which depth hoar forms, and the instability that results when it undermines a snow pack. With enough depth hoar, steep slopes with moderately heavy timber will avalanche. This area was steep, had more than enough depth hoar, and only had scattered trees. If contact had been made with the local ranger or with the lodge owner, they would have been warned of the unstable conditions.

With three separate groups working the rescue, many people were involved. To be successful, coordination and good organization are a must. It is commendable that control was exercised over the men, and only organized groups dispatched. Good judgement was exercised in not searching the unknown terrain until dawn. This had no bearing on the survival of the victim--his only chance would have been for discovery by the other members of his party.

Note that the victim was located by a visual search which spotted an exposed piece of his snowshoe. If the survivors had noticed this, they might have saved their buried partner. But they began their search toward dusk, and were quickly forced to decide whether one man should go for help. In the light of the situation at that time, they probably made the sensible choice, although hindsight suggests they might better have both continued the search. The importance of careful scrutiny for visual signs among the avalanche debris is demonstrated again.

ACCIDENT SUMMARY

B.S., the victim of this avalanche and an excellent deep snow skier, had had three years experience in the Ski Patrol. His work has included checking out suspected avalanche areas. At 2:30 p.m., 23 December, he entered Bridger Bowl to check avalanche hazards in the area. His account speaks for itself.

"I had checked out Avalanche Gulch, and had called it safe for skiing. I then went to check out Bridger Bowl. Although I knew better, I was checking them out alone.

"As one enters the Bridger Bowl, there is an area which is very susceptible to slabbing. Here the wind consistently blows from the south, along the face, and then drops into the bowl. I was so confident that the Bowl would check out that I opened the area to the public with the avalanche danger sign at the entrance to the Bowl, an error which later proved to be very critical. This mistake could very easily have cost a skier his life.

"The wind had been blowing for the previous two days, and had indeed created a slab at the entrance to the bowl. I even heard and felt the slab settle as I entered the Bowl about twenty feet below the cliffs, but I refused to turn back. Then the slab fractured about ten feet above me, to a depth of about one foot (down to the cup crystals). All the slab below the fracture slid, giving an area about fifty by fifty feet. The snow below this, which was not slab, did not slide to any extent, but provided a sliding surface for the slab. The slab was soft and fairly dry; the snow below was for the most part settled powder.

"When the slide hit, I tried to get my skis pointed straight down the hill, but didn't have much luck due to the boiling of the snow. I tried swimming, but this is very difficult to accomplish with skis on, for the instant they are pulled out of being parallel with the fall line the feet are pulled uphill with respect to the rest of the body, causing a roll. I rolled about three times in the slide.

"Although the snow was fairly dry, there was no tendency toward suffocation. However, I may have done very little breathing while the slide was running, for when the slide stopped, I was very much out of breath. This could also be explained by my excited state, but whatever the reason, it is very important. If the snow had been a little drier and had I been buried a little deeper so that there was more pressure against my mouth and nose, I would have suffocated, because once the slide stops, there is no chance to protect the face from the snow, and the deep panting would suck in the snow just like a vacuum cleaner.

"Returning to the moving slide, about half way down I lost one ski. The right ski stayed on by means of the arlberg strap, even though the safety binding had released. This windmilling ski made it even more impossible

to keep from rolling. Also about three-fourths of the way down my goggles became filled with snow, and I pulled them off so I could see where I was going. I must have lost my poles near the start of the slide (my hands were not in the straps).

"Somewhere along the way I received a slight bruise beside my right eye -- the only injury I received. It could have happened as I was bounced off a steep-angle rock slope.

"It is extremely unlikely that a victim would be found in the upper portions of a slidepath. The velocity is so great that he would have to be literally snagged by something in order to be stopped, such as if he caught a ski in the branches of a tree. Furthermore, the snow does not pile up in the upper portions; in fact, in this case they were swept bare. A victim, or some part of him, would most likely be on top of the snow. Thus checking the upper slopes, at least for the first time, should only be a matter of looking for the victim, but not probing.

"When the slide reached flatter, lower slopes, it began to slow down. I was trying my hardest to be on top when it stopped, but didn't make it. Although the pressure of the snow was fairly great, at no time did the snow feel as though it would break any bones, although it was great enough to make me worry about it. As for riding the slide, I think it might help to arch one's back and lay as nearly parallel to the slope as possible. I was trying for a more or less sitting position, and think the snow pressure on my back and head may have increased the rolling tendency.

"The slide, losing speed, went through some small trees, and I hung up crossways to the fall line on one of these. The snow kept running for another second or two, piling up against the tree on top of me. Fortunately my head was near the edge of the pile, so there wasn't much pressure on my breathing passages. Another important observation is that the snow set up on stopping, even though it was fairly dry. It was fluid only as long as it was moving, but as the speed decreased, fluidity decreased and pressure increased.

"When the slide stopped, I was completely pinned, with the exception of my left hand and my head. For two minutes I did nothing but pant, trying to keep the snow out of my mouth. The snow on my head was light, and I could see daylight seeping through the snow, so I reasoned fresh air must not be too far away. After much pushing of the snow with my left hand and my head (a process which sometimes piled snow against my face) I managed to get a hole through to the air. The snow I had pushed away had slid down the edge of the pile of snow which imprisoned the rest of my body. I began calling for help, and presently heard an answer.

RESCUE

"J.K., K.W., and J.R. had skied to the Bowl to check it out, not knowing what had happened to me. They skied into the bowl across more slab which could have slid. J.K. found me and dug me out. Although dressed very warmly, with my hood up, I had gotten very cold in just a few minutes.

My right ski was with me. I later found my left ski and one pole about twenty feet from the end of the slide. Missing are one pair of goggles and one pole. Not having found my other ski at the time, I skied to the bottom of the hill on one ski and began filling out this report while the accident was still fresh in my mind. (J.K. had earlier sent J.R. to close the area at the sign).

"J.K. and I even skied into the area again to get material for this report. The same dangerous slab was still there and settled as we skied across it. How much does it take to teach a guy a lesson?"

COMMENT

None needed.

No. 61-1 ASPEN, COLORADO 23 February 1961

WEATHER FACTORS

A total of 27 inches of snow fell during the seven days prior to the accident. Ten inches fell the night before. Winds were estimated at 10-15 m.p.h. with gusts to 28 m.p.h. for the 12 hours before the slide. The temperature at 0845 hours on the morning of the accident was -4° F., but was though to be about $+15^{\circ}$ to $+20^{\circ}$ F. when the slide ran.

SUMMARY OF ACCIDENT

Two women, Mrs.T. and Mrs. B. were skiing at an established ski area. Because of a recent heavy storm, avalanche warnings had been published in the paper, and were posted throughout the area. The women, both experienced skiers, cut through some timber to reach a small slope 150' x 150', that lies above and to the side of a main ski run. When B. reached the bottom of the slope, she couldn't see her companion. Another skier thought he had seen a small slide and stopped by B. on the main run. They both climbed back to the area and found a small slide, but no trace of T. The time was estimated to be 1415 hours. Another skier who came by was sent to the nearest lift terminal to report the accident. The request given to the patrol was for a toboggan and mentioned nothing about an avalanche. At 1425, two patrolmen arrived with the toboggan, and immediately sent another messenger to sound the proper alarm. These men then made a hasty search of the area for clues. The advance rescue-party arrived at 1438 with six men. B. was very upset and questioning was difficult--hence the last seen point was never firmly established. The hasty party began probing near a clump of trees that the victim had been skiing above and toward. Finding nothing, a probe line was started using passing skiers and their poles.

At 1448 hours the main party arrived with 20 men. Two doctors arrived at 1450. A new probe line was established and the victim was located at 1510 hours, 50 minutes after the accident happened. She was 10 feet below the clump of trees, buried under three feet of snow, head downhill but face up. The victim was unconscious and not breathing. Mrs. T. was pronounced dead at the scene. An autopsy revealed death due to suffocation.

AVALANCHE DATA

This slope is 66% (33.5°), and the dimensions of the avalanche were approximately 120' wide, running down the slope 90 feet. The slide was a soft slab 18 inches thick (SS-AS-2). Prior to 17 February, there had been no snow for 30 days, thus the old snow surface was a hard crust. The slab slid on this surface. This slope had been skied and part of the old track could be seen. It is not known when this was done, or if it was by the patrol or by another skier.

COMMENTS

There is no better example to illustrate the point that the small avalanches are often the killers. The snow ran only 90 feet -- yet it was able to bury the victim sufficiently to suffocate her. This accident graphically illustrates the need to check out all slopes within the protection boundary that are steep enough for snow to slide on -- no matter how small they may be. Those responsible for the safety of the public must keep up with the changing conditions -- a slope safe in the morning may be dangerous in the afternoon. Winds and changing temperatures can produce a serious hazard in a matter of hours.

No. 61-2 ARAPAHOE BASIN, COLORADO 24 November 1961

WEATHER FACTORS

During the night of 23 November, temperatures dropped to below zero. Temperatures during the day of 24 November were estimated to abe around 35 degrees. At the time of the accident, this north slope would have been in the shadows from 30 to 45 minutes. Ski area personnel indicated they did not have snow and wind conditions like those at Berthoud Pass during the week, that is, high winds, drifting snow and light flurries. Normally the weather conditions at Berthoud and Arapahoe are quite similar. They did indicate that four inches of snow fell on 23 November. This could result in wind transported deposition of 12 to 24 inches of snow in the vicinity of the slide.

ACCIDENT SUMMARY

On Friday, 24 November, Mr. D., age 19, and Mr. M., 35, were skiing the Palivacinni ski run at the Arapahoe Basin ski area in Colorado. Mr. D. was in the lead, and at approximately 1605 hours he released an avalanche which carried him down with it. Mr. M., who was not caught in this slide, was able to see Mr. D. in the slide for approximately 200 yards. Three ski patrolmen were sweeping the run and arrived at the scene moments after the accident. One patrolman skied to the base area, notifying the area manager. The other two patrolmen had Mr. M. designate the last seen point, and then began a hasty search of the slide area. The first party was dispatched at 1610 hours, and had a total of four men and two shovels. A second party left at 1625 hours with 16 men, 30 probe poles, 8 shovels, 10 lights, and a toboggan. A doctor was with the second party. At 1740 hours, the third party was sent with 22 men and probe poles, shovels, lights, and a resuscitator. A fourth party was formed, to be held at the base area for relief of the other rescuers.

The first party continued the hasty search of the slide. A probe line was formed when the second party arrived at the scene. The probe line was widened when the third party arrived. At 1805 hours, the victim was found by the probe line. He was under two feet of snow, head downhill, with his skis and poles still attached. The doctor at the scene applied artificial respiration, to no avail. The county coroner attributed death to suffocation and multiple internal injuries, including a possible broken neck.

AVALANCHE DATA

The professional ski patrol stated that the area had been skied every day for the last two weeks. High explosives had been applied on 20 November, and the run had been ski checked on the mornings of 23 and 24 November. On 26 November, six five-pound charges were used, with the following results:

1. Large area of settlement in "West Alley" area
2. Large sluffs at three different locations
3. One size 2 avalanche in "Main Street"
4. One size 3 avalanche under the cornice

All of these areas are within the large Palivacinni slide. The fatal avalanche was a soft slab, with a 30-inch fracture. The top nine-inches was newly deposited snow. The sliding surface was a sun crust, above which were highly unstable crystals up to 4mm in size (beginning depth hoar). Avalanche was a size 3, and would be coded as SS-AS-3.

This slope was undoubtedly under increasing stress due to the dropping temperatures. Snow depths were as much as nine feet on the Palivacinni on 25 November.

COMMENTS

Rapid changes in temperatures, such as when the sun leaves or first strikes a slope, can decrease the stability due to increased stress. The ski check in the morning didn't release any slide, even though the under-layers were quite weak.

The "Palivacinni" avalanche path includes six smaller slide paths, all of which can slide individually, in any combination, or all at once. The control plan indicates 12 shot points, and stresses that high explosives be used. An avalanche area of this size must be continually checked with explosives and penetrometer tests run so as to know what is happening in the lower layers. Perhaps a slope with such complex problems should be kept closed until spring.

No. 61-3 BRIDGER BOWL, MONTANA 31 December 1961

WEATHER FACTORS

In 1961 winter came earlier than usual to the Bridger Bowl area in Montana. Snow began falling early in October, and temperatures ranged slightly below normal through December. The usual alternate warm spells occurred sporadically until the end of December, interspersed with more light snow layers. By late December, three to six feet of well-stratified snow covered the slopes. There were at least five distinct, potential glide planes of icy snow present in this pack. On 31 December, twenty-four hours had elapsed since the most recent foot of new snow had fallen. The temperature had risen from just above zero to about freezing. The day was clear and bright with no appreciable wind.

ACCIDENT SUMMARY

Slightly after noon on 31 December, seven skiers, all expert (six were or had been members of the Bridger Bowl Ski Patrol), approached the North Bowl area by traversing northward from the top of the upper lift of the main ski face. The North Bowl is well below the summit of the main mountain mass. The Bowl is divided from the regular ski hill by a small subsidiary ridge. At this time the Bowl was closed by the Ski Patrol, although warning signs had been drifted over. The seven men intended to ski to the Bowl partly because of the powder snow there and partly to test out the area.

The lead man entered the more steep North Bowl area and skied into a 40 degree (82%) couloir. In doing this he started a surface sluff that carried him with it at least one hundred feet down the gully. The others,

noting this incident, took an alternate route, going below the south lower bowl rim to test its stability. All but two of the men, J.M. and W.E., had dropped slightly below the rim and were within the bowl area, when one of them, S.W., tried a gentle jump-turn on the 38 degree slope. This set the entire slope in motion, as the fracture line ran all along the rim and in places on flatter ground beyond it. The three to four-foot slab ran to bedrock and formed a slide consisting of blocks and powder about one-hundred yards wide, running downhill about two-thousand feet.

Those below the rim were engulfed. One skier managed to stay on his feet for a time but was dragged over a cliff of steeply dipping limestone, coming to rest on his back in stifling clouds of powder nearly one-thousand feet below on the runout slopes, unhurt. Two others followed approximately the same path and both were severely mauled. One of these went clear to the toe of the slide and the other suffered a badly comminuted leg fracture. By "swimming" all managed to stay near the surface of the slide. W.E. was barely in the slide and managed to stay at the top of the slope by grasping bedrock. J.M. escaped and gained high ground. The others were not involved. Immediately these two extricated the victims, who were not completely buried, and reported the accident to active patrol members. Rescue toboggans were quickly brought in to evacuate the skier whose leg was broken.

Since the slide engulfed the fringes of a heavily traveled, easy ski run past the shelf of the lower North Bowl, patrolmen felt it necessary to carry out a probe line search of the lower slide area. One probe party climbed too high, and was thus endangered by a second slide potential. The large number of branches and trees buried by the slide made probing difficult, since shovel crews frequently had to check out these false alarms. An hour later the dispatcher, utilizing the public address system organized a car check. Within one and a half hours, management and Ski Patrol personnel were reasonably sure that all were accounted for, and the probe line was terminated.

COMMENTS

This accident happpened on a large, dangerous slope. It was no place to be "testing" snow conditions by any means except an explosive charge thrown from a safe place. Enthusiasm for skiing the fresh snow undoubtedly was the dominant motive for skiing this slope. If it was, in fact, a place suitable for test-skiing, it should have been done by one man at a time, not by a five-man team on the slope all at once. If the slide path endangered a frequented ski run below, this run should have been closed and a guard posted before test-skiing began.

The dispatcher used good judgement in having a "car" check -- this eliminated the need to continue probing the large deposition zone.

WEATHER FACTORS

The storm began early on 6 January. Eighteen inches of snow fell that day, accompanied by a strong northwest wind. The snow and wind continued through the night and during most of the next day. Total new snowfall nted to 26 inches on the eastern side of Loveland. Daytime temperatures were around 20° F. until 1400 hours on the 7th, then dropped to 10°.

SUMMARY OF ACCIDENT

After a 36-hour storm accompanied by strong winds common to the high Rockies, considerable avalanche activity had been observed. The highway had not been closed, nor had control been attempted by artillery. At about 1900 hours, the Floral Park slide ran on Berthoud Pass.

At approximately 1930 hours, on the west side of Loveland Pass, the Black Widow avalanche ran. This slide consists of two paths which join just above the highway. One path is 2,500 feet long and the other is 1,500 feet. The slide is 200 feet wide where it crosses the road. When the slide ran, a car with a man, his wife, and three children were directly under it. The car was pushed off the road and buried. Witnesses to the accident summoned help from the local ranger and nearby ski area, and the car was located in a short time. The family was dug from the car, all uninjured but badly shaken. It was believed another car had been caught and probing was continued until confirmation was received that the driver had arrived home safely.

At approximately 2000 hours, the Bethel avalanche on the east side of Loveland Pass ran and caught a pickup with two occupants. The truck was swept 150 feet off the highway, and the windows were broken out. Both people were able to get out uninjured. Snow covered the highway to a depth of 3-4 feet. The highway is on a fill at this point and snow depths away from the roadway were around eight feet. A diversion barrier had been constructed in the transition zone above the road several years before. This barrier has effectively turned some of the Bethel avalanches, and it has always reduced the volume of snow that reaches the road. This barrier may well have saved two lives on this occasion. The Bethel slide is 3,000 feet long, with a 25-acre release zone.

COMMENTS

Major transcontinental highways are difficult to close because of severe weather and avalanche conditions. There is too much pressure to keep them open, especially for commercial traffic. Nearly every winter several vehicles are caught by slides, but fortunately the occupants usually survive. (The protective packaging of a steel automotile body offers an obvious advantage.) Loveland Pass (U.S. Highway 6) has 12 individual avalanche paths, as well as another group made up of 7 slides, side by side. Some of these will run after every storm of moderate or large size. It is interesting to

note that three major avalanche paths ran within approximately one hour. Two vehicles were caught, involving seven people.

Highway use increases eacy year, with the result that the odds of highway avalanche fatalities are also increasing.

No. 62-2 NEAR BRIDGER BOWL, MONTANA January 1962

WEATHER FACTORS

Weather conditions preceding the day of the slide are unknown. Heavy snows had occurred early in the season, (October and November). On the day of the slide, a heavy, wet snowstorm was in progress, with an accumulation of well over one-foot of fresh snow. Temperature was steady at about freezing. Wind was very light.

AVALANCHE DATA

The avalanche occurred at approximately 3:00 p.m. on a day in late January, involving a prominent spur two miles north and west of Bridger Bowl. The slide took place immediately below, but not involving, a party of five, led by C.B., which had just completed a ski ascent of the crest of the Bridger Range by way of a northeast running spur.

The party attempted to anticipate avalanche conditions. Artificially induced slides on very steep slopes indicated that powder snow avalanche conditions were building up rapidly. Appropriate precautions were taken: the party avoided very steep slopes and proceeded one person at a time over questionable areas. The leader made numerous ski pole probes in a determined effort to anticipate slab conditions. These attempts did not reveal the hazardous hair-trigger conditions existing below the firm sub-crust. The situation was similar to the conditions existing prior to the avalanche in the same area in early February, 1960 (See Report No. 60-4). In this case also, pole probing did not penetrate the sub-crust and reveal the fragile depth-hoar adjacent to the ground.

Just as the trailing members of the party reached the crest of the Bridger Range, a distinct, deep "crunch" was heard and felt in the snow. A thin fracture appeared to the skiers close to their position and showed a vertical displacement of about two inches. This gave definite warning of slab conditions. Since a descent had to be made, the leader gave a general warning to move quickly and singly across all open slopes on the way down, and for the party to keep together by assembling on minor spurs from time to time. The warning was unnecessary, however, for the avalanche had already occurred below the party at the line of maximum convexity. It was

No. 62-3 Twin Lakes, Colorado

discovered that the slab was approximately five feet thick, and had swept the entire area clean of snow, down to grass and bedrock. The slab had been split up by numerous large trees on the slope. The slide ran out for about one-half mile and was almost a mile wide at the lower end.

COMMENTS

The leader concluded that the ski party had little or nothing to do with releasing the slide, but this cannot be completely ruled out as a possibility. It might also have been triggered by the rapidly accumulating wet snow which finally collapsed the weak bottom layer.

Three reasons for a false sense of security on the part of the ski party should be noted:

1. The ski pole probe was inadequate in revealing the existence of slab avalanche conditions;
2. The leader kept the party on the crest of the spur, assuming it to be safe;
3. The spur was heavily forested with large trees, giving no evidence that it had ever been subject to slides; these trees, like the ridge position gave an unwarranted feeling of security.

Still, the fracturing of the snow, if not the avalanche, reached clear to the ridge top. Avalanches generated by a slab resting on depth hoar can originate in surprisingly thick stands of trees.

No. 62-3 TWIN LAKES, COLORADO 21 January 1962

WEATHER FACTORS

During September, 1961, 72 inches of snow was recorded at Berthoud Pass, which is approximately 60 airline miles northeast of Twin Lakes, Colorado. During October and November the weather in the Rocky Mountains warmed, leaving an ice crust on top of the snow at the higher elevations. Additional snow fell during late November and early December, after which it turned quite cold. The lower portions of the snow pack readily turned to depth hoar. During the second week in January, 1962, a 41-inch storm fell at Berthoud, causing avalanching on nearly all slopes, either back to the ice layer to to the ground. On the evening of Thursday, 18 January, a light snow began which continued throughout Friday. On Saturday, 20 January, the intensity of the snow storm increased, and the S-SW winds were reported gusting to 70 m.p.h. The lifts were unable to operate due to the winds at

three of the major ski areas in the vicinity. At nightfall, the winds eased some, but still blew well above critical "snow transportation" limits.

ACCIDENT SUMMARY

State Highway 82 follows the Lake Creek drainage westward, traversing around the northern edge of Twin Lakes Reservoir. Toward the upper end of the reservoir and at the foot of 12,676 Perry Mountain, the small town of Twin Lakes is scattered along the road on private ground for over a half mile. Five to seven families usually spend the winter there, but most of the cabins are occupied only during the summer. After passing Twin Lakes, the road enters a narrow canyon and crosses over Independence Pass on its way to Aspen, Colorado. Moderate to dense conifer timber covers the hillside in back of most of the houses. These trees vary in age from 50 to 160 years. In back of five of the dwellings the hillside was covered with 60 to 70 year old aspen -- a particularly pretty location when the leaves were gold in the fall. Next to this aspen slope was the mouth of Gordon Gulch whose headwaters lie far up the slopes of Perry Mountain.

Around 0400 hours on 21 January W. A. arose to let his dog out. A few minutes later he let the dog back in, and returned to bed. In the house with W. A. was his wife, B. A., and their two sons, By. A. and M. A. Several feet west of their house was the residence of G. S., his wife M. S., their son S. S., and daughters L. S. and V. S.

At about 0830, N. L., another resident of Twin Lakes, got out of bed. He lived two houses west of the G. S. house. He looked out the window to see if the two-day storm was still in progress. As he looked eastward, he saw a white expanse over 700 feet wide. Intermingled with the snow were odd shapes and colors. Suddenly N. L. realized he was looking at the remains of what had been seven buildings and a house trailer. Now only splinters of wood, pieces of walls, and parts of cars remained -- all mixed among tons of snow. There was no sign of any of the nine residents who had lived there the night before.

At a few moments before 0530 on Sunday, 21 January, a very large climax avalanche had released in Gordon Gulch, near the summit of Perry Mountain. Starting near the 12,000 foot level, the avalanche had dropped 2,800 vertical feet along a path 9,000 feet in length to the valley floor below. The main avalanche undercut two other slides, which added a considerable volume of snow. Toward the bottom of the slide path there is a glacial moraine (or small ridge) 100 feet high, which lies at an angle of 40^{o} to 60^{o} to the main axis of Gordon Gulch. This moraine forms a natural barrier, and all of the avalanches for the past 70 years had been stopped by this ridge. However, on this tragic Sunday, the volume and velocity of the snow was so great that it flowed up and over the ridge with ease, leaving very little snow deposited on either the upper or lower sides of the barrier. From the top of the moraine the snow dropped down the aspen-covered slope, disintegrating everything in its path, and continued out on the flat valley floor for 1200 feet.

The remains of the G. S. home were moved 500 feet from its foundation. The W. A. house was nothing but pieces of broken walls, roof and shattered boards. In addition, one other house, a cabin, a garage and a barn were completely destroyed. Only one-half of the trailer house remained, and another cabin was pushed off its foundation. Two cars, three trucks, two pickups, two tractors, two small trailers, and other miscellaneous machinery were demolished. All household items were a complete loss. In addition to covering the road to a depth of eight feet, power and telephone lines were obliterated for 1000 feet. A six-ton boiler came to rest on the flat beyond the road. Before the avalanche, this boiler was located at the Gordon Tiger mine. The slide carried it 4,600 feet down the mountain. As if this destruction was not enough, the "white death" added another ironic note -- among the debris the bodies of two deer were found.

RESCUE

When N. L. awoke at 0830 he remembered hearing nothing during the night. As soon as he realized what the scene of destruction before him meant, he woke a nearby resident and together they walked to the store down the road to telephone for help. The phone lines were dead, but a little farther on they saw some people getting into their car and asked them to notify the sheriff's office. The alert was received at 0850 and rescue operations were set in gear immediately. D. D. headed up the local Lake County Rescue group, and other volunteer rescuers poured to the scene. The first rescuers at the scene could hear W. A. and his wife B. A. calling for help. It took considerable time to extricate them from the snow and splintered debris. W. A. was uncovered around 0930 (4 hours after the avalanche struck. Electric clocks at Twin Lakes stopped at 0531.) His wife, B. A., was freed about 1110, 5 hours and 40 minutes after she had been buried. She was about 75 feet from her husband. Their family dog was also found alive in the debris, cowering under what had been the kitchen table. Mr. and Mrs. A. were evacuated to the Leadville hospital where they were treated for multiple bruises, cuts, and frostbite.

W. A. described his harrowing experience in vivid detail. "I awoke suddenly and heard a loud crack like the house had blown up. The house started moving and then caved in and snow came into my face. A dresser and two sliding closet doors came across the room and fell over me forming a kind of lean-to. When the snow and debris stopped moving, I was pinned in a twisted, almost standing position. I thought I was a goner but I never was knocked out. The time sure went slow--it seemed like five years.

"At a time like that you pray hard, but I yelled for help off and on. At first I could raise my arm to see my watch, but then the snow kept settling until I was pinned so tight I couldn't look at it anymore."

Both Mr. and Mrs. A. were under approximately one foot of snow mixed with parts of their house. As the search continued, rescuers numbered around 400. The road to the area was lined with cars for $3\frac{1}{2}$ miles, with an estimated 2000 spectators. At about 1300 hours, rescuers uncovered the body of 15 year old S.S. He was buried under 10 feet of snow and debris, still

lying on his mattress and covered with blankets. A little later the bodies of Mr. and Mrs. S. were located 15 feet from their son, covered with 8 feet of snow, and also on a mattress and covered with bedding. Next searchers found the A.'s son, By.A., some 30 feet from the main wreckage of their home. He was under 14 inches of snow.

The seemingly impossible search continued, each rescuer hoping that somehow one or all of the three missing victims would be found alive. Around 1600 hours the two S. girls, L.S., 10, and V. S., 7, were found dead under six feet of snow, covered with blankets on a mattress, and locked in each others' arms. This left only seven year old M.A. missing. The Sheriff called off the search around 1730 hours because of darkness and an approaching storm was increasing the slide hazard in the area.

On Monday, 22 January, the State Highway Department shot various avalanche slopes in the area with a 75mm howitzer. Another slide was released in the same area by this control work, and it also reached Highway 82. The search continued throughout the day, but turned up only a broken child's wagon, one of the girl's dolls, and miscellaneous household items.

Tuesday the searchers continued working through the tons of snow and rubble. Finally at 1010 hours, the body of the seventh victim, M.A., age 7, was located under 12 feet of snow and debris. It was near where his brother was found, but buried much deeper. Thus ended the sad search for nine avalanche victims. A family of five had been wiped out, and, of a family of four, only the parents survived.

AVALANCHE DATA

This avalanche was a climax, hard slab, size 5, which released naturally. (though two deer were found in the debris, it is doubtful they would have been high enough to release the slide during such a severe storm.) The fracture line was 10 feet at its maximum depth. The bottom 18 inches of the snow pack was unconsolidated depth hoar. The remainder of the mass was a combination of very hard slab and some soft slab. The avalanche undoubtedly reached very high speeds due to the unstable depth hoar base and the lower layers sliding on top of an ice crust. Indications of the hardness of some of the slabs involved was the fact that after traveling 8,000 to 8,500 feet, large blocks of hard slab 3 feet square and 18 inches thick were still intact.

The lower 10% of the slide area is private land. Above this, the land is intermingled National Forest and patented mining claims. This same avalanche has claimed three other lives, but these occurred higher on the mountain. One fatality was recorded in 1899 and two in 1916. Some of the older residents around Leadville can remember when this same avalanche came across the road and into the flat "around 70 years ago." This is confirmed by the age of the aspen growing in back of the buildings that were destroyed.

COMMENTS

The moraine which lies across the Gordon Gulch drainage nearly always stops the several avalanches which run in this path each year. However, when a large climax avalanche releases, even a 100 foot barrier is of little use.

As more and more people live, work, and play in the mountains in the winter, avalanches will become an increasing hazard. The people using mountainous areas in the winter must be made aware of this hazard. Known avalanche paths must be delineated on maps or photos to prevent unnecessary construction of roads and buildings in avalanche paths.

To the trained eye, it was obvious these houses were built at the toe of an avalanche path. Those who have not had such training should be cautious of any snowy slopes over 20^{o} -- whether they are skiing or building a cabin at its foot.

No. 62-4 SWIFT CREEK, WYOMING 10 February 1962

WEATHER FACTORS

Three days prior to the 10th, the weather had been warm and rainy. The snow-pack was relatively deep. This created a condition which was ideal for damp or wet snow slides.

ACCIDENT SUMMARY

Located about two miles east of Afton, Wyoming, Swift Creek Canyon appeared to have an excellent potential for development into a ski area. Prior to February, 1962, the area had been inspected by Forest Service avalanche experts, who refused to recommend the site for future development because of its extreme avalanche hazards. Despite these recommendations, several local people were still convinced that the area could be used for skiing. Consequently, on Saturday afternoon, 10 February, Dr. M.S., a local dentist and an avid skier, and a companion, B.G., went into Swift Creek on snowshoes to appraise the snow and slide conditions. They had purposely chosen a day when the slide potential was high.

On entering the canyon, the two men located the power company pipeline and followed it to the mouth of Sheep Canyon. From there they went by snowshoes two miles up Sheep Canyon. After checking conditions the two men started back. When they got to the pipeline, they decided to walk it back down and carry their snowshoes and ski poles. At this point they had already passed through the most hazardous areas in the canyon. About a mile and a

half from the power plant they came to a small slide, which had come down earlier in the day. It covered the line and went into the creek. They assumed with some justification, that since the snow had already avalanched, the hazard had been eliminated; hence the men felt safe in crossing the slide path.

As they started across the slide, B.G. was ahead of Dr. M.S. Just as they reached the center, they heard the snow release near the top of the slope. (Only the bottom section slid in the earlier avalanche) B.G. shouted a warning to Dr. M.S., though he undoubtedly heard the slide also. Instead of moving backwards out of the slide's path, both men impulsively headed down the slide's path and across the creek, in an attempt to outrun the cascading snow. As long as the two men ran on the packed surface of the old slide, they were able to escape the avalanche, but as they ran off the first slide into the soft snow, both sunk down too far to move any further. Dr. M.S. sunk into the snow much further than B.G.; his hands were at the level of the other man's feet. Just as B.G. reached out to help him, the wet, heavy snow slammed into the two men. Though he attempted to kick himself free, B.G. was buried up to his waist. He watched another wave of snow run towards him, but fortunately it stopped short of his position. Dr. M.S. was completely buried.

B.G. worked himself free and frantically began to dig for his companion. He worked alone for some time, but the snow was so hard that he could make little headway. He continued to dig until he felt that either his friend was dead or that he might be in an air pocket. If the latter were true, the best thing B.G. could do was to get help. When he reported the accident in Afton, many people immediately responded. Forty or fifty men with shovels went into the area. A short while later Dr. M.S.'s body was found. Although a doctor at the scene knew the man was dead, a resuscitator of the Afton Fire Department was used in vain effort to revive him.

COMMENTS

The assumption that a slide path is safe after an avalanche has come down is a sound one, if there are no other potential slides left hanging. The latter situation is sometimes difficult to recognize. In this case the victims were unaware of the remaining hazard. Later release of the upper part of slab, as happened here, is an unusual occurrence. Why it was triggered at the fatal moment remains a mystery. (See report No. 65-2 also.)

This accident also points out the futility of trying to "outrun" an avalanche down the slope.

WEATHER FACTORS

No records of the storm are available. On the day of the accident, the weather was clear, about 25°, with a wind of 5-10 m.p.h. from the west. It is known that a previous storm was accompanied by moderate to high winds.

SUMMARY OF ACCIDENT

Nine men, a sno-cat and trailer, 24" of snowfall from a recent storm with winds, and a steep wide-open slope found themselves together on a clear mid-winter day. Eight of the men were State Game and Fish employees and the ninth a Forest Service man. Purpose of the trip was to do fisheries research on lakes and streams in the Heart Lake area. The men had expressed concern about possible avalanche danger farther up the road, but at this location were worried about the trailer or cat tipping over on the steep slope. When the cat was about 30 feet into an opening, the avalanche released. The three men riding on the trailer were knocked off and remember being worried that the trailer would tip over on top of them. The others, in the sno-cat, found themselves buried except for the back door. Neither the trailer nor the cat turned over, but were pushed off the road and down the hill. The three men from the trailer climbed back up to the cat where the six men were just emerging. None were injured.

The avalanche was about 100 yards wide and 500 yards long. The accident occurred at 1345 hours, and it took the nine men until 1715 hours to free the cat and trailer so they could return to their cars.

AVALANCHE DATA

The slide was a hard slab, about 100 yards wide, and ran approximately 500 yards. The slab was about 24 inches thick, and slid on an "old crusted base." The slope faced southeast, and only low shrubs were visible on the path. Elevation was estimated at 9,000 feet.

COMMENTS

It appears that the sno-cat undercut the slab. If this had occurred in the middle of the slide instead of at the edge, the greater volume of snow could have buried the cat completely and probably buried some of the men who were riding on the trailer. Training is needed in avalanche hazard recognition and rescue techniques among those who work in steep snow terrain during the winter.

ACCIDENT SUMMARY

Early Sunday morning, 25 March, 1962, two skiers set out to climb Granite Mountain, west of Denny Creek and Snoqualmie Pass. Both men were experienced climbers; Dr. C.A. had been climbing for two years. D.L. had sixteen years of mountain climbing experience, although much of this was on Eastern slopes. The two men followed the Granite Mountain trail until it left the timber. While they seemed to have exercised caution when traveling in wet snow conditions, the climbers apparently failed to recognize the formation of dry slab avalanche conditions as they progressed upward. On the ascent they safely crossed the upper end of the cirque, which was heavily wind-slabbed, but their failure to note the hazardous conditions which existed in this area proved fatal on the descent.

At 1:00 p.m., Mr. and Mrs. R.S., who were following about three-quarters of an hour behind the pair, noticed a large avalanche come down the couloir to their right. R.S. quickly climbed higher on the mountain, following the footsteps of the two men. At about 5000 feet the trail cut diagonally out over the upper corner of the main cirque and disappeared into the avalanched snow. R.S., seeing no trace of the missing skiers, returned with his wife to the road and notified the State Patrol.

RESCUE

At 8:00 p.m., the sheriff and the Seattle Mountain Rescue Council were notified of the avalanche. There was some delay in organizing rescue operations since a major portion of their equipment and a large number of the Mountain Rescue personnel were on another rescue operation. Additional equipment was available at the State Patrol's avalanche cache, but there was confusion as to its location. Several hours later, Mountain Rescue Council members rendezvoused at Factoria and drove to the junction of the Denny Creek Road and Highway 10. They arrived at the junction about 11:30 p.m. and were met by the Washington State Patrol and U.S. Forest Service personnel who provided a limited number of probes and shovels (not enough to outfit all twenty members of the rescue party). The party was divided into two ten-men teams, the first leaving the road at 12:15 a.m. with the available equipment. The second group followed a half-hour later with more equipment obtained from the Snoqualmie Summit cache. However, they were not the first searchers to arrive at the scene of the avalanche; both teams were preceded by a Forest Service and Ski Patrol team which left the highway about 10:30 p.m.

The three groups joined at the head of the avalanche. A search was organized, although not everyone had a probe. The searchers were split into two groups - some probing the top and some beginning near the middle of the avalanche. Those without probes were sent on a hasty search. Lookouts were posted to warn the party of any additional avalanches. Probing anywhere in the slide was difficult, since the snow was often piled deeper than the eight foot probes. At various times during the search three of the men,

who were wearing slick soled shoes and had no ice axes, came close to a second disaster, when they slid uncontrolled down the avalanche track of hard ice. Fortunately all hit soft snow which stopped them short of going over a two-hundred foot waterfall.

After about an hour of probing the long avalanche, the group below lit a red smoke flare and notified the group above by radio that Dr. C.A.'s body had been found. Probing then continued down hill. Before the bottom of the slide was reached, two more teams arrived to help complete the search. Every clue was checked out by the searchers, but they had no success in locating D.L. Below the falls, the pile-up of avalanche snow was thirty-feet deep, and it was impossible to probe thoroughly. The search was finally called off at dark the next day. Although Mountain Rescue personnel and two army teams with mine detectors searched the area the following weekend, D.L.'s body was not recovered until three weeks later, when it was uncovered by melt.

COMMENTS

Both a hazardous choice of route and misjudgement of snow conditions contributed to this accident. Once more a basic rule of ski touring is emphasized. When in doubt, stick to the ridges. The rescue was complicated by an earlier dispatch of equipment and trained personnel to another accident. The problem of an icy surface exposed by sliding snow is not an uncommon one. Rescue leaders need to be alert for this hazard.

No. 62-7 TABERG, NEW YORK 31 December 1962

WEATHER FACTORS

The year's end brought snow storms and sub-zero temperatures to the area around Taberg, New York. An additional eight to twelve inches of snow fell on 29 and 30 December, bringing the total accumulation between eighteen and twenty-four inches. At midnight on the 29th, Saturday, the temperature dropped to -16 degrees, and was only up to -10 degrees on Sunday. Strong wind gusts up to fifty m.p.h. created wind packed cornices on the slopes adjacent to open land. Below the cornices, the snow developed into slab conditions. Throughout the area, conditions were basically alpine. Some of the area's residents later recalled the peculiar texture of the snow. One noted that it was like salt; another stated that the snow had a crust on top and was like sugar beneath.

ACCIDENT SUMMARY

At about 3:00 p.m. on 31 December, three young boys living near Furnace Creek in the Taberg area headed for the slopes along the creek to play in the snow. The boys, T.V., 14, D.M., 13, and D.A., liked to "kick the ripples off the hill" from above and watch the snow fall. By 3:30, D.A. was getting cold and decided to return home. The other two went on to a point above the creek. The grades on this slope range from very steep at the top to 35 degrees (70%) at the bottom. Parts of the slope are heavily timbered, but certain areas contain only very sparse vegetation. Most of these potential slide areas are not over thirty feet in width. Apparently while the two boys were kicking off the cornices along the ridge top, they triggered an avalanche, which swept them about three hundred feet down the slope. Both were completely covered by the snow.

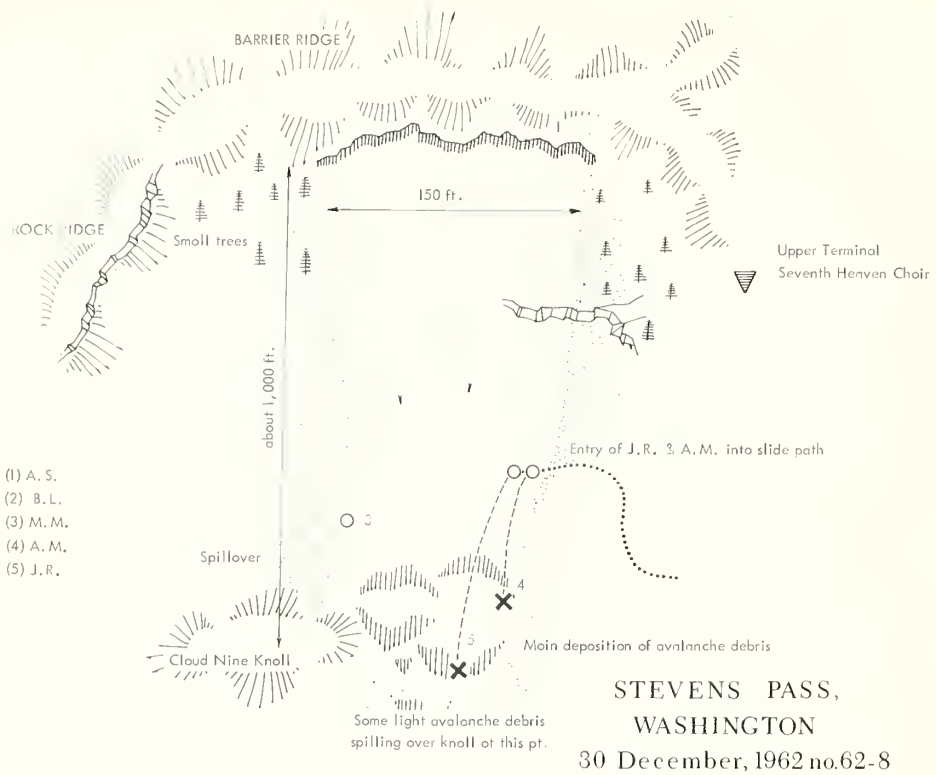
RESCUE

At 4:30 p.m. when the two boys failed to return, relatives grew concerned. At 6:50 local firemen were called out to search the area. When the search party arrived at the slope. they found ample evidence of slide activity. Probably these slides had been triggered by the boys either on the 31st or on the day before. During the search, a father and his son released another slide. As they walked across the area, the two heard a crunch, and the snow started moving. The father was able to get out of the slide area, while his son hung on to a tree with the snow passing by on either side. Neither was hurt.

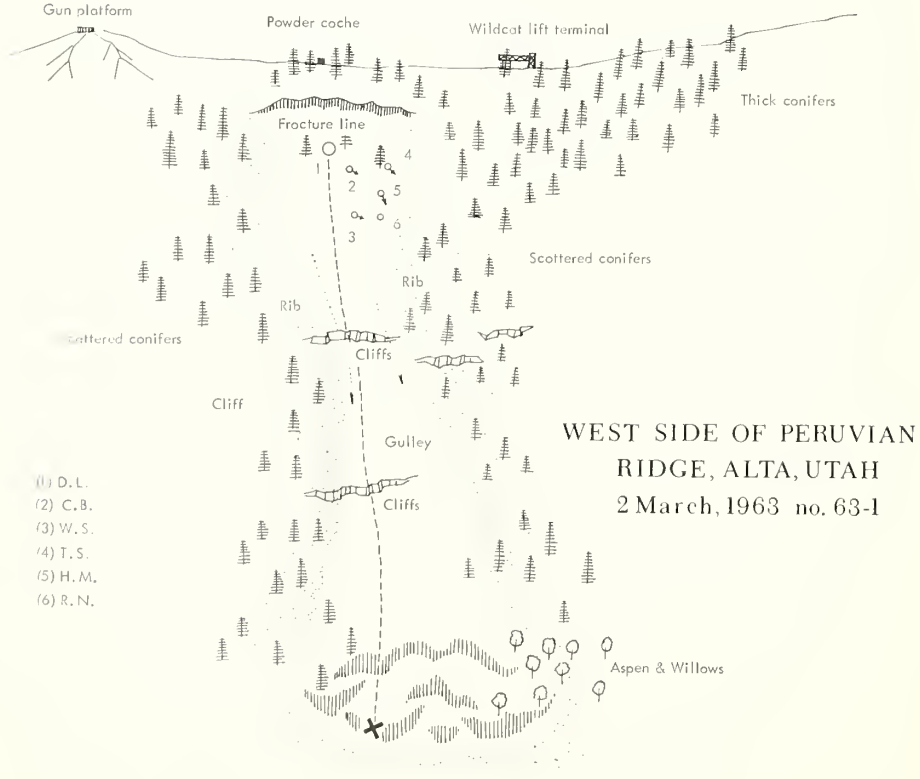
The search party was large, but was not organized specifically for avalanche rescue. Slides occur so infrequently in the area that residents scarcely considered the possibility that the boys had been buried in an avalanche. Darkness also slowed search efforts, which had to be conducted by flash light. Finally, after searching for some time, one of the searchers, Rev. R.D., discovered some single tracks leading to an area where he kicked the surface snow and exposed a boot. Even then, his first reaction was that one of the boys had lost a shoe. However, further digging uncovered the body of D.M. As soon as his face was exposed, mouth to mouth resuscitation was attempted. Despite their efforts, rescuers were unable to revive the boy. Another searcher uncovered the body of T.V. about three feet from D.M. Both apparently died from suffocation.

COMMENTS

Steep slopes and the right snow conditions can make an avalanche anywhere. See also Report No. 64-11.



STEVENS PASS,
WASHINGTON
30 December, 1962 no.62-8



WEST SIDE OF PERUVIAN
RIDGE, ALTA, UTAH
2 March, 1963 no. 63-1

WEATHER FACTORS

Saturday, 29 December, added four inches of dense new snow to ten inches which had fallen the previous day. Saturday morning a 105 mm rifle was used to control the usual avalanche chutes in the Barrier Bowl area. There were rising temperatures through Saturday afternoon and evening. On Sunday morning, 30 December, the Bowl was foggy; there was no new snow. Most areas slid naturally, with the exception of one area above and adjacent to the upper terminal of the Seventh Heaven chair. Because this area had slid only two times in the past four seasons, the conditions weren't considered dangerous. The contr l work on Saturday, plus the natural avalanche cycle at the same elevation, led rangers to believe all slide areas ere safe.

ACCIDENT SUMMARY

At 10:00 Sunday morning operator M.M. arrived at the upper terminal of Seventh Heaven, and the chair lift began operating. Earlier that morning two snow rangers, A.S., and his assistant, B.L., had gone to the top of Barrier Mountain to check snow conditions in and around the Bowl. By 11:15 the two were starting to check the snow along Barrier Ridge, at the top of the Bowl, when ranger A.S. saw several chunks fall from the cornice about two hundred feet away. A fracture line ran along the ridge towards him. Growing to a width of one hundred and fifty feet, the avalanche slid about one thousand feet down the slope, some of it falling over the "Cloud Nine" area.

Just prior to the slide, H.B. relieved lift operator M.M., who skied down the bowl. Shortly after he left, two ski patrolmen had just started down when the avalanche broke into the bowl. Although M.M. arrived safely at "Cloud Nine," the two patrolmen were caught in the slide. The skier back at the upper terminal immediately reported the avalanche.

RESCUE

The two rangers immediately came off the ridge and told the lift operator to call for additional help. Both then continued into the slide area, where they were joined by M.M. from "Cloud Nine," and a third skier. By then one of the Patrolmen, A.M., dug himself out and alerted the others that J.R. was still in the slide. At 11:20, A.S. organized a search, assigning probe areas to the small group. Noting that the slide had traveled over the "Cloud Nine" area, A.S. checked the next slope, but found nothing. Twenty minutes later, at 11:40, L.B. arrived with a crew of searchers and equipment. Due to the heavy fog, there was some delay before this new group could locate the others. Shortly the two groups joined and organized themselves into two probe lines. About five minutes later one of the searchers noticed a ski pole and alerted the snow ranger. After a few minutes of frantic digging, J.R.'s head and shoulders were uncovered at

about 11:50, thirty-five minutes after the slide occurred. He was unconscious, his breathing was shallow, but he was apparently uninjured. Two patrolmen administered oxygen, and he soon regained consciousness.

COMMENTS

This near-miss emphasizes the importance of maintaining strict coordination and skier control when snow safety work is done in an operating ski area. All work in potential avalanche areas must be accompanied by stringently enforced closures of the danger areas - even when the snow is apparently stable.

This is another example of probing before a thorough check for visual clues had been made.

No. 63-1 NEAR ALTA, UTAH (Peruvian Gulch) 2 March 1963

WEATHER FACTORS

After a long snow drought, a short but intense storm on the morning of 1 March, 1963, brought six to eight inches of new snow, increasing the total depth on the Alta Guard Station stake to 59 inches. Wind level was above critical levels during the heavy precipitation period, but died down as the snowfall eased off in the afternoon. The best powder snow skiing in the otherwise snow-scarce winter was experienced as runs were reopened that afternoon. Test skiing and control work released a few small slabs of new snow from steep areas, but no general hazard appeared to have developed. Snow conditions were judged stable in the regular ski areas.

ACCIDENT SUMMARY

A party of six composed of R.N., Chief Patrolman of the Alta Ski Patrol, Mrs. D.L., Alta ski instructor, H.M., internationally known mountain climber, T.S., former Alta Ski patrolman, and W.S. and C.B., Alta ski patrolmen left the top of the Wildcat Lift about 5:00 p.m. on the afternoon of 2 March for a last run down Peruvian Gulch. The party decided to ski by way of the steep slopes on the west side of Peruvian Ridge on a little-used ski run. These slopes had not yet been skied during the winter due to lack of snow and were not subject to routine avalanche control. Recognizing the possibility of avalanche danger because of the extremely steep terrain (many areas 40 to 50 degrees), the skiers proceeded with caution, moving one at a time and taking advantage of terrain protection. At approximately 5:15 p.m., D.L. had trouble with her binding and stopped to work on it while her companions skied ahead. Having repaired her binding, D.L. cut

across an open slope above the other skiers in an attempt to catch up with them. As she did so, a shallow, soft slab (fracture line estimated 6-10 inches thick) broke loose on the open slope 75 to 100 feet above her. She shouted a warning to her companions and then was swept down by the slide. The rest of the party attempted to escape the flowing snow. Two were carried off their feet and swept against trees, where they managed to hang on. The three remaining members of the party were able to reach the edges of the slide and watched D.L. as she was carried past them and over the small cliffs below. The slide moved extremely fast and was accompanied by a dust cloud.

When the slide ceased, D. L. could not be seen. H.M. had suffered cuts around the mouth and had had the wind knocked out of him by the impact against the tree. R.N. received cuts on the face. The others escaped injury. Rescue action was initiated immediately for the lost member of the party. R.N. began climbing back up the slide path in order to ski down Collins Gulch for help. The others marked the line of the victim's fall and began searching down this line. One descended to go for help via Peruvian Gulch. W.S. skied to the bottom to begin the search from below. When he reached the top of the deposition zone he discovered the victim's hand sticking out of the snow in an area where snow had piled up to an estimated three foot depth. He dug her out while the others descended to help administer first aid. Word was shouted to R.N. that the victim had been found and was injured. R.N. then continued out Collins Gulch to seek help while T.S. skied out Peruvian Gulch.

RESCUE

At approximately 5:40 p.m. R.N. reached the Alta Lodge with news of the accident. He notified the Assistant Patrol Leader who immediately called the Avalanche Hazard Forecaster. The latter directed the rescue operation. It was apparent from the patrolman's report that the rescue action required the evacuation of the injured skiers rather than a search for missing victims. The extent of injuries suffered by D.L. and H.M. was undetermined at this point. Three rescue parties were dispatched via different routes to the accident scene, each equipped with a toboggan: One group went by road to the Wasatch Mine, intending to climb up Peruvian Gulch to the accident scene; a second party, led by the Alta Patrol Leader, set out around the end of Peruvian Ridge, intending also to climb to the scene of the accident; the third party consisting of eight patrolmen, the Avalanche Hazard Forecaster, and R.N., went up the Wildcat Lift (where they picked up the light-weight toboggan and a litter) and descended the avalanche path. A fourth group was instructed to follow with radios. While transportation of the toboggan over the difficult terrain was organized, the leader descended to the accident scene, leaving ski patrolmen spaced behind to provide communication with the ridge. There he found D.L. suffering from leg injuries, and H.M. recovered from his minor injuries. Word was relayed up the chain of patrolmen that only one toboggan was required and that sufficient manpower was already at the scene to handle the evacuation.

No. 63-2 East Riverside Slide, Colorado Colorado State Patrol Photo

Because of the extremely steep and hazardous slide path, the rescue party experienced some difficulty in lowering the toboggan to the victim's location. Due to increasing darkness, two men were dispatched to mark an exit route to the Wasatch Mine road at the bottom of the Gulch. The evacuation of the victim began at 7:05 p.m. The ambulance had been summoned and was waiting for the rescue party when it reached the Wasatch Mine. The injured skier was immediately transported to the County Hospital in Salt Lake City, arriving there at 8:00 p.m., only two hours and forty-five minutes after the accident occurred. It was found that the victim suffered fractures of the left leg and dislocation of the right hip. H.M. was also brought to the hospital where his injuries were found to be superficial.

AVALANCHE DATA

The slide began as a shallow, soft slab some 100 feet or more wide, funneled down through a narrow zone in the cliff band, and then spread out in the deposition areas below. Vertical relief from the avalanche fracture line to the tip of the deposition zone was about 550 feet with the slant distance close to 800 feet. The slide path was covered by scattered timber except in the open basin at the release zone. The slide initially involved only the new snow from the 1 March storm, sliding on a hard sun crust. Further down, in the narrow part of the gully, some deep layers of snow were dislodged by the force of the sliding snow.

COMMENTS

This accident involved a party of very experienced skiers who recognized the danger of the terrain they entered and were cautious of avalanche possibilities. The slide was triggered by the victim's momentary disregard of precautionary measures. A shouted warning and quick reaction by the experienced party enabled them to escape the slide with minimum injuries. Their prompt recovery of the buried victim and dispatch of a messenger for help led to a safe and rapid rescue operation. Training and experience tell; panic or confusion by an inexperienced party in this same situation could have had fatal results. Commenting later on her rescue, D.L. remarked: "It pays to be choosy with whom you ski in avalanche country." We strongly endorse this advice.

No. 63-2 RED MOUNTAIN PASS, COLORADO 3 March 1963

WEATHER FACTORS

The winter had produced a snow depth which was less than average. It had stormed off and on during the week, but this particular storm began on Saturday afternoon, 2 March, and continued throughout the night. Winds were

persistent and especially strong Saturday night. Temperatures were not excessively cold, and the storm was a normal one for this area.

ACCIDENT SUMMARY

A bitter wind sliced around the snowbacks of the narrow "Million Dollar" highway. This road, in many places carved from solid rock walls in the narrow, rugged canyon, has 38 avalanche paths in the 23 miles from Silverton to Ouray, Colorado. One group of avalanches threatens the road for a continuous $3\frac{1}{2}$ miles. Control work is accomplished with a 75mm pack howitzer by the Colorado State Highway department. The shooting is normally conducted immediately after the storm clears, for the target areas cannot be seen until then. Control work has been very successful, as lack of accidents in this avalanche-prone area testifies.

Around 0400 on 3 March, the "East Riverside" avalanche, about five miles south of Ouray, released and blocked the highway to a depth of six feet. Several other slides had run during this storm, and highway crews had worked throughout the night to keep the road open. The East Riverside avalanche has a catchment basin of 75 acres, is a mile long, and drops 3,200 vertical feet. As the avalanche path approaches the highway, it narrows and steepens. The highway takes the full brunt of the sliding snow. There is no runout zone--the snow fills the Uncompahgre Gorge below the road. (The West Riverside avalanche is directly across the canyon and is just slightly smaller in length and drop, but has a 150 acre catchment area. It is not uncommon for both the West and East Riverside slides to run simultaneously.)

The small town of Silverton could not support a full-time minister, and Rev. M.H., 39, drove from Ouray to Silverton each Sunday to conduct services. Early in the morning, residents of Silverton had called M.H. and urged him not to come that Sunday because of the storm that was in progress and because several slides had already run across the highway. Members of his family tried to discourage him from going, and especially urged that he not take two of his daughters along. In 1961, H. had nearly been caught when a slide ran just in front of his car. He traded cars with a man blocked on the other side of the avalanche, and continued on to Silverton. State highway personnel stated H. had been in too much of a hurry on several occasions and had gone around barriers or tried to get through before the road was cleared.

H. set out for Silverton on 3 March with two of his daughters, A., 17, and P., 12. Highway signs warning of the potential avalanche areas were in place. Three State Highway snowplows were working to clear the road, and had a one-way track through the debris from the earlier East Riverside run. The trucks had backed up to begin clearing a wider path when H. drove around them. He "spun out" about 40 feet before he reached the main chute of the East Riverside slide path. During an average run, the volume of sliding snow is so great it extends up and down the highway 30-50 feet on both sides of the main chute. It is unknown why H. did not choose to back down the road--he was not stuck in loose snow but merely could not get

sufficient traction. He jacked up the car and put a chain on the left rear wheel. The girls remained in the car. J. then started ahead in his highway truck to pull Rev. H. back down the road. The time was approximately 0930 hours.

Suddenly, the air was filled with dense, fine snow, making breathing almost impossible. The East Riverside avalanche had struck again. The air blast pushed J's heavy highway truck back down the road into another truck behind him. When the air cleared, the highway and canyon below were filled with snow. There was no sign of the H.'s car or its occupants. It was evident they had been swept off the highway into the gorge and were buried under tons of snow.

RESCUE

A call for help was sent over the highway radio from one of the trucks, and while two of the men began to search the snow, the third walked down the road about a mile to get a bulldozer. All three trucks were stuck in snow that had been deposited on the road, but none of the highway men were injured. The local sheriff arrived and took charge about 1000 hours, followed by about 20 men. Highway worker J. was taken back to Ouray in a state of shock for treatment by a doctor. Only a few probes of various design and length were available, but crews shoveled whenever anything suspicious was contacted. A systematic search was not conducted. The snow was 50 to 60 feet deep in the canyon below the road, and temperatures dropped to below zero and blowing wind continued to drift the snow. These conditions made the search difficult, but it was continued until dark.

On Monday, about 50 volunteers helped with the search, and probe lines searched the "most likely" locations. Dogs and metal detectors were brought to the scene but failed to locate either the car or any of the victims. The services of trained Forest Service avalanche men and ski patrolmen were offered (they were within 45 minutes driving time) on both Sunday and Monday, but the offers were declined by the rescue leaders. Monday's search failed to turn up any clues.

Tuesday three bulldozers were brought to the scene and began excavation. Miscellaneous probing was also done. This type of searching was continued throughout the week. On several occasions the search was halted until the State Highway 75mm howitzer could be fired to eliminate any slide hazards that threatened the searchers. In addition to the mine detectors and dogs, a special metal detector designed for avalanche work was brought in from California, and divining rods and witching sticks were tried--all to no avail. As each successive layer of snow was dozed off, it was pushed on down the canyon. The search was conducted from a point below where the car was last seen on the road and downstream to a small dropoff in the deposited snow. This dropoff was 6-8 feet high, and was thought to be the toe of the debris. It was located about 250 feet downstream from the point where Rev. H.'s car had been parked on the road. After the first victim was located, it was realized that this dropoff was not the toe, but merely a small waterfall or rapid drop in the creek bottom. The avalanche had

carried the debris a considerable distance below this dropoff.

At 1150 hours on Sunday, 10 March, (7 days after the accident) H.'s body was uncovered by a dozer. He was located 280 feet downstream from the last seen point, and 71 vertical feet below where his car had been parked. H. was buried under 8 feet of avalanche snow. (Another 12-15 feet of snow had been dozed on top of the natural debris, this snow coming from the search up-canyon.)

On Saturday, 16 March, 13 days after the accident, the car was located. Under the right front wheel the body of A. was found. The car was under five feet of natural avalanche debris, and was 600 feet below the point where it had been swept from the road into the canyon. The top had been completely torn off, and all doors were either open or gone. Miraculously, a glass jar of cream was found unbroken on the front floor and only six of a dozen eggs had been broken. Searching continued intermittently, but was finally discontinued when the snow became too soft to support equipment. Relatives walked the slide debris as the snow melted, and finally on 30 May, P. was found -- 88 days after the accident. Her body was 20 feet downstream from where the car had been found, and probably had been buried under about 15 feet of natural sliding snow. Autopsies indicated that all three victims had probably died instantly due to the severe battering sustained in the avalanche.

AVALANCHE DATA

This avalanche had been shot by the control crew on Monday, six days before the accident occurred, with negative results. Stormy weather had prevented further control work, but winds and storms continued to deposit snow in the catchment basin.

A portion of the catchment basin apparently released at 0400 hours on 3 March, with the remainder releasing about 0930. It was evident the slide was a climax and a hard slab. The volume of snow was considerable. About one-half way up the path, the snow had ricocheted off one wall of the gulch, changed directions by 60 degrees, swept far out onto the opposite wall breaking off 20-30 year old aspen, then plummeted down the side slope as well as down the main avalanche gully. Fracture lines were evident on all three aspects of the catchment basin. After the snow crossed the highway, it dropped into the canyon and climbed the opposite wall which was nearly vertical. This cliff turned the avalanche downstream, but the velocity was so great the snow ran along the face horizontally for about 75 feet, before it gradually fell downwards and again into the gorge of the creek. The creek was filled with snow from 30 to 60 feet deep, and was deposited downstream from the main avalanche track for some 650 feet.

The slide is classified as HS-N-5 (Climax).

COMMENTS

This tragedy resulted when a person who had lived in the Rocky Mountains for a number of years (and had been nearly caught two years before) failed to heed recognized avalanche conditions or warnings from other people. The only way to prevent such accidents is to close the road during hazard periods.

It is evident that all communities, highway maintenance stations, winter resorts, etc. that are in even occasional avalanche country need a complete avalanche rescue cache.

Careful analysis of the lower part of the debris before it was disturbed by dozed snow would have revealed the actual terminus of the debris. This would have resulted in a search of all the debris, and undoubtedly the car and two of the victims would have been located much sooner. It is believed all three victims died instantly, so earlier discovery would not have saved any of the victims.

Here again the importance of carefully analyzing the debris to find the actual terminus can be seen.

No. 64-1 CARDIFF PASS, ALTA, UTAH 12 January 1964

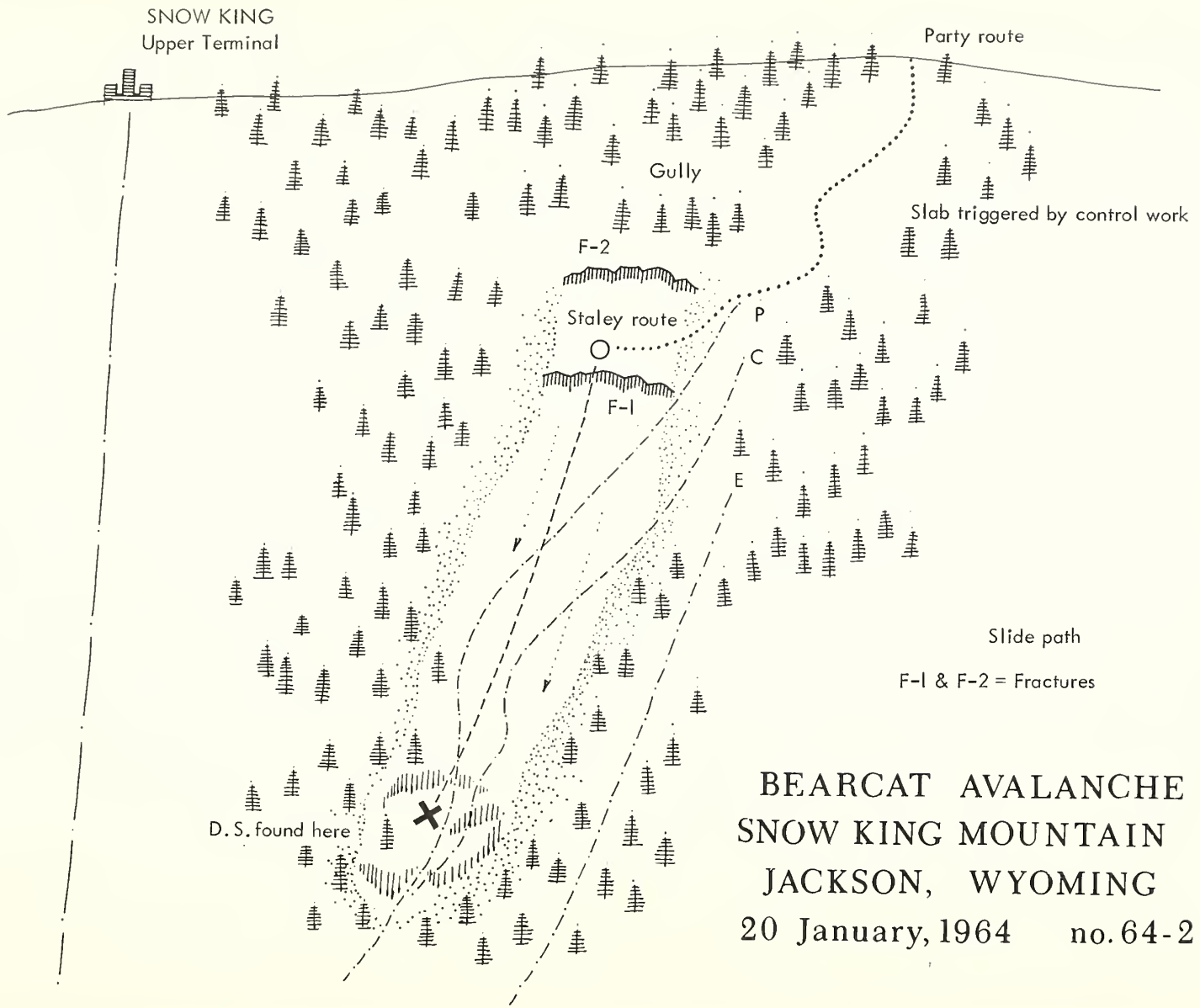
WEATHER FACTORS

On 12 January in the Cardiff Pass area, there was an estimated 15 inches of day-old, powder snow on a wind-blown surface. Early-winter depth hoar formation had been strong.

ACCIDENT SUMMARY

On 12 January, 1964, ten members of a mountain club ski tour encountered dangerous avalanche conditions while skiing north of Cardiff Pass. At approximately 1:00 p.m., they began skiing north along the right side of the Cirque. As the fourth skier, Mrs. J. W., was crossing the first open stretch of snow, a slab avalanche broke loose approximately 50 feet above the ski track. The slide, about 100 feet wide, ran 300 to 400 feet before piling up 8 to 10 feet deep at the bottom. The fracture line was about one-foot deep.

When the avalanche occurred, the first skier, J.M., was beyond the path of the slide. The second skier in line held on to some trees and was not affected. The third skier, M.D., was carried 300 feet, but was not buried, and easily freed himself. Mrs. J.W., however, was caught in the center of the slide. She attempted to ski it out, but eventually was pulled under.



BEARCAT AVALANCHE
SNOW KING MOUNTAIN
JACKSON, WYOMING
20 January, 1964 no. 64-2

Her safety bindings did not release, and she was unable to swim with the avalanche although she attempted to do so after being pulled down. She remained visible to the other members of the party until she was buried by nearly 3 feet of snow at the bottom. The weight of the snow prevented her from moving or maintaining an air space with her arms. She was conscious after being buried, but lost consciousness before the other members of the group dug her out. Fortunately, one ski remained visible above the snow and she was located and dug out approximately four or five minutes after the slide occurred. She regained consciousness as soon as her face was uncovered, and was uninjured.

AVALANCHE DATA

The shock wave from the first avalanche set off additional slides in the area. Three slides occurred on the south and west sides of the Cirque. These were each approximately 400 feet wide and 300 feet long. The bottom of the slides did not overlap. At the same time, a longer slide occurred about 300 yards down the canyon on the east side. This slide was about 800 feet long and 50 feet wide.

COMMENTS

This tour was undertaken during a period of very high avalanche hazard. It might better have been postponed, or a safer route chosen. But careful adherence by the party to wide spacing between skiers in dangerous terrain averted a possibly much more serious accident. This Cardiff Pass accident also illustrates the value of prompt action by the survivors. A few minutes delay could have been fatal.

No. 64-2 JACKSON, WYOMING 20 January 1964

WEATHER FACTORS

On the night of 18 January a severe storm with strong winds and heavy snow began in Jackson Hole. This storm, which continued through the night of the 19th, brought the temperature to a minimum of 10 degrees. As the storm subsided, the temperature rose to a high of 35° at noon on 20 January. At Snow King Mountain ski area there was an eight-inch total of new snow. As a result of the storm, there was extensive cornice build-up on the upper runs and also a general wind-pack condition. Early on the morning of the 20th, two professional ski patrolmen began control work on the ski slopes. Beginning at the upper lift terminal, they worked east along the ridges to Elk Run. In some areas there was limited cornice breakoff, but no slides; on two occasions work produced small wind (hard) slab avalanches. The Upper

Grizzly run, which has a slope of 80% (39°) and is seldom skied, tested stable, with no reaction to ski cutting, though it avalanched two days later, while being ski stabilized.

ACCIDENT SUMMARY

After the majority of the hill was opened the two patrolmen and a patrol candidate entered the Bearcat run to inspect it and possibly to do control work. With an average slope of approximately 70%, Bearcat run had not been heavily skied that year. The run consists of an open ridge and a steep gully, which is a natural slide path; both continue into open timber. Because Bearcat is a north facing slope, it has very limited sun exposure at that time of the year. By late January, a severe depth hoar condition existed in the area. As the three men entered the area, the candidate was instructed to observe from a safe vantage point. The patrolmen skied the ridge without incident. No settling was observed, but the gully was not skied and was not opened to the public. One small slab kicked loose seemed to stabilize the entire ridge.

After the patrolmen completed their control work, they were joined by three ski school instructors (two of whom were former members of the Ski Patrol; the other had been a member of the 1963 Mt. Everest expedition). The five skiers decided to ski Bearcat, thinking that more skiing might stabilize it. When the group arrived at the run, they found new fracture lines in the gully, and it appeared more unstable than was previously thought. Two members of the group skied the ridge, which felt good under test, and stopped at the head of the gully. No new fractures or settling was observed on the ridge. The other three skied down the ridge, and they too found it stable.

One of the patrolmen, R.P. and an instructor, D.S., noticed a fracture line at the head of the gully, and discussed the possibility of skiing above it to break it loose. D.S., who was in a better position for the first traverse, started across, but bottomed in depth hoar about eight feet from the trees. While trying to get his skis to the surface, D.S. saw a soft slab release five feet below him. R.P shouted a warning to him and then added, "Above you!" when he saw that D.S. was unaware that a second slab had released above his position. D.S. tried to dive for the timber, but the small slide carried him into the larger slide below.

R.P. shouted to D.S. to swim. The victim tried to make swimming motions, but his ski poles kept pulling him down. Unfortunately he was wearing long thongs and tight pole straps. He was able to keep his head above the surface nearly two hundred feet, until the slide entered the trees. Then the snow started to churn. He was pulled under and felt his body and legs strike obstructions. The slide carried him four-hundred feet more before coming to a stop.

Feeling the pressure increase as the snow stopped moving, D.S. tried to get his hands to his face to make a breathing pocket, but his poles frustrated his effort. The snow was packed so tightly about him that his rib cage

could not expand, making only shallow breathing possible. He could tell his relative position and was aware that one ski tip was possibly out of the snow. After about two minutes, though still rational and almost detached, D.S. began to lose consciousness. Very aware that he might not live through the experience, he later recalled that his strongest emotion was anger at himself for getting in such a predicament. He remembered deciding that he might use less oxygen if he let himself pass out, and he then stopped trying to remain conscious.

RESCUE

R.P., the patrolman, kept his position until the slide stopped. As it slowed to a halt, he skied the slide path, searching for any indication of D.S.'s position. One of the instructors skied directly to the lower terminal, where he reported the slide and asked for men, shovels, and the avalanche cache. The second instructor, who had been about one hundred feet below R.P., skied down the ridge in the timber; he began searching in the slide tail. The second patrolman was temporarily stranded because of a ski binding problem.

After searching for a short time, R.P. saw a ski tip in the slide. Both he and the ski instructor began digging with their hands and skis. D.S. became aware of people above him and heard the digging. He was conscious when the two men reached his hands and his face; he heard some one say, "He's alive!" D.S. was found laying on his back with his hands ten inches above his face. One ski pole was broken off below the grip. One of the victim's metal skis was broken off behind the heel. The two men checked D.S. for injuries and wrapped him in parkas to get the skier warm.

The second instructor, on his way to the area with additional equipment, learned that D.S. had been found. On hearing that, he started back for a toboggan. Noting that others were organizing a search party, he called by phone to the lower lift terminal to report that D.S. was safe. As the victim wanted to walk around in order to get some circulation, rescuers helped him walk out of the trees to rendezvous with the toboggan. D.S. was later checked by a doctor, who found that his injuries were limited to a badly bruised leg and internal bleeding.

COMMENTS

Test and protective skiing can be a risky business. To be done safely, precautions have to be strictly observed. This was a group of experienced ski patrolmen who did most of the job right, but not all of it. Because they did err in some respects, an accident occurred. Because they reacted quickly and correctly, a possible fatality was averted.

Tests of snow conditions prior to the accident warned of instability. Any avalanche slope had to be approached with caution. The gravest mistake was for D.S. to enter a slope where there was a chance for a slab to release above him. Fortunately his companions were safely disposed on the slope and watching him. They found him quickly in debris, thanks to a protruding

ski tip. If it were not for this ski, he might have suffocated before they found him. He should have worn an avalanche cord. He should have removed his ski pole wrist loops before test skiing. Long-thong bindings aren't recommended for this work, either.

No. 64-3 GEORGETOWN CANYON, IDAHO 25 January 1964

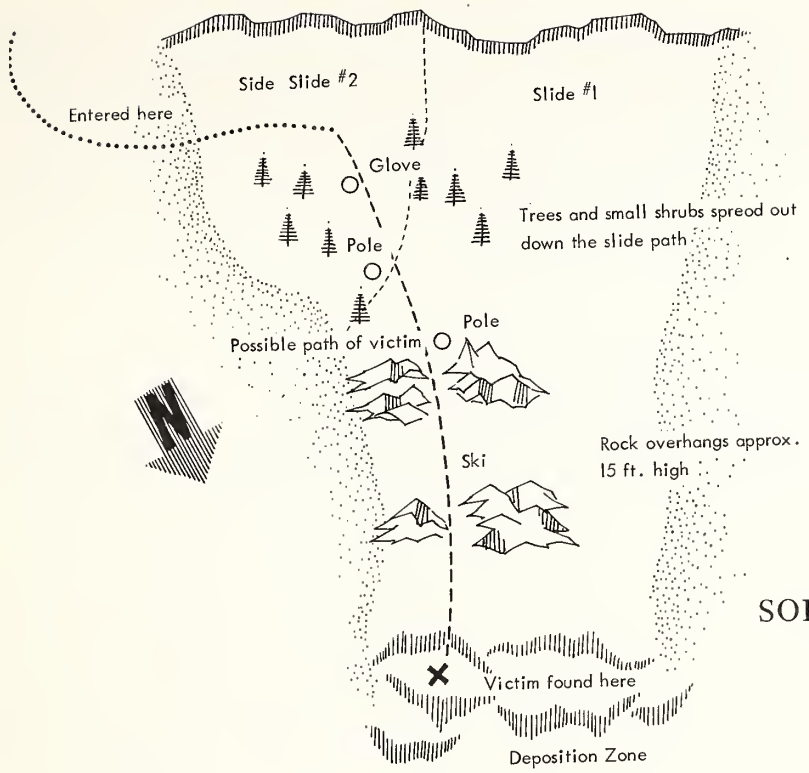
ACCIDENT SUMMARY

The fifteen-million-dollar plant of the Central Framers Fertilizer Company is located four miles inside the National Forest boundary in narrow Georgetown Canyon. The slopes immediately above the plant have snowslide marks on them which indicate that, when snow conditions are right, the entire plant area can be covered with snow. This was pointed out to the company's officials before the plant was built. In 1960, when three company employees were caught in a snow slide, the company realized the real danger which exists in the area. Their safety officer contacted the ranger at Montpelier, and made some efforts to investigate avalanche control measures.

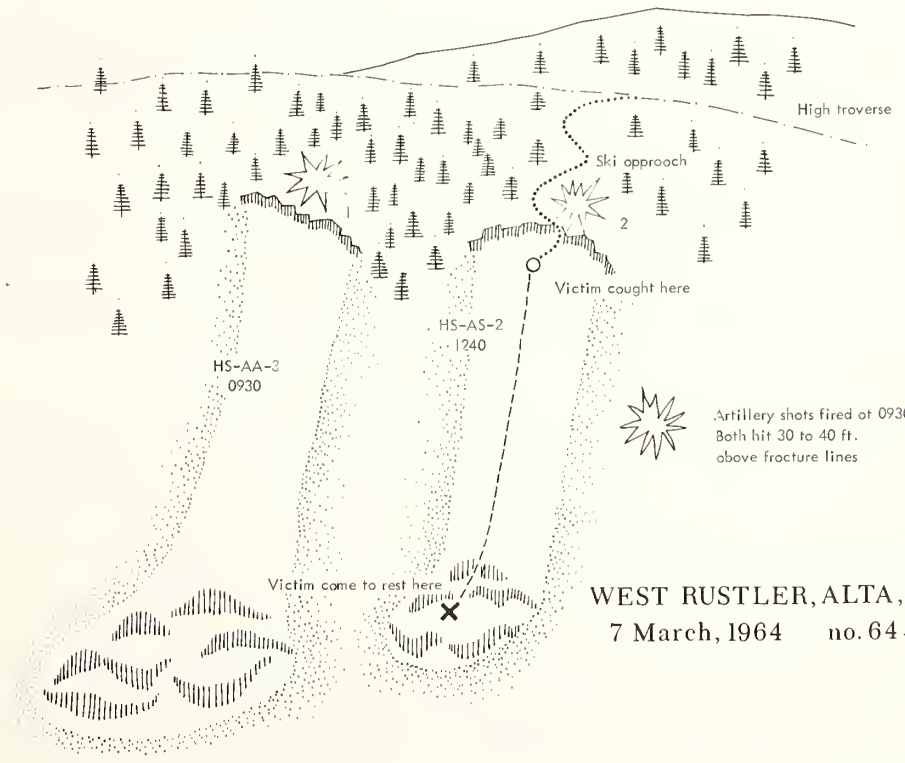
Unfortunately the company continued to be plagued by damaging snow slides. In 1961 and 1962 National Guard gun crews fired high explosives into the area to reduce slide dangers. In 1963 snow fall was light. But in January, 1964, there were heavy snows from 11 January through the 24th. The avalanche hazard increased until at approximately 3:00 a.m. on Saturday, the 25th, a snowslide thundered down the west side of the canyon and smashed into the company's administration building.

Damage to the building and contents was extensive. The force of the snow penetrated the southwest portion of the company's administration building, breaking down the ground floor wall on the west, and traveling through two interior walls. The snow was approximately four-and-a-half feet deep in this area of the building. Office furniture, files, records, and machine were battered and damaged. The buffeting action of the slide also broke through the west wall of the second story in several places, causing damage in three offices. This damage was considerably less than the ground floor. In addition to the structural damage, there was considerable damage on the second floor caused by the dampness of the melting snow.

The security officer was in the guard station when the slide hit. Glass windows were shattered; snow poured in and buried the man to his waist. He was uninjured, but suffered from shock. Fortunately the guard station was not located in the direct path of the slide. Yard area damage was also extensive. The scale house and control unit were torn from the scale platform.



SOLITUDE, UTAH
7 March, 1964
no. 64-4



WEST RUSTLER, ALTA, UT.
7 March, 1964 no. 64-5

Due to the hazardous conditions, inspection of the slide release zone was possible only from a distance, using binoculars. The fracture line was about six-hundred to seven-hundred yards above the by-pass road above the plant. Apparently there were actually two separate slides which joined about a third of the way down the slope. Several days after the slide, the National Guard Gun Crew fired high explosives to bring down or settle the remaining snow on the hill. Nine rounds were fired from the 105 mm gun. Only minor slides were generated, but apparently the explosives settled the snow field.

COMMENTS

This problem repeats a pattern all too common to mountain installations. Avalanches usually can be avoided at little cost if foreseen before construction begins. Protection afterwards can be prohibitively expensive. (Note: A gas company installation was damaged by an avalanche in this same canyon one year later. See report No. 65-4.)

No. 64-4 SOLITUDE SKI AREA, UTAH 7 March 1964

WEATHER FACTORS

Snowfall the day preceding the accident deposited about 18 inches of fresh powder snow in the area.

ACCIDENT SUMMARY

On the morning of 7 March, 1964, an Avalanche Theory and Practical Experience Course was being conducted by members of the National Ski Patrol System Intermountain Division, at the Solitude Ski Area. Five patrolmen were responsible for setting up a mock avalanche in Hoppies Hollow for practical field work while the class instruction was conducted at the Lodge.

In Hoppies Hollow, the patrolmen artificially released an avalanche, throwing a dummy onto the slide path in order to give the class practice in recovery of buried victims. Everything went as planned. The mock scene was complete with the exception of ski tracks entering the slide area. Patrolman R.G. joined Patrolmen D.W. and S.U. on the left side of the slide area in preparation for making the necessary tracks. S.U. was approximately 30 feet below the two other patrolmen. The three were separated from the original slide area by a small knoll. S.U. called to D.W. that there appeared to be some overhang that did not slide. It was also noticed that quite a few fracture lines were evident in the snow. D.W. called down to him to wait. However, the patrolman did not hear the call and skied around

the bottom of the knoll towards the slide area, disappearing from view. D.W. immediately followed his tracks. At the bottom of the knoll the tracks disappeared. The second avalanche was not heard from D.W.'s position. However, on the right side of the original side, the two remaining patrolmen, B.H. and D.K., observed the slide and watched S.U. as he was swept away by it.

S.U. did not have his pole straps on his wrists, but did have safety straps on his skis. The snow hit him extremely hard, making it difficult to regain any control. He managed to free himself from his equipment and started swimming with the slide. He credits this "swimming" motion with saving his life. He was thus able to get a maximum amount of air and landed in an upright, sitting position. The patrolman was carried approximately 1,500 feet before being deposited near the top of the deposition zone of the first avalanche.

D.K. was the first to reach the injured patrolman. He was immediately removed to the right side of the slide path and placed out of danger of other possible slides. First Aid was administered and a toboggan called for. S.U. suffered a concussion, the loss of some front teeth, and slight head and shoulder abrasions. His equipment was found spread throughout the slide path: One glove was discovered just below where he entered the slide; one ski pole was found a little further down, caught in a tree; the second pole was located toward the bottom of the slide, about 25 feet above the spot where the skis were recovered.

At the patrol room, the secondary slide had been observed. A hasty party was immediately dispatched, followed by a main party equipped with probes, snow shovels and other equipment, to make a thorough search for any possible victims. The main party was sent back, however, when they received word that the situation was under control, and that the victim was on his way out.

AVALANCHE DATA

The main avalanche, set off by explosives, occurred in a concave bowl. The entire bowl apparently did not slide. An area approximately 50 feet wide remained hanging. According to S.U., as he entered the bowl about 50 feet below the main fracture line, a new fracture was caused by his weight and the entire area slid out, taking him with it. The second slide made its own path for about 75 feet, then broke out onto the main slide path for the rest of the way down the mountain. There seems to have existed a large layer of depth hoar on top of an ice layer. This accounts for the second slide moving so fast, the ice layer giving it an excellent sliding surface. The lapse of time from start to finish of the second slide was approximately five to ten seconds.

COMMENTS

The chance of unstable snow being left hanging adjacent to a newly-fallen avalanche is particularly good in a depth hoar situation. This demands care when working around such slides, especially in the case of rescue operations.

It is important to note that S.U. attributes the training he had received in avalanche procedure with saving his life.

No. 64-5 ALTA, UTAH, (WEST RUSTLER) 7 March 1964

WEATHER FACTORS

During the week preceding the accident on 7 March, 48 inches of snow fell in a series of small storms. The most severe storm occurred the night of 5-6 March, depositing 14 inches of new snow. The storm on 5 March was the only one accompanied by extensive high winds. Intensive avalanche control work showed the general snow conditions to be reasonably stable. The main hazard seemed to occur in patches of deep drift on steep slopes. Temperatures were unusually low throughout the week.

ACCIDENT SUMMARY

At approximately 12:40 p.m. on 7 March, J.R., a guest at Alta Lodge from Los Angeles, skied into one of the narrow, steep chutes on West Rustler. As he did so, he dislodged a small avalanche with a fracture line 18 to 24 inches high, which carried him about 400 feet down the face of West Rustler. Snow deposition was very shallow on the open slopes below, and he was not buried or injured. Ski patrolmen and other skiers hastened to his aid, helping him recover his equipment.

AVALANCHE DATA

The avalanche released by J.R. was classified as HS-AS-2. The chute on which the slide occurred had been shot with a 75 mm recoilless rifle at 9:30 a.m. the morning of the slide. The adjacent chute to the north had also been shot, releasing a slab avalanche similar to theone released by J.R., but somewhat larger. Several skiers had evidently preceded J.R. in the chute without releasing a slide. It is interesting to note that this accident, though minor in consequence, occurred on a slope which had been both shot and skied.

COMMENTS

Accidents like this are rare, but they are not completely unknown. Even the most exacting avalanche control program may fail to remove one last pocket of slab somewhere. Such incidents are part of a growing body of evidence that the explosive charge in a 75 mm artillery shell is close to the marginally effective size. No case has yet been reported of an avalanche falling on a slope shot with 105 mm artillery.

WEATHER FACTORS

Intensity of a storm beginning the night of 11 March increased on the morning of 12 March. Snowfall and precipitation intensity were low but increasing, with a warming trend in mid-morning. Maximum temperature for the period was 34 degrees; minimum temperature, 23 degrees. Visibility was poor due to cloudiness, snowfall and falling snow.

ACCIDENT SUMMARY

The avalanche accident involved R.P., a professional ski patrolman with over five years experience and an experienced mountain climber, and F.E., a ski patrolman and ski mountaineer with four years experience. R.P. was responsible for avalanche hazard evaluation in the Snow King Ski Area. The two patrolmen had patrolled, toured, and worked on avalanche control together during the last five winters.

About 11:15 a.m., the patrolmen left the lower terminal on Snow King Mountain and proceeded to the upper terminal where they intended to remove a small cornice - about 30 inches of overhang which had built up overnight due to wind and four inches of snowfall - on the east ridge of Snow King. This is a routine procedure in the area. The men roped up with a 45 foot, 3/8 inch manila rope, chosen repeatedly by them for this type of routine cornice work in preference to the more cumbersome 120 or 150 foot, 3/8 or 7/8 inch mountain climbing nylon rope. They were three-quarters of the way up the ridge and had released cornices and small, new slabs. It was decided to climb the remaining distance on foot along the windblown ridge crest, above the Upper Grizzly access cut. Regular control work is not always carried out along the upper portion of the ridge. The patrolmen could not remember whether the upper portion of the ridge had released at any time earlier in the winter.

They stopped on the drift at the head of the first avalanche gully east of Grizzly Run and decided to stamp on it to see if they could make it slide. F.E. established a static belay using his ski poles at the top of the drift and at the edge of the timber. R.P. moved out to the end of the rope, stamping as he went, with no slide occurring. He called for more rope. Leaving his poles behind, F.E. moved out and down about 15 feet and set his skis. As R.P. stamped the slope, old wind slab under the new snow fractured simultaneously in many places, with a fracture about six feet deep. Both patrolmen were catapulted into the narrow slide gully, about 20 feet wide and directly below their position. The slide path was quite thickly forested with young fir trees, 3 to 5 inches in diameter and 15 to 25 feet high. F.E. was carried about 150 feet down the slope before catching among several small trees. The rope snapped at the knot, and R.P. continued down the slide for about 1,000 feet.

Though shaken up, F.E. was unhurt in the accident. He extricated himself from the trees and immediately began the search for his partner. Upon reaching the terminus of the slide, he spotted a boot sticking out of the snow, just below a small tree. The victim was caught around the tree, his back uphill, barely covered with snow. F.E. immediately administered mouth to mouth respiration. No more than 12 to 15 minutes had elapsed from the release of the slide to the discovery of the injured patrolman. After approximately an hour and a half, F.E. concluded that he could not help his friend. He left the body at 2:05 p.m. and reached a patrol phone at 2:20 p.m.

RESCUE

At 2:00 p.m. Forester E.H. received the report of a possible avalanche accident on the ski hill. He was informed that Patrolmen R.P. and F.E. had not been heard from in over two hours. He was asked to take charge of rescue operations. At this time, the call was received from F.E. and a party of seven was dispatched to the exact location. Two medical doctors were included in this party. Several other volunteers arrived to join the search party. To avoid additional slide hazard and to account for all personnel, no other parties were sent to the scene. By 3:30 p.m. the body of R.P. was removed from the area, and all personnel were off the hill.

The victim suffered a fractured leg. Death was due to suffocation.

AVALANCHE DATA

The slide occurred on a 45 degree slope. The entire hill on which the slide had occurred was closed during the search and removal of the victim, and after his removal. Further control work was continued the following day, 13 March, to insure safety of the area.

COMMENTS

It has repeatedly been emphasized in training programs and publications that avalanche release and cornice breaking by cutting or stamping with skis should be done only on slopes where accidents will not have serious or fatal consequences. This type of avalanche control by ski release should be employed only on small slopes. Slide paths of the magnitude involved in this accident should be controlled only by explosives.

An improperly located and unsafe belay position was also, in part, responsible for this accident. The belayer was below the fracture line when the cornice broke off. The secondary cause was an inadequate rope. The weathered, 3/8 inch manila rope was too short, necessitating the improper placement of the belayer, and was not strong enough to hold when the slide occurred. A regular nylon climbing rope with a very safe belay is required for cornice control work. The forces generated by sliding snow are every bit as large as those encountered in the most severe mountaineering fall.

This accident illustrates the lesson that nothing can be left to chance, and no deviation from known safe practice can be considered as acceptable in

No. 64-7 Squaw Valley, California

avalanche control work. The hazards are great even when all rules are strictly followed.

No. 64-7 SQUAW VALLEY, CALIFORNIA 14 March 1964

WEATHER FACTORS

In the immediate area of the slide, 20 to 30 inches of unconsolidated new and old snow existed. On the morning of 14 March, a rapid increase in temperature occurred, from a 6 degrees low to a 27 degrees high at 8:00 a.m. Further temperatures are unrecorded. A sharp warmup was obvious, however, and the snow on sun-beaten slopes converted rapidly to slush. Snow on north exposures remained skiable, but was of a heavy consistency.

ACCIDENT SUMMARY

The avalanche occurred in a closed ski area at approximately 9:45 or 10:00 a.m., 14 March, 1964. The slide and the accident were unobserved. Exhaustive examination of ski tracks led to the conclusion that G.K. had been skiing on KT-22 with a companion, C.H. They parted company above the slide scene. G.K. was last seen by his companion heading for untracked snow in the vicinity of the slide area. It was ascertained that G.K. skied past "closed area" signs to the top of a chute where he was caught by the slide. The slide apparently began when he entered the chute, fracturing approximately 30 feet above him.

RESCUE

Ski Patrolman D.M. received the report of a slide occurrence between 12:30 and 1:00 p.m. The observer had not seen the slide occur. A patrolman sent to the scene to investigate reported no sign of buried victims. Further investigation by patrolmen D.M. and W.S., however, revealed a ski pole and then skis, which were still attached to the victim. The body was buried face down only 12 to 18 inches below the surface. Artificial respiration was attempted on the victim, but was unsuccessful. The patrolmen then brought the body down to the doctor's office in the main ski area. Meanwhile, patrolmen probed with shovel handles in pileup zones in case other victims were buried.

At 2:30 p.m. it had not been determined whether or not the victim was skiing alone when the accident occurred. The Snow Safety Specialist in the area ordered equipment to be secured for a hasty search of the area. After ordering the main lift in the slide area closed to skiers, he proceeded with a party of four to the avalanche scene. An attempt was made to establish

the victim's tracks, and to determine the possibility of other victims buried in the slide. The tracks indicated that no other victims existed. Hasty search procedure was followed, however. Probing in likely pile-up zones continued until 5:00 p.m., but no other victims were discovered.

AVALANCHE DATA

The avalanche was approximately 200 feet wide, and ran for about 300 feet. The fracture line was two to three feet deep. Slope angle in the release zone was 40 degrees; slope angle in the run-out zone, 23 degrees; slope orientation at the fracture zone was north-northeast. The slide surface was depth hoar.

COMMENTS

The area in which the avalanche fractured was a closed, uncontrolled area. The body was found at the intersection of the East Face Run and the Red Run, both of which were open to the public. Until this time, persons skiing down the East Face could reach the fracture zone of this slide without encountering a "closed area" sign. The warning signs were thus not disposed to maximum advantage. But this does not alter the fact that the victim's route took him past warning signs which he chose to ignore. Further, he violated the cardinal rule of skiing: Never ski alone. Considering that he was buried in such a shallow area of the avalanche, a companion could have saved his life.

No. 64-8 SNOW BASIN, UTAH (TAYLOR CANYON) 29 March 1964

WEATHER FACTORS

A prolonged period of cold and snowfall occurred during the week preceding the accident. Clearing weather came on 28 March, but temperatures remained low. March 29 was warm and sunny. A general avalanche cycle was expected, and safety precautions, including closure of hazardous runs, were undertaken at the Wasatch ski areas.

ACCIDENT SUMMARY

On Sunday, 29 March, at 3:00 p.m., two Snow Basin Snow Rangers, L.A. and P.J., accompanied Dr. A.R. and his son on a proposed tour over the top of Mt. Ogden and down Taylor Canyon into Ogden. The two rangers intended to inspect the west-facing slopes for avalanche hazard, and determine if they were advisable for skier use. By 4:00 p.m. the party had climbed to the

saddle near Mt. Ogden. The route proposed by A.R. ran near the ridge dividing Taylor Canyon and Malan Basin. This route was safe and free from avalanches. A.R. assured the rangers that he did not intend to enter the obviously hazardous area south of Malan's Basin.

The two snow rangers travelled considerably behind A.R. and his son. Upon approaching the Taylor Canyon drainage - Malan Basin ridge, A.R. and his son deviated from the planned, safe route without consulting the rangers. They crossed the ridge and dropped into the Taylor Canyon drainage on a north facing slope. They then traversed along the Taylor Canyon side of the ridge in a westerly direction. The rangers immediately recognized the danger of entering this area and shouted a warning. The warning apparently was not heard. The rangers then attempted to overtake the two skiers; they were thus forced to enter terrain that they knew to be extremely dangerous. Due to the thickness of the trees, the party travelled well into the slide area before realizing that the danger was so immediate. Practicing the safety precautions that they had been taught, the rangers skied to the protection of a large tree. P.J. stopped above the tree and his partner below. At the same time, A.R. and his son realized the slide danger and also stopped. They were located about 15 feet out and 15 feet below the two rangers.

The time was 4:15 p.m. It was hurriedly decided to return to the top of the ridge by the same route they had entered. While A.R. was attempting to execute a kick turn, Ranger P.J. felt and saw the snow directly in front of him and above A.R. start to move. He yelled for the party to grab a tree, and when he saw that A.R. and his son were already engulfed in the slide shouted to them to "swim for your lives!" The slide lasted approximately 50 seconds.

As the slide came to rest, P.J. could find no trace of his partner near the tree. He removed his skis and proceeded through the slide area searching for the three members of the party. He found A.R. and his son high in the slide area and suffering only minor injuries. No trace of the other ranger could be found. Neither the doctor nor his son had seen him in the slide. It was decided that P.J. would continue down the slide area searching for the lost ranger, and if he could not find any evidence, go for help. While checking in and around the trees where A.R. had been deposited, a ski belonging to the ranger was found sticking out of the snow, east of where the doctor was located. A ski pole was spotted about 50 feet below the ski. It seemed reasonably certain that L.A. had been carried below the other members of the party. A.R. and his son were instructed to continue checking the upper area around all trees and rocks wherever deposition was found. P.J. moved down the slide path, checking the deposition at the bottom thoroughly. No further evidence of L.A. was found.

After searching for approximately 20 minutes, P.J. headed for help. About 5:20 p.m., after fighting a trail heavy with scrub oak thickets, he reached a telephone and contacted the Sheriff's Office. He then notified the Forest Service and Ski Patrol. He recommended that a rescue party follow the route

along the bottom of Taylor Canyon, a long and difficult trail, but relatively free of avalanche hazard.

RESCUE

The rescue party was organized with the aid of Sheriff's Deputies, Forest Service personnel and members of the National Ski Patrol. At 6:30 p.m. nine men, three on snowshoes and six on skis, were dispatched under the direction of Ski Patrol Leader R.N. as the hasty search party. They were equipped with a radio and shovels. At 7:05 p.m. a second party, consisting of ten men all on snowshoes, left for the scene of the accident, carrying probes, shovels, flashlights, rations, pack sacks, and radios. At 7:30 p.m. a third rescue team with more equipment left for the accident scene.

The three rescue parties had an extremely difficult time reaching the scene of the accident. Soft snow and heavy brush made travel almost impossible for the men without snowshoes. Many of the rescuers did not make it to the accident scene due to exhaustion. The first men to arrive at the scene talked immediately with A.R. about the results of his search, the possible location of the victim, and details of the slide. A.R. then started down from the slide. His son had left an hour earlier, and had gone directly home without reporting to the base camp.

Approximately 15 men began the search for the lost ranger. The party was directed to break into two groups; the five most experienced and energetic volunteers were sent up the slide to probe for the victim or his equipment, while the remaining members began probing upwards from the terminus of the slide. As more men arrived they assisted with the probing. By approximately 1:30 a.m. all crews, involving 19 men, had worked their way down to the probe line near the bottom. The slide had now been searched over its entire surface without success. Due to the darkness and the exhaustion of the searchers, it was decided to discontinue the search until morning.

On the morning of 30 March, a helicopter and experienced personnel from the Wasatch National Forest and the Alta and Park City Ski Patrols were organized to help. Assistance also came from local Forest Service, Ski Patrol and Mountain Rescue personnel. E.L. of the Wasatch National Forest assumed direction of the search party. A helicopter landing pad was located and the area was checked for further avalanche hazard. At 7:00 a.m. a 16-man rescue group, consisting of trained foresters and ski patrolmen, was ferried to the scene by helicopter. Two men were assigned to act as avalanche guards, posted on promontories above the slide path. The rescue group was divided into two parties, one to search the probable fall line of the victim, the other to probe systematically the lower slide path. A relief crew and rations were provided by the helicopter.

At 12:45 p.m. the body of L.A. was located by probe line in the main deposition zone. The victim was close to the centerline of the slide path, some 200 feet or more below the cliffs in the lower gully, and in the deepest part of the deposition zone. The body was horizontal, oriented about 45 degrees to the fall line, buried about 5 feet deep at the head, and about

two and a half feet deep at the feet. Feet were downhill. There was no evidence of the victim having breathed after he came to rest. The body was close to the steep face of debris caused by deposition of a last wave of snow as the avalanche came to rest. The victim had been carried 1120 feet vertically, and 1700 feet horizontally.

At 1:10 p.m., due to possible avalanche hazard from wet slides originating during the midday heat, all rescue personnel and equipment were dispatched to the helipad to await evacuation. At 1:35 p.m. the body was transported to the helipad and flown out to Ogden. By 4:00 p.m. the last members of the rescue party were evacuated and the search operation was concluded.

AVALANCHE DATA

The site of the accident was a 40-degree, north-facing slope covered with scattered conifers. Fracture line depth ranged from one and a half to three feet, involving what appeared to be snow from the immediately preceding storm. The snow was dry, the steep north exposure having been little affected by sun action. The slab slid on a hard crust, which appeared to be an old sliding surface from previous avalanches. Further down the slide path, snow was dislodged back to a fragile depth hoar layer close to the ground. Evidence indicated that this avalanche had also fallen earlier in the winter. The total vertical distance traveled by the avalanche was 1300 feet; total horizontal distance was 2175 feet. The avalanche was classified SS-AS-4.

COMMENTS

The repeated fall of avalanches on north slopes, where a crust had been developed by early avalanche release, was a common feature in the Wasatch Mountains during the winter of 1963-64. The direct cause of this particular slide was the presence of one or more skiers close to the fracture line and on the most unstable part of the slab a short distance below the cornice. In leaving the planned, safe route without discussion or consent, A.R. and his son seriously erred.

The search operations on 29 and 30 March were carried out safely and effectively. The efficient operation of a prolonged probing job, with minimum supervision from the search leader, illustrates the value of a trained reservoir of personnel developed through Forest Service and National Ski Patrol training courses. This, and the earlier safe execution of the hasty search under trying conditions, are a testimony to the effectiveness of avalanche training.

As a result of the experiences of the search party in this accident, it is strongly recommended that either steel tubing or suitable aluminum (thick-wall or tempered pipe) be used for avalanche probing poles. The deficiencies of soft aluminum conduit poles were clear in the deep, solidly packed avalanche debris.

No. 64-9 Huntington Ravine, N.H. Warren

No. 64-9 MT. WASHINGTON, NEW HAMPSHIRE (HUNTINGTON RAVINE) 4 April 1964

WEATHER FACTORS

Storm conditions existed in the area for a few days preceding the accident. On Friday, 3 April, there was a northwest wind at 33 m.p.h., temperature ranging between 4 and 16 degrees above zero, with ten inches of new snow. On Saturday, 4 April, storm conditions became more severe. Wind increased, 60 to 92 m.p.h. northwest, changing to north, temperature fell, ranging from 0 degrees to 11 degrees below zero, with 6 inches of new snow, and heavy fog. Visibility on the summit of Mt. Washington was zero, and below the summit limited to less than 50 feet. Avalanche danger was extremely high in the entire Presidential Range. Numerous slides occurred throughout the area.

ACCIDENT SUMMARY

On Saturday morning, 4 April, 1964, two climbers, J.G. and H.S. departed for Tuckerman Ravine. Learning that the Forest Service had closed the Bowl due to high avalanche danger, they proceeded to Huntington Ravine, about one and a half miles north of Tuckerman. Both men had previous alpine climbing experience and H.S. was rated as an expert mountain climber. Upon reaching the floor of Huntington Ravine they met two other climbers and informed them of their plan to climb Odell Gully. The men actually climbed Central Gully, indicating that they were unfamiliar with the area. They were last seen alive heading toward the upper slopes of the Ravine.

There were no eye witnesses to the accident. From evidence of tracks and climbing gear it is believed that the climbers reached the upper ice field in Central Gully and then proceeded to rappel down. It is assumed that about this time, around 2:00 p.m., they triggered an avalanche which carried them across a snow field and through the rocks below to the Ravine Floor.

RESCUE

At 12:30 p.m. on Sunday, 5 April, the District Ranger was notified by the Appalachian Mountain Club that the two climbers were missing. A search party was immediately organized under the direction of R.G., District Ranger at Androscoggin. By 3:00 p.m. the party was in Huntington Ravine and began a hasty search of the area. Blood was found at several places in the slide path. A hat, a white climbing rope and a broken lens from sun goggles were also discovered. About 5:00 p.m. one member of the search party fell and slid into some rocks on the upper slopes of the Ravine. In was necessary to take him back to the base camp before dark. As avalanche danger in the area was still high, and since the victims by this time had been buried for a period of 26 hours or more, it was decided to discontinue the search until the next morning.

On Sunday night a large search party was organized consisting of Forest Service employees, members of the Appalachian Mountain Club, New Hampshire Fish and Game Department, and the Mt. Washington Ski Patrol. At 6:00 a.m., Monday, 6 April, equipment and search party proceeded to Huntington Ravine.

A short instruction period was given to volunteers in the use of probes and search procedure while the Snow Rangers taped out the search areas in the fall line where the victims' belongings were found. Two technical climbers were sent up to the ice field. They found fresh rappel points, but established that no one had gone beyond this point.

At approximately 2:45 p.m. the first victim was found and identified as J.G. The body was discovered under about four feet of snow, feet down-slope. An ice mask had formed around his face. The top of his head was badly damaged and it seemed quite evident that he had suffered several fractures.

At 3:15 p.m. the body of the second victim was discovered about 100 feet above the body of J.G. He was buried about three feet under the surface with feet up-slope. A great deal of blood was found under his body, saturating the snow. He had suffered severe head injuries and obvious internal injuries and fractures. The men were not roped together. Between the two bodies an ice axe and a glove were found. The rucksack and second climbing rope belonging to the climbers were not located.

The bodies were checked by State Trooper L.H. and then moved by akia to the Tuckerman Trail where they were taken to the base. Medical reports concluded that the victims died instantly from multiple fractures and internal injuries.

By 5:00 p.m. the search operation was officially concluded, with all parties returned to the base.

AVALANCHE DATA

The slide in Central Gully was a soft slab avalanche, about 2,000 feet long and 500 feet wide. The deposited snow was between 15 and 20 feet deep at the terminus.

COMMENTS

Although the victims had previous alpine climbing experience, they made a grave and fatal error by attempting to climb under the severe weather conditions of 4 April. Avalanche danger was obviously high. The climbers, though unfamiliar with the area, did not check weather conditions, or sign out on the winter register with the Snow Ranger. The victims also ignored posted warning signs.

WEATHER FACTORS

Throughout November and December the snow cover in the Wasatch Mountain area was shallow (less than three feet) with many periods of fair weather. This led to extensive depth hoar formation, especially on north and northeast exposures. By mid-December the snowpack had become very unstable and avalanches began to run following snowfalls only a few inches deep. One accident occurred on High Rustler when two ski patrolmen were caught in a slide, but they escaped uninjured.

The snow storms of early January brought heavy avalanching. Large climax slides fell naturally, and were released by artillery fire on many of the major slide paths in the ski area. On 12 January, two people in a touring party narrowly escaped injury when caught in a large slide on the north side of Cardiff Pass. (See No. 64-1) Nine inches of snow fell on 18-19 January, followed by high winds on 20 January. These factors combined to trigger further natural slides and establish conditions for artificial slide releases on 19 and 20 January. In all cases the very fragile depth hoar in the lower snow layers provided the basic weakness needed for avalanching. The accompanying fracture line profile from the Greeley Bowl slide of 8 January, (artificial release), illustrates this unstable character of the 1963-64 winter snow cover. The profile for the Ballroom Traverse slide on 25 January indicates that these climax slides were still breaking loose on the same fragile depth hoar layer.

The dangerous avalanche situation in the Wasatch Mountains was thus clearly demonstrated prior to the arrival of the severe storm of 21-24 January, the largest single fall of snow recorded at Alta since February, 1958.

A period of high winds, reaching 50-60 m.p.h., preceded the storm on 20-21 January. Precipitation began early on the afternoon of the 21st with the arrival of a strong cold front. Snow fell heavily for several hours, diminishing somewhat during the evening, while the wind diminished rapidly after passage of the front. Temperature fell sharply, then remained around 10-15 degrees during most of the storm, falling again to 5 degrees at the end of the storm period. Snowfall set in with renewed vigor during the night of 21-22 January, diminished early on the morning of 22 January, then by 10:00 a.m. reached the highest snowfall intensity of the storm. Snow fall continued throughout the day of 22 January. Wind occasionally rose above critical levels, but did not remain high for extended periods. By afternoon of 23 January, snowfall had become intermittent, with occasional periods of fairly good visibility. Precipitation ended shortly after dawn on 24 January, followed by rapidly clearing skies. A total of 51 inches of snow had fallen during this storm.

AVALANCHE DATA

Due to rapidly rising avalanche hazard, the Little Cottonwood Canyon highway was closed at 10:00 a.m. on 22 January. Skiing was permitted on minimum hazard slopes served by the Wildcat Lift; however, the lift was shut down at 3:00 p.m. due to increasing hazard. During the high hazard situation on 24 January, everyone (except those participating in the control program) was restricted to the lodges.

Prior to 24 January, large climax slides (SS-AA-4 & 5) were released by gunfire on High Rustler, Lone Pine and Stonecrusher. Blind firing at Baldy Cirque and Shoulder released a very large and destructive slide (SS-AA-5) from the center of the Cirque which overran upper Main Street and Mambo and descended with terrific force clear into lower Mambo, a zone normally classified as minimum hazard. Extensive timber destruction indicated a strong wind blast action.

A fast moving slide (SS-N-4) descended the Little White Pine gully sometime on the morning of 22 January, blocking the road. Several natural slides also ran on the lower slopes of Peruvian Gulch about this time. The northeast slopes of the knoll adjacent to the Race Course Saddle slid back to the ground sometime on 23 January, (SS-N-3), the first time a slide has ever been observed at this site.

The accumulation of a 51-inch snowfall on the unstable base brought the hazard situation to a critical point by the morning of 24 January. Most of the major slide paths had not yet slid. Immediate and vigorous control measures were undertaken to insure releases while area and highway traffic were under supervision. When firing began, it became obvious that the snow was even more critically unstable than first estimated. Messengers were dispatched to the various lodges instructing everyone to remain inside and to be prepared for large avalanches from the north side of the canyon.

Firing began shortly after dawn with a 75 mm howitzer. Climax avalanches were released from Baldy Shoulder and Cirque, the largest setting up a dust cloud which filled the entire head of Collins Gulch. A shot on Superior released a slab avalanche which ran across the road. The howitzer was fired several times on the Hell Gate and Cardiff targets, but no slides were dislodged.

The first shot at Flagstaff Bowl released a major climax avalanche from the entire basin. This avalanche descended the usual slide-path gully at high velocity, struck and partially overran the rock knoll west of the guard station, was deflected slightly to the west, and landed along the east side of Peruvian Lodge and in the east edge of the Peruvian Lodge parking lot. A number of vehicles were buried in the parking lot, and one jeep was overturned.

One attendant and two guests at the lodge failed to heed safety measures imposed before the firing began. The attendant was in a snowcat belonging

to the lodge when the avalanche hit the parking lot. The snow entered the open windows of the snowcat, completely filled the interior, and buried him in the seat. The cat was not completely covered and rescuers from the lodge were able to dig him out unharmed in just a few minutes. He later reported a rumor had started in the lodge that firing was over, and he thought it safe to go outside. Two guests outside the lodge when the dust cloud struck were shaken up but unharmed. A legend has already sprung up that one became so excited he ran full-tilt into the swimming pool! The firing operation was suspended until it could be ascertained that no one had been trapped at Peruvian Lodge. Before firing began again on other targets, messengers were sent to move everyone to the basements.

Shots were then fired on Flagstaff Shoulder and Peak, releasing a major climax slide which ran between the lodges and across the parking lot.

The next target was a series of gullies which normally slide into the parking lot above Snow Pine Lodge. The second shot on this target released a major climax slide with a fracture line which propagated from gully to gully eastward clear to the area above Grizzly Gulch. The entire side of the mountain was set in motion and the sliding snow reached across the parking lot from the Snow Pine Lodge eastward to the mouth of Grizzly Gulch. The eastern-most arm overran the gun position and nearly buried the howitzer. The gun crew was forced to retreat hastily up the road in order to escape the sliding snow. One arm of the slide damaged the corner of a cabin, and another arm overran a mine tunnel, damaging two compressors.

Shots then fired on the Greeley Hill slopes released slides from adjacent hillsides. The fracturing continued to propagate clear around Albion Basin, releasing the Sugarloaf and Devil's Castle slides, and eventually releasing two small slides on the southwest face of Mt. Wolverine, across the valley from the original target. The extensive fracturing and avalanching throughout the entire Albion Basin from this single shot gave further evidence of the critical instability of the snow.

The next slide was a major climax avalanche released on the North Rustler slopes. This slide in turn dislodged the upper slopes of Eagles Nest. This snow descended the bowl, spilled over the rim of Eagles Nest, and dislodged practically all of the snow lying on the steep, heavily timbered slopes. The combined avalanche, the largest seen to descend these slopes in many years, struck the concrete pedestal of the old Rustler tow, broke the 1,000 gallon gas tank located on top of this pedestal, and destroyed two support towers of a rope tow. This avalanche removed the entire winter snow cover back to the unstable depth hoar next to the ground.

Further firing with the recoilless rifle on the Superior and Hell Gate slopes released several slides, the largest of which was a climax avalanche from the Little Superior main gully which ran across the road.

The ski slopes which had not yet slid were the next targets. Slides fell on Sunspot and above the race course, one on a slope that had never been seen to slide before this time. Shots into the chutes south of West Rustler

resulting in a large avalanche into upper corkscrew and across the ridge into the Meadow. Firing on targets at the head of Peruvian Gulch released a series of major avalanches throughout the entire Upper Peruvian Gulch. These in turn triggered the major slide paths in the next two canyons to the west.

COMMENTS

A highly unstable snow condition like this represents the most dangerous type of avalanche situation. Even the most minor disturbance or displacement of a single small slide can set an entire mountain-side into motion, or inundate the head of an entire canyon, bringing down large and dangerous avalanches at points far distant from the initial disturbance. Fracturing and avalanche release on this occasion literally propogated for miles throughout the Alta area from the triggering effect of single artillery shells.

The major avalanche cycle of 24 January was the largest observed in Little Cottonwood Canyon in several years. Disastrous consequences might well have resulted if the natural avalanche cycle had been left uncontrolled and widespread avalanche release had occurred with skiers on the lifts, slopes and highways. The decision to shoot in such circumstances, at the risk of property damage, is not an easy one. In a similar situation at Alta in 1965, the decision was not to shoot. Canyon residents retired to the basements for safety, large avalanches fell by natural release, and extensive damage occurred anyway. The only serious crisis in 1964 arose from the ill-founded rumor at Peruvian Lodge that the shooting was over, just when the avalanche hazard was most dangerous. After this incident, ski patrolmen were stationed at the door of each lodge to keep people inside, where they should have been at the beginning of the control program. In dealing with the unpredictable mixture of avalanche and skier, the Snow Ranger must never take anything for granted.

No. 64-11 POCATELLO, IDAHO 7 March 1964

WEATHER FACTORS

Weather conditions unknown.

ACCIDENT SUMMARY

Two ten-year-old boys were playing with several friends in a snow covered gully in the "bench" area of West Pocatello. The boys were sliding down the side of the gully when they suddenly sank out of sight and a large

overhang of snow toppled over on them, carrying them several hundred feet down the hill and burying them. The other youngsters, having observed the accident, ran for help.

RESCUE

Police and firemen were immediately notified. An announcement of the accident on radio brought some 70 to 100 volunteers with shovels to help search for the boys. The approximate spot where the boys were buried was pointed out by the other youngsters, but probing with shovel handles failed to locate the victims. The searchers then began digging at the base of the slide area. The body of one victim was discovered face down with his head downhill. He was dug from the snow about one hour after the slide occurred. Rescuers attempted mouth to mouth respiration and a doctor attempted to revive the boy with external heart massage. He was pronounced dead at the scene of the accident.

Shortly after the discovery of the first victim, searchers located the body of the second boy buried nearby. He was found face up with his head uphill. He was still alive when dug from the snow. However, in spite of constant artificial respiration and cardiac massage at the scene and at the hospital, he died several hours later.

The large number of volunteers who came to help search for the young boys blocked roads into the area, and hampered ambulance service.

AVALANCHE DATA

No avalanche data are available.

COMMENTS

Given the right snow conditions, even small and harmless-looking slopes can be lethal. (See also No. 62-7). Once again we repeat: The small avalanches are the killers.

No. 65-1 SUGAR BOWL, CALIFORNIA 2 January 1965

ACCIDENT SUMMARY

At 10:30 a.m. on Saturday, 2 January, Miss M.G. and Mr. J.H. entered the Sugar Bowl Ski Area to begin a ski tour over the back country to the Sierra Club Benson Hut on Mt. Anderson. In order to get to the Benson Hut the couple had to cross Mt. Lincoln. The Mt. Lincoln chair lift had been

closed since 23 December because of mechanical difficulties. Consequently no avalanche control was undertaken in the area, and the avalanche danger was high. Moreover, a bad storm was predicted for Saturday afternoon. Miss M.G. was inexperienced both in skiing and mountaineering, and was making the trip on snowshoes. Her companion, J. had some knowledge of ski touring and avalanche dangers.

At 10:45 a.m. a volunteer ski patrolman in the Sugar Bowl Ski area stopped the two, inquired about their destination, and took their names. He warned them of the avalanche danger and the approaching storm. The couple continued to the bottom of the chair lift at Mt. Lincoln, where the acting professional patrol leader of the Sugar Bowl Ski Patrol, P.M., stopped them. He asked about their destination and J.H. replied that it was the Benson Hut. He added that the couple had signed out in the trip book at the Sierra Club's Clair Tappain Lodge. P.M. again warned them of the dangers in the area they would be crossing.

In spite of these warnings, the two continued their trip. The predicted storm arrived, one of the worst in several years. The snow and a thirty-five-mile an hour wind reduced visibility to less than two-hundred feet. The couple began traversing Mt. Lincoln about fifty yards below the ridge, J.H. in front on skis, and Miss M.G. behind on snowshoes. At approximately 2:10 p.m. a slab avalanche suddenly broke above M.G., but below the ridge. J.H. shouted instructions to her, and he began to ski down the slope. Although the avalanche caught him and tore off his skis, J.H. was fortunately able to stay on the surface of the slide. M.G. was buried.

RESCUE

J.H. spent an hour and fifteen minutes in vain search for his companion. Meanwhile, the intensity of the storm increased; visibility dropped to a few feet. After finding M.G.'s pack and snowshoe without locating her, the survivor returned to the Sugar Bowl Ski Area for help. The acting patrol leader formed a search party and telephoned adjacent areas for additional rescue personnel and equipment. At this time it was learned that the pair had not signed out at Clair Tappain Lodge.

By 6:40 p.m. the search party, aided by two snowcats, reached the toe of the avalanche in the East Bowl of Mt. Lincoln. The severity of the storm combined with the approaching darkness made visibility nearly zero. The survivor, exhausted and in shock, was returned to the Sugar Bowl area. The rescue party began a hasty probe which was unsuccessful. A preliminary probe line was equally unsuccessful. At 7:30 the main search party arrived with food, lights and additional equipment. A longer probe line was formed and M.G.'s body was finally recovered about one hundred and fifty feet above the location where J.H. found her pack and snowshoe. The body was found wrapped around a small tree and one snowshoe was still on her foot. An autopsy showed that she died of asphyxiation.

COMMENTS

Those who are determined to seek danger in the face of repeated warnings will insure a steady future flow of reports to this and other accident files.

No. 65-2 FARMINGTON CANYON, UTAH 29 January 1965

ACCIDENT SUMMARY

At 8:00 a.m., 29 January, 1965, two research foresters, R.J. and R.D., left the Farmington Experiment Station to take the monthly snow course measurements in Farmington Canyon. After leaving their trucks at Hollingsworth Creek, the foresters continued on two newly-acquired power toboggans. Originally they planned to reach the snow course area via the road to the Farmington Guard Station, but a deep snow drift on the road forced them to abandon that route. At this point the two decided to take an alternate route up the Left Fork of Farmington Creek. Both men were aware of avalanche dangers and had several years of experience working under conditions of this type. R.J. had participated in avalanche studies, but neither was a trained snow ranger. Moreover, the two had checked this alternate route on snowshoes the previous month.

After leaving the road at 11:00 a.m., they started up the creek; the precipitous terrain forced them to travel right in the creek bottom. They were traveling about one hundred feet apart with R.J. in the lead; R.J. was careful to look back every few hundred feet to check on R.D.'s position. Although the two were aware that a considerable snow depth had accumulated in the entire area, they saw no cornices along the ridge tops, nor did they notice any fracture lines on the slopes.

The two men had traveled almost five hundred yards from the main road, when a small snow slide broke to the right of R.D. Hoping to avoid the slide, which was slightly ahead of him, R.D. stopped his machine. A one foot high wall of snow slid to a stop against the vehicle, burying one of its skis, and making it impossible for R.D. to get started again. Since R.J. had checked back just prior to the slide activity, he went on out of sight without observing any of it. After this first slide, R.D. stood on his machine, hoping to get his companion's attention. Suddenly a much larger slide started to tumble towards him. His first impulse was to run, but before he could move, he was caught in the avalanche. Feeling as if he were riding a large wave, he was carried a considerable distance up the opposite slope. As the snow stopped, it pressed in around R.D., leaving him completely buried.

RESCUE

After he had gone on about one hundred yards, R.J. realized he had not heard the other vehicle for several minutes; on checking back, he discovered what had happened. Figuring R.D.'s probable location when the slide struck him. R.J. made a brief preliminary check. This only revealed that additional help was imperative if the large slide area was to be searched thoroughly. As quickly as possible he made his way by over-snow vehicle three-quarters of a mile down the canyon to a Federal Aviation Agency maintenance shed. Since the door was nailed shut, he was forced to break in through a window. As he hoped, the shed contained a radio. After several minutes he finally made contact with the F.A.A. in Salt Lake City, and notified them of the accident and his location. Then, finding a long wooden pole, he returned to the avalanche area to probe for the missing man.

In the meantime the F.A.A. notified the near-by Bountiful Ranger Office, and by noon the rangers were organizing rescue operations. The county sheriff and jeep posse were alerted; other avalanche control work in the vicinity was halted and these rangers started to the Bountiful area. The Solitude Ski Patrol volunteered its assistance. The various groups reported to the Salt Lake Fire Control Center, fifteen miles from the Farmington area. This became a staging area for the rescue operations. Probes and other equipment were assembled.

Shortly after 1:00 the first rescuers, two F.A.A. road maintenance men, appeared at the avalanche area, unfortunately without probes. After obtaining some wooden probes, they joined in search efforts, but two of these probes quickly broke. Fifteen minutes later, three more men arrived by an over-snow vehicle, but they too had only wooden probes. Meanwhile, attempts were being made to fly Assistant Ranger R.T. into the area by helicopter from the Fire Control Center. However, high winds and lack of radio communication made it impossible for the helicopter to land in the avalanche area. Finally the pilot landed R.T. at the Farmington F.A.A. building.

By 1:30 additional personnel reached the site with snow plows and a few aluminum probes. Forty-five minutes later R.T. arrived with the remainder of the probes. R.J. explained the situation to the ranger, who organized a systematic probe of the slide, starting at R.D.'s estimated line of travel and proceeding uphill. The search was begun on the downhill portion of the slide. Several times during the probing the searchers had false indications that they had found something and stopped to investigate. At 3:30 one of the men who had been digging out a false lead moved further uphill and upstream to rest. Apparently he sat down right above R.D. The buried victim was conscious, heard the man, and shouted. The searcher alerted the others, and all frantically began to dig with their hands.

R.D. was found buried under $1\frac{1}{2}$ to 3 feet of snow in the center of the slide area. The snow vehicle was located eighty feet downhill from him. Briefly describing his four-hour ordeal to rescuers, R.D. recalled that after the

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snow buried him, he was still able to move his right arm below the elbow, although his left arm was pinned under him. Using the free arm, he was able to push a small cleared space around his face. He tried several times to attract attention by shouting, but realized that he was only using up his energy and oxygen.

Forcing himself to relax a little, he tried to reduce his breathing but finally lost consciousness. Apparently because of a probe pole stuck in the snow near him, his air supply improved and he regained consciousness. Finally he heard the voice of the fellow who sat on or near him and was rescued. He was cold - his body temperature was three degrees below normal - but a doctor on the scene could find no other injuries.

COMMENTS

The snowmobiles undoubtedly undercut the steep slope above them. This left the victim in the worst possible position when the slide ran. Recognition and avoidance of potential avalanche slopes would have prevented this accident.

This is another example of a second or "hangfire" avalanche running from above the original slide. (See report No. 62-4)

This accident occurred during a period of exceptionally high avalanche hazard throughout the Intermountain West.

No. 65-3 SNOWBANK MOUNTAIN, IDAHO 29 January 1965

ACCIDENT SUMMARY

On 29 January, 1965, a Federal Aviation Agency crew was working overtime to open the access road to the Agency's radio and television antenna site on Snowbank Mountain in Idaho. At this time of year the site was dependent on its own diesel generator for power. By late January the access road had to be cleared in order to transport additional fuel to the station's light plant. The area in which the crew was working had been covered by snow since late November; intermittent rain and snow during December and January resulted in a heavy snow pack. It had snowed the previous week and was raining on the 29th. Personnel working in the area did not consider the situation as potentially dangerous, although they had requested Forest Service action to remove a nearby cornice build-up.

Late in the evening of the 29th, two D-7 tractors (without canopies) were operating approximately a quarter of a mile apart in an area near Potter's

Pond. The road in this area ran beneath a short but steep and corniced slope. Because of darkness and poor visibility due to storm conditions, they were working by the headlights on the tractors. Around 10:30 p.m. the driver of the second tractor realized that he had not seen N.F.'s headlights in front of him for several minutes. Going forward to check, he found that a heavy snow slide had moved down the hill, crossed the road, and completely covered the tractor and operator. There was no indication of the location of either N.F. or his tractor. The second operator immediately returned to the F.A.A. service garage, four miles down the road, to get additional help. It was 2:00 a.m. before other men and equipment could get back to the slide area and begin searching for the missing man. At 2:30, searchers, using a probe, found the tractor; the seat was under about four feet of snow. N.F.'s body was found a few feet away from the tractor. Attempts to revive him failed. An autopsy revealed that he had died of suffocation.

COMMENTS

Darkness, poor visibility and no realization of the potential danger led to this accident. The victim might have survived with a canopy on the D-7, for the top would have offered protection and would have been above the snow surface.

No. 65-4 GEORGETOWN CANYON, IDAHO 30 January 1965

ACCIDENT SUMMARY

On 30 January, 1965, the management of the El Paso Natural Gas Company requested a gun crew from the Idaho National Guard at Preston to take avalanche control measures above their plant in Georgetown Canyon. An earlier attempt by the same gun crew on 10 January failed to produce any slides or noticeable settling of the pack. By the 30th the avalanche danger in the area was significantly higher; during the previous two days thirteen snowslides occurred below the plant site. From 24 January to 30 January there had been a continuous accumulation of heavy wet snow on top of an early season pack of deep powder snow. Snow depths were estimated at sixty inches with drifts of more than one-hundred inches.

In preparation for this second control attempt, all vehicles and personnel were removed from the plant area. The natural gas and electric service were turned off. Shortly after 2:00 p.m. the gun crew began firing the 105 mm Howitzer. A series of five shots produced a noticeable settling of the snow. Then a sixth was fired. At first it appeared that a small slide was generating in the shell's impact area. Almost instantaneously,

three-thousand yards above the canyon bottom, fracture lines appeared in the entire basin. A massive slide swept down the slope and directly onto the administration building, virtually demolishing the structure. Management personnel estimated the damage at $225,000.

COMMENTS

One, or several, rounds of artillery fire may not always trigger a large slide. The key shot has to be placed in just the right location. Knowledge of normal fracture line locations is essential. Under favorable conditions, fracture lines can propogate a long distance.

A year before, 25 January, 1964, a major natural slide occurred at the same place. Considerable damage was also done to the administration building at that time. (See No. 64-3)

No. 65-5 HOMESTAKE LAKE, COLORADO 31 January 1965

WEATHER FACTORS

The amount of snowfall in the area prior to 31 January was above normal. Soil Conservation records show that the snow pack was at 130% of normal for the Upper Colorado River Basin. During the last six days of January, fifty-eight inches of new snow fell on the hills around the valley. Fourteen inches fell on the 30th alone.

ACCIDENT SUMMARY

During the winter of 1965, employees of the Berco Company (subcontractors of the Morrison Knudson Construction Company) were engaged in extensive tunneling operations in the valley floor near Homestake Lake. Three parallel tunnels were being driven into the slope along one side of the valley. These "Coyote Tunnels," were to be used in May, 1965, to plant a large dynamite charge - 1,100,000 pounds - which was intended to provide earth fill for a dam. Because of a tight construction schedule, contractors were working through the winter, around the clock.

On the night of 30 January, six employees were working the graveyard shift; two men were working in each tunnel. D.H. and L.K. were working in Tunnel Three. L.K. left the tunnel at 2:30 a.m. (31 January) to dry out his clothes in another short tunnel about sixty feet from number three. While drying his boots and socks, L.K. heard what sounded like a gust of wind and noticed snow blowing into the tunnel. A huge avalanche had released two thousand feet up the mountain, carrying five to ten thousand cubic

feet of snow down into the valley. D.H., who was standing outside his tunnel when the slide hit, was carried forty feet from the portal and buried under twelve feet of snow.

As soon as the snow settled, L.K. dug himself out of the other tunnel, checked the situation at Tunnel Three, and went immediately for help. He notified the men in the other tunnels who ran over the Tunnel Three, where they were soon joined by the off-shift crew and a D-8 tractor. The quarry superintendent notified other company officials who ordered three more tractor operators to report to the area. Two D-8 tractors and shovel crews continued search operations until 5:40 a.m. when one of the tractor operators uncovered a sleeve of the victim's raincoat. Tractor operations were halted and the rest of the snow was removed by hand. No pulse was found and D.H. was assumed dead at the site.

COMMENTS

Terrain and snow conditions generated an obvious hazard at this tunnel site. Reports on this accident are brief; they do not mention whether the construction crew was ignorant of the danger or chose to ignore it in order to meet a tight schedule.

No. 65-6 MT. BALDY, CALIFORNIA 4 April 1965

WEATHER AND OTHER FACTORS

Located about 50 air miles east of Los Angeles, the Mount Baldy Winter Sports Area is listed as one of the four major avalanche hazard areas in California. Winter weekends bring swarms of winter sports enthusiasts from the coastal metropolitan areas. Often these people are unfamiliar with avalanche and snow-covered terrain dangers. When this factor is combined with the area's existing avalanche hazards, it presents a formidable problem of snow safety. Compounding the problem is the fact that snowfall on Mt. Baldy is sporadic. Consequently, the actual avalanche hazard also varies widely from year to year.

Because of the gravity of the situation, Forest Service personnel have prepared a detailed snow safety plan. To the extent that the plan is carried out by trained personnel, it is successful, but efforts to secure public cooperation and to warn them about potentially dangerous areas are continually thwarted. Slopes posted as dangerous frequently get as much traffic as unposted ones. Signs warning of avalanche hazards are carted away for souvenirs almost as rapidly as they are posted. Adequate enforcement of closure requires the assistance of armed deputies.

The last days of March, 1965, brought an unusually heavy spring snow storm to the Mt. Baldy area which lasted through 3 April. By Saturday the 3rd, new snow depths ranged from over thirty-inches at the Mt. Baldy Notch to twelve to fifteen inches in the Movie Slope region. Investigations by Snow Ranger D.R. indicated a potentially dangerous avalanche hazard existed throughout the area. This was confirmed when members of the National Ski Patrol skied all major avalanche areas. They reported the fracture lines and settling which typically indicates a slab avalanche hazard.

Early Saturday evening the lower slopes were posted with the standard "Avalanche Danger" signs. In addition, Deputy Sheriffs and Ski Patrol personnel were scheduled on duty to warn people about particularly dangerous regions. By Sunday, the weather began clearing; the rain in the valley and the snow in the mountains both stopped. Because of the clearing conditions, and the fact that local press, radio and T.V. had given extensive coverage to the unusually late storm, large numbers of people invaded Mt. Baldy's slopes.

ACCIDENT SUMMARY

At 12:15 p.m. Sunday a wet, soft slab avalanche released on a steep slope northeast of the Movie Slope Ski Area. Snow rangers, aware that a hazard existed on this slope, had posted signs the previous day warning "Danger Avalanche - Keep Out." In spite of this, there were approximately one hundred people within the immediate area when the slide occurred. According to observers, seven to twelve people were actually caught in the fifty-yard-wide avalanche as it tumbled nearly three-hundred yards down the mountain. Those not completely covered by the snow were immediately rescued from the debris by parents and other bystanders. One of these rescuers, a private in the Marine Corps, managed to run clear of the slide. After the snow stopped, he helped pull out a man who was completely covered, except for his head. He and the man he rescued dug out another boy who was covered except for his foot. Witnesses quickly reported the accident to the ski patrolman on duty at Movie Slope "Hogan." He immediately left for the scene to organize rescue operations. The Patrolman assisted bystanders in removing some of the people trapped in the slide and then dispatched messengers to request additional help from the Forest Service and Mt. Baldy Ski Lift.

RESCUE

At 1:30 Snow Ranger D.R. arrived with ten Ski Patrolmen and rescue equipment from the avalanche cache at Baldy Notch. On questioning witnesses, they learned that one, and possibly two, victims remained trapped in the slide. Two probe lines were formed, one beginning at the lower end of the deposition area, and the other starting in the center of the slide. D.R. organized shovel crews from among bystanders and put them under the direction of the Ski Patrol. They were directed to dig trenches to ground level at two foot intervals, beginning at the deepest part of the terminus and following behind the probe line.

By this time the road below the slide was congested with traffic; large numbers of spectators were heading toward the slide area. Since the possibility of new slides remained high, and officials at the scene had no personnel to spare for crowd control and traffic direction, D.R. requested that the Highway Patrol close the road to uphill traffic. An officer from the county sheriff's office who had been informed of the avalanche arrived on the scene at 2:00 p.m. D.R. asked him to request additional help from the Sheriff's office. The snow ranger also advised him of the possibility of additional slides and suggested that he move spectators to a safe area. As search operations continued into the afternoon, Forest Service assistance was requested by radio to handle the assortment of reporters from the press and other news media.

At 3:00, all but two strips of the slide area had been covered with no results. By now only one victim, a teenager who had been last seen in the center of the slide, was confirmed as still in the avalanche. D.R. directed the two probe lines to each search one of the unsearched strips. By 3:20 five Forest Service employees arrived. Two took charge of the news media, and the other three were instructed to check avalanche signs in the area and assist in controlling the crowd of spectators. Traffic was, by then, congested and at a standstill. The San Bernardino County Sheriff's Search and Rescue Team arrived at 3:30. D.R. assigned them to the larger of the two unsearched areas to conclude the first stage of the search.

As rescue operations continued into the late afternoon, it was clear that relief would be needed for the Ski Patrol for the second stage of the search. Lt. W. of the Sheriff's office advised D.R. that relief, food, and lights had been ordered. Then at 4:00 the victim was found alive in the southwest corner of the deposition area, about three to four feet below the snow surface. He was dug out and first aid was administered by the Ski Patrol. A later examination by a doctor indicated that he was suffering from exposure, shock, and possibly a broken leg. A still later examination at the hospital revealed that there was no break.

The avalanche search was continued until approximately 9:45 p.m. under the direction of Lt. W. Men from his department, the San Bernardino County Mountain Search and Rescue Team, the Los Angeles County Special Enforcement detail, and the Los Angeles County Mountain Search and Rescue Squad made a systematic probe of the entire area. No other people were discovered in the debris, but the avalanche danger sign was recovered only a few feet from the victim.

COMMENTS

The victim was in a semi-upright position, but facing downward. The official reports unfortunately are silent on the details which would explain the victim's very lucky survival for $3\frac{1}{2}$ hours under this depth of heavy,wet snow. Photographs taken at the scene show avalanche debris composed of large wet "snow balls," a typical feature in damp or wet slides. There probably existed air channels which allowed the victim to breath. Why his chest was not constricted is unknown.

No. 65-7 Geneva Basin, Colorado Bailey

Site of the Quickslip avalanche. This photo shows a similar avalanche in 1962. Dark line is the fracture line of the 1965 accident avalanche.

WEATHER FACTORS

By Monday morning, 20 December, 1965, there had been only two snowfalls of any significance in the Geneva Basin Ski Area. There was hardly enough snow on the ground for the area to operate. Because of this, there was little concern about avalanche hazard. On Sunday, the 19th, there had been a severe wind storm lasting until early Monday morning which deposited a large amount of snow in the "Quick Slip" area. The temperature on Monday was between 25 and 30 degrees; it was quite sunny.

ACCIDENT SUMMARY

Early Monday, L.U., J.H., his sister and her friend reached Geneva Basin for a day of skiing. Although this was their first trip to the Basin, both of the boys were skiers of intermediate or better ability. L.U., sixteen, had been skiing for some time; J.H., seventeen, started skiing the year before. Shortly after they arrived, all four took the lift to the top of the ski area. The two girls skied south, but the boys went off in a northerly direction looking for an area called "Silver Streak," which a map at the lodge indicated was an intermediate slope. This area lay to the north and east of "The Glades" and "Quick Slip."

As the boys continued north they passed three or four signs with red diamonds on them. Unsure of their meaning, they tried to avoid the general location in which the signs were posted. Passing through "The Glades," the pair arrived at the "Quick Slip" area above "Silver Streak" by about 10:30. Posted as dangerous, this slope is steep (50%) and concave at the top. Gradually it levels off into a dense willow patch and boggy area. There had been one slide in the area the previous evening. As the two boys skied out across the slab, the whole area began to move, almost as a sheet, down the slope. Then the avalanche started, L.U. was ahead of and a little below J.H. For a while the boys were able to ride along on the surface of the slide, but as the avalanche slowed down, both went under and were pinned by the onrushing chunks of snow.

At 12:30, almost two hours later, when the two girls were unable to locate their friends, they reported them missing to the Geneva Basin management. The area assistant manager, and the assistant director of the ski school left in a Sno Cat to check the places in the Basin where people commonly get lost. When this search failed to turn up any clue as to the whereabouts of the two, the manager sent instructors down the main slopes to check for people matching their description. He also sent his assistant through "The Glades" toward "Silver Streak." Then he took the Sno Cat back to the lodge area and continued to search the slopes.

The assistant, S.B., arrived at the avalanche in "Quick Slip" about 1:30, but could see no sign of the skiers. He shouted and then heard the muffled voice of J.H. Shouting at him to keep yelling back, S.B. finally located him and removed the blocks covering his face. This accomplished,

S.B. made a quick but unsuccessful search for L.U. Unable to make radio contact with the lodge, he rushed back there for additional help. The manager, who had by then returned to the lodge, quickly began to organize rescue personnel and equipment, while S.B. went back to the avalanche with three other skiers. By 1:45, S.B. had J.H. almost dug out. At 1:50 the manager arrived with eight others. They helped remove J.H. from the snow, and began a hasty search for the other boy. A probe line was formed; just as they started to probe in an organized fashion, one of the men noticed a small piece of ski sticking out of the snow. L.U.'s body, buried under two feet of snow, was soon recovered. Rescuers were unable to revive him, although mouth-to-mouth resuscitation was continued for 45 minutes.

Fortunately J.H. had been buried face up and with his head relatively close to the surface. Moreover, he was not buried in an area where a large amount of snow was deposited. Although unable to move his limbs, the boy tried to make a small clearing around his head by moving it around and eating all the snow he could. L.U.'s position in the slide was less fortunate. He apparently fell parallel to the wave of snow and was buried deeper than J.H. He was found face down with his head below the level of his feet.

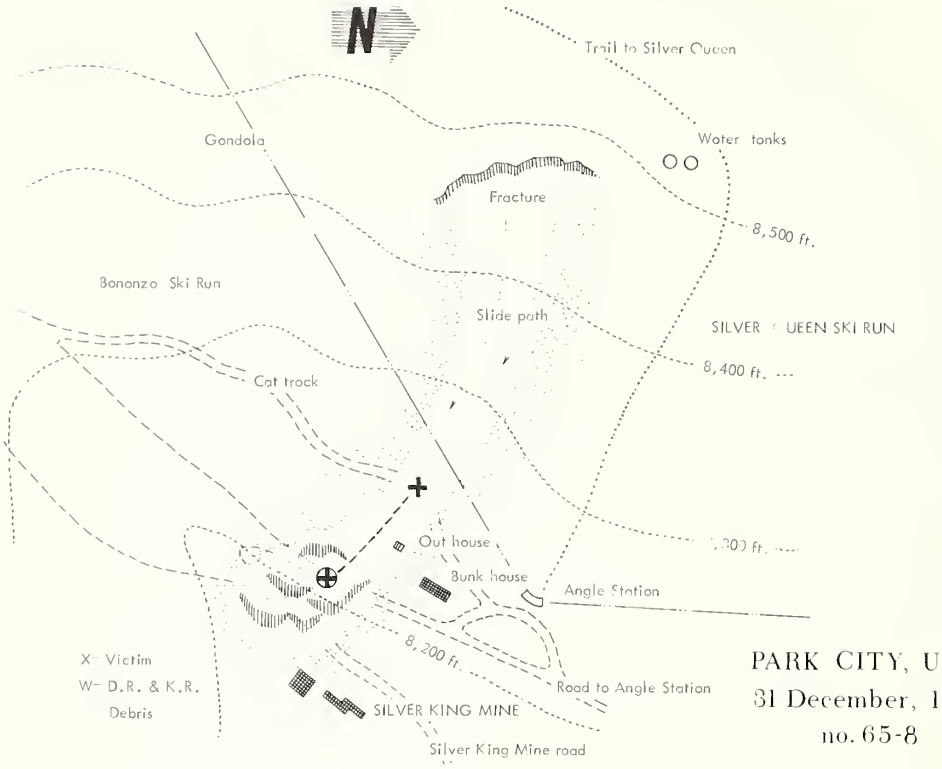
The avalanche was a hard slab, coded HS-AS-3.

COMMENTS

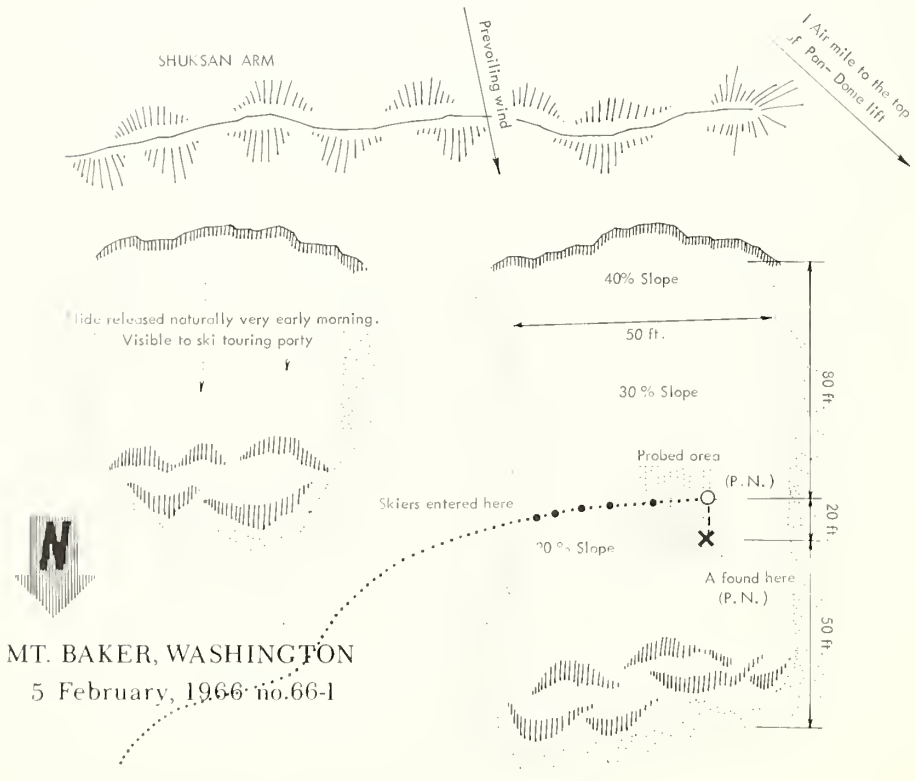
Wind-drift alone can create avalanche hazard. This is especially true in the timberline zone of the Colorado Rockies. This accident occurred early in the season when the general snow cover was still very shallow and apparently no source of hazard. But snow deposition at the "Quick-Slip" fracture line was not shallow. We see here a reiteration of the basic law that steep terrain and snow are the fundamental requirements for an avalanche. This law does not prescribe the manner in which the snow must be deposited. Wind-drift can be as effective as precipitation. It could also just as well be a bull-dozer or the discharge plume from a rotary snow plow; under favorable conditions, enough snow on a steep slope will slide.

This is another instance of a probe line being organized before a thorough search of the avalanche debris had been made for any visible evidence of the victim.

The accident site was shown as an avalanche danger area on a map at the bottom of the ski hill, but this was far from clear to the skiers already on the mountain.



PARK CITY, UTAH
31 December, 1965
no. 65-8



MT. BAKER, WASHINGTON
5 February, 1966 no.66-1

WEATHER FACTORS

By late December, 1965, the avalanche hazard in all ski areas of the Western Wasatch Mountains was high, due to slab deposition on crust layers and depth hoar. Some areas were taking control measures daily. Many ski runs were closed. At the Treasure Mountain Ski Area, part-time patrolman W.B. noted the avalanche hazard, although area personnel did not feel the danger there was great enough to warrant control measures. The steeper runs at Treasure Mountain, where the hazards were considered greatest, were closed to skiers. However, as the month drew to a close, minor avalanche activity on the mountain increased. On 28 December, a large, soft slab avalanche released in Jupiter Bowl; on the 29th, a Treasure Mountain Ski Patrolman triggered a small avalanche off a mine dump below Angle Station. Two ski school instructors reported a small slide and fracturing on the low-angle slopes of "Willy's Road" run on the 30th. On the 29th and the 30th storms dropped sixteen inches of new snow on the area. By the 31st, while there was no snow falling, wind speeds were moderately high and considerable drifting was reported.

ACCIDENT SUMMARY

The only beginner-intermediate run off the upper mountain at Treasure Mountain is the "Bonanza" run. The upper slopes of the trail are connected to lower Bonanza and other lower mountain ski areas by a cat track, which also provides access to the Gondola Angle Station. Both the cat track and Bonanza are threatened by three potential avalanche paths, though slides are relatively infrequent. The hazard is compounded by the fact that skier traffic on the cat track and the intermediate ski run is usually heavy.

At about 3:30 p.m. Friday, 31 December, a slab released in a small bowl above the cat track and spilled down a small gully which intersects the track. As it swept over the cat track, three skiers in its path were trapped and carried one to two hundred feet down the slope to the lower cat track. Two of them were completely buried, while the third, a young boy, was only partially covered. Two witnesses, D.R. and his sister K.R., were nearly caught. They stated that there was no sound or warning, but noted that they had seen two skiers in the closed area above the fracture line just before the slab released.

RESCUE

One of the two who were completely covered was able to free himself; he then helped the boy dig himself out. Both were unhurt and went for help to rescue the third victim, the boy's father. D.R. entered the slide area and made a quick search. A few moments later, both he and his sister went for help. By 3:45 the accident had been reported. Immediately a hasty search was organized. Before the hasty search party reached the scene, several instructors and ski patrolmen arrived and began random probing with ski poles and skis. By 4:00 the Hasty Party arrived at the accident and

several small probe lines were formed at various places along the slide path. The victim's son returned to the avalanche, but since he was unable to supply any additional facts, he was quickly taken off the mountain. At 4:15 the victim's body was found on the lower cat track, buried three feet under the surface. A doctor on the scene administered artificial resuscitation and closed heart massage, but at 4:30 the man was pronounced dead.

Two major probe lines were formed to search for any additional avalanche victims. The area was crossed several times by the original rescuers and relief groups. Names of those participating in the rescue operations were relayed by radio to the lodge to eliminate anxiety among waiting friends and relatives. The skis and equipment of the first three were recovered, but no evidence was found to indicate that anyone else was trapped in the slide.

COMMENTS

The role of the two unidentified skiers seen near the release zone has never been clarified. It is possible that they started the slide. The victim's widow brought suit against the Treasure Mountain Ski Area, charging negligence. The court found for the defendent, on the grounds that the avalanche was an act of God and a normal risk assumed by a skier when he went skiing.

No. 66-1 MT. BAKER, WASHINGTON 5 February 1966

WEATHER FACTORS

On Saturday morning, 5 February, 1966, the avalanche danger in the Mt. Baker Winter Sports Area was high. Twelve inches of new snow covered the slopes; the temperature had dropped from 30 degrees the previous day to 25 degrees. Wind velocity was six to twenty m.p.h. with gusts of fifteen to fifty m.p.h. on the ridges - high enough for extensive snow transport. Early Saturday the lift-served area was controlled, using a 105 mm recoilless rifle, with the resulting release of a damp soft slab on some areas, but not on others. All areas but the North Side were closed until snow rangers had skied the slopes.

It was clear that conditions were very hazardous in all areas except those controlled and checked out by the rangers. A skier on the top of Panorama Dome en route to North Side released an avalanche to the left of the Dome. During the night and early morning several slides released naturally on the steeper slopes. The control measures released a large number of slides on the lee slopes, all of which were in a "hair-trigger" condition.

Avalanches occurred in many areas which did not usually slide. One large slide was clearly visible on Shuksan Arm, beyond the controlled ski area. Conditions were so hazardous that no attempt was made to control Shuksan Arm with the 75 mm mounted on Panorama Dome. This area, not served by lifts, was accordingly posted as closed.

ACCIDENT SUMMARY

In the valley, a party of six Canadian Alpine Club members from Vancouver, B.C. arrived at the Razorhone Creek bridge at 10:45 a.m. to begin their planned climb to the top of Shuksan Arm. All were experienced skiers; several had made this trip before. The leader of the party, J.S., was an experienced Canadian mountain climber and skier. As they climbed higher and onto the upper slopes of Shuksan Arm, they could see the same slab avalanche that was visible from Panorama Dome. Undaunted, they continued up the slope. Coming to a small bench area, P.N. took the lead to relieve the trail breaker, and the rest followed, fairly close together. At 1:45 p.m., after the group had climbed about 1700 feet, one of the party saw a slab release just above them. She shouted a warning to the rest, but, badly frightened, she lost her balance and fell. The slide was nearly fifty feet wide. It spilled one hundred and fifty feet down the slope, burying all but two members of the party. One was knocked down in the slide area, but remained on the surface, while B.S. skied to safety off the deposition area.

RESCUE

Three of the skiers were buried waist deep, but P.N. was completely covered. Those only partially covered were frightened but able to dig themselves out. Several minutes later they realized P.N. was still missing and probed for him unsuccessfully with ski poles for nearly an hour. J.S., the tour leader, then sent two of the survivors down to the highway to report the accident to the Forest Service. She and the two others remained to continue searching. By 4:30, when there was still no trace of P.N., J.S. gave up the search. As skiing conditions were very bad, she had to get the other skiers off the mountain before dark.

At 4:35 p.m., one of the survivors sent out earlier in the afternoon reported the accident to Assistant Snow Ranger J.A. in the near-by Ski Area. At 4:45, after picking up all necessary rescue equipment from a cache at the lift terminal, a party of two rangers (trained avalanche experts) and four ski patrolmen left on the hasty search. A main party of twenty-one people left the area at 5:00 p.m. Both parties attempted to reach the avalanche from Panorama dome. They were forced to abandon that route when the snow ranger in the lead party radioed that extreme avalanche hazards made it impossible to get out on the slope.

The entire party returned to the lodge and left for the Razorhone Creek Bridge to approach the slide along the same route the tour party used. An over-snow vehicle broke out a track one-third the distance up the Arm. This proved a major aid in the rescue effort. A reorganized lead party of nine ski school instructors and rangers, and tour leader J.S., arrived

at the slide at 9:30. By this time four to five inches of new snow covered the ground andwind speed was increasing. A systematic probe was organized and P.N.'s body was located four feet under the surface at 10:09 p.m. on the first pass. The body was dug out and marked with probes. Since the rescuers were wet and seriously chilled, they left the body for the second party to bring out. The fresh mountain rescue team arrived shortly after the first left and evacuated the victim's body. They returned to the highway at about 1:30 a.m.

COMMENTS

Entering the trail to Shuksan Arm by a different route than through the ski area, the touring party did not have the benefit of warnings or see any closure signs. Even so, they persisted on their tour in the face of obvious danger signs and by an ill-chosen route for a time of avalanche danger. They also failed to keep the party spread out while crossing an avalanche slope.

Touring groups like this can benefit from available expert knowledge about snow hazards only if they take the trouble to seek it. Above all, the best protection for the ski tourer is wise route selection. Even the most experienced avalanche expert cannot outguess all snow conditions, but a novice can recognize dangerous terrain and go around it.

The rescue leader faced a difficult decision when he delayed the rescue party to take them around by a safer route. His expert knowledge and judgement averted a possible compound disaster. (See Report No. 58-2 for one which was not averted by the rescue party.) The decision not to risk additional lives at the cost of delay was probably a sound one, considering the dangerously unstable snow condition.

Five caught; four survive -- one dead. Size of slide-small, running only 150 feet. Small avalanches are the killers.

No. 66-2 SNOQUALMIE PASS, WASHINGTON 11 March 1966

ACCIDENT SUMMARY

Late Friday afternoon G.F. was traveling U.S. Highway 10 on his way to see his family at Wenatchee, Washington. About 1800 hours on the east side of Snoqualmie Pass, at the edge of a snow shed, an avalanche struck the station wagon, partially crushing the roof and breaking out some of the windows. Highway crews soon reached the scene and removed the occupants of a second

car which had been partially buried. They probed for other cars, but finding none, began clearing the snow which had covered two lanes of the road. At approximately 0215 hours on Saturday, 12 March, the highway crew uncovered the car with Mr. F. inside. He was rushed to the hospital and found to be suffering only from small cuts and exposure.

Mr. F. stated that the car came to an abrupt halt when the avalanche struck. He was glad he had his seat belt on. The dome light came on by itself, and all he could see outside was snow. He crawled to the rear of the station wagon, and attempted to dig free through the broken rear window with a tire iron. He finally gave up because he was too exhausted. He soon became very cold and began "shaking like an epileptic." He listened to his radio for about two hours, then turned it off to save the battery for the dome light. He finally curled up in the back seat and either passed out or fell asleep. When he awoke he heard a pounding sound and soon saw a light which looked like "pure gold." He had been buried over eight hours. He stated that there seemed to be plenty of air--at least he hadn't noticed any difficulty breathing.

COMMENTS

In avalanches that cover a highway, extensive probing should be done to be sure there are no additional cars buried. Eyewitness accounts can be incorrect, especially if the witnesses were also caught in the slide.

A P P E N D I X

REPORT NUMBERING SYSTEM

The report number designates the year in which the avalanche accident occurred and the number of the accident for that year. Report number 62-3 indicates the accident took place in 1962, and that this particular writeup is report number 3 for 1962.

GLOSSARY OF SNOW TERMS

ACCUMULATION ZONE - In an avalanche path, the main collection area for snow.

ASPECT - (or exposure) - The position or terrain facing a particular direct. North aspect faces north.

AVALANCHE of snow - Rapid downhill snow movement--sluffs, slides, falling snow from trees, etc.

AVALANCHE HAZARD - A threat to life and property from cascading snow.

AVALANCHE SIZES -

1. Sluffs
2. Small
3. Medium
4. Large
5. Major

CLIMAX AVALANCHE - A large or major slide which is a result of cumulative factors working over a longer interval of time than those associated with single storms.

CORNICE - The overhanging lip of snow that develops from wind drifted snow on the lee of a ridge.

DEBRIS - Snow, trees, rocks, etc., brought down by an avalanche and deposited at the terminus.

DEPOSITION ZONE - That area in the avalanche path where the debris comes to rest.

DEPTH HOAR - (Also known as Cup Crystals and Sugar Snow) - New centers of crystallization caused by vertical diffusion of water vapor. (Constructive metamorphism.) These crystals are of a different character than the original snow, and often are cup shaped and layered. Cohesion is very poor between the crystals. A steep temperature gradient within the snow cover usually will induce such formations.

EXPOSURE - See Aspect

FALL LINE - A line perpendicular to the contour, which has the greatest pull of gravity. The line a round ball would roll down if the slope was free from obstructions.

FRACTURE LINE - The well-defined line across the top of the avalanche path where the slab breaks away from the stable snow. The face of the fracture is perpendicular to the slope.

H. E. - High Explosives.

LEE side of a slope - The side sheltered or protected from the wind. An eastern aspect would be the lee side for a western wind. (See also Windward)

PPT. - Abbreviation for precipitation.

PROBE LINE - A line of rescuers, formed along the contour and facing uphill organized to probe the snow with poles to locate an avalanche victim.

PROBE POLE - A lightweight metal pole, (about 12 feet in length and $\frac{1}{2}$" to 1" in diameter), used to penetrate the snow in searching for an avalanche victim.

SLAB - A layer of snow held together by internal cohesion. Wind often a predominate but not necessary factor.

SNOW PLUME (Banners) - Snow being carried by the wind away from a peak or ridge into the air.

STABILIZATION - The relief of tension in the snow cover which reduces or eliminates the avalanche hazard.

TENSION - The straining and stretching of the snow pack. The Tension Zone of a slab occurs at the top where it is trying to pull away from the stable snow.

TRANSITION OF A SLOPE - Any point where the profile (grade) makes a sharp change.

WINDWARD side of a slope - The side from which the wind blows. A western aspect would be the windward slope for a wind blowing from the west. (Opposite of Lee side.)

ABBREVIATIONS FOR AVALANCHE CLASSIFICATION

HS---hard slab

SS---soft slab

WS---wet slab

L---loose snow

WL---wet loose snow

D---damp (prefixed to HS, SS, or L)

B---sunballs

1---sluffs

2---small

3---medium

4---large

5---major

N---natural

A---artificial

AA---artificial, artillery

AE---artificial, explosives

AS---artificial, ski

0---surface avalanche

G---ground avalanche

J---windblast

T↑--- temperature rising

T↓--- temperature falling

Example: A large, dry, soft slab avalanche released by artillery fire would be entered on the Snow Study Chart as SS-AA-4.

PERCENTAGE EQUIVALENTS OF DEGREE (SLOPE ANGLES)

Degree	Percent	Degree	Percent	Degree	Percent
1	1.74	21	38.39	41	86.93
2	3.49	22	40.40	42	90.04
3	5.24	23	42.45	43	93.25
4	6.99	24	44.52	44	96.57
5	8.75	25	46.63	45	100.00
6	10.51	26	48.77	46	103.55
7	12.28	27	50.95	47	107.24
8	14.05	28	53.17	48	111.06
9	15.84	29	55.43	49	115.04
10	17.63	30	57.73	50	119.18
11	19.44	31	60.09	51	123.49
12	21.26	32	62.49	52	127.99
13	23.09	33	64.94	53	132.70
14	24.93	34	67.45	54	137.64
15	26.80	35	70.02	55	142.81
16	28.67	36	72.65	56	148.26
17	30.57	37	75.35	57	153.99
18	32.49	38	78.13	58	160.03
19	34.43	39	80.98	59	166.43
20	36.40	40	83.91	60	173.20

"24 HOUR" CLOCK SYSTEM

0100 = 1 a.m.	0700 = 7 a.m.	1300 = 1 p.m.	1900 = 7 p.m.
0200 = 2 a.m.	0800 = 8 a.m.	1400 = 2 p.m.	2000 = 8 p.m.
0300 = 3 a.m.	0900 = 9 a.m.	1500 = 3 p.m.	2100 = 9 p.m.
0400 = 4 a.m.	1000 = 10 a.m.	1600 = 4 p.m.	2200 = 10 p.m.
0500 = 5 a.m.	1100 = 11 a.m.	1700 = 5 p.m.	2300 = 11 p.m.
0600 = 6 a.m.	1200 = 12 noon	1800 = 6 p.m.	2400 = 12 midnight

COMPARISON IN FEET, INCHES, CENTIMETERS

Feet	Inches	Centimeters	Feet	Inches	Centimeters
	1	2.54 (Cm's rounded below here)	9	108	274
				110	282
	2	5	9½	114	289
	3	8		115	292
	4	10	10	120	305
	5	13		125	318
½	6	15	10½	126	320
	7	18		130	330
	8	20	11	132	333
	9	23		135	343
	10	25.40	11½	138	350
1	12	30		140	353
	15	38	12	144	366
1½	18	46			
	20	51			
2	24	61			
	25	64			
2½	30	76			
	35	89			
3	36	91			
	40	102			
3½	42	107			
	45	114			
4	48	123			
	50	127			
4½	54	137			
	55	140			
5	60	153			
	65	165			
5½	66	170			
	70	178			
6	72	183			
	75	191			
6½	78	197			
	80	203			
7	84	214			
	85	216			
7½	90	229			
	95	241			
8	96	244			
	100	254			
8½	102	259			
	105	267			

COMPARATIVE MEASUREMENTS

1 centimeter = .3937 inches
1 inch = 2.54 cm.

1 meter = 39.37 inches
1 yard = .9144 meter

1 kilogram = 2.2046 lb.
1 pound = .4536 kilo.

AVALANCHE ACCIDENT REPORT

Contents

(A) Accident Information Sheet (See attached)

1. Complete all blanks, including address of author.
2. Be accurate.
3. Cross-reference to map and narrative section.

(B) Narrative Section

1. Location including state. (Be as specific as possible.)
2. Date.
3. Members of Party. Name-Age-Address.
4. Events prior to accident.
5. The Accident.
6. Rescue operations.
7. Weather & Hazard.
8. Terrain Data (altitude, angle of slope, aspect, vegetative cover, etc.)
9. Conclusions (why it happened.)
10. Recommendations.
11. Sign and give your address.

(C) "Key" Map - To indicate location of accident relative to nearest town, a portion of a contour or National Forest Map is ideal.

(D) Detailed Map/Diagram

1. Name of Author.
2. Date.
3. Location.
4. Legend & Direction arrow.
5. Scale (or slide size.)
6. Designate slide area.
7. Location of last seen point.
8. Location of Clues.
9. Fracture line.
10. Victim's (& others) route.
11. Deposition zone.
12. Where victim found.
13. Show area probed.
14. Closure signs (if applicable.)

NOTE: The following items should always be included if known.

- Location of clues and victims with reference to the last seen point of victim.
- Depth of victims and length of time buried.
- Weather

Rescue procedures are based on detailed study of the above facts. Complete and accurate reporting may be the key to saving someone's life in the next avalanche.

U. S. DEPARTMENT OF AGRICULTURE
Forest Service

AVALANCHE RESCUE
INFORMATION SHEET

- PART "I" -

Date: Time of Accident:
Exact Location: Time of first report:

Victim(s) - Name(s) Age Address & Phone

Summary of events prior to accident -
Departure Point: Route Taken:

Objective of Party:

General description of events:

Eyewitness account of accident (if available): Important: How slide was released; last seen point; location of victim in relation to release point; etc.

- PART "II" -

Summary of rescue operation (Times and names are important):
Time hasty party dispatched_____Number in party_____.

Name, hasty leader_____Time hasty party arrived at site____.

Time follow-up (main) party dispatched_____Number in party_____.

Name rescue leader_____Time main party arrived at site_____.

Procedure at slide (briefly describe search):

AVALANCHE RESCUE INFORMATION SHEET (cont.)

Time victim found_____condition and injuries:
(Show victim's location on sketch map.)

Time operation was concluded_____.

Any other pertinent information:

Weather and Avalanche hazard information: (Condition which caused avalanche):

Wind velocity_____Duration_____Direction_____

Temperature_____Snow data_____

Type of slide_____Dimensions of slide_____

Were restrictions in force?_____

Terrain data (% slope; open or timbered; aspect; etc. Include sketch map and diagrams)

Recommendations and conclusions:

Signed _____

Title_____

AFPS, Ogden, Utah