

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF MINES  
HEALTH AND SAFETY ACTIVITY



HEALTH AND SAFETY REPORT

FINAL REPORT OF MAJOR MINE FIRE DISASTER  
SUNSHINE MINE  
SUNSHINE MINING COMPANY  
KELLOGG, SHOSHONE COUNTY, IDAHO

May 2, 1972

By

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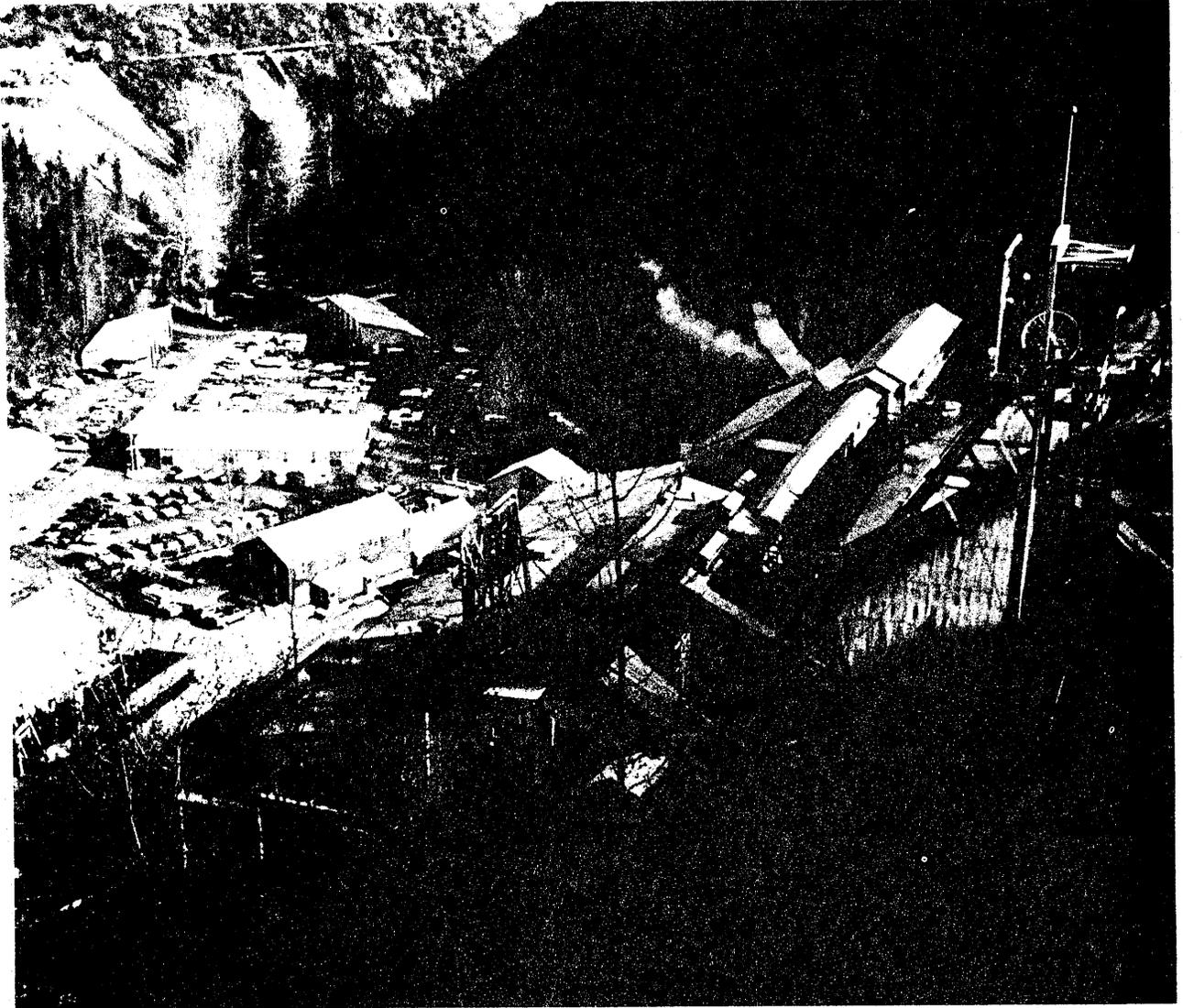
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SUNSHINE MINE

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INTRODUCTION

This report is based on an investigation made pursuant to clause (1) of Section 4 of the Federal Metal and Nonmetallic Mine Safety Act (80 Stat. 772).

Reference numbers used in the report identify mine safety standards promulgated in the Federal Register, Vol. 34, No. 145, Thursday, July 31, 1969; Federal Register, Vol. 35, No. 38, Wednesday, February 25, 1970; Federal Register, Vol. 35, No. 237, Tuesday, December 8, 1970; and Federal Register, Vol. 37, No. 139, Wednesday, July 19, 1972.

This report relates all available facts pertaining to conditions prior to discovery of the fire, events immediately thereafter, subsequent rescue and recovery efforts, investigation of the cause of the disaster and analysis of all the foregoing.

This report also includes reasonable conclusions consistent with known conditions and practices at the Sunshine Mine. Conclusions are so identified.

Recommendations are made to prevent recurrence of a similar disaster.

While this report deals with conditions and events at the Sunshine Mine, the information presented may be applied, with little basic adaptation, to many other underground mines.

#### ABSTRACT

Smoke was detected in the main haulageway near the electric shop on the 3700 level of the Sunshine Mine, Kellogg, Idaho, about 11:40 a.m., May 2, 1972. The volume of smoke, accompanied by carbon monoxide, increased rapidly and was also detected in the 3100 level main haulageway. Both the 3100 level and 3700 level haulage drifts served as main fresh air intakes to the stope area below 3700 level near No. 10 shaft, where most of the 173 men in the mine that shift were assigned. Mine supervisors, after attempting to locate the fire, ordered evacuation of workmen from the mine about 12:03 p.m. Before the evacuation was halted by the death of the No. 10 shaft hoistman, 80 men escaped from the mine. An intensive rescue operation, organized by industry and Bureau of Mines personnel resulted in the rescue of 2 men. The remaining 91 men died of carbon monoxide poisoning. None of the survivors reported seeing fire or flames.

The Bureau of Mines believes the probable cause of the fire was spontaneous combustion of refuse near scrap timber used to backfill worked out stopes. The fire occurred in an abandoned stoping area near the intersection between the 3400 level exhaust airway and the 09 vein. Extensive ground falls and caving occurred in the immediate area when timber supports were consumed, making investigation of the entire fire area impossible.

It is not possible to single out any one fact as the chief cause for the large loss of life. However, the Bureau of Mines believes that the following major factors contributed to the severity of the disaster:

1. The emergency escapeway system from the mine was not adequate for rapid evacuation.
2. Top mine officials were not at the mine on the day of the fire and no person had been designated as being in charge of the entire operation. Individual supervisors were reluctant to order immediate evacuation or to make a major decision such as stopping the 3400 level fans.
3. Company personnel delayed ordering evacuation of the mine for about 20 minutes while they searched for the fire.
4. The series ventilation system used in the mine caused all persons in by the fire, which contaminated the main intake airways, to be exposed to smoke and carbon monoxide.
5. Most of the underground employees had not been trained in the use of the provided self rescuers and had difficulty in using them. Some self rescuers provided by the company had not been maintained in useable condition.

6. Mine survival training, including evacuation procedures, barricading, and hazards of gases, such as carbon monoxide, had not been given mine employees.
7. The emergency fire plan developed by the company was not effective. The company had not conducted evacuation drills.
8. Abandoned areas of the mine had not been sealed to exclude contaminated air from entering the ventilation airstreams.
9. The controls built into the ventilation system did not allow the isolation of No. 10 Shaft and its hoist rooms and service raises or the compartmentalization of the mine. Smoke and gas from this fire was thus able to move unrestricted into almost all workings and travelways.

These and many other factors involved in the disaster are discussed in detail in the Findings and Analysis section of this report.

#### GENERAL INFORMATION

The Sunshine silver mine, which also produces copper and antimony, is in Big Creek Canyon about 8 miles east of Kellogg, Shoshone County, Idaho. It was first opened in the late 19th century and is operated by Sunshine Mining Company.

Irwin P. Underweiser was president; Marvin C. Chase, vice president and general manager; Al Walkup, mine superintendent; Leon Barr, mill superintendent; James Farris, personnel and safety director; and Robert Launhardt, safety engineer.

Employment totaled 522 persons, 429 of whom worked underground. The mine was operated three shifts daily, 5 days weekly. Main access to the mine was through a 200-foot long adit to the Jewell Shaft, at the western edge of the mine, down that shaft to the 3100 and 3700 levels, eastward through 5,000-foot long drifts to the No. 10 Shaft, which was collared at the 3100 level, and down that shaft to the active working levels. No. 10

winze and several other vertical openings in the mine were sunk as winzes, but were locally referred to as shafts. (Local terminology is used in this report).

The No. 10 shaft was bottomed just below the 6000 level. Ore was produced from the 4000, 4200, 4400, 4600, 4800, 5000, and 5200 levels. Level development work was in progress on the 5400 level; shaft station development work was in progress on the 5600 and 5800 levels. Surface elevation at the collar of the Jewell shaft was about 2,700 feet above sea level. Level designations represent distances in feet below the Jewell shaft collar. For references, maps are included in the appendix. In December 1945 an underground fire caused extensive property damage, but no loss of life. That fire was started by a short circuit in the 2900 level storage-battery-charging station and was extinguished by sealing and flooding the lower levels.

Large mined out square-set stopes reportedly were above the 3700 level and west of No. 10 shaft. The general condition of the mine was dry. The last regular Federal inspection of the mine was made November 9-12, 1971, and subsequent spot inspections were made January 12 and March 22, 1972. Copies of these reports are available for inspection at the Bureau of Mines Offices, Washington, D. C., and at the following Metal and Nonmetal Mine Health and Safety Offices:

Western District Office  
620 Central Avenue  
Alameda, California

Seattle Subdistrict Office  
Federal Office Building  
Seattle, Washington

Spokane Field Office  
Seattle Subdistrict  
Post Office Building  
Spokane, Washington

## MINING METHODS, CONDITIONS, AND EQUIPMENT

### Mining Methods

Steeply dipping fissure veins were mined by the horizontal cut and sand-fill method by either breasting down or back stoping. The principal ore mineral was tetrahedrite. The stopes were developed a maximum of 100 feet along the strike of the vein. Level intervals were 200 feet. A raise climber was used to drive 6- by 6-foot raises between levels. Ore was concentrated in the mill adjoining the mine.

Ground was controlled in drifts by steel mats and 3/4-inch-diameter rock-bolts 4 and 6 feet in length. The mats and bolts were used alone or in conjunction with drift timber. Similar rock-bolts with or without headboards were used in the stopes. Stulls and three-piece timber sets with squeeze caps were used in combination with rock-bolts and headboards to support incompetent ground in stopes. While waste rock had been used to backfill stopes above 3700 level, sand-fill with cement capping was used to stabilize the mined-out sections of stopes below 3700 level.

### Ventilation

Air flow for the Sunshine mine was dependent upon pressures developed by fans located underground. A diagram of the overall ventilation system for the mine is included on the mine map in Appendix J. All of the intake air for the ventilation of the mine was coursed down the Jewell Shaft to the 3100 and 3700 levels. The air was split between those two levels and traveled laterally to the No. 10 Shaft. About 2,000 cfm of air on the 3700 level was coursed through the No. 12 borehole to the 4800 level and then laterally to No. 10 Shaft. Also on the 3700 level, some air was diverted through the Sun Con crosscut.

Intake air from the 3100, 3700 and 4800 levels joined at the No. 10 shaft and coursed down to the 5200 level. Air flow was split on the 5200 level into east and west laterals and was then moved upward through the working stopes to the 4400 level. Up to 16,000 cfm of air was added to the system by the use of compressed air powered equipment. From the 4400 level, ventilation raises located approximately 400 feet to the east of No. 10 shaft provided the airways for upward flow to the 3400 level. Less than 5,000 cfm of the return air flow was passed to the 3100 level, then eastward through the interconnected Silver Summit mine to the surface. The balance of the return air moved westward along the 3400 level exhaust airway to the No. 3 ventilation raise, through which it passed to the 1900 level. An air split was made on the 1900 level where 12,000 cfm of air moved through the Big Hole ventilation shaft to the surface, and the remainder coursed up the inclined shaft and out the Sunshine tunnel. Measurements made April 24, 1972, indicated 95,300 cfm of air travelled across the 3400 level exhaust airway. About 2,000 cfm of air leaked from the 3700 level pipe shop area upward through No. 8 Shaft to the 3550 level and then to the intake side of the 3400 level exhaust fans.

Main fans were located on the 5200, 3400, and 1900 levels and in the Sunshine adit, in a series system. The fan controls were located near the fans.

Methane or other flammable strata gases were not emitted into the mine. A flame safety lamp was available for testing for oxygen deficiency. Two carbon monoxide detectors were available at the mine safety office.

Refrigeration air-conditioning units were installed in the mine to cool the high ambient air temperatures on the lower levels.

Additional information concerning air quantities, fan installations, the effect of natural ventilation, and resistance to air flow is given in the Bureau of Mines report "Ventilation Survey, Sunshine mine, Sunshine Mining Company, Kellogg, Shoshone County, Idaho, September 14 to October 4, 1971, by R. K. Foster and J. W. Andrews," and in the report of "Supplemental Ventilation Survey, April 24, 1972," by the above individuals.

Copies of the reports are available for inspection at the Bureau of Mines in Washington, D. C., and at the following Metal and Nonmetal Mine Health and Safety Offices:

Western District Office  
620 Central Avenue  
Alameda, California

Seattle Subdistrict Office  
Federal Office Building  
Seattle, Washington

Spokane Field Office  
Seattle Subdistrict  
Post Office Building  
Spokane, Washington

## Shafts and Hoisting

The Jewell and No. 10 shafts were each provided with electric-powered double-drum hoists, and electric-powered single-drum "chippy" hoists.

The Jewell Shaft was originally sunk to a depth of 3860 feet as a four-compartment shaft. Later, two of the four compartments were extended to 45 feet below the 4000 level. The double-drum hoist at the Jewell shaft was used to hoist ore from the 3700 level and for hoisting ore and waste from the 3100 level. The "chippy" hoist at the Jewell shaft was used for moving men and materials to all levels as far down as the 4000 level and for hoisting ore from the 4000 level to the 3100 level.

The No. 10 shaft was a three-compartment shaft from the 3100 level down to 90 feet below 4400 level. From there it was three-and-a-half compartments down to 48 feet below the 4600 level. From that point, it continued to the 6000 level as a four-compartment shaft. The No. 10 double-drum hoist on the 3100 level was used primarily for hoisting ore and waste from mine production and development work. Ore was dumped into a pocket on 3700 and was transferred by train to the Jewell shaft for hoisting to the surface. Waste rock was hoisted to the 3100 level and was similarly transferred for hoisting to the surface at the Jewell shaft. A single-deck 9-man capacity man cage was suspended below the skip in each of the two compartments served by the double-drum hoist. The No. 10 "chippy" hoist was on the 3700 level and was equipped with a four-deck man cage with a total capacity of 48 men. It was used for servicing all levels below 3700.

### Escapeways

Escapeways from the mine consisted of raise ladderways from stopes to main levels, drifts and crosscuts to the shafts, No. 10 shaft, Jewell shaft, service raises paralleling No. 10 shaft from 4600 level to 3700 level, and the drift to Silver Summit shaft. Escapeways from the various working areas of the mine are illustrated in Appendix J.

### Electricity

Electricity from two surface substations was conducted down the Jewell shaft at 13,800 volts and 2,300 volts, alternating current, by armored borehole cables.

At the Strand substation on 3700 level, the 13,800 volts electricity was transformed to 2,300 volts alternating current. Four individual cables conducted electricity from the Strand substation to 3100 level No. 10 shaft hoist, 3400 level main ventilation fans, 3700 level F-19 switch station, and 3700 level No. 10 shaft service hoist. From F-19 switch station, electricity was conducted to substations on 3700, 4200, 4400, 4600, 4800, 5000, 5200, 5400, and 5800 levels. At the individual level substations the 2,300-volt power was transformed to 440, 220, and 110 volts, alternating current, to power auxiliary fans, slusher hoists, other mining equipment, and for mine illumination.

Grounding grids were buried in the earth at the utility company substations, company surface substations, and adjacent to the Jewell shaft collar. The ground network was extended into the mine upon the armor sheath of the borehole-type cables installed in the mine shafts and upon messenger cables used to suspend cables throughout the mine. Grounding of portable mine equipment was provided through a ground conductor in the equipment cable which was connected to the messenger wire system.

Overload protection, short-circuit protection, and individual disconnect switches were provided at the individual mine equipment, switch stations and substations. Diagrams of the mine substations and switch stations were on file at the mine electric shop.

#### Communications

A single telephone circuit was provided for normal communications between underground shaft stations, hoistroom, shops and the mine surface. An emergency system was provided with telephones in the safety engineer's office on the surface and the underground first-aid room on 3700 level.

#### Illumination and Smoking

Individual cap lamps were provided for the mine personnel. Shaft stations were illuminated by 110-volt incandescent lamps, as were shops and maintenance areas.

Smoking was prohibited underground near shafts and explosives-magazine areas, in the 3400 level ventilation return drift and in such areas as oil-storage and battery-charging stations. These areas were posted with signs prohibiting smoking.

### Safety Program

The company personnel director, who reported to the general manager, was responsible for the safety program. A full-time safety engineer was employed. The safety engineer's duties included coordinating safety efforts, conducting safety inspections, and inspection and maintenance of safety equipment. Biweekly labor-management safety committee meetings were held. In addition to regular daily inspections conducted by the company safety engineer, a monthly inspection was conducted by the safety engineer with a union safety committeeman, in an area of the mine selected by the union. First-aid classes were conducted once a year. Use of self rescue devices was included in the first-aid training. A total of 46 persons received training in the class conducted during March 1971. Employees attended the classes on a voluntary basis and were compensated for class time. Even though the company provided training, those attending training sessions represented a small percentage of the work force.

### Mine Rescue

Fourteen men were trained in mine rescue in May 1971. Nine other men had received training the year before. The company had a program of retraining at maximum intervals of 1 year, but had held retraining classes twice a year during the past few years. Ten sets of 2-hour McCaa self-contained oxygen breathing apparatus were available on the surface. The apparatus were tested every Thursday by a representative of the Central Mine Rescue Station in Wallace, and records were kept of the tests. The self rescuers were stored in locked wooden boxes at various No. 10 shaft stations, the No. 10 shaft hoistroom on 3100 level and in the first-aid

room on 3700 level. Locks had been installed on the boxes to prevent pilferage.

#### Firefighting Facilities and Organization

Water was available at all working places underground at 60 psi, through 1- and 2-inch lines. Water deluge systems had been installed in both the Jewell shaft and in the No. 10 shaft. The water supply included a 50,000-gallon tank reserved for firefighting. A 60,000-gallon mine and mill supply tank and a 30,000-gallon tank used for the sandfill system could also be valved into the fire-fighting system. Water could also be pumped directly into the system from a creek on the property by two pumps capable of furnishing 1,200 gpm at 180 psi. The pumps were checked weekly and records were kept. Water from the mine supply was delivered underground through a 4-inch-diameter pipeline to a small surge sump on the 1900 level. A 4-inch-diameter pipeline carried water from the 1900 level sump to a 25,000-gallon-capacity sump on 3100 level near No. 10 shaft. Water flow to these sumps was controlled by solenoid valves. All underground water lines had 1-inch valves and connections at 150-foot intervals.

A foam generator capable of being moved on rails or on rubber tires was kept on the surface. About 600 feet of polyethylene roll-out tubing and 1,200 gallons of high expansion foam were kept on hand.

Each shaft station was equipped with a 20-pound multipurpose, dry chemical fire extinguisher, and hoistrooms, pump rooms, battery-charging

stations, underground shops, and most transformer stations were equipped with 10- or 20-pound dry-chemical extinguishers, while 5-pound dry-chemical extinguishers were installed on portable welding equipment. Also, battery-charging stations were equipped with 5-pound CO<sub>2</sub> extinguishers. Company officials stated that extinguishers were checked at regular intervals. Records of underground inspections were not kept.

Automatic fire doors equipped with carbon-monoxide sensors had been installed as an additional precaution on the 3100- and 3700-foot levels, about 300 feet from the Jewell shaft. The doors were designed to close automatically within 45 seconds of sensing carbon monoxide, preceded by a light and whistle for warning workers to clear the door. These doors were designed to protect the workers in the event of a fire occurred in the main (Jewell) shaft.

A stench-warning system to warn underground workers was located in the main compressor building on the surface. The warning system consisted of two containers, each with a 500-gram vial of ethanethiol (C<sub>2</sub>H<sub>5</sub>SH) 15 percent in trichlorofluoro-methane. The vials could be ruptured and the contents injected into the main compressed air supply to the mine.

Instructions for its use were posted at the installation.

The "Fire Protection and Escape Plan" and "Procedure to Follow in Case of Mine Fire," included as Appendix I, were issued to each supervisor and were posted along with a ventilation map at shaft stations on 3100 and 3700 levels for the information of underground workers.

## STORY OF THE FIRE AND RESCUE AND RECOVERY OPERATIONS

The following description of the events related to the major disaster at the Sunshine silver mine is based on records maintained by the mine operator, interviews with mine officials and workers, depositions taken by Department of the Interior attorneys from survivors of the catastrophe and others, Federal mine inspection reports, and observations made by Bureau of Mines personnel.

Times stated are based on evaluation of the above sources of information. Although conflicts exist, the Bureau of Mines believes the times used are accurate.

### Evidence of Activities and Story of Fire

On May 2, 1972, a total of 173 men making up a normal day shift (7 a.m. to 3 p.m.) crew entered the mine and proceeded to perform their regular duties until the time they learned of the fire. The work locations of these men are shown in Appendix B. The principal operating officials of the Sunshine Mining Company were in Coeur d'Alene, Idaho, about 45 miles away, attending their annual stockholders' meeting. During their absence, surface and underground foremen were responsible for the activities of their own crews, with no designated individual in charge of the entire operation.

Most of the salaried and day's pay personnel who normally ate their lunch from 11 a.m. to 11:30 a.m. did so at their regular work locations.

During the morning, miners Custer Keough and William Walty were engaged in enlarging the 3400 ventilation drift to decrease ventilation resistance in the main exhaust airway. Their work consisted of drilling and blasting along the back and ribs, mucking, and rock bolting. An underground mechanic, Homer Benson, also reported to the 3400 level with an oxygen-acetylene cutting torch which was needed to remove old rockbolts along the drift. The cutting torch was transported to the worksite about 340 feet west of the 09 vein bulkhead, with a small battery-powered locomotive. Benson completed the cutting of the old rockbolts and arrived back at the 3700 level station with his equipment at 10:35 a.m. Keough and Walty probably ate lunch on the 3400 level No. 10 shaft station, as was their practice.

Floyd Strand, chief electrician; Kenneth Ross, geologist; Larry Hawkins, sampler; and John Reardon, pumpman, completed their morning activities at the No. 10 shaft area and at 11:30 a.m., departed the No. 10 shaft station on the 3700 level enroute to the Jewell Shaft on a man coach. Their route took them past the Strand substation, 910 raise, No. 5 shaft, and No. 4 shaft. They arrived at the Jewell station shortly after 11:40 a.m. and did not report any unusual conditions enroute.

Shortly after lunch, about 11:40 a.m., Norman Ulrich and Arnold Anderson, electricians, stepped out of the electric shop, smelled smoke, and shouted a warning. Harvey Dionne and Bob Bush, foremen, came out of the Blue Room (underground foremen's office) and the four men started in the direction of the smoke. The smoke was discovered to be coming down the

910 raise, about 50 feet west of the Strand substation. Harvey Dionne climbed up onto drift timber below the raise but was unable to detect fire. Jim Bush, foreman, then arrived on a small battery-powered locomotive. Harvey Dionne, Jim Bush, and Ulrich proceeded toward the Jewell Shaft meeting Ronald Stansbury, haulage locomotive operator, enroute. Stansbury and Ulrich closed the fire door near the Jewell Shaft, in accordance with instructions from the mine foremen. Jim Bush and Harvey Dionne returned toward the 910 raise.

At about 11:45 a.m., Delbert (Dusty) Rhoads, lead mechanic, and Jim Salyer, foreman, simultaneously telephone Pete Bennett, mechanic, in the 08 machine shop. They asked Bennett to determine if a fire was burning in the shop area. Bennett and his partner, Kenneth Tucker, knowing there was no fire in the shop, went from the shop toward the 808 and 820 drifts. Bennett discovered the 820 crosscut was so full of smoke he could not enter. He met Bob Bush at the 808 drift, where they found smoke so thick they could travel but a few feet. They retreated toward the 08 machine shop, encountering much heavier smoke in the 820 crosscut. Return to the 08 shop was impossible.

Bob Bush then instructed Bennett and Tucker to go the Jewell Shaft. As Harvey Dionne and Jim Bush returned toward No. 10 shaft, they attempted to go into the 08 machine shop area. They reached the 820 drift and went about 100 feet into the smoke before being forced back. Harvey Dionne then went back to make sure the fire door was closed and to prepare for evacuation at the Jewell Shaft. Jim Bush found Bob Bush, Wayne Blalack and Pat Hobson in a state of near exhaustion near 910 raise.

He attempted to assist the three men by carrying Bob Bush and Hobson under their shoulders and pushing Blalack in front of him. About halfway to the Jewell Shaft, Jim Bush was near exhaustion and had to leave all three men and go for assistance. Harvey Dionne, after returning to the Jewell Shaft, made the decision to remove restrictions over the No. 12 borehole to allow more fresh air to reach the lower levels.

About 12:03 p.m., Fred (Gene) Johnson, shaft foreman, while at the 3700 level No. 10 shaft, telephoned the mine maintenance foreman, Tom Harrah, at his office in the surface machine shop and requested that the stench-warning system be activated and that oxygen breathing apparatus be sent into the mine. At this time, he also instructed the No. 10 shaft double drum hoistman to prepare the cage for moving the men to the 3100 level to get them out of the mine. Harrah contacted Robert Launhardt, company Safety Engineer, at the mine safety office and relayed the requests. The stench warning system was activated at 12:05 p.m. by Launhardt and Harrah, and the oxygen breathing apparatus was transported down Jewell Shaft to the 3100 level station.

Most workmen became aware of fire when smoke entered their workplaces. In some instances, men were dispatched to relay verbal warnings to men in remote locations. Within a short time of detecting the smoke, most of the workmen made their way to the No. 10 shaft station in hopes of escaping. Because of the dense smoke between the 910 raise and No. 10 shaft, Don Wood, the hoistman operating the No. 10 shaft "chippy" hoist on the 3700 level, was forced to abandon the hoistroom.

According to the hoist log taken from the No. 10 double drum hoist on the 3100 level, the first load of men was hoisted at 12:10 p.m. About 12 men rode the cage from the 3700 level to the 3100 level, including men who had ridden up from the 4500 level. The cage arrived at the 3100 level at 12:13 p.m. and returned to the 3700 level where additional men boarded. They left the 3700 level at 12:16 p.m. and arrived at 3100 level at 12:17 p.m. Greg Dionne, a former cager volunteering his assistance, reboarded the cage and went down to the 4600 level with short stops on the 3700 level and 4400 level to pick up additional men, including Delbert (Dusty) Rhoads, who, among others, had ridden the "chippy" cage down after lunch.

A full cage load of men was sent up to the 3100 level from the 4600 level at 12:24 p.m. Greg Dionne remained on the 4600 level station. Byron Schulz, cager, reboarded the cage and went back down to 4600 level, arriving at 12:27 p.m., where another load of men boarded. Dionne remained at the station and Schulz rode up to the 3100 level, arriving at 12:30 p.m. Schulz reboarded at 3100 level and went to the 5000 level with a stop at 4600 to pick up Dionne and additional men. The cage then traveled back to the 3100 level arriving at 12:35 p.m. Delbert (Dusty) Rhoads and Arnold Anderson, mechanical and electrical lead men, possibly returned on this trip to the 3400 level. Another trip was made back to the 5000 level and returned at 12:44 p.m. Schulz

and Dionne both returned to the 3100 level on this trip. The cage went back to the 5000 level, and remained 12 minutes. The cage then went to the 5400 level and made a trip back to the 3100 station. All of the above trips were made on the south cage of the double-drum hoist.

The north cage was unclutched at 12:06 p.m. and remained parked near the 4400 station until it was clutched back in at 12:16 p.m. A load of 9 men boarded it at the 4400 level and traveled to the 3700 level. The cage was again unclutched at 12:17 p.m. near the 3700 level station and remained until 12:21 p.m. It was then clutched in and went to a point near the 3100 level station and remained until 12:26 p.m., when it was again clutched in and went to the 4200 level, arriving at 12:27 p.m. The north cage then remained unclutched until 12:50 p.m., when it was clutched in and made a trip to the 5800 level and returned slowly to the 3100 level, with short stops at 5600, 5400, and 5000 stations. All men on 5800 and 5600 were aboard this skip and traveled to the 3100 level. It was not possible to determine why the north skip was intermittently inactive.

Rhoads and Anderson were standing by on the telephone on 3400 level, requesting permission to stop the main exhaust fans on that level. It was apparently realized that the operation of these fans was a critical factor in forcing smoke and carbon monoxide through the mine. Of those persons present at the mine, no individual assumed authority to issue instructions to stop the fans. Consequently, the fans were never stopped.

The men hoisted from the lower levels of the mine were directed by Gene Johnson to travel to the Jewell Shaft via the 3100 level, to be hoisted to the surface. Gene Johnson had remained at the 3100 station to direct the crews to Jewell Shaft instead of the Silver Summit escapeway, which was contaminated with toxic gases.

All hoisting at No. 10 shaft ceased at 1:02 p.m., when the double-drum hoistman was overcome. While the men on the lower levels attempted unsuccessfully to communicate with the hoistman, a few on the 5200 level tried to build a barricade in a tail drift just off the station. They died from carbon monoxide exposure before completing the job.

Some of the men reported they had difficulty in using the self-rescuers, obtained from storage boxes on shaft stations, and discarded them, while others used them successfully. Many men who succeeded in reaching 3100 level were overcome by carbon monoxide and smoke and died.

The first group to attempt to locate and rescue additional survivors entered the 3100 level from the Jewell Shaft about 1 p.m. The crew, made up of Robert Launhardt, Larry Hawkins, James Zingler, and Don Beehner, equipped with oxygen breathing apparatus, attempted to cross the 3100 level from the Jewell Shaft. On the way toward No. 10 shaft, they met Roger Findley, who was on his way out toward the Jewell Shaft. Findley was having difficulty breathing and was given oxygen. Zingler then took Findley out to good air.

The rescue crew continued toward No. 10 shaft and met Byron Schulz, who appeared to be in serious trouble and pleaded for oxygen. Beehner responded and gave Schulz his face mask, but collapsed as he attempted to put his mask back on. Launhardt tried to assist Schulz, and Hawkins placed his mask over Beehner's face, while holding his breath as long as he could before taking another breath of air from his mask. When Hawkins tried to place his mask again to Beehner's face, Beehner lost consciousness. Hawkins' apparatus then malfunctioned, and he attempted to make his way out. He fell twice and managed to climb onto the last car of a train, which Launhardt was bringing out, with Schulz aboard. All three reached the Jewell Shaft station and were hoisted.

While these events were occurring on the 3100 level, moves were undertaken by some of the miners to rescue fellow workers on the 3700 level. Jim Bush, a mine foreman, had called to the attention of some other miners that three men, Robert Bush, Wayne Blalack, and Patrick Hobson, were in trouble in the No. 5 Shaft. He had tried earlier to save them but was unable to do so. According to depositions from survivors of the disaster, three men at the Jewell Station, Ronald Stansbury, Roberto Diaz, and another man, traveling in a locomotive, made a rescue attempt. After stopping their locomotive near Blalack, Stansbury went farther and located Bob Bush lying on the ground, but Stansbury was rapidly being overcome and was forced to retreat. While returning, he saw Roberto Diaz on the ground. He reached fresh air at No. 5 Shaft where he encountered Harvey Dionne, Paul Johnson, and Jasper Beare reentering the drift.

Stansbury informed them that in addition to the three men that his group had tried to rescue, Diaz was down, making a total of four.

Johnson and his companions then continued toward No. 10 shaft. They boarded the locomotive and car which had been used and abandoned by the previous rescuers. Realizing they could not help any of the fallen men, they started to walk toward the Jewell Shaft after their locomotive derailed. During the trip, Johnson was overcome.

Subsequently, Jim Bush and Ulrich, protected only by self-rescuers, made one more rescue attempt, but had to abandon their efforts. The last survivors who evacuated on May 2 reached the surface at about 1:30 p.m. A total of 80 men safely reached the surface that day.

#### Rescue and Recovery Operations

Nearly 100 trained rescue personnel from seven other mines in the U.S. and Canada began arriving at the Sunshine Mine about 2 p.m. on May 2. The crews are listed in Appendix G. One of the first crews recovered five bodies along the 3700 level drift and returned to the surface about 4:30 p.m.

The location of the fire was not known by the initial rescue crews nor by any individuals who reached safety during the mine evacuation. The approximate area of the fire was assumed to be between the 3100 and 3700 levels, and between the No. 10 shaft and the Jewell Shaft.

Robert Launhardt, upon returning to the surface, asked Silver Summit officials to stop the Silver Summit fan in hopes that fresh air would then enter the Sunshine 3100 level, allowing any possible survivors to use that escapeway. This was done at about 4 p.m.

Another attempt was made at rescue operations on the 3100 level. This attempt was unsuccessful because of having to travel too great a distance without an established fresh air base. The crew returned to the surface about 1 a.m. on May 3.

Later the same day, the first attempts were made to reach the No. 10 shaft area from the Silver Summit mine. A rescue crew reached a point about 1,000 feet from the Silver Summit raise but was forced to retreat by smoke and heat. The Sunshine fan, which normally forced air out through the Silver Summit, was reversed about 6 a.m. to clear the Sunshine 3100 level and force fresh air toward No. 10 hoistroom.

After the initial attempts to rescue men were made, the assessment of the ventilation situation was that the 3400 fan operations, and that of other fans, would be changed only with care to avoid disturbing the balance of air flows in the lower mine levels so as not to endanger survivors who might be depending on that balance.

Since the smoke-filled 3100 and 3700 levels were the access routes and intake airways to the No. 10 shaft from the Jewell, it became obvious that these levels had to be restored for access to the No. 10 shaft in the hope of reaching the lower mine levels where most men were believed to be trapped. Therefore, a three-phase rescue plan was developed by company and Bureau of Mines personnel. The approaches were: (1) To establish fresh air and access across the 3100 level to the No. 10 hoistroom from the Jewell Shaft; (2) To establish fresh air and access across the 3700 level to the No. 10 shaft and "chippy" hoistroom from the Jewell Shaft; and (3) To establish fresh air and access across the Silver Summit 3000 level and subsequently the Sunshine 3100 level to the No. 10 hoistroom. All of the above approaches would result in fresh air being forced down the No. 10 shaft to the deeper levels. To accomplish all of the above objectives, it was decided to place seals at every opening along each of the access routes to keep out smoke and gas.

On the morning of May 3, apparatus-equipped crews from the Jewell Shaft attempted to erect a bulkhead in the No. 4 Shaft area on the 3100 level but were unsuccessful. Upon returning to the surface at 11 a.m., they sealed off the water drift on the Jewell Adit level to prevent leakage of contaminated air from the Sunshine Tunnel into the Jewell Shaft. The crew then returned to the 3100 level, approaching near enough to No. 10 shaft to hear the ventilation fans operating. Six bodies were recovered during this trip.

At about the same time, crews working from the direction of the Silver Summit mine carried bulkheading material to the Sunshine 3100 level, and advanced to the No. 10 Shaft air door. The drift was clear to within 50 feet of the door until the door was opened, at which time heavy smoke was encountered. The area behind the crew was also contaminated by leakage from openings in a mined-out area north of the No. 10 Shaft called the "Hook" area. Work continued on bulkheads in the "Hook" area in an attempt to seal the old openings and force fresh air into the 3100 No. 10 Shaft station. To provide the necessary seals in the shortest possible time, the Bureau of Mines had its contractor, Westinghouse Electric Corporation, attempt to locate large inflatable bags that could possibly fulfill the need. These inflatable bags, sealed quickly with rigid urethane foam, proved to be effective as temporary stoppings to control the mine ventilation. Monitoring of the Jewell Shaft airstream continued during the afternoon and evening of May 3, in order to ensure fresh air moving down No. 12 borehole to the 4800 level.

On May 4, at about 3 p.m., while examining conditions on the No. 10 Shaft station, the Silver Summit crew reported the presence of more bodies in the station area.

A 10- by 40-foot bulkhead was erected from the Silver Summit side to seal an abandoned drift. A new 150-hp. fan, designated the Silver Dollar fan, was prepared for operation in an attempt to increase fresh air flow to No. 10 Shaft from the Silver Summit mine.

At about 6 p.m., the Silver Dollar fan was started. This increased the volume of air moving toward No. 10 Shaft to more than 50,000 c.f.m. Leakage occurred, however, through the "Hook" area bulkheads when the door to No. 10 station was opened.

Also on May 4, a bulkhead and a 30-hp. fan were installed in 3700 No. 12 Shaft area to ensure fresh air to 4800 level via No. 12 borehole.

By 1 a.m. on May 5, back pressure had developed on the Jewell Shaft air doors on levels between the surface and 3100, causing leakage into the shaft. The Sunshine Tunnel exhaust fan was restarted about 2 a.m., and by 3:30 a.m. all Jewell Shaft air doors had been pressurized from the shaft side. The 150-hp. Silver Dollar fan was also shut down and the 30-hp. fan restarted on the Silver Summit side. At 3:40 a.m., the 3700 level Jewell Shaft air door was reopened, resulting in a strong flow of fresh air toward No. 10 Shaft. Crews then began advancing across the 3700 level, erecting bulkheads. Efforts were resumed to seal leaking bulkheads on the Silver Summit side to provide circulation of fresh air into the 3100 level No. 10 Shaft station. Work was begun on installation of a 250-hp. adjustable-range fan on the surface at the exhaust borehole ("Big Hole"), to increase exhaust air flow and clear the 3100 and 3700 levels.

On May 7, because delays were encountered in attempts to gain access to No. 10 Shaft, a fourth rescue approach was developed by the Bureau of Mines. The purpose was to gain access to 4800 level by means of a capsule lowered from 3700 level through No. 12 borehole.

The Bureau assembled additional rescue personnel from all over the country, along with oxygen-breathing apparatus and gas detection equipment.

The 250-hp. fan on the exhaust borehole was started and brought into balance with the Sunshine Tunnel fan about 5 a.m. By 6:30 a.m., the 3100 No. 10 Shaft station area was cleared of carbon monoxide. The Silver Summit crew reported 15 bodies in this area.

Progress toward No. 10 Shaft required many stoppings and seals making advance very slow. Based on the smoke problems and on information about the existing ventilation, it was decided to stop the 3400 fans. They were probably feeding air to the fire area.

At 3:06 p.m., in order to eliminate recirculation and facilities access to No. 10 Shaft, fans on the 3400 level were shut down from the 3700 level switch station. Four more bodies were found at the 3700 cable shop. By 4 p.m., ventilation to the 3100 level No. 10 Shaft station had improved considerably, and the air door was opened. At 5:13 p.m., the compressed air pressure dropped to 25 psi, indicating a major rupture in the system. The 3700 level door to No. 10 Shaft was closed, and efforts were directed toward opening the 3100 level between the Jewell and No. 10 Shafts. Crews from the Silver Summit and Sunshine met on the 3100 level at 8:45 p.m.

On May 8, at 3:50 p.m., an extensive cave-in was discovered in the 910 raise area on the 3700 level. A 12-inch compressed air line and a main powerline to the Strand substation had been broken by the cave-in, explaining the loss of compressed air pressure. The cave-in also caused a loss of power to No. 10 hoist, which was critical to all phases of the three-phase approach to reach the lower levels. Installing a new electric cable on 3100 level from the Jewell Shaft, therefore, was immediately assigned to electrical crews so that the hoist could be made operable as soon as possible.

The three-phase attack on the fire was now reduced to two with the loss of access through the 3700 level. In re-examining all possible alternatives, it was decided to again examine the No. 12 borehole as a possible way to get to the 4800 level where men were known to have been working. This approach was to be undertaken in a way which would not diminish the progress of work to reach and descend through the No. 10 Shaft, which had to remain the principal effort.

In preparing to send men to the lower levels via the No. 12 borehole, as part of its plan to carry out rescue and recovery operations through a fourth front, the Bureau had obtained two man-capsules from the AEC Nevada test site. Frank Solaegui, an engineer employed by Reynolds Electrical and Engineering Corp., an AEC prime contractor, provided invaluable help with the rigging and use of the capsules in the Sunshine mine.

The compressed air pressure in the mine was inadequate to operate the air-powered hoist installed at No. 12 borehole. In order to lower men down the borehole in one of the capsules, a portable air compressor was obtained. This was connected to a separate pipeline to supply power for the capsule hoist. After the borehole was surveyed by means of a closed-circuit television camera and found to be passable, it was decided to make various additional tests to determine if any difficulties would be encountered when men were lowered. After the hoist for the capsule was rigged, one of the capsules was cycled twice down the borehole to the 4800 level. In making these tests, it was found that the weight of the capsule loaded with 600 pounds of sand caused the portable compressor to labor heavily. The compressor was replaced with two others.

Shortly after 9 p.m., on May 8, the first two-man crew was lowered into the No. 12 borehole in the AEC capsule selected as most suitable for the operation. They discovered that the borehole not only was irregular and rough, but contained many slabs of loose rock which could endanger the lives of men making the descent. Therefore, as the men were lowered, they scaled loose rock. In the first hour, they progressed less than 150 feet of the total 1,100-foot distance and were hoisted because of fatigue. Other crews followed, scaling the walls of the hole. By 3 a.m. on May 9, the capsule had descended 450 feet.

After the crews reached a depth of 580 feet, conditions improved and the manned capsule reached 4800 level shortly after 7 a.m. A new crew with equipment was lowered and began exploring 4800 level for survivors.

This crew searched the area around the bottom of the borehole and the drifts west and east of the hole for a distance of 1,000 feet each direction before they made the ascent back to the 3700 level. Another Bureau crew was lowered and started to search the remaining areas on the 4800 level east of the borehole. At 5:43 p.m., May 9, they found two miners, Tom Wilkinson and Ron Flory, alive and in good condition at a diamond drill station 1,800 feet west of the No. 10 Shaft. Wilkinson and Flory were taken to No. 12 borehole and hoisted. They were the last survivors found in the mine.

Early on May 9, the Sunshine Tunnel and Big Hole exhaust fans were regulated and balanced to increase the flow of exhaust air. A plan for bypassing the cave-in on 3700 level to reach No. 10 Shaft could not be developed, so the decision was made to concentrate all recovery efforts on 3100 level. Increased air flow had been established on this level from the Jewell Shaft by 5 a.m., and fresh air leaks were reduced by reinforcing bulkheads. Electrical crews continued to remove moisture, condensed on the No. 10 hoist and its associated equipment, to prevent electrical short circuits. The hoist was energized at 10:34 a.m. The exhaust fan in the Sunshine Tunnel vibrated excessively and was turned off at 11:55 a.m. The flow of exhaust air was maintained by activating an auxiliary 100-hp. fan on the 1900 level. The fan on the exhaust borehole was adjusted to an increased output at 4:15 p.m., and an acceptable atmosphere was again created on 3100 level. The task of recovering bodies continued during the afternoon and succeeding shifts.

Because access to No. 10 Shaft had already been achieved via 3100 level from the Jewell Shaft, and recovery efforts could be conducted from that direction, efforts were discontinued from the Silver Summit mine and crews were moved to the Sunshine mine at the start of day shift, May 10. Work continued on activating No. 10 hoist, as some electrical difficulties were encountered while the hoisting system was being fully energized. As a result of a discussion between electrical crews, engineers, and personnel of the Washington Water Power Company, the voltage from the Bonneville Power Administration was reduced at 2:15 p.m. to accommodate the hoist circuits. By 3:15 p.m. the hoist was again operating. Other delays in hoisting were encountered, due to failures in the shaft signaling system, and it was necessary to repair the system to each level before proceeding to the next level below. The first rescue crew was able to descend No. 10 Shaft at 9:22 p.m. to 3400 level where four additional bodies were found. Another crew reached 3700 level about 11 p.m. and began searching for victims.

Upon activation of No. 10 hoist, which provided access to all levels, rescue operations at No. 12 borehole were discontinued. Alternate plans had been prepared should difficulties continue with No. 10 hoist. An electric hoist was installed May 10, as a backup for the compressed-air-operated hoist which serviced the rescue capsule at No. 12 borehole. A backup hoist was considered for installation at No. 10 Shaft on 3100 level.

On May 11, at 12:40 p.m., a crew reported that the atmosphere was uncontaminated at No. 10 Shaft, 3700 level, and that seven additional bodies had been found in the tail drift behind the shaft. Another crew made a more thorough search of 3700 level in the vicinity of No. 10 Shaft and found no bodies except the four which had been located by a crew working from the Jewell Shaft.

Initially, no bodies had been found on 4200 level, but three were located at 8:15 p.m. at the 42-539 raise. At 7:13 p.m. seven bodies were found on 4400 level. These victims had attempted to remain alive by inhaling oxygen from a cylinder on a welding unit. The "chippy" hoist cage with no one aboard was found at 4500 level. Since the atmosphere appeared satisfactory on 3100 level, work there was directed toward strengthening the bulkheads and sealing off about 20,000 c.f.m. of air leaking to upper levels between No. 4 and No. 5 Shafts.

A valve near No. 10 Shaft, 3700 level, was closed to stop compressed air escaping from the 12-inch-diameter air line ruptured by the cave-in at 910 raise. Heat was building up in the area as bulkhead construction continued to reduce circulation of air. Additional seals were constructed to isolate No. 10 Shaft station from the remainder of the 3700 level.

By late May 11, all victims had been located as shown:

<u>Level</u>	<u>No. of victims</u>
3100	31
3400	4
3700	16
4200	3
4400	7
4800	7
5000	2
5200	<u>21</u>
Total	91

By May 13 all bodies were recovered. The Shoshone County, Idaho, coroner issued a finding that all had died of "Suffocation from carbon monoxide and smoke." A copy of the coroner's report is included as Appendix C.

Sunshine mine officials on May 15, 1972, provided Bureau officials with an updated accounting of personnel in the mine when the fire was discovered. The final figure was determined when it was confirmed that only 13 of a possible 33 mechanics, only 5 of a possible 17 electricians were underground at the time of the fire, and four other employees did not go underground during the day shift on May 2.

On the morning of May 12, a meeting between company and Bureau of Mines personnel was held to consider methods of extinguishing or containing the fire, and of conducting an investigation to determine the origin and cause of the fire. Two approaches to extinguishing or containing the fire were considered: (1) Complete sealing of the mine or (2) Sealing only the fire area. It was recognized that both the Jewell and No. 10 Shafts had to be protected, and that this would require many leakproof seals.

It was agreed that efforts would be concentrated on suffocating the fire by sealing the fire area with sandfill plugs and bulkheads.

The Sunshine Mining Company had about 60 men qualified to wear oxygen-breathing apparatus, and the Bureau of Mines, about 26 at the property. It was planned to supplement these numbers by training additional persons in the care and use of oxygen-breathing apparatus, and by offering premium pay to induce experienced men to participate in firefighting or fire containment efforts.

Additional seals were placed in all areas which might allow oxygen leakage into the fire area. Many areas on the 09 and 08 veins, however, were caving due to the burning of the timber ground support. These occurrences not only seriously hampered control efforts but posed additional serious risks to persons who were to go underground to investigate the burned-out areas.

Thereafter work was directed toward fire extinguishment by sealing and sandfilling, isolation of the fire area, and mine reclamation as well as continuing the investigation. In conjunction with mine reclamation, a mine reopening plan was developed jointly by company officials, employee representatives, State mine inspector, and Bureau of Mines officials.

#### Activities of Bureau of Mines Personnel

A Federal Bureau of Mines inspector, Martin R. Castellan, heard of a mine fire at the nearby Sunshine mine while at the Galena mine, American Smelting and Refining Company, May 2, 1972. He telephoned the news from the Galena mine to the Bureau's field office, Spokane, Washington, at 1:15 p.m., and was instructed to proceed immediately to the mine. The Bureau's Seattle, Washington, Subdistrict office was advised at 1:20 p.m. At 1:35 p.m., Castellan, after he arrived at the Sunshine Mine, verified that smoke was issuing from the Sunshine tunnel, and so notified the Spokane field office.

Roland V. Wilson, supervisory mining engineer, accompanied by William S. McCullough, mining engineer, left the Spokane office immediately and arrived at the mine, a distance of 70 miles, at 3 p.m. After assessing the situation, Wilson made several recommendations and issued Withdrawal Order No. 1 at 3:30 p.m., May 2, 1972, because of imminent danger (fire). This Order prohibited entry into the mine by any persons except those actively engaged in rescue or recovery work. Under this Order, rescue and recovery operations were subject to Bureau of Mines approval.

Bureau of Mines personnel who arrived at the mine served initially as advisors and assisted company personnel in tests for ventilation and toxic gases, while the company was sending local rescue crews underground and was contacting other mines in the Coeur d'Alene Mining District, neighboring States, and Canada for additional crews and equipment. Supervisors and miners throughout all of the district responded promptly to the company's request for aid. Experienced mining engineers in the district also arrived at the site to contribute, along with Bureau personnel, their expertise and assistance.

Leaders of the Bureau's Technical Support Group, including Bruce Grant and Don Ward, arrived at 7 a.m. on May 3, to establish liaison with the Sunshine Mine management. They were accompanied by key personnel of the Mine Emergency Operation Staff, Westinghouse Electric Corporation, under contract with the Bureau.

At 8:30 a.m., May 3rd, Arthur P. Nelson, then Assistant Deputy Director--Health and Safety, and Stanley M. Jarrett, then Assistant Director--Metal and Nonmetal Mine Health and Safety, along with William Wood, Technical Assistant; Allen D. Look, Western District Manager; Kenneth U. Russell, Seattle Subdistrict Manager; and other health and safety officials arrived at the property.

After assessing the situation, an immediate conference was requested by S. M. Jarrett to examine the organizational needs of the rescue operations. Called into conference were key personnel of the Sunshine Mine, officials

from nearby mines that responded to the fire, and top Bureau of Mines personnel. An organization and a chart were developed to cover the functions and relations needed to coordinate the rescue and recovery effort, mechanical and electrical assistance, issuing supplies, making acquisitions of additional items as needed, releasing information to relatives and to the press and television groups, and plant security. All the functions were assigned to appropriate managers and manned on a 12-hour shift basis. It was evident that by the morning of May 3rd, an extended rescue mission was likely; personnel on the property were showing signs of being tired, and a higher degree of coordination was needed to avoid worsening the disaster. Coordination would also assure that vital information was properly collected and made available to all those who needed it.

The organization not only served to establish order but also provided coordination with State officials and mine worker representatives. The organization chart showing the assigned duties and responsibilities is attached to this report as Appendix D.

Also decided at the meeting was that daily logs would be kept to record events. Further, it was decided to establish immediately a program for training additional men in mine rescue work so that any eventual need might readily be met.

Secretary of the Interior Rogers C. B. Morton arrived at 1 p.m. on May 3 and met with company and Bureau of Mines officials, as well as with families of victims.

At 5:30 p.m. that day, Dr. Elburt F. Osborn, Director, Bureau of Mines, accompanied by Lewis Helm, Executive Assistant to the Director, Office of Communications, U.S. Department of the Interior, arrived at the mine and reviewed the situation with many of the above-named officials.

At 5:45 a.m., May 5, the Bureau's emergency communications research group, under direction of John Murphy, Pittsburgh Mining Research Center, arrived along with Westinghouse engineers and geophysicists of the corporation's rescue and survival staff, who brought with them the Bureau's mine emergency communications gear.

Also, to assist the Bureau in its rescue procedures at the No. 12 borehole, described earlier, Frank Solaegui, an engineer with the Reynolds Electrical and Engineer Corporation, under contract to the Nevada Operations Office, Atomic Energy Commission, arrived on May 7, along with the man cages made available by the AEC.

Hollis Dole, then Assistant Secretary--Mineral Resources; Tobias Welo, assistant to Mr. Dole; Donald P. Schlick, Deputy Director--Health and Safety; John W. Crawford, Assistant Director--Coal Mine Health and Safety; and Robert Dalzell, ventilation engineer, Pittsburgh Technical Support Group, arrived May 9, 1972.

Other Bureau of Mines personnel who assisted at the mine, and their arrival dates, are shown in Appendix E.

The Bureau's mine health and safety personnel participated in the removal of the victims' bodies from the mine; joined in firefighting operations; went underground with many of the rescue and recovery crews; provided needed equipment and instrumentation; trained personnel in mine rescue; monitored the quality of the mine atmosphere; and participated in all phases of the work.

Instructors from the Bureau's Division of Education and Training and engineers and inspectors from the Metal and Nonmetal Health and Safety offices trained a total of 174 mine employees in the use and care of the McCaa 2-hour self-contained breathing apparatus between May 3 and June 8.

#### INVESTIGATION OF CAUSE OF THE DISASTER

##### Investigation Committee

The Bureau of Mines investigation of the disaster was begun almost immediately after Bureau personnel arrived at the mine site and was conducted concurrently with mine rescue, recovery, and rehabilitation operations.

The Director of the Bureau of Mines designated the following persons,  
under the direction of Stanley M. Jarrett, to conduct the investigation:

Roland V. Wilson	Supervisory Mining Engineer, Western District, Seattle Subdistrict, Spokane Field Office, Metal and Nonmetal Mine Health and Safety
E. Levi Brake	Mining Engineer, Western District Phoenix Subdistrict, Metal and Nonmetal Mine Health and Safety
Robert E. Riley	Mining Engineer, Rocky Mountain District, Salt Lake City Subdistrict, Metal and Nonmetal Mine Health and Safety

The following persons also participated in all or parts of the  
underground investigation:

Sunshine Mining Company

Robert Russell	Assistant General Manager
Albert Walkup	Mine Superintendent
Robert Launhardt	Safety Engineer
Harvey Dionne	Mine Foreman
James Bush	Mine Foreman
J. M. Kniseley	Consultant - J. M. Kniseley Engineering Corporation



were taken by attorneys from the Department of the Interior. Representatives of the State of Idaho, the Sunshine Mining Company, and the United Steelworkers of America participated.

A public hearing concerning the disaster was conducted by the Office of Hearings and Appeals, Department of the Interior, in Kellogg, Idaho, July 18-25, 1972. The Select Labor Subcommittee of the U.S. House of Representatives conducted a public hearing in Kellogg, Idaho on July 31, 1972.

### Findings and Analysis

Conditions observed in the mine during the investigation following the fire, together with information available from Bureau of Mines inspection and investigation reports, from depositions of survivors, interviews with company officials, and from company records, provided data on the cause of the disaster. The facts so obtained and conclusions drawn therefrom by Bureau of Mines investigators are identified. Distinctions will be made among the following and so noted:

Violations of Federal Metal and Nonmetal Mine Health and Safety standards with which compliance is mandatory.

Noncompliance with Federal Metal and Nonmetal Mine Health and Safety standards that are advisory in nature.

Absence of sound safety practices consistent with the conditions understood to prevail at the Sunshine Mine.

1. A mine fire resulting in the loss of 91 lives due to carbon monoxide poisoning occurred in the Sunshine mine on May 2, 1972. No flame or fire was observed by any of the survivors. Investigation revealed the fire to have burned through portions of 08, 09, and D veins between the 3100 and 3700 levels.
2. Large quantities of timber were used for ground support in raises, drifts, and stopes in the fire areas. During the time mining was in progress in the fire area it was customary to bury refuse and scrap timber in waste rock used to backfill the mined-out stopes. Scrap timber piled in abandoned drifts was observed during investigation of the 3400 level and many other areas. It is a logical assumption that the fire area contained similar quantities of combustibles.

Such accumulations are a Violation of Advisory Standard 57.4-12.

3. Ventilation control bulkheads were constructed of combustible materials. The 3400 level exhaust airway was supported by standard drift timber sets where it crossed the 09 vein. The timber sets extended along the airway for about 50 feet and were solidly lined on the top and ribs with plywood to provide a smooth surface. The plywood had been sealed on the air flow side with asphalt mastic. The asphalt mastic had been covered with urethane foam to seal air leaks. Other bulkheads and doors in the fire area were also constructed of wood.

4. Abandoned mine areas were not effectively sealed since most bulkheads and doors leaked excessively. Ventilation surveys conducted by the Bureau of Mines September 14 to October 4, 1971, pointed out leakage into the area where the fire occurred. Efforts were subsequently made by Sunshine Mining Company to reduce the total quantity of leakage. As of the survey conducted April 24, 1972, leakage had been reduced from 8,000 cfm to 2,000 cfm. Leakage through the 09 vein bulkhead was minor as considerable effort had been expended to achieve a tight seal.
  
5. The mine ventilation system was not designed to reduce hazards presented by a mine fire. The location of main fans on the 3400 level caused high positive pressures in exhaust airways and negative pressures in intake airways thus creating a pressure differential between the positive side of the fans and the 3100 and 3700 levels. However, the portion of the 3400 level exhaust airway inby the fans and the connected 3550 level was at a lower pressure than the intake airways. The normal leakage pattern prior to the fire was from the positive pressure side of the 3400 level fans and from the 3100 and 3700 level intake airstream to the 3550 level and then toward the negative pressure side of the exhaust fans on 3400 level. This leakage pattern prevented smoke from entering the intake airstream, where it would have been detected, until the fire caused a direct short circuit in the ventilation system.

The basic ventilation system was designed as a series system which resulted in air, contaminated by fire gases, being coursed through all working places inby the fire area before entering the mine exhaust system.

The controls built into the ventilation system did not allow the isolation of No. 10 Shaft and its hoistrooms and service raises or the compartmentalization of the mine. Smoke and gas from this fire was thus able to move unrestricted into almost all workings and travelways.

6. Remote controls were not provided to operate main ventilation fans. The only means to stop the 3400 level fans, without stopping the No. 10 Shaft double-drum hoist which was on the same power circuit, was to travel to 3400 level to the fan controls.

Lack of remote fan controls is a Violation of Advisory Standard 57.5-21.

7. Several employees reported, after the fire, that they possibly smelled smoke on 3700 level during graveyard shifts April 30 and May 1. These reports could not be substantiated.

8. The company did not carry out a regular program of monitoring the mine atmosphere for carbon monoxide or other gases.

Failure to make tests of the mine atmosphere is a Violation of Advisory Standard 57.5-26.

9. Large quantities of smoke and toxic gases were rapidly forced out into the intake airways. The Bureau of Mines believes a fire smoldered in the abandoned area, filling it with smoke before the smoke was expelled and detected. The sudden release of a large volume of smoke and toxic gases was not characteristic of the normal growth of an open fire.
  
10. Air to maintain the smoldering fire may have been provided by small amounts of leakage through the 09 vein bulkhead on the 3400 level. Other bulkheads may have also leaked. A blast initiated on day shift May 1, 1972, to enlarge the exhaust airway 340 feet west of the 09 vein bulkhead may have further loosened the bulkhead causing increased leakage of air. A differential of about 12 inches of water gauge pressure existed across the bulkhead and 95,300 cfm of air at a velocity of about 1600 feet per minute was passing through the exhaust airway.
  
11. Investigation showed that the burning of timber had progressed from the abandoned area through the 09 bulkhead into the exhaust airway. Timber posts on the east side of the drift were more severely burned than the posts on the west side of the airway. Remnants of the tar paper left on the west side of the airway were not burned.

12. When the fire burned through the urethane foam coated bulkhead, a rapidly increasing portion of the exhaust air short-circuited into the fire area. Analytical results of a tar-like material collected near the 3700 level 08 shop exhaust fan showed the presence of unburned hydrocarbons volatilized from incomplete combustion of wood and small amounts of residue from burned urethane foam. The only location where urethane foam is known to have burned was the 3400 level of 09 vein bulkhead.
13. The Bureau of Mines believes that when the 09 vein bulkhead burned through, a large quantity of air reached the smoldering fire which then rapidly increased in intensity. The burning of the bulkhead allowed a direct short circuit in the mine ventilation system. High ventilating pressure forced contaminated air from the fire area into the intake airstreams on 3700 level and 3100 level.
14. Smoke was discovered emanating from the bottom of the 910 raise on 3700 level about 11:40 a.m. Shortly after, smoke was detected in drifts near the 08 shop. A few minutes later, smoke began entering the 3100 level from connections to abandoned drifts and raises.

The smoke and carbon monoxide contaminated air that was forced out of the abandoned areas into the intake airways was rapidly circulated throughout the lower levels of the mine where men were exposed to its toxic effects. The air returned through the 3400 level fans

and was recirculated over the fire, continually increasing the concentration of carbon monoxide. No measurements of carbon monoxide in the mine atmosphere were available during the early stages of the fire, but concentrations of nearly 1.0 percent were detected in the mine exhaust air several hours later.

Results of gas analyses made during the early days of the fire are attached as Appendix L. The samples were taken in the exhaust air at the Sunshine tunnel and were analyzed at the Bureau of Mines Laboratory, Mt. Hope, West Virginia, and by chromatograph on the mine property. At 8:30 p.m., May 3, 1972, the gas content was 14.47 percent oxygen, and 0.82 percent carbon monoxide, 0.18 percent methane, and 0.18 percent hydrogen. Based upon ventilation calculations, these results could have diluted by air by as much as five or six to one and did not indicate actual gas content in the fire area.

15. The preceeding findings indicate that the fire increased in intensity, spread more rapidly, and produced more toxic gases than is considered normal for underground mine fires.

A possible explanation may be found in the results of recent experiments conducted by A. F. Roberts and J. R. Blackwell at the Safety in Mines Research Establishment, Ministry of Power, Great Britain, as summarized in the paper titled, "The Possibility of the Occurrence of Fuel-Rich Mine Fires," published in The Mining Engineer, September 1969. The experiments demonstrated "the possibility of fires of exceptional severity, with characteristics very different from those so far observed in large scale fires."

In Roberts' and Blackwells' paper, eight other mine fires were summarized with results showing a burning rate of 2.3-19.0 yards an hour advance in a timberlined drift compared with an experimental fuel-rich advance of up to 275 yards an hour.

Roberts and Blackwell also stated that the experimental results showed the products of combustion of fuel-rich fires typically consists of 18-20 percent carbon dioxide, 5-8 percent carbon monoxide, 2-5 percent hydrogen, 0-1 percent oxygen, together with tarry materials and small concentrations of other gases. Considering the dilution of these combustion products by about 5:1 into the intake airstream at Sunshine mine, the gas analysis should be 3.3 percent - 3.5 percent carbon dioxide, .83 percent - 1.3 percent carbon monoxide, .33 percent - .83 percent hydrogen, and 17.5 percent - 17.7 percent oxygen.

These results compare favorably with the analytical results in the Sunshine tunnel shown in Appendix M.

Although it is not known exactly what quantity of air crossed the 3100 and 3700 levels to the east of No. 5 winze just prior to fire discovery, it is estimated that 13,500 cfm and 43,500 cfm reached No. 10 Shaft. It is evident that the amount of diluting air was much less on 3100 level than 3700 level. It is also not known how

much air was forced out into the intake airstream on 3100 level and 3700 level when the 09 vein bulkhead collapsed and allowed the short circuit. It is not unreasonable to assume that about 3,000 cfm and 6,000 cfm of fire gases were injected into the intake airways on 3100 and 3700 levels, respectively. If this were the case and assuming the Roberts and Blackwell fuel-rich gas composition, the resultant gas composition on the levels would be:

	<u>3100 Level</u>	<u>3700 Level</u>
CO <sub>2</sub>	3.4 percent	2.3 percent
CO	0.91 percent	0.60 percent
O <sub>2</sub>	17.0 percent	18.75 percent

Closing of fire doors on 3100 and 3700 levels reduced the dilution air available which caused an increase in the concentration of carbon monoxide circulated in the lower levels of the No. 10 Shaft. The doors were closed manually, not by the automatic carbon monoxide sensors, according to instructions in the Fire Plan posted by the company.

Roberts and Blackwell also state: "A polyurethane foam fire achieves a fuel-rich condition very rapidly, giving rise to temperature levels

and gas concentrations similar to those described for fuel-rich fires in timber lagging, with the addition of toxic concentrations of hydrogen cyanide;" "a polyurethane foam fire could act as an igniting source for a fuel-rich fire in timber lagging;" and "the flammability of polyurethane foam is such that a fuel-rich fire can develop within two minutes of foam being exposed to the flames from an igniter." Polyurethane foam present on the 09 vein bulk-head may have burned in this manner.

The above discussion of the research done by Roberts and Blackwell lends credence to the fuel-rich mine fire theory and may explain why the Sunshine mine fire was so severe. The fact is also brought out in their research that "there is no positive evidence that a fuel-rich fire has ever developed." The fire at Sunshine mine may have been the first example of such a fire.

16. The "Fire Protection and Escape Plan and "Procedure to Follow in Case of Mine Fire," included as Appendix I, were issued to each supervisor and were posted along with a ventilation map at shaft stations on 3100 and 3700 levels for the information of underground workers. The plan was not posted on any level below 3700. The primary emphasis of the plans was placed upon reacting to a fire in the Jewell Shaft. The "Fire Protection and Escape Plan" proved ineffective for coping with a situation where smoke and toxic gases spread as rapidly as at the outset of the fire. Under "Escape Plans" as outlined in the "Fire Protection and Escape Plan," emphasis was

placed upon mechanical hoisting of men from the mine. Only once was the possibility of loss of hoisting power mentioned. An alternate escape method was not described.

Evacuation drills had never been conducted. Employees were not adequately trained in emergency procedures to follow when most of the escape route was through contaminated atmosphere. This was a Violation of Advisory Standard 57.4-32.

In the "Procedure to Follow in Case of Mine Fire," Section (3)d properly states "Begin immediate evacuation of the mine ----." Section (3)e states "Send first available shift boss to ascertain the exact condition of the fire, by the safest available route. Have him report immediately, either by phone or in person." In this case, evacuation was delayed at least 20 minutes while an investigation was conducted.

Undoubtedly many more men could have been hoisted to the 3100 level and could have traveled to safety, had it not been for the 20 minute delay in evacuation.

17. A member of mine management had not been designated as being in charge of mine operations of May 2. Top mine officials were attending the annual stockholders meeting in Coeur d'Alene, Idaho. Underground foremen were responsible only for the activities of their own crews. There was an apparent reluctance to issue an evacuation order.

Lack of an individual being designated as being in charge is a Violation of Advisory Standard 57.18-9.

18. The stench-warning system was not effective in warning employees of the fire. Subsequent testing of the system during the investigation using the same quantity of ethyl mercaptan revealed that the stench was detected at all locations in the mine, except the 4800 west syndicate lateral drift. The stench was detected within 15 minutes of activation but dissipated within 3 to 4 minutes and did not have a strong odor. Judging by Bureau of Mines Technical Paper 244, 1920, the Sunshine mine stench-warning system contained about 20 percent of the necessary amount of ethyl mercaptan for the quantity of air entering the mine. Prior to the fire, the system had never been tested to determine its adequacy. Late activation of the system and the density of the smoke may have also been factors in the ineffectiveness of the warning system. Most miners, having smelled smoke, had already departed from their work areas.

Since the system was less than adequate, it was in Violation of Mandatory Standard 57.4-51.

19. The No. 10 Shaft "chippy" hoistman was forced by smoke to leave his controls, hindering rapid evacuation of men from lower levels. Smoke rapidly entered the 3700 level "chippy" hoistroom, which was located immediately down the ventilation airstream from the 910 raise where smoke was first detected. Many survivors reported

- the hoist signals were inoperative, not knowing that the hoistman was unable to remain in the hoistroom to answer the signals. The "chippy" hoist was normally capable of hoisting 48 men to the 3700 level in a single trip.
20. The south cage of the No. 10 Shaft double-drum hoist was used to hoist most of the men. The north cage was used to hoist only two cage loads of men from the lower levels of the mine. The reason both cages were not used in balance to more rapidly hoist men has not been determined.
  21. The No. 10 Shaft double-drum hoistroom on the 3100 level was contaminated with carbon monoxide and smoke. The regular hoistman was nearly overcome and was told to leave the controls. The second hoistman died at the controls leaving many men on lower levels.
  22. An adequate number of qualified cagers was not available to rapidly hoist men. Volunteers made heroic efforts to assist men up No. 10 Shaft.
  23. The mine communications system, consisting of a single circuit with telephones in hoistroom, shops, and shaft stations, was not effective during the emergency because many persons attempted to use it simultaneously. An emergency circuit was available from the Blue Room on 3700 level to the surface but was not used.

24. The emergency escapeway system from the mine was not adequate for rapid evacuation. It was not possible for men to climb several thousand feet up ladders in raise manways which served as exhaust airways, since the ladderways were contaminated with carbon monoxide and smoke. Best estimates indicated that 3 to 4 hours would have been required to climb to safety under good conditions.

Mandatory Standard 57.11-50 requires every mine to have two separate escapeways to the surface and does not require that the escapeways be provided with mechanical hoisting. In light of this disaster, it is obvious that the present standard does not assure escape from a mine. The Bureau of Mines believes that mechanical hoisting is essential to provide an adequate emergency escapeway from a deep mine.

25. During the investigation it was revealed that the secondary escape routes were inadequately marked. Lack of proper marking of escape routes made it difficult to determine which sections were maintained in travelable condition.

Lack of proper marking of escape routes is a Violation of Mandatory Standard 57.11-51(b).

26. Self rescuers were available at each active working station between 3100 and 5200 levels in the No. 10 Shaft, the hoistroom on the 3100 level, and in the first-aid room on the 3700 level. No self rescuers

were stored on stations below 5200 level. The recovery of empty self rescuer containers, along with statements of survivors and the company safety engineer, indicate the following relationship between numbers of employees and self rescuers on each level on May 2:

<u>Level</u>	<u>Employees</u>	<u>Self Rescuers</u>
3100	3	6
3400	4	12
3700	31	24
4000	1	0
4200	4	6
4400	8	18
4600	20	24
4800	18	18
5000	25	24
5200	21	24
5400	8	0
5600-5800	<u>10</u>	<u>0</u>
	153	156

The remaining 20 employees were working near the Jewell Shaft or along the 3100 or 3700 level haulageways where self rescuers were not stored.

Self rescuers were stored in locked wooden boxes. The company had found it necessary to lock the boxes to prevent pilferage. The locks were easily broken and did not prevent access to self rescuers.

The self rescuers had been obtained over a period of years, some having been manufactured as early as 1951. The Bureau of Mines recommends that the shelf life of the model 1447 self rescuers should not exceed 5 years when stored in caches.

The company had done some maintenance work of self rescuers but did not conduct regular inspections nor did they maintain records of the number and condition.

When the self rescuers were needed on May 2, the rear covers on many could not be released by pushing the plunger. Examination showed that the gasket on the rear cover had become deteriorated and tightly stuck. The manufacturer of the self rescuers indicated that prolonged storage in an area having high temperatures could have caused this deterioration.

Self rescuers and replacement cartridges were collected from the mine and from the surface first-aid room and sent to the Bureau of Mines Health and Safety Technical Support Center, Pittsburgh, Pennsylvania, for testing. The seals on some of the self rescuers had been broken by men who attempted to use them on May 2, allowing

the self rescuers to become too badly deteriorated for testing. Tests showed that the rear covers on some of the self rescuers were difficult to remove. Some were effective against carbon monoxide while others offered no protection. Detailed results of the tests are included in Appendix N.

27. Most of the mine employees had not been trained in the use and limitations of the self rescuer. Self rescue training had been presented as a part of first-aid and mine rescue training, but men trained represented only a small portion of the mine employees. Survivors reported that some men were not able to use the self rescuers and that others discarded the rescuers when they became hot, as is normal, in high concentrations of carbon monoxide.
28. Survival training, including evacuation procedures, hazards of gases such as carbon monoxide, and barricading had not been given to all mine employees.

The attempt at building a barricade on the 5200 level was an indication of initiative on the part of some miners, although selection of the barricade site was poor for the materials and time available.

29. The company did not have in effect a check-in check-out system which accurately represented persons underground. Miners were

checked into the mine in shift bosses' time books. Mechanics, electricians, and other service groups entered the mine without such control. The shift bosses' time books did not remain on the surface, and at the time of the fire several books were temporarily lost, underground with the shift bosses.

Cap lamp issues were used as a second means of control, but additional lamps sent into the mine to replace defective lamps during the shift and other factors obviated use of the system to maintain a check on men in the mine.

Since the check-in - check-out system in effect at the mine proved inaccurate and ineffective, it was in Violation of Mandatory Standard 57.18-27(M).

30. Refuge chambers were not provided on the 5400 and 5600 level to serve until secondary escapeways were developed. No. 10 Shaft provided the only access to these levels. The 5400 level drift had been advanced in excess of 2000 feet and the 5600 level cross-cut about 400 feet from No. 10 Shaft. The failure to provide refuge chambers on individual levels of the mine during the period of time that work toward a second exit was in progress was not considered, prior to the fire, to be a Violation of Mandatory Standard 57.11-50 which states:

57.11-50(M). Every mine shall have two separate properly maintained escapeways to the surface which are so positioned that damage to one shall not lessen the effectiveness of the other, or a method of refuge shall be provided when only one opening to the surface is possible.

It is clear that the depth of No. 10 Shaft below a second exit and the lengths of the drifts make it essential that refuge areas be provided in excess of the minimum prescribed by the standard.

In light of this disaster, the Bureau of Mines feels that refuge chambers should be provided on all levels and in isolated areas, where applicable, until a second exit is provided.

#### Possible Causes of the Fire

Possible causes of the fire considered during this investigation were smoking, welding, blasting, electricity, equipment, incendiarism, spontaneous combustion of sulfide minerals, and spontaneous combustion of refuse and scrap timber. Numerous samples of soot, charred wood, and fire distillation products were collected from the fire area and surrounding mine openings. These samples were collected and analyzed in attempts to determine, from the products of combustion, what fuels had been consumed by the fire, including any not normal to a mine environment. The samples were analyzed in laboratories at the Bureau of

Mines Health and Safety Technical Support Center in Pittsburgh, Pennsylvania. Results of these analyses revealed no products of combustion other than those which could normally be expected from a fire of this nature. Detailed results and evaluations of the analyses are included as Appendix M.

Possible causes considered were:

1. Smoking was a common practice at the Sunshine mine with restrictions placed on hazardous fire areas. Smoking was not allowed in the 3400 level exhaust airway. No persons were known to have been in the immediate fire area for several days before or on the day of the fire except a crew of miners who were enlarging the 3400 level exhaust airway. One of the miners and the welder who worked in the 3400 level exhaust airway were known smokers. The difficulty involved in smoking in air velocities between 1000 and 2000 feet per minute made it improbable that smoking did occur near the fire area on 3400 level.
2. A welder used an oxygen-acetylene torch to cut off protruding rock bolts left by a blast in the 3400 level exhaust airway. The cutting was done in a section of drift containing no combustibles except track ties which were not burned. The cutting was done about 340 feet down the ventilation airstream from the 09 bulkhead. According to a deposition given by the welder who performed the cutting, the area was wet down with water before and after cutting. Due to the high air velocities involved in the exhaust airway and the direction of air flow away from the area where the cutting was done, it would have been virtually impossible for a spark to reach the 09 vein bulkhead vicinity.

3. Several blastholes charged with dynamite and primed with electric blasting caps were detonated by the crew enlarging the 3400 level exhaust airway the afternoon of May 1, 1972. The blast was made in an untimbered drift area about 340 feet west of the intersection of the ventilation drift and the 09 vein drift. No evidence of fire was reported by the crew on the morning of the mine fire.
4. Energized electric conductors were not present in the fire area. The only electric conductors in the area extended from the 3700 level through No. 8 shaft to the 3550 level. It was revealed, by tracing the wires, that they were disconnected and were not involved in the fire.
5. The only electrical or mechanical equipment in the fire area was an electric-storage-battery-powered locomotive on the 3400 level. The locomotive was discovered in good condition and had not been involved in the fire.
6. In considering incendiaryism as a possible cause of the Sunshine fire it is necessary to realize where the fire originated. Evidence indicates that the fire started in an abandoned area near the 09 vein bulkhead on 3400 level. Access to that bulkhead would have had to be from 3400 level or 3550 level. On the 3400 level, access would have had to be from the No. 10 Shaft or No. 4 Shaft. It is known that the 3400 level workmen were on the level all morning May 2 and did not report any unusual occurrence. If any person were to have started the fire on 3400

level it would have been necessary to come from No. 4 Shaft and carry a sufficient supply of rapidly combustible material. Any fire started there would require, because of high air velocities, an ignition substance and be very intense so as to burn through the bulkhead rapidly. The individual(s) would also have had to climb up or down No. 4 Shaft to reach 3400 level and also carry the necessary supplies. Investigation revealed that the fire burned from the abandoned area outward through the bulkhead.

The possibility of incendiarism on 3550 level is slightly more realistic. Access to 3550 level was by No. 10 Shaft and No. 8 Shaft from 3700 level. Investigation revealed that the door on 3550 No. 10 station had not been opened prior to the fire which meant the only possible access was from No. 8 Shaft. A person(s) would have had to climb No. 8 Shaft from the pipe shop and traverse the old workings through 08 vein to reach a point below the 09 bulkhead on 3400 level.

Access to this area would have been very difficult and hazardous and later investigation revealed no footprints or disturbances in the dust in the ladderway in No. 8 Shaft or near the shaft station on 3550 level. The fire could have been started with any combustible material available and would not have required any incendiary device. The fire could have been started as much as a month but probably not less than two weeks before detection. Time would have been necessary for migration from the 3550 level 09 vein to the 3400 level 09 bulkhead. The fire probably would have

been detected before it reached 3400 level.

There has been no evidence available to the Bureau of Mines at this time to indicate that incendiarism was the cause of the fire.

7. The vein material in the Sunshine mine generally contained less than 10 percent sulfide minerals. There is no known instance of a fire igniting spontaneously from sulfide minerals in the Coeur d'Alene Mining District.

8. A possible cause which cannot be ruled out is spontaneous combustion of refuse near scrap timber. It is known that many varieties of refuse were discarded into waste rock used for backfill of mined-out stopes. Refuse included such things as papers, rags, abandoned oil containers, and explosives cartons, all of which could contribute to possible spontaneous combustion. The question then has arisen as to why spontaneous combustion had not occurred during the many years previous that the materials had been in the stopes. However, when spontaneous combustion occurs it requires a special set of circumstances which may not have existed until the present. Leakages in the ventilation system as described in the Bureau of Mines "Ventilation Survey" report probably had an indirect relationship to the cause of the fire. It is entirely possible that changes in the volume of air leaked as reported following the supplemental ventilation survey may have contributed to spontaneous combustion in the 09 vein area. As reported in the proceedings of the "Symposium on the Prevention of Spontaneous Combustion," a meeting of the Institution of Mining Engineers, London, England, (Nov. 3-5, 1970), a change in ventilation always preceds

spontaneous combustion in an underground mine. It is possible that prior to the reduction of air leakage into the abandoned 09 vein, sufficient air was flowing to keep the temperature suppressed to the extent that combustion could not occur spontaneously. With the sealing of some of these leaks, oxidation of waste materials could have elevated the temperature to the point of combustion and the remaining air flow was sufficient to supply the necessary oxygen for combustion but not sufficient to provide cooling.

#### Probable cause of the fire

The Bureau of Mines believes that spontaneous combustion of refuse near scrap timber was the probable cause of the Sunshine mine fire.

#### Causes of the Disaster

The Bureau of Mines believes the following factors contributed to the severity of the disaster:

1. Ineffectiveness of stench warning system.
2. Delay in beginning mine evacuation.
3. Ineffectiveness of the mine communication system.
4. Inadequacy of the emergency escapeway system.
5. Inadequacy of the emergency fire plan.
6. Use of a series ventilation system.
7. Failure to seal abandoned areas of the mine.
8. Failure to monitor the mine atmosphere.
9. Failure to construct incombustible ventilation bulkheads.
10. Lack of remote controls on major underground fans.
11. Failure to maintain self rescuers in useable condition.

12. Failure to train underground employees in use of self rescuers.
13. Failure to conduct mine survival training.
14. Failure to designate anyone as being in charge of the entire operation in the absence of top mine officials.
15. Inability to use No. 10 Shaft chippy hoist.
16. Death of the No. 10 Shaft hoistman.
17. Failure to make use of both cages on No. 10 Shaft double-drum hoists.

#### Recommendations

Reference numbers used in the report identify mine safety standards promulgated in the Federal Register, Vol. 34, No. 145, Thursday, July 31, 1969; Federal Register, Vol. 35, No. 38, Wednesday, February 25, 1970; Federal Register, Vol. 35, No. 237, Tuesday, December 8, 1970; Federal Register, Vol. 37, No. 139, Wednesday, July 19, 1972, and Federal Register, Vol. 37, No. 238, Saturday, December 9, 1972.

Promulgated Mandatory Standards are identified by (M) after the reference number.

Promulgated Advisory Standards are identified by the reference number only.

Mandatory Standards proposed by the Secretary of the Interior in the aftermath of the Sunshine disaster are identified in the text of the recommendation.

Recommendations not identified by a standard number were made to correct conditions for which no promulgated or proposed standards exist.

Although the specific cause of the fire could not be established, the following recommendation concerning the probable cause is made:

Bureau of Mines Advisory Standard 57.4-12 recommends:

"Combustible materials, grease, lubricants, or flammable liquids should not be allowed to accumulate where they can create a fire hazard."

The Bureau of Mines further recommends that scrap timber and refuse be removed from the mine each day.

Although not directly related to the cause of the mine fire, the following recommendations may prevent loss of life during a similar occurrence:

1. Bureau of Mines Mandatory Standard 57.5-28(M) requires that:  
"unventilated areas shall be sealed, or barricaded and posted against entry."

The Bureau of Mines further recommends that, immediately upon completion of mining, abandoned mine areas should be tightly sealed to prevent escape of any possible toxic gases into active mine areas. All seals and stoppings, used to isolate unventilated, abandoned mine areas should be tightly constructed of noncombustible materials.

If the area cannot be effectively sealed, the area should be ventilated and inspected each day for unusual conditions. The daily inspection should include monitoring of the atmosphere for detection of carbon monoxide and other toxic gases. Records should be kept of the daily inspections.

2. The mine ventilation system should be redesigned to minimize possibility of the spread of fire gases to active working areas.

(a) A series air flow system, which would carry contaminated air to all working places in by a possible fire, should not be used.

(b) Pressure differentials should be such that any leakage of air would be from intake airways to exhaust airways.

(c) Bureau of Mines Advisory Standard 57.5-21 recommends:  
"Main fans should be installed on the surface; if it is necessary to locate them underground, they should be in fire-resistant areas and should be provided with remote controls."

(d) Fans which control the primary ventilation air flows should be provided with monitoring equipment to indicate abnormal fan operation. Monitoring instruments should be extended to a continuously manned surface location.

(e) Bureau of Mines Advisory Standard 57.4-61 recommends:  
"Fire doors should be provided at shaft stations or other appropriate locations where necessary to prevent the spread of smoke or gas; the doors should be equipped with latches operable from both sides."

(f) Shops, substations, and other high-fire-hazard areas should be ventilated by separate splits of air which are returned directly to main exhaust airways.

3. Bureau of Mines Advisory Standard 57.5026 recommends:

"Instruments should be provided to test the mine atmosphere quantitatively for carbon monoxide, nitrogen dioxide, and other gases that occur in the mine. Tests should be conducted as frequently as necessary to assure that the required quality of air is maintained."

The Bureau of Mines further recommends that the tests be made daily, that all supervisors be provided with carbon monoxide detectors, and that the supervisors be trained in the use of the detection equipment. All personnel should be evacuated from the mine immediately upon detection of smoke or carbon monoxide above the threshold limit value.

4. Escape and evacuation plan

(a) A specific escape and evacuation plan should be developed according to provisions of proposed Mandatory Standard 57.11-53(M) published in the Federal Register, Volume 37, No. 238, Saturday, December 9, 1972:

"57.11-53(M) A specific escape and evacuation plan and revisions thereof suitable to the conditions and mining system of the mine shall be developed by the operator and set out in written form. Within 45 calendar days after promulgation of this standard a copy of the plan and revisions thereof shall be available to the

Secretary or his authorized representative. Also copies of the plan and revisions thereof shall be made available to the miners and their representatives and shall be posted at locations convenient to all persons on the surface and underground. Such a plan shall be updated as necessary and shall be reviewed jointly by the operator and the Secretary or his authorized representative at least once every 6 months from the date of the last review. The plan shall include:

(a) Mine maps showing directions of principal air flow, locations of escape routes, telephones, fans, fan controls, fire doors, ventilation doors, exits, and refuge chambers. Appropriate portions of such maps shall be posted at all shaft stations and in underground shops, lunchrooms, and elsewhere in working areas where men congregate.

(b) Procedures to show how the miners will be notified of emergency, and by whom.

(c) An escape plan for each working area in the mine to include instructions showing how each working area should be evacuated. Each such plan shall be posted at appropriate shaft stations and elsewhere in working areas where men congregate.

(d) A firefighting plan showing assigned responsibilities in the event of an emergency.

(e) Procedures for surface personnel to follow in an emergency, to include the notification of proper authorities, preparing rescue equipment, checking fans, and other vital equipment, and maintaining such equipment.

(f) Details of provisions for communication and transportation facilities, for emergency power and ventilation, and availability and location of rescue personnel and equipment."

(b) All employees should be instructed on current escape and evacuation plans, according to provisions of proposed Mandatory Standard 57.4-74(M) published in the Federal Register, Volume 37, No. 238, Saturday, December 9, 1972:

"57.5-74(M) MNMSAC--All employees at an underground operation shall be instructed at least once each calendar year on current escape and evacuation plans, fire alarm signals, and applicable procedures to be followed in case of fire or other emergency. New employees shall receive such instructions before going underground. Records of instruction shall be kept. Whenever an employee is assigned to work in another area of the mine he shall be instructed on the escapeway for that area at the time of such assignment. Whenever a change is made in escape and evacuation plans and procedures for any area of a mine, all affected employees shall be instructed of such change."

(c) Mine evacuation drills should be held according to provisions of proposed Mandatory Standard 57.4-73(M) published in the Federal Register, Volume 37, No. 238, Saturday December 9, 1972:

"57.4-73(M)MNSAC--Mine evacuation drills shall be held for each shift once every 6 months. These evacuation drills shall involve all employees on each shift and shall include:

- (a) Activation of the fire-alarm system.
- (b) Evacuation of all men from their work areas to the surface or to designated central evacuation points at some time other than a shift change.

Records of such drills, showing the time and date, shall be kept for at least 1 year after each drill.

5. Bureau of Mines Advisory Standard 57.18-9 recommends that:

"A competent person should be in charge at all times when men are working."

The Bureau of Mines further recommends that a member of mine management should be designated as being in charge of mine operations when regular officials are away from the mine. All persons should be notified of this designation. The designated person should be capable and willing to make critical decisions during emergency situations.

6. Bureau of Mines Mandatory Standard 57.4-51(M) requires that:  
"Fire-alarm systems adequate to warn all employees shall  
be provided and maintained in operating condition."

In order to improve the effectiveness of the Sunshine mine stench warning system, the Bureau of Mines recommends that:

- (a) The quantity of ethyl mercaptan released into the compressed air lines, by the stench warning system, should be increased. Experiments should be made to determine the proper quantity. The ethyl mercaptan should be metered into the compressed air system more slowly to increase the duration of the stench in the compressed air.
- (b) An auxiliary stench-warning system should be installed on 3700 level near No. 10 Shaft.
- (c) The stench-warning system should be activated to initiate each emergency evacuation drill. The use of the system during drills should act as a test of the effectiveness of the system and familiarize personnel with the warning system.

7. A procedure should be developed to use man cages in both compartments of a double-drum-hoist-equipped shaft to speed hoisting during an emergency. All hoistmen should be trained in the hoisting procedure.

8. Emergency air supplies should be provided in underground hoist-rooms for the use of the hoistmen during evacuation of the mine during a fire.

9. Underground hoists should be provided with airtight cabs which could be closed and pressurized with compressed air to exclude smoke.

10. Key underground personnel should be trained as cagers to assist regularly scheduled cagers while hoisting men during an emergency.

11. Improvements to the mine communications system should be made which include extension of the system to central locations near work areas. The communications system should be designed for use as a backup system to the stench-warning system.

12. Escapeways

- (a) Bureau of Mines Mandatory Standard 57.11-50(M) requires that:
- "Every mine shall have two separate properly maintained escapeways to the surface which are so positioned that one shall not lessen the effectiveness of the other, or a method of refuge shall be provided when only one opening to the surface is possible."

The Bureau of Mines recommends that secondary escapeways should be equipped with hoisting facilities capable of rapidly removing men, including those who might be incapacitated, from the mine. Where climbing is required, distances to be traversed should be limited by a man's physical capability to climb to safety within the time limit of protection provided by a Bureau of Mines approved self rescuer.

(b) Bureau of Mines Mandatory Standard 57.11-51(M) requires that:

"Escape routes shall be:

(b) Marked with conspicuous and easily read direction signs that clearly indicated the ways of escape."

13. Self rescuers should be made available to and be carried by all personnel underground according to provisions and proposed Mandatory Standards 57.15-30(M) and 57.15-31(M) published in the Federal Register, Volume 37, No. 238, Saturday, December 9, 1972.

"57.15-30(M) A 1-hour self rescue device approved by the Bureau of Mines shall be made available by the operator to all personnel underground. Each operator shall maintain self-rescue devices in good condition."

"57.15-31(M) Self-rescue devices meeting the requirements of Standard 57.15-30 shall be carried by all persons underground, except where a person works on or around mobile equipment self-rescue devices may be placed in a readily accessible location on such equipment."

14. Mine emergency training and training in the use of the self rescuer should be given all underground employees according to provisions of proposed Mandatory Standard 57.18-28(M) published in the Federal Register, Volume 37, No. 238, Saturday, December 9, 1972.

"57.18-28(M) Within 6 months after promulgation of this standard and thereafter on an annual basis all underground employees shall be instructed in the Bureau of Mines approved courses on mine emergency training and the use of self-rescue devices by Bureau personnel or by qualified persons who are certified by the Bureau of Mines Division of Education and Training Services to give such instruction. Instructional materials, handouts, visual aids, and other teaching accessories used in these courses shall be available for inspection by the Secretary or his representative.

New employees shall be trained in the use of self rescue devices before going underground. Such training of new employees may be conducted by qualified company personnel who are not certified but who have obtained provisional approval from the Bureau of Mines Division of Education and Training Services to conduct such training.

Records of all training shall be kept at the mine site, or nearest mine office. Upon completion of such training, copies of the record shall be submitted to the nearest Bureau of Mines Training Center."

15. A check-in and check-out system should be provided for all persons entering the mine according to the provisions of proposed Mandatory Standard 57.11-58(M) published in the Federal Register, Volume 37, No. 238, Saturday, December 9, 1972:

"57.11-58(M) MNMSAC--Each operator of an underground mine shall establish a check-in and check-out system which shall provide an accurate record of persons in the mine. These records shall be kept on the surface in a place chosen to minimize the danger of destruction by fire or other hazards. Every person underground shall carry a positive means of being identified."

16. Bureau of Mines Mandatory Standards relating to refuge chambers are:

"57.11-50(M) Every mine shall have two separate properly maintained escapeways to the surface which are so positioned that damage to one shall not lessen the effectiveness of the other, or a method of refuge shall be provided when only one opening to the surface is possible."

The Bureau of Mines further recommends that refuge chambers be provided on all levels and in all isolated areas of a mine until second exits are provided.

"57.11-52(M) Refuge areas shall be:

- (a) Of fire resistant construction, preferably in untimbered areas of the mine.
- (b) Large enough to accommodate readily the normal number of men in the particular area of the mine.
- (c) Constructed so they can be made gastight.
- (d) Provided with compressed air lines, water-lines, suitable handtools, and stopping materials."

17. Auxiliary power cables from the mine surface to 3100 level No. 10 Shaft hoist and Silver Summit fans, installed through a route other than the Jewell Shaft, should be provided. This would ensure operation of the hoist and fans during a Jewell Shaft fire.

18. Ventilation fans and man hoists should be powered through individual power circuits to allow emergency deenergizing of the fan circuit without interrupting hoist operation.

#### Mine Reopening

The Deputy Director--Health and Safety, on July 21, 1972, appointed a committee of Bureau of Mines personnel to assist the company in developing a proposal outlining mine improvements to be completed before Bureau of Mines Withdrawal Order No. 1 could be annulled and the mine allowed to

resume production. Joint discussions were held between company, State, union, and Bureau of Mines officials and all concurred upon the requirements of the company proposal.

Guidelines used in developing the reopening proposal were to:

1. Minimize fire hazards underground in all reasonable and practical ways.
2. Provide evacuation and escape facilities, plans, and training that would allow all underground crews to be assured escape or refuge in the event of a fire.
3. Provide a ventilation system offering maximum resistance to contamination by toxic fire gases.
4. Provide management support for an active safety and accident prevention program.
5. Eliminate hazards caused by the mine fire by permanently sealing and sandfilling the fire area. The 3100 and 3700 levels intake airways and 3400 level exhaust airway would be nonflammable and without leakage.

Specific work projects within the proposal to be accomplished for reopening the mine were:

- Project 1. Installation of all seals and bulkheads necessary to seal the fire area and all old workings from active workings.
- Project 2. Sandfilling of the fire area.
- Project 3. Rehabilitation of the 3400 level exhaust airway and removal of existing fans.
- Project 4. Excavation of 3700 level 910 raise bypass drift.
- Project 5. Excavation of 3700 level No. 5 Shaft bypass drift.
- Project 6. Excavation of 3700 level fan drift and 3700 level fan installation for intake air to No. 10 Shaft.
- Project 7. Excavation of 3700 level fan and bulkhead door installation for intake air to No. 12 borehole.
- Project 8. Installation of 3100 level ventilation to provide reversible ventilation between Sunshine mine and the Silver Summit mine.
- Project 9. Installation of supplemental water fire rings, No. 10 Shaft.
- Project 10. Installation of emergency air supply at all active underground hoists. Enclosed "Chippy" hoist in cab at 3700 level No. 10 Shaft.
- Project 11. Installation of CO detector fire doors at various locations and other fire-vent doors as necessary.
- Project 12. Installation of refuge area using west end of 4800 level, 500 level and 5200 level.
- Project 13. Installation of refuge chamber on 5600 level.
- Project 14. Installation of stench warning system at 3700 level No. 10 Shaft. This will be in addition to surface stench system.

Project 15. Installation and improvement of mine communication system.

In addition to the above work projects, the following safety programs were to be developed:

- Program 1. Approved one-hour self rescuers must be carried by each man entering the mine.
- Program 2. Mandatory fire drills will be required.
- Program 3. Carbon monoxide detectors and tubes will be readily available to underground supervisors in order that they may determine the presence of carbon monoxide.
- Program 5. Well illustrated emergency maps and escapeways postings will be achieved at each active working level.
- Program 6. Written fire plan summaries, detailing procedures for supervisors and men in the event of emergency, will be posted on all active working levels of the mine.
- Program 7. An emergency mobilization plan outlining the responsibility of underground and surface supervisory personnel will be adopted. All supervisory personnel will receive continuing instructions as to the responsibility.
- Program 8. More stringent and specific fire prevention controls will be established.
- Program 9. A new check-in - check-out system will be required.

Program 10. The company has adopted a formal management policy and directive regarding safety at the Sunshine mine.

Program 11. Training programs involving self-rescuer training, survival training, mine rescue training, first-aid training, accident prevention and new employees orientation have been inaugurated.

Summary of ventilation plan and its objectives: The initial ventilation plan will continue utilizing the Jewell Shaft as the air intake. A remote controlled reversible fan will be installed in the Silver Summit escape-way to permit that to be turned into an additional intake airway in emergency circumstances. Intake and exhaust airways will be effectively isolated from each other to prevent leakage between the two and the location and control of fans has been carefully considered. Intake air will be split and coursed through two independent, well-separated airways to the 5200 level. Doors will be established wherever connection exists between these two airways so that smoke or fumes in one can be isolated to that single airway, permitting escape through the other. Refuge chambers will be provided in actively working levels below the 5200 level. The possibility of fire occurring in the several portions of the mine has been considered in relation to ventilation and the ventilation plan and its control is designed so that men are assured of escaping from fire.

Although not required by existing Bureau of Mines Health and Safety Standards, the following recommendations were made by the Bureau of Mines to further strengthen the mine reopening proposal:

1. A mechanical means of escape be provided from the 4800 level refuge area. The proposed plan requires persons to travel to the refuge area on the west ends of 5200, 5000, and 4800 levels during emergency conditions in No. 10 Shaft or east mine areas, but no adequate means has been proposed to remove the people to safety. The most desirable method of mechanical escape from the refuge area would be the completion of No. 12 Shaft to a full operating shaft status but an adequate means of escape could be provided by installing a smooth lining in No. 12 borehole and providing a properly designed man-hoisting installation.
2. An auxiliary power cable be provided from the mine surface to the 3100 level No. 10. Shaft hoist and Silver Summit fans through a route other than the Jewell Shaft. The only power cables are presently installed in the Jewell Shaft and are subject to damage from fire or other emergency. Such emergency could render the No. 10 Shaft hoist and the Silver Summit fans inoperative and greatly complicate escape from lower levels of the mine. The auxiliary power circuit could be especially effective because electrical power is available at the mine surface from two different utility companies.

3. Improvements to the mine communications system be made which would include extension of the system into all major working areas. The communications system should be designed to serve as a backup system to the stench warning system.
4. A separate power circuit be installed to allow independent operation of the surface "Big Hole" fan. This fan is critical to mine ventilation and must be provided with a reliable power source not interconnected with any other power circuits.
5. A remote monitoring and warning system and remote controls be extended from the surface "Big Hole" and 3700 level fans to a location on the surface which is continually manned such as the shifter's shack. This system should indicate any abnormal fan operating condition such as pressure change in the ventilation system and should provide remote control of these fans.
6. A means of air-flow reversal be provided at the "Big Hole" fan installation. Reversal of the mine air flow might be necessary in the event of a fire in the Jewell Shaft and loss of electrical power to the 3100 level Silver Summit fans.
7. The remote controls for the 3100 level Silver Summit fans be installed in the 3100 level No. 10 Shaft hoist room so the hoistman would not be required to leave his duty post to operate the controls.

8. Tests be made while operating mine ventilating fans independently and in all possible operating combinations in order to accurately predict mine ventilation conditions during emergency situations.
9. Fire doors be provided at the collar of the Jewell Shaft and at the entrance to the Jewell adit to prevent the entrance of smoke or fire into the Jewell Shaft from the adjacent highly flammable surface buildings. These doors would also limit the "chimney effect" created by a fire in the Jewell Shaft.
10. The proposed fire doors on 4600 level and 5200 level near No. 10 Shaft be relocated to isolate No. 10 Shaft and allow persons to traverse from either side of No. 10 Shaft to the other side to reach fresh air without entering possible contaminated atmosphere on the No. 10 Shaft stations.
11. Visual and audible warning systems be installed on all automatic fire doors (activated by carbon monoxide sensors) to warn train operators that the doors will close within a certain period of time. Without this warning the door could be damaged by a passing train or a train operator could be injured by a closing door.
12. An easily operated manual means to open the automatic fire doors be provided to allow a person trapped behind the door a means of escape.

13. A door be provided on the west end of 5200 level to isolate the fresh air refuge area. This door would normally be open but could be closed if needed.
14. Sand boxes be permanently installed on both sides of each fire door bulkhead to contain sand for use in sealing the bottom of the fire door.
15. The surface stench warning system be relocated to the discharge side of the compressed air receivers.
16. All shop areas, main combustible-materials storage areas, and main explosives-storage magazines must be located out of main airways and in locations where smoke and fumes will be vented directly to exhaust airways.
17. Two-inch-diameter fire hydrants equipped with hose and nozzle must be provided on every shaft station.

All of the work projects and safety program items in the company reopening proposal and improvements recommended by the Bureau of Mines were completed before the Bureau of Mines Withdrawal Order No. 1 was annulled December 8, 1972, except:

1. Project 2 - Sandfilling of the fire area. Sand for hydraulic backfilling the fire area would not be available until sufficient ore had been mined to operate the mill.

2. Project 12 - Installation of refuge area using west end of 4800 level, 5000 level, and 5200 level.

Establishment of the west-end refuge area was dependent upon completion of a new ventilation and escapeway raise from 5200 level to 4800 level. Raising was begun immediately.

3. Project 13 - Installation of refuge chamber on 5600 level. Work was not scheduled below 5200 level until a later date. The refuge chamber will be completed as soon as work is scheduled in the area.

4. Bureau of Mines Recommendation 1 - Mechanical means of secondary escape.

The company has agreed to establish a second mechanically-serviced escapeway to the lower levels of the mine.

5. Bureau of Mines Recommendation 2 - Auxiliary power cable to No. 10 Shaft hoist.

The company entered into negotiations with the operator of the connecting Silver Summit mine to allow installation of an auxiliary power cable from the Silver Summit mine to No. 10 Shaft double-drum hoist.

ACKNOWLEDGMENT

The writers wish to thank all the individuals and organizations who cooperated and assisted in providing the data and information on which this report is based.

Respectfully submitted,



Stanley M. Jarrett



E. Levi Brake

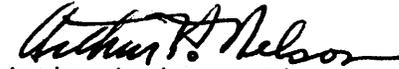


Robert E. Riley



Roland V. Wilson

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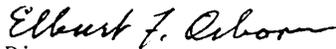


Acting Assistant Director--Metal and Nonmetal Mine Health and Safety



Deputy Director--Mine Health and Safety

Approved:



Director

## APPENDIXES

APPENDIX A  
 VICTIMS OF MINE DISASTER, SUNSHINE MINE  
 SUNSHINE MINING COMPANY

May 2, 1972

<u>Name</u>	<u>Social Security Number</u>	<u>Age</u>	<u>Dependents</u>	<u>Occupation</u>
Alexander, Robert H.	519-12-0426	50	1	Stope Miner
Allen, Billy W.	518-54-7655	24	3	Raise Miner
Allen, Wayne L.	476-34-9040	39	3	Drift Miner
Allison, Richard M.	533-34-2477	37	9	Drift Miner
Anderson, Arnold E.	476-12-7154	48	3	Electrician
Anderson, Robert L.	503-34-0154	37	6	Boss
Armijo, Joe E.	525-66-7762	38	4	Stope Miner
Barber, Benjamin S.	192-32-0148	31	1	Repairman
Barker, Robert E.	518-22-9910	42	4	Shaft Repairman
Bebb, Virgil F.	518-05-5525	53	2	Shift Boss
Beehner, Donald G.	519-26-7736	38	5	Nipper
Bewley, Richard D.	574-09-8630	40	-	Motorman
Birchett, George W.	440-28-9312	40	3	Stope Miner
Blalack, Wayne	519-36-3214	35	3	Electrician
Bush, Robert A.	519-20-5983	47	1	Foreman
Byington, Floyd L.	518-36-5217	35	6	Stope Miner
Case, Clarence L.	496-07-4594	55	5	Shift Boss
Casteel, Charles L.	518-50-5521	30	3	Shift Boss
Crocker, Kevin A.	523-72-7926	29	4	Repairman
Crow, Duwain D.	519-30-7337	39	5	Drift Miner
Davenport, Roderick	238-54-9033	35	5	Stope Miner
Davis, John W.	518-52-6440	28	4	Diamond Driller

May 2, 1972

<u>Name</u>	<u>Social Security Number</u>	<u>Age</u>	<u>Dependents</u>	<u>Occupation</u>
Delbridge, Richard L.	518-56-7871	24	3	Stope Miner
Delbridge, William R.	519-16-0847	55	2	Stope Miner
Diaz, Roberto	551-42-8793	55	5	Motorman
Dionne, Gregory G.	518-56-4747	23	2	Pipeman
Don Carlos, Carter M.	504-12-8944	47	-	Repairman
Fee, Norman S.	537-42-1786	27	-	Motor Helper
Findley, Lyle M.	538-36-6944	30	4	Repairman
Firkins, Donald K.	519-32-0676	37	4	Drift Miner
Fleshman, Howard L.	518-34-1992	38	4	Stope Miner
Follette, William L.	503-60-7504	23	1	Raise Miner
Garcia, Richard	517-05-0159	56	1	Stope Miner
George, Richard G.	519-64-2023	20	1	Motor Helper
Goff, Robert W.	521-44-8579	35	6	Stope Miner
Goos, Louis W.	503-16-3576	51	1	Raise Miner
Guertner, John P.	520-14-1956	54	1	Repairman
Hanna, William F.	543-16-4646	47	1	Pumpman
Harrison, Howard	324-32-9380	34	1	Drift Miner
Hobson, Patrick M.	519-32-5783	57	1	Repairman
House, Melvin L.	535-26-1496	41	4	Repairman
Hudson, Merle E.	516-24-0357	47	1	Stope Miner
Ivers, Jack B.	519-26-1492	44	2	Stope Miner
Johnson, Fred E.	518-24-2380	45	3	Foreman
Johnson, Paul E.	721-16-4372	47	3	Shift Boss

May 2, 1972

<u>Name</u>	<u>Social Security Number</u>	<u>Age</u>	<u>Dependents</u>	<u>Occupation</u>
Johnson, Wayne L.	519-78-7743	43	6	Repairman
Johnston, James M.	518-70-3151	20	-	Motor Helper
Keough, Custer L.	702-01-6990	59	1	Repairman
Kester, Sherman C.	519-16-9989	60	3	Trackman
Kitchen, Dewellyn E.	518-40-6627	31	5	Stope Miner
Kitchen, Elmer E.	518-03-7269	54	4	Shaft Miner
La Voie, Kenneth C.	518-46-6246	29	4	Repairman
Lynch, Richard M.	519-60-8630	24	2	Motorman
McLachlan, Donald J.	519-56-9840	23	3	Motorman
McNutt, Delbert J.	534-18-9099	48	-	Motorman
Moore, James C.	518-40-5424	29	3	Repairman
Mullin, David J.	446-36-1920	34	8	Stope Miner
Naccarato, Joe R.	518-32-1161	40	1	Raise Miner
Nelson, Orlin W.	519-44-0937	32	2	Stope Miner
Norris, Richard D.	519-58-5032	24	3	Raise Miner
Orr, Donald R.	519-12-7314	50	-	Stope Miner
Patrick, Hubert B.	516-28-8045	45	1	Drift Miner
Pena, Casey	531-18-8129	52	1	Shaft Miner
Peterson, John W.	149-05-9267	57	2	Motorman
Phillips, Francis W.	516-32-2712	42	4	Repairman
Puckett, Irvan L.	518-05-7835	51	1	Shaft Repairman
Rais, Floys A.	535-14-1387	61	1	Pumpman

May 2, 1972

<u>Name</u>	<u>Social Security Number</u>	<u>Age</u>	<u>Dependents</u>	<u>Occupation</u>
Rathbun, Leonard D.	520-46-0480	29	3	Stope Miner
Rawson, John R.	516-50-0807	27	3	Drift Miner
Reichert, Jack L.	521-32-5982	45	-	Hoistman
Rhoads, Delbert C.	518-01-9462	57	1	Lead Mechanic
Rossiter, Glen R.	537-32-2581	37	2	Motorman
Russell, Paul M.	533-40-3473	30	4	Stope Miner
Salyer, Gene F.	519-14-8025	54	1	Repairman
Salyer, James P.	519-16-4791	51	1	Foreman
Sargent, Allen L.	535-32-7496	38	2	Drift Miner
Scanlan, Robert B.	518-36-9890	38	3	Hoistman
Serano, John	331-34-7066	37	8	Stope Miner
Sharette, Nick D.	516-22-9173	48	2	Shaft Miner
Sisk, Frankie R.	585-03-1342	31	4	Stope Miner
Stephens, Darrell E.	519-62-4197	20	-	Motor Helper
Thor, Gustav G.	518-40-2833	38	6	Stope Miner
Truelock, Grady D.	443-30-9522	40	1	Raise Miner
Waldvogel, Robert E.	561-22-4829	50	-	Stope Miner
Walty, William R.	519-48-1912	29	4	Repairman
Whatcott, Gordon	528-42-9611	37	5	Stope Miner
Wiederrick, Douglas L.	519-36-7198	37	1	Shaft Miner
Wilson, Ronald L.	782-01-8945	41	6	Drift Miner
Wilson, William E.	518-44-3281	28	2	Hoistman
Wolff, John D.	504-24-4549	49	5	Stope Miner
Wood, Don B.	539-24-4756	53	2	Hoistman

WORK LOCATIONS, ESCAPE ROUTES, USE OF SELF-RESCUERS, AND LOCATION OF DEATH OF MINE EMPLOYEES

NAME	SURVIVED (S) DIED (D)		WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
1. Alexander, Robert H.	D		5200 No. 4 E. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
2. Allen, Billy W.	D		5200 No. 5 Raise	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
3. Allen, Wayne L.	D		5600 So. Crosscut	Unknown	To 5600 # 10 Station - 3100 # 10 Station	3100 # 10 Station	No
4. Allison, Richard M.	D		4800 W. Syndicate Lateral	Messenger	To 4800 # 10 Station	Near 4800 # 10 Station	No
5. Anderson, Arnold E.	D		3700 Electric Shop	Smoke	To 3100 # 10 Station - 3400 # 10 Station	3400 # 10 Station	Yes
6. Anderson, Darol A	S		5000 No. 5 Raise	Motorman	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes
7. Anderson, Robert L.	D		5000 Level-Shift Boss	Smoke	To 5000 # 10 Station	5000 # 10 Station	Yes
8. Armijo, Joe E.	D		5000 No. 4 W. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station	3100 # 10 Station	Yes
9. Baillie, Ernest F.	S		5000 No. 12 Drift	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	No
10. Barber, Benjamin S.	D		4400 No. 10 Shaft Pocket	Smoke	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
11. Barker, Robert E.	D	4400 No. 10 Shaft Pocket	Smoke	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No
12. Beare, Jasper W.	S	3700 Level Motor	Messenger	To 3700 Jewell Station - Surface	-----	No
13. Bebb, Virgil F.	D	4600 Level -Shift Boss	Telephone	To 4600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	Yes
14. Beckes, Gary W.	S	3700 Electric Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	No
15. Beehner, Donald G.	D.	Sanitation	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Back toward # 10 Shaft	3100 Between # 5 and # 10 Shaft	Yes
16. Bennett, Peter L.	S	3700 "08" Shop	Telephone	To 3700 Jewell Station- Surface	-----	No
17. Bennett, William L.	S	3700 Drill Shop	Smoke	To 4400 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	No
18. Benson, Homer G.	S	3700 Drill Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes
19. Bewley, Richard D.	D	4800 Level Motor	Messenger	To 4800 # 10 Station	Near 4800 # 10 Station	No
20. Birchett, George W.	D	4600 No. 11 E. Stope	Messenger	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
21. Blalack, Wayne	D	3700 Electric Shop	Smoke	Toward 3700 Jewell Station	3700 Level Between # 5 and # 10 Shaft	No
22. Bourgard, Leonard R.	S	5000 No. 9 E. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
23. Breazeal, Richard D.	S	4400 No. 10 Shaft	Smoke	To 4500 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	No
24. Bruhn, Wilbur C.	S	5000 No. 27 Raise	Motorman	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
25. Bush, James E.	S	3700 Blue Room	Smoke	To 3700 Jewell Station - Surface	-----	Yes
26. Bush, Robert A.	D	3700 Blue Room	Smoke	Toward 3700 Jewell Station	3700 Level Between # 5 and # 10 Shaft	Yes
27. Byington, Floyd L.	D	4600 No. 13 W. Stope	Messenger	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No
28. Case, Clarence L.	D	5200 Level - Shift Boss	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
29. Casteel, Charles L.	D	4600 Level - Shift Boss	Telephone	To 4600 # 10 Station - 3100 # 10 Station	3100 # 10 Station	Yes
30. Clapp, Dennis	S	4800 H-6 Stope	Messenger	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
31. Croker, Kevin A.	D	4800 K Drift	Messenger	To 4400 # 10 Station	4400 # 10 Station	Yes
32. Crow, Duwain D.	D	5600 No. 10 Shaft Station	Unknown	To 5600 # 10 Station- 3100 # 10 Station	Near 3100 # 10 Station	No
33. Davenport, Roderick	D	4600 13 E. Stope	Messenger	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No
34. Davis, Edward O.	S	3700 Level Track	Messenger	To 3700 Jewell Station - Surface	-----	No
35. Davis, John W.	D	4200 Level Damond Drill	Smoke	Did not leave work area	East of 4200 # 10 Shaft	?
36. Delbridge, Richard L.	D	5200 No. 11 E. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
37. Delbridge, William R.	D	5200 No. 11 E. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
38. Diaz, Roberto	D	3700 Level Motor	Messenger	To 3700 Jewell Station - Between # 5 and # 10 Shaft	3700 Level Between # 5 and # 10 Shaft	No
39.. Dionne, Gregory G.	D	3700 Pipe Shop	Smoke	3700 # 10 Station - 3100 # 10 Station -4400 # 10 Station - 4600 # 10 Station -5000 # 10 Station - 3100 # 10 Station	3100 # 10 Station	Yes
40. Dionne, Harvey	S	3700 Blue Room	Smoke	To 3700 Jewell Station - Surface	-----	No
41. DonCarlos, Carter M.	D	5200 Level No. 13 Sill	Unknown	To 5200 # 10 Station	5200 # 10 Station	?

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
42. Dunlap, Clyde L.	S	Jewell Shaft	Voice	3700 Jewell Station - 3100 Jewell Station - Surface	-----	No
43. Fee, Norman S.	D	5000 Level Motor	Smoke	To 5000 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	Yes
44. Fenner, James D.	S	5000 No. 7 Raise	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes
45. Findley, Lyle M.	D	5200 No. 13 Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
46. Findley, Roger V.	S	No. 10 Shaft Cager	Smoke	To 4500 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes
47. Firkins, Donald K.	D	5400 1 E. Drift	Unknown	To 5400 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
48. Fister, Wayne	S	4800 H-6 E. Stope	Voice	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
49. Fleshman, Howard L.	D	5000 H-8 E. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	Yes
50. Flory, Ronald R.	S	4800 No. 4 E. Stope	Voice	To 4800 # 12 Borehole - 3700 Jewell Station - Surface	-----	Yes
51. Follette, Robert S.	S	5000 No. 10 W. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
52. Follette, William R.	D	5400 No. 4 Raise	Unknown	To 5400 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
53. Fowler, Harvellé E.	S	3700 Level Warehouse	Smoke	To 3700 Jewell Station - Surface	-----	Yes
54. Fox, Edward	S	4600 Pocket	Shift Boss	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
55. Garcia, Richard	D	5200 No. 9 W. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
56. Gardner, John H.	S	3700 Level Machine Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
57. George, Richard G.	D	5200 No. 9 W. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
58. Goff, Robert	D	5000 No. 15 W. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	Yes
59. Goos, Louis W.	D	5400 No. 4 Raise	Smoke	To 5400 No. 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
60. Gonzalez, Edward R.	S	4600 No. 4 E. Stope	Messenger	To 4400 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
61. Guertner, John P.	D	5200 Level No. 13 Sill	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
62. Hanna, William F.	D	5600 Level Pumpman	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
63. Hansen, Larry E.	S	4000 Jewell - 71 E.	Shift Boss	To 3700 Jewell Station - Surface	-----	No
64. Harris, Wilbur	S	4400 No. 10 Shaft Pocket	Smoke	To 4500 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	No
65. Harrison, Howard	D	4400 625 W. Drift	Messenger	To 4400 # 10 Station	Near 4400 # 10 Station	Yes
66. Hawkins, Larry	S	Underground Sampler 3700 Jewell Shaft at 11:40 am	Telephone	To 3700 Jewell Station - Surface	-----	No
67. Henry, John	S	4800 Level Grizzly	Smoke	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes
68. Hobson, Patrick M	D	3700 Level Machine Shop	Smoke	Toward 3700 Jewell Station	3700 Level Between # 5 and # 10 Shaft	No
69. House, Melvin L.	D	5200 No. 13 Raise	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
70. Hudson, Merle E.	D	5000 H-8 E. Stope	Smoke	To 5000 # 10 Station	5000 # 10 Station	Yes
71. Ivers, Jack B.	D	4600 No.15 E. Stope	Messenger	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No
72. Jerome, Terrance M.	S	4600 Service Raise	Messenger	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUE
73. Johnson, Fred E.	D	3700 Blue Room	Smoke	To 3700 # 10 Station - 3100 # 10 Station	3100 # 10 Station	Yes
74. Johnson, Paul E.	D	3700 Level	Telephone	To 3700 Jewell Station - Back toward # 10 Shaft	3700 Level Between # 5 and # 10 Shaft	No
75. Johnson, Wayne L.	D	5000 No. 12 Drift	Smoke	To 5000 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	Unknown
76. Johnston, James M.	D	5200 Level Motor	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
77. Keough, Custer L.	D	3400 Vent Drift	Smoke	To 3400 # 10 Station	3400 # 10 Station	Yes
78. Kester, Sherman C.	D	5200 Level Track	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
79. Kienholz, Ernie A.	S	4800 No. 13 W. Stope	Messenger	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
80. Kitchen, Delmar J.	S	5000 No. 5 Raise	Motorman	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
81. Kitchen, Dewellyn E.	D	5000 No. 27 Raise	Motorman	To 5000 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	Yes
82. Kitchen, Elmer, E.	D	5600 No. 10 Shaft	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
83. Knapp, George M.	S	5400 No. 5 Raise	Unknown	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes

NAME	SURVIVED (S) DIED (D)		WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUE
84. Koist, Roger	S		4600 Service Raise	Smoke	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
85. Lamphere, James A.	S		3700 Level Machine Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station -Surface	-----	No
86. LaVoie, Kenneth C.	D		5200 Level E. Drift	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
87. Lovesee, Jasper C.	S		5000 Level 1 E. Drift	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
88. Lynch, Richard M.	D		5000 Level Motor	Smoke	To 5000 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	Yes
89. Macartrey, Robert M.	S		5000 No. 7 Raise	Smoke	To 5000 # 10 Station - 3100 #10 Station - 3100 Jewell Station-Surface	-----	Yes
90. Markve, Howard J.	S		5000 No. 10 W. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
91. Mathews, Robert L.	S		3700 Level Motor	Voice	To 3700 Jewell Station - Surface	-----	No
92. McCoy, Robert F.	S		5000 No. 10 Shaft	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
93. McDaniel, Remos P.	S		4800 Level K Drift	Messenger	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station -Surface	-----	Yes
94. McGillivray, Charles W.	S		5000 Level 9 E. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes

NAME	SURVIVED (S) DIED (D)		WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
95. McKeen, William F.	S		4000 Motor (Was on 3700 Level at 11:40 am)	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
96. McKinney, Richard P.	S		Jewell Shaft Station	Voice	To Surface	-----	No
97. McLachlan, Donald J.	D		5200 Level Motor	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
98. McNutt, Delbert J.	D		5600 No. 10 Shaft Station	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10	No
99. Mendy, Harold	S		4600 Level Motor	Shift Boss	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	No
100. Mendy, Reuben	S		4600 Level Motor	Shift Boss	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	No
101. Mitchell, William	S		4400 No. 10 E. Stope	Voice	To 4400 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	No
102. Moore, James C.	D		5200 No. 4 Raise	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
103. Morris, Robert E.	S.		4800 Level No. 13 W. Stope	Messenger	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
104. Mossburgh, Leslie M.	S		3700 Level Drill Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	No
105. Mullin, David J.	D		4800 Level No. 11 W. Stope	Messenger	To 4800 # 10 Station	Near 4800 # 10 Station	No

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
106. Naccarato, Joe R.	D	5400 No. 5 Raise	Unknown	To 5400 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
107. Napier, Clyde	S	3700 Level Drill Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station -Surface	-----	No
108. Nelson, Orlin W.	D	4200 539 W. Stope	Smoke	Did not leave work area	East of 4200 # 10 Shaft	No
109. Nickelby, Richard L.	S	3700 Jewell Shaft	Voice	To 3700 Jewell Station - Surface	-----	No
110. Norris, Frank D.	S	4600 J-4 Raise	Smoke	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
111. Norris, Richard D.	D	5200 No. 5 Raise	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
112. Olson, Henry G. L.	S	2300 Jewell Shaft	Jewell Shaft Cager	To Surface	-----	No
113. Oman, Birdeen	S	Jewell Shaft	Unknown	To Surface	-----	No
114. Orr, Donald R.	D	5200 9 W. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
115. Osterberg, Gordon M.	S	4600 Level Motor	Telephone	To 4600 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
116. Ostoj, Robert L.	S	4600 J-4 Raise	Smoke	To 4600 # 10 Station - 3100 #10 Station - 3100 Jewell Station-Surface	-----	Yes

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
117. Patrick, Hubert B.	D	4800 No. 7 W. Stope	Messenger	To 4800 # 10 Station	Near 4800 # 10 Station	No
118. Pederson, Einar	S	2300 Jewell Shaft	Jewell Shaft Cager	To Surface	-----	No
119. Pena, Casey	D	5600 No. 10 Shaft Station	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
120. Perkins, Robert L.	S	Ventilation (3100 Jewell at 11:40 am)	Overheard on Telephone	To 3100 Jewell Station - Surface	-----	No
121. Peterson, Clifford R.	S	Jewell Shaft Station	Voice	To Surface	-----	No
122. Peterson, George R.	S	No. 10 Shaft Cager	Voice	To 4400 # 10 Station - 3100 # 10 Station - 3100 Jewell Station=Surface	-----	?
123. Peterson, John W.	D	4400 Level Motor	Messenger	To 4400 # 10 Station	Near 4400 # 10 Station	Yes
124. Phillips, Francis W.	D	5200 E. Drift	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
125. Puckett, Irvan L.	D	No. 10 Shaft Repair	Smoke	To 4400 # 10 Station	Near 4400 # 10 Station	Yes
126. Rais, Floyd A.	D	5600 No. 10 Shaft	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
127. Rathbun, Leonard D.	D	4600 No. 15 E. Stope	Messenger	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No

NAME	SURVIVED (S) DIED (D)		WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUE
128. Rawson, John R.	D		5400 Level 1 E. Drift	Unknown	To 5400 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
129. Reardon, John F.	S		3700 Jewell Shaft	Voice	To 3700 Jewell Station - Surface	-----	No
130. Reichert, Jack L.	D		4400 Level No. 10 Shaft	Smoke	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No
131. Rhoads, Delbert C.	D		Mechanic Leadman (4400 Level at 11:40 am)	Smoke	To 4400 # 10 Station - 3100 # 10 Station - 3400 # 10 Station	3400 # 10 Station	Yes
132. Rihtarshik, Lando	S		5000 Level Motor	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
133. Riley, Kenneth A.	S		5000 No. 4 W. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
134. Ross, Kenneth B.	S		3700 Jewell Shaft	Telephone	To 3700 Jewell Station - Surface	-----	No
135. Rossiter, Glen R.	D		5400 Level Motor	Unknown	To 5400 #10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
136. Russell, Paul M.	D		4200 Level 539 Stope	Smoke	Did not leave work area	East of 4200 # 10 Station	No
137. Sabala, Tony J.	S		3700 Pipe Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUE
138. Salyer, Gene F.	D	5600 No. 10 Shaft	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
139. Salyer, James P.	D	3700 Level Blue Room	Smoke	Did not leave 3700 # 10 Station	Near 3700 # 10 Station	No
140. Sargent, Allen L.	D	4400 Level 625 W.	Messenger	To 4400 # 10 Station	Near 4400 # 10 Station	Yes
141. Scanlan, Robert B.	D	3100 Level No. 10 Hoist	Telephone	Did not leave 3100 #10 Hoistroom	3100 # 10 Hoistroom	Yes
142. Seagraves, Jack M.	S	4000 Jewell 71 E. Stope	Shift Boss	To 3700 Jewell Station - Surface	-----	No
143. Serano, John	D	5200 Level No. 3 E. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
144. Sharette, Nick D.	D	5600 No. 10 Shaft	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
145. Sheppard, James E.	S	4800 - H6 E. Stope	Messenger	To 4600 # 10 Station - 3100 # 10 Station	-----	Yes
146. Schulz, Byron L.	S	No. 10 Shaft Cager	Signal from hoistman	To 5730 # 10 Pocket - 3100 # 10 Station - 4600 # 10 Station - 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes
147. Sisk, Frankie R.	D	4600 4 E. Stope	Messenger	To 4400 # 10 Station	Near 4400 # 10 Station	Yes

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
148. Sliger, Ira F.	S	3100 Level No. 10 Hoist	Telephone	To 3100 Jewell Station - Surface	-----	Yes
149. Smith, Alfred E.	S	3100 Level Motor	Telephone	To 3100 # 10 Station - 3100 Jewell Station - Surface	-----	No
150. Stanley, Clarence B.	S	3700 Machine Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station -Surface	-----	Yes
151. Stansbury, Ronald H.	S	3700 Level Motor	Voice	To 3700 Jewell Station - Surface	-----	No
152. Stephens, Darrell E.	D	4800 Level Motor	Messenger	To 4800 # 10 Station	Near 4800 # 10 Station	No
153. Stevenson, Isaac D.	S	5000 - 15 W. Stope	Smoke	To 5000 # 10 Station - 3100 # 10 Station - 3100 Jewell Station - Surface	-----	Yes
154. Story, Marcellus E.	S	3700 Level Machine Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
155. Strand, Floyd W.	S	Electrical Foreman (3700 Jewell Shaft at 11:40 am	Telephone	To 3700 Jewell Station - Surface	-----	No
156. Thor, Gustav G.	D	4600 - 11 E. Stope	Messenger	To 4400 # 10 Station - 3700 # 10 Station	Near 3700 # 10 Station	No
157. Truelock, Grady D.	D	5400 No. 5 Raise	Unknown	To 5400 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
158. Tucker, Kenneth W.	S	3700 "08" Shop	Telephone	To 3700 Jewell Station - Surface	-----	No

NAME	SURVIVED (S) DIED (D)		WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
159. Ulrick, Norman R.	S		3700 Electric Shop	Smoke	To 3700 Jewell Station - Surface	-----	No
160. Waldvogel, Robert E.	D		4400 - 10 E. Stope	Messenger	To 4400 # 10 Station	Near 4400 # 10 Station	Yes
161. Walty, William R.	D		3400 Vent. Drift	Smoke	To 3400 # 10 Station	3400 # 10 Station	Yes
162. Watts, Thomas D.	S		5000 - 1 E. Drift	Smoke	To 5000 # 10 Station - 3100 # 10 Station 3100 Jewell Station - Surface	-----	Yes
163. Wells, Gary D.	S		Jewell Shaft	Voice	To Surface	-----	No
164. Whatcott, Gordon	D		4800 - 11 W. Stope	Messenger	To 4800 # 10 Station	Near 4800 # 10 Station	No
165. Wiederrick, Douglas L.	D		5600 No. 10 Shaft	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
166. Wilbur, Kenneth B.	S		Jewell Shaft	Telephone	To Surface	-----	Yes
167. Wilkinson, Thomas R.	S		4800 - 4 E. Stope	Messenger	To 4800 # 12 Borehole - 3700 Jewell Station - Surface	-----	Yes
168. Williams, John L.	S		3700 Level Electric Shop	Smoke	To 3700 # 10 Station - 3100 # 10 Station - 3100 Jewell Station-Surface	-----	Yes
169. Wilson, Ronald E.	D		4800 W. Syndicate Lateral	Messenger	To 4800 # 10 Station	Near 4800 # 10 Station	No

NAME	SURVIVED (S) DIED (D)	WORK LOCATION	NOTIFICATION	ESCAPE ROUTE	BODY LOCATION	USED SELF-RESCUER
170. Wilson, William E.	D	5600 No. 10 Shaft	Unknown	To 5600 # 10 Station - 3100 # 10 Station	Near 3100 # 10 Station	No
171. Wolff, John S.	D	5200 - 3 E. Stope	Unknown	To 5200 # 10 Station	5200 # 10 Station	?
172. Wood, Don B.	D	3700 No. 10 Chippy Hoist	Smoke	Did not leave 3700 # 10 Station Area	Near 3700 # 10 Station	No
173. Zingler, James D.	S	Jewell Shaft Station	Voice	To Surface	-----	No

Appendix C

CORONER'S STATEMENT

**DR. A. M. PETERSON**

PHYSICIAN AND SURGEON

IDAHO FIRST NATIONAL BANK BUILDING

WALLACE, IDAHO

83678

May 24, 1972

Mr. W. S. McCullough  
U. S. Bureau of Mines  
U.S.A.R. Center  
712 Hotel St.  
Wallace, Idaho 83873

Dear Mr. McCullough:

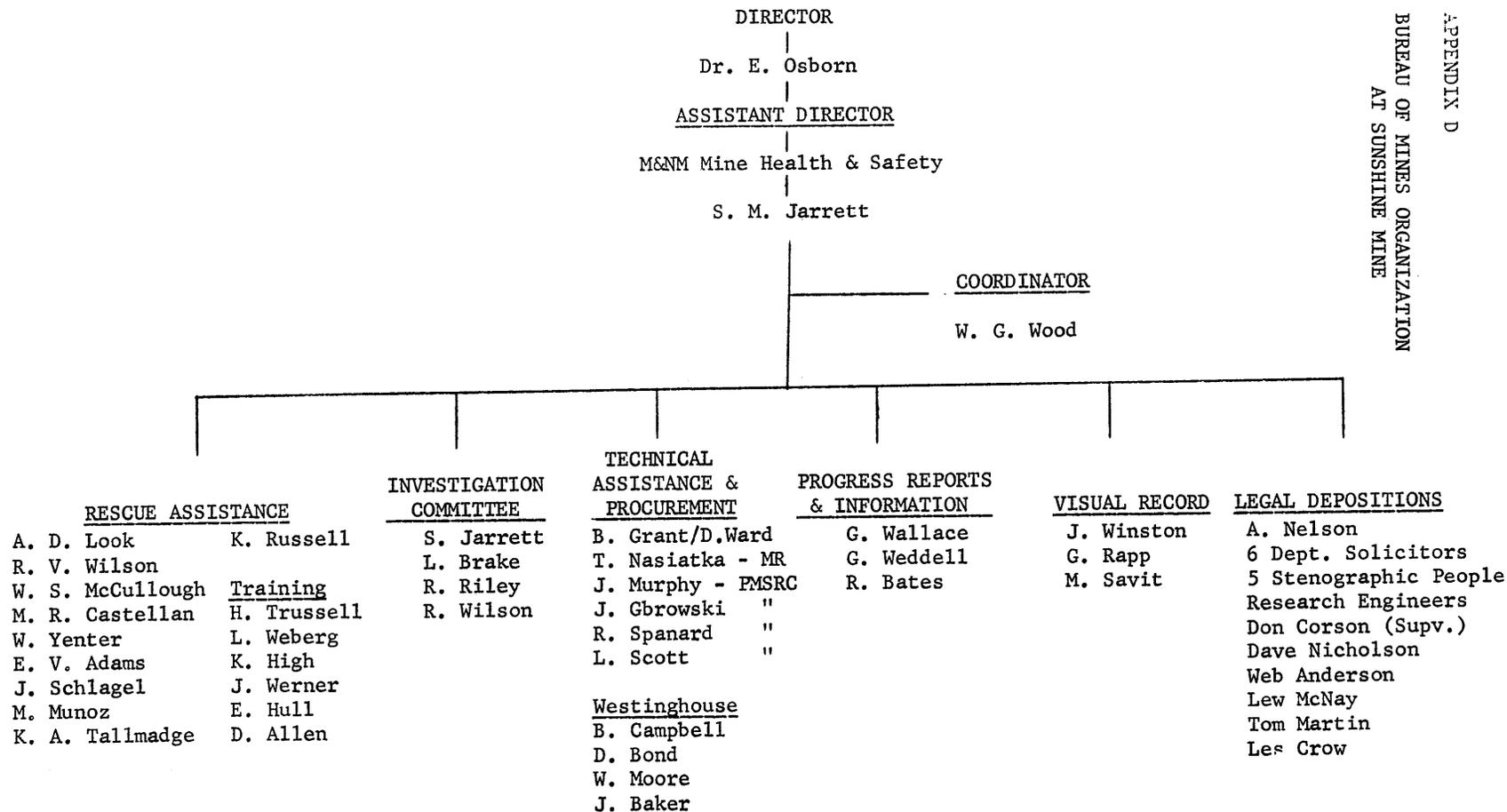
This is to certify that in my opinion on 5-2-72 at about 11:50 A.M. ninety one men died in the Sunshine Mine as a result of a fire which broke out in the mine. Cause of death being Suffocation from Carbon Monoxide and Smoke.

Sincerely,



A. M. Peterson, M. D.  
Shoshone County Coroner

AMP:nm



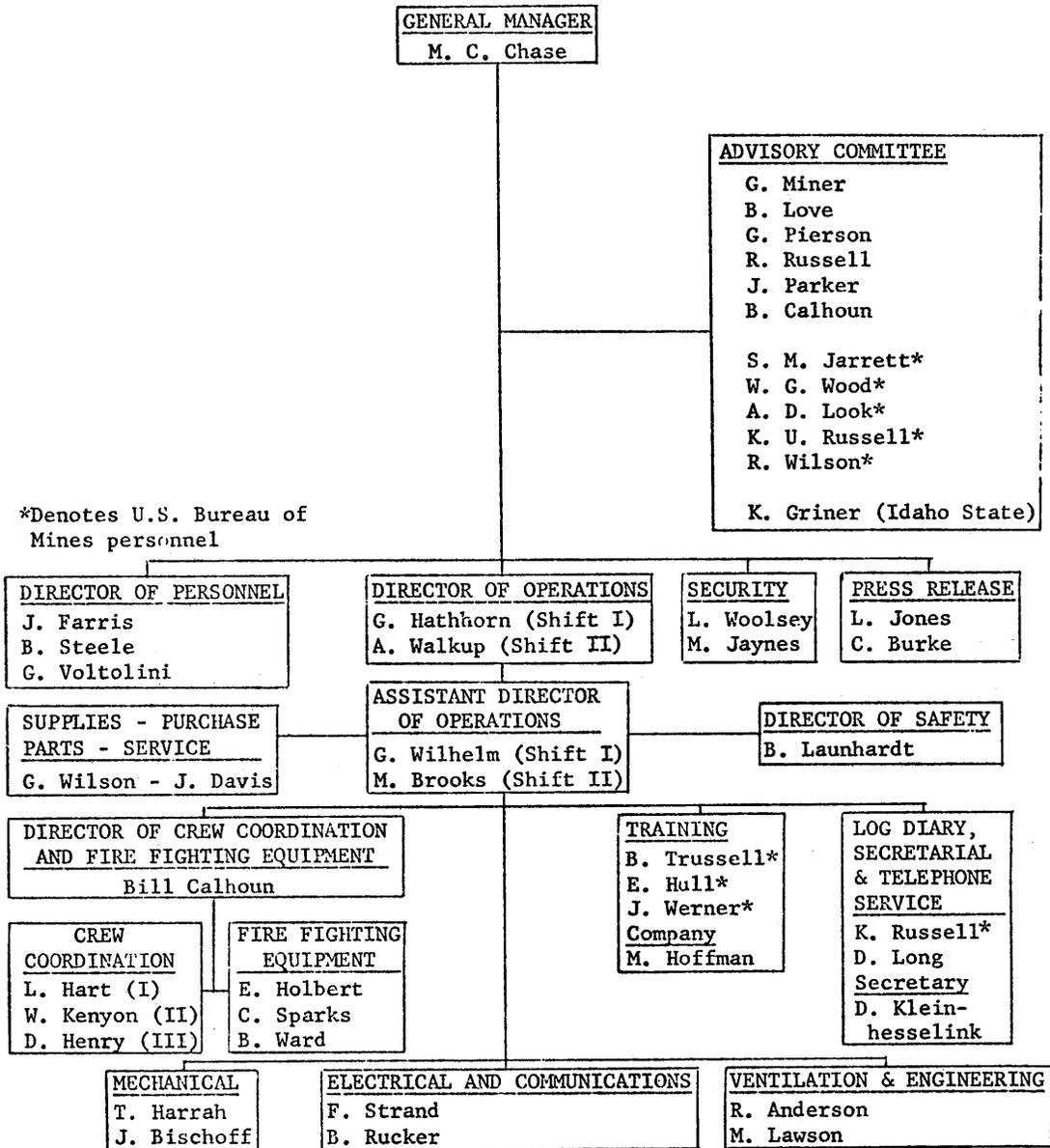
OFFICE LOCATED  
in Personnel Building (Sunshine Mining Co.)  
Telephone (208) 784-1186  
Extension 24

Secretary: Sylvia Wilson

Most BuM personnel were  
lodged at the Sunshine Inn,  
Kellogg

APPENDIX D

ORGANIZATION CHART  
FOR MINE RESCUE AND RECOVERY OPERATIONS



APPENDIX E  
PARTICIPATING BUREAU OF MINES PERSONNEL  
AND THEIR ARRIVAL DATES

May 2, 1972

Martin R. Castellan, Metal and Nonmetal Mine Health and Safety,

Spokane, Washington

Roland V. Wilson, Metal and Nonmetal Mine Health and Safety,

Spokane, Washington

William S. McCullough, Metal and Nonmetal Mine Health and Safety,

Spokane, Washington

Kenneth A. Talmadge, Metal and Nonmetal Mine Health and Safety,

Spokane, Washington

Edward V. Adams, Metal and Nonmetal Mine Health and Safety,

Spokane, Washington

John A. Werner, Education and Training, Albany, Oregon

Earl Hull, Education and Training, Albany, Oregon

May 3, 1972

Stanley M. Jarrett, Metal and Nonmetal Mine Health and Safety,

Washington, D. C.

William G. Wood, Metal and Nonmetal Mine Health and Safety,

Washington, D. C.

Allen D. Look, Metal and Nonmetal Mine Health and Safety,

Alameda, California

Arthur P. Nelson, Office of Mine Health and Safety, Washington, D. C.

George Wallace, Mining Research Center, Spokane, Washington

Elburt F. Osborn, Director, Washington, D. C.

Bruce Grant, Technical Support Staff, Washington, D. C.

Don Ward, Technical Support Center, Pittsburgh, Pennsylvania

Robert Bates, Mining Research Center, Spokane, Washington

Galen Wadell, Mining Research Center, Spokane, Washington

Warren M. Yenter, Metal and Nonmetal Mine Health and Safety,  
Boise, Idaho

Homer E. Trussell, Metal and Nonmetal Mine Health and Safety,  
Boise, Idaho

Kenneth U. Russell, Metal and Nonmetal Mine Health and Safety,  
Seattle, Washington

Eugene J. Rapp, Education and Training, Pittsburgh, Pennsylvania

John Murphy, Pittsburgh Mining and Safety Research Center,  
Pittsburgh, Pennsylvania

J. Grbowski, Pittsbrgh Mining and Safety Research Center,  
Pittsburgh, Pennsylvania

R. Spanard, Pittsburgh Mining and Safety Research Center,  
Pittsburgh, Pennsylvania

L. Scott, Pittsburgh Mining and Safety Research Center,  
Pittsburgh, Pennsylvania

Lawrence E. Davis, Liaison Officer--Idaho, Boise, Idaho  
Donald Corson, Spokane Mining Research Center, Spokane,  
Washington

May 4, 1972

Larry O. Weberg, Metal and Nonmetal Mine Health and Safety,  
Reno, Nevada

John Schlagel, Metal and Nonmetal Mine Health and Safety,  
Seattle, Washington

Mark Savit, Education and Training

David Nicholson, Spokane Mining Research Center, Spokane,  
Washington

Webster Anderson, Spokane Mining Research Center, Spokane,  
Washington

Fred Ryan, Denver Technical Support Center, Denver, Colorado

Richard Kaplan, Denver Technical Support Center, Denver,  
Colorado

Kenneth L. High, Metal and Nonmetal Mine Health and Safety,  
Alameda, California

John Hill, Spokane Mining Research Center, Spokane, Washington

James Winston, Office of the Deputy Director, Health and Safety,  
Washington, D. C.

May 5, 1972

Michael Munoz, Metal and Nonmetal Mine Health and Safety, Reno,  
Nevada

Eldred F. Allen, Metal and Nonmetal Mine Health and Safety,

Alameda, California

Howard E. Poland, Metal and Nonmetal Mine Health and Safety,

Alameda, California

Sylvia Wilson, Spokane Mining Research Center, Spokane, Washington

Gloria Schonder, Spokane Mining Reserach Center, Spokane,

Washington

Nadine Hawley, Spokane Mining Research Center, Spokane, Washington

Naomi White, Western Field Operation Center, Spokane, Washington

May 7, 1972

Daniel Sanders, Spokane Mining Research Center, Spokane, Washington

Robert E. Riley, Metal and Nonmetal Mine Health and Safety, Salt

Lake City, Utah

William H. Donley, Metal and Nonmetal Mine Health and Safety,

Salt Lake City, Utah

E. Levi Brake, Metal and Nonmetal Mine Health and Safety, Phoenix,

Arizona

James D. Pitts, Metal and Nonmetal Mine Health and Safety,

Phoenix, Arizona

Horst S. Gottschalk, Metal and Nonmetal Mine Health and Safety

Denver, Colorado

James B. Daugherty, Metal and Nonmetal Mine Health and Safety,

Denver, Colorado

Billie G. Ritchey, Metal and Nonmetal Mine Health and Safety,

Dallas, Texas

Marvin W. Traugott, Metal and Nonmetal Mine Health and Safety,  
Dallas, Texas

Reino L. Mattson, Metal and Nonmetal Mine Health and Safety  
Vincennes, Indiana

Frank Delimba, Metal and Nonmetal Mine Health and Safety,  
Vincennes, Indiana

Donald K. Morris, Metal and Nonmetal Mine Health and Safety,  
Vincennes, Indiana

Paul E. Talley, Metal and Nonmetal Mine Health and Safety, Denver,  
Colorado

William A. Miller, Metal and Nonmetal Mine Health and Safety,  
Phoenix, Arizona

Raymond F. Povondra, Metal and Nonmetal Mine Health and Safety,  
San Bernardino, California

Wallace M. Myers, Metal and Nonmetal Mine Health and Safety,  
Seattle, Washington

Barbara Gill, Spokane Mining Research Center, Spokane, Washington

Lee Nugum, Spokane Mining Research Center, Spokane, Washington

Lewis M. McNay, Spokane Mining Research Center, Spokane, Washington

May 8, 1972

Thomas R. Bjorkman, Metal and Nonmetal Mine Health and Safety,  
Duluth, Minnesota

Wayne D. Kanack, Metal and Nonmetal Mine Health and Safety,  
Rolla, Missouri

James A. Fraser, Metal and Nonmetal Mine Health and Safety,  
Rolla, Missouri

Charles D. Wofford, Metal and Nonmetal Mine Health and Safety,  
Rolla, Missouri

John V. Hawkins, Metal and Nonmetal Mine Health and Safety,  
Knoxville, Tennessee

Jack Baker, Metal and Nonmetal Mine Health and Safety, Knoxville,  
Tennessee

Thomas J. Castor, Metal and Nonmetal Mine Health and Safety,  
Knoxville, Tennessee

Glenn L. Dyke, Metal and Nonmetal Mine Health and Safety, Knoxville,  
Tennessee

Paul Theisen, Metal and Nonmetal Mine Health and Safety, Duluth,  
Minnesota

Alexander Schrader, Metal and Nonmetal Mine Health and Safety,  
Duluth, Minnesota

Neil E. Handley, Metal and Nonmetal Mine Health and Safety,  
Duluth, Minnesota

Dennis R. Schackleton, Metal and Nonmetal Mine Health and Safety  
Knoxville, Tennessee

Ralph K. Foster, Denver, Technical Support Center, Denver, Colorado

Albert J. Rambosek, Denver Technical Support Center, Denver, Colorado

J. Warren Andrews, Denver Technical Support Center, Denver, Colorado

May 9, 1972

Robert H. Dickey, Metal and Nonmetal Mine Health and Safety,  
Alameda, California

Larry Shallenberger, Education and Training, Pittsburgh, Pennsylvania

Donald P. Schlick, Deputy Director--Health and Safety, Washington, D. C.

John Crawford, Assistant Director - Coal Mine Safety, Washington, D. C.

Robert Dalzell, Technical Support Group, Pittsburgh, Pennsylvania

Alvin J. Lords, Education and Training, Albany, Oregon

May 10, 1972

Wilbur Synhorst, Metal and Nonmetal Mine Health and Safety,

Albany, New York

Garry J. Day, Metal and Nonmetal Mine Health and Safety, Albany,

New York

Russell L. Spencer, Metal and Nonmetal Mine Health and Safety,

Albany, New York

Steve Mitchell, Metal and Nonmetal Mine Health and Safety,

Albany, New York

Edward Roberts, Metal and Nonmetal Mine Health and Safety,

Albany, New York

May 12, 1972

John Franklin, Bureau of Mines, Denver, Colorado

May 13, 1972

James Krese, Office of Deputy Director--Health and Safety,

Washington, D. C.

May 14, 1972

Jack Stevenson, Pittsburgh Technical Support Center, Pittsburgh,

Pennsylvania

May 15, 1972

V. A. Danielson, Metal and Nonmetal Mine Health and Safety, Seattle,

Washington

Merlyn L. Ellickson, Denver Technical Support Center, Denver,

Colorado

May 16, 1972

Joseph Marshalek, Coal Mine Safety, Morgantown, West Virginia

Merl McManus, Coal Mine Safety, Morgantown, West Virginia

May 18, 1972

Edward Faylor, Staff Associate to Director, Washington, D. C.

Vivian Young, Bureau of Mines, Washington, D. C.

Vivian Rosenthal, Bureau of Mines Pittsburgh, Pennsylvania

Julia Hart, Bureau of Mines, Knoxville, Tennessee

Galen Trubant, Bureau of Mines, Pittsburgh, Pennsylvania

Jack Petty, Metal and Nonmetal Mine Health and Safety,

Helena, Montana

John Miley, Metal and Nonmetal Mine Health and Safety,

Grand Junction, Colorado

James Inderberg, Metal and Nonmetal Mine Health and Safety,

Phoenix, Arizona

May 19, 1972

John Thatcher, Technical Adviser, Denver Technical Support

Center, Denver, Colorado

George Weems, Technical Adviser and Analyst, Denver Technical

Support Center, Denver, Colorado

Marvin Nichols, Metal and Nonmetal Mine Health and Safety,

Knoxville, Tennessee

Jack Gill, Metal and Nonmetal Mine Health and Safety,

Vincennes, Indiana

Donald Johnson, Metal and Nonmetal Mine Health and Safety,  
Vincennes, Indiana

Richard Nielson, Metal and Nonmetal Mine Health and Safety,  
Salt Lake City, Utah

May 21, 1972

Claude Narramore, Metal and Nonmetal Mine Health and Safety,  
Birmingham, Alabama

Melvin Jacobsen, Metal and Nonmetal Mine Health and Safety,  
Dallas, Texas

William Carlson, Metal and Nonmetal Mine Health and Safety,  
Duluth, Minnesota

Martin Rosta, Metal and Nonmetal Mine Health and Safety,  
Birmingham, Alabama

Russell Smith, Metal and Nonmetal Mine Health and Safety,  
Birmingham, Alabama

May 22, 1972

Stanley Clark, Metal and Nonmetal Mine Health and Safety,  
Reno, Nevada

Donald Burrus, Metal and Nonmetal Mine Health and Safety,  
Reno, Nevada

May 23, 1972

Robert G. Hobbs, Denver Technical Support Center, Denver, Colorado

May 31, 1972

William E. Bales, Metal and Nonmetal Mine Health and Safety,  
Albany, Oregon

June 1, 1972

Robert Hall, Metal and Nonmetal Mine Health and Safety,  
San Bernardino, California

APPENDIX F  
COOPERATING ORGANIZATIONS

The following companies or organizations in addition to the Bureau of Mines, supplied trained mine rescue personnel, mine rescue apparatus, technical services, or other assistance during the mine fire and rescue operations:

American Red Cross  
American Smelting and Refining Company, Galena mine  
Anaconda Company, The, Montana Operations  
Atomic Energy Commission, Nevada Operations Office  
Bunker Hill Company, Bunker Hill mine  
Callahan Mining Co.  
Central Rescue Station, Wallace, Idaho  
Civil Defense  
Cominco, Sullivan mine, Kimberly, B. C., Canada  
Day Mines, Inc.  
East Shoshone Hospital  
General Telephone Company of the Northwest.  
Hecla Mining Company, Lucky Friday and Star-Morning mines  
Kaiser Resources, Balmer mine, Sparwood, B. C., Canada  
Kennecott Copper Corporation, Burgin mine, Utah  
Ministerial Association  
National Ski Patrol  
Siebe Gorman, England  
State Inspector of Mines, State of Idaho  
University of Idaho

U. S. Air Force

U. S. Army Reserve

U. S. Forest Service

Veterans of Foreign Wars

Washington Water Power Company, Kellogg, Idaho

Westinghouse Electric Corporation

West Shoshone Hospital

APPENDIX G  
NON-FEDERAL PARTICIPANTS IN RESCUE AND RECOVERY OPERATIONS

The Anaconda Company, Butte, Montana

Rescue Personnel

J. Hodge	W. Gilbert	J. Rautio
M. Johnson	R. Kirby	C. Richards
B. Brock	H. Nebres	C. Thornook
B. Dickenson	D. Phillips	A. Wassberg

American Smelting and Refining Company, Galena Mine

Rescue Personnel

W. Badgley	W. Erickson	B. Malone
B. Benson	D. Jutila	R. Peterson
D. Cody	E. Karst	E. Salo
G. Covey	J. Lepo	E. Werlinger

Participating Official: L. Hart

Bunker Hill Company, Bunker Hill Mine

Rescue Personnel

J. Austin	D. Deeder	R. Rucker
E. Baker	T. Dumont	B. Stricklan
J. Buckner	V. Hoffman	A. Summers
W. Coe	E. Holbert	D. Targett
J. Connell	R. Muhs	K. Wittke
R. Cooper	W. Newsom	A. Wolfe
H. Cougher	C. Pangallo	

Participating Officials

M. Brooks	M. Jaynes	J. Parker
B. Crummer	W. Kenyon	B. Russell
	M. Lawson	



Hecla Mining Company, Star and Lucky Friday Mines, Continued

Participating Officials

G. Wilhelm	D. Ferguson	G. Lander
G. Miner	H. Rolletto	W. Paroni
B. Love	G. Turnbow	A. Wilcox
B. Anderson	W. Crandall	C. Rauio
B. Hanson	D. Henry	H. Harper
	N. Graham	

Kaiser Resources, Fernie, B. C.

Rescue Personnel

W. Bradelley	Roy Moss	
John Brown	Jack Peters	
John Findlay	Pete Reghenas	
John Keller	Chester Taje	
John Kelly	Harvey Travers	
Jim Lee	Pete Zeith	
Albert Littler	R. W. Lewis, District Inspector of Mines, B. C.	
Bud Morgan		

Kennecott Copper Corporation, Burgin Mine, Eureka, Utah

Rescue Personnel

Kay Sorensen	Bill Hawes	Bill Renzello
Myron Carpenter	Darrel Holden	Bill Riley
Joel White	David Jacob	Max Sorenson
Carl Christensen	William Partridge	Gordon Thomas
Fred Hansen	Murdy Peterson	Loy Thomas
Ron Bray		

Physicians

Robert W. Cordwell

Keith Dahlberg

E. E. Gnaedinger

Washington Water Power Company

Participating Personnel

Dick Coe

Frank Kotkey

Don Stevenson

Roy Faler

Tim Schoenweld

Ralph Warner

Westinghouse Company

Participating Personnel

Jess Baker

Bob Campbell

J. Gibbons

S. Banks

J. Curran

Jeff Kravitz

D. Banta

John Davis

J. Moore

C. Bell

D. George

Neil Peterson

Tom Bond

J. Gerding

R. Raviller

APPENDIX H

ATTORNEYS AND REPRESENTATIVES OF ORGANIZATIONS TAKING DEPOSITIONS:

Department of the Interior

Richard V. Backley, Office of the Solicitor, Washington, D. C.

William Breck, Office of the Regional Solicitor, Portland, Oregon

Eugene A. Briggs, Office of the Regional Solicitor, Portland, Oregon

Lawrence J. Cox, Office of the Regional Solicitor, Portland, Oregon

Donald P. Lawton, Office of the Regional Solicitor, Portland, Oregon

Robert S. Burr, Field Solicitor's Office, Boise, Idaho

Robert T. VanUden, Field Solicitor's Office, Boise, Idaho

State of Idaho

Warren Felton, Deputy Attorney General, Boise

Richard Greener, Deputy Attorney General, Boise

James Reid, Deputy Attorney General, Boise

Donald E. Knickrehm, Assistant Attorney General, Boise

Stewart Morris, Assistant Attorney General, Boise

Carl Griner, State Mine Inspector, Boise

William H. Spear, Deputy Mine Inspector, Kellogg

Lyle Wadsworth, Deputy Mine Inspector, Kellogg

Steven M. Kennedy, Fire Investigator, Salt Lake City, Utah

Sunshine Mining Company

Alden Hull, Hull, Hull, and Wheeler, Attorneys at Law, Wallace, Idaho

Piatt Hull, Hull, Hull, and Wheeler, Attorneys at Law, Wallace, Idaho

Dennis E. Wheeler, Hull, Hull, and Wheeler, Attorneys at Law, Wallace, Idaho

Leo Driscoll, Winston, Cashatt, Repsold, McNichols, Connelly, Rekofke

& Driscoll, Attorneys at Law, Spokane, Washington

Robert L. Anderson, Chief Engineer, Wallace, Idaho

United Steelworkers of America

David L. Gore, Counsel, Pittsburgh, Pennsylvania

A. E. Lawson, Assistant General Counsel, Pittsburgh, Pennsylvania

Adolph Schwartz, Director of Safety and Health, Pittsburgh, Pennsylvania

Marco Vestich, Assistant Director of Safety, Pittsburgh, Pennsylvania

Frank S. McKee, Director, District 38, El Segundo, California

James Thompson, Staff Representative, Spokane, Washington

Larry Marshall, Staff Representative, Kellogg, Idaho

J. P. Mooney, Staff Representative, Kellogg, Idaho

George Kalafatich, Boulder, Montana

Barney Rask, Butte, Montana

Lavern Melton, President, Local Union 5089, Wallace, Idaho

## FIRE PROTECTION AND ESCAPE PLAN

Each underground employee should become familiar with this plan, since it contains basic information about the mine fire protection and escape plans for fires in various sections of the mine.

BASIC PROTECTIONFIRE EXTINGUISHERS

Shaft stations, battery charging stations and hoistrooms have extinguishers readily available. In some instances, a shaft station and battery charging station share a unit. Observe where the extinguishers are located in the parts of the mine where you travel and work.

It is extremely important to notify your supervisor if you use an extinguisher so it can be recharged. Do this on any unit on which you break the seal, even though you do not discharge it.

FIRE RINGS

Two fire rings are installed in the Jewell shaft. When activated, they will dump large quantities of water down the shaft. Both rings can be operated from the Jewell hoist cab. The top ring can be operated manually from the east end of the rockhouse under the sand tank. The lower ring has a storage dam on the 1900 station and can be operated manually there.

FIRE DOORS

Both the 3100 and 3700 levels have fire doors of heavy steel mounted in concrete bulkheads. The doors are designed to keep smoke-filled air from the Jewell shaft out of the workings of the mine. The doors will close automatically if carbon monoxide is present in the air. This will occur before the monoxide reaches a harmful concentration. Each door is equipped with a time delay and a warning device (air whistle) to alert personnel that the door is about to close. If the whistle blows, be sure to GET CLEAR OF THE DOOR before it closes. Note: If the situation is such that a crew of men will open a fire door, all men shall gather at the door before it is opened.

STENCH WARNING SYSTEM

A stench warning injection system is located in the compressor room on the surface. The system contains a liquid which, when dumped into the air line, will give the compressed air an odor similar to rotten cabbage. THIS ALARM SYSTEM WILL BE USED ONLY IN CASE OF FIRE.

### SELF RESCUERS

Each station has an emergency unit containing a number of self rescuers. These units are not to be opened without the instruction of a supervisor. They provide protection for 30 minutes or more against carbon monoxide gas.

### FANS AND AIR DOORS

Fans and air doors throughout the mine are vitally important in the control of air flow. IT IS OF UTMOST IMPORTANCE IN A MINE FIRE THAT THE VENTILATION IS NOT ALTERED AT RANDOM BY ANYONE. NEVER LEAVE A DRAFT DOOR OPEN OR TAMPER WITH A FAN DURING A FIRE. If changes in the ventilation will be of benefit to the men, the decision must be made by responsible management personnel who are thoroughly familiar with the ventilation system.

## E S C A P E P L A N S

### BASIC PLAN

Any fire which endangers the lives of men in the mine must be met immediately with an orderly exit from the mine by all employees so endangered. The Sunshine Mine has two means of exit:

- 1) The Jewell shaft, your regular means of access to the mine.
- 2) The Silver Summit escapeway. In a sense, the #10 shaft is a part of this system, since the escapeway starts at the 3100 #10 station. From the east end the 3100 level, there is a cribbed manway to the 3000 level of the Silver Summit mine. Exit is made through the Silver Summit shaft.

A fundamental principle of escape is, "WHENEVER POSSIBLE, MOVE INTO FRESH AIR. Since the Jewell shaft is intake or "fresh" air, whenever possible, employees will leave the mine by way of the Jewell shaft.

The Jewell shaft, #4 shaft and #10 shaft are all ventilated by intake air.

Exhaust air leaves the mine through a system of raises, drifts & crosscuts in the eastern end of the mine, moving upward and out of the mine through the following exhaust airways:

- 1) The #3 shaft, incline shaft and Sunshine tunnel.
- 2) The old vent raise system from the 3100 level to the surface.
- 3) The Silver Summit exhaust system.

### DIRECTIONS

For the purpose of this plan the mine shall be considered as lying in an east-west line. From #10 shaft, you would travel west to the Jewell. From the Jewell shaft, you would travel east to the #10 shaft. The "back end" of the mine is east of #10 shaft.

Escape from any fire east of #10 shaft will be made through the Jewell. The same is true for any fire below the 3700 level or above the 3100 level, unless in the Jewell shaft itself.

### JEWELL SHAFT FIRE

A fire in the intake air shaft is extremely dangerous. However, steps have been taken by the Sunshine Mining Company to minimize this danger. The fire doors on 3100 and 3700 will close automatically when a dangerous level of carbon monoxide gas is present in the airstream.

If you discover a fire in the Jewell shaft which cannot be readily extinguished, do the following:

- 1) Immediately notify the Jewell hoistroom so the fire rings can be activated and the stench dumped into the airline.
- 2) Warn others in the area and get out of the shaft. If you cannot get out the Jewell on the cage, go out the Silver Summit escapeway.

#### Below 3100 Jewell

The 3700 fire door will be closed. The crew will leave the mine via 3100 Jewell as long as the station is free of smoke. Otherwise the Silver Summit escapeway will be used.

#### Above 3100 Jewell

Both the 3100 & 3700 fire doors will be closed. The crew will leave by way of the Silver Summit escapeway. As long as #10 has power, hoisting will continue STARTING WITH THE BOTTOM LEVEL and clearing each level before moving to the next higher level. A major fire in the Jewell shaft would undoubtedly result in a power failure in the mine. Because of this, it is very important that the lower levels evacuate quickly while there is still electric power.

#### Fire on 3700 between the Jewell & #10 shaft

For men on 3700 or above, go up #10 to 3100 and out to the Jewell. Men below 3700 may go by way of #10 Shaft, up to 3100 and out to the Jewell. The fire doors should both be closed to slow the spread of smoke.

ANY FIRE east of #10 shaft

If the way is clear, go directly to #10 shaft and out to the Jewell. If the fire is between you and #10, go below the fire and then to #10. As soon as you are west of the fire, you will be on fresh air the rest of the way.

Fire on 3100 in the intake air stream

Request Jewell hoistroom to close the 3100 fire door. Leave the mine by way of the 3700 level to the Jewell shaft.

Fire in the "old workings" on the 3400 level.

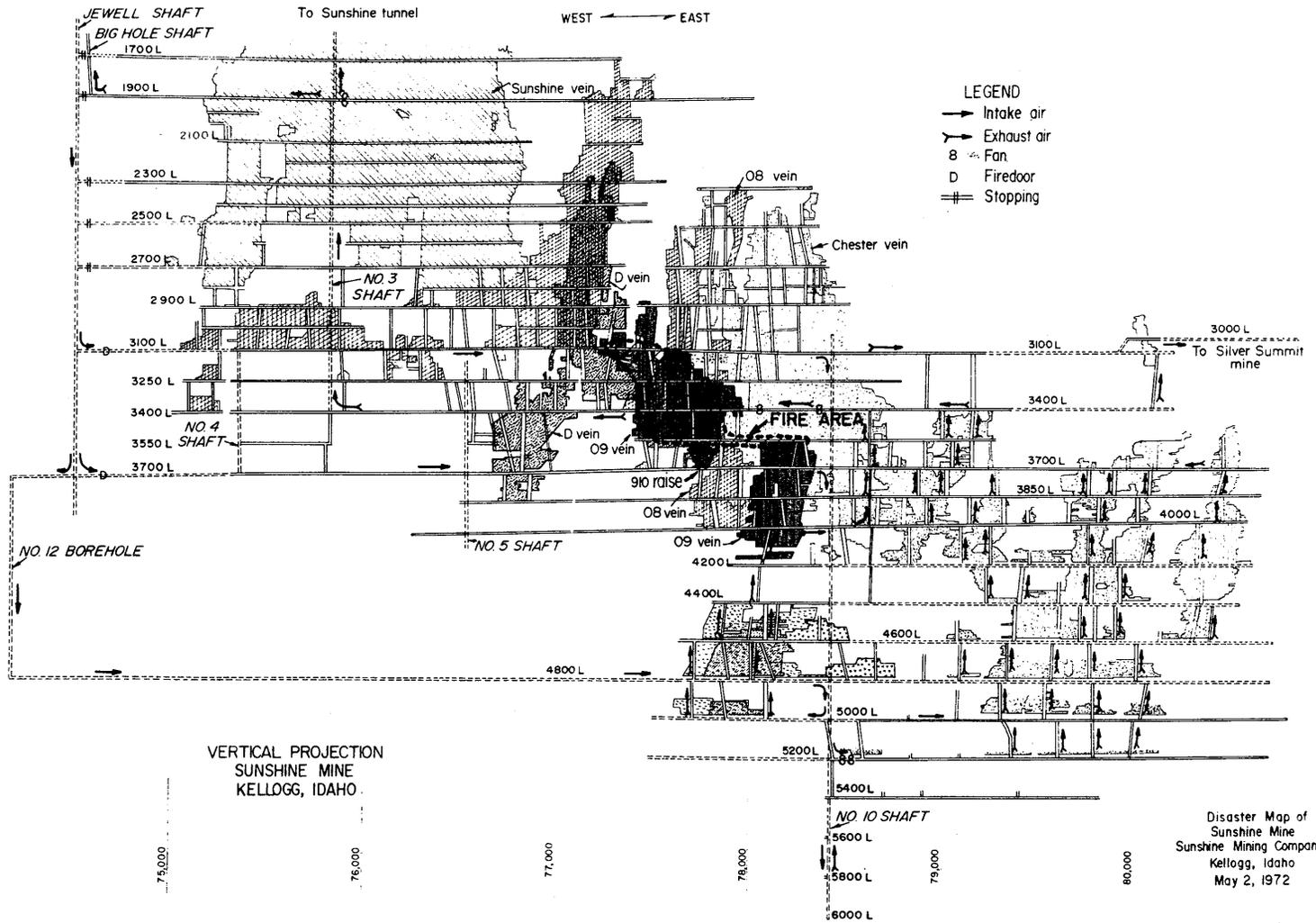
Go out by way of #3 shaft to 3100. Remember, the smoke will be going up and out the exhaust system. Your fresh air supply by way of 3100 will not be contaminated.

SUNSHINE MINE

..... Procedure to Follow in Case of Mine Fire .....

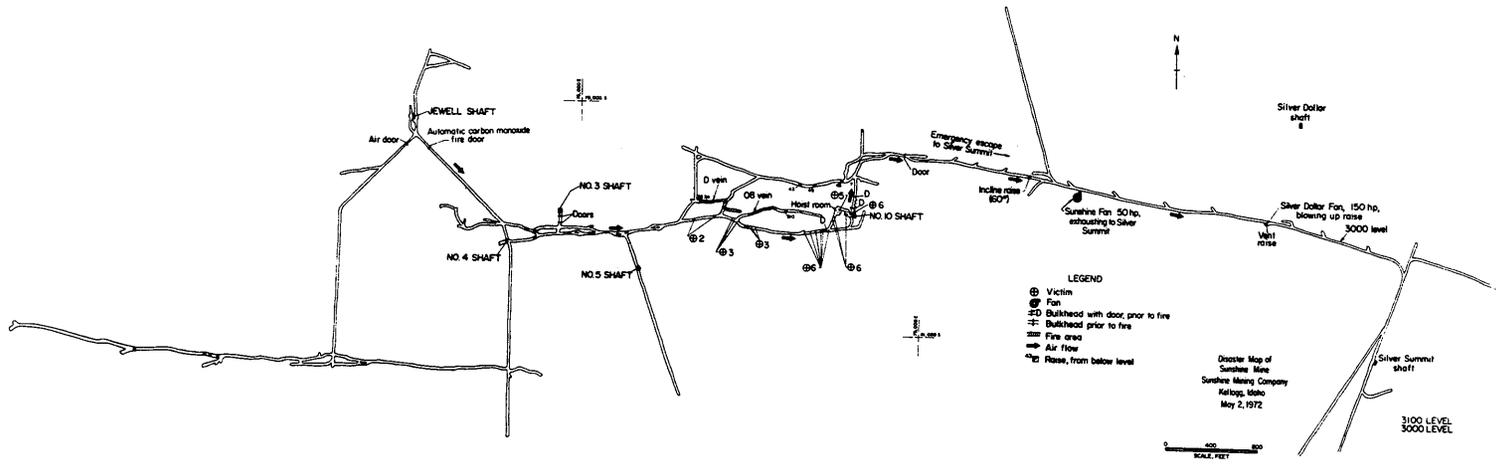
- (1) NOTIFY JEWELL HOISTMAN (2 short rings on mine phone) - Give Exact Location of Fire, if known
- (2) JEWELL HOISTMAN (Chippy)
  - a. Dump "stench" into the compressed air line.
  - b. Activate fire rings if the fire is in the Jewell Shaft or #10 Shaft.
  - c. Activate fire doors if the fire is above 3100. If it is below 3100, close ONLY the 3700 door.
  - d. Notify Mine Superintendent, Charlie Hathhorn:
    1. Through Mine Switchboard
    2. Call Residence in Elizabeth Park, 784-5501
  - e. Notify Underground Foremen - Robert Bush, 784-6301  
- Harvey Dionne, 682-2088
  - f. Notify the Shaft Foreman - Gene Johnson, 786-3573
  - g. Notify Jewell double-drum Hoistman,  
#4 Hoistman and #10 Hoistman.
- (3) DIVISION FOREMAN
  - a. If underground, go to "Blue Room". Stand by Emergency Telephone System.
  - b. If on the surface, go to the Mine Safety and Rescue Office.
  - c. Establish communications with #10 Hoistman and "Blue Room".
  - d. Begin immediate evacuation of men. If the Fire is in the Jewell Shaft or Intake Air, evacuate by way of the Silver Summit escape route.
  - e. Send first available shift boss to ascertain the exact condition of the fire, by the safest available route. Have him report immediately, either by phone or in person.
- (4) MINE SUPERINTENDENT
  - a. Notify Mine General Manager - M. C. Chase, 784-6932
  - b. Notify Safety Director - M. M. Hoffman, 682-2177
  - c. Notify-Mine Rescue Station, 752-1181  
R. K. Ward, 753-3481  
C. E. Sparks, 752-4882
  - d. Notify Electrical and Mechanical Supervisors and Chief Engineer as needed.
  - e. Headquarters will be in the Mine Safety and Rescue Office.
- (5) HOISTMEN
  - a. Remain on duty until relieved or recalled.
  - b. See that phones stay "on the hook" so necessary calls are not interrupted.  
THIS IS EXTREMELY IMPORTANT!
- (6) ELECTRICAL & MECHANICAL SUPERVISORS
  - a. Go to headquarters in the Mine Safety & Rescue Office.
  - b. Secure necessary help to keep compressors and hoists operating.
- (7) CHIEF ENGINEER
  - a. Go to headquarters in the Mine Safety & Rescue Office.
  - b. Bring up-to-date maps of mine workings and ventilation currents.
- (8) EMPLOYEES
  - a. Go to the #10 Shaft station nearest you and wait for instructions, UNLESS OTHERWISE instructed by a supervisor.
  - b. BE SURE NO AIR DOORS ARE LEFT OPEN!
  - c. Do not tamper with any fans or other ventilation equipment.

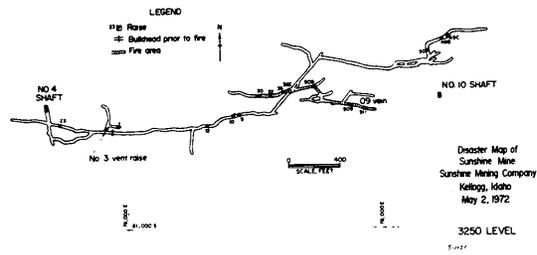
*Intentionally Left Blank*

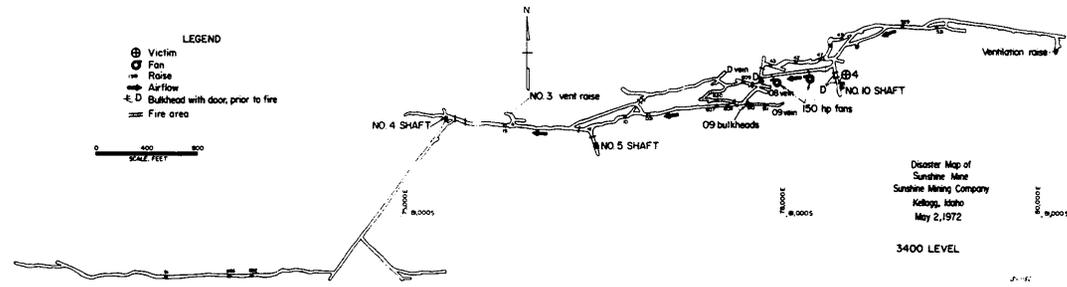


VERTICAL PROJECTION  
SUNSHINE MINE  
KELLOGG, IDAHO

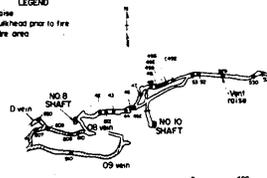
Disaster Map of  
Sunshine Mine  
Sunshine Mining Company  
Kellogg, Idaho  
May 2, 1972





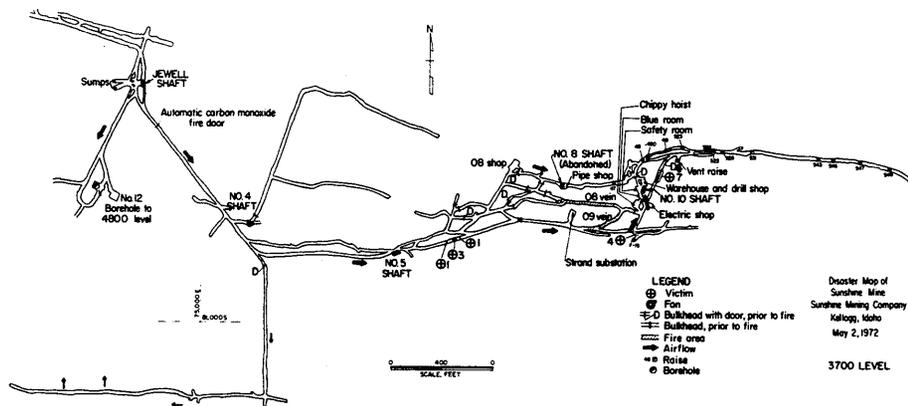


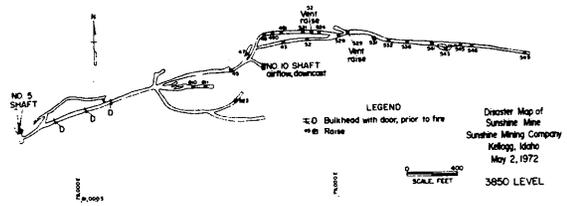
LEGEND  
--- 118 Poles  
--- Bulkhead prior to fire  
--- Fire area



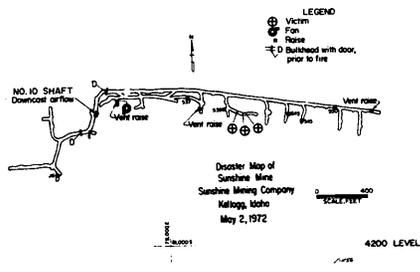
Disaster Map of  
Sunshine Mine  
Sunshine Mining Company  
Kellogg, Idaho  
May 2, 1972

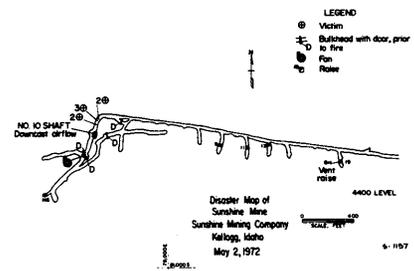


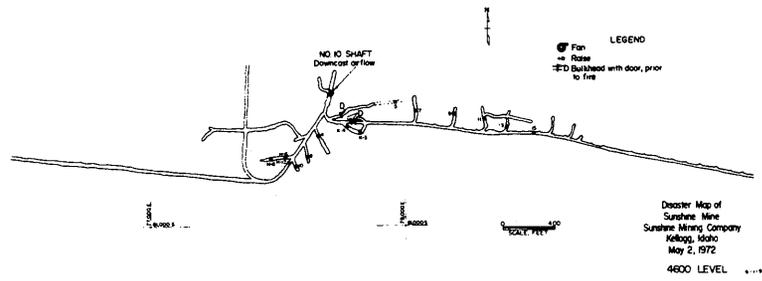


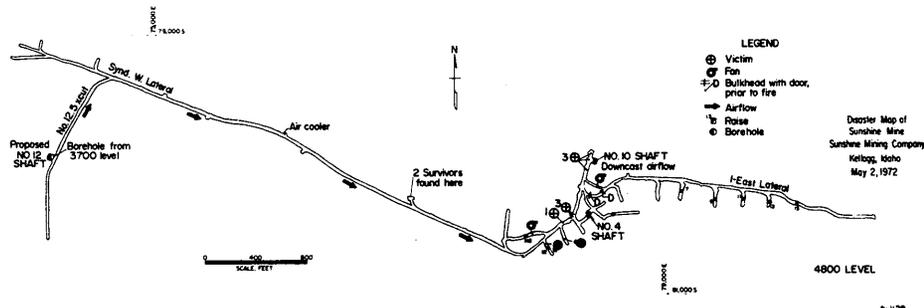












**LEGEND**

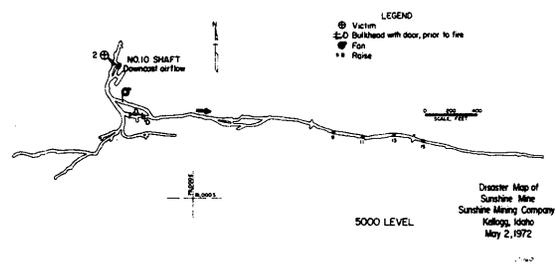
- ⊙ Victim
- ⊙ Fan
- ⊙ Bulkhead with door, prior to fire
- Airflow
- ⊙ Rise
- ⊙ Borehole

Dazsler Map of Sunshine Mine Kellogg, Idaho May 2, 1972

0 200 400  
SCALE FEET

N

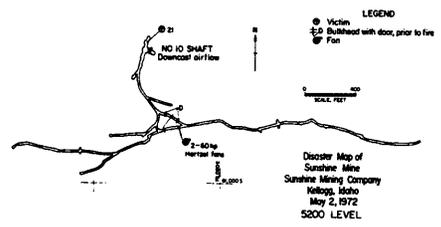
4800 LEVEL

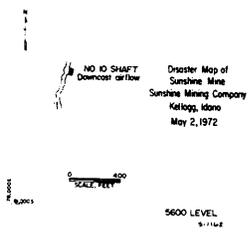


LEGEND

- ⊙ Victim
- ⊕ Shafthead with door, prior to fire
- ⊖ Fan
- Rise

Disaster Map of  
Sunshine Mine  
Sunshine Mining Company  
Kollgoff, Idaho  
May 2, 1972





GAS ANALYSIS OF EXHAUST AIR  
SUNSHINE TUNNEL

DATE	TIME	AIR QUANTITY	O <sub>2</sub>	CO <sub>2</sub>	CO
May 3	5 a.m.	-----	18.76	2.67	0.42
May 3	1:30 p.m.	-----	18.52	2.63	0.39
May 3	5:45 p.m.	-----	15.81	5.19	0.84
May 3	8:30 p.m.	44,500	14.47	6.74	0.82
May 3	10:45 p.m.	48,000	14.86	2.87	0.89
May 4	1:25 a.m.	52,650	20.72	0.73	0.04
May 4	4:25 a.m.	54,000	-----	-----	-----
May 4	7:05 a.m.	54,500	15.14	6.58	0.81
May 4	10:15 a.m.	51,000	17.69	3.36	0.37
May 4	2 p.m.	47,200	15.41	5.24	0.73
May 4	5:05 p.m.	65,000	15.31	5.20	0.76
May 5	12:30 a.m.	54,500	15.69	5.05	0.63
May 5	2:30 p.m.	100,050	15.13	5.52	0.82
May 5	6:30 p.m.	81,100	14.93	5.71	0.79
May 5	11:15 p.m.	-----	16.94	5.22	0.32
May 6	3:45 a.m.	-----	15.71	5.00	0.24
May 6	5:45 a.m.	-----	16.90	4.98	0.27
May 6	8:10 a.m.	90,650	16.75	4.49	0.16
May 6	11:45 a.m.	87,800	16.51	5.10	0.22
May 6	2:30 p.m.	86,300	16.33	5.49	0.21
May 6	6 p.m.	82,500	16.83	4.17	0.31
May 7	12:01 a.m.	80,900	18.03	3.78	0.20
May 7	9 p.m.	87,000	15.10	6.49	0.47
May 7	11 p.m.	90,500	16.36	4.99	0.25
May 8	5:30 p.m.	83,150	17.13	3.27	0.35
May 8	9 p.m.	73,300	17.16	3.74	0.58
May 8	10 p.m.	70,000	17.68	3.61	0.49



# United States Department of the Interior

## BUREAU OF MINES

4800 FORBES AVENUE  
PITTSBURGH, PENNSYLVANIA 15213

Health and Safety  
Technical Support Center

September 12, 1972

Memorandum

To: ➔ Roland V. Wilson, Supervisory Mining Engineer, Spokane Mining Research Laboratory

Through: W. R. Wayment, Assistant Director--Technical Support *RL*

From: Technical Staff Advisor

Subject: Examination of 8 Samples from the Sunshine Mine

As requested by letter of June 23, and in subsequent phone conversations, information is reported on the 8 samples collected in the Sunshine Mine following the fire.

These samples are identified by you as:

Sample No.	Description	Our lab. No.
1	Substance removed from exhaust fan of 08 Shop - 3700 level	34
2	Substance removed from door near pipe Shop - 3700 level	35
3	Wood removed from 3400 level about 200 feet west of 09 bulkhead	36
4	Charred hose removed from 3400 level 200 feet west of 09 bulkhead	37
5	Wood removed from 09 bulkhead - 3400 level	38
6	Charred foam removed from 09 bulkhead - 3400 level	39
7	Wood removed from below 9-10 raise - 3700 level	40
8	Charred foam from 08 vein seal - 3400 level	41

cc: W. R. Wayment, WO  
R. A. Friedel  
E. J. Harris  
E. M. Kawenski  
J. W. Conn

A number of tests were made on the materials in hope that some might provide useful data for interpreting the events relative to the mine fire. The information, listed in appended tables, includes:

- (a) Visual inspection.
- (b) Proximate analyses.
- (c) Ultimate analyses.
- (d) Dust cloud ignition temperature.
- (e) Dust layer ignition temperature
- (f) Mass spectrometer examination.
- (g) Infrared examination.

Dr. Robert A. Friedel, Project Coordinator, Pittsburgh Coal Research Center, Mr. Forrest E. Walker, Chemist-in-Charge, Coal Analysis, and Mr. Edwin M. Murphy, Chemical Research Engineer, Pittsburgh Mining and Safety Research Center, cooperated in the studies.

You asked for special information on Samples No. 1 and 6:

Sample No. 1 (Lab. No. 34) is a greasy material collected on the blades of the exhaust fan in 08 Shop - 3700 level. It was first identified by visual examination as a grease-tar substance, brown-black, tacky and having the appearance of grease which was subjected to heat. Through our phone conversations, we learned this material was deposited from the air onto the blades during the fire. Dr. Friedel made special efforts toward identifying the source. His most instructive informal note is attached. Dr. Friedel states with certainty that the so-called "grease" material is hydrocarbons volatilized from wood and to lesser extent from polyurethane foam having an MDI base which were exposed to high temperatures. These hydrocarbons, produced by heat (not burning action), subsequently condensed on the fan blades.

Sample No. 6 (Lab. No. 39) was urethane foam which was partially charred. Examination shows (see supporting memos attached):

- (a) Foam was of the type (MDI) recommended for use in mines by the Bureau.
- (b) Foam contained fire retardants.
- (c) The foam is coarse grained with enlarged cells, a type that would not pass the recommended Bureau of Mines' fire penetration test.

- (d) The exposed foam surface was not charred or subjected to excessive heat, whereas the surface that was in contact with the wood base was charred. This indicated the fire burned through the wood to the foam. This is shown clearly in the attached photograph.

The chemical analyses of the charred materials show these still contain appreciable quantities of combustible matter -- much more than if they were exposed to open flame in an atmosphere containing normal or near normal oxygen. As shown, the samples ignited in the heated furnace test.

The proximate analyses showed all of the samples to have volatile matter in excess of 8 percent. Previous work shows that carbonaceous dusts having less than 8-percent volatile matter do not generally contribute to an explosion or fire hazard.

In our phone conversations, you asked for a comparison between timber and urethane foam fires, particularly with regard to carbon monoxide liberation. The British have done considerable work on this subject. I enclose a copy of Roberts and Blackwell's paper -- The Possibility of Occurrence of Fuel-Rich Mine Fires, as well as Wilde's paper -- Polyurethane Foam Fire Hazard in Mines. I also have a more lengthy paper by the British -- Research Report 282, Combustion of Polyurethane Foam in an Experimental Mine Roadway. I can send you a copy if you wish.

Direct comparison between timber and urethane foam fires is difficult because of the different burning characteristics and the effects of length of zone, air velocity, location of fuel in entry, time and location of sampling. Robert's shows in his paper that in a large-scale timber fire the carbon monoxide concentration can be as high as 0.96% -- the average in several fires was about 0.30%. Wilde shows that the CO concentration in a foam fire can be as high as 7%; however, an average value would be considerably lower. In a foam fire with sufficient fuel present, the oxygen concentration drops to about 1%, whereas in a timber fire the atmospheric oxygen is never lower than 14 percent.



John Nagy



# United States Department of the Interior

## BUREAU OF MINES

4800 FORBES AVENUE  
PITTSBURGH, PENNSYLVANIA 15213

Pittsburgh Technical  
Support Center

November 6, 1972

### Memorandum

To: Chief, Mine Safety Evaluation

From: L. J. E. Hofer, Chemist, Mine Safety Evaluation

Subject: Report on Samples 9, 10, 11, 12, 13, 14, 15 and 16 from  
Sunshine Mine, Wallace, Idaho

Eight samples from the Sunshine Silver Mine in Idaho have been submitted for evaluation by Roland V. Wilson, Subdistrict Manager, Seattle Metal and Nonmetal Mine Health and Safety. His sample numbers are No. 9 to No. 16.

The samples are:

Sample No.	Description	Our Lab. No.
9	Charred wood from area east of 910 raise. Collected by R.V.W. 6-27-72	25
10	Charred wood from bottom of 923 raise on 3700 level. Collected by R.V.W. 6-27-72	26
11	Material collected in end of vent pipe to Strand Substation	27
12	Material collected from 5200 level from housing. 9-27-72	28
13	Material from floor of drift at top of 810 raise on 3550 level. 9-27-72	29
14	Material from roof of drift No. 8 shaft on 3550 level. 9-27-72	30
15	Material from floor of drift south of No. 8 shaft on 3550 level. 9-27-72	31
16	Material from top of drift 30 feet west of 810 raise on 3700 level. 10-2-72	32

## Methods of Analysis

Samples No. 9 and 10 (MSE 25 and 26) were submitted for Proximate and Ultimate Analysis by methods described in detail in Bureau of Mines Bulletin 638 - Methods of Analyzing and Testing Coal and Coke, written by the Staff of the Office of Coal Research, 1967.

Samples No. 11, 12, 13, 14, 15, and 16 were submitted for infrared analysis using the KBr pellet technique as described in Bureau of Mines Bulletin 640 - Advances in Coal Spectrometry Adsorption Spectrometry, written by R. A. Friedel, H. L. Retcofsky and J. A. Queiser in 1967. A Perkin Elmer 21 Infrared Spectrometer was the principle instrument used.

Samples No. 11, 12, 13, 14, 15, and 16 were submitted to microscopy with a polarizing Bausch and Lomb crystallographic microscope.

Samples No. 11, 12, 13, 14, 15, and 16 were submitted to direct probe mass spectrometry using the Dupont 21-491 Mass Spectrometer. This is a new technique not generally available for mass spectrometric studies. It permits taking a complete mass spectrum of a whole sample of a solid material provided that a portion will volatilize off at some temperature below 400° C. Qualitative indications of the organic compounds present can be obtained by this method.

Normally all mass spectra are taken with 70.0 volt excitation and all samples were taken in this way. In addition, the apparatus has been modified to permit 7.0 volt ecitation. Only certain aromatic hydrocarbons then tend to be excited and the parent peaks of these compounds stand out above the rest of the spectrum. Aromatic hydrocarbons are frequently present in pyrolysis products (fire products) and are characteristic of fire.

## Results

The charred wood samples No. 9 and 10 are confirmed as charred wood. The fiber and cell structure could be observed. Direct probe mass spectrometry showed No. 9 to contain more volatile matter of organic nature than No. 10. Proximate and ultimate analyses of both samples were quite similar and indicative of a charcoal. Low ionizing potentials are indicative of aromatic hydrocarbons and these in turn are characteristic of pyrolysis (fire) products of organic materials. Some intense m/e peaks found correspond to anthracene and/or phenathrene pyrene, mono-, di-, tri-, and tetramethyl anthracene and/or phenanthrene. There can be little doubt that this sample contains substances characteristic of pyrolysis (fire).

Sample No. 11 contained organic compounds as shown by the C-H bond frequencies in infrared analysis. Visual examination showed a greasy texture. Direct probe mass spectrometric analysis at 70.0 volts gave a spectrum similar to that of a straight chain aliphatic hydrocarbon mixture such as might be found in a lubricating oil or in a diesel fuel oil. The oil could not be produced by the fire but it is indicative of a malfunction or the improper use of a lubricating oil or diesel fuel oil. The oil accumulated in the dust after the dust was formed, assuming the dust was char or soot. It cannot with certainty be stated that the dust was originally deposited before, during, or after the fire. The time of the addition of the oil to the dust relative to the time of the fire cannot be stated with certainty.

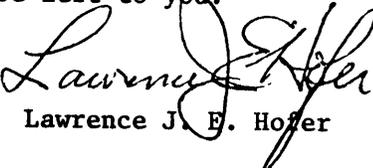
Microscopic examination does not add much to the picture. The strands of fibrous material are undoubtedly glass from the vent pipe but most of the material is opaque and gives little clue as to its nature.

Sample No. 12 also had much organic (hydrocarbon-like) material as indicated by the presence of C-H bonds observed by infrared analysis. Direct probe mass spectrometry at 70 volts showed a complex pattern extending to m/e of nearly 400 or more. Direct probe mass spectrometry at 7.0 volts continued to show a complex pattern indicating that many if not all of the mass peaks are capable of ionization at this low voltage and therefore represent products. These pyrolysis products either condensed into the sample from the atmosphere or were produced at the site. The latter possibility seems unlikely since the site judging from the meager description was not exposed to high temperatures over a sufficient period of time to have such a concentration of pyrolysis products.

Sample No. 13 contains much less volatile material than No. 11 or No. 12. Infrared analysis indicated no C-H bond vibrations and therefore little organic matter if any. Low voltage ionization mass spectrometry gave a mass peak at 234 which can be interpreted as characteristic of the pyrolysis product tetramethyl phenanthrene or tetramethyl anthracene or both. The sample is rich in inorganics such as silica and clay and is therefore mainly a mud.

Samples No. 14, 15 and 16 give little interpretable data by any of the methods. The samples contained so little volatiles that mass spectrometric analysis gave no reliable information. Infrared analysis indicated presence of silica, clays, carbonates, and traces of organic material. In other words, such things as one would find in any road mud. A trace of calcium nitrate  $\text{Ca}(\text{NO}_3)_2$  was reported for No. 14.

The presence of  $\text{Ca}(\text{NO}_3)_2$  should be confirmed with other samples and the significance of its presence must be left to you.

  
Lawrence J. E. Hofer



# United States Department of the Interior

## BUREAU OF MINES

4800 FORBES AVENUE

PITTSBURGH, PENNSYLVANIA 15213

Pittsburgh Technical  
Support Center

December 8, 1972

### Memorandum

To: Assistant Director--Technical Support

Through: Chief, Mine Safety Evaluation *EMK*

From: L. J. E. Hofer, Chemist, Mine Safety Evaluation

Subject: Ammonia, Sulfate, and Nitrate in Sunshine Samples

1. What is the significance of ammonia in the samples?

In our examination of the samples we have received we have found no evidence of ammonia.

The reported presence of ammonia in other samples is not particularly significant since ammonia is a normal product of incomplete combustion and of bacterial decomposition of nitrogenous materials which may be found in the normal mining environment.

2. The burning of what materials normally found in a mine will produce ammonia?

The decomposition or burning of nitrogenous materials generally produce ammonia. Examples are explosives (from the ammonium nitrate in both high explosives of the dynamite type and slurry type), brattice cloths and ventilation ducting (which may contain nylon and polyamide polymers), plywood (which may be held together with urea-formaldehyde resins), insulation (which may contain amines in the rubber formulation), human excreta which is normally rich in ammonia and amines, Polyurethane foam which is rich in nitrogen and is known to produce amines when decomposed in air, industrial refrigerants (which are frequently mainly ammonia), etc.

In short, any nitrogenous material can potentially give up its nitrogen as ammonia. This means that any living or once living thing can give up ammonia when burned. Food, wood, paper, glue, etc., are thus all possible sources of ammonia.

3. How does the presence of ammonia support the idea of arson?

The presence of ammonia is only very indirectly relatable to arson. As mentioned, there are normal non-arson sources of ammonia in most mines so that unless these are ruled out in detail arson cannot be proved.

The arson theory requires that ammonia be an indication of ammonium nitrate as a component of an incendiary device. This is impossible since there are easier more direct ways of making an incendiary which do not involve ammonium nitrate. Normally one would think of ammonium nitrate as being a component of an explosive device not an incendiary one.

4. What is the significance of sulfate in samples?

In our examination of the samples we have received we have found no evidence of sulfate.

We attach no significance to the presence of sulfate since sulfates of various forms are ordinary products of combustion of materials found in mines.

5. What materials normally found in mines could generate sulfate?

Sulfur is a component of timber, lubricating oil; detergents (lauryl sulfate), fire retardants (ammonium sulfamate), storage batteries (sulfuric acid). In a mine such as the Sunshine Mine where the ore mined is a sulfide, oxidation as in a fire would produce sulfates of various kinds. Black powder explosives will also burn to sulfate.

6. How does the presence of sulfate support idea of arson as the cause of the fire?

Sulfate is also only indirectly relatable to arson. As mentioned, there are many normal sources of sulfate in the mine so that the problem of distinguishing between the normal forms and the abnormal is very difficult. Sulfur involved in arson probably will be postulated to be in the form of black powder which could also be a normally used material in the mine or sulfate might be an indication of sulfuric acid which is a component of the triggering mechanism of certain incendiary devices. There are, however, so many other ways in which sulfate can be generated that no conclusions can be drawn.

7. What is the significance of nitrate in the samples?

We have observed no nitrate in the samples with the possible exception of one. If nitrate was observed in other samples the significance is again doubtful since one might normally expect to find nitrates in the mining situation. Also combustion products from diesels contain oxides

of nitrogen which are closely related to nitrate and indeed may be converted to nitrate.

8. The burning of what materials normally found in a mine will result in generation of nitrate?

Explosives commonly used in the mining environment contain ammonium nitrate and potassium nitrate. These are black powder, dynamite and the new ammonium nitrate explosives.

Nitrates can be generated by decaying organic material especially if it is rich in nitrogen. Such materials are excreta of humans, donkeys and bats, to name a few which might be met in the mines. Certain caves are known to be a rich source of nitrate because of the bat excreta lying around in roosting areas.

Nitrates can be generated indirectly from diesel exhausts when the mixture is set on the lean side. The oxides of nitrogen so formed can conceivably be trapped and further oxidized to  $N_2O_5$ , the anhydride of nitric acid, on proper surfaces.

9. How does the presence of nitrate support the postulation of the fire being set by arsonists?

Again the presence of nitrate by itself does not support the postulation of the fire being set by an arsonist. There are too many alternate ways in which nitrates might be generated.

In general, looking for evidence of arson in the combustion products from a serious mine fire is a difficult task because any characteristic components from the combustion of an incendiary device will be so diluted by normal combustion products that analytical devices will be seriously taxed to find them.

To explain the meaning of the last sentence of my November 6, memo to Chief, Mine Safety Evaluation, I can only say that at the time I had so little descriptive material about the sample, such as why they were taken, the meaning of the locations, what was being sought, etc., that I could only ask my superiors to fit the experimental fact into the investigation themselves.

Our samples have all been rerun and the spectra have been examined in detail for the possible presence of ammonia, ammonium salts, sulfuric acid and sulfate salts, and nitrate salts. The conclusion is that the infra red spectra show no indication of these compounds. Even in the case of the sample previously reported as having a trace of  $Ca(NO_3)_2$  the rerun indicates the presence of  $Ca(NO_3)_2$  is very doubtful.

It is our opinion that based on the samples we have analyzed, there is no direct or incontrovertible evidence that fire was started by an arsonist.

  
L. J. E. Hofer



# United States Department of the Interior

## BUREAU OF MINES

1800 FORBES AVENUE

PITTSBURGH, PENNSYLVANIA 15213

Pittsburgh Technical  
Support Center

December 15, 1972

### Memorandum

To: Assistant Director--Technical Support

Through: Chief, Pittsburgh Technical Support Center *JH*  
Chief, Mine Safety Evaluation *SEP in ERK*

From: L. J. E. Hofer, Chemist, Mine Safety Evaluation

Subject: Char and soot as collecting agents for products of combustion and especially ammonia

In the investigation of a mine fire, the collection of combustion products for subsequent analysis is very desirable. (1) Activated charcoal is known to concentrate high molecular weight combustion products by adsorption. (2) Chars which may be like activated carbon in their adsorptive characteristics are formed in combustion processes. (3) Therefore charred products around a fire may be examined successfully by suitable analytical processes for the presence of combustion products from the fire itself. Thus reads the basic syllogism. Presumably this is done to determine something of the nature of the fire which produced the combustion products.

The above is the general argument used to support the idea that char and soot can be used as collecting agents to evaluate the nature of the combustion products from an accidental fire. Long before the Sunshine Mine disaster I had considered the merits of this possibility and I personally have come to the conclusion that herein may be a powerful tool for investigating toxic gases and smokes evolved in accidental fires. Unfortunately the procedures and techniques still remain to be worked out. This applies particularly to where and how the samples will be collected, how the samples of carbon will be treated after collection to resolve the combustion products, and whether any particular sample can give an interpretable result.

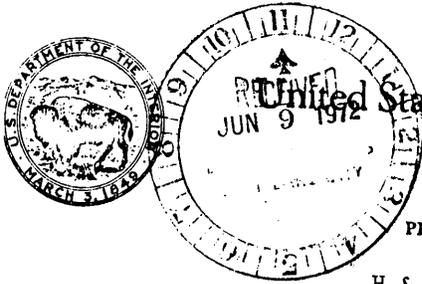
In the preparation of activated carbon, a carbonaceous material such as wood, coal, sugar, starch, cellulose, etc., is heated to temperatures in the neighborhood of 110° C in the presence of carbon dioxide and/or steam. The charring process begins to take place at much lower temperatures but is only complete at the 1000 to 1100° C mentioned. At lower temperatures,

cc: E. J. Harris  
E. M. Kawenski

various products of combustion from the activation process itself remains behind. A material activated at lower temperatures and then used for adsorption of combustion products will then contain both combustion products produced by its own activation as well as combustion products adsorbed subsequently. The problem will then be to decide which is which. Unless the one or the other can be unambiguously identified the problem is hopeless. On the other hand, if the fire involved chlorinated, brominated, phosphated, antimonated or sulfated compounds and the combustion products are chlorinated, brominated, phosphated, antimonated, or sulfated, the distinction can be made. No such distinction seems possible in the Sunshine Mine fragments.

Ammonia is a low molecular weight compound which does not adsorb well on activated carbon in the dry state. It adsorbs much better in the wet state. This now is a process of solution of ammonia in water quite distinct from adsorption on activated carbon. Ammonia will tend to be caught primarily where there is water and where the water is acidic. Such places too are likely to be found in the periphery of a fire where acid compounds have condensed.

  
L. J. E. Hofer

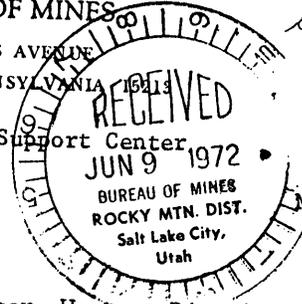


United States Department of the Interior

BUREAU OF MINES

4800 FORBES AVENUE  
PITTSBURGH, PENNSYLVANIA 15213

H & S Technical Support Center



cc: Russell  
Wilson  
Brake  
Riley  
Memo  
only

May 31, 1972

Approval and Testing

Memorandum

To : Allen D. Look, District Manager, Western District, Alameda, California

From : Research Chemist, Approval and Testing, Pittsburgh Technical Support Group

Subject: Examination of Selfrescuers

Seven MSA BM-1447 Selfrescuers were received through John Nagy on May 24, 1972. They were examined per instructions in your memo to W. Ross Wayment of May 20, 1972. Visual examination when first received showed the following:

<u>Selfrescuer No.</u>	<u>Seal Condition</u>	<u>Date of Manufacture</u>	<u>Comments on Condition</u>
A	Open	4-14-64	Slightly rusted
B	Open	Unknown	Looks OK
C	half open	Unknown	Bottom sealed, opened easily; Looks OK
D	Sealed	6-20-52	Looks OK; opened easily; (received cartridge only)
E.	Open	1-1-52	Looks OK; (received cartridge only)
F.	Open	7-20-65	Completely rusted
G	Open	4-25-63	Completely rusted

Selfrescuers F and G were terribly deteriorated. The cartridge in G disintegrated into small pieces when removed from the rubber boot. Both were obviously unsuitable for use and no further testing was done on them.

The other five cartridges, A through E, were sound in structure and were tested against a one percent carbon monoxide-air mixture at a flowrate of 32 liters per minute. Only A was completely inefficient against CO.

Cartridges B, C, D and E passed the Bureau of Mines test requirement of less than 770 cubic centimeters of CO leakage on this test. Cartridge D, the only one received with both seals intact, performed almost like new. Cartridges B, C and E had high initial leakage but gradually improved as their tests progressed. They obviously picked up some moisture from exposure to the air because they were open and would probably have performed better if resealed for shipment.

On the basis of our examination, therefore, properly used cartridges B, C, D and E were suitable for use, but A, F and G were not.

The age of selfrescuer cartridges B and C is not known because the seals which bear the date codes were missing.

Two black and white polaroid snapshots are enclosed.

We will retain the selfrescuers for a few weeks pending instructions from you on their disposition.



E. J. Kloos

Enclosures

cc:  
W. R. Wayment, W. O.  
E. J. Harris  
John Nagy

Resp Lab  
Bd File  
A&T

EJKloos:gvs

DATA ON SELF RESCUERS SENT TO  
PITTSBURGH FOR EXAMINATION MAY 20, 1972

- A. MSA self rescuer, BM 1447, no number, marked with chalk "4(4) - UG". Taken from body on 3700 level.
- B. MSA self rescuer - BM 1447 - new. Out of underground cache - probably 3100.
- C. MSA self rescuer - BM 1447 - new. Out of underground cache - probably 3100.
- D. MSA cartridge No. EC 49806, approved 1447, serial no. 250260. From shelf storage in surface first aid room. Bob Launhart (Safety Engineer - Sunshine Mining Company) wants evaluation made.
- E. MSA cartridge No. EC 49806, approved 1447, serial no. 25110. From shelf storage in surface first aid room. S. M. Jarrett tested and needed a knife to apply enough pressure to force off the back plate.
- F. MSA self rescuer, part no. 48391, in box labeled "cartridge good for 6 years from 7-65." Brought out from 4000 level March 15, 1972. Shows evidence of having been tampered with.
- G. MSA self rescuer no. 1447. Rusty bad looking appearance. "Found in cache on 5000 level 5/4/72 - dusty."



# United States Department of the Interior

## BUREAU OF MINES

4800 FORBES AVENUE  
PITTSBURGH, PENNSYLVANIA 15213

Pittsburgh Technical Support Center

Approval and Testing

October 2, 1972

Memorandum

To : Roland V. Wilson, Supervisory Mining Engineer, Metal and Non-Metal Mine Health and Safety, Spokane, Washington  
Through: E. J. Harris, Chief, Pittsburgh Technical Support Center *EJH*

From : Research Chemist, Approval and Testing, Pittsburgh Technical Support Center

Subject: Examination of BM-1447 Self-rescuers

Two cartons containing a total of thirty-one self-rescuers were received here on September 21, 1972. They were examined per your previous telephone request. Results of visual inspection of the self-rescuers as first received are listed on the enclosed Table. Manufacturer's date codes are read backwards, that is, date code 365240 means April 25, 1963.

As indicated in the Table, nine of the thirty-one self-rescuers were tested against a one-percent carbon monoxide-air mixture at a flowrate of 32 liters per minute. All nine appeared to have tight seals, except number 8a, which had a bulged bottom seal and the opening lever missing on the top seal. All nine passed the carbon monoxide test.

Six of the nine tested cartridges opened easily; three did not. Numbers 10a and 11 required maximum pressure from both thumbs on the pin to push off the bottom seals. Number 7e opened by tapping the pin twice with the handle of a screwdriver.

With the exception of number 10b, which looked like new and was saved for future reference or testing, all the others were in obviously useless condition.

We will retain the self-rescuers for another 60 days before discarding them as you suggested. Please advise if this is not satisfactory.

The carbon monoxide test data will be kept in our permanent record and always available.



E. J. Kloos

Enclosure

cc:  
B. Grant, W.O.  
E. J. Harris  
Files  
Bd File  
A&T

TABLE

for

BM-1447 SELFRESCUERS from SPOKANE OFFICE

Received September 21, 1972

(SR means Selfrescuer)

<u>ITEM NO.</u>	<u>DATE CODE</u>	<u>DESCRIPTION &amp; CONDITION</u>	<u>CARBON MONOXIDE TEST NO.</u>
1	365240	*SR in carton - disintegrated. (5000 ft level - SR locker)	None
2	36614	*SR in carton - disintegrated. (5000 ft - under SR locker)	
*Seals were open; top seals gone.			
3	255101	SR in carton - rusted, top seal loose (bulged). 4800 level - near phone, above grizzly. Bottom seal was open (small pin type). Inside cartridge clean.	None
4	152230	SR in carton - cartridge rusted and caked solid; both seals open; (4800 level, near phone, above grizzly)	None
The following five SR's were in metal case, case rusted but without holes. All SR cartridges were rusted and caked solid, unusable.			None
5a	36614		
5b	463170		
5c	864130		
5d	25821		
5e	864130		
6	36514	SR in carton, cartridge rusted and caked solid, open; no seals intact, unusable. (4600 level)	None

TABLE  
for  
BM-1447 SELFRESCUERS from SPOKANE OFFICE

Received September 21, 1972

(SR means Selfrescuer)

<u>ITEM NO.</u>	<u>DATE CODE</u>	<u>DESCRIPTION &amp; CONDITION</u>	<u>CARBON MONOXIDE TEST NO.</u>
<u>Note:</u> The "7" group of SR's were in metal can with good paint and were 4400 level:			
7a	560270	SR in dirty plastic bag only, not open; Exhale valve damaged; looks OK otherwise	6787
7b	None	SR's not in carton, very dirty; cartridges open, rusted and caked solid. (No clamp, strings, or hose clip; no bottom seal on 7b.)	None
7c	367250		None
7d	464140	SR's in carton and plastic bags, look good, not open.	6788
7e	460170		6789
<u>Note:</u> The "8" group of SR's were also in metal can with good paint and 4400 level.			
8a	367250	SR in open and dirty plastic bag, rust on band only. Not open; looks OK, otherwise.	6790
8b	560270 &	SR's not in carton, seals open; cartridges rusted and breaking up.	None
8c	560270		None
8d	560270	SR in carton & plastic bag. Looks OK; seals not open; clean.	6791
9	560270	SR in carton, cartridge rusted and caked solid; breaking up; bottom seal not removed; (seal rusty, too) top seal gone. (4200 level).	None
10a	76950	Cartridges only, in carton and plastic bags;	6792
10b	860150	seals tight; look good, like new.	Save

TABLE  
for  
BM-1447 SELFRESCUERS from SPOKANE OFFICE

Received September 21, 1972

(SR means Selfrescuer)

<u>ITEM NO.</u>	<u>DATE CODE</u>	<u>DESCRIPTION &amp; CONDITION</u>	<u>CARBON MONOXIDE TEST NO.</u>
11	064120	SR in carton only, band slightly rusty; looks OK; seals tight, slightly dirty.	6793
12	755101	SR only (no carton or bag) looks good; seals tight.	6794
13	255101	Cartridge only in carton; no plastic bag; seals tight, looks good.	6795
14a	?	SR only - <u>no</u> seals at all; otherwise completely assembled w/band, cartridge inlet side screen 60% rusty.	None
		<u>Note:</u> The next five SR's very dirty without top seals, cartridges rusty, caked solid.	
14b & 14c	362250 362250	Both had bottom seal on - removed easily	None None
14d	?	No bottom seal	None
14e & 14f	360250 367250	Both had bottom seal on - removed easily	None None
--		Selfrescuer cashe lock and hasp (locked)	