Report of Investigation
Underground Coal Mine Fire
Wilberg Mine
I.D. No. 42-00080
Emery Mining Corporation
Orangeville, Emery County, Utah
December 19,1984

U.S. Department of Labor
Mine Safety and Health Administration

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United States
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December 19, 1984

By

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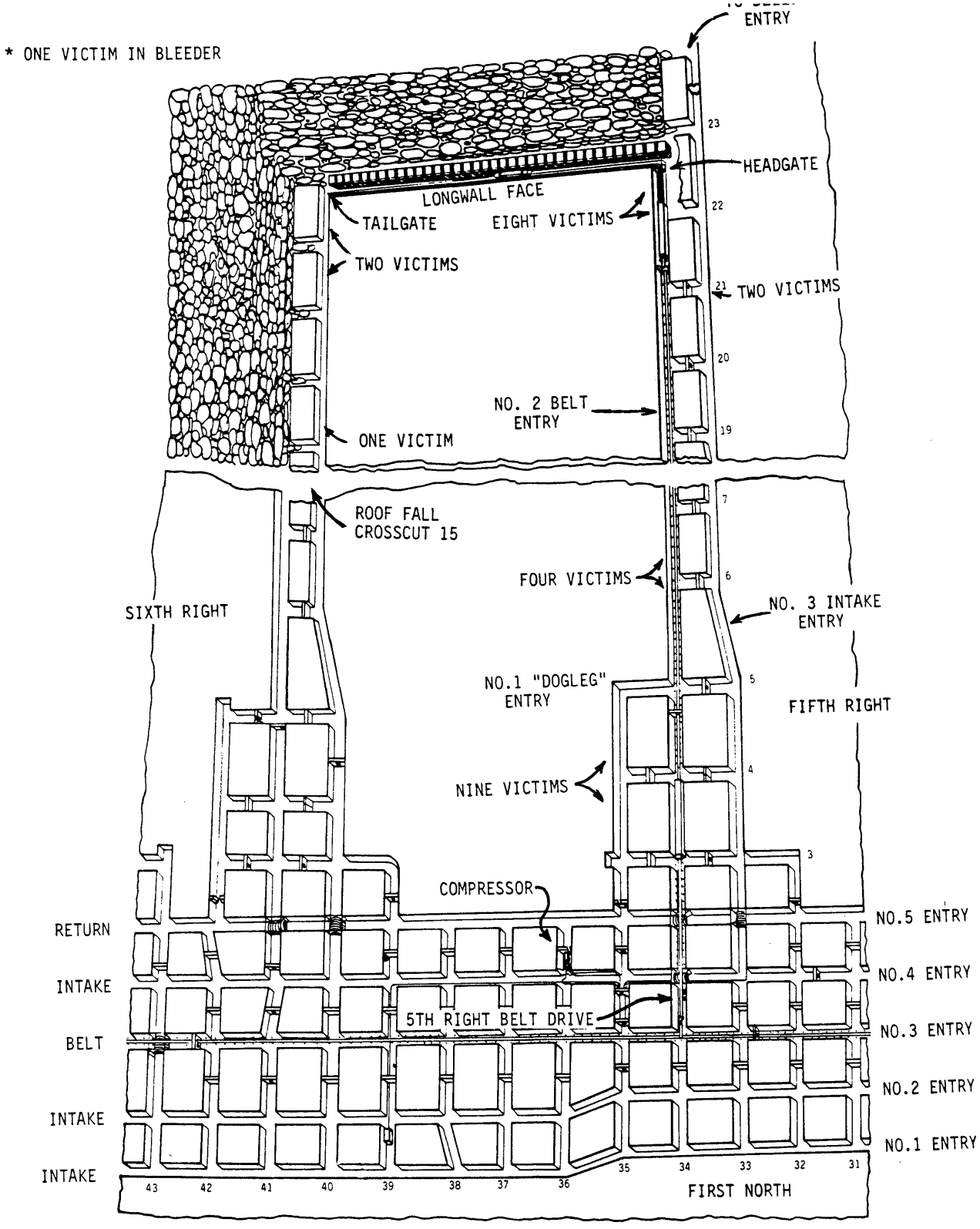

Underground Coal Mine Fire
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Emery Mining Corporation
Orangeville, Emery County, Utah
December 19, 1984

Abstract of Investigation

U.S. Department of Labor
Mine Safety and Health Administration

Authority—This report is based on an investigation made pursuant to the Federal Mine Safety and Health Act of 1977, Public Law 91-173, as amended by Public Law 95-164.

Section A—Identification Data

1. Title of investigation:	2. Date MSHA investigation started:
Fatal Mine Fire	12/27/84
3. Report release date:	4. Mine:
8/7/87	Wilberg Mine
5. Mine ID number:	6. Company:
42-00080	Emery Mining Corporation
7. Town, County, State:	8. Author(s):
Orangeville, Emery County, Utah	Cavanaugh, Denning, Huntley, Oakes, Painter

Section B—Mine Information

9. Daily production:	10. Surface employment:
11,000 tons	36
11. Underground employment:	12. Name of coalbed:
290	Hiawatha
13. Thickness of coalbed:	
8 feet (mining height)	

Section C—Last Quarter Injury Frequency Rate (HSAC) for:

14. Industry:	15. This operation:
9.77	19.13
16. Training program approved:	17. Mine Profile Rating:
4/28/83	DNA

Section D—Originating Office

18. Mine Safety and Health Administration	Address: 4015 Wilson Boulevard
Administrator, Coal Mine Safety & Health	Arlington, Virginia 22203

Section E—Abstract

At about 9:00 p.m., December 19, 1984, a mine fire occurred at an air compressor station at the mouth of the 5th Right longwall section in the Wilberg Mine. Twenty-eight miners were present in the 5th Right section at the time of the fire. Only one survived.

The fire started at an air compressor that was operating unattended with the over-temperature safety switch intentionally by-passed, without a fire suppression system, and without being installed in a fireproof structure or area.

The fire spread rapidly in the intake airway to the belt entry, causing both of the 5th Right section escapeways to be impassable and all the section airways to be filled with thick smoke and toxic gases. Early failure of aluminum overcasts, a delayed response to the emergency, improper use of self-rescue devices, and the miners' unfamiliarity with other exits for escape purposes increased the severity of this accident.

Section F—Mine Organization

Company officials:	Name	Address
19. President:	Neal Savage	P.O. Box 310, Huntington, Utah 84528
20. Mine Manager:	David Bocook	"
21. Safety Director:	Neldon Sitterud	"
22. Principle officer—H&S:	Evert Winder	"
23. Labor Organization:	United Mine Workers of America	900 Fifteenth Street, N.W. Washington, D.C. 20005
24. President-Local Union No. 2176:	Robert Riley	Orangeville, Utah 84537

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GENERAL INFORMATION

The Wilberg Mine is located approximately 7 miles northwest of Orangeville, Emery County, Utah. At the time of the accident, the mine operation was owned by Utah Power & Light Company (UP&L) and was operated by Emery Mining Corporation (EMC). The principal corporate officials for EMC at the time of the fire were:

Neal Savage	-	President
William Zeller	-	Senior Vice President
James Hamlin (Victim)	-	Vice President of Operations
Evert Winder	-	Director of Health and Safety

The Wilberg Mine management officials at the time of the fire were:

David Bocook (Victim)	-	Mine Manager
Victor Cingolani (Victim)	-	General Mine Foreman
Alex Poulos (Victim)	-	General Mine Foreman-Longwall
Lee Lemmon	-	Maintenance Superintendent
Neldon Sitterud	-	Safety Director

The mine was opened in September 1949 by Cyrus Wilberg. The mining rights were purchased by Peabody Coal Company in October 1968 and the mine was idle, except for limited exploratory mining, until March 1974. UP&L purchased the mining rights on April 18, 1977, and the operation of the mine was contracted to American Coal Company. EMC began operation of the mine in June 1979. At the time of the fire, the mine employed 326 miners, with 290 working underground on three shifts a day, five days a week. Production averaged 11,000 tons of coal daily.

In June 1985, the Wilberg Mine was divided to form two mines. The mine workings west of the fire seals became the Cottonwood Mine (ID No. 42-01944) and has since been operated as a separate mine. On April 29, 1986, UP&L assumed sole operating control of both mines and formed the UP&L Mining Division. Most of the EMC employees and management personnel were retained by UP&L.

Mining Methods

The mine was opened by 15 drift entries into the Hiawatha coal seam. The main portals, located near the underground office complex, were at an elevation of about 7,650 feet above sea level. Main and submain entries were driven to the north for 9,600 feet and to the west for 16,000 feet. Various maps of the mine are contained in Appendices W, X, Y, and Z to assist the reader in following detailed portions of this report.

Mining was conducted in the Hiawatha seam using two continuous mining machine sections and two longwall sections. A third continuous mining machine section was located in the Blind Canyon seam, which was approximately 110 feet above the Hiawatha seam. Mine workings in the two seams were connected by two slopes and a shaft. The Hiawatha seam thickness varied from 6 to 15 feet within the mine workings, and mining height varied from 7 to 8 feet. Head coal was normally left during mining. Ripper-type continuous mining machines were used for development in 4th Right off 1st North, 2nd South off Main West, and 1st West in the

Blind Canyon seam. Shearer-type longwall machines with shield supports were used for retreat mining in 13th Right and 5th Right off 1st North.

Entries and crosscuts were developed 20 feet wide on 80- or 100-foot centers, except for longwall panels, which were developed with entries on 50-foot centers and crosscuts on 100-foot centers. Each set of longwall development entries was separated by about 600 feet and extended from 2,000 to 4,000 feet in length.

The 5th Right longwall panel was 3,000 feet in length, and the longwall face was 550 feet in width. The 5th Right longwall began operation on November 5, 1984, and had retreated 700 feet at the time of the fire.

Mine Inspections

Prior to the fire, the last Mine Safety and Health Administration (MSHA) inspection of the entire mine was conducted from November 6 through December 18, 1984.

Twenty-seven citations, two orders, and one notice to provide a safeguard were issued and abated during this inspection. A Federal inspector inspected the 5th Right panel on November 21, 27, and 28 and December 6, 1984.

An MSHA electrical inspection was conducted at the mine from July 2 through September 28, 1984. Eleven citations were issued and abated during this inspection.

On August 21, 22, and 23, 1984, a State inspector conducted a general inspection of the underground and surface areas of the Wilberg Mine. Ten conditions not complying with the Utah State regulations were identified. At the time of this inspection, the 5th Right longwall panel was being developed.

On December 12 and 13, 1984, the United Mine Workers of America (UMWA) Safety Committee at the mine performed an inspection of the entire mine. The 5th Right panel was inspected on December 12. Throughout the mine, 61 items were identified for correction, including 7 items in the 5th Right panel area.

Emery Mining Corporation's safety department conducted inspections on an irregular basis. A member of EMC's safety department was on the 5th Right panel on December 11, 1984. The self-contained self-rescuers and about two-thirds of the belt entry were inspected, and no unsafe conditions or violations were recorded.

Roof Support

The roof control plan in effect at the mine was approved by MSHA on August 10, 1984. Generally, the immediate roof consisted of about 4 feet of coal. The strata directly over the roof coal consisted of shale, sandy shale, or sandstone. The main roof consisted of sandstone and shale. The roof was supported throughout most of the mine with 6-foot fully grouted resin roof bolts installed on 5-foot centers. On longwall sections, cribs were installed as additional support for the bleeder and return entries.

Truss bolts and steel beams were installed where additional roof support was needed. In severe areas, a polyurethane binder system was used. All of these roof support methods were used in the 5th Right entries between crosscuts 8 and

10 where faulty roof strata was present. Four hundred fifty-four ton shields were used to control the roof at the longwall faces, and hydraulic jacks were used at the headgates and stageloaders.

Ventilation

The Ventilation System and Methane and Dust Control Plan in effect at the mine was approved by MSHA on February 23, 1983. This plan was reviewed and approved with amendments on September 19, 1984. Mine ventilation was induced by a single fan installation located on the surface at an opening off the Main North entries. The installation consisted of a Joy Model M96-50DS fan driven at 1,175 rpm by a 1,000-horsepower electric motor. A 500-horsepower diesel engine was provided to automatically power the fan upon failure of the mine electric power. Automatic closing and explosion relief doors, as well as a fan stoppage warning system, were provided for the fan. According to the mine fan chart, the fan was operating at 2.8 inches of water gauge pressure on December 19, 1984. A copy of the fan chart is contained in Appendix F. During an MSHA inspection made on December 11, 1984, 411,000 cubic feet of air per minute (cfm) was measured exhausting from the mine. Minimal methane and no other explosive gases had been reported at the mine prior to the fire.

Permanent stoppings and overcasts were used to provide the required separation between various air courses. The stoppings were normally constructed of hollow-type concrete blocks and were coated on the high-pressure side with a sealant. In areas subject to squeezing, an 8- to 10-inch thick layer of polystyrene was installed at the top of the stoppings to help prevent the stopping from crushing out. In heavy squeeze areas, stoppings were constructed with 4-inch by 4-inch by 36-inch crib blocks laid skin to skin. Prefabricated aluminum-alloy overcasts were used in the vicinity of 5th Right and other recently mined areas. The prefabricated aluminum overcasts were installed on concrete-block bases and stabilized with chains suspended from roof bolts. A photograph of an aluminum overcast is contained in Appendix U.

Mine ventilation was controlled by regulators located in the returns near the mouth of each section and by isolation stoppings located in the belt entries. Section belt entries were ventilated with return air on two-entry development sections and with intake air on longwall sections. Although either approved or accepted by MSHA prior to the fire, the ventilation system and structures employed in the mine were found later to be unsatisfactory in some cases, details of which are discussed in other parts of the report.

Combustible Material and Rock Dusting

The operator had established a program to prevent the accumulation of loose coal, coal dust, float coal dust, and other combustible materials in the active workings; however, rib sloughage was common. The application of rock dust was the primary means used for inerting coal dust.

Water lines were extended to the working sections, and each section was equipped with sufficient hose to reach each working face. Coal dust created by mining in the face areas was controlled by water sprays on the equipment, and dust at conveyor belt transfer points was controlled by water as needed.

Electricity

Electric power was obtained from UP&L at 69,000 volts AC and was reduced to 7,200-volt, three-phase power at the main substation. The main substation contained two high-voltage circuits that supplied 7,200-volt, three-phase power to the surface distribution substation. Only one of the circuits was energized in normal mine operation. Each circuit was protected by an oil circuit breaker equipped with a ground wire monitor and devices to provide protection against short circuit, overload, grounded-phase, and undervoltage. In addition, each circuit contained a grounding circuit, originating at the grounded side of the grounding resistors, to ground the metallic frames and enclosures of all electric equipment receiving power from the circuit.

The surface distribution substation contained two 7,200-volt busses and oil circuit breakers that provided protection for the Wilberg Mine fan circuit, two tipple circuits, the Blind Canyon seam circuit, and two high-voltage underground circuits for the Wilberg Mine. Each protective oil circuit breaker was equipped with a ground wire monitor and devices to provide protection against short circuit, overload, grounded-phase and undervoltage.

Additional protection for the underground high-voltage circuits was provided by triple section switches throughout the mine. The triple section switches provided coordination of electrical protective switchgear, branch circuit isolation, and a visible means of disconnect for each high-voltage branch circuit.

Both high-voltage circuits supplied power to section power centers, trolley rectifiers, and various other power centers for belt drives and water pumps. The longwall section power centers reduced 7,200-volt, three-phase, AC power to 995-volt and 480-volt, AC, three-phase power for longwall section equipment. The pump and belt drive power centers reduced 7,200-volt, three-phase, AC power to 480-volt, AC, three-phase power for the belt drive units and pumps. Trolley rectifiers converted 7,200-volt, AC, three-phase power to 300-volt, direct current power for use by the trolley-powered equipment. The trolley system was being replaced with rubber tired diesel equipment.

Electric face equipment was permissible in accordance to MSHA regulations, and mine record books indicate that this equipment was examined weekly. A record of these examinations was kept in books at the mine office.

Fire Protection and Emergency Procedures

EMC had not submitted to MSHA a program of instruction of all miners in the location and use of fire fighting equipment, location of escapeways, exits and routes of travel to the surface and proper evacuation procedures to be followed in the event of an emergency. Peabody Coal Company, a previous operator, had submitted a program for the Wilberg Mine which was approved by MSHA on October 11, 1974, but EMC had not formally adopted this program although several management personnel stated it was the plan in use at the mine prior to October 1984. Prior to the fire, EMC developed an "Emergency Procedure Manual" and used parts of both plans to train miners at the Wilberg Mine during the last annual refresher training session. The "Emergency Procedures Manual" had not been submitted to the MSHA District Manager for approval.

Underground fire fighting equipment included a water supply line with 1-1/2-inch outlets installed at 300-foot intervals in the belt conveyor entries. Fire hoses were provided at belt drives and other strategic locations. The 6-inch diameter water line in the 1st North belt entry was a combination of fiberglass and aluminum pipe. The 5th Right branch was 4-inch diameter aluminum pipe. A large sump, estimated to contain 40,000,000 gallons of water, was located at crosscut 9, Main North, where four 13-horsepower electric pumps were used to provide pressure to the water supply lines. Rock dust and dry chemical fire extinguishers were available at appropriate underground locations and heat-activated foam generating systems were provided at belt drives. Fire drills were conducted by the foremen supervising various crews, and a record was kept in a book on the surface. The records indicated that fire drills were conducted at intervals not exceeding 90 days and that mine personnel traveled the escapeways during these drills. Records also indicated annual tests of fire fighting equipment were conducted in January 1984 on fire outlets and hoses, and on foam generators in February 1984.

A Gulton Femco, Continuous Belt Drive Fire Detection (CBFD) system was installed to provide fire detection on the conveyor belt flights. The CBFD master control station was located in the bathhouse and was monitored by the bathhouse attendant.

Designated Escapeways

Generally, the two designated escapeways from working sections to the surface were the diesel roadway (intake) and the belt conveyor entries. The escapeways were parallel and adjacent in the 1st North areas of the mine. Concrete block stoppings, aluminum overcasts and material doors were used to separate the two escapeways in the 1st North area. Ladders or ramps were provided at overcasts to facilitate travel over these structures. There were deficiencies in both the route and condition of these escapeways, details of which are discussed in other parts of the report.

Explosives

Explosives were not used for coal production but were used for underground construction work. Explosives and detonators were obtained off mine property on a need-to-use basis.

Transportation and Haulage

Personnel and supplies were transported from the surface to the sections in compact diesel pickup trucks and diesel mantrip vehicles. Graded and graveled roadways were provided from the surface to the working sections. Equipment and supplies were transported with diesel scoops or diesel-powered tractors pulling supply trailers. Track haulage with trolley wire was available in 1st North from the surface to the mouth of 4th Right.

Coal was transported from the faces of continuous mining machine sections by shuttle cars, which discharged the coal onto a belt conveyor system at the section's loading point. Coal was transported from the headgates of the longwalls by panel belt conveyors which discharged onto the mine belt conveyor system. The conveyor system transported the coal to the surface storage and

loadout facility. Over-the-road haulage trucks transported the coal to the Hunter Power Plant.

Communications

Two-way voice communication was provided by a mine telephone system containing eight-line telephone console units located in the maintenance office, conference room, bathhouse, and the general mine foreman's office and pager telephones were located on the surface, on working sections, and at other appropriate locations underground. A permissible telephone system that was independent of the mine telephone system was used for communication across the longwall faces.

Oil Wells and Gas Wells

No oil wells or gas wells were known to exist on mine property.

Smoking

EMC had not submitted to MSHA a search program to ensure that smoking articles were not taken into the mine. A search program had been submitted by Peabody Coal Company and approved by MSHA on May 8, 1974, but EMC had not formally adopted the program. Records indicating that searches for smoking articles were being made were contained in a book on the surface; however, sworn statements from several miners indicated that they had not been searched for several months.

Mine Rescue and Self-Rescuers

EMC maintained two mine rescue teams and a fully equipped rescue station located near Huntington, Utah. This station served all of EMC's mines and was located 20 highway miles from the Wilberg Mine. The mine rescue teams were equipped with 4-hour, self-contained breathing apparatus.

EMC's self-rescuer storage plan for the Wilberg mine was approved by MSHA on February 10, 1983. The plan required a primary storage location within 1,000 feet or not more than five minutes travel time from the face workers. Storage locations were required to be accessible from more than one entry and a minimum of five SCSRs were to be stored in the return entry within 1,000 feet or five minutes from the tailgate of each longwall. SCSR secondary storage was required on nonface mobile equipment for all persons riding such equipment and in all areas outby the working sections so that persons working or traveling these areas will be within 2,000 feet or ten minutes travel time of the SCSRs at all times. All personnel carriers, jeeps, tractors, etc., used as mantrips were required to have enough SCSRs available on each unit to supply all persons riding on it.

Both filter-type self-rescuers (FSRs) and self-contained self-rescuers (SCSRs) were provided for all underground employees. Instruction in the use of the self-rescuers had been given by EMC.

Identification Check System

A check-in and check-out system was provided at the mine which consisted of a checkboard in the mine office complex and numbered brass tags that corresponded to the numbers on assigned cap lamps. Brass identification tags were affixed to the miners' belts on all but one of the victims.

Training Program

EMC's training and retraining plan, which was submitted in accordance with 30 CFR Part 48, was approved by MSHA on April 28, 1983. According to sworn statements, instruction was being given in accordance with this plan. However, the SCSR training was not adequate and is discussed in other parts of this report.

Emergency Medical Assistance

EMC had made arrangements with the Emery County Medical Center in Castle Dale, Utah, and the Castleview Hospital in Price, Utah, to provide emergency medical assistance for mine employees. A fully equipped ambulance was provided at the mine for transporting injured persons, and arrangements were also made with Emery County to provide ambulance service.

Illumination

Permissible electric cap lamps were worn by all persons in the mine for portable illumination. Permissible light fixtures were installed on the electric face equipment to provide illumination while the equipment was being operated in the working places of the mine. In various outby locations that were ventilated by intake air, nonpermissible light fixtures were used to provide area illumination.

Mine Drainage System

Approximately 1,200,000 gallons of water a day entered the Wilberg Mine. About 500,000 gallons entered the 1st North area and drained in a northwest direction to one of several sumps located on the west side of the No. 1 entry, 1st North. Water flowed north in a drainage ditch in the No. 4 entry on the east side of the diesel haulage road at the mouth of 5th Right where the smoke from the fire was first observed. Mine water was pumped into the main sump at crosscut 9 in Main North from six major collection and transfer sumps.

FIRE, FIREFIGHTING, SEARCH AND RESCUE ATTEMPTS, AND SEALING OF THE MINE

Fire

The information obtained from MSHA's underground observations and from the voluntary sworn statements of the miners and mine officials during the investigation revealed the following activities and sequence of events. The information about the activities in the 5th Right section before and after the fire is based primarily on the statement of the one miner who escaped from the section.

Activities Prior to the Fire

The afternoon shift of about 80 miners entered the mine at 4:00 p.m. on December 19, 1984, and the majority of the workers went to their normal work locations. Earlier in the day coal production on 5th Right longwall section had been above normal, and mine management decided to attempt a company longwall production record. Extra support personnel were assigned to assist the normal crew of 10 to 14 miners on the section. Clinton Price, timberman, was stationed at the 5th Right section belt drive to maintain the belt drive and operate the Super 500 belt take-up system. Leroy Hersh, service foreman (victim), and members of his crew were assigned to build cribs and help remove belt structure in the longwall stage loader area. Hersh and his crew arrived on the 5th Right panel around midshift. Kenneth Blake, general maintenance foreman-longwall, was called at home by David Bocook, mine manager (victim), and asked to report to the 5th Right section to provide his expertise in case of equipment breakdown. Blake arrived on the 5th Right section about 8:00 p.m. and joined Bocook, James Hamlin, vice president-operations (victim), Victor Cingoloni, general mine foreman (victim), and Alex Poulas, general mine foreman-longwall (victim), on the section.

Kelly Riddle, beltman (victim), and Price ate their evening meal together at the 5th Right belt drive. Just before 9:00 p.m., Riddle left the drive area to check the 5th Right belt conveyor. He entered the 5th Right intake entry (No. 4 entry, 1st North) through a mandoor in the overcast at crosscut 34. A few minutes later Price saw Lynn Robinson, fireboss (victim), pass through the drive area enroute to the section. The duties of the fireboss include the inspection of the belt entries and travelways in the mine for hazards and unsafe conditions and recording time, date and initials on fireboss tags to document the examination. Robinson also entered the No. 4 entry through the mandoor in the overcast. According to fireboss tags, Robinson probably entered the 5th Right belt entry through crosscut 4 and walked the belt entry to the headgate area where he initialed a tag at 9:15 p.m. With the arrival of Robinson, there were 28 miners on the 5th Right panel. There were no indications of any abnormal conditions on the 5th Right panel prior to 9:00 p.m.

Discovery of the Fire

Shortly after 9:00 p.m., Paul Salisbury, parts runner, was driving to 5th Right in a diesel pickup truck. After turning south into No. 4 entry, 1st North, (diesel roadway and intake entry), he saw smoke in the roadway at about crosscut 36. He turned the truck around and drove approximately 1,200 feet to a mine phone located at crosscut 39 in the No. 2 entry, 1st North, and reported the smoke to Percy Mounteer, warehouseman. Mounteer connected the 5th Right section

telephone circuit to the general mine circuit so Salisbury could also talk to them. It is believed that Robert Christensen, longwall cornerman (victim), answered the 5th Right mine phone. This three-way conversation was joined by Greg O'Neil, service foreman, who was listening on a phone at crosscut 25 in the 1st North belt entry. O'Neil asked Salisbury if it could be steam from the drainage ditch along the roadway in No. 4 entry instead of smoke. Apparently, water in this ditch occasionally gave off a water vapor mist during cold weather. Christensen did not give any indication of smoke being present on the section. Both Christensen and Salisbury indicated they would check out the smoke.

At about the same time that Salisbury discovered smoke, Price and Alex Tidwell, beltman, saw white smoke coming through bolt holes in the overcast near the 5th Right belt drive. The smoke was coming from the intake entry, into the belt entry and was drifting toward the 5th Right section. Tidwell turned off the 5th Right belt conveyor and Price opened the mandoor to the intake entry and observed thick smoke. Fire could be seen in the intake entry north of the overcast. Price looked at his watch and it was 9:15 p.m. Tidwell went to obtain a nearby firehose, and Price tried to contact the 5th Right section with the mine phone at the belt drive. No one responded to his page. Tidwell could not remove a plastic protective cover on the fire hose outlet on the main waterline, so he used a small washdown hose to spray water through the overcast mandoor. Price looked over the overcast in the direction of the 5th Right panel and could see that the Super 500 belt take-up area was clear of smoke, except for smoke drifting in that direction from the overcast.

The stopping of the 5th Right belt by Tidwell caused the 5th Right production equipment to stop at about the same time Christensen was involved in the first phone conversation between Salisbury and Mounteer about the presence of smoke in the intake entry.

On the surface, Leslie Cox, electrician, was in the bathhouse at the CBFD master station. Cox saw the belt run indicator light for 5th Right belt stop blinking, indicating the belt had stopped. He picked up the mine phone to inquire why the belt was down and overheard Salisbury reporting smoke. Cox continued listening on the phone.

Salisbury said that he drove back to the location where he first saw the smoke, got out of the truck, and saw flames on the roof above the roadway. Salisbury returned to the mine phone at crosscut 39 and reported the flames. Because the truck he was driving ran only in 1st gear, his round trip took about 5 minutes.

L. Cox and Ned Leavitt, maintenance foreman, heard Salisbury's second report of fire and immediately drove into the mine to fight the fire.

O'Neil left crosscut 25 and traveled in the belt entry toward the fire. He quickly arrived at the 5th Right belt drive and was informed of the seriousness of the fire and that the mine phone at the belt drive did not work. O'Neil then instructed Tidwell to go to the mine phone at crosscut 25 and report the condition. Tidwell ran to crosscut 25 and asked Robert Phelps, beltman, to make the call for him because he was out of breath. Phelps said that when he attempted to make the call he overheard conversations about the fire. Tidwell hurried back to the overcast where Price was still spraying water through the mandoor into the intake entry.

O'Neil continued in the belt entry to crosscut 40, where he entered No. 4 entry and traveled south to the fire. O'Neil said the fire was located 20 feet south of crosscut 36 or 37, flames were on the floor in a diagonal line across the entry, and chunks of top coal were falling from the roof. After Salisbury, O'Neil was the next person to arrive at the fire. O'Neil then traveled north to crosscut 46, belt entry, to a mine phone and called Mounteer and Willard Tharp, surface mechanic. O'Neil instructed Tharp to deenergize the high-voltage cable to 5th Right because he had seen the high-voltage cable down in the fire and felt that the cable could have been the source of the fire.

Tharp went to the surface substation and deenergized all electric power to the mine. The fan recording chart showed that the mine fan was shutdown at 9:26 p.m. and was automatically restarted by the backup diesel motor at a reduced pressure reading (See fan recording chart, Appendix E). The underground pumps, which provided water to the water supply line and fire hose outlets, stopped when the mine power was deenergized.

According to Price and Tidwell, the heat caused the belt/intake overcast to buckle and move, with small openings appearing around the concrete-block footer and wingwalls. The holes became larger as flames began coming through the overcast. The wingwalls began to fall and the overcast collapsed. When the overcast failed, heavy smoke and flames entered the belt entry and Tidwell and Price retreated to the intake (No. 2 entry) where they encountered some of the 4th Right section crew carrying hoses and fire extinguishers and the 13th Right section crew, who were evacuating the mine. Tidwell and Price joined the miners evacuating the mine and traveled to the surface.

Activities on the 5th Right Section and Escape of Only Survivor

Kenneth Blake, the only survivor, said that at some point prior to the fire a hazy condition was present at the headgate area, and a discussion about it concluded that it was probably due to diesel equipment fumes. He said that the section was relatively quiet and he was standing at the headgate when Cingolani received confirmation of the fire. Cingolani instructed Barry Jacobs, longwall section foreman (victim), to get the self-rescuers off the tailgate and to get his crew out the belt line. He believed that the top management officials left the headgate, traveling outby in the belt entry and he saw Jacobs start across the longwall face to warn the face workers. Blake traveled into the intake entry to get self-contained self-rescuers (SCSRs) and quickly became engulfed in smoke but proceeded to the section power center at crosscut 20, where he turned off the circuit breakers to the pumps and heard them stop. As he was returning to the headgate, Blake met two miners who gave him an SCSR. Blake stated that he and the two miners put on the SCSRs and went into the belt entry, which was also filled with thick smoke. As Blake proceeded out the belt entry, he recalled passing two more miners who were going in the same direction. When he reached crosscut 5, which was about 1,750 feet from the headgate, Blake met four or five miners gathered there. This area was very smoky with visibility of about one foot. All the miners Blake encountered during his escape were wearing SCSRs. Blake checked the mandoor in the isolation stopping located just west of crosscut 5. The door was not hot, but the air on the other side was hot. He checked the mandoor in the stopping located in crosscut 5 between the belt and intake entries. The air on the other side of the door was even hotter. At this time the miners realized that both the intake and belt entry escapeways were blocked.

Blake suggested that they try to escape out the return entry. He did not know at that time that the return entry was blocked by a roof fall.

Blake said that Hersh joined the group at crosscut 5 and he also checked the two mandoors, Hersh said to follow him and he traveled under the belt conveyor and entered the short entry off the belt entry known as the "dogleg" entry. As far as Blake could tell, he was the only one to follow. After a few minutes of wandering in this entry, which was filled with dense smoke, Hersh decided to return to the belt entry. After they turned to go back, they became separated. Blake decided to continue in the "dogleg" entry because he did not think he had enough time on his SCSR to travel back to the face and through the return entry.

After traveling about 250 feet, Blake eventually found a mandoor in a stopping and went through the door into No. 5 entry, 1st North. The air in this entry, which was the main return air course for 1st North, was smoky but cool. Blake traveled with the return air for a short distance when he heard the fire roaring and the top falling. He turned around and traveled against the air current farther into the mine. He noticed that the smoke was clearing near his feet, and got down on the floor and looked up the entry, where he saw the smoke coming around a corner. He walked past the corner and encountered clear air. Blake went through a door in an overcast and into No. 4 entry at crosscut 40.

As firefighters were installing a fire hose to fight the fire, Blake appeared in No. 4 entry. Brian Blomquist was one of the first persons to see Blake. He described him as in a state of shock, covered with soot and smoke residue, and wearing an SCSR. Blake told Blomquist that he had traveled out of 5th Right through the smoke. Blomquist told Richard Cox, mine foreman, about Blake and took him to the surface, where he was later questioned by mine officials and an MSHA inspector. Blake was asked to write a statement of the events he could recall. A copy of this initial statement that was taken immediately after his escape is contained in Appendix F.

Mine Evacuation and Notification of Mine Emergency Personnel

After confirmation of the fire by Salisbury, Mounteer began notifying miners in other areas of the mine. Mounteer contacted R. Cox at the 13th Right longwall, and informed him of the fire. R. Cox told Mounteer to evacuate the mine and have everyone report to the bathhouse so they could account for personnel. A general mine evacuation occurred and mine personnel gathered inside the bathhouse. All mine personnel, except for those fighting the fire and the victims on the 5th Right section, evacuated the mine.

Mounteer and Don Wilberg, bathhouse attendent, telephoned designated emergency personnel, and additional miners arrived for their regular 12:00 a.m. shift. Neldon Sitterud, safety director, arrived at the mine at about 10:00 p.m. and took charge of the overall fire fighting and rescue activities until William Zeller, senior vice president, arrived around 11:00 p.m. Travel to the mine was hampered by a severe winter snow storm.

Activities of MSHA Personnel

At 9:55 p.m., December 19, 1984, John Turner, coal mine safety and health inspector, Orangeville, Utah, received a telephone call from Blake and was

notified of the fire. Turner contacted Robert Huggins, coal mine safety and health inspector, and Jack Matekovic, supervisory coal mine safety and health inspector, Orangeville, Utah. At the time there was no positive information concerning missing personnel. Matekovic contacted Lamar Bishop, subdistrict manager, Price, Utah, who notified John Barton, district manager, Denver, Colorado, at 10:20 p.m.

Turner and Huggins arrived at the mine shortly after 10:00 p.m. and Turner immediately traveled underground. After ensuring a check out system was established on the surface, Huggins entered the mine and traveled to 8th Right to see if any miners had escaped out the bleeder entry while Turner monitored the area of the fire.

Turner first traveled in the belt entry to crosscut 34 where he observed flames in No. 4 entry at crosscut 34, but no fire was present on the 5th Right belt drive itself. A hose was being used to fight the fire, but the water pressure was low because of the deenergized pumps. He requested that an additional hose be installed, then traveled in the belt entry to crosscut 30 where miners were installing a fire hose to use at a mandoor into the No. 4 entry. No fire was observed in this area. Turner then traveled to No. 4 entry, where he observed miners fighting the fire at crosscut 36.

The firefighters were using a line curtain to shield them from the heat and smoke and were spraying water into the fire area. Turner returned to the 5th Right belt drive and to crosscut 30, in the belt entry. At about 11:30 p.m. Huggins returned to the surface to coordinate MSHA activities and Turner remained underground to monitor fire fighting.

On the surface, Huggins issued a Section 103(k) order and began a written log of mine activities. The 103(k) order covered the entire mine and permitted only those persons necessary for the fire fighting and rescue operations to enter the mine. Additionally, it required all fire fighting and rescue activities to be approved by MSHA.

Matekovic and Bishop arrived at the mine at about midnight. A second 103(k) order was issued to the Deer Creek Mine which was located above the Wilberg Mine, because the two mines were interconnected by a shaft and roof cracks in the longwall gobs. A surface control center was established and Bishop assumed the direction of MSHA activities. Bishop contacted Barton at 12:30 a.m. and advised him of the seriousness of the fire and that there were missing miners. Barton contacted Joseph Lamonica, administrator for coal mine safety and health, and requested that the Mine Emergency Operation staff be placed on alert. Donald Walker, chief, Safety and Health Technology Center, Denver, Colorado, was also contacted and he began preparations to dispatch mine emergengy equipment and technical staff to the mine. Barton and the District staff, substantially delayed by the storm, arrived at the mine at 4:00 p.m., December 20 and Barton assumed direction of MSHA activities from Bishop.

Equipment and technical support staff from the MSHA Safety and Health Technology Center arrived at the mine at 7:00 p.m., December 20, and installed a gas chromatograph, infrared gas analyzers, and other equipment. The infrared gas analyzers provided a continuous digital readout and a strip chart record for methane, carbon monoxide, and carbon dioxide. Mine gas samples were drawn

through tubing from the Main North return entries, about 800 feet inby the mine fan. Additional technical support staff and MSHA's mine emergency van arrived at the mine at 10:00 p.m., December 20.

Donald Huntley, district manager, Pittsburgh, Pennsylvania, and Ray Ross, district manager, Norton, Virginia, were dispatched to the mine to assist in directing MSHA activities. Huntley and Ross arrived at the mine at 10:00 p.m., December 21, 1984.

Jeffrey Kravitz, chief, Mine Emergency Operations (MEO), Aliquippa, Pennsylvania, was notified of the fire at 6:49 a.m., EST, December 20, 1984, and was instructed to send equipment and personnel. Communication equipment, seismic locating equipment, an auxiliary generator, and additional personnel arrived at the mine at 10:25 p.m. EST, December 21. Seismic equipment was set up in the adjacent Little Dove Mine, and tests were conducted on December 22 to locate miners who might be behind barricades in the 4th Right longwall set up entries. MEO personnel established and maintained radio and telephone communications to the mine emergency van and also assisted with mine gas analysis.

Fire Fighting

Initial Fire Fighting Activities

L. Cox and Leavitt arrived at the fire a few minutes after leaving the surface. In their sworn statements, they located the fire between crosscuts 36 and 37 in the No. 4 entry of 1st North. They expended several fire extinguishers at the fire and left to get help. O'Neil met Leavitt and L. Cox at crosscut 43. Leavitt told O'Neil that he was going to get help and would be back. O'Neil returned to the fire, where he saw the spent fire extinguishers and described the fire as roaring and involving the entire entry. O'Neil began hooking up a fire hose to fight the fire.

Leavitt traveled to crosscut 22, No. 2 entry, where he called the diesel shop at crosscut 68, 1st North, and told the mechanics to bring fire fighting equipment to 5th Right. When Bryan Blomquist, Rick Boyle, and Earl Nelson, mechanics, arrived at the fire, they too expended fire extinguishers to no avail and then assisted O'Neil in hooking up a water hose.

Leavitt and L. Cox returned to the fire with Joseph Edgehouse and Edmond Taylor, truck drivers. They expended more fire extinguishers and assisted with installing fire hoses.

After being informed of the fire by Mounteer, R. Cox left 13th Right, which was located about 7,600 feet inby the fire, and traveled to the fire in a pickup truck. R. Cox arrived at the 5th Right belt drive at crosscut 34, No. 3 entry, and then traveled to the No. 4 entry where miners were installing a fire hose. He then walked south to a location between crosscuts 36 and 37 and stopped because of smoke. R. Cox assumed control of the fire fighting activities in the No. 4 entry and instructed Leavitt to go outside to restore mine power and restart the mine water supply pumps.

Fire hoses were installed from the water line in the belt entry to the No. 4 entry and to the 5th Right belt drive at crosscut 34. Two problems were

encountered while installing the fire hoses. The plastic cap that protected the pipe threads on one of the outlets could not be easily removed, and a "T" fitting was uncapped allowing water to flow out of the uncapped end of the "T" instead of through the fire hose. After the hoses were installed minimal water pressure was available because the mine pumps were deenergized.

Using the fire hose and the minimal water flow, the firefighters held up a brattice curtain across the No. 4 entry and pushed back the smoke to crosscut 36. After about 20 minutes, water pressure was completely lost. While waiting for pressure to be restored, a check curtain was installed across the No. 4 entry to restrict the air current to the fire and a second fire hose was installed. Brattice was also hung on stoppings between the Nos. 2 and 3 entries, 1st North, and at the isolation stopping north of crosscut 31 in the belt entry to reduce air reaching the fire at crosscut 34.

Restoration of Water and Additional Water Problems

Shortly after the power was deenergized, Leavitt called the mine office from underground and told Phillip Cox, electrician, to restart the water pumps. P. Cox proceeded to the surface substation where he checked the position of the oil circuit breakers, opened the visual disconnects on the six mine circuits, and energized the Main West feed circuit in preparation for restoring power to the underground circuits. L. Cox and Douglas Jensen, mechanic, traveled underground to isolate the high-voltage circuit to the 5th Right section. After this was done, P. Cox restored power to the No. 1 high-voltage cable circuit which supplied power to the power center for the water supply pumps. At 10:18 p.m., December 19, Steven McDonald, service foreman, reset the circuit breaker to the pump and restarted the water pumps at crosscut 9, Main North. This restored water pressure to the water supply line.

Even though the water pumps were restarted, water pressure still was not received at the fire hoses in the No. 4 entry, 1st North. Leavitt traveled to the 5th Right belt drive at crosscut 34 and found the water line to 5th Right burned into and water flowing from the line. Leavitt closed the valve to the 5th Right water line, which provided pressure to the fire hoses. Leavitt estimated that water pressure was restored between 11:00 and 11:30 p.m., December 19, approximately 2 hours after the fire was detected.

With water pressure restored, the firefighters advanced in No. 4 entry to crosscut 36, by holding a curtain in front of them and spraying water over the curtain. Miners holding the curtain on the east side of the entry could not proceed past the north corner of crosscut 36 due to heavy smoke. Those on the west side advanced past crosscut 36. A line curtain was installed in No. 4 entry from the northeast corner of crosscut 36 to within a few feet of the west rib. R. Cox and two other miners continued their advance, spraying water and extending the line curtain along the west rib, until they reached the northwest corner of crosscut 35. After this advance, a roof fall or mild explosion occurred in the fire area between 1:00 and 2:00 a.m., December 20, which forced them to retreat. Firefighters at crosscut 34, No. 3 entry, were also forced to retreat.

Water pressure was lost several times during the fire fighting because the water supply line in the belt entry, 1st North, was severed by the fire. The 1st

North discharge water system, which normally provided water to the main sump at Main North, was used to provide water directly to the water supply line. This was accomplished by using the discharge pumps at the crosscut 46, 1st North water sump. The installation of a 4-inch aluminum water line from crosscut 40 to crosscut 10 in the No. 2 entry, which bypassed the fire area, connected the discharge water system in 1st North to the water supply system from the main sump. Water was then provided to the fire hoses from two separate sources. Water from the fire fighting drained back to the 1st North collection system and was recycled to the fire hoses. The main sump contained an estimated 40 million gallons of water. Following this change in the water system, a relatively constant supply of water was provided for fire fighting.

Fire Fighting Activities and Advance of the Fire

Soon after the fire was discovered, fire hoses were installed from the water line in the belt entry, 1st North, to the overcast in crosscut 34 and to crosscut 30 at a mandoor into No. 4 entry. Fire was observed in the No. 4 entry through the mandoor at crosscut 30 between 12:30 and 1:00 a.m., December 20. Around 1:30 a.m., flames intensified at this location after what seemed to be a large roof fall or explosion in the fire area.

Around 2:00 a.m., December 20, the 4th Right intake/return overcast, located at crosscut 23, No. 5 entry, started to burn through. After the overcast failed, a stopping was installed in crosscut 23 between Nos. 4 and 5 entries to keep intake air from short-circuiting directly into the 1st North return entries.

During the early morning hours of December 20, a track-mounted rock-dusting machine was used to blow 40 tons of rock dust into No. 5 entry at crosscuts 20 and 17. Rock dust was also blown into No. 5 entry at other outby locations in an attempt to slow down the advance of the fire. In addition, an electric foam-generating machine was used at crosscut 21 to blow foam into No. 5 entry. This machine was moved to crosscut 12 after fire broke into the No. 4 entry at crosscut 24, between 6:30 and 7:30 a.m., December 20.

Stoppings were constructed between crosscuts 12 and 13 across the Nos. 3 and 4 entries to prevent the fire from spreading south of crosscut 13 in these entries. The stoppings were completed by 1:50 p.m. on December 20. Afterwards, fire fighting in the outby areas consisted mainly of injecting foam into the No. 5 entry at crosscut 12, and maintaining the stoppings between Nos. 2 and 3 entries north of crosscut 12 and between the Nos. 4 and 5 entries south of crosscut 12. Several stoppings had to be built in most of these crosscuts to prevent the fire from burning through into the No. 2 entry. The fire was contained behind these stoppings until about 3:15 p.m. on December 23, when the mine was evacuated after the fire broke into the No. 4 entry at crosscuts 2 and 10.

Search and Rescue Attempts

Initial Explorations

Kenneth Valdez, longwall coordinator, traveled into the No. 5 entry to crosscut 35 and to the mandoor in the 5th Right panel regulator. He activated an SCSR and went into the "dogleg" entry. Valdez described the entry as very smoky, and after going about 70 feet he retreated. He did not observe any of the victims

in the entry due to the heavy smoke. Valdez returned to the No. 2 entry, where he met MSHA inspectors Huggins and Turner. Based upon their arrival time at the mine, it is estimated that Valdez entered the "dogleg" entry between 10:30 and 11:00 p.m. on December 19.

Valdez, Gilberto Madrid, longwall service foreman, and Michael Ledger, shift foreman, decided to explore the longwall bleeder entries for miners who may have escaped. At about 12:30 a.m., they traveled through the bleeder entries from 8th Right to 6th Right. At the intersection of the 6th Right entries with the bleeder entries they encountered a roof fall that appeared to block their way. Several fireboss tags were left as the group entered and returned from this area. During this voluntary exploration, only traces of carbon monoxide were detected, and although SCSRs were carried, they were not used. Valdez, Madrid, and Ledger traveled a one-way distance of 4,700 feet in the bleeder entries.

Valdez and Ledger joined Blake Webster, mine rescue team member, and explored 6th Right panel, which was the return airway from 5th Right longwall. Webster used a mine rescue breathing apparatus and Valdez and Ledger used SCSRs to explore. They encountered a roof fall at about crosscut 13 and detected 300 parts per million (ppm) of CO so they returned to 1st North. Two other trips into 6th Right were attempted by Valdez and Ledger, but because the SCSRs Ledger was using would not inflate properly all three explorations had to be abandoned.

Mine Rescue Team Response

The first mine rescue team entered the mine around 11:50 p.m., traveled to crosscut 39, No. 2 entry, 1st North, where they put on apparatus, and went to the fire area in No. 4 entry. Gary Christensen, team captain, left two team members with the firefighters in No. 4 entry and the remaining team members traveled into No. 5 entry, to the overcast at crosscut 34. The overcast had collapsed and fire was in the intersection. The stopping at crosscut 35 between Nos. 4 and 5 entries was hot and smoke was coming through a hole in the stopping at crosscut 36. They installed a fire hose down the No. 5 entry to crosscut 35 and sprayed water into No. 4 entry through the mandoor. At about 2:00 a.m., the team had installed a second fire hose in No. 5 entry and was fighting the fire at the collapsed overcast at crosscut 34. Firefighters remained at this location throughout the rescue and exploration attempt into 5th Right.

David Lauriski, safety specialist, arrived at the fire area around 2:00 a.m., December 20. He established a fresh-air base at crosscut 40, No. 4 entry, and had a mine phone installed. The fresh-air base was continuously manned by MSHA and EMC personnel and was the underground command center for fire fighting and exploration efforts throughout the rescue attempt.

The fresh-air base was located inby the fire area in 1st North and was accessible via the diesel roadway in the No. 2 entry, through crosscut 43 to the No. 4 entry, and then south to crosscut 40. This route was also the escapeway from the fresh-air base. Due to the possibility of fire breaking into No. 2 entry from the belt entry, a second intake air escapeway was established in the No. 1 entry, by installing a line of temporary stoppings in the crosscuts between the Nos. 1 and 2 entries. Construction of these stoppings from crosscut 9 to crosscut 43 was completed on December 22. Initially the stoppings were brattice curtains hung in the crosscuts, but metal stoppings were later installed.

Isolation drop curtains were also installed across the No. 2 entry, 1st North, that could be quickly dropped in place if fire and smoke entered from No. 3 entry.

The first exploration of the 5th Right entries by a mine rescue team occurred around 11:00 a.m., December 20. A mine rescue team entered the "dogleg" entry and encountered heavy smoke and extremely poor visibility of about one-foot. The team advanced 300 feet to crosscut 5, but did not discover any of the nine victims that were later found in the entry. Exploration was stopped because of the heavy smoke and apparatus problems.

At the same time, another exploration was conducted into 6th Right. Valdez and Daniel Brink, longwall superintendent, Deer Creek Mine, using mine rescue breathing apparatus, explored to the caved area near crosscut 13. While returning, Brink's apparatus reached depletion and he collapsed near crosscut 8. Valdez ran back to the fresh-air base to get help. Several rescue team members including Madrid and Blomquist, rushed into 6th Right to rescue Brink. During this rescue attempt, Madrid was also overcome after giving his breathing apparatus to Brink and attempting to escape the area sharing Blomquist's breathing apparatus. Both Brink and Madrid were rescued by other mine rescue team members and transported to the surface where they received emergency medical treatment.

Following these attempts, no further explorations were made until the morning hours of December 21. Work continued to control the fire at the mouth of 5th Right. Several stoppings were installed in the crosscuts between the Nos. 2 and 3 entries in 1st North to prevent the fire from entering the No. 2 entry.

During the evening hours of December 20, a diesel foam-generating machine was set up in No. 4 entry between crosscuts 37 and 38. This machine was started at 6:30 p.m., and after some adjustments was able to block the No. 4 entry with foam. A second foam generating machine was installed at crosscut 34, No. 2 entry. This machine was started around 10:00 p.m., December 20, and foam was directed into No. 4 entry at crosscut 34. These two machines remained at these locations for the remainder of the fire fighting operation. The objective of using these machines at these locations was to control the fire at the entrance to 5th Right so that exploration teams could be sent into the section. In addition to the foam generating machines, fire hoses continued to be used in No. 5 entry between crosscuts 34 and 36. Mine rescue teams were used to maintain the foam generating machines and to man the fire hoses.

On December 21, the fire at the mouth of 5th Right was under control and a second mine rescue team exploration was conducted. Around 5:00 a.m., the stopping in crosscut 39, between Nos. 4 and 5 entries was breached, directing intake air into No. 5 entry. Kaiser Coal Corporation's mine rescue team installed a check curtain across the No. 5 entry between crosscuts 34 and 35, to direct airflow into the "dogleg" entry of 5th Right. After waiting a few minutes to see if the smoke would clear, the team entered the smoke-filled entry around 5:30 a.m. The team explored to crosscut 5 in the "dogleg" entry and discovered the bodies of nine victims. David Bocook, mine manager, and James Hamlin, vice president of operations, were found near the regulator. The other seven victims were located within 230 feet of the regulator. These seven were: Phillip Bell, longwall coordinator; Randall Curry, longwall mechanic; Roger Ellis, loading machine

operator; Alex Poulos, longwall general mine foreman; Lee Johansen, mechanic; Leroy Hersh, service foreman; and Victor Cingolani, general mine foreman.

The team continued the exploration through crosscut 5 into the belt entry and propped open the mandoor of the stopping to the intake entry. The smoke and air in the belt entry started to move noticeably. The team retreated to the fresh-air base to let the smoke clear and to obtain a fire hose. After about 20 minutes, the Kaiser team returned to the belt entry of 5th Right, where they cut the conveyor belt and erected a check curtain just east of crosscut 5. The team retreated to the fresh-air base at 7:10 a.m., December 21.

The Price River Coal Company team made the next exploration. Visibility in the "dogleg" entry was about 20 feet. The team advanced to the belt entry, where visibility was 3 to 5 feet, and into the intake entry at crosscut 5, where visibility was zero. Due to the visibility and a team member becoming ill, the team retreated to No. 5 entry, 1st North. The team then returned to the belt entry, where a fire hose was used to spray water into the intake entry at crosscut 5, to try and clear the smoke. The fire at the mouth of 5th Right flared up, forcing the Price River team to retreat at 8:00 a.m.

An EMC team entered the "dogleg" entry to identify the nine victims. Visibility was again poor, and the team traveled only to crosscut 5 in the belt entry. Further explorations into 5th Right were briefly halted until the fire could be brought back under control at the mouth of 5th Right.

Around 3:00 p.m., December 21, a second EMC team entered the "dogleg" entry. Visibility in the "dogleg" entry had improved, but thick smoke and heat were encountered in the intake entry at crosscut 5. The team hung a curtain across the intake entry east of crosscut 5, and returned to the fresh-air base at 3:35 p.m.

Around 4:00 p.m., the Rio Algom No. 1 team went into 5th Right. They advanced inby the curtain in the belt entry at crosscut 5 and discovered four bodies between crosscuts 5 and 7. Visibility was about 20 feet and the team stopped at crosscut 7, where they knocked out a hole in the stopping for ventilation. They retreated to the fresh-air base at 5:30 p.m. All four victims were found along the belt entry walkway. Kelly Riddle, beltman, was located about 25 feet east of crosscut 5. Lynn Robinson, fireboss, was found at crosscut 6. Robert Christensen, longwall cornerman, was located about 45 feet east of crosscut 6; and Joel Nevitt, laborer, was found at crosscut 7.

The next advance was made by the Kaiser Coal Corporation No. 1 team. This team installed a mine phone in the belt entry at crosscut 5. They advanced to crosscut 7, then returned to crosscut 5, went into the intake entry, and took down the curtain which had been installed by the EMC team. The Kaiser team retreated to the fresh-air base at 7:15 p.m., December 21, due to an apparatus problem.

The Price River team entered the belt entry, and visibility had deteriorated to 1 to 5 feet. The team returned to the fresh-air base at 8:15 p.m., December 21, after a team member became ill. The Southern Utah Fuel Company team entered 5th Right at 8:30 p.m. and advanced to crosscut 7 to identify a body in the belt entry. This team returned to the fresh-air base at 9:00 p.m., and was replaced by the Soldier Creek Coal Company team, which advanced in the belt entry to

crosscut 11. Visibility at crosscut 5 in the belt entry was 3 to 4 feet. A team member became ill and the team retreated to the fresh-air base, arriving at 10:30 p.m. During their retreat, the Soldier Creek team installed a curtain over the hole in the stopping in crosscut 7.

The Rio Algom No. 2 team entered 5th Right at 10:50 p.m., December 21, and traveled to crosscut 10 in the belt entry. Visibility was 4 to 5 feet. The team installed a mine phone at crosscut 10 in the belt entry, and opened the mandoor into the intake entry. A team member became ill at about 11:50 p.m., and they returned to the fresh-air base. Another mine rescue team entered 5th Right at 12:45 a.m., December 22, and advanced in the belt entry to crosscut 14, 900 feet from the longwall headgate. The smoke was beginning to clear in the belt entry. As the team retreated, they closed the mandoor in crosscut 10, and they returned to the fresh-air base at 2:30 a.m. The Plateau Mining Company team entered 5th Right at 3:10 a.m. December 22, and advanced in the belt entry to crosscut 10. They were told to return to the fresh-air base and to evacuate the mine.

At 3:40 a.m., December 22, fire broke through the stopping at crosscut 25, between Nos. 2 and 3 entries, 1st North, and all underground personnel were withdrawn from the mine. At 5:10 a.m., MSHA personnel and two mine rescue teams entered the mine and traveled to crosscut 25 where they found a 1-1/2-by 2-foot hole in the upper left corner of the stopping. Work was started to build another stopping there. At 6:50 a.m., the Carbon County Coal Company team was sent to examine the stoppings north of crosscut 25. The team advanced to the fresh-air base at crosscut 40, at 7:20 a.m., and resumed fire fighting efforts.

Prior to the evacuation, an auxiliary fan was brought to the fresh-air base to clear the smoke in 5th Right, but installation was delayed due to the evacuation. Installation resumed around 8:00 a.m. Rigid tubing, 24 inches in diameter, was installed from the auxiliary fan located just south of crosscut 40, in the No. 4 entry, through crosscut 39, south in the No. 5 entry, to crosscut 35, where it was placed through the regulator into the "dogleg" entry. Installation was completed by 1:15 p.m., December 22, and the fan started.

The Rio Algom team entered 5th Right around 1:45 p.m., December 22, and advanced in the belt entry to crosscut 10. Air readings in the entry showed oxygen at 21% and carbon monoxide at 5 ppm. They went into the intake entry where the oxygen, carbon monoxide, and methane were 19.6%, 850 ppm, and 0.5%, respectively. They explored the intake entry from crosscut 10 to crosscut 5 and returned to the fresh-air base at 3:30 p.m.

An EMC team entered 5th Right at 4:15 p.m. and traveled to crosscut 10 in the belt entry. They went into the intake entry, where visibility was about 50 feet, and explored back to crosscut 3, where they encountered heavy smoke and could see flames in the entry. They returned to crosscut 10 in the intake entry. As they returned they went into crosscut 4 toward the belt entry, and observed a material door with the east door approximately 80% open. The smoke was heavy in the belt entry, and the team was instructed not to go into the area. The Super 500 belt take-up was located in this area. The material door was left as it was found.

The EMC team continued to explore in the intake entry to the section power center at crosscut 20, where visibility was extremely good. The team found two H & J diesel mantrip vehicles and four Isuzu pickup trucks parked between crosscuts 15 and 20. Some of the SCSRs stored on these vehicles had been removed. An opened SCSR with lid and clamp was observed at a Wagner diesel scoop in crosscut 15, and an SCSR and two pairs of goggles were found in the intake entry at crosscut 16.

The EMC team returned to crosscut 10 and went into the belt entry. The mine phone was advanced to crosscut 15, and the team advanced through a check curtain located just west of crosscut 22, and found five victims in the walkway along the south side of the stage loader. Brian Howard, longwall faceman, was located at crosscut 22 about 70 feet west of the longwall face. The other four victims, Nannette M. Wheeler, gas watchman; Lester Walls, Jr., longwall shear operator; Curtis A. Carter, stoper operator; and John Wilsey, laborer, were found in a group located between 20 and 45 feet west of the longwall face. The five victims at the longwall headgate were found at 6:15 p.m., December 22. The EMC team retreated from the section, arriving at the fresh-air base at 6:40 p.m.

The Kaiser Coal Corporation No. 2 team entered 5th Right, advanced the mine phone to crosscut 20 in the belt entry, and entered the intake entry. At 6:46 p.m., December 22, the body of Ricci Camberlango, longwall shear operator, was found in crosscut 21, which was the "kitchen" area. Visibility was 60 to 70 feet with light smoke, but the illumination by cap lamps was very poor due to the smoke and soot residue that covered the area.

The team went through crosscut 22 into the headgate area and observed the five victims that had been found by the EMC team. They returned to the intake entry and traveled east in the bleeder entry. Three check curtains were found across the entry between crosscuts 22 and 24. The team first thought that these curtains were barricades, but after examination they were determined to be ventilation curtains for the longwall. The Kaiser team traveled to the setup entries for the 4th Right longwall at crosscut 29. These entries were thought to be an area where miners might have barricaded, but no curtains or barricades were found. The Kaiser team retreated to crosscut 20, in the intake entry and at 7:05 p.m., and found the body of Owen Curtis, beltman, at the east corner of crosscut 21.

The Kaiser team returned to the belt entry and took down the check curtain near crosscut 22. They then explored both sides of the stage loader to the headgate. At 7:25 p.m. three victims were found under the first three shields. John Waldoch, laborer; Bert A. Bennett, longwall propman; and Barry Jacobs, longwall section foreman, were found in a group beside the face conveyor. Visibility was clear along the longwall face, and the Kaiser team captain traveled to the No. 15 shield. The Kaiser team returned to the fresh-air base, arriving at 7:50 p.m.

An EMC team left the fresh-air base at 7:45 p.m. and traveled in the belt entry to the longwall headgate. The EMC team advanced the mine phone from crosscut 20 to the headgate, and identified the three victims on the face. They began exploration across the longwall face at 8:30 p.m., traveling past the shearing machine, located approximately 320 feet from the headgate, to the tailgate at 9:05 p.m. The bodies of two victims were discovered in the return entry at 9:10 p.m., December 22. Gary Jennings, longwall propman, was found 30 feet west of

the longwall face, and Ray Snow, laborer, was found 160 feet west of the face. Both of the victims were found in the walkway between a double row of cribs. The EMC team continued west in the return entry to a roof fall at crosscut 19, about 320 feet from the longwall face. They had followed footprints to the caved area but decided to retreat because of the bad roof conditions. The team returned to the longwall tailgate and explored east in the entry approximately 150 feet. They then retreated to the headgate, and traveled in the intake entry to the 4th Right longwall setup entries. Carbon monoxide exceeded the 3,000 ppm limit of a Draeger test tube in the setup entries, but visibility was excellent. No other victims were found and the team returned to the fresh-air base.

Another EMC team entered 5th Right at 9:30 p.m., and traveled to the 4th Right longwall setup entries. They explored the setup entries then advanced into the 5th Right bleeder entry where they encountered a squeezed area at 6th Right. This was the same area that Valdez, Madrid, and Ledger had approached from the 8th Right side. Christensen crawled through the squeezed area as far as he could with his apparatus on. He stated that the area was about 2 feet high and that he could see through to the other side. The EMC team returned to the longwall headgate at about 11:30 p.m. and retreated out of the section. As they traveled out the belt entry, the EMC team again identified the bodies of the victims. The team arrived at the fresh-air base at 12:20 a.m., December 23, 1984.

As the EMC team was exploring, the U.S. Fuel team started recovering the victims in the "dogleg" entry. The nine victims were to be placed in body bags and removed to a temporary morgue near the fresh-air base.

The Mid-Continent Coal Company team began the final exploration of 5th Right at 12:35 a.m., December 23. At that time two miners were still missing. The belt entry west of crosscut 4, which contained the Super 500 belt take-up was the only accessible area which hadn't been explored. The Mid-Continent team explored the belt entry from the isolation stopping at crosscut 5 to crosscut 3. Smoke was heavy in this area, and flames were observed near crosscut 3. The team also explored into the intake entry near crosscut 4. No other victims were found. The team was instructed to take two body bags and travel to the tailgate entry to remove the two victims there. As the team prepared to go to the 5th Right tailgate, visibility became noticeably worse. The Price River Coal Company team, fighting the fire in the No. 5 entry, 1st North, called the fresh-air base to report zero visibility and an increase in carbon monoxide from 400 to 2,000 ppm within fifteen minutes. At 1:50 a.m., December 23, the teams were told to return to the fresh-air base.

By 2:00 a.m., all mine rescue team personnel had returned to the fresh-air base. The conditions were deteriorating, with smoke backing up in the No. 4 entry to the auxiliary fan and carbon monoxide increasing from about 10 to 150 ppm at the fresh-air base. At 2:04 a.m., December 23, the command center advised personnel at the fresh-air base to retreat to the No. 2 entry, 1st North, and establish a new fresh-air base. Attempts were made to establish a fresh-air base at crosscut 39 and then 24; however, most of the underground personnel went to the surface. Several MSHA and EMC personnel remained at crosscut 24, No. 2 entry, and crosscut 12, No. 4 entry, to monitor conditions. Prior to this partial evacuation, eight of the nine bodies in the "dogleg" entry had been moved to an

underground temporary morgue at crosscut 40. Because of the unplanned nature of the evacuation and the emergency situation, these bodies were left underground.

Around 3:15 a.m., December 23, additional MSHA and EMC personnel went into 1st North to assess the fire conditions. Stoppings at crosscuts 10, 11, 24, and 25, were found to be very hot. Following this examination, MSHA officials felt that it was unsafe to continue direct fire fighting and that the fire area should be sealed. Two of the 27 miners remained missing, but based on the conditions observed in 5th Right, it was agreed that they could not have survived. By 6:00 a.m., December 23, EMC officials decided to seal the fire area at underground locations.

Sealing of the Mine

Plans to seal the fire area at underground locations required construction of nine temporary seals, five across the 1st North entries between crosscuts 2 and 3, and four across the Main North entries between crosscuts 19 and 20. These temporary seals were to be constructed of brattice curtain hung on timbers and boards and sealed with a polyurethane foam. The temporary seals in Nos. 1, 2, and 3 entries, 1st North, were completed by 1:45 p.m., December 23.

Around 2:00 p.m., an EMC mine rescue team traveled to crosscut 2, 1st North, to begin construction of temporary seals in the Nos. 5 and 6 entries. The team traveled to the stopping in crosscut 2 between Nos. 3 and 4 entries, and Curtis Steele, rescue team captain, stepped through into the No. 4 (return) entry. Smoke was very dense, with visibility less than 6 inches, and the entry was extremely hot. Steele returned to the belt entry to advise the command center of the conditions. At 2:56 p.m., the No. 4 entry at crosscut 2 erupted in flames. Within minutes, personnel in the track entry of Main West reported that the stopping at crosscut 10 between the track and return entries had blown out. Shortly after these occurrences, MSHA Technical Support personnel advised the command center of a drastic increase in methane and carbon monoxide concentrations near the mine fan in Main North. An evacuation of the underground portion of the mine was ordered at 3:13 p.m. By 3:20 p.m., all personnel had arrived at the surface and were accounted for.

The concentration of explosive gases continued to increase, and at 3:25 p.m. a methane concentration of 4.0% was recorded by infrared analyzing equipment. Between 3:30 and 4:00 p.m. evacuation of the mine surface facilities was ordered because of the proximity of the 1st South and Main North portals. At 5:00 p.m., December 23, MSHA issued a Section 107(a) imminent danger order, prohibiting access to the surface area of the mine. Emery County sheriff deputies and MSHA inspectors monitored a roadblock to prohibit access to the mine.

The following table summarizes mine gas concentrations that were obtained from Main North return entries prior to the evacuation on December 23, 1984.

12/23/84	CO (ppm)	CO_2(%)	CH_4(%)
6:00 a.m.	3,100	1.3	0.5
6:30 a.m.	3,200	1.2	0.5
7:00 a.m.	3,800	1.1	0.45
7:30 a.m.	3,800	1.1	0.5
8:00 a.m.	4,000	1.2	0.6
8:30 a.m.	4,000	1.1	0.65
9:00 a.m.	4,400	1.1	0.65
9:30 a.m.	4,100	1.0	0.70
10:00 a.m.	4,300	1.0	0.65
10:30 a.m.	4,500	1.1	0.80
11:00 a.m.	4,500	1.1	0.85
11:30 a.m.	4,500	1.1	0.75
12:30 p.m.	3,800	1.2	0.75
1:30 p.m.	4,000	1.5	0.80
2:30 p.m.	3,600	1.6	0.70
2:54 p.m.	5,000	2.5	1.3
3:04 p.m.	6,800	2.7	1.5
3:15 p.m.	11,200	-	2.8
3:25 p.m.	-	-	4.0

Mine power was deenergized during final evacuation of the mine, but the fan continued to operate for approximately 24 hours on the back-up diesel engine. To slow the spread of the fire, the fan needed to be stopped; however, because of the possibility of an explosion, this could not be done safely on the ground. The diesel engine was disabled, using a high-powered rifle, fired from a helicopter.

By December 25, the fire had progressed to the 1st South portals, where flames and heavy, black smoke were visible. The fire intensified during the day, and on December 26 the rock cliffs above the portals collapsed, blocking the portal entrances and extinguishing the flames.

Sealing the mine at the portals began on December 26, 1984. Substantial permanent seals were constructed at eight portals. Temporary seals of brattice cloth and polyurethane foam were installed at the other seven mine openings. The raise bin between the Wilberg and Deer Creek Mines was sealed by dumping rock dust into the bin and constructing concrete block seals in the Deer Creek entries leading to the bin.

On December 27 the fire had progressed to the 3rd East intake portal. The smoke was less intense than at the 1st South portals. Initial seals were completed at the 15 mine openings by 8:00 p.m., December 29, 1984. Permanent seals were completed on January 7, 1985, at the seven temporary seal locations.

RECOVERY AND INVESTIGATION

Recovery

Recovery work began on February 13, 1985, with reentry into the western portion of the mine at 4th East. The primary objectives of the recovery were to recover the bodies of the victims, and to recover the initial fire area and 5th Right panel to complete the investigation into the cause of the accident. Reentry occurred in the western area of the mine since it was relatively unaffected by the fire.

The following is a summary of recovery activities at the mine. A detailed account of the recovery is contained in Appendix O.

Recovery of the Mine

The planned sequence of the recovery of the mine was to enter the 4th East portals and recover in order 4th East, 2nd South, Main West, and 1st North to the 5th Right panel. This recovery route was about 14,300 feet long. By April 9, 1985, recovery crews had advanced 12,300 feet to the intersection of 1st North and Main West where massive roof falls and smoldering fires blocked further advance. With the planned route blocked, recovery efforts moved to the northern portion of the mine.

On April 15, 1985, recovery crews entered Main North and systematically advanced to 1st North via 1st Right. Main North had not been chosen for initial reentry because extensive fire damage was expected. This was not the case. By May 28, recovery had proceeded through 1st North, with mine rescue teams exploring to within 500 feet of the fire's origin. At that time, extensive roof falls and bad roof conditions prevented further advance. In addition, gas analyses indicated that the fire was rekindling. Seals were placed across the 1st North entries by June 6, 1985, and a decision was made to mine new entries to 5th Right.

Recovery Entries

A set of three entries, known as the 5th Right recovery entries, was developed off 1st Right, about 300 feet east of 1st North and was designed to intersect the 4th, 5th, and 6th Right entries. Mining of the 5th Right recovery entries started on July 27, 1985, and reached 5th Right on November 2, 1985. The recovery section mined 1,100 feet to 4th Right, an additional 720 feet to 5th Right, and 550 feet farther to 6th Right.

Breakthrough of the recovery entries into 5th Right provided direct access to the mouth of the section and to the longwall headgate area. From November 2 to November 12, 1985, the 5th Right entries were systematically recovered by mine rescue teams. The bodies of 25 victims were removed and the 5th Right entries and longwall headgate area were investigated. Breakthrough into 6th Right occurred on December 11, 1985. After ventilation and further explorations, the two missing victims were located and removed from the mine on December 16, 1985. Gordon Conover, faceman, was found in the bleeder system, 7th Right panel, between crosscuts 27 and 28, 2,400 feet from the 5th Right longwall headgate and 800 feet past the squeezed area in the bleeder entry. James Bertuzzi, longwall

maintenance foreman, was found in the 5th Right longwall return entry, about 380 feet west of the longwall face. He was located between two roof falls. During this work, the originial fire area in 1st North was surrounded with seals and was inaccessible for inspection due to extensive roof falls and smoldering fire.

Recovery of the Fire Area

The fire area in 1st North remained sealed to extinguish and cool any hot spots remaining in the area. In preparing plans to recover the area, normal recovery procedures were complicated by the numerous roof falls and by expected hot spots. Conventional air locking procedures could not be easily used and a large area could not be opened and ventilated due to the possibility of rekindling the fire.

To recover the fire area in a controlled and limited manner, an innovative method was employed which used nitrogen and gelling agents to produce an inert gas foam barrier. This technology, referred to as a nitrogen-generated foam plug, was used to form a ventilation barrier in advance of the recovery work in No. 4 entry.

Recovery of the fire origination area began on July 22, 1986. The nitrogen-generated foam plug was used to recover approximately 230 feet of entry and 80 feet of crosscut. Investigation of the area concluded on August 18, 1986, and the area was resealed to maintain its integrity and to keep the unrecovered fire area isolated.

Completion of this work concluded the underground portion of the recovery operation. UP&L continued with the rehabilitation of the 13th Right longwall panel and production resumed in October 1986. No further rehabilitation work was done on the 5th Right longwall section, which was abandoned by the company.

Investigation of the Accident

Participants

An MSHA investigation team headed by Herschel H. Potter, chief, division of safety, was dispatched to central Utah on December 27, 1984. The investigation was to be conducted jointly with the Utah Industrial Commission (UIC), with the participation of Emery Mining Corporation (EMC), Utah Power and Light (UP&L), and United Mine Workers of America (UMWA) officials. Because the Wilberg Mine was being sealed, the investigation team focused on identifying potential witnesses, establishing procedures and questions for planned formal interviews, collecting and reviewing all mine records, maps and other documents, and conducting over 200 preliminary interviews of mine personnel, rescue team members, MSHA and State inspectors, and others.

During the months of April through August 1985 much media attention was devoted to the Wilberg Mine fire, and arson was discussed. Eyewitness accounts of the quickness with which the fire spread in the early stages seemed to support arson as a possible source of the fire. MSHA was informed by the Emery County Sheriff's Office (ECSO) that they were actively investigating the fire. In early September 1985, the Federal Bureau of Investigation (FBI) entered into the investigation, pursuant to a then new provision of the United States Code that

made it a Federal criminal offense to harm an energy producing facility. The four enforcement agencies conducted a joint investigation sharing information and expertise until an act of arson was discounted as the source of the fire.

All of the participants in the fire fighting, rescue attempts, sealing, recovery and the investigation of the mine are recognized for their excellence and dedication. A list of the mine rescue team members that participated in the rescue attempt is contained in Appendix B. Persons who participated during this lengthy investigation are listed in Appendix C.

Sworn Statements

Intermittently between January 21 to March 11, 1985, representatives from MSHA, UIC, EMC, and the UMWA received voluntary sworn statements from 78 persons who participated in the fire fighting and rescue attempt, or could have had knowledge of the conditions in the affected area of the mine at the time of the fire. A list of persons providing sworn statements can be found in Appendix D.

On January 24, 1985, the taking of sworn statements was stopped because a Federal District Court Judge in Salt Lake City, Utah, issued a temporary restraining order. The judge's decision was based on a complaint filed by the Society of Professional Journalists and a number of television stations and print news-gathering companies in Utah, as well as the United Press International and the National Broadcasting Company. The media alleged that MSHA was conducting a formal hearing behind closed doors and that MSHA should be enjoined from continuing the alleged hearing unless at least one print reporter was allowed to be present. The taking of the statements recessed pending the preliminary injunction hearings held on February 1 and February 8, 1985. The Court's preliminary injunction permitted MSHA to continue the taking of statements privately if the participants were limited to representatives of MSHA, UIC, and the UMWA. If anyone other than representatives of these groups, the individual giving the statements, and the court reporter were allowed to be present, the taking of the statements would have to be open to the press and the public. Under the terms of the injunction, representatives of EMC were not permitted to be present. EMC filed a complaint with the Court asking to be permitted to participate and on February 14, 1985, the preliminary injunction was modified to permit EMC to participate. The taking of statements was resumed on February 18, 1985, and completed March 11, 1985, except for the taking of sworn statements from State, MSHA, UMWA, and EMC personnel involved in inspection activities at the Wilberg Mine.

On February 18, 1985, four MSHA employees gave sworn statements as to their activities on and after the evening of the fire. Questions on their inspection activities prior to the fire were not permitted at that time so that the focus of the immediate investigation could remain on the rescue attempt, fire fighting, and cause of the fire.

On April 12, 1985, the Society of Professional Journalists again filed a motion for a temporary restraining order because the press was being excluded from the room where the sworn statements were being taken from inspectors and safety representatives. The court denied the request for a temporary restraining order and the taking of sworn statements resumed on April 15.

During the week of April 15, 20 additional sworn statements were taken from MSHA, UIC, EMC, and UMWA personnel who had knowledge of, or inspection responsibilities at, the Wilberg Mine prior to the fire. Seven of the individuals had given a statement earlier. Statements were taken to determine the condition of the mine prior to the fire, the attitude of mine management toward safety, and the working relationships among EMC, the UMWA, and inspection agencies.

Statements revealed that the attitude of mine management toward the safety and health of the miners had improved in the 2 years preceding the fire. The UMWA safety committee and MSHA inspectors were generally satisfied with their working relationship with EMC officials.

Underground Investigation

The four enforcement entities, MSHA, FBI, ECSO, and UIC, combined efforts to conduct a joint investigation to determine the cause of the fire. ECSO assigned seven officers, including the sheriff, to the investigation. Four agents of the FBI were assigned to participate. Three inspectors from UIC's inspection force and six MSHA investigators completed the core of the investigation group. During the investigation, each agency supplemented the investigation with specialists. Also participating in the underground portion of the investigation were UMWA officials, from the union's international, district and local offices, EMC officials, UP&L officials, and various consultants retained by both mining companies.

In September 1985, plans submitted by EMC that contained procedures for entering the 5th Right panel from the recovery entries were finalized and agreed to by all of the participating organizations. The procedures stipulated that: 1) mine rescue teams would enter the area and erect temporary seals and ventilate the area; 2) a limited number of investigators would be allowed in the area to make observations of the bodies and circumstances surrounding each victim; 3) the bodies would be removed, and 4) mapping and the collection of evidence in the area would be conducted. An MSHA investigator would be present during all mine rescue team activities in the area. On November 2, 1985, the underground portion of the investigation began when the recovery entries intersected the 5th Right panel. Detailed maps of the 5th Right panel are contained in Appendix Z.

In accordance with the procedures of EMC's plan, the area from crosscut 5 to the longwall face was thoroughly investigated. The bodies of 15 miners were removed from the area, transported to the surface, and released to the Utah State Medical Examiner's office. Teams were assigned to map and collect evidence in the area. Additional searches for evidence related to the activities of the victims at the time of the fire were conducted on several occasions.

Following the body recovery and investigation of the 5th Right panel, rescue teams entered sealed areas and recovered the remaining 10 victims that had been located. Two bodies were recovered from the 5th Right section tailgate area and eight were removed from crosscut 40 in the 1st North area. The rescue teams were given instructions to collect any physical property around the bodies and to take accurate notes of observations made in the areas. These bodies were also released to the State Medical Examiner for autopsy. By November 12, 1985, all but two of the 27 victims had been recovered and a part of the 5th Right panel had been investigated.

Mining of the recovery entries resumed through the 5th Right longwall block of coal. When the recovery entries intersected the 6th Right entries, the northern side of the fire-damaged area of 1st North was sealed and the northern area of 1st North was ventilated, which permitted the investigation to continue. Mapping teams were assigned to explore and map the longwall bleeder system from 8th Right to 5th Right and the 5th Right section face and return entry. The remaining two victims were found during this activity on December 17, 1985. At the end of December 1985, all areas of the mine important to the investigation had been inspected and mapped with the exception of the original fire area.

Investigation work in the No. 4 (intake) entry in 1st North from crosscuts 37 to 34 began on July 29, 1986. Due to the close confines of the area and the size of the equipment that was used to excavate the fallen material, the number of personnel at the actual work area was generally restricted to one enforcement person, one company official, one crew foreman, and the equipment operators. When an item of interest was uncovered, the operation was stopped and other investigative representatives were allowed to observe the item. The following are the major recovered items and location where they were found:

1. Two portable fire extinguishers located just north of crosscut 36;

2. A large air compressor located in crosscut 36 east;

3. A 600kVA power center located in crosscut 35 west;

4. An aluminum overcast located in crosscut 34;

5. A motor starter, conveyor belt take-up, Super 500 line starter, numerous cans of oil both full and empty located in crosscut 34 west;

6. Portions of the air compressor power cable located in the No. 4 entry, between crosscuts 36 and 35; and

7. High-voltage cable, numerous pieces of fiberglass air line, and several other power cables located between crosscuts 37 and 34.

All of the recovered items were removed from the mine and placed in a mock mine layout simulating the locations of each. The simulated mine was located at the Emery County Sheriff's complex in Castledale, Utah. Careful observations were made both underground and at the mine layout site. Detailed visual analyses were made as each item was further disassembled or field tested. Various parts or components important to the determination of the cause of the fire were identified and removed for laboratory testing. During this phase of the investigation, the probable source of the fire was determined. A detailed map of the original fire area is contained in Appendix Z2.

Extensive Testing and Involvement of Experts and Specialists

The underground investigation consisted of detailed examination of the affected areas of the mine, particularly the accident area to determine the origin of the fire and the circumstances surrounding it. Extensive evidence was gathered and equipment was tested. All of the information and data was throughly analyzed. The investigation was a painstaking process which involved many experts and

specialists from the various segments of MSHA. Other government entities and the private sector were also involved. A structured analysis (fault tree) was conducted and consisted of listing all the potential sources of the mine fire and the elimination of potential sources based on examinations and laboratory test results, analysis of sworn statements, and other physical factors and phenomena of the mine fire. Special laboratory services from the FBI, the Bureau of Mines, and MSHA Technical Support were obtained for the expert examination of many important items.

Independent Expert Analysis

MSHA engaged John Nagy as a consultant to perform an independent study and analysis of the Wilberg fire. Mr. Nagy is a renowned mine expert, having spent his entire 42-year career, most of it with the Bureau of Mines, researching and investigating mine fires and explosions. Mr. Nagy's report of his findings can be found in Appendix H.

The services of PTL-Inspectorate, Inc. (PTL) were also engaged to perform tests and analysis on critical compressor parts. Their independent opinions and conclusions are discussed in the Discussion and Evaluation section of this report. PTL's test results can be found in Appendix K.

DISCUSSION AND EVALUATION

Longwall Panel Development

The three entries of 8th Right were started in December 1982 and were driven a distance of approximately 3,000 feet. From there, two longwall setup entries were driven 520 feet south to connect with 7th Right, a two-entry longwall development system started in March 1983. Longwall mining of the panel between 8th Right and 7th Right was conducted from September 1983 to February 1984. The two 7th Right entries provided the intake air course and belt haulage entry and the 8th Right entries were used for the return air course for the 7th Right longwall panel.

The two 6th Right entries were started about October 1983. They were driven about 2,800 feet and connected to the east end of 7th Right by two longwall setup entries. The 6th Right longwall began operation in April 1984. At that time, the original 8th Right entries and the setup entries between 6th Right and 8th Right became bleeder entries. The remaining 7th Right entry became the 6th Right return and the 6th Right entries provided the intake air course and belt haulage entry for the 6th Right longwall panel.

The Wilberg Mine was permitted to develop a two-entry mining system without a petition for modification prior to 1985 based on an interpretation of 30 CFR 75.326 for "any coal mine opened after March 30, 1970." Under this interpretation, mines opened prior to that date were permitted to use belt entries as return airways. Thus, permission to use the belt entry as a return air course on two-entry longwall development sections was granted in the ventilation plans at Wilberg.

After the fire, MSHA declared a moratorium on the approval of ventilation plans for two-entry systems. In addition, the administrator in consultation with the Solicitor's Office examined the scope and application of the 30 CFR 75.326 provision for pre-1970 mines. Following the review, the determination was made to limit the application of the pre-1970 authority to existing longwall panels, and all operators using belt conveyors to develop two-entry systems are now required to petition the Agency under section 101(c) of the Mine Act for a modification of 30 CFR 75.326. The 5th Right panel was developed with a two-entry system; however, at the time of the fire this section included a third entry.

Ventilation of 5th Right

The two 5th Right entries were started in March 1984 and driven approximately 3,000 feet. The two longwall setup entries for the 5th Right longwall were developed north 550 feet and connected to 6th Right in August 1984 and two longwall setup entries for 4th Right were driven south approximately 350 feet. The 5th Right longwall began operation on November 11, 1984.

Ventilation for the 5th Right longwall panel was provided with a single intake entry, a belt haulage entry, a return entry, a bleeder entry, and a 300-foot "dogleg" entry which served to course belt air into the 1st North return.

Intake air for the 5th Right panel was coursed from Nos. 1 and 2 entries of the 1st North intake entries through crosscut 43, under the No. 3 entry belt overcast and south into the No. 4 entry. The air then passed under the 5th Right belt overcast at crosscut 34, was directed east at crosscut 33, passed under the No. 5 entry return overcast and entered 5th Right panel, flowing to the longwall headgate area at crosscut 22. The majority of the ventilating air was coursed through crosscut 22 and across the longwall face to the return entry at 6th Right. Air also passed through the gob to the bleeder entries and regulators at the mouth of 7th Right and 8th Right.

Airflow in 5th Right and the gob was controlled by four regulators, one at the mouth of each set of longwall development entries. Airflow at the longwall face was controlled by a curtain across the belt entry just west of crosscut 22 and by three curtains across the intake entry east of crosscut 22.

Air from crosscut 22 was also directed west into the 5th Right belt entry to crosscut 5 where it mixed with air moving east from the 1st North belt entry. The two converging belt air currents entered the "dogleg" entry at crosscut 5 and were coursed to the 1st North return through the "dogleg" regulator.

A third split of intake air continued east at crosscut 22, through the bleeder entries to the mouth of 8th Right where it entered the 1st North return.

On December 6, 1984, an MSHA inspector measured an air velocity of 95 feet per minute (fpm) in the belt entry of 5th Right. During the weekly ventilation examination performed December 17, 1984, mine officials measured 43,300 cfm of air in the intake entry at crosscut 2 and 39,750 cfm in the last open crosscut. Air movement was detected in the 5th Right return entry and 8th Right bleeder entries. Air movement was also detected in the bleeder system at 7th Right on December 19.

Ventilation Control Devices for 5th Right

EMC's approved ventilation system and methane and dust control plan required ventilation devices such as stoppings, overcasts, undercasts, shaft partitions, etc., to be of substantial and incombustible construction, installed in a workmanlike manner and maintained in a condition to serve the purpose for which it was intended.

The investigators found concrete block stoppings in the 5th Right panel, separating the intake, belt, and "dogleg" entries in all crosscuts west of crosscut 22 except for crosscut 4 between the intake and belt entries where a material door had been installed. The majority of the stoppings were mortared on the horizontal joints and all were plastered with a stopping sealant on the intake (high pressure) side. Construction of the stoppings from crosscut 22 to crosscut 5 included a layer of polystyrene, 3 to 16 inches in thickness at the top. Polystyrene is used in stopping construction to prevent roof and floor pressure from crushing out the stopping. The polystyrene protects the stopping to some degree by compressing. Polystyrene is a flame-resistant material; however, it melts at about 270°F. Based on notes and discussions with both MSHA and company mine rescue team members who explored the area west of crosscut 5, the stoppings in crosscuts 3 and 4 were determined to have had polystyrene installed at the

top of the stoppings prior to the fire. The polystyrene had melted from the tops of these stoppings.

A fire contamination study conducted by MSHA's Technical Support indicates the air temperature at the roof level in the intake entry at the stoppings at the mouth of 5th Right would have been much higher than 300°F within 5 to 10 minutes after the fire started. As the air temperature in the belt entry quickly increased from both the intake air entering and the transfer of heat at the intake/belt overcast, the polystyrene on the stopping in crosscut 3 between the belt and "dogleg" entries melted. When this occurred, heavy smoke and high concentrations of toxic gases would then flow from the belt entry through crosscuts 3 and 4 to the "dogleg" regulator.

These determinations are supported by Blake's sworn statement. He stated that he had placed his hand through the mandoor in the isolation stopping across the belt entry just west of crosscut 5, and found the air to be hot. His determination was made at mid-entry height. The air temperature at the roof level would have been much hotter. A copy of the Fire Contamination Report is contained in Appendix G.

Damage and utility holes existed prior to the fire in three stoppings separating the intake and belt entries of 5th Right. The stopping in crosscut 16 had six 8-inch by 16-inch blocks missing at the bottom of the stopping where sections of 4-inch water pipes had been pushed through the stopping. The stopping in crosscut 18 contained a 4-inch by 7-inch utility hole near the top with a horizontal opening 1-inch by 3-foot extending from the hole. A wire rope had been routed through the hole into the belt entry where the rope was reeved through a pulley and extended east in the belt entry to crosscut 19 and was attached to the longwall stage loader cables. The wire rope was used to pull back the stage loader cable during a belt move. This action apparently caused the wire rope to cut through the stopping, creating the 1-inch by 3-foot hole.

The stopping in crosscut 20 had a utility hole about 12 inches in diameter near the middle of the stopping on the right side. Two power cables and two hoses were routed through the hole from the power center in the intake entry to the stage loader area. This hole had not been repaired to maintain the stopping reasonably air tight.

Curtains were used to direct air on the section. Three curtains had been installed in the bleeder entry east of crosscut 22 and served to direct air to the face and limit air to the bleeder. A curtain had been installed across the belt entry between crosscuts 21 and 22. This curtain served to limit the air velocity in the belt entry.

Three overcasts had been constructed at the beginning of the 5th Right panel (See map appendices). These overcasts were constructed using concrete blocks and prefabricated arched aluminum panels. The concrete blocks were used for the foundation and wingwall portion of the structure. The aluminum panels were bolted together, set on the foundation and anchored in place with chains suspended from roof bolts. The joints, corners and wingwalls were reportedly sealed with concrete and stopping sealants. Sworn statements and mine examiner's records indicated the overcasts were subject to damage by large mobile equipment hauling supplies but the equipment operators were careful when passing under an

overcast. Sworn statements indicated the intake/belt overcast at crosscut 34 was in good repair at the time of the fire. Mine examiner's records indicated that the return/intake overcast may have contained a hole. It could not be established whether this hole had been patched prior to the fire.

All three of the overcasts failed in the early hours of the fire. The intake/belt overcast at crosscut 34 failed within 15 to 20 minutes after the discovery of the fire. Because of the quickness of the failure of the overcasts, studies were conducted by MSHA's Technical Support. This testing revealed that wrought aluminum alloys lose over 90 percent of their strength, when heated to 700°F. Coal mine fire studies show that an uncontrolled fire spreads rapidly and achieves a temperature of 1800°F within 5 minutes of coal ignition. A computer simulation of the Wilberg Mine fire showed, when the temperature at the fire source was 1800°F, the temperature at the roof, 160 feet downwind (at the belt/intake overcast), was about 1500°F. Under these conditions, the structural strength of the overcast would not be sufficient to support the concrete block wingwalls and the overcast would collapse.

A batwing-type material door had been built in crosscut 4 between the intake entry and belt entry of 5th Right to permit easy access by mobile equipment to the Super 500 belt take-up to facilitate adding or removing conveyor belting. The door was constructed of angle iron frame work and plywood sheets. Belt material was used to seal around the edges and where the doors met. According to the mine rescue teams, the east door was found about 80 percent open. It could not be determined whether the door was opened before the fire or during the escape attempt. Generally doors of this type are very difficult to seal and the investigators believe that some air from the intake entry was entering the belt entry at crosscut 4 through the door installation at the time of the fire.

Escapeways and Travelways

Escapeways

Title 30 CFR requires that two separate and distinct escapeways are to be maintained from each working section, continuous to the surface openings. These escapeways are designated by the mine operator and one of the escapeways is required to be ventilated with intake air. Escapeways normally are required to be at least 5 feet in height and at least 6 feet in width. In addition to training and annual refresher training in the location and use of escapeways, escapeway drills are required to be conducted at least every 90 days. Further, a map showing the main escapeway system for the entire mine is required to be posted on the surface at a location available to all miners and a second map that shows the designated escapeways from the section is required to be posted in each working section.

In the 1st North area of the mine, the designated escapeway that was ventilated with intake air followed the diesel haul road and exited the mine at the 1st South portals. Except for an approximate 1,600-foot area located between crosscuts 6 and 26 in 1st North, the second designated escapeway followed the belt haulage system and exited the mine at the Main North portals. According to the escapeway map that was posted in the mine foreman's office at the time of the fire, the second designated escapeway was routed from the No. 3 (belt) entry into the No. 4 (track) entry at crosscut 26, 1st North. The second designated

escapeway was routed through the 4th Right section intake entry at crosscut 23, and then returned to the No. 3 (belt) entry at crosscut 6, 1st North. Since up to 80 feet of the second designated escapeway was ventilated by the same split of air, MSHA investigators concluded there was only one separate and distinct escapeway designated for the 1st North area of the mine north of crosscut 22 which included the 4th Right, 5th Right, and 13th Right sections.

The two designated escapeways from 5th Right section were the intake and the belt entries off the longwall headgate. These two escapeways were parallel and adjacent, with interconnecting crosscuts on 100-foot centers. Concrete-block stoppings were constructed in the crosscuts to separate the two escapeways. The escapeways were parallel for a distance of 2,100 feet from the headgate to No. 4 entry, 1st North. At that point, the intake air escapeway turned north into No. 4 entry and passed under the belt entry escapeway. The intake air escapeway continued another 1,000 feet before reaching the 1st North intake escapeway. The belt entry escapeway continued 80 feet to the 1st North belt entry escapeway. The 5th Right belt and intake entry escapeways were separated at the No. 4 entry intersection by an aluminum overcast.

According to Carl Pollastro, senior mining engineer, the intake/belt overcast at crosscut 43, 1st North, was constructed at the time 7th Right was developed. He stated that to save the down time and expense of constructing an intake overcast for the 1st North belt at crosscut 33, a split of intake air from crosscut 43 was directed south in the No. 4 entry to ventilate the 5th Right section. This procedure had also been used to ventilate 6th Right. The overcast at crosscut 23 at 4th Right was constructed because EMC management felt that they could not maintain sufficient ventilation to 4th Right from crosscut 43 and that it would be difficult to maintain the No. 4 entry diesel roadway after the 5th Right panel was extracted. The decision not to construct an intake/belt overcast at crosscut 33 for the 5th Right section resulted in an additional intake escapeway travel distance of 1,840 feet for the miners of the 5th Right section. Therefore, the intake escapeway did not follow the safest direct practical route to the nearest mine opening.

The width of the intake entry escapeway travelway in 5th Right exceeded the minimum requirements since it was also the diesel haulroad.

The travelway in the 5th Right belt entry escapeway was not maintained at a width of 6 feet. The walkway width ranged from 2.5 feet to 6 feet over its 2,240-foot length. Travel in the belt entry escapeway was further restricted by a 30-inch square mandoor in the isolation stopping between crosscuts 4 and 5. Two overcasts, at the beginning of the section, were reportedly provided with ladders or ramps.

Investigators found a map in the mine foreman's office that showed current escapeway designations; however, an escapeway map was not found in the 5th Right section or on or around any of the victims.

Upon outbreak of the fire, the intake air escapeway was contaminated immediately by the fire gases and rendered impassable before evacuation started. The aluminum overcast separating the two escapeways began to heat up quickly due to its location only 160 feet downwind from the source of the fire. The intake/belt overcast located at crosscut 34, No. 4 entry, began to fail minutes after the

fire was first observed, resulting in the belt entry escapeway becoming impassable in the very early stages of the fire.

The stoppings separating the two escapeways in 5th Right were not maintained. Holes in stoppings at crosscuts 16, 18, and 20 allowed smoke and toxic gases to contaminate the belt entry sooner than would have occurred with the normal airflow.

Although escape remained possible through the "dogleg" entry from crosscut 5 in the belt entry to the 1st North return throughout the fire fighting and rescue attempts, this entry was filled with heavy smoke and escape was only possible by using an SCSR. The only miner that escaped the section used an SCSR and traveled this route.

Thirteen victims were found along this escape route, nine in the "dogleg" entry between crosscuts 3 and 5, and four in the belt entry just east of the "dogleg" entry connection.

5th Right Return

During the UMWA contract strike in October 1984, a roof fall occurred in the 5th Right return entry between crosscuts 13 and 15. At the time of the fire, the return airway was not a designated escapeway and served only as a ventilation entry. Mine management personnel installed additional cribbing but were unable to maintain a safe travelway. Return airways are required, by 30 CFR 75.305, to be examined for hazardous conditions once a week by a certified person. If adverse conditions prevent the required examination, the mine operator can seek relief of this standard by filing for a petition of modification under 101(c) of the Mine Act.

On October 25, 1984, EMC requested by letter a variance of the requirement to examine the airway in its entirety. EMC justified the request in part by stating the bleeder entry was in good condition and airflow could be maintained in the return entry.

After a meeting with local and district MSHA officials, EMC sent a letter to the MSHA District Manager describing a method of evaluating the airflow in the 5th Right return entry that they felt was adequate. In a letter dated November 23, 1984, MSHA accepted EMC's proposal for evaluation of the 5th Right longwall return airway as compliance with the examination requirements of 30 CFR 75.305.

After the fire occurred, this situation was brought to the attention of the Administrator for Coal Mine Safety and Health. A review at headquarters level concluded that a violation had occurred when the entry could not be physically examined in its entirety and a citation should have been issued. The alternate evaluation procedure could only be accepted through the petition for modification process.

The miners were informed of the roof fall during the retraining classes in November 1984, but, according to sworn statements, not all miners knew that the return entry was blocked at the time of the fire. Several members of the union safety committee were aware of a fall and did not inquire further after they were told by mine management that MSHA had accepted it. Very few miners stated

they were aware that the return entry was completely blocked for travel prior to the fire. Three victims were found in the return entry inby the fall, one near the tailgate, one near crosscut 18, and one at crosscut 20.

Bleeder Entries

Although not well known by most miners, the bleeder system was open for travel from the 5th Right longwall headgate to the 1st North return at 8th Right. This system was still travelable one year after the fire although one 50-foot area was extremely tight.

On the night of the fire, three miners entered the bleeder system from 8th Right in an attempt to reach the miners in 5th Right. They said the air was clear and that they tested for CO and left tags at several locations. The travelway appeared to be blocked at 6th Right and they returned to 1st North. They left a tag with the date, their initials, and the time (1:27 a.m.) in the bleeder entry at 7th Right near where Gordon Conover's body was later found by the investigation team.

MSHA investigators concluded that the two designated escapeways were blocked by fire and heat and were filled with heavy smoke, soon after the fire started. The 5th Right return entry was blocked by a roof fall and the bleeder entry travelway was restricted at the 6th Right entries, but open for travel. The "dogleg" entry remained open and was the most available entry for escape during the entire rescue effort, but it was smoke filled and not well known to most of the miners. At the time evacuation started, escape from the 5th Right section was dependent on the proper use of self-rescue devices.

Fire Fighting and Evacuation Training

Each coal mine operator is required by 30 CFR 75.1101-23 to adopt a program for the instruction of all miners in the location and use of fire fighting equipment, location of escapeways, exits, and routes of travel to the surface, and proper evacuation procedures to be followed in event of an emergency. Emery Mining Corporation's program of instruction was not submitted to the MSHA District Manager for approval. The only plan on file with MSHA for the Wilberg Mine was one submitted by Peabody Coal Company and approved by MSHA on October 11, 1974. The Peabody Coal Company's approved plan contained provisions for outdated emergency equipment and mining methods and did not address longwall section emergency procedures.

A draft "Emergency Procedures Manual" was in the process of being evaluated by EMC and had been partially adopted at the time of the fire. Ray Guymon, safety specialist, stated he used material from both the Peabody plan and the new manual to train and retrain miners at the mine during the annual refresher training classes held in November 1984. Although only part of the Emergency Procedures Manual was being used for training prior to the fire, provisions in the manual could have had an impact on the events following the discovery of smoke.

One provision in the manual stated: "NOTE: DO NOT activate the self-rescuer until smoke is encountered." No apparent attempt was made by the miners in 5th Right to obtain an SCSR after the first notification of the fire and prior to

smoke arriving on the section. Some of the victims obtained an SCSR after the confirmation of a fire, but carried the SCSRs for several hundred feet in smoke before deciding to don the units.

When the miners in 5th Right were notified of the fire, Blake said Jacobs was sent down the longwall face to evacuate the face crew. It is believed that Jacobs and part of the face crew had time to reach the SCSR storage location at the tailgate before smoke reached the tailgate. None of the lids from the SCSRs stored on the tailgate were found at that location. Apparently the SCSRs were carried at least two-thirds of the way along the face towards the headgate before the first one was activated. Two lids from the SCSRs that were stored at the tailgate storage location were found at Shield No. 40 and Shield No. 15.

Another provision stated: "When smoke is found or suspected, immediate action shall be taken to find and correct the cause." When the mine management was first notified of the smoke in the intake, they waited until the fire was confirmed before beginning evacuation. After the fire was confirmed, four management officials left the section without SCSRs as though going to find and correct the cause, without first implementing all of the emergency evacuation procedures. These officials passed by two SCSRs stored in the belt entry at crosscut 15.

A third provision stated: "If a fire occurs in a working section and is not extinguished within 30 minutes, all persons except those required for fire fighting activities shall be removed from the mine," and, "If a fire occurs outby a working section, all persons inby the fire area shall be notified and withdrawn immediately. All other persons, except those involved in fire fighting, shall be withdrawn if the fire is not extinguished within 30 minutes". (According to 30 CFR 50.20-5, a fire occurring in a mine does not have to be reported to MSHA if it is unplanned and extinguished within 30 minutes of discovery.)

Smoke was reported in the intake of the 5th Right section, but the management officials waited for confirmation of fire before they prepared for and started a section evacuation. This provision, although requiring immediate evacuation of persons inby the fire, implies that a fire is not necessarily hazardous until after 30 minutes. After being notified of the fire, the EMC management officials left the 5th Right section without telling the warehouseman to contact anyone or order a general mine evacuation. A general mine evacuation was not ordered until the shift foreman was notified about 10 minutes after the fire was confirmed. This provision instructed him not to withdraw outby personnel for another 20 minutes.

The manual further allowed SCSRs to be used when it was necessary to enter smoke, and several of them were used during fire fighting; however, the manufacturer recommends that SCSRs be used only for emergency escape.

The miners were not adequately instructed in fire fighting procedures. Power was cut off to the entire mine including the water pumps, and effective fire fighting activities did not begin until nearly 2 hours after the fire started. Miners could not get a plastic cap off one of the water outlets and another outlet near the fire area was reportedly modified such that it was not readily usable for fire fighting purposes. During the early stages of the fire, venti-

lation was not appropriately controlled and fire fighting activities were conducted inby the fire. Several miners stated that they believed the fire could have been controlled if they had had adequate water pressure from the outset.

The Emergency Procedures Manual established that the mine foreman or designated individual has the responsiblity to direct assembly and transportation of necessary personnel, equipment, and supplies to the scene of the fire and to maintain control of and know the location of all persons in the fire area. This was made more difficult by the fact that so many officials were trapped inby the fire. The highest ranking official at the fire location (shift foreman) assumed direction of the evacuation, mine power restoration, and front line fire fighting efforts. No one, however, maintained control of or knew the location of all persons in the fire area. Shortly after the fire was discovered, several individuals traveled several thousand feet inby the fire and one miner entered the smoke filled 5th Right "dogleg" entry using an SCSR. In addition, two miners nearly died when they were overcome in the 5th Right return entry during an exploration attempt.

Overall, the inappropriate reaction and response to the emergency contributed to the severity of the accident and spread of the fire. The lack of control of the search and rescue attempts nearly led to additional deaths. The lack of an approved program of instruction in fire fighting and evacuation; the failure to maintain the water supply; the delayed call for an evacuation of the 5th Right section; and subsequent use of self-rescue devices, all indicate a lack of preparedness and a deficient fire fighting and evacuation program.

Products of the Fire

Contaminants from the Fire

Since there were indications that many of the victims were quickly overcome, MSHA investigators requested a study be conducted by Technical Support personnel to determine the type, degree, and time of contamination that would be expected at various locations. Results of the computer simulation combined with other studies revealed that the routes traveled by the victims and the survivor were contaminated by deadly combinations of high carbon monoxide (CO), high carbon dioxide (CO_2), and low oxygen (O_2), very soon after evacuation of the section started. A copy of Technical Support's report is contained in Appendix G.

Mine Equipment and Substances

Polyurethane foam sealants (Rigipack), roof consolidation material (RokLok), polystyrene based squeeze blocks, hydraulic fluids, conveyor belting, and cable jacket insulation were considered to be possible sources of contamination in addition to the products of burning coal. Although Rigipack had been used in the mine, there was no substantial use of it established in the burned area which would have affected the victims. RokLok was used in the 5th Right panel in the vicinity of crosscut 8, but there was no fire in this area and the containers for this material were not burned. There was, at most, 700 feet of rubber conveyor belting burned, but the products from this material would not be significantly different from that of burning coal. There was approximately 550 feet of electric power cable jacket insulation consumed in an area which could

have affected the victims. Polystyrene squeeze blocks were used as the top row of blocks on stoppings in the 5th Right panel; they had melted from the top of three stoppings near the fire area. The automatic transmission fluid (as much as 30 gallons) in the air compressor was consumed.

Analysis of the victim's tissue revealed the presence of hydrogen cyanide (HCN); however, according to the medical examiner, the HCN level may increase or decrease after death. The victims may not have been exposed to HCN and the HCN detected may have been due to postmortem production. MSHA investigators could not determine if HCN was present at the time of their death. Fifteen opened filter self-rescuers were analyzed at the Pittsburgh Health Technology Center, and one contained organic compounds. The laboratory reported that the origin of these compounds cannot be conclusively determined; they may have come from burning synthetic materials, from the combustion and pyrolysis of coal, or they may have accumulated in the rescuer from the water where the rescuer was recovered.

Carbon Monoxide, Oxygen, and Carbon Dioxide

The effects of the gases commonly generated by coal mine fires are known. These effects can be found in the tables in Appendix G. Carbon monoxide, O_2 deficiency, and CO_2 in combination, immediately downwind of a well-established coal mine fire, quickly becomes lethal within 10 minutes. After 15 minutes, the concentrations are around 1.0% CO, 10.0% O_2, and 4% CO_2. At these levels, an FSR affords little or no protection for several reasons. Since the wearer must rely on the O_2 content of the air outside the unit, the O_2 level is below that where significant physical effort can be expended. The physiological effects of CO_2 at this level causes a person to breath deeper and faster. Levels of CO in the 1% range causes high temperatures (135 to 194°F) to be generated by an FSR, which must be inhaled by the wearer possibly burning the mouth and throat. The net result is that a person unprotected, or protected by an FSR only, cannot survive in this atmosphere.

A study of gas concentrations developed during a test coal mine fire shows when the gases from a fire that has burned for 10 minutes reach miners, their survival without an SCSR is questionable. After an additional five minutes the atmosphere at the same location is deadly unless an SCSR has been properly donned. In summary, when located downstream from a fully developed mine fire in a high velocity air current, a miner has very little time to react, obtain an SCSR, and don the SCSR before concentrations change to those levels where survival becomes unlikely.

The autopsies revealed CO in the tissues of some of the victims. According to the medical examiners, the level of CO detected may not represent the levels that were present at the time of death because CO levels change with time due to postmortem absorbtion and release of gases.

Carbon and Soot

Downstream air currents from coal fires carry heavy concentrations of carbon or soot particles which constitute the visible smoke. Breathing soot is irritating and very uncomfortable. Discussions with medical examiners revealed that although many of the victims had moderate to severe depositions of soot in their airways, this in itself was not fatal. The before-mentioned gases that are

associated with smoke or soot are the deadly factors. The amount of soot observed in the airways does indicate that the person breathed greater or lesser amounts of contaminated air, further indicating exposure to hazardous gases. Eight of the victims showed mild to slight exposure to soot and the remaining 19 miners displayed moderate to extensive soot in their airways.

The State of Utah Medical Examiner has determined that the 27 miners died from smoke and soot inhalation resulting from the fire.

Self-Rescuers - Location and Use

Self-Contained Self-Rescuers

The Wilberg Mine mainly used the Draeger OXY-SR 60B self-contained self-rescuer. The investigation identified 54 SCSRs as having been located on the 5th Right panel at the time of the fire. The location and number of the units, prior to the fire, were as follows:

Five units at the longwall tailgate;
Six units in the kitchen at crosscut 21;
One unit on the Wagner scoop near crosscut 22;
Twelve units on the mantrip vehicle inby crosscut 19;
Thirteen units on the four pickup trucks located around crosscut 19;
Twelve units on the mantrip vehicle inby crosscut 17;
One unit on the General forklift near crosscut 16;
One unit on the Wagner scoop in crosscut 15;
Two units in the belt entry at crosscut 15; and
One unit that may have been carried by the roving fire boss.

In accordance with the approved plan, signs identifying the storage locations of the SCSRs at crosscuts 21 and 15 were found posted on the panel.

Fifty-two SCSRs were recovered from the 5th Right panel and were sent to the Pittsburgh Research Center (PRC), Bureau of Mines, for testing and evaluation. Thirty of the units were sealed and unused, and 22 of the units had been opened by the victims. An extra lid was also recovered for which a unit bottom was not found. The unit used by the survivor accounts for the 54th SCSR.

All of the units were evaluated by PRC. The report of their findings is contained in Appendix I. The 30 unused units were tested; all were found to work properly and would have provided a sufficient supply of oxygen to support a successful escape.

The opened SCSRs were evaluated visually and a detailed dissection was performed. The evaluation was conducted to determine the physical condition of each unit and to establish whether the unit was used by an individual for any length of time. Seven of the units were not properly activated because quick starter pins had not been pulled and the lanyards and the unit's lid were still attached. Proper procedure when donning an SCSR is to release the sealing clamp and pull the lid free from the unit, activating a chemical quick starter to provide the first minute or two of oxygen. When the lid is not pulled, the user must manually activate the unit by inhaling air outside of the unit and exhaling into

the unit 6 to 10 times. Three other units had the mouthpiece plugs still in place indicating they were not used.

The visual evaluation found physical factors on three units which could have affected the units' integrity. Two units' breathing bags contained holes and one unit's hose was torn. These three items were scrutinized by PRC and returned to the investigators. After an evaluation of the damaged parts the investigators requested that the FBI laboratory also examine the items. As a result of these examinations, the investigators believe that these conditions occurred either during the victims' attempt to escape or during transportation of the victims' bodies.

Nose clips were missing from units being used by three victims. Two of the nose clips were found some distance away from the victims. The third nose clip could not be found.

Testing and analysis conducted under the direction of PRC to determine if the opened SCSRs were used, and duration of use was inconclusive due to the characteristics of the chemicals involved and the exposure of the units to the mine environment.

Filter Self-Rescuers

It is believed that each of the 28 miners on the 5th Right panel had a Mine Safety Appliances W-65, filter-type self-rescuer either on their belt or available nearby. Twenty-seven FSRs were found on the panel. Some of the FSRs had been used by the victims. The remainder of the FSRs were found on the miner's belt or on a piece of mobile equipment. Twenty-four of these devices (eight unused and sixteen used) were sent to PRC for evaluation.

Testing of the eight unused units revealed no defects and that the units would have provided protection from carbon monoxide (CO) as designed.

The remaining 16 units were dissected in an attempt to determine the nature of contaminants in the mine atmosphere at the time of the fire. These tests were inconclusive because the only contaminants that could be found were organic compounds which could have come from a number of sources including the burning of the coal. The long period of time and exposure of the units to the mine environment prior to their recovery, directly affected the results of these tests.

Use of Rescue Devices by the Victims

As the 5th Right panel was recovered, each self-rescue device or portion of a self-rescue device was photographed, mapped, collected, and subsequently examined in an effort to determine the use of these devices. Each SCSR has a unique alpha-numeric number placed on the unit's bottom and lid by the manufacturer. EMC also placed a company number on most of the units. It was felt that this information would be critical in determining why only one miner successfully escaped from the section. A lengthy study was made by the investigators in order to determine, to the extent possible, each miner's activities after being warned of the fire. This study was done by correlating the location of each self-rescue device or part, with the test results from Pittsburgh Research

Center, the autopsy information from the Utah Medical Examiner, a study on the spread of the fire and smoke, sworn statements and the dispostion and location of each victim.

It has been estimated that at least 5 minutes passed from the time the first sighting of smoke in the intake was reported to the section to the time that a fire was confirmed. No steps to assemble the miners or SCSRs were taken until the second call was received, confirming the fire. According to Blake, within 2 or 3 minutes, after the second call, heavy smoke arrived at the headgate area. At this time the section's primary escapeway (intake entry) was smoke-filled and the face and tailgate would be contaminated with heavy smoke within minutes after the miners on the section reacted to the emergency. All but eight of the SCSRs were stored in the intake entry. The belt entry was also progressively being contaminated through the holes in the stoppings and from the air flowing outby from the headgate. Many of the miners would be expected to have donned their FSRs as they made their way to storage locations of SCSRs. Under these conditions, all of the miners would be donning an SCSR in smoke and quickly increasing levels of carbon monoxide. The effects of the contaminated air on the miners would have been minimized if SCSRs been obtained and donned at the time of the first call.

The following sequence of events is believed to have occurred:

When the fire was confirmed (second call by Salisbury), Bocook, Hamlin, Cingolani, and Poulos moved quickly to the belt entry and traveled in the belt entry past one SCSR storage location to crosscut 5. At crosscut 5 they either went through the isolation stopping and tried to escape over the belt/intake overcast and could not because the fire had compromised the overcast; or they could not pass through the isolation stopping because this overcast had been compromised. The four miners unsuccessfully tried to escape through the No. 1 entry "dogleg". While in the "dogleg", they donned their FSRs. At about this same time, MSHA investigators believe serious failure of the belt/intake overcast occurred, and thick smoke, high concentrations of CO, and low oxygen moved into the belt entry and into the "dogleg". The four miners could not survive with the protection afforded by FSRs in this atmosphere. In addition, the belt entry became hotter and the squeeze blocks at the top of the stopping in crosscut 3 melted, which short-circuited some of the toxic air directly into the "dogleg" at the regulator. At this time, it is probable that O_2-deficient and/or CO-laden air would overcome a miner wearing only an FSR in the "dogleg" at the regulator.

Jacobs quickly moved down the longwall face from the headgate to warn the face crew and ensure the SCSRs from the tailgate were obtained. There should have been at least six or seven miners along the face. Numerous parts of both FSRs and SCSRs were found by the investigators along the longwall face, from Shield No. 1 to Shield No. 95. A cribbing crew of four or more miners and a supervisor were located around crosscut 22 in the intake entry. The bodies of the face workers and the cribbing crew were found in the headgate area. MSHA investigators believe that they were either in the process of donning SCSRs or attempting to obtain an SCSR.

Eight miners were found from crosscut 22 to the headgate. This area was subjected to direct contamination from the fire in the intake entry and would be expected to have a rapid increase in CO and decrease in O_2. Of the eight victims, only two, Waldoch and Carter, appeared to have successfully used an SCSR.

Waldoch and Carter probably secured their SCSRs from the mantrip vehicle near crosscut 20. The lid to Carter's unit was found in the belt entry near crosscut 19 and Waldoch's lid was still attached to the SCSR, which indicates that the unit was not properly activated. It is thought that both successfully made their way down the belt entry to crosscut 5, stayed in that area for a while, then returned to the headgate area where their SCSRs reached depletion.

The other six victims around the headgate generally appeared to be in the process of attempting to don or obtain an SCSR. Howard was found near crosscut 22 in the belt entry without an SCSR. It appears he had not attempted to use the FSR on his belt even though he must have traveled in smoke to the belt entry or to obtain an SCSR from the intake entry.

Wheeler should have been located near the tailgate and would have helped retrieve the SCSRs located in that area. The lid to the SCSR she was wearing was found at Shield No. 15 indicating the unit was activated there; however, the mouthpiece plug had not been removed from the mouthpiece of her unit. It is thought that she traveled along the face using only an FSR and was beside the stage loader when either the contaminents in the air reached a level that overcame the FSR's capability to protect her or she unsuccessfully attempted to switch to the SCSR.

Walls should have been along the face near the shearer when warned. He might have helped carry the tailgate SCSRs to the headgate and would have been traveling in smoke. He did not use his FSR which was still attached to his belt. Walls was found beside the stage loader with an SCSR around his neck. The lid was still attached to the lanyard, indicating the unit's quick starter had not been activated. He was most likely attempting to don the unit when he was overcome.

Wilsey is believed to have traveled in smoke along the face and assisted in retrieving the tailgate SCSRs. He did not use the FSR attached to his belt. The lid to his SCSR was found at Shield No. 40 and the unit indicated little use. It is believed he was attempting to use the unit when he was overcome. A large hole was found in the breathing bag of his unit. The hole may have been the result of a puncture or tear during his travel along the longwall face or when he fell onto the SCSR unit when he collapsed beside the stage loader.

Bennett also would have been along the face and could have been involved in retrieving the tailgate SCSRs. It is believed that he was traveling in smoke along the face to the headgate, but did not use the FSR on his belt. An SCSR was near his body, and it appeared that he was attempting to don the unit. This SCSR had been opened and the quick starter activated by pulling the lid and lanyard free; however, Bennett was overcome before he could remove the plug from the mouthpiece. A small hole was found at the base of the breathing bag of this SCSR.

Jacobs is known to have left the headgate area, heading along the face toward the tailgate to warn the longwall crew and ensure the SCSRs from the tailgate were obtained. It is not known how far down the face he traveled. He did use his FSR from his miner's belt and it appears that he was attempting to assist Bennett with an SCSR. The atmosphere may have became so laden with CO or deficient in O_2 that the protection afforded by his FSR became inadequate. He was overcome under Shield No. 3 at the headgate.

The investigators believe the following 15 miners traveled in the partially contaminated belt entry escapeway to crosscut 5 and either found their way into the "dogleg" entry or were traveling back to the face to attempt to escape by another route.

Camberlango was found in the kitchen in crosscut 21 with an SCSR at this feet. His SCSR was opened and it is believed to have come from the tailgate location. It appears that he donned his SCSR along the face or at the headgate and traveled in heavy smoke into the belt entry. He may have traveled down the belt entry to crosscut 5 and eventually traveled back to the kitchen at crosscut 21. The unit's quick starter had not been activated by pulling the lid and lanyard free, but his unit appeared heavily used. It is possible that his SCSR was depleted and he was attempting to switch to his FSR unit when he was overcome.

Curtis's work location is not known, although he could have been assisting with the building of cribs in the intake. His SCSR came from one of the pickup trucks located in the intake at crosscut 19, and the lid to this unit was found in the belt entry between crosscuts 21 and 22. It is believed he traveled in the intake wearing an FSR, secured an SCSR, returned to crosscut 22, and went into the belt entry. He opened and donned the SCSR in the belt entry and traveled to crosscut 5. He then traveled back to the section. His body was found at crosscut 21 in the intake entry where his SCSR apparently became depleted.

Riddle was probably in the belt entry when the smoke arrived on the section and began coming into the belt entry through the holes in the stoppings. He may have been informed of the fire by the four management people traveling down the belt line or noticed smoke coming into the belt entry. He used or attempted to use his FSR but was overcome and died near crosscut 5 in the belt entry. Three opened FSRs were found beside his body.

Christensen and Robinson were wearing SCSRs obtained from the kitchen storage location in the intake entry. Nevitt's SCSR came from the mantrip between crosscut 19 and 20, also in the intake. Christensen apparently used his FSR for a while, but Robinson and Nevitt did not. Nevitt and Christensen activated their SCSRs at crosscut 22 by pulling the lid and lanyard free, and Robinson did the same at crosscut 20. All the lids to the units were found in the belt entry. It is believed that all three miners made their way to crosscut 5 in the belt entry, where they encountered other miners waiting there. All three men apparently had lost the nose clips to the SCSRs because they were found on their units. Christensen, Nevitt, and Robinson started back toward the face in the belt entry. The SCSRs being worn by Christensen and Nevitt did not show much usage. Robinson's showed heavy usage. It is extremely difficult to breath only through the mouth without wearing a nose clip and it is believed that the three miners were being poisoned by CO as contaminated air entered through their

noses. Robinson was overcome at crosscut 6 in the belt entry, Christensen 50 feet further east in the belt entry, and Nevitt another 50 feet further at crosscut 7. An open notebook was found by Robinson. The notebook was examined by an FBI testing laboratory and no pertinent message or note could be found.

Hersh was supervising the installation of cribs near crosscut 22 in the intake entry. It is believed he quickly traveled to the kitchen at crosscut 21, where he secured an SCSR. He did not activate the quick starter by pulling the lid free, nor did he use his FSR which was still attached to his belt. He was later observed by Blake traveling outby in the belt entry wearing an SCSR. Upon arriving at crosscut 5, he had a conversation with Blake and checked the mandoor in the isolation stopping and in the stopping in crosscut 5. Hersh then told Blake and the others in the area to follow him. Blake followed Hersh under the belt into the "dogleg" entry, where they became disoriented because the smoke was very thick.

Hersh attempted to return to the belt entry. The SCSR unit appears to show slight usage and upon inspection by PRC it was found that the mouthpiece hose was torn.

Bell was probably located at the headgate when smoke was reported in the intake entry. He must have traveled to the kitchen area and obtained an SCSR at that location. The lid to his unit was found near crosscut 14 in the belt entry. Indications were that he traveled the belt entry to crosscut 5, where he made his way into the "dogleg" entry. An FSR was found at his feet by the first rescuers into the area. His SCSR had slight indication of use. It is possible he decided to switch from the FSR to the SCSR at the location where he was found.

Ellis was working with the cribbing crew in the intake entry and may have worn his FSR to a pickup truck parked in crosscut 19 where he obtained an SCSR. The quick starter on the SCSR he was using was not activated by pulling the lid free. It is thought that Ellis made his way down the belt entry to crosscut 5, where he and Curry found their way into the "dogleg" entry. Curry should have been around the headgate or kitchen area and, using his FSR, traveled to one of the mantrips and secured an SCSR. The lid to his SCSR was found in the belt entry between crosscuts 15 and 16, indicating he activated his SCSR at this location. He also traveled to crosscut 5 in the belt entry. Once in the "dogleg", the two miners became lost and disoriented in the heavy smoke and sat down beside each other along the rib. It is possible the two tried to talk to one another and succumbed to the lethal atmosphere because neither man's SCSR indicated full usage. A notebook found next to Curry was examined by an FBI laboratory where a personal note was discovered on a soot-covered page.

Johansen apparently traveled down the belt entry past an SCSR storage location with Bocook and the three other management persons to crosscut 5 and into the "dogleg." He probably donned his FSR in the "dogleg" during this attempted escape; however, the atmosphere was quickly becoming lethal and the FSR provided inadequate protection against the increasing levels of CO and decreasing levels of O_2. He did not have an SCSR. It appeared that he succumbed while attempting to retreat from the smoke-filled "dogleg" entry.

Bertuzzi most likely used his FSR to obtain an SCSR from the truck parked in crosscut 19 in the intake entry. Although he did not activate the SCSR by pulling the lid free, thereby activating the quick starter, the unit was started by his breathing into it. It is believed he traveled the belt entry to crosscut 5 where he checked the two mandoors before Blake arrived. Blake stated he talked to Bertuzzi and it was decided that they should try to escape through the return. Blake, however, followed Hersh into the "dogleg," but apparently Bertuzzi did not. It is believed that he returned to the longwall face and traveled to the return entry. Because of the hazardous roof conditions, it could not be determined by the investigators whether Bertuzzi traveled to the roof fall that blocked the return airway. It appears that the SCSR he was wearing became depleted while he was traveling the return entry and he was overcome.

Snow probably retrieved an SCSR from either a mantrip or pickup truck in the intake entry and traveled toward the headgate in the intake entry. The SCSR unit he was wearing was activated between crosscuts 21 and 22 in the intake entry. It is believed he traveled down the belt entry to crosscut 5 where he waited until the group of miners decided to make their way to the return. He traveled back to the face in the belt entry, across the face to the return, where his SCSR reached depletion. Realizing the condition of this SCSR, Snow attempted to retrieve his FSR from his miner's belt but succumbed to the toxic environment after only partially opening the FSR.

Jennings worked as propman along the longwall face but could have been at the kitchen when the warning was given. He secured an SCSR from the kitchen location and traveled back to crosscut 22 and into the belt entry. He removed the lid to the SCSR in the belt entry between crosscuts 21 and 22 and traveled out the belt entry. He probably traveled to crosscut 5 and waited with the other miners or was intercepted by the others attempting to reach the return. He then crossed the longwall face to the return where his SCSR unit became depleted. He most likely realized the condition of this SCSR and opened his FSR, but, the atmosphere was too high in CO or low in O_2 or both for the FSR to protect him.

Conover was delivering cribs to the cribbing crew and was most likely in the area of crosscut 22 in the intake when the warning was given. It can only be guessed that he secured an SCSR from the Wagner scoop parked at crosscut 22 and activated the unit there. He was seen by Blake in the belt entry traveling outby and again at crosscut 5. It is believed Conover left with the group seeking another escape route, but either became separated or elected to secure another SCSR. Although the investigators cannot be certain of the following sequence of events, there are indications that Conover may have accomplished the following activities and used as many as four SCSRs after leaving crosscut 5. The bottom portion (unit body) of the SCSR that matches the lid found by the Wagner scoop at crosscut 22 was found beside a second Wagner scoop parked in crosscut 15. The lid from the SCSR taken off this second scoop was also found at this location. The matching SCSR unit bottom from the second Wagner was found in the intake entry across from crosscut 16 with the lid to another SCSR, which was taken off a General forklift nearby. The unit bottom that matches this third lid was not found. A fourth SCSR was found in the bleeder entry behind 6th Right about 500 feet away from the location of Conover's body. This unit had been used, and the lid for it could not be found. It is believed that the lid for the fourth unit and the bottom portion of the third unit are together at a location in the bleeders that was not accessible for exploration

by the investigation team. A fifth unit found with Conover had been opened but the quick starter had not been activated by pulling the lid free nor had Conover pulled the mouthpiece plug from the mouthpiece. Sworn statements and the presence of fire boss tags left by rescuers exploring the bleeders in an attempt to reach the 5th Right section indicate Conover survived for over 4-1/2 hours after the fire started. In addition the mandoor had been kicked out of the stopping separating the short 100-foot entry and the 1st North return at crosscut 3 near the mouth of 5th Right. Technical analysis indicates the door was kicked out after having been exposed to the fire. It is thought that Conover, who was familar with this entry, may have been seeking a way off the section through the main return or trying to short circuit the smoke-filled intake air into the return. After finding no other way off the section, Conover traveled to the bleeder entry and made his way to the area behind the old 6th Right panel, where he encountered what he thought to be clear air. In all probablity the air in this area was smoke-free but was laden with CO. It is also possible he read the fire boss tags left earlier and believed that this area was safe from the effects of the fire. He took off and dropped the SCSR he was wearing, opened another SCSR, and walked about 500 feet unprotected. He succumbed to the toxic atmosphere before realizing he was still in a hazardous atmosphere and before he could don the spare SCSR he was carrying. He collapsed in the bleeder entry at the old 7th Right panel.

In summary, 54 SCSRs were available to the 28 miners on the 5th Right panel. Because of the location and nature of the fire, only the five SCSRs on the tailgate were obtainable in a somewhat smoke-free atmosphere and then only for a few minutes after the miners reacted to the emergency. All of the other SCSR locations were within areas that were affected by heavy smoke and related fire gases.

The actions of the victims in obtaining and using self-rescue devices indicate many were not sufficiently instructed to be considered adequately trained in the use of the self-rescue devices. SCSRs were not obtained immediately when senior mine officials were first warned of smoke in the intake entry. Four high management officials attempted to leave the section without obtaining an SCSR. Seven of the victims failed to activate the quick starter device on the SCSRs in their position. Three victims failed to use their FSRs while traveling in smoke, either to obtain an SCSR or while activating an SCSR. One victim continued to use an FSR in heavy smoke even though wearing an activated SCSR. Another victim failed to continue using an SCSR in his possession to a place of known safety. According to sworn statements, miners were taking their SCSR mouthpieces out and talking in smoke filled areas.

The slow response to the emergency, the location of the SCSRs, the quickness of the elevation of the concentrations of toxic gases, the early contamination of the belt entry, and the lack of training on the use of self-rescue devices greatly impacted the victims' chances of survival.

Electricity

Electric power was reduced to 7,200-volt, AC, three-phase power at the main substation. The main substation contained two high-voltage circuits identified as the East Main feed and West Main feed. A single-line diagram of this circuit is contained in Appendix Q. The East Main feed contained a 6,000kVA, three-phase

transformer, a 1,200-ampere oil circuit breaker, and a 25-ampere grounding resistor. The West Main feed contained a 6,000kVA, three-phase transformer, a 1,200-ampere oil circuit breaker, a 25-ampere grounding resistor, and a 333kVA bank of voltage regulators. Under normal conditions, the West Main feed provided 7,200-volt, three-phase power to the mine surface distribution (Promontory) substation. The East Main feed was used as a spare feed and probably was not in use at the time of the fire.

Both of the main substation transformers were connected delta-wye and both secondary neutrals were properly grounded through the grounding resistors to a single safety ground field. Each high-voltage circuit to the surface distribution substation from the main substation contained a grounding circuit, originating at the grounded side of the grounding resistors, to ground the metallic frames and enclosures of all electric equipment receiving power from the circuit. Each high-voltage circuit to the surface distribution substation was protected by an individual oil circuit breaker. Four sets of air-break switches were provided in the main substation to allow disconnecting and isolating the transformer and oil circuit breaker of each main feed.

The surface distribution substation contained two 7,200-volt busses (connected by a tie-switch); six 1,200-ampere oil circuit breakers; six sets of three 600-ampere, single-pole, knife blade switches; and three 600-ampere, three-phase, gang-operated, load break interrupter switches. A single-line diagram of this circuit is contained in Appendix Q. Under normal conditions, the tie-switch was in the closed position. All components were totally enclosed inside an eight-compartment metal structure. The surface distribution substation provided protection for two independent underground circuits, a surface fan circuit, two surface tipple circuits, and the Blind Canyon seam circuit.

The two underground power circuits were protected by separate oil circuit breakers, identified as OCB 1 and OCB 2. Each circuit breaker was equipped with a ground wire monitor and relays designed to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection for the appropriate underground cable circuit.

The oil circuit breaker, identified as OCB 3, provided isolation for the voltage regulators of the Main West feed. The protective relays would not trip the circuit breaker because the capacitor trip circuit had been disconnected.

The Blind Canyon seam circuit was protected by an oil circuit breaker, identified as OCB 4, which was equipped with a ground wire monitor and relays designed to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection.

The surface fan circuit was protected by an oil circuit breaker, identified as OCB 5, which was equipped with relays to provide overcurrent, short-circuit, and grounded-phase protection.

The two tipple circuits were protected by an oil circuit breaker, identified as OCB 6, which was equipped with a ground wire monitor and relays designed to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection. Each tipple circuit contained a load break interrupting switch and fuses.

The six sets of single-pole, knife blade switches that were contained in the surface substation would provide visual evidence that the power to each high-voltage surface and underground circuit was disconnected when the knife blades were opened.

Both underground high-voltage circuits entered the mine at the Main North portals. The No. 1 high-voltage cable circuit, protected by OCB 1, supplied power to six belt drive power centers, one longwall power center, two pump power centers, two trolley circuit rectifiers, and the power centers for the dewatering system of the 1st North area of the mine and the mine water supply system. A single line diagram (Drawing No. WU720B) is contained in Appendix Q. Since this high-voltage circuit did not extend into the immediate fire area, it will not be described in detail in this report.

The high-voltage cable circuit that was protected by OCB 2 supplied five belt drive power centers, three section power centers, one longwall power center, three pump power centers, two idle power centers, two banks of capacitors, and one trolley circuit rectifier. A single line diagram (Drawing No. WU721B) is contained in Appendix Q. The power centers for the dewatering system of the Main West, 2nd South, and 4th South areas of the mine and the high-pressure Kobe water pump for the 5th Right longwall were also protected by OCB 2.

The high-voltage cable circuit that was protected by OCB 2 contained approximately 28,000 feet of shielded, three conductor, 8kV, type SHD-GC mine power cable. The phase conductors in the mine power cable were No. 4/0 AWG copper. Triple section switches were installed at crosscut 13, Main West; crosscut 22, 1st North; crosscut 39, 1st North; crosscut 10, 2nd South; crosscut 22, 2nd South; and crosscut 4, 3rd North. Each triple section switch contained three manually-operated, three-phase, load break switches and three vacuum circuit breakers. See Drawing No. ES 579D, Appendix Q. The load break switches provided visual evidence that the power was disconnected when the load break switch was opened. The high-voltage cable circuit that supplied power from OCB 2 to the 600kVA 5th Right belt drive power center and to the 2,000kVA, 5th Right longwall section power center contained the triple section switches located at crosscut 13, Main West; crosscut 22, 1st North; and crosscut 39, 1st North.

At the time of the fire, the 5th Right belt drive power center supplied 480-volt, three-phase power to the 5th Right belt drive motor starter located in crosscut 34 between Nos. 3 and 4 entries and the 5th Right air compressor located in crosscut 36 between Nos. 4 and 5 entries, 1st North. The 5th Right longwall section power center supplied 995-volt and 480-volt, three-phase power for use by the electric equipment on the longwall section. The low- and medium-voltage secondary circuits of the belt drive and longwall section power centers were resistance-grounded. A three-pole, molded-case circuit breaker was provided for each low- and medium-voltage, three-phase circuit originating at the 5th Right belt drive and longwall section power centers. Each receptacle circuit breaker was equipped with a ground wire monitor and devices to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection for the circuit. A cable coupler receptacle was provided for each low- and medium-voltage, three-phase circuit originating at the 5th Right belt drive and section power center to provide visual evidence that the power was disconnected when the cable coupler was withdrawn from the receptacle.

Since the No. 2 high-voltage cable and protective switchgear were energized when the fire occurred, MSHA investigators carefully examined and tested this high-voltage cable and protective switch gear to determine why the vacuum circuit breakers of the triple switches and OCB 2 tripped and if a fault in the No. 2 high-voltage cable or the high-voltage portion of the 5th Right belt drive power center could have provided the source of the fire. Also, since all the triple section switches, OCB 2, and West Main Feed OCB were located outside of the fire origination area, they were not considered potential sources of fire; however, the condition of the protective switchgear was relevant in determining whether the No. 2 high-voltage cable and equipment in the No. 4 entry could have provided the source of the fire.

Triple Section Switches Located at Crosscut 39, 1st North; Crosscut 22, 1st North; and Crosscut 13, Main West

Each triple section switch contained three manually operated load break switches and three vacuum circuit breakers. Each vacuum breaker was equipped with a ground wire monitor and relays designed to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection for the No. 2 high-voltage cable circuit (See Drawing No. ES 579D, Appendix Q). The triple section switch located at crosscut 13, Main West, was not recovered. The No. 2 high-voltage cable circuit was connected to the C-2 outlet of the crosscut 39 triple section switch and the A-2 outlet of the crosscut 22 triple section switch.

Examination and testing of the crosscut 39 and crosscut 22 triple section switches revealed that the ground wire monitors and protective relays were operative when the fire occurred. The vacuum circuit breakers were found in the tripped position and instantaneous targets were present on the solid-state, three-phase overcurrent relay of each triple section switch.

OCB 2

OCB 2 was equipped with a ground wire monitor and relays designed to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection for the No. 2 high-voltage cable circuit.

Examination and testing of OCB 2 revealed that the ground wire monitor and overcurrent protective relays were operative when the fire occurred; however, OCB 2 could not have provided grounded-phase protection for the No. 2 high-voltage cable circuit because of a defective grounded-phase current transformer (CT). Examination of OCB 2 also showed that the circuit breaker was tripped, and instantaneous targets were found on two overcurrent relays.

West Main Feed OCB

West Main Feed OCB was equipped with a ground wire monitor and relays designed to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection for the high-voltage circuit supplying power to OCB 2.

Examination and testing of West Main Feed OCB revealed that the ground wire monitor and protective relays were operative and no targets were found on any of the protective relays.

Examination and Maintenance of Electric Equipment

The maintenance management structure for the mine consisted of a maintenance superintendent, a general maintenance foreman, two maintenance foremen, a longwall general maintenance foreman and two longwall maintenance foremen. The general maintenance foremen each reported to the maintenance superintendent. The longwall general maintenance foreman and the two longwall maintenance foremen were responsible for the longwall face equipment, which included the longwall section power centers and the Super 500 belt take-up and storage units. The general maintenance foreman and the two maintenance foremen were responsible for all underground maintenance except for the longwall face equipment. This equipment included the telephone system, high-voltage switchgear, section and outby power centers, belt drives, fire detection and fire suppression systems for belt flights, rectifiers, and diesel equipment.

The weekly and monthly examinations of electric equipment were usually performed on a Sunday night on the midnight shift. Check sheets, which identified each unit of underground electric equipment by a five-digit number and location, were given to mine electricians to record the results of their examinations and tests. The first two digits identified the type of equipment (01 for continuous mining machines and 14 for air compressors) and the last three digits identified the specific unit of equipment. The check sheets were issued to electricians in the appropriate areas of the mine where the equipment to be examined was located. The electricians returned the check sheets to the maintenance foreman's office where the information was recorded into the weekly examination book and the needed repairs were listed on the running repair log by Ken Larsen, mine maintenance planner.

The running repair log listed the equipment that needed repair by the same five-digit number and location. The log contained a brief description of the needed repairs, status of the required parts (ordered and location), and catagory of the repair work (scheduled, unscheduled, or emergency). The log was updated by the maintenance foreman at the beginning of each shift by calling inside mine personnel and adding electric equipment that needed to be repaired and deleting equipment that had been repaired. The log was computer-updated each day and was kept in the maintenance foreman's office, where shift assignments and copies of the log were given to the electricians.

The maintenance work performed on electric equipment by electricians was recorded on maintenance activity report (MAR) cards by the electricians. The card contained the same five-digit code for the electric equipment, category of work for the repair (scheduled or emergency), brief description of repair, failure code, job completed check mark column, and man-hours worked. The purpose of the MAR was to account for the time spent on and type of repair work performed on individual equipment.

According to Larsen, the location of outby electric equipment such as air compressors that were moved frequently was difficult for the computer maintenance system to track accurately. Mr. Larsen also stated that mine personnel did not always notify him when equipment was moved so the records could be kept up to date. This was a contributing factor that caused weekly examinations and tests not to be performed on frequently moved outby electric equipment.

Location of the Source of the Fire

Location of the Fire When First Observed

To determine the fire origin, it is necessary to establish the location where the fire was first observed in the No. 4 entry. Since none of the first miners to arrive at the fire looked at the numbers placed on the nearby stoppings, their sworn statements were analyzed and the miners' recollections of mine component installations in the No. 4 entry were relied upon to determine their location in the entry when they first observed the fire. The following equipment was present in the No. 4 entry between crosscuts 36 and 34 at the time of the fire (See Detailed Map of Fire Area, Appendix Z).

1. An air compressor was located in crosscut 36 on the east side of the entry.

2. A ventilation curtain was installed in front of the air compressor across the entrance to crosscut 36 flush with the east rib line of the entry.

3. A 1-inch flexible rubber air line was installed along the roof across the entry at crosscut 36.

4. The compressor power cable was hung at the roof on the east side of the entry between crosscuts 36 and 35. The cable was installed along the roof across the entry at crosscut 35.

5. A 600kVA power center was located on the west side of the entry in crosscut 35.

6. A stopping, containing a mandoor, was constructed in crosscut 35 in front of the power center and was nearly flush with the west rib line of the entry.

7. A 4-inch pipe extended from the power center stopping across the entry to the No. 5 entry.

8. An aluminum and concrete-block overcast was constructed at the intersection of the entry and crosscut 34.

9. A 7,200-volt power cable was hung from the roof on the west side of the entry. The cable was routed through the stopping at crosscut 35 and connected to the power center.

10. A 2-inch fiberglass air line was hung from the roof on the west side of the entry between crosscut 36 and 34.

11. A roof drill power cable was hung from the roof across the entry at crosscut 35 from the power center and along the east side of the entry between crosscuts 34 and 35.

12. The belt drive power cable was hung from the roof along the west rib of the entry from the power center stopping at crosscut 35 to the overcast at crosscut 34.

The following is a brief summary of sworn statements of the first miners to arrive at the fire:

Salisbury stated he thought he first saw the fire near the intake/belt overcast while standing in crosscut 35; however, he did not remember seeing any of the aforementioned material at the time he first saw the smoke.

O'Neil was the second person to arrive at the fire. He remembered seeing the 7,200-volt cable down in the fire but none of the other equipment in the entry. He said he could see the fire from crosscut 39 and estimated the location of the fire to be just north of crosscut 36.

Leavitt and L. Cox arrived together just after O'Neil left. Neither miner was sure, but they thought they first saw the flames at or just north of crosscut 36. Cox said he could not see the power center stopping at crosscut 35 so he knew he first saw the flames at or north of crosscut 36.

R. Cox first observed the fire from crosscut 34 in the belt entry. He stated the belt overcast had collapsed before he arrived, and he then traveled around to No. 4 entry. He stated that he walked south past crosscut 37, but smoke prevented him from reaching crosscut 36.

MSHA investigators concluded that the first miners to observe the fire from the No. 4 entry were located north of crosscut 36 because none of these miners saw the air lines or the curtain at crosscut 36, any of the power cables entering the power center stopping at crosscut 35, the stopping with a mandoor at crosscut 35, or the 4-inch pipe extending from crosscut 35.

Fire Spread in the Direction of Airflow

The determination of the fire origin also depends upon the speed and direction that the fire spread. Much head coal had been present in the fire area and it was well documented that the fire quickly spread in the direction of airflow. Within four hours after the fire started, the fire had spread south, with the airflow, approximately 1,000 feet. The fire showed no tendency to spread against the airflow. Oxygen rich air flowed into the fire from the following locations near the mouth of 5th Right:

1. Air flowed south into the fire in the 5th Right intake entry (No. 4 entry) at crosscut 36.

2. Air flowed south into the fire in the 1st North return entry (No. 5 entry) at crosscut 34.

3. Air flowed east into the fire in the 5th Right belt entry (crosscut 34) at the belt overcast.

The following is a summary of the investigators' observations of the fire area and of the sworn statements of the miners working in the three affected areas:

1. No. 4 Entry Area

Leavitt said he was at the fire in the No. 4 entry about 5 minutes after Salisbury's second call. When he approached the fire, he could see flames and the smoke was down low.

O'Neil stated that at the time he first approached the fire in the No. 4 entry the smoke was not backing up against the air current. He left and traveled about 800 feet to a phone, made two calls and returned to the fire. The fire had increased in intensity but smoke was still not rolling back against the airflow. Several other miners stated they could easily approach the fire from the upwind side.

Kenneth Valdez arrived at the fire in the No. 4 entry several minutes after the power to the mine was shut off. He had a curtain installed partially across the No. 4 entry to reduce the air reaching the fire. Even with the reduced volume of air, the fire did not spread north of crosscut 36 against the direction of airflow. In addition, the mine fan continued to operate nearly 24 hours after the area was abandoned and the fire still did not spread north of crosscut 36.

2. No. 5 Entry Area

Gary Christensen, EMC Mine Rescue Team Captain, arrived at crosscut 34 in the No. 5 entry at about 12:30 a.m., about 3-1/2 hours after the fire started. He stated that the overcast had collapsed before he arrived and that the intersection was in flames. Christensen and his team then traveled to the 1st North belt entry and installed a fire hose from there to the No. 5 entry. They sprayed water into crosscut 35 and just before 3:00 a.m. took the hose to crosscut 34. The fire had not spread north from crosscut 34 against the airflow although nothing had been done to suppress the fire at this location until Christensen's team arrived with the fire hose. The fire also did not spread north of crosscut 35 after the area was abandoned.

3. 5th Right Belt Drive Area

R. Cox stood beside the controls of the 5th Right belt drive after the belt overcast at crosscut 34 had collapsed into the No. 4 entry. Although the airflow in the belt entry was restricted, the fire did not spread appreciably against the airflow toward the No. 3 entry of 1st North. Cox said he left to help with the fire hose and when he returned he could still see the flames to the right and left of the collapsed overcast. Valdez measured an air velocity of 211 feet per minute moving toward the fire near the 5th Right belt drive within an hour after fire started. He stated that he stood next to the belt drive and could see the belt starter box. The rest of the intersection was engulfed in flames.

A readable paper notebook was recovered from a nitrogen bottle next to the belt starter box and several cables were found undamaged by heat between the belt drive and belt starter box which indicated the fire did not spread west of the belt starter box.

The mine fan continued to operate nearly 24 hours after fire fighting ceased, and MSHA investigators found that the fire did not spread against the airflow in any of these areas. The fire did eventually spread into the intake entries, but only after the mine was abandoned. Without an airflow to carry the heat and oxygen downwind, the fire would be expected to spread toward available oxygen. After the fan was stopped it took nearly 20 hours for the fire to traverse the 1,200 feet from the burning return entry in Main West through the intake entries to the 1st South portals. MSHA investigators found no indication that the fire had spread against the air velocity at any time before or after the fire area was abandoned.

Burn Pattern of the Fire

As the fallen material was removed from No. 4 entry, the presence of ash and burned coal was monitored, investigated and recorded. A thick layer of ash and coked coal was present around and at the southwest corner of the air compressor. The amount of ash quickly dissipated in an easterly and northerly direction within crosscut 36. A band of ash and coked coal several feet thick extended from the southeast corner of crosscut 36 and increased in width toward crosscut 35, where the band of ash widened from rib to rib across the entry. Two power cables had been installed on opposite sides of No. 4 entry between crosscut 36 and 35. The cable on the east side of the entry was severely damaged and completely melted in places while the cable on the west side was minimally damaged by heat, with the major portion of this cable undamaged.

This burn pattern would be characteristic of a fire that had progressively increased in intensity and magnitude as it spread in the direction of the airflow (south) from crosscut 36 along the east rib of the No. 4 entry to crosscut 35.

Cable Damage

The high-voltage cable which was located on the west rib of the No. 4 entry, was essentially undamaged by fire between crosscuts 36 and 35 and had been suspended from the mine roof with nylon straps. In the early stages of the fire, the nylon straps melted and allowed the cable to fall to the mine floor as observed by O'Neil. The compressor cable, however, was hung near the roof by metal "J" hooks attached to roof bolt plates. Bureau of Mines research has shown the mine roof to be the hottest area in test fires, with temperatures commonly reaching 2,100°F. Since the metal "J" hooks would have maintained the cable near the roof and the high-voltage cable was supported by nylon straps, the damage to the power cables strongly support the fact that the fire started and propagated from crosscut 36.

Energized Equipment

The belt drive cable that was installed on the west rib of No. 4 entry, was one of two low-voltage circuits energized in the area between crosscuts 36 and 34. If the fire had started south of crosscut 36, it would have had to burn for several minutes without burning the belt drive cable or the high-voltage cable which was installed beside the belt drive cable. The high-voltage cable supplied power to the section equipment which was energized for at least 8 minutes (the time required for smoke to reach the section power center) after

the fire started. The belt drive was energized while dense smoke was observed in the No. 4 entry. The length of time electrical equipment remained operating after the discovery of the fire strongly support the belief that the fire started and propagated from crosscut 36.

MSHA investigators determined that the fire started and propagated from crosscut 36, between the No. 4 and 5 entries because:

1. The first miners to observe the fire were located north of crosscut 36.

2. The fire quickly spread in the direction of airflow.

3. The burn pattern was characteristic of a fire that had progressively increased in intensity and magnitude with the airflow (south) from crosscut 36 along the east rib of No. 4 entry to crosscut 35.

4. The damage to the power cables and the length of time electrical equipment remained operating after the start of the fire is consistant with a fire starting and propagating from crosscut 36.

A 150-horsepower, Ingersoll-Rand, flood lubricated, rotary-screw air compressor was the only potential fire source found in crosscut 36

Source of the Fire - Air Compressor

Underground Use of Air Compressors

At least three air compressors were available at the mine for use underground, two electric and one diesel powered. At the time of the fire, the two electric air compressors were underground and the diesel air compressor was on the surface being repaired.

In the two weeks prior to the fire, air compressors were used in at least three separate underground locations. The air compressors, although quite large, were easily and frequently moved with diesel equipment. During November and the first part of December, a Joy Manufacturing Company compressor was stationed at crosscut 36, 1st North, and used to inject RokLok into the roof near the mouth of 5th Right. On December 10, 1984, this compressor was moved to crosscut 22 in the intake entry of 13th Right and was used to drill blast holes in the roof to provide clearance for the 13th Right longwall stage loader. The Joy air compressor was found in this location by MSHA investigators. On December 10, 1984, the Ingersoll-Rand air compressor was moved from 4th Right to crosscut 36, 1st North and was found in this location by MSHA investigators.

Installation and Ventilation - Air Compressor Station

The compressor location in crosscut 36 had been provided with a crushed gravel floor. The compressor was situated with the receiver tank portion located toward the No. 4 entry. The location was ventilated to the return by the removal of one 8-by-16-inch block from the stopping separating the crosscut from the 1st North return air course. A curtain was installed across the crosscut opening and was cut vertically near the center to provide access to the crosscut and to allow ventilation. Approximately 500 feet of 2-inch diameter rigid

fiberglass air line had been installed between crosscut 36, 1st North and crosscut 4 belt entry, 5th Right. A 1-inch diameter flexible air line was hung from the roof from the compressor location across the No. 4 entry and was connected to the rigid fiberglass air line. The power cable was installed at the roof with metal "J" hooks along the east rib from crosscut 36 to crosscut 35. The cable crossed the No. 4 entry at crosscut 35 to the 5th Right belt drive power center. Crosscut 36 was a designated location where compressors were routinely placed and used and was determined by MSHA investigators to be an air compressor station. As stated previously, the Joy Manufacturing Company air compressor had been installed at this location just prior to the Ingersoll-Rand compressor being installed.

In normal operation, the Ingersoll-Rand air compressor should contain approximately 30 gallons of combustible automatic transmission fluid (ATF) which served to lubricate, cool, and seal during the compression process. The ATF is a National Fire Protection Association Class II B combustible liquid with a flash point of 330°F. Investigation and examination of the air compressor and installation revealed that the air compressor was normally operated unattended and was not housed in a fireproof structure or area nor equipped with a fire suppression device. The compressor was mounted on skids and set on a gravel floor. Several bags of rock dust and a fire extinguisher were provided, but there was no fireproof material applied to the roof or ribs.

The manufacturer of the air compressor, Ingersoll-Rand, did not address compressor use in undergound mines in the "Operating and Maintenance Manual" that was supplied with the machine. The manual does address ventilation and states in part: "Choose a clean, relatively cool location for the compressor package, and provide ample space around the unit for general accessibility and to ensure effective heat dissipation. Extreme care must be taken in locating an air-cooled unit of this type so there is an unrestricted supply of air to the cooling fan which pulls air over the oil cooler core. The fan discharge air must be ducted away from the unit so that it may be readily dissipated to the atmosphere without recirculating hot air to the fan intake. Any recirculation of the cooling air may result in an excessively high compressor operating temperature."

The ventilation in crosscut 36 was not adequate to conduct the smoke from the early fire to the return air course nor to prevent recirculation of heated air to the fan intake. According to UP&L engineers, a pressure drop of about 0.6 inches of water existed between the Nos. 4 and 5 entries near crosscut 34. There was a one-square-foot opening in the stopping between the compressor station and the 1st North return airway, and the quantity of air flowing through the hole in the stopping at the rear of the station was calculated to be 1,936 cfm. According to the manufacturer, the cooling fan capacity depends on the cleanliness of the oil coolers and can be as high as 18,000 cfm.

Examination and Maintenance of 5th Right Air Compressor

There was no record of air compressor examinations, and sworn statements revealed that the required weekly examinations and tests were not being conducted. According to Lee Lemmon, maintenance superintendent, air compressors were considered section equipment. Larsen stated that air compressors appeared

only on longwall section equipment examination sheets, and the person performing weekly examinations on the longwall equipment should have examined them.

The weekly examination records of the 5th Right longwall section equipment for the week of December 10 through 17 did not contain a record of any examination for the air compressor located in crosscut 36, 1st North. The mechanic who made these weekly examinations stated he was not aware that a compressor was located near the section.

The weekly examination records of 5th Right belt drive power center for December 10 through 17 did not contain a record of examination for the air compressor located in crosscut 36. The mechanic who was assigned to examine the power center stated he was not assigned to examine any of the air compressors. The first and second shift section foremen on the 5th Right section stated they too were not aware that an air compressor was stationed at crosscut 36.

A structured maintenance program and the responsibility for maintenance was not established for air compressors. On November 28, 1984, L. Cox worked on the Ingersoll-Rand air compressor near the mouth of 4th Right. He completed a maintenance activity report (MAR) and charged 4-1/2 hours to the installation of a coupler to an air compressor power cable and repair of the controller, but this MAR did not designate which air compressor had received the repair. The MAR contained a check mark in the next-to-last column, which indicated the repair was completed.

According to EMC records, an over-temperature safety switch was ordered on November 30, 1984, received at the mine on December 5, 1984, and issued to Ed Harrison, parts-runner, for delivery. Harrison signed for the switch but does not remember delivering it or any part of an air compressor. The over-temperature safety switch was never installed and was not found during the investigation.

Although air compressors were considered longwall section equipment, according to sworn statements, section foremen assumed no responsibility for them when used in outby locations. The repair work on the Ingersoll-Rand compressor when it was located at 4th Right was performed by general mine personnel, not longwall personnel, and the over-temperature safety switch was ordered by the general maintenance department.

Air compressors were primarily used by construction crews, but the crew members were not trained in or instructed to perform maintenance other than to check the oil level prior to starting.

Ingersoll-Rand, recommended a nine-point preventive maintenance schedule. This schedule was outlined in the "Operating and Maintenance Manual" and on a decal placed on the unit at the factory by the manufacturer. A copy of the manual can be found in Appendix J. The recommended maintenance, in part, is as follows:

1. Drain condensate from receiver-separator daily.

2. Check oil level daily.

3. Inspect air cleaner service gauge daily.

4. Lubricate regulator linkage weekly.

5. Keep exterior of oil coolers clean of accumulated oil, dirt, and grease. Clean each month or after each 200 hours of operation.

6. Change compressor lube oil every 300 to 500 hours of operation depending on conditions.

7. Service compressor oil filter at every oil change or when indicated by light or horn.

8. Check operation of safety shutdown switches every three months and check setting every year.

9. Remove and clean oil line orifice in scavenger lines every 1,000 hours.

According to sworn statements and the lack of any air compressor maintenance records, checking and adding oil was the only maintenance regularly performed on air compressors. A record was not kept of the amount of oil or the frequency that oil was added to the compressor. Records were not kept of the hours of operation on which four of the preventive maintenance requirements are based. The investigation team found no indication that the air compressors were ever cleaned other than during an overhaul.

History of 5th Right Air Compressor

In November 1984, an Ingersoll-Rand air compressor was installed in crosscut 25 on the east side of the No. 2 entry of 1st North, near where the 4th Right belt drive was to be installed. On November 28 a cable coupler was installed on the compressor cable, and the air compressor was connected to the 4th Right power center. When the compressor failed to start, Leslie Cox, electrican, found that the linkage to the on/off switch was disconnected and the over-temperature safety switch was open (defective). L. Cox stated he by-passed the over-temperature safety switch and taped a tag to the cable coupler which read "DO NOT OPERATE." He also said he notified the maintenance foreman, Ned Leavitt, of the air compressor deficiencies. An additional "DO NOT OPERATE" tag was reported to have been placed on the on/off switch by the following shift maintenance foreman, Jerry Carlson. Although the air compressor was "tagged-out," it would still operate.

EMC personnel used the "tagged-out" air compressor at the 4th Right location on at least three separate occasions. Tom Hersh was reported to have used the air compressor after Leavitt told Hersh it could be used if attended.

Brent Olson, service foreman, needed to use the compressor to anchor the 4th Right belt drive. After finding the tag on the air compressor, Olson contacted Dominic Oliveto, general maintenance foreman, who told him that he could use the air compressor if a person was stationed at the air compressor to watch the temperature gauge. Olson assigned James Ceal, mason, to watch the air compressor while it was being used. Ceal stated that the on/off switch was defective and that during the 2 hours of use, the compressor did not overheat but there was a slight, misty oil leak at the side of the compressor and a coating of oil on its power cable. He applied rock dust on the oily area at the air compressor.

On a subsequent shift, after finding the "DO NOT OPERATE" tag on the air compressor, Joseph Trenery, service foreman, contacted Carlson and was told he could use the air compressor if a person was assigned to watch the temperature gauge. Derek Jones, mechanic, was given this assignment, and when he arrived at the compressor it was already running. He didn't remember an oil leak but did notice an accumulation of rock dust on the compressor cable.

On December 10, 1984, the Ingersoll-Rand air compressor was moved into crosscut 36 off the No. 4 entry of 1st North to replace the Joy Manufacturing Company air compressor that was moved to 13th Right. The "DO NOT OPERATE" tag on the on/off switch was apparently lost or removed during this move.

There were two 400-ampere receptacles on the 5th Right belt drive power center. The belt drive motor starter power cable was connected to one and the other was tagged out. Carlson assigned Stephen Adams, mechanic, to replace the 400-ampere coupler on the air compressor power cable with a 225-ampere coupler. Adams installed the 225-ampere coupler and apparently placed the 400-ampere coupler, with the "DO NOT OPERATE" tag, on top of the power center. Adams also installed an external conductor for the ground wire monitor system. Adams said he attached an identifying tag on the air compressor cable coupler, corrected the rotation of the motor, and blew out the air lines before leaving the area but did not check the oil level or temperature gauge or notice an oil leak.

On December 11, 12, and 13, 1984, the air compressor was used to power a drill and mixing pumps for RokLok injection in the 5th Right intake entry between crosscuts 8 and 10. Nickolas Manning, laborer, worked on one of the day shift RokLok crews. Manning said that he turned the air compressor on and off at the transformer on all but one of the three shifts he used it. He said that the air compressor was running at the start of one of his shifts.

Oliveto said he was near the compressor location on December 14 or 17 and the compressor was not running at that time.

On December 16, 1984, an examination of the 5th Right high-voltage system was performed by Stanley Willson, mechanic. The examination deenergized portions of the high-voltage system and caused the low-voltage circuit breakers on the 5th Right belt drive power center to trip. During this examination, the belt drive and the air compressor circuit breakers were reset because the power cables for both were found connected to the power center. After resetting the circuit breakers, Willson observed the air compressor running and assumed that it had been running prior to the high-voltage examination.

A few hours later, between 1:00 and 2:00 a.m. on December 17, Willson again heard the air compressor running as he traveled to 5th Right to perform the weekly examination of the 5th Right belt drive power center.

On the first shift of December 19, 1984, Marvin Garrett, mechanic, said he heard the 5th Right air compressor running as he drove by the air compressor station on a Kubota tractor. On the following shift, Morris Blackburn, beltman, stated that he heard air leaking from the 2-inch fiberglass air line in the belt conveyor entry just above the return entry overcast during the entire shift. This indicates that the air compressor was operating all shift. MSHA investiga-

tors concluded that the air compressor ran unused and unattended for about 69 hours prior to the fire.

Recovery of the Air Compressor

The air compressor was severely damaged by the fire and completely covered by and somewhat damaged by the fallen roof material. Recovery of the air compressor was performed using a small front-end loading machine and by hand. Excavation by hand was used within one foot of the air compressor or within one foot of the mine floor.

After the roof fall was removed from around the compressor, it was examined and transported to the Emery County Sheriff's Office for disassembly and additional testing. The fallen material one foot above the mine floor was loaded out with a large diesel scoop. The remaining material in crosscut 36, west of the stopping and rib to rib, was passed through a wire mesh. Recovered items were removed from the mine for closer examination.

Air Compressor Operating While Flames Present

Testing and examination of the air compressor components revealed the following conditions that indicated the air compressor was operating at the time flames were present both inside the compressor system and in the crosscut around it:

1. The sheet steel enclosure cabinet was damaged by the rock and top coal that fell as a result of the fire. The top of the enclosure, which was hinged on the right side (south) and provided access to the enclosure, was concavely deformed down and was in contact with the compressor housing inlet ring, 10 inches below the normal position of the lid. The tops of the side panels were compressed down in places up to 8 inches. The fan shroud, mounted on the rear panel, was deformed downward 3 inches into the path of the rotating fan blades.

2. The oil shutoff valve was found in the open position. This valve is designed to close automatically upon compressor shutdown to prevent oil from flooding the rotor housing. The valve piston was frozen in this position by corrosion and charred remains of an O-ring and piston seal.

3. The inside surface of the separator tank had a low-temperature scale coating and hollow, droplet-shaped, shiny magnetic metal deposits in the top of the tank directly above the inlet pipe from the receiver tank. This indicated that the compressor rotors were moving air through the compressor and that the temperature of the gases that carried the molten iron droplets had reached at least 2,800°F. Testing revealed that this high internal temperature was present for only a short period of time since the inner surface of the tank was only raised to a temperature of between 1,300° and 1,500°F.

4. Both sides of the rear bearing housing were charred, and the inside surface was gouged and pitted from contact with the turning rotors. Smeared metal and metal deposits were observed on both rear rotor faces. This damage resulted from heated air from the fire being drawn into the compressor, causing thermal expansion of the rotors. Friction

between the rotating rotor faces and bearing housing produced the high localized heating of at least 2,800°F.

5. All six aluminum fan blades mounted on the compressor drive shaft were broken in a symmetrical manner. This was caused by the intrusion of the top of the fan blade shroud into the path of the rotating blades. The deformation of the shroud also symmetrically bent the trailing edge of the blades toward the inside of the enclosure.

   A bend test was performed on one of the damaged blades. The most severe cracking occurred in the area of the blade next to the fractured face. This indicated that the heat from the fire was sufficient to contribute to the embrittlement of the blades, allowing them to shatter upon impact with the shroud. Many small, shattered pieces of the fan blades were recovered from the bottom of the enclosure cabinet.

6. The normally closed air check valve was found in the down or open position. The valve return spring below the valve was partially melted in the area in direct line with the over-temperature safety switch. The outside surface of the discharge body did not show any mechanical or high-temperature damage.

7. The threaded steel portion of the over-temperature safety switch was intact. The heat-sensitive portion (metallic cap and bimetal strip) of the over-temperature safety switch was found in the receiver tank drain valve elbow. As the internal temperature in this area exceeded about 360°F, the solder that bonded the two pieces together melted and the separated portion of the switch was carried by the airflow to the receiver tank. The compressor remained running to fuel and to supply oxygen to the fire in the area of the switch long enough to raise the temperature of portions of the check valve spring to at least 2,800°F.

8. There was little or no oil or oil residue found in the oil filter, temperature by-pass valve, oil control valve, or compressor housing. This indicated that the compressor had continued to operate after oil no longer was available in the receiver tank and the system pressure purged the oil system prior to the compressor's stopping.

After analyzing the test results and physical condition of the air compressor components, MSHA investigators concluded that the air compressor was operating while the ATF was burning within the compressor and that it was operating at the time heat from the fire caused some of the roof coal to fall and deform the enclosure cabinet into the rotating fan blades.

Indications of Sudden Over-Pressure

There were several indications of sudden over-pressure due to an ignition in the receiver and separator tanks. The indications of over-pressure are as follows:

1. The pressure relief valve was partially melted and separated from the compressor. It was found on the mine floor approximately 2 feet in front of the air compressor. There were no pieces of the bronze valve visible in the threaded opening in the tank. Cracks in the top end of

the valve tend to indicate a tearing stress and the severe internal melting indicates that fire or extreme heat had passed through the valve.

2. The end housing of the manual blowdown valve had been separated from the compressor and was found on the mine floor about one foot from the south side of the air compressor adjacent to the receiver tank. It was charred, mechanically damaged, and appeared to have localized melting. The main portion of the valve was not found.

3. The receiver tank oil drain valve was separated from the compressor and was found buried in coke and ash on the mine floor, 4 inches directly below the location where it had been attached. The valve housing was fractured with some melting visible. This valve would have had to have been in place for the compressor to have operated for more than a few minutes. Since the fractured faces were partially melted, this damage must have occurred during the fire.

4. The separator tank end of the air discharge hose had been separated from the coupling and was found leading in the opposite direction from normal toward the rear of the compressor beneath the right side of the enclosure cabinet. The steel portion of the coupling was found on the mine floor directly beneath the discharge fitting where it had been attached. The bronze lock ring was melted away, which had allowed the coupling to drop to the mine floor.

5. The top front surface of the separator element was uniformly collapsed inward by pressure. According to the separator element manufacturer, the normal pressure drop across a new element is 3 psi and that at least 50 psi pressure differential would be required to collapse it.

MSHA investigators concluded that when the oil mist ignited within the separator and receiver tanks, the resultant high pressure fractured the drain valve at the bottom of the receiver tank and separated the 2-inch diameter discharge hose at the separator tank. This would have lowered the pressure inside the separator element and the higher pressure in the separator tank caused the element to collapse. The high pressure would have also opened the pressure relief valve and possibly caused the relief valve and manual blowdown valve to separate from the separator tank.

Evidence of Localized High Temperatures

Evidence of localized temperatures high enough to melt steel (2,800°F) was found on internal parts of the compressor. There was no evidence of temperatures high enough to melt steel on the external surfaces of the compressor. The maximum temperature that most internal parts were exposed to was harder to determine due to the relatively short duration of the fire within the compressor. The longer duration of the lower external heat from the burning coal and oil had a greater effect than the hotter internal fire on the maximum temperature attained by the components. The results of PTL-Inspectorate tests on the air compressor components are contained in Appendix K.

Oil Used in 5th Right Air Compressor - An Accelerant

The mine fire started much too quickly without the detectable odor of a burning cable to indicate a cable fire. Five to fifteen minutes prior to the fire, a fire boss traveled in the intake entry just 160 feet downwind of the fire origination area and did not note any unusual conditions on several fireboss tags he initialed in the 5th Right entries. Kenneth Blake stated that heavy smoke filled the intake entry almost immediately after the 5th Right crew was notified of the fire. Dense smoke in the No. 4 entry within this short period of time indicates a sudden failure. The rapidity at which the fire developed and spread is consistent with a fire initiated from heated oil especially if suspended in the air as a mist. Most of the oil that was contained in the compressor, up to 30 gallons, was discharged into crosscut 36 through the broken drain valve within the first few minutes of the fire.

The oil used in the air compressor was reportedly Conoco Power-Tran II Automatic Transmission Fluid (ATF). A crushed 5-gallon Conoco Power-Tran II can was found next to the compressor. Conoco no longer manufactures Power-Tran II ATF, and has replaced it with a very similar oil, Power-Tran III. MSHA tested Power-Tran III ATF for ignition and flame propagation properties as outlined in 30 CFR Part 35 - Fire Resistant Hydraulic Fluids. The auto ignition temperature (AIT) was determined to be 668°F. Bureau of Mines research has determined the AIT of oils would be expected to decrease by 150° to 200°F at an elevated system pressure of 125 pounds per square inch (psi) which is within the normal operating pressure of the air compressor.

Power-Tran III was also tested for fire retardant or self-extinguishing properties. The oil was heated to 150°F and sprayed into a test chamber under 150 psi nozzle pressure. These conditions could simulate the condition around an operating air compressor after a hose failure or the opening of the automatic pressure relief valve. The test oil was ignited by electric arcing and two other means. The oil failed the test by not self-extinguishing within 10 seconds when ignited at 18 inches and 24 inches from the nozzle. The report of these tests is contained in Appendix N.

Conoco Power-Tran II was a nonsynthetic hydraulic transmission fluid in the petroleum chemical family. The heat value of these petroleum oils ranges from 125,000 to 145,000 BTU per gallon. Using the lower, conservative figure, the total heat of combustion available from 30 gallons of oil is calculated to be 3.75 million BTU. Obviously not all of the oil would burn or burn efficiently enough to produce this heat value in a short period of time. The calculation is intended to illustrate the large quantity of potential heat energy immediately available when up to 30 gallons of the heated oil was ignited and released into the compressor station.

Electrical Deficiencies - Over-Temperature Safety Switch and On/Off Switch

Examination and testing of the electric components and wiring of the air compressor revealed the following:

1. Both control circuit conductors to the over-temperature safety switch were intentionally connected to the same terminal post of the switch,

rendering the switch inoperative (See Appendix Q). This connection prevented the air compressor from being protected against overheating when the fire occurred. The switch is a normally closed type thermal switch and is factory set to open at 245°F (118°C) and deenergize the main contactor coil (M), which will deenergize the air compressor motor. The safety switch was installed in the main air discharge piping, which is the location that would normally have the highest internal temperature of the air/automatic transmission fluid mixture.

2. The linkage extending from the on/off control handle, located on top of the Crouse Hinds enclosure, was found disconnected and lying in the bottom of the enclosure beneath the control panel tray. The linkage provided start and stop capability for the air compressor at the air compressor. The physical construction, assembly, and design of the control panel inside the Crouse Hinds enclosure, and the location of the linkage when found, indicated that the linkage was manually disconnected and placed in this location before the fire. The failure to maintain the linkage in operative condition necessitated placing the 225-ampere circuit breaker of the air compressor control panel in the "on" position, then using the receptacle "5" panel circuit breaker of the 5th Right belt drive power center to start and stop the air compressor. The 5th Right belt drive power center was located approximately 100 feet away from the air compressor.

In summary, MSHA investigators concluded that the over-temperature safety switch was rendered inoperative and the on/off control handle linkage on the 5th Right air compressor was disconnected prior to the fire.

MSHA investigators concluded that the air compressor, located in crosscut 36, was the source of the fire because:

1. Examination and testing of the air compressor components revealed that:

   (a) The air compressor was operating when flames were present both within the compressor system and in the crosscut around it.

   (b) There were indications of a sudden over-pressure due to an ignition in the receiver and separator tanks.

   (c) Localized internal temperatures were high enough to melt steel (2800°F).

   (d) The over-temperature safety switch was rendered inoperative prior to the fire.

2. The air compressor was not being properly maintained or adequately ventilated to the manufacturer's recommendations.

3. Sworn statements indicated the compressor had been unattended and continuously operating for at least 69 hours prior to the fire.

4. The air compressor contained approximately 30 gallons of combustible ATF fluid.

5. The mine fire started much too quickly without detectable odor of a burning cable to indicate a cable fire. Within 5 to 15 minutes prior to the fire, a fire boss traveled in the intake entry just 160 feet downwind of the fire origination area and did not note any unusual conditions on several fire boss tags he initialed in the 5th Right entries. Kenneth Blake stated that heavy smoke filled the intake entry almost immediately after the 5th Right crew was notified of the fire. Dense smoke in the No. 4 entry within this short period of time indicates a sudden failure and is uncharacteristic of a cable fire. The rapidity at which the fire developed and spread is consistent with a fire initiated from heated oil fuel. Essentially all of the oil that was contained in the compressor, up to 30 gallons, was discharged into crosscut 36 during the fire.

6. Analysis of test results and sworn statements of EMC personnel indicated that the air compressor station was the location of the source of the fire because:

   (a) Testing of a similar compressor showed that an operating compressor increased the sound level in the entry adjacent to the compressor by approximately 35 dba and therefore, any miners located at or south of crosscut 36 when he first saw the fire would have heard the air compressor running. None of the first miners to observe the fire heard the air compressor operating in crosscut 36. The fire therefore was located at crosscut 36 and the compressor had stopped due to the fire when the first miners approached.

   (b) MSHA investigators cannot find support to justify the possibility that the fire started along the west rib of the No. 4 entry at or south of crosscut 35, spread across the entry, then 100 feet north along the east rib of the entry (without burning the power cables) and into the compressor station within 10 minutes, against the airflow, and then did not spread farther north during the following two hours after the airflow was reduced.

   (c) The FBI, ECSO, State mine inspectors, and arson investigators concluded that the fire did not and could not have traveled north against the airflow without burning the compressor power cable insulation and that the fire had to have started in crosscut 36 on the east side of the No. 4 entry. Since the only fire source in crosscut 36 was the air compressor, the investigators concluded that the air compressor started the fire. As the heat and flame were carried south with the airflow, the fire spread along the east rib of No. 4 entry, increased in intensity, and gradually engulfed the entire entry near crosscut 35.

7. PTL-Inspectorate, Inc. performed extensive tests on the compressor components. Their analysis was based solely upon their findings and general mine information supplied by MSHA. PTL-Inspectorate concluded the following:

(a) Internal fire and resultant heat and pressure appears to have started from the compressor overheating from prolonged operation at a "no flow" or minimum flow condition. The fire from the compressor rotors went through the open air discharge valve to the receiver and oil separator causing an increase in pressure.

(b) The drain valve, which was broken and the main section subjected to melting temperatures when examined, also saw the higher pressures and may have cracked and/or failed.

(c) The compressor showed all indications that it continued to run after a period of internal burning.

(d) The high temperature inlet air with the reduction in cooling caused the compressor to further overheat. This overheating with a probable lube oil failure produced expansion of the rotors. The friction produced temperatures at the melting point of steel and added torque to the drive.

8. An independent study performed by John Nagy, fire expert, is a very exacting analysis of the Wilberg fire, and states ". . . as the study progressed, the accumulation of evidence that the fire started at the compressor became so overwhelming and conclusive that an assignment of a probability of ignition to other sources would be misleading."

9. P. D. Laing and A. G. Russell of Howden Compressor Limited, Glasgow, Scotland, wrote an article on air compressor fires entitled, "Fires in Oil Injected Screw Compressors--Their Prediction, Analysis and Prevention." They performed tests with pressure- and temperature-recording equipment and deliberately delayed the injection of oil until a flash fire occurred. Of the 29 tests that were performed, 10 resulted in a flash fire. The fire occurred in the separator where oil and oil mist were fed with hot air from the compressor. The temperature at which a fire occurred seemed to vary from about 410° to 752°F. After a fire occurred the pressure inside the separator tank rose to 200 to 220 psig and the temperature to between 1,112° and 1,292°F.

   The Bureau of Mines publication, "Study of Air Compressor Hazards in Underground and Surface Mines", Contract #J0100006, states that air compressors that are poorly maintained have resulted in fires and that most compressor failures that had resulted in fires involved a faulty or by-passed over-temperature safety switch.

10. Although there was not conclusive evidence that any specific mode of failure led to the ignition is this case, a review of past compressor failures and test results indicated that the most likely mode of ignition in the 5th Right compressor was localized heating in either the oil separator/receiver tank(s) or at the point of compression.

11. In addition, all the other potential sources of fire in the belt entry and in the No. 4 entry between crosscuts 36 and 34 were carefully investigated and tested and were determined not to be the source of the

fire. MSHA findings are contained in this section and the appendices of this report.

Other Potential Fire Sources Considered By MSHA

Spontaneous Combustion

Coal can heat spontaneously, but the likelihood of self-heating is greatest among the lower-grade coals. The heating begins as soon as the freshly broken coal is exposed to the air. The 1st North entries, where the fire occurred, had been developed between December 1979 and February 1980 and had a sufficiently long time for cooling of the exposed coal and strata. The mine environment was in equilibrium with the air currents. Temperatures over 100°F existed in the compressor station, but the cooling fan on the compressor would maintain air movement within the compressor station to prevent higher localized heating of the surrounding coal. Since the fire area was a relatively well-ventilated area and there was no history or evidence of spontaneous combustion at the mine, MSHA investigators concluded spontaneous combustion was not the source of the fire.

Smoking Articles

No smoking materials were found in the lunch buckets on the 5th Right section or in the personal effects of the victims. Although several miners said they either were not searched or were searched at lengthy intervals, no evidence was found to indicate that smoking materials were being taken or used underground. Consequently, MSHA investigators concluded that the use of smoking materials did not provide the ignition source for the fire.

Diesel Equipment

No diesel equipment was found in the recovered area of the No. 4 entry diesel roadway of 1st North. Mine management stated they could not account for one diesel pickup truck, but there was no other evidence or indication from sworn statements that there was a truck in the fire area at the time of the fire that had not been recovered.

There are two areas on the diesel roadway in 1st North that were not fully explored and recovered. Both of these areas, the No. 2 entry between crosscuts 29 and 35 and the No. 4 entry south of crosscut 34, are in the area that is still sealed. The physical evidence and sworn statements clearly indicate the fire started north of the overcast at crosscut 34. Therefore, MSHA investigators concluded that diesel equipment did not provide the source of the fire.

Arson or Sabotage

Arson and sabotage were considered because of initial allegations and rumors of arson and due to reports that the fire spread rapidly enough to suggest the presence of a super-heated hydrocarbon or an accelerant. No physical evidence was found nor were there any indications from interviews and sworn statements obtained that would support an act of arson or sabotage. The FBI, ECSO, and the State of Utah arson investigators concluded that arson or sabotage was not the cause of the fire.

Electric Circuits and Equipment

Since sworn statements indicate that the area of No. 4 entry, 1st North, between crosscuts 36 and 34 was the fire origination area, MSHA investigators carefully examined and tested the electric circuits and equipment that were located in this area or supplied power to equipment in this area for any evidence that the circuits or equipment provided the source of the fire.

The electric circuits and equipment contained in the 5th Right belt entry were also evaluated as potential sources of the fire. The results of these tests and examinations are summarized below. A detailed description of all equipment and tests and examinations conducted by MSHA investigators on these electric circuits and equipment is contained in Appendix P.

Sworn statements also indicated that the 5th Right belt drive was operating when dense smoke was present in the No. 4 intake entry at the belt overcast. In addition, the 5th Right section Kobe and emulsion pump motors were running when the dense smoke from the fire arrived at the longwall power center, located at crosscut 20, in the intake entry of 5th Right longwall panel. This indicates that the No. 2 high-voltage cable circuit, both the belt drive and longwall power centers, the belt drive motor starter and belt drive motors, the Super 500-HD belt take-up unit, the 5th Right belt take-up unit, the low-voltage cables supplying the take-up units, and the 5th Right belt control cables were all energized during the early stages of the fire. In addition, MSHA investigators concluded that the No. 2 AWG power cable that supplied power from the belt drive power center to the air compressor was also energized when the fire occurred.

MSHA investigators tested and examined the following electric circuits and equipment that were located in the fire origination area and in the 5th Right belt entry:

1. No. 4 Entry - High-Voltage Circuits and Equipment

   (a) The high-voltage cable that supplied 7,200-volt, three-phase power from a triple section switch located at crosscut 39, between Nos. 1 and 2 entries, 1st North, to the 5th Right belt drive power center and the 5th Right longwall section power center.

   (b) The 5th Right belt drive power center, located in crosscut 35, between Nos. 3 and 4 entries.

2. No. 4 Entry - Low-Voltage Circuits and Equipment

   (a) The No. 2 AWG portable power cable that supplied power from the 5th Right belt drive power center to a Joy single boom roof drill located at crosscut 7, intake entry, 5th Right longwall panel.

   (b) The No. 6 AWG portable power cable (P-122-MSHA) that supplied power from the 5th Right belt drive power center location to a Jeffrey satellite pump located at crosscut 5, intake entry, 5th Right longwall panel.

(c) Approximately 180 feet of No. 2 AWG cable that supplied power from the 5th Right belt drive power center to a 150-horsepower air compressor located in crosscut 36.

(d) Approximately 125 feet of No. 4/0 AWG power cable that supplied power from the 5th Right belt drive power center to the 5th Right belt drive motor starter.

3. Belt Entry - Low-Voltage Circuits and Equipment

(a) The 5th Right belt drive motor starter located in crosscut 34, between Nos. 3 and 4 entries, 1st North.

(b) Two No. 4/0 AWG cables, approximately 50 feet in length, that supplied power from the motor starter to each belt drive motor, approximately 20 feet of No. 2 AWG cable that supplied power to a separate electric enclosure located at the motor starter, and approximately 8 feet of No. 6 AWG cable that supplied power to the line starter enclosure of the Super 500 belt take-up.

(c) Seven belt control cables, of various lengths, that were connected to the motor starter and remote belt control components.

(d) The hydraulic take-up unit (located adjacent to the motor starter) and approximately 20 feet of No. 10 AWG cable that supplied power from the motor starter to the belt take-up unit.

(e) The Super 500 belt take-up and storage unit and separate power pack located between crosscuts 3 and 5, 5th Right belt entry. The 100 ampere line starter (located at the belt drive motor starter) and approximately 300 feet of No. 6 AWG cable that supplied power from the line starter to the Super 500 belt take-up power pack line starter located at crosscut 4, 5th Right belt entry.

4. 5th Right Belt Conveyor

The 5th Right belt conveyor extended from the belt drive between entries 3 and 4, 1st North over the overcasts at crosscuts 34 and 35, and through the belt entry of the 5th Right longwall panel to the stage loader area of the 5th Right longwall section.

No. 4 Entry - High-Voltage Circuits and Equipment

High-Voltage Cable

The No. 2 high-voltage cable circuit within the fire origination area contained approximately 180 feet of No. 4/0 AWG copper, 8KV, three conductor, type SHD-GC mine power cable. The high-voltage cable was installed on the west rib of the No. 4 entry, supported from the mine roof by plastic fiber straps. A cable installed in this mandoor would not contact the mine roof. A splice in the cable was located approximately 38 feet south of the southeast corner of crosscut 35.

The high-voltage cable from crosscut 36 to crosscut 35 showed only minor heat damage to portions of the outer cable jacket. The outer cable jacket and the phase conductor insulation was totally melted away on major portions of the cable from crosscut 35 to crosscut 34.

The high-voltage cable did not reveal any evidence of arcing or heating from within on any sections of cable examined. Many portions of the high-voltage cable did exhibit damage that suggested exposure to radiation or elevated gas temperatures from the fire. Examination of the splice did not reveal any evidence of arcing, which would be characterized by melting, fusion, or blow holes in the shielding of the splice.

Belt Drive Power Center

The belt drive power center was located in crosscut 35 of No. 4 entry between the Nos. 3 and No. 4 entries, 1st North, and was separated from the entries by concrete-block stoppings containing mandoors. The high-voltage end of the power center was positioned toward the No. 4 entry, and the low-voltage receptacle outlets were located on the north side of the power center. The power center was installed approximately one foot above the mine floor and approximately three feet away from the coal roof. The power center was 80 feet upwind from the overcast where dense smoke was seen by Tidwell and Price.

The power center reduced 7,200-volt, three-phase power to 480-volt, three-phase power to supply seven outlet receptacles. Examination of the power center revealed that only two cables were connected to the power center. A No. 4/0 AWG cable was connected to receptacle "6" panel and served power to the 5th Right belt drive motor starter, and a No. 2 AWG cable was connected to receptacle "5" panel and served power to the air compressor.

A sustained arc or electrical fault inside the power center and the failure of protective switchgear and circuits could have provided the ignition source of a fire. Except for the oil-filled 120kVAR bank of capacitors, the power center did not contain combustible material. Examination of the bank of capacitors revealed that their discharge resistors were intact, both steel cases were deformed and only a very small amount of oil was found inside the steel case of one of the capacitors. MSHA investigators found no signs of internal arcing in either capacitor.

The power center had been damaged by heat from the fire. The plastic emergency stop switch, plastic lid interlock switches, plastic grounded-phase test buttons, and plastic relay covers were melted, and numerous internal electronic components were damaged by heat. However, the insulation of the control wiring was pliable and did not show evidence of extreme heat damage.

MSHA investigators found no evidence of a short circuit or ground fault in the high- and low-voltage portions of the power center. There was no evidence of arcing or fire inside the power center. Lumps of coal and an unburned cardboard box of electrical components were found inside the high-voltage portion of the power center. The lower portion of a paper service manual, located on the high-voltage end of the power center, was found unburned. The roof above the power center had not caved, and the coal roof and ribs did not show evidence of burning or coking. The physical damage to the power center indicated that the

fire did not enter the power center enclosure and that the damage to the power center was caused by the hot gases from the fire in the No. 4 entry.

Protective Switchgear

Testing and analysis of the cascaded high-voltage protective switchgear revealed that a phase-to-phase fault in the fire origination area would trip three of the cascaded high-voltage protective switchgear (crosscut 22 and 39 triple section switches and OCB 2) instantaneously and would also trip the crosscut 13, Main West, triple section switch in 0.4 seconds and the West Main Feed OCB in 9.0 seconds, if the fault were not removed by the other switchgear. Also, a phase-to-ground fault in the fire origination area would trip the crosscut 22 and 39 triple section switches in 0.11 seconds and the West Main Feed OCB in 0.4 seconds.

After analyzing the information gathered during the investigation, MSHA investigators reached the following conclusions about the No. 2 high-voltage cable circuit and 5th Right belt drive power center:

1. EMC personnel reset targets of protective relays after monthly examinations and after the tripping of the switchgear by the protective devices. Since vacuum breaker C of crosscut 39 triple section switch was not reenergized during the fire fighting and recovery efforts, the targets of the instantaneous units of the overcurrent relays for the No. 2 high-voltage cable protective switchgear occurred at the time of the fire.

2. The presence of targets on the instantaneous units on the cascaded No. 2 high-voltage protective switchgear indicated that a short circuit occurred in the fire origination area.

3. The tripping of the high-voltage cascaded protective switchgear did not occur for about eight minutes after dense smoke was present in the fire origination area of No. 4 entry. Eight minutes is the estimated time for the smoke to travel from the fire orgination area to the longwall face.

4. The UP&L/CRSP Power Report (See Appendix Q) did not show a peak that would indicate a sustained fault on the high-voltage system the night the fire occurred, and the cable did not show any evidence of arcing or heating from within any section of the high-voltage cable that was examined. Therefore, the damage to the No. 2 high-voltage cable was caused by the fire and was not the result of a sustained overcurrent condition.

5. The OCB 2; vacuum breaker A of crosscut 22, 1st North, triple section switch; and vacuum breaker C of crosscut 39, 1st North, triple section switch tripped and deenergized the No. 2 high-voltage cable in the fire origination area when the hot gases from the fire melted the outer cable jacket (approximately 410°F) and the phase conductor insulation (approximately 500°F) and created a short-circuit condition.

In summary, MSHA investigators concluded that neither the No. 2 high-voltage cable nor the 5th Right belt drive power center provided the source of the fire.

No. 4 Entry - Low-Voltage Circuits and Equipment

Roof Drill Cable and Satellite Pump Cable

In addition to the motor starter cable and the air compressor cable, two other cables extended into crosscut 35 but were not connected to the power enter. The cables were a No. 6 AWG, five conductor, P-122-MSHA cable and a No. 2 AWG, three conductor, type G-GC, Rome, P-105-50 cable. Investigation of the No. 2 AWG cable revealed that a No. 2 AWG, three conductor, type G-GC, Rome, P-105-50 power cable exited the seal located east of crosscut 4, intake entry of 5th Right, and was connected to the Joy single boom drill, located along the intake entry in crosscut 7. The cable attached to the Jeffrey satellite pump located in crosscut 5, intake entry of 5th Right, was a No. 6 AWG, five conductor, P-122-MSHA power cable.

MSHA investigators concluded that the No. 2 AWG cable had supplied 480-volt, three phase power to the Joy single boom drill and the No. 6 AWG cable had supplied 480-volt, three-phase power to the Jeffrey satellite pump.

MSHA investigators also concluded that both cables were deenergized and not in use when the fire occurred, and could not provide the source of the fire.

Air Compressor Cable

Approximately 180 feet of No. 2 AWG, 2000-volt, four conductor, type W, power cable was installed to supply 480-volt, three-phase power from the belt drive power center to the air compressor. The cable was installed on the east rib of No. 4 entry and was supported from the mine roof by "J" hooks attached to roof bolt plates and was located upwind from the area of the No. 4 entry where dense smoke was seen by Price and Tidwell. The area where the cable was recovered was caved as a result of the fire. A sustained arc or fault in the cable and the failure of protective switchgear components could have provided the ignition source of the fire. However, as supported below, the observations and test results showed no indication that this was the source.

Examination and testing of the air compressor cable revealed the following:

1. The No. 2 AWG air compressor cable was not sufficient in size and did not have adequate current carrying capacity, as per the specifications of the 1968 National Electric Code, to supply power to the 480-volt, three-phase, 150-horsepower air compressor motor.

2. All tested sections of the cable showed no evidence of internal heating or arcing.

3. The air compressor cable jacket was flame resistant.

The damage to the No. 2 AWG air compressor cable observed by MSHA investigators included the following:

1. Approximately 23 feet of the cable, at the end connected to the power center, sustained only minor damage to the cable jacket.

2. Only melted copper deposits of the cable were found across the No. 4 entry and along the east rib to approximately 36 feet south of the south corner of crosscut 36.

3. Approximately 44 feet of cable, from 36 feet south of crosscut 36 to approximately the south corner of crosscut 36, was extensively damaged. The outer jacket and phase conductor insulation were not present on the major portions of the cable.

4. The cable was severed during the recovery efforts at approximately 17 feet south of the south corner of crosscut 36.

5. The outer jacket on approximately 61 feet of cable was extensively damaged, from the south corner of crosscut 36 to the electrical enclosure of the air compressor. The outer cable jacket was charred, brittle, and blistered on the major portions of the cable jacket and was totally gone on other portions of the cable in this area.

Receptacle "5" Panel - Power Center The receptacle "5" panel of the 5th Right belt drive power center provided short-circuit, overcurrent, undervoltage, and grounded-phase protection for the air compressor cable circuit. In addition, the panel was equipped with a ground wire monitor to monitor the continuity of the air compressor grounding circuit. The receptacle "5" panel consisted of a molded-case circuit breaker, ground wire monitor, grounded-phase relay, and control circuit.

Examination and testing of the receptacle "5" panel revealed the following:

1. The three-pole, molded-case, seltronic circuit breaker (300-ampere frame LCM with a 300-ampere continuous rating plug and a 600-1500-ampere instantaneous trip unit as per Ohio Brass Drawing Nos. 3622 and 3622A, Appendix Q) was found in the tripped position. The contacts of the circuit breaker showed average arcing with some carbon, but did not have molten metal present.

2. All components and wiring were installed in accordance with the manufacturer's specifications.

3. The electronic components of the seltronic circuit breaker, ground wire monitor and grounded-phase relay were destroyed and these components could not be tested.

4. The seltronic circuit breaker in this receptacle panel must be manually reset after a power outage.

5. The last examination of the power center prior to the fire occurred on December 17, 1984. The reported deficiency was not having an identification tag on the air compressor cable coupler.

6. A phase-to-phase fault in the air compressor cable circuit would trip the receptacle "5" circuit breaker instantaneously (even if the instantaneous setting was at the maximum of 1,500 amperes) and would trip the 5th Right belt drive power center high-voltage vacuum breaker in 2.5 seconds, if the fault were not removed by the circuit breaker.

7. A phase-to-ground fault in the air compressor cable would trip the receptacle "5" circuit breaker instantaneously.

8. An open grounding circuit would trip the receptacle "5" circuit breaker instantaneously.

After analyzing the information gathered during the investigation, MSHA investigators concluded the following about the receptacle "5" panel and the air compressor cable:

1. No wiring deficiencies were found that would affect the receptacle "5" panel's ability to detect an open grounding circuit, or a short-circuit, grounded-phase, or undervoltage condition.

   Since the electronic components of the seltronic circuit breaker grounded-phase relay, and ground wire monitor were destroyed by heat MSHA investigators could not determine by testing if these devices were functional at the time of the fire. However, sworn statements and examination records of EMC personnel indicate that the ground wire monitor and the grounded-phase protective circuit were functional when the fire occurred. Consequently, MSHA investigators concluded that the receptacle "5" breaker tripped as a result of a short circuit, grounded-phase, or an open grounding circuit as a result of the fire.

2. Since none of the cable sections of the air compressor cable examined displayed any evidence of internal heating or arcing the air compressor cable was not damaged by a sustained phase-to-phase fault condition.

3. The odor liberated from a burning cable is readily detectable and would have been smelled by Robinson or Riddle when they traveled the No. 4 entry 5 to 15 minutes prior to the fire, if the air compressor cable was burning.

4. The exposure of the air compressor cable to heat from a fire would melt away the outer cable jacket and phase conductor insulation and create a phase-to-ground fault or a phase-to-phase fault that would trip the receptacle "5" circuit breaker of the belt drive power center or the high-voltage protective switchgear if the circuit breaker of the belt drive power center failed to trip.

In summary, MSHA investigators concluded that the No. 2 AWG air compressor cable did not provide the source of the fire.

Motor Starter Cable

Approximately 125 feet of No. 4/0 AWG, 600/2000-volt, three conductor, type G-GC power cable supplied 480-volt, three-phase power from the belt drive power

center to the belt drive motor starter. The motor starter cable was installed on insulated cable hangers from the mine roof on the west rib of No. 4 entry and was located upwind from the area where dense smoke was seen by Price and Tidwell. The area where the cable was recovered was caved as a result of the fire. A sustained arc or fault in the cable and the failure of protective switchgear components could have provided the ignition source of the fire. However, as supported below, the investigation revealed no indications that this was the source.

Examination and testing of the motor starter cable revealed the following:

1. The No. 4/0 AWG motor starter cable was not sufficient in size and did not have adequate current carrying capacity, as per the specifications of the 1968 National Electric Code, to supply power to the belt drive motor starter and connected loads. However, calculations of the power necessary to operate a loaded 5th Right belt conveyor was approximately 98-horsepower (125 amperes). Based on ampacity tables, a 0-2,000-volt, 90°C, No. 4/0 AWG cable has an ampacity of 329 amperes at 20°C ambient temperature.

2. No tested sections of the motor starter cable displayed any evidence of internal heating or arcing.

3. The motor starter cable jacket was flame resistant.

The damage to the motor starter cable included the following:

1. Portions of the cable that were connected to the power center and motor starter sustained only minor heat damage to the cable jacket.

2. The outer cable jacket was totally burned away on the the cable south of crosscut 35 for approximately 40 feet.

3. The outer cable jacket and all the phase conductor insulation were burned away on the cable from approximately 40 feet south of crosscut 35 to the belt overcast in crosscut 34.

4. The cable was severed at three locations. A detailed analysis revealed that the cable was mechanically damaged during the recovery efforts since the ends of the phase conductors were characterized by sharp breaks and shiny, well-defined surfaces.

Receptacle "6" Panel The receptacle "6" panel of the 5th Right belt drive power center provided short-circuit, overcurrent, undervoltage, and grounded-phase protection for the motor starter cable circuit. In addition, the panel was equipped with a ground wire monitor to monitor the continuity of the motor starter cable grounding circuit. The receptacle "6" panel consisted of a molded-case circuit breaker, ground wire monitor, grounded-phase relay, and control circuit.

Examination and testing of the receptacle "6" panel revealed the following:

1. The three-pole, molded-case, seltronic circuit breaker (600-ampere frame MCM with a 600-ampere continuous-current rating plug, and an 800- to 2,500-ampere instantaneous trip unit as per Ohio Brass Drawing Nos. 3622 and 3622A, Appendix Q), was found in the tripped position. The contacts of the circuit breaker showed little evidence of arcing, and the arc chutes were coated with some carbon, but did not have molten metal present.

2. The control wire to terminal No. 1 of the solid-state, grounded-phase relay was found disconnected (See Drawing Nos. 3622A and D-3622, Appendix Q). Terminal No. 1 was the normally open contact of the grounded-phase relay. The grounded-phase current transformer (CT) was functional.

3. Except for the terminal No. 1 connection of the grounded-phase relay, all components and wiring were installed in accordance with the manufacturer's specifications.

4. The electronic components of the seltronic circuit breaker, ground wire monitor and grounded-phase relay were destroyed by heat and these components could not be tested.

5. The seltronic circuit breaker in this receptacle panel must be manually reset after a power outage.

6. The last examination of the power center prior to the fire occurred on December 17, 1984. The reported deficiency was not having an identification tag on the motor starter cable coupler.

7. The grounded-phase relay circuit of the receptacle "6" panel had been reported defective since November 16, 1984, on the running repair logs and was reported defective on six weekly examination records since September 25, 1984.

8. A phase-to-ground fault in the No. 4/0 AWG motor starter cable circuit would not trip the receptacle "6" circuit breaker nor any of the high-voltage switchgear since the fault current would be limited to 15 amperes and the grounded-phase protective relay had been intentionally rendered inoperative prior to the fire.

9. A phase-to-phase fault in the motor starter cable circuit would trip the receptacle "6" panel circuit breaker instantaneously (even if the instantaneous setting was set at the maximum of 2,500 amperes). It would trip the 5th Right belt drive high-voltage vacuum breaker in 1.1 seconds; vacuum breaker C of the triple section switch located at crosscut 39, 1st North, in 4.0 seconds; and vacuum breaker A of the triple section switch located at crosscut 22, 1st North, in 12 to 15 seconds if the fault were not removed by other protective switchgear.

10. An open grounding circuit would trip the receptacle "6" circuit breaker instantaneously.

After analyzing the information gathered during the investigation, MSHA investigators reached the following conclusions about the receptacle "6" panel and the No. 4/0 AWG motor starter cable:

1. No wiring deficiencies were found that would affect the receptacle "6" panel's ability to detect a short circuit, undervoltage, or an open grounding circuit. Since the electronic components of the seltronic circuit breaker and ground wire monitor were destroyed by heat, MSHA investigators could not determine by testing whether these devices were functional at the time of the fire. Although some sworn statements and examination records of EMC personnel indicate that the ground wire monitor and the grounded-phase protective circuit were functional when the fire occurred, MSHA investigators concluded that the grounded-phase protective circuit was not operative when the fire occurred. MSHA investigators also concluded that the receptacle "6" breaker tripped as a result of a short circuit or an open grounding circuit due to the fire.

2. The intentional defeating of the grounded-phase relay of the receptacle "6" panel and the intentional defeating of both grounded-phase relay circuits in the motor starter (discussion to follow within this section) indicates the presence of a grounded-phase condition at the time these circuits were rendered inoperative. The grounded-phase protective circuit of the receptacle "6" panel was rendered inoperative and reported defective on the weekly examination record of September 25, 1984.

3. The presence of a 15-ampere phase-to-ground fault in the motor starter cable circuit could have provided the source of the fire; however, MSHA investigators found no evidence of internal heating or arcing in this cable circuit. Most phase-to-ground faults are contained within the cable jackets due to the limited energy available and the physical design of the cables. Should the phase-to-ground fault have resulted in the burning of the motor starter cable, a phase-to-phase fault would have promptly occurred due to the rapid deterioration of the insulation of the phase conductors and physical design of the cable. A phase-to-phase fault would have caused the receptacle "6" circuit breaker to trip instantaneously which would have removed the power from the cable, and deenergized the motor starter.

4. Since none of the examined cable sections of the motor starter cable displayed any evidence of internal heating or arcing, the motor starter cable was not damaged by a sustained phase-to-phase fault condition.

5. The odor liberated from a burning cable is readily detectable and would have been smelled by Robinson or Riddle when they traveled in the No. 4 entry 5 to 15 minutes prior to the fire if the motor starter cable was burning.

6. The exposure of the motor starter cable to heat from a fire would melt away the outer cable jacket and phase conductor insulation and create a phase-to-phase fault that would trip the receptacle "6" circuit breaker of the belt drive power center or the high-voltage protective switch-

gear if the circuit breaker of the belt drive power center failed to trip.

In summary, since the 5th Right belt drive was operating after dense smoke was observed in the No. 4 entry, MSHA investigators concluded that the motor starter cable did not provide the source of the fire.

EMC Source of Fire Scenario

The EMC scenario proposed that current leakage from the faulted belt drive motor starter cable to a roof bolt into the coal roof strata caused sufficient heating to ignite the coal. The smoldering roof coal fell from the roof at crosscut 35 and the contact with the intake air quickly spread the fire in the No. 4 entry. MSHA Technical Support in conjunction with the Bureau of Mines throughly investigated this scenario by conducting underground tests in the Pittsburgh coal seam and laboratory tests of coal from the Hiawatha seam coal.

After analyzing the test results and the information gathered during the investigation, MSHA investigators concluded the following about the EMC source of fire scenario:

1. Although it cannot be concluded with certainty that the Pittsburgh and Hiawatha seams will react identically, it is highly probable that they will act similarly since they are both bituminous coal seams. From the test results of power being directly applied to a roof bolt in the coal strata of the Pittsburgh coal seam, the mass heating of coal appeared to be limited to a maximum temperature below 400°F. This temperature was reached in approximately 3-1/2 days. A fault to a roof bolt in the Wilberg Mine (Hiawatha seam) could be expected to produce approximately the same temperature pattern and time frame.

2. The spontaneous ignition temperature of Hiawatha coal is approximately 900°F. This is the temperature that the coal must have been heated to in order for it to burst into flaming combustion when exposed to oxygen (intake air) as described in the scenario. It is very unlikely that the coal roof could have been heated to this temperature and have gone unnoticed by EMC personnel because the coal produces a very strong characteristic odor at temperatures of 302°F to 392°F and copious quantities of yellowish-white smoke at temperatures of 572°F to 752°F. The characteristic odor and smoke would have been detected by Robinson and/or Riddle when they traveled in the No. 4 entry (approximately 80 feet downwind) within 5 to 15 minutes prior to the fire had the coal roof strata been heated to these temperatures.

3. The Hiawatha coal also develops cracks and loses all of its strength at approximately 572°F. The coal roof at crosscut 35 most likely would have fallen long before the spontaneous ignition temperature (900°F) would have been reached.

4. As discussed previously, if a fire had started at the belt drive power cable, the fire would have had to have spread 100 feet north against a 300 fpm air velocity and into the air compressor station before it burned the cable insulation on the compressor power cable or the high-

voltage cable. The fire would have also had to have burned at least 8 minutes after it erupted in flames without burning the high-voltage cable since the 5th Right section power center was energized when heavy smoke was present on the section

In summary, MSHA investigators concluded that since the heating of the coal roof strata, as described in the EMC scenario, could not have gone unnoticed by EMC personnel for any length of time prior to the fire, the current leakage from a faulted motor starter cable to a roof bolt was not the source of the fire. The mine and laboratory test results are contained in Appendix T.

Belt Entry - Low-Voltage Circuits and Equipment

Belt Drive Motor Starter

The motor starter was located in crosscut 34, belt entry, between No. 3 and No. 4 entries and was installed to provide starting and controlling for each of the 480-volt, three-phase, 200-horsepower, 5th Right belt drive motors. The motor starter was not located in the fire origination area. The No. 4/0 AWG cable supplying the motor starter and the power and control cables and equipment that were located in the belt entry and connected to the motor starter were in the general fire area and could have provided the ignition source of the fire. Consequently, MSHA investigators carefully examined and tested the motor starter and connected cables and equipment to determine if these circuits and equipment provided the source of the fire.

The roof in the area where the motor starter was recovered was caved as a result of the fire. The motor starter contained two three-pole, molded-case circuit breakers (CB1 and CB2) to provide protection for the motor starter circuitry and the belt drive take-up unit located adjacent to the motor starter. The CB1 circuit breaker was rated 600 amperes and was equipped with a ground wire monitor and devices to provide grounded-phase and undervoltage protection for each belt drive motor circuit. The CB2 circuit breaker was equipped with a ground wire monitor and devices to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection for the belt take-up unit circuit.

Two additional circuits were installed by EMC personnel and were connected to the load-side of the CB1 circuit breaker. One circuit provided 480-volt, three-phase power to the line starter enclosure for the 20-horsepower, Long Airdox Super 500-HD belt take-up unit. The second circuit provided 480-volt, three-phase power to a gray electrical enclosure box located adjacent to the motor starter.

Examination and testing of the 5th Right dual 200-horsepower motor starter revealed the following:

1. The CB1 circuit breaker was functional and was found in the closed (on) position. The CB2 circuit breaker had been affected by the fire but was functional and was found in the tripped (open) position.

2. The connections to the secondaries of the grounded-phase current transformers (CTs) were found disconnected from each belt drive

grounded-phase relay, which rendered the grounded-phase protection for each belt drive motor circuit inoperative.

3. A 750 ohm output control resistor (R3) on each of the belt drive ground wire monitor circuits was by-passed. The by-passing of the resistors did not affect each monitor's ability to detect an open ground wire; however, this condition would create a short circuit in the motor starter control circuit when the grounded-phase relay of either belt drive circuit detected a grounded-phase condition (See Mining Controls Inc. Drawing Nos. D-23772, D-23772WD, and C-21927, Appendix Q). The components of the three grounded wire monitors of the motor starter were affected by corrosion and could not be tested.

4. The phase guard relays for each belt drive circuit were found miswired and rendered inoperative. Both relays were defective and the failure mode of one of the phase guard relays would have prevented the starting of one of the belt drive motors if the relays were properly wired in the motor starter.

5. Pressure switch No. 4 (Long-Airdox Wiring Diagram No. 97297, See Appendix Q) of the Super 500 power pack was not connected to the control circuitry of the 5th Right belt drive motor starter to prevent the starting and operating of the 5th Right belt prior to the required minimum pressure being obtained by the Super 500 hydraulic system.

6. The overload protection for each 200-horsepower belt drive motor was operative; however, the overload setting for each motor was set at 331 amperes (138% of full-load motor current) which exceeds the specifications of the 1968 National Electric Code (125% of the full-load motor current).

7. There was no evidence of electrical arcing or fire inside the motor starter. The wiring insulation was pliable and flexible.

8. Except for the wiring of the phase guard relay, the two grounded-phase relays, the output control resistors of the ground wire monitors of both belt drive protective circuits, and the pressure switch for the Super 500-HD unit, the control circuitry of the motor starter was properly wired.

After analyzing the information gathered during the investigation, MSHA investigators reached the following conclusions about the 5th Right belt drive motor starter:

1. The presence of soot, rust, and corrosion on the disconnected wiring connectors and relay terminals of the two grounded-phase relays located in the motor starter indicated that the wires had been disconnected prior to the fire. The relays were defeated because the occurrence or the presence of a grounded-phase condition on either belt drive motor circuit would create a short circuit in the control circuit of the motor starter. The short circuit would cause the motor starter to shut down both belt drive motors.

2. The intentional defeating of the grounded-phase relay of the receptacle "6" panel and the intentional defeating of both grounded-phase relay circuits in the motor starter indicates the presence of a grounded-phase condition at the time these circuits were rendered inoperative.

3. The physical damage to the motor starter indicated that the fire did not enter the motor starter enclosure and that the motor starter was damaged by the cave of roof.

In summary, since the 5th Right belt drive was operating after dense smoke was observed in the No. 4 entry, MSHA investigators concluded that the 5th Right belt drive motor starter did not provide the source of the fire.

Belt Drive Motor Cables and Electric Enclosure Cable

Two No. 4/0 AWG, 600/2000-volt, three conductor, type G-GC power cables, each approximately 50 feet in length, were installed in the belt entry to supply 480-volt, three-phase power from the 5th Right belt drive motor starter to each 200-horsepower belt drive motor. Approximately 20 feet of No. 2 AWG, four conductor power cable was installed to supply 480-volt, three-phase power from the 5th Right motor starter to a separate electric enclosure located at the motor starter. In addition, approximately 8 feet of No. 6 AWG, five conductor power cable was installed to supply 480-volt, three-phase power from the 5th Right motor starter to the line starter enclosure of the Super 500 belt take-up and storage unit. A sustained arc or fault in these cables and the failure of protective switchgear components could have provided the iginition source of the fire. No tested sections of any of the cables displayed any evidence of internal heating or arcing. Tidwell and Price were in the area where these cables were located at the time of the fire and did not observe smoke being liberated from these cables. Because the 5th Right belt drive was operating after dense smoke was observed in the No. 4 entry, which was on a different split of air, and because of the physical condition of the belt entry area where these cables were located, MSHA investigators concluded that neither of the two No. 4/0 AWG belt drive motor cables nor the No. 2 AWG to the separate electric enclosure nor the No. 6 AWG to the line starter enclosure of the Super 500 belt take-up provided the source of fire.

Belt Control Cables

Seven control cables were connected to the motor starter to provide various belt control functions. Examination of the control cables and protective circuits revealed that each of the cables was protected by fuses and all the cable jackets showed minimal evidence of heat damage. The protective fuses were tested and found to be intact and functional. Therefore, MSHA investigators concluded that none of the seven control cables provided the source of the fire.

Belt Take-Up and Power Cable

A No. 10 AWG, five conductor cable supplied 480-volt, three-phase power to the electrical enclosure of the 10-horsepower motor of the 5th Right belt drive take-up, located in crosscut 34, belt entry, between No. 3 and No. 4 entries, adjacent to the motor starter.

The CB2 circuit breaker of the motor starter provided protection for the belt take-up circuit, and the protective relay and ground wire monitor circuitry of CB2 were properly wired and installed.

Examination and testing of the belt take-up unit and No. 10 AWG power cable revealed no evidence of electrical arcing inside the take-up line starter, and hydraulic fluid was present in the belt take-up reservoir. Therefore, MSHA investigators concluded that the 5th Right belt drive take-up and No. 10 AWG power cable did not provide the source of the fire.

Super 500 and Protective Line Starter

A Long-Airdox Company Super 500-HD belt take-up and storage unit was located between crosscuts 3 and 5, of the 5th Right belt entry. The Super 500 provided storage for up to 500 feet of conveyor belt. The hydraulic power pack for the Super 500 belt take-up consisted of an 80-gallon hydraulic reservoir; hydraulic controls; a 20-horsepower, 480-volt, three-phase electric motor; and electrical motor starter controls. The area where the Super 500 was located was explored but was not recovered. This area was not caved. The line starter, which was located at the 5th Right belt drive motor starter, was recovered and tested.

Examination and testing of the 100-ampere Super 500 line starter revealed the following:

1. The circuit breaker was functional; however, the fire probably affected the trip adjustment mechanism. MSHA investigators could not determine the position of the circuit breaker when found.

2. The instantaneous setting of the circuit breaker was found in the "Hi" position, which exceeded the specifications of the 1968 National Electric Code.

3. No wiring deficiencies were found that would affect the Super 500 line starter's ability to detect an overcurrent, short circuit, grounded-phase, or open grounding circuit and cause the tripping of the 100-ampere circuit breaker or the tripping of the overcurrent relay.

4. The ground wire monitor and grounded-phase relay protective circuits were functional.

5. There was no evidence of electrical arcing or fire inside the line starter enclosure. The manufacturer's paper instruction sheet was present on the back of the front panel cover of the enclosure. The paper instructions were legible.

6. Part of the ground wire monitor test button was missing and the remainder was found hanging free inside the enclosure. The control relay of the ground wire monitor was found out of the relay mounting socket and loose inside the line starter enclosure.

7. The top of the red plastic reset rod of the overload relay showed signs of localized melting. Localized melting of the overload relay case and trip adjustment had also occurred on the inside of the relay around the

heater element, which had a pronounced effect on the trip characteristics of the relay when tested.

8. The No. 6 AWG, five conductor, Super 500-HD power cable had apparently been pulled out of the enclosure about 4 inches prior to being recovered. The outer jacket of the cable contained depressions that could have been caused by compression from the line starter enclosure strain clamp. The insulation of the phase conductors passing through the strain clamp was cut and abraded. The grounding conductor was found disconnected from the equipment ground terminal. The exposed strands of the grounding conductor were covered with dust and soot and could not reach the ground terminal inside the line starter enclosure.

MSHA investigators concluded that the high instantaneous trip current of the circuit breaker and the excess tripping time of the overload relay were caused by heat from the fire. The ground wire monitor relay, that was found out of the relay mounting socket, was a result of the roof fall. Earlier MSHA investigators had concluded that the pressure switch No. 4 (Long-Airdox Wiring Diagram No. 97297, See Appendix Q) of the Super 500 power pack was not connected to the control circuitry of the 5th Right belt drive motor starter to prevent the starting and operating of the 5th Right belt prior to the required minimum pressure being obtained by the Super 500 hydraulic system.

Sworn statements of EMC personnel who first discovered the fire indicated that the fire was located in the No. 4 entry between crosscuts 34 and 37. This location was approximately 200 feet from the location of the Super 500 and in a different air course.

Based on the foregoing, MSHA investigators concluded that neither the 5th Right Super 500-HD belt take-up unit nor the line starter for the hydraulic power pack provided the source of the fire.

5th Right Belt Conveyor

The 5th Right belt conveyor was running when the fire was discovered by Salisbury in the intake entry and when smoke was seen by Price and Tidwell beneath the 5th Right belt overcast. Sworn statements from these three miners describe the initial fire and smoke as located in the No. 4 intake entry. Price further stated that he looked toward the Super 500 area and saw no smoke except for that which came up from the intake entry through bolt holes in the overcast and had drifted along the roof toward the Super 500. Based on these eyewitness accounts and on the physical conditions observed in the fire area, MSHA investigators concluded that the 5th Right belt conveyor system was not the source of the fire and that the belt entry was not involved in the fire until after the aluminum overcast located near the belt drive failed.

Belt Fire Detection and Fire Suppression Systems

Fire Detection System

A Gulton/Femco, Continuous Belt Fire Detection (CBFD) system was installed to provide fire detection on the conveyor belt flights of the Wilberg Mine. The remote station for the 5th Right belt flight was located at the 5th Right motor

starter. The master station was located in the bathhouse. The janitor for the bathhouse (bathhouseman) for each shift was assigned the duties of monitoring the CBFD master station.

The master station was removed from the bathhouse and disassembled by EMC personnel after the fire but prior to MSHA's on-sight testing of the unit. An MSHA investigation under Section 110 of the Federal Mine Safety and Health Act of 1977 concluded that there was insufficient evidence at that time to indicate that such action constituted a willful or knowing violation under the Act. However, a citation was issued under Section 103(j) of the Act for failing to preserve evidence at a mine accident scene. Portions of the master station were re-assembled and tested.

Examination, testing, and investigation of the Gulton/Femco, Continuous Belt Fire Detection (CBFD) system revealed the following:

1. The master station was found to be functional when powered by primary AC power, but the functionality of the master station before the fire could not be verified by testing because the equipment had been moved and disturbed before MSHA tests were conducted. However, MSHA investigators determined that the internal back-up batteries of the master station, that were designed to power the unit when there is a loss of primary AC power, were found to be defective and incapable of either powering the master station or of accepting a charge.

2. No wiring deficiencies in the connections to the CBFD remote station or its circuitry were found that would affect the CBFD system's ability to detect a fire as long as the remote station was powered by primary AC power. However, the remote station was found with the negative lead to the back-up battery not connected to the battery. The negative lead connector blade inside the remote station enclosure (metal box) was superficially covered with carbon and soot, and no scratches could be seen on the connector blade indicating that the wire was disconnected at the time of the fire.

3. The evaluation and testing of the remote station and the sworn statements of EMC personnel indicate that the remote station was properly functioning at the time of the fire when powered by primary AC power.

4. All heat sensors removed from the sensor cable of the 5th Right belt were found to be functional after the fire and it is presumed that they were functional before the fire.

5. There were no wiring deficiencies or damage found in the line termination box and so it was concluded that this box functioned properly before, during, and after the fire.

6. Records indicate that EMC personnel performed frequent repairs in an effort to maintain the CBFD system in operative condition.

After analyzing the information gathered during the investigation, MSHA investigators concluded the following about the CBFD fire detection system of the Wilberg Mine:

1. The master station was found to be inoperative and incapable of indicating a belt fire alarm or system trouble alarm under a condition in which there is loss of primary AC power to the unit.

2. Testing of the master station indicated that the master station functioned properly when powered by primary AC power. Although the prefire condition of the master station is in question since the unit had been moved before the MSHA on-site testing, sworn statements of EMC personnel indicate that the unit was functional at the time of the fire.

3. Earlier, MSHA investigators had concluded that power to the surface and underground facilities of the Wilberg Mine was lost at approximately 9:26 p.m. on December 19, 1984. Based on the Utah Power & Light/CRSP Report for December 19, 1984, (See Appendix Q), surface power to the Wilberg Mine was restored between 10:00 p.m. and 10:15 p.m. During this period of time, neither the master station nor the remote station would have functioned because of the defective back-up battery in the master station and the negative lead to the back-up battery being disconnected in the remote station.

4. Based on test results, sworn statements, maintenance records, and analysis of the CBFD system components, MSHA investigators concluded that the Wilberg Mine CBFD system was functional when powered by primary AC power. Primary AC power was not turned off until after the discovery of the fire. Therefore, during the early stages of the fire the CBFD system was functional and did not detect the presence of fire in the 5 Right belt entry.

Fire Suppression System

A Mine Safety Appliances Company, Model 700 Foamaker was installed on the 5th Right belt drive. Only the nitrogen cylinder, the electrical controls for the Foamaker, and the examination book of the fire suppression system, were recovered from the caved area of crosscut 34.

Examination, testing, and investigation of the Model 700 Foamaker revealed the following:

1. The nitrogen cylinder was empty and was blackened and covered with soot.

2. Inspection of the unit and comparison with the manufacturer's documentation indicates the fire suppression electrical controls were properly wired.

3. The control unit would function properly with batteries at 62% charge, or greater, but would not work with weaker batteries.

4. Records indicate that the 5th Right belt drive fire suppression system was examined twice on the day of the fire by the shift beltmen and recorded as "OK".

5. Earlier, MSHA investigators had concluded that power to the surface and underground facilities of the Wilberg Mine was switched off at approximately 9:26 p.m. on December 19, 1984. The sworn statements of EMC personnel and the Utah Power and Light/CRSP Power Report for December 19, 1984 (See Appendix Q) revealed that the underground power to the main water supply system was restored between 10:15 and 10:30 p.m. During this period of time, water pressure would not be present at the fire suppression system and the fire suppression system would not be operational.

Tidwell stated that he heard the system activate and saw bubbles coming out of the canister during the initial fire fighting activities at the 5th Right belt drive after the loss of water pressure.

After analyzing the information gathered during the investigation, MSHA investigators were unable to determine whether or not the Model 700 Foamaker fire suppression system was functional at the time of the fire. The electrical controls for the Foamaker were properly wired and were functional; however, other critical components of the fire suppression system were not recovered. Records of the examination of the shift beltmen indicate that the fire suppression system was operative on the day of the fire. The sworn statement of Tidwell revealed that the fire suppression system did activate after the fire was discovered, but the system was not operational due to the lack of water pressure.

CONTRIBUTORY VIOLATIONS AND MSHA ACTIONS

Contributory Violations

Nine conditions and practices contributed to the cause of and seriousness of the mine fire and constituted violations of the Federal Mine Safety and Health Act of 1977 and the mandatory standards contained in Title 30 of the Code of Federal Regulations (CFR). They are listed below:

30 CFR 75.1725(a) - The 5th Right Ingersoll-Rand air compressor was not maintained in safe operating condition because the on/off control linkage was disconnected and the over-temperature safety switch was intentionally by-passed prior to the fire.

The disconnecting of the on/off switch resulted in the air compressor having to be turned on and off at the 5th Right belt drive power center and allowing the air compressor to be inadvertently turned on. The by-passing of the over-temperature safety switch defeated the only protective device installed on this air compressor to protect the air compressor against overheating.

After operating continuously for about 69 hours, fire occurred at the air compressor. The fire quickly spread into the intake air course to 5th Right. Toxic gases and smoke traveled with the intake air to the 5th Right longwall panel and caused the deaths of 27 miners.

30 CFR 75.512 - According to examination records and sworn statements, weekly examinations by a qualified person to assure the safe operating condition of the 5th Right Ingersoll-Rand electric air compressor, were not being conducted. The absence of weekly examinations prevented the detection of the disconnected on/off switch and the defeated over-temperature safety switch.

30 CFR 75.1704 - Two separate and distinct escapeways were not maintained in a safe condition in the 5th Right longwall panel in that: 1) Six 8-inch by 16-inch blocks were missing at the bottom of the stopping in crosscut 16; 2) a four-inch by seven-inch hole, with a one-inch by three-foot horizontal opening extending from it, existed at the top of the stopping at crosscut 18, and 3) a one-square-foot hole with cables passing through it existed in the stopping at crosscut 20. The holes in the stoppings caused the belt entry escapeway to be contaminated more quickly with deadly gases and smoke.

30 CFR 75.1101-23(a) - The operator's program of instruction of all miners in the location and use of fire fighting equipment, location of escapeways, exits, and routes of travel to the surface, and proper evacuation procedures to be followed in event of an emergency was not submitted to the District Manager for approval. The programs of instruction being implemented by the company at the time of the fire did not meet the requirements for MSHA approval because they did not address the present mining methods and contained a provision that self-rescue devices not be used unless smoke is encountered.

In addition, the water supply needed for fire fighting was disrupted when the electric power was removed from the entire mine during fire fighting activities, and when the power was already isolated to the 5th Right area.

30 CFR 75.1704-2(d) - A map showing the designated escapeways from the working section to the main escape system was not posted in the 5th Right section. According to the locations of the victims as determined by the investigation team and the sworn statement by the survivor, several of the miners in the working section were not aware of the travel routes available to them during their attempt to escape.

30 CFR 75.1714(b) - Emery Mining Corporation failed to adequately train the miners who were on the 5th Right longwall section on December 19, 1984, in the location and use of self-rescue devices in that:

1. Five of the victims did not obtain and use a self-contained self-rescuer (SCSR) even though they had knowledge of a fire and traveled near locations where a total of 49 SCSRs were stored. Four of these victims were senior mine management officials.

2. Six of the victims did not properly start their SCSRs in that they failed to pull the lid and lanyard to activate the chlorate candle immediately upon donning their units.

3. Three victims failed to use a self-rescue device in their possession when they had time to use it in that (a) one victim wore an activated SCSR for some distance without using it, (b) one failed to use his filter self-rescuer (FSR) before activating an SCSR in smoke, and (c) one victim failed to use his FSR while traveling in smoke.

4. Overall, management officials and other miners failed to obtain and use SCSRs at the first indication of fire. This contributed to the severity of the mine fire in that some of the victims might have escaped to safety if they had used self-rescue devices properly. Also, several miners, in their sworn statements, indicated lack of training in the use of these devices.

30 CFR 75.1105 - The compressor station at crosscut 36, which contained an Ingersoll-Rand air compressor, was not housed in a fireproof structure or area, a condition which allowed the fire at the compressor to spread rapidly to the intake air course.

30 CFR 75.1107-1(a)(2) - The unattended electric air compressor, located in the crosscut 36 air compressor station, which contained combustible material and fluid and operated for more than 24 production shift-hours, was not provided with a fire suppression device. The absence of a fire suppression device allowed the fire to quickly spread into the intake air course.

30 CFR 75.1600-2(e) - The MSA Pager III mine telephone located at the 5th Right belt drive, was not maintained in good operating condition at all times in that the page switch was found defective (remained open) and prevented paging out from this telephone. This condition prevented the person at the belt drive from paging to warn others of the mine fire. Persons on the 5th Right section would have had additional time to escape, had they received this earlier warning.

All of the above conditions or practices were found during the investigation of the mine fire which occurred in the 1st North, 5th Right area of the mine on December 19, 1984, and contributed to the cause of the fire and deaths of the 27 miners.

Actions Taken by MSHA to Reduce the Likelihood of Similar Occurrences

During this investigation, MSHA identified several actions which would help improve the conditions or practices in all mines and reduce the likelihood of a similar occurrence. Listed below are the actions taken by the Mine Safety and Health Administration National Office:

1. Underground mine operators and MSHA personnel were informed that:

   a. Temperature-sensitive switches or other devices which shutdown air compressors when overheating occurs must be maintained in operation to comply with 30 CFR 75.1725, and

   b. The examination required by 30 CFR 75.512 should include attention to the temperature sensitive switches on air compressors.

2. Section 75.1107, 30 CFR, has been interpreted to require fire suppression devices on air compressors that use combustible fluid. Information about this interpretation was distributed to underground mine operators and MSHA personnel.

3. Information has been provided to MSHA and industry personnel which better defines those compressor installations that must include a fireproof structure and ventilation with air coursed directly to the return in accordance with 30 CFR 75.1105.

4. A training course on air compressor maintenance and inspection has been developed and presented to about half of MSHA's electrical inspectors, who will present this training to the remaining MSHA inspectors.

5. A special procedure was developed to evaluate self-contained self-rescuer training. Such evaluation was conducted by MSHA at 1,174 underground mines and additional training was required at 243 of the mines.

6. Guidelines for MSHA approval of SCSR storage plans have been changed to include a full complement of SCSRs on both the tailgate and headgate side of longwall sections.

7. An emergency temporary standard has been promulgated requiring annual "hands-on" self-contained self-rescuer training for all persons entering underground coal mines after September 28, 1987. The temporary standard also serves as a proposed permanent MSHA rule.

8. A research project to develop a "belt wearable" self-contained self-rescuer is nearing completion. The prototype design appears to simplify the donning procedures, and will eliminate the need for filter-type self rescuers. If this project is successful, self-rescuer use and training will be much simpler.

9. A report has been made available to all District Managers and appropriate mine operators, providing information on how aluminum ventilation control structures (stoppings, overcasts, etc.) can be covered or coated to increase their fire durability to an acceptable level.

10. MSHA policy instructions were issued to prohibit approval of aluminum ventilation control structures in future ventilation plans unless protected against early fire failure and to have such structures that are already in place removed or suitably protected against early fire damage.

11. A report on the use of phenolic foam instead of polystyrene as "squeeze blocks" in stopping construction was distributed to appropriate industry and MSHA personnel.

12. MSHA policy instructions were issued to prohibit approval of polystyrene "squeeze blocks" for stopping construction in future ventilation plans and to replace or properly cover those already installed.

13. MSHA personnel have been informed that the examination of return and intake air courses in their entirety as described in 30 CFR 75.305 requires the examiner to "travel" the complete intake and return airway.

14. District Managers were instructed to emphasize the review of programs regarding fire fighting, escapeways, routes of travel, and evacuation procedures.

15. Current action to revise regulations will address:

    a. Ventilation of designated escapeways.

    b. More extensive environmental monitoring systems for early fire warning.

    c. The recommendations stated in the Two-entry Task Force Report.

    d. Keeping tailgate entries open for travel.

    e. Further safeguards in the use and installation of air compressors.

MSHA anticipates that all mine operators will respond positively to the new initiatives set forth above. MSHA also expects mine safety personnel to review this report and to take appropriate action to further insure safety at their mine.

It is important to note that a special investigation under Section 110 of the Federal Mine Safety and Health Act was requested by the investigators. This investigation is underway. Also the Assistant Secretary of Labor for MSHA requested the Inspector General to investigate MSHA activity related to the incident. This investigation is underway.

CONCLUSION

MSHA investigators conclude that the 5th Right air compressor was not properly installed and was not properly maintained in a safe operating condition. Ventilation of the air compressor station was not adequate to prevent the recirculation of cooling air to the compressor. The over-temperature safety switch was intentionally by-passed and the on/off switch linkage was disconnected so that the air compressor had to be turned on and off at the 5th Right belt drive power center. In addition, the air compressor was not frequently examined or tested to identify potentially dangerous conditions.

The air compressor was inadvertently turned on and operated continuously for about 69 hours before the fire started. The fire spread into the 5th Right intake air course and blocked this escapeway. The fire quickly spread with the airflow and caused the early failure of the aluminum intake/belt overcast blocking the other designated escapeway.

The primary cause of the fire was the failure of mine management to remove the air compressor from service or properly repair the air compressor when it was known to be in an unsafe condition.

The following factors contributed to the severity of the accident:

1. The failure to house the air compressor station in a fireproof structure or area.

2. The failure to provide the air compressor with a fire suppression device.

3. The increased number of miners present on the section because of an attempt to set a production record.

4. The failure to respond to the first notification of smoke in the intake entry.

5. The failure to maintain the pager phone at the 5th Right belt drive.

6. The failure to maintain the stoppings that provided separation of the escapeways.

7. The early failure of the intake/belt overcast at crosscut 34.

8. The failure to properly train and/or instruct the miners in the use of self-rescue devices, fire fighting procedures, mine evacuation procedures, and alternate routes of travel off the 5th Right section.

9. The failure to post a map showing the designated escapeways from the 5th Right working section.

Respectfully submitted,

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