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Coal Mine Safety and Health

REPORT OF INVESTIGATION
DECEMBER 7, 1992
UNDERGROUND COAL MINE EXPLOSION
#3 MINE - ID. NO. 44-06594
SOUTHMOUNTAIN COAL CO., INC.
NORTON, WISE COUNTY, VIRGINIA

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OVERVIEW

Abstract of Explosion

At approximately 6:15 a.m., December 7, 1992, an explosion occurred on the 1 Left section of Southmountain Coal Co., Inc.'s (Southmountain), #3 Mine. Eight miners were killed and another miner working in an outby area was injured. The names of these miners are listed in Appendix A.

The bleeder system of the pillared 1 Right off 1 Left, 2 Right off 1 Left, and 1 Left sections was not examined or maintained to continuously move methane-air mixtures away from the active faces (See map, Appendix E). The condition of the mine roof in the bleeder entry had deteriorated to the point where the bleeder entry had not been examined for several weeks. Methane, liberated primarily from the closely overlying Kelly Rider Seam, accumulated in the pillared areas and bleeder entry. Ventilation controls, both permanent and temporary, on the active working section had been removed or were not maintained. This action allowed the methane to migrate from the pillared area and bleeder entry to the No. 1 entry and in the No. 2 crosscut between Nos. 1 and 2 entries. Other factors included the dip of the coal seam, the drop of the barometric pressure before the explosion, the possibility of water accumulations and roof falls occurring within the pillared areas and bleeder entry.

The methane was ignited on the 1 Left section in the No. 2 crosscut between the Nos. 1 and 2 entries by an open flame from a butane cigarette lighter. The methane explosion resulted in sufficient forces and flames to suspend and ignite coal dust in 1 Left. The coal dust explosion continued to propagate the entire distance of the No. 1 West Main entries to the surface area of the mine.

Background

The #3 Mine, I.D. No. 44-06594, was operated by Southmountain, a subsidiary of Apple Coal Co. & Affiliates, Inc. The mine opened in 1990 and was located in Wise County, Virginia, approximately 7 miles northeast of Norton, Virginia, on Route 620.

The principal management officers of the mine at the time of the explosion were:

William Jack Davis	President
Bobby Kyle	Vice President
Deborah K. Davis	Secretary/Treasurer
William Ridley Elkins	Consultant for Apple Coal Co. & Affiliates, Inc.
Donnie F. Short	General Superintendent
Freddie Deatherage	Mine Superintendent (Also fulfills requirements of Mine Foreman)

Although William Ridley Elkins' official title is listed as a "Consultant", based on the information obtained during the investigation, MSHA considers Mr. Elkins to be a mine operator with full authority and responsibility to control all aspects of the mining operations at the #3 Mine.

The mine was opened into the Imboden Seam by four drift entries. The seam varied in height from five to seven feet. The methane liberation was approximately 188,000 cubic feet in a 24-hour period as measured in October 1992.

The mineral rights where the Southmountain #3 Mine was located are owned by Penn Virginia Resources Corporation. Penn Virginia leased the coal mineral rights on this property to Virginia Iron, Coal and Coke Company (VICC). VICC engaged Southmountain to mine the coal. VICC prepared and furnished mining plans to Southmountain to be followed during mining operations.

At the time of the explosion, the mine employed 34 miners, 31 underground and 3 on the surface. The active section was located approximately 6,000 feet from the surface. The elevation from the portals to the 1 Left section had dropped approximately 400 feet. There was one continuous mining unit working two shifts per day, producing an average of 1,500 tons of raw coal per 24-hour period. Maintenance was performed on the evening shift (3:00 p.m. to 11:00 p.m.). Coal was being produced at the time of the explosion. The normal work week was six days per week; but, due to a request for additional tonnage by VICC, the mine produced coal seven days the first week of December 1992. On December 7, 1992, the midnight shift had worked on eight consecutive days.

The Mine Safety and Health Administration (MSHA) completed a safety and health inspection (AAA) of the #3 Mine between October 20, and 27, 1992. An electrical spot inspection was conducted on November 30, 1992.

EVENTS PRECEDING THE EXPLOSION

On Sunday, December 6, 1992, at 7:00 a.m., the day shift crew of 11 men under the supervision of Paul Ramey, Section Foreman, entered the mine. The crew traveled in a rail mounted battery-powered mantrip to the 1 Left section. Ramey examined the section and did not find any hazards. Mining commenced in the No. 6 entry on pillars located between the Nos. 2 and 3 cross-cuts. Five cuts were mined in the left and right pillars in No. 6 entry. The continuous mining machine was moved to the No. 5 entry where approximately six cuts were mined. Mining continued without incident until the shift ended at 3:00 p.m. with the exception of a steering arm that broke on a shuttle car ten minutes before the end of the shift. Ramey stated he did not notice anything unusual during the shift except for some loud noises (thumps) originating from either the mine roof, floor, or coal pillars in the No. 5 entry.

According to Ramey methane was not encountered during the shift and all the ventilation controls were in place. He also stated that ventilation controls were not changed during the shift. He took an air measurement in the No. 1 entry and recorded 23,200 cubic feet per minute (cfm) in the preshift record book. The preshift examination was conducted from 2:10 p.m to 2:30 p.m.

Freddie Deatherage, Superintendent, was in the mine during the day shift on December 6, 1992. Deatherage entered the mine and traveled to the No. 4 belt drive where he parked the personnel carrier and walked to the section. He traveled the section and walked the return entries out to the No. 4 belt drive. Deatherage returned to the section where he, Ramey, and Jackie Davis, Electrician, worked late to repair the steering arm on the shuttle car. They arrived on the surface at approximately 4:10 p.m. Deatherage stated he did not observe anything out of the ordinary and considered it a normal production shift. Ramey did not call out the results of the preshift examination prior to the oncoming shift going underground.

At 3:00 p.m., the maintenance crew of four miners under the supervision of Kenneth Brooks, Section Foreman, entered the mine. The crew traveled in a rail mounted battery-powered mantrip to the 1 Left section. The results of the preshift examination were communicated underground to Brooks by Ramey. Brooks examined the section and instructed David Goode and Gleason Silcox, General Inside Laborers, to service the continuous mining machine. He also instructed them to take down some loose coal ribs and reinstall four check curtains which had been torn down by small pieces of falling rock. While Goode and Silcox were servicing the continuous mining machine located in the No. 4 entry, they heard a loud thump. The thump shook the area and Goode and Silcox ran from the area until they determined there was not any danger. This was the only abnormality noted during the shift.

During the servicing process, the continuous mining machine was energized to rotate the ripper head in order to change bits. Goode stated the methane monitor readout was functioning properly. However, he did not observe the condition of the monitor sensor. After Goode and Silcox serviced the continuous mining machine, Brooks told Goode to go to the surface and get a load of rock dust and apply it to the No. 3 entry of the Mains where the belt/track was located. Goode rock dusted in the No. 3 entry from the portal to the No. 32 crosscut.

Goode returned to the section at 8:00 p.m. Brooks and the remaining members of the crew were moving belt and belt structure which had been stored in the Nos. 1 and 2 entries of the Mains to outby crosscuts in the No. 1 entry. A new section was to be started, left off the Mains, when mining was completed in 1 Left.

Brooks used the scoop to clean the Nos. 1 and 2 entries beginning at the No. 83 crosscut in the Mains inby the coal feeder. The cleaning was done in preparation for pillar recovery in this area of the Mains following completion of mining in 1 Left. Brooks stated that the ventilation controls were not disturbed during the cleanup activities and check curtains were always replaced when they were pulled down by the scoop.

Brooks conducted the preshift examination for the oncoming shift between 9:30 p.m. and 10:30 p.m. During the examination methane was not encountered. However, Brooks did not go into the Nos. 1, 5, and 6 entries of 1 Left during the preshift examination. He recorded an air measurement of 29,460 cfm in the No. 2 entry of 1 Left. Brooks and the evening shift crew arrived on the surface about 11:00 p.m. The results of the preshift examination were communicated to Norman Vanover, Section Foreman, when Brooks arrived on the surface.

Brooks also told Vanover that Deatherage had left instructions to move the power center back one crosscut when the continuous mining machine was moved to the right side of the section. Brooks had not made any preparations to move the power center. During the investigation it was found that the high voltage cable had been pulled back and placed in a figure eight position. It appeared the preparation to move the power center was done on the midnight shift.

The midnight shift crew normally consisted of 11 underground employees, but only nine worked the night of the explosion. At 11:00 p.m., the midnight shift crew entered the mine under the supervision of Vanover. Eight of the men were section employees and one was a belt attendant. The crew produced coal in 1 Left. The shift was almost complete when a methane and coal dust explosion occurred. The approximate time of the explosion was 6:15 a.m., December 7, 1992.

George Phillip Shortt, Outside Loader Operator, stationed on the mine surface, did not recall anything unusual during the shift. Shortt was transferring coal from the stacker belt to the coal stockpile. At approximately 6:20 a.m., Shortt noticed the surface lights were out but had neither seen nor heard anything abnormal. He traveled approximately 150 feet toward the mine portals where he observed signs of the explosion. At that time, he saw Robert Kevin Fleming, Underground Belt Attendant, exiting the mine from the No. 3 entry. Fleming had suffered burn injuries to the hands and face from the explosion. Shortt transported Fleming to the hospital for medical attention.

Fleming's shift began at 11:00 p.m. and continued without incident until the time of the explosion. His work activities consisted of servicing and cleaning the belts. When the explosion occurred, he was at the No. 2 belt drive. The forces of the explosion propelled Fleming approximately two crosscuts before he could get back on his feet. He did not see any flame but reported seeing dust and feeling heat. Fleming found the water line which he used to establish direction and crawled to the surface where he was met by Shortt.

As Shortt was transporting Fleming to the hospital they met Deatherage who was on his way to work. Shortt informed Deatherage of the explosion. Deatherage traveled to the mine and, during his assessment of the damage, he observed that the commercial telephone had been destroyed. Leaving the mine property to access a telephone, he met Jackie Davis who was on his way to work. Deatherage instructed Davis to go to the nearby Plowboy Coal Company mine and call the authorities and company officials.

Shortt and Fleming indicated that coal production had been normal during the shift. Neither had communicated with Vanover or any other member of the underground crew during the midnight shift.

RECOVERY OPERATIONS

At approximately 7:10 a.m. on December 7, 1992, the Norton, Virginia, MSHA Subdistrict Office, received a telephone call from William Ridley Elkins, Consultant for Apple Coal Co. & Affiliates, Inc., that an explosion had occurred at Southmountain, #3 Mine. MSHA personnel were immediately dispatched to the mine to secure the scene and assist in the recovery operations. Mine rescue teams were alerted of the explosion. MSHA Headquarters in Arlington, Virginia was notified and subsequently dispatched MSHA's Mine Emergency Unit and Mine Emergency Technology Team to the site. The Westinghouse Electric Company and the Montgomery County (Maryland) Fire Department were contracted to provide and operate a seismic locating system and borehole camera.

Elkins, Donnie Short, General Superintendent, Deatherage, and various laborers arriving for the day shift, observed that an explosion had occurred. There was black smoke exiting the Nos. 3 and 4 entries and destruction was evident on the surface. The portal canopies were damaged, the belt head and structure were damaged, and the fan housing and explosion doors were destroyed. In addition, the motor barn/office building located in line with the No. 2 entry was destroyed and debris from the building was carried approximately 1,000 feet. Vehicles parked approximately 200 feet from the openings had windows blown out. The surface electrical installations had been damaged. A thin layer of black dust had settled over the entire area.

Eight miners were unaccounted for after the explosion. It was speculated that the eight miners were on the 1 Left section.

At about 8:00 a.m. rescue and recovery operations began and the following took place:

1. A command center was organized at the mine trailer with the following responsible officials from each organization identified as the spokesmen: Donnie Short from Southmountain, Harry Childress from Virginia Department of Mines, Minerals, and Energy (VDMME), and Michael Lawless from MSHA. A 103(k) Order was issued by MSHA and the operator was informed that their rescue and recovery plans had to be approved by MSHA who would consult with the VDMME as provided for by Section 103(k) of the Act.

2. Once mine rescue teams arrived, mine officials, MSHA, and VDMME personnel began briefing and organizing the team activities.

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2. Once mine rescue teams arrived, mine officials, MSHA, and VDMME personnel began briefing and organizing the team activities.

3. Continuous gas testing apparatus was obtained from MSHA's Norton District Office and preparations were made to monitor the mine atmosphere.

4. Efforts were started to reset the mine fan and restore electric power.

About 9:00 a.m., the Westmoreland Mine Rescue Team, the Paramont Mine Rescue Team, and the Mine Technology Mine Rescue Team had arrived on site. The Clinchfield Mine Rescue Team arrived a few hours later. Initial readings from the No. 4 entry at 10:00 a.m. were 12,800 parts per million (ppm) carbon monoxide, 17.3 percent oxygen, and 0.7 percent methane. The Mine Technology Mine Rescue Team was sent underground to obtain air quality readings and install sampling tubing in the Nos. 3 and 4 entries for continuous gas monitoring. Sample tubing was hung to approximately the No. 3 crosscut in the Nos. 3 and 4 entries and continuous monitors were set up on the surface. Appendix B is a list of Mine Rescue Team Members and others who participated in mine rescue and recovery and establishment of ventilation.

After an initial period in which air readings were analyzed, a decision was made to send mine rescue teams into the mine to the suspected location of the miners. A natural flow of intake air was entering Nos. 1 and 2 entries and exiting Nos. 3 and 4 entries. A quantity of approximately 70,000 cfm remained relatively constant throughout the rescue and recovery operations. For this reason, the main fan was never restarted during the rescue and recovery. Since natural ventilation is driven by temperature differences and the differences in the surface and underground elevations, the temperature and weather forecast were continuously monitored.

Between 10:30 a.m. and 3:20 p.m. various mine rescue teams systematically explored up to No. 20 crosscut. During this exploration, the highest concentration of methane detected was 1.6 percent and the highest concentration of carbon monoxide was 2,000 ppm. The intake air quantity measured in the No. 16 Crosscut was 77,161 cfm.

At this time, ventilating air continued to intake in Nos. 1 and 2 entries and returned through the Nos. 3, 4, 5, and 6 entries, even though there were not any ventilation controls inby the No. 6 crosscut. Rescue teams continued to explore and install temporary ventilation controls to the No. 70 crosscut.

By 2:05 a.m. on December 8, 1992, the Clinchfield Team had advanced to the No. 81 crosscut. This was the entrance to the 1 Left section, approximately 300 feet from where the miners were expected to be located. After the team turned the corner into 1 Left, they reported 6.4 percent methane, in excess of 10,000 ppm carbon monoxide and rolling smoke and heat coming from the working section. The ventilation current had diminished and was not turning the corner and traveling into 1 Left. At this time, there were concerns about the explosive mixture of gas and the possibility of fire. At 2:15 a.m., the team was instructed to return to the surface.

Because of these concerns, a drilling contractor was retained. The contractor traveled to the site and at 2:05 p.m. began drilling operations. The borehole would be used to monitor the mine atmosphere to determine if a fire existed. The 6.5-inch diameter borehole, designated as the No. 1 Borehole, intersected the No. 3 entry near the No. 1 crosscut at 10:28 a.m. on December 9, 1992. Sampling tubing was installed and the borehole was sealed to assure accurate sampling. Continuous monitoring began shortly thereafter and the initial readings at 11:00 a.m. were 1,770 ppm carbon monoxide, 18.0 percent oxygen, and 4.0 percent methane.

At 2:25 p.m., a test was initiated with the seismic locating system. Three surface shots were fired to notify any surviving miners that the rescue efforts were in progress. A negative response was recorded after one hour of monitoring.

By 5:00 p.m., the gas analysis indicated that the mine environment had stabilized and it was concluded that a fire did not exist underground. A decision was then made to send the rescue teams back underground to explore the 1 Left section.

The Clinchfield Mine Rescue Team reentered the mine and traveled to the No. 81 crosscut. By 7:46 p.m. on December 9, 1992, the team had located the bodies of all miners on the section, except Vanover. The team reported an air quality reading of 7.1 percent methane and 16.9 percent oxygen in the vicinity of the battery powered scoop located in the No. 2 crosscut between Nos. 1 and 2 entries. The rescue teams were again withdrawn from the mine and recovery was suspended until the area could be ventilated.

After an assessment of available options, a decision was made to drill a second borehole to ventilate the 1 Left pillared area. The borehole would be 12 inches in diameter and located at the back of the 1 Left pillared area.

Drilling of the No. 2 Borehole began at 3:35 p.m. on December 10, 1992. At 4:05 p.m. on December 11, 1992, the No. 2 Borehole intersected the mine. Shortly thereafter, a high pressure centrifugal exhaust fan was installed onto the collar of the No. 2 Borehole. The fan produced approximately 3,500 cfm at 38 inches of water. Continuous monitors were set up to sample the exhaust from the fan. At 5:15 p.m., the initial readings were 740 ppm carbon monoxide, and 38 percent methane. By 3:30 p.m., December 12, 1992, the readings showed 3.9 percent methane, 240 ppm carbon monoxide and 18.9 percent oxygen. At this time, a decision was made to recover the bodies and search for the one remaining miner.

The Paramont and Westmoreland Mine Rescue Teams traveled underground at 4:40 p.m. By 6:12 p.m., the Westmoreland Team had examined the ventilation system and installed temporary ventilation controls and communications to the No. 81 crosscut. The Paramont Team searched the 1 Left section for the missing miner after confirming that the explosive mixture did not exist in the vicinity of the battery powered scoop. At approximately 7:00 p.m., the final body was located and preparations were begun to transport all of the bodies to the surface.

The bodies arrived on the surface at 8:57 p.m. They were transported to the Sturgill Funeral Home in Coeburn, Virginia, where Dr. David Oxley, Chief Medical Examiner for the Commonwealth of Virginia, removed personal effects and performed post-mortem examinations on December 13, 1992.

During the entire rescue and recovery operations, mine rescue teams were in communication with the surface and their findings were recorded on mine maps in the command center. Mine rescue teams were briefed upon entering the mine and debriefed upon arrival back on the surface. All information was double checked.

Mine rescue teams attempted to identify victims by observing the required brass ID checks attached to the miners' belt. The teams were under instructions not to disturb mine conditions unless absolutely necessary. If any changes were made, they were to report them to the surface. While attempting to identify one of the victims, the mine rescue team was required to turn one of the bodies over to observe the brass ID check. When this was done, cigarettes fell from the victim's pocket.

INVESTIGATION OF THE EXPLOSION

During the investigation, MSHA and VDMME cooperated to conduct a joint investigation. Management personnel from Southmountain and a representative of the miners were recognized as parties to the investigation and allowed to participate (Two miners designated a third employee as the representative in accordance with 30 CFR, Part 40).

Timothy J. Thompson was appointed the Chief Investigator for MSHA and Jack Tisdale as Technical Advisor. A list of those persons who participated in the investigation can be found in Appendix C.

Briefings for the MSHA investigation team were conducted by MSHA's District 5 personnel who participated in the rescue and recovery operations. MSHA District 5 personnel also provided information about mine conditions, practices, and plan requirements to the MSHA investigators. The MSHA investigators conducted a pre-investigation conference at the #3 Mine on December 14, 1992. During this conference, the format of the investigative procedures was discussed with the representatives of the state, company, and miners. Prior to beginning the underground phase of the investigation, several team members made an initial walk-through examination of the mine without disturbing any evidence. A plan for the systematic investigation of the affected areas was established and discussed with the various participating parties and investigative teams before they entered the mine. By this time, the primary focus of the investigation was the determination of the role, source, and location of explosive methane gas, the role, if any, of coal dust participation in the explosion, and the ignition source of the explosion. The sequence of the investigation was later adjusted because of the deteriorating roof conditions in the Mains.

The investigation was conducted by organized teams consisting of representatives from each participating organization. The underground investigation was conducted in all accessible locations affected by the explosion. All existing conditions were evaluated and recorded on maps and notebooks by team members.

Prior to beginning the underground portion of the investigation, the mine fan was reinstalled and started, all ventilation controls were checked, and the mine was examined for hazardous conditions. During the investigation, the mine atmosphere was continuously monitored at the main fan and at the No. 2 Borehole fan which was being utilized to ventilate the pillared areas.

The on-site investigation began on December 14, 1992. Surface areas of the mine were mapped and photographed. The underground investigation of the explosion began on December 18, 1992. The physical examination of the underground areas of the mine began with the "Mapping", "Ventilation", "Flame and Forces", "Mine Dust Survey", "Photo and Collection of Evidence", and "Electrical" Teams entering the mine to examine and record the evidence.

Evidence was collected, identified, and tagged for further inspection, testing, or analysis. A "Ventilation" Team conducted a survey of the ventilation system of the #3 Mine. Remaining ventilation controls, pressure drops, and direction of air flow were determined. The damage to ventilation controls as a result of the forces of the explosion limited the team's ability to evaluate actual conditions which existed prior to the explosion. The "Flames and Forces" Team evaluated areas affected by the explosion to determine the possible cause and origin of the explosion, the magnitude and direction of explosion forces, as well as the extent and path of the flame. The "Electrical" Team examined and tested electric equipment and circuitry in the mine as part of determining the source of the ignition.

The "Mine Dust Survey" Team collected mine dust samples in the Mains and on the 1 Left section from the surface to the 1 Left pillar line. A total of 252 mine dust samples were collected and submitted for laboratory analysis to determine percent of incombustible content and the presence of coke.

Information from the investigative findings is contained on the maps located in Appendices D, E, and F.

As part of the investigation, MSHA and VDMME conducted interviews of persons with knowledge of the facts surrounding the explosion. Initially, interviews were conducted with 31 individuals between January 11 and 21, 1993, in the MSHA, District 5 Office, located in Norton, Virginia. Follow-up interviews were conducted with eight individuals on March 25, and 26, 1993, at the VDMME Office, located in Big Stone Gap, Virginia. One additional person was interviewed for the first time on March 25, 1993. All interviews were recorded and transcribed. Copies of interviews of individuals who had not requested confidentiality were made available to interested parties. Those persons interviewed are listed in Appendix G.

DISCUSSION

Mine Development

The mine was developed from the surface through four drift openings designated as the No. 1 West Mains which were later expanded to six entries. The Mains were developed to a depth of 7,400 feet from the surface and the development was terminated in December 1991 due to adverse roof conditions. (See Appendix D) Development of 1 Left off the Mains began in January 1992. It continued to a depth of 800 feet and in February 1992, mining was directed to 1 Right. Development of 1 Right off 1 Left began and continued to a depth of 1,400 feet in April 1992, when mining was terminated due to adverse roof conditions. Pillar extraction was conducted in 1 Right beginning approximately 400 feet outby where the developing entries were terminated. Pillars were mined outby for a distance of approximately 700 feet, leaving several rows of pillars in 1 Right.

In May 1992, the section relocated back to 1 Left and these entries were advanced an additional 1,000 feet until they were terminated in June 1992, because of high reject material in the raw coal. Development of 2 Right off 1 Left began and these entries were developed to a depth of 1,300 feet, when in September 1992, mining was terminated due to adverse roof conditions. The section was relocated outby approximately 400 feet from the end of 2 Right and rooms were developed to connect 2 Right with the previously mined 1 Right. Additionally, rooms were developed to the left off 2 Right to a depth of approximately 150 feet. Pillars were sequentially extracted from the rooms to the left and right off 2 Right and from the panel entries. The section was retreated outby to 1 Left.

Pillar extraction in 1 Left began in November 1992 and progressed outby to 1 Right. Pillar extraction was halted in 1 Left and the section moved into 1 Right to extract the remaining pillars in 1 Right. Following completion of pillar recovery in 1 Right, pillar recovery was resumed in 1 Left and continued until the time of the explosion. During this period, the barrier that had been left between 1 Right and the Mains was mined by developing rooms and by recovering the pillars. Statements given during interviews indicated that this area was mined between the time that mining was resumed in 1 Left and the day of the explosion.

Bleeder System

The approved ventilation plan for the #3 Mine provided for establishment of a bleeder system to control the air passing through the area and to continuously dilute and move methane-air mixtures and other gases, dusts, and fumes from worked-out areas away from active workings and into the return air course. The system for the #3 Mine is referred to as a "wrap-around" bleeder which utilized at least one row of unmined bleeder pillars around the perimeter of the area where pillars have been fully or partially extracted. Framed-check ventilation controls were required to be installed in conjunction with the bleeder pillars to direct airflow.

1 Right

The bleeder system for 1 Right was established in the manner previously discussed. As a result of adverse roof conditions, two evaluation points were established to evaluate the pillared area of 1 Right. One evaluation point was established on the return side inby the pillar line and the second was established on the intake side of the pillar line. These evaluation points were approved by MSHA on February 26, 1992. Due to deteriorating roof conditions, the intake bleeder evaluation point was subsequently moved outby the pillared area. Additionally, the return bleeder evaluation point was relocated two crosscuts outby the original location due to an accumulation of water. Both relocations had been approved by the MSHA District Manager on May 22, 1992 and August 7, 1992, respectively.

2 Right

The bleeder system for 2 Right was established by leaving a row of pillars unmined on the left side of the panel and one or more on the inby end of the pillared area. Rooms were developed to the left of 2 Right and pillar recovery was conducted in these rooms during October 1992.

The bleeder system for 2 Right was connected to 1 Right inby the 2 Right pillared area. Pillar recovery of the pillar block adjacent to the 1 Right intake bleeder evaluation point rendered it inaccessible. However, the operator failed to submit to MSHA a request to eliminate or change the location of the intake bleeder evaluation point.

1 Left

The bleeder system for 1 Left was connected at the inby end of the entries to the bleeder system for 2 Right. The framed-check ventilation controls for 2 Right were required to be extended across the end of the 1 Left entries. While 1 Left was being pillared, one row of bleeder pillars was left unmined on the intake side of the entries. Framed-check controls were not required to be installed in conjunction with these bleeder pillars. Section ventilation controls were to be utilized to assure proper airflow through the 1 Left pillared area into the bleeder system at the inby end of 1 Left.

Mine Superintendent Deatherage indicated in his interviews that check curtains were installed inby the No. 87 crosscut in the Mains to separate the return entry from the pillared area and bleeder entry. Bad roof conditions and roof falls prevented the investigation team from traveling inby the No. 86 crosscut in the Mains.

Additional evaluation points, other than those for 1 Right, were not established for the evaluation of the pillared areas of 2 Right and 1 Left. Therefore, examiners were required to travel the bleeder system of 1 Left and 2 Right in its entirety.

The investigation revealed that the bleeder system for the 1 Left pillared areas was not maintained and became ineffective to continuously move methane-air mixtures away from the active faces.

Roof Control and Pillar Recovery

The approved roof control plan required the use of roof bolts ranging from a minimum 60-inch fully grouted resin bolts to 96-inch point anchorage bolts. Entries and crosscuts were developed to a width of 20 feet supported primarily with 60-inch resin bolts on a 4 feet by 4 feet roof bolting pattern. The pillar recovery system addressed in the approved plan permitted either full or partial pillar recovery. Full recovery addressed the pocket and wing method of pillar recovery. Two partial recovery plans addressed a three and a five cut sequence depending on pillar dimensions. At the time of the explosion, 60 feet by 70 feet pillars were being recovered, utilizing the five cut partial recovery method.

The geological conditions of the Imboden Seam, at the #3 Mine, included a coalbed of five to seven feet in thickness, an immediate roof of one to two feet of firm shale, and a sandstone secondary roof of varying thickness. In some areas, as in the 1 Left area being mined, the sandstone was located directly over the coalbed. An 18-inch seam of coal, known as the Kelly Rider Seam, undulated from 7 to 14 feet above the Imboden Seam in some areas of the #3 Mine.

At the time of the explosion, the continuous mining machine was located on the pillar line at the No. 2 crosscut in the No. 3 entry of 1 Left. Sixty-inch fully grouted resin bolts on 4 feet by 4 feet centers were installed in the massive sandstone roof in the 1 Left area being mined. Split and round posts had been installed as breaker posts and turn posts to protect active workings.

Prior to the explosion, the back side of outby pillars in the Nos. 2 and 4 entries had been mined (See Appendix E). These cuts were not a part of the approved pillar mining sequence. Also in the No. 3 entry, pillar recovery was conducted out of sequence with the approved plan. During the investigation, excessive coal rib sloughing occurred along the pillar line and outby for approximately 200 feet. This condition appeared to have been created by substantial overburden pressures and stresses created by the pillar mining. Interview statements indicated that pillared area caving proceeded normally while retreating 1 Left until approximately the No. 9 crosscut. Here, massive sandstone roof conditions impeded pillared area caving outby to the No. 2 crosscut where the explosion occurred.

Changes were made in the intended mine projections at the end of the Mains, 1 Right and 2 Right. Adverse roof conditions and roof falls in these areas would not permit further development even after 96-inch point anchorage roof bolts were installed. Interviews of employees suggested normal caving would occur up to the Kelly Rider Seam during pillar recovery, in 1 Right and 2 Right and to approximately the No. 9 crosscut of 1 Left.

Unintentional roof falls, above roof bolt anchorage, were observed by the investigators in the active workings in the Mains at the Nos. 62, 78, and 83 - 84 crosscuts in the Nos. 5 and 6 entries, and at the No. 81 crosscut in the No. 4 entry.

Water Accumulations

The Imboden Seam elevations in the #3 Mine varied from 2,352 feet on the surface to 1,902 feet at the inby end of the Mains. During development of the Mains, it was necessary to pump water from the advancing faces to the surface. When mining in the Mains was terminated, pumping of water ceased and water was allowed to accumulate in the face areas. Water was known to have accumulated in the Mains to approximately the 1,918 feet elevation level. Two entries were driven to connect the Mains with 1 Right near the No. 93 crosscut. These entries were part of the bleeder entries for the pillared areas. The elevation of the lowest entry was approximately 1,920 feet. This indicates that if the water level in the Mains increased, water would flow through the two entries and into 1 Right possibly reducing the effectiveness of the bleeder system. Deatherage stated that problems with water in the area ceased after development stopped.

On August 5, 1992, Southmountain requested that the return bleeder evaluation point established in 1 Right be relocated two crosscuts further outby due to an accumulation of water in a swag area. The request indicated that ventilation was moving over the water. The request was approved on August 7, 1992. This evaluation point had recently been inspected by MSHA on an August 3, 1992, ventilation technical inspection. The MSHA inspector measured 12,100 cfm of air and a methane reading of 0.0 percent.

Methane Liberation

Several test holes were drilled into the mine roof to intersect the Kelly Rider Seam during the development of No. 1 West Mains, 1 Right and 2 Right. They were drilled when bad roof conditions were encountered. Various persons interviewed stated that elevated methane concentrations were encountered near the collar of the holes. On December 20, 1991, an MSHA inspector, using a methane detector, found 8.1 percent methane inside a roof test hole with 0.3 percent 12-inches from the roof. This indicates that the Kelly Rider Seam had the potential to produce methane. This methane could enter the mine whenever a roof fall extended up to the Kelly Rider Seam.

A review of the methane liberation in the mine was conducted based on the results of samples that were taken during the past seven MSHA inspections. Table 1 shows the results of the review.

Table 1 - Methane Liberation at the #3 Mine

DATE	05/91	08/91	10/91	01/92	07/92	08/92	10/92
METHANE, %	0.00	0.00	0.02	0.04	0.07	0.06	0.12
CFM METHANE IN 24 HOURS	0	0	21151	56137	90811	77414	187799

Methane was not detected in MSHA samples taken at the main fan until around October 1991, when mining was being conducted in the Mains, near what is now the 1 Left intersection. Methane liberation at the main fan in October 1991 was 21,151 cubic feet per 24 hours (CF/24 HR) and in July 1992, the liberation was 90,811 CF/24 HR. During this period of time, mining was completed in the Mains, 1 Right was developed and the pillars mined, and development of 2 Right was started. When pillar recovery of 2 Right was nearly completed, the methane liberation at the main fan in October 1992 was 187,799 CF/24 HR.

A comparative review of the total methane liberation in the North Fork Mining Corporation, Mine No. 2, an adjacent mine in the same seam, was conducted based on the results of air samples that were taken from October 1991 to February 1993. Table 2 shows the results of that review. The methane liberation from the mine was minimal until February 1992. The methane liberation gradually increased as the mine was developed. It increased significantly when pillar recovery was being conducted as indicated in the samples collected in July 1992. The liberation decreased dramatically after the area that had been pillared was sealed as indicated in the sample collected in November 1992. The methane liberation increased significantly when the sealed area was reopened as indicated in the sample collected in February 1993. This indicates an increase in methane liberation that corresponds with the amount of area that has been pillared or to the amount of roof falls at the adjacent mine.

Table 2 - Methane Liberation At Adjacent Mine

DATE	10/91	02/92	03/92	04/92	07/92	11/92	02/93
METHANE, %	0.00	0.01	0.01	0.03	0.16	0.01	0.17
CFM METHANE IN 24 HOURS	0	11808	10680	34906	188741	11520	195816

During the investigation, statements were provided, both formally and informally, by persons with knowledge of methane liberations at the #3 Mine. Normally during development, minimal amounts of methane were encountered in the faces of the Mains, 1 Right and 2 Right. The typical methane concentrations were from 0.1 percent to 0.3 percent. Methane concentrations from 0.1 percent to in excess of 5 percent had been detected at several locations in these areas. The highest methane found by MSHA inspectors more than 12 inches from the roof, face, or rib was 0.59 in an air bottle sample taken on October 22, 1992.

On April 20, 1992, the Daily and On-shift record book indicated that 9.9 percent methane was found in the #2 Heading of 1 Right and that it was ventilated out. This report was countersigned by Deatherage in fulfilling the responsibilities of the mine foreman. One interviewee stated that approximately two weeks prior to the explosion, 8 percent methane was detected at the edge of the pillared area by a section foreman. The section power was de-energized and section ventilation controls were checked for leakage. Mining was interrupted for approximately one hour until ventilation cleared the area of methane. Three other instances were revealed during interviews where methane concentrations were greater than 1 percent, two instances were in 1 Right where 2.0 percent and 5 percent were found and one instance in 2 Right where in excess of 5 percent was found. All three instances were in developing faces and the methane was removed by utilizing ventilation curtains.

Additionally, the investigation obtained information from statements which were provided both formally and informally, regarding methane in the bleeder system and pillared areas of the #3 Mine. Methane tests conducted at the return bleeder evaluation point indicated that the methane content of air leaving the pillared area normally contained 0.2 percent to 0.3 percent during weekly examinations. During October 1992, MSHA found 0.59 percent methane at the return bleeder evaluation point. Deatherage stated that ventilation controls were installed to increase airflow through the bleeder system. The methane concentration during the next weekly examination was 0.3 percent.

The continuous mining machine water spray system was modified around July 1992 to include fan sprays added to the left side of the machine. Statements of interviewees indicated that this change was made to assist in controlling anticipated methane liberation.

During rescue and recovery efforts, continuous monitoring was conducted at the main return and at the No. 2 Borehole. Air quantity measurements were taken at regular intervals. From December 7 through 21, 1992, approximately 1.9 million cubic feet of methane exhausted from the mine through the main return. From December 11 through 21, 1992, approximately 1.9 million cubic feet of methane was exhausted from the mine through the No. 2 Borehole. The average total methane liberation for the mine in October 1992 was approximately 188,000 cubic feet in 24 hours. The methane liberation was approximately the same after the methane concentrations stabilized at the main fan and at the borehole after the explosion. This indicates there could have been approximately 1.1 million cubic feet of methane in the pillared area and in the strata above the pillared area, just prior to the explosion. It is probable that the 1 Left pillared area contained a large volume of high concentrations of methane at the time of the explosion which had accumulated over a period of time.

Ventilation

Mechanical ventilation for the #3 Mine was induced by a Joy five-foot diameter exhaust fan at the No. 4 entry. Power to the fan was supplied by a 75-horsepower, 480 Volts Alternating Current (VAC) motor. Air measurements taken during the investigation indicated that when the fan was operating it was producing approximately 88,000 cfm at a static pressure of approximately one inch of water.

Natural Ventilation Pressure (NVP) also produced airflow into the mine. The difference in elevation between the drift openings and the 1 Left intersection with the Mains was approximately 400 feet. Air measurements taken during the rescue and recovery efforts and during the investigation indicated airflows ranging between 47,000 cfm and 85,000 cfm when the main mine fan was not in operation. A ventilation study, completed during the rescue and recovery efforts, indicated that the NVP when the outside temperature was 37° F was approximately 0.11 inch of water. This caused an airflow of approximately 60,000 cfm. The NVP and the corresponding airflow, would vary with the temperature. The NVP assisted the mechanical ventilation system.

Ventilation Plan

The ventilation plan required that a minimum of 3,000 cfm of air be maintained in any working face where coal is being cut, mined, loaded, or drilled. It also required that a minimum of 9,000 cfm of air be maintained in the last open crosscut in any set of developing entries and in the intake end of any pillar line. Cuts were limited to 20 feet in depth and the line brattice had to be maintained inby the machine operator.

Permanent stoppings were to be used to separate the intake and return entries and were to be maintained up to and including the third open crosscut outby the face of the active section. Permanent stoppings were to be constructed between the intake entries and the belt haulage entries up to the section dumping point. They were to be constructed using concrete or cinder blocks coated with a suitable mine sealant on the high pressure side.

No. 1 West Mains

The Mains was generally developed using six entries. Outby 1 Left, the Nos. 1 and 2 entries were used as intake aircourses. The Nos. 3 and 4 entries were used for haulage. Airflow entered the haulage entries at the No. 3 entry near the surface and traveled inby to regulators located in the Nos. 4, 8, 10, and 13 crosscuts where it was coursed into the return entries. Intake airflow outby the section entered the haulage entries and traveled outby to the same regulators where it was coursed into the return entries. The Nos. 5 and 6 entries were used as return aircourses.

The Mains inby 1 Left was utilized as a return aircourse. According to mine maps and interview statements, some of this area was roofed with water and ventilation was provided to the edge of the water.

1 Left Section

In order to maintain adequate ventilation for the 1 Left section, it would have been necessary to install and maintain ventilation controls to separate intake and return entries. The investigation revealed that some of these ventilation controls may not have been in place prior to the explosion.

According to interviewees, the permanent ventilation controls in the Nos. 1 and 2 entries between the Nos. 81 and 82 crosscuts in the Mains to direct the intake air into the 1 Left section had been removed. Brooks, evening shift section foreman, indicated that as of approximately 10:30 p.m. on December 6, 1992, check curtains were installed in these two locations. A check curtain was reported to have been installed in the No. 1 crosscut between the Nos. 2 and 3 entries of 1 Left. The evidence obtained during the underground investigation indicated that these checks may not have been in place at the time of the explosion.

According to interviewees, the permanent ventilation controls in the Nos. 1 and 2 entries between the Nos. 83 and 84 crosscuts in the Mains had been partially removed. Brooks indicated that as of approximately 10:30 p.m. on December 6, 1992, check curtains were installed at the two partially removed stoppings. A check curtain was also installed in the No. 1 crosscut between the Nos. 4 and 5 entries of 1 Left. The ventilation plan required that a permanent ventilation control be installed and maintained in the No. 2 entry between the Nos. 83 and 84 crosscuts in the Mains and that check curtains be installed from that location to the active working face to separate the intake and return air. The evidence obtained during the underground investigation indicates that only one check curtain located in the No. 1 entry between the Nos. 83 and 84 crosscuts may have been in place at the time of the explosion. Additionally, the evidence indicates that the permanent stopping located in the No. 3 entry between the Nos. 83 and 84 crosscuts was not in place at the time of the explosion.

The ventilation plan required that check curtains be installed across the Nos. 3 and 4 entries of the Mains near the section. During the investigation, a small remnant, approximately a one foot piece of check curtain, was found in the No. 3 entry near the No. 81 crosscut. The No. 4 entry between the Nos. 81 and 82 crosscuts was blocked by a roof fall. Remnants of any check curtain were not found in the area.

During initial rescue and recovery efforts by advancing rescue teams, elevated concentrations of methane were encountered in 1 Left. The highest methane concentrations were found in the No. 1 Bleeder entry of 1 Left. The methane concentration in the adjacent entries was lower, indicating that some ventilation was reaching those entries even in the absence of ventilation controls in the area.

Methane Migration

The No. 1 Bleeder entry of 1 Left was at the highest elevation of the 1 Left pillared area. The coal seam dipped from this entry toward the furthest point of advance in 1 Right and 2 Right. When little ventilation is directed through an area, methane can accumulate and will migrate to the highest elevation. Therefore, with inadequate ventilation in the pillared area and bleeder entry, methane would accumulate in or near the No. 1 entry of 1 Left.

Ventilation Surveys and Computer Simulations

Mine ventilation pressure-air quantity surveys were conducted on December 14, and 20, 1992. The first survey was conducted with the main fan not operating. The mine was being ventilated by means of a borehole fan and natural ventilation. The second survey was conducted with the main fan also operating. Numerous computer simulations were developed from the data obtained from these surveys.

The ventilation surveys showed that a high resistance to airflow existed between the 1 Left section and the bottom of the No. 2 Borehole. This high resistance to airflow indicated that the bleeder entry was severely restricted. Computer simulations were developed using this measured resistance as well as a lower calculated resistance that corresponded to an open bleeder entry with all of the necessary ventilation controls intact.

The simulations indicated that if all of the ventilation controls required in the ventilation plan were intact and if the bleeder entry was open, there would have been sufficient airflow in the bleeder entry and in the 1 Left section to dilute methane liberated from the pillared area.

Various simulations were developed to evaluate the effects to the ventilation system when any or all of the following conditions existed:

1. The bleeder entry was not maintained open in its entirety;

2. The ventilation controls were not maintained between the pillared area and the bleeder entry;

3. The ventilation controls were not maintained across the Nos. 3 and 4 entries between the Nos. 81 and 82 crosscuts of the Mains;

4. The ventilation controls were not maintained between the intake and return aircourses in the Mains near the section and in 1 Left; and,

5. The ventilation controls were not maintained between the return and bleeder aircourses in the Mains.

The simulations indicated that if the bleeder entry for the 1 Left pillared area was not maintained open or if the framed-checks between the pillared area and the bleeder entry were not maintained, the airflow in the bleeder entry would be insufficient to dilute and render harmless methane that may have come from the pillared area. Additionally, they indicated that if the ventilation controls were not maintained on the 1 Left section, the airflow in the No. 1 entry would be inconsequential and could allow methane to flow from the bleeder entry onto the 1 Left section. Also indicated was there would be some airflow near the active face in the No. 3 entry where the continuous mining machine was located.

Barometric Pressure

The barometric pressure was recorded by the National Weather Service at nearby Bristol, Tennessee. Figure 1 is a graph of the barometric pressure from December 6 through December 8, 1992.

Figure 1 - Graph of the Barometric Pressure

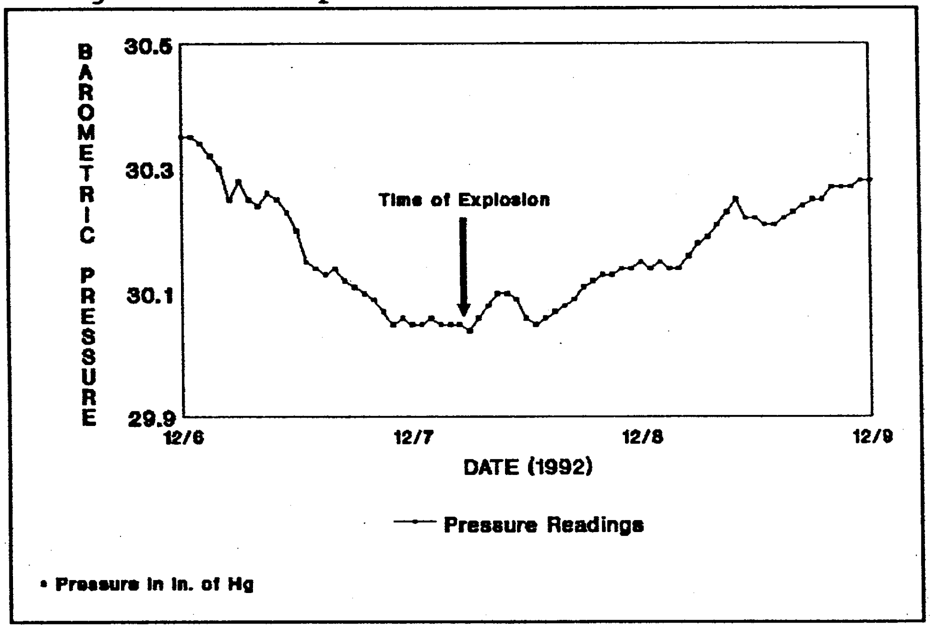

Figure 1 indicates that a significant drop in the barometric pressure occurred in the hours prior to the explosion. This increases the likelihood of methane migrating from the 1 Left pillared areas.

Electricity

Electrical power for the underground circuits and equipment was supplied from a totally enclosed surface substation that contained a 1,000 kilovolt-ampere (kVA) delta-wye connected three-phase transformer. This transformer supplied one underground circuit that entered the mine through the No. 4 entry. The high-voltage system was protected by a 600-ampere oil circuit breaker located in the surface substation. The oil circuit breaker was equipped with a ground-check monitor and relays designed to provide overcurrent, short-circuit, grounded-phase, and under-voltage protection for the circuit.

The underground high-voltage circuit supplied power to three belt drive power centers and the section power center. The belt drive power centers reduced the 4,160 VAC to 480 VAC for the belt conveyor drive motors. The power center reduced 4,160 VAC to 575 VAC and 480 VAC power for operation of the section electric equipment. A three-pole, molded-case, circuit breaker was provided for each power circuit. Each circuit was equipped with a ground-check monitor and devices to provide overcurrent, short-circuit, grounded-phase, and undervoltage protection.

Electric Circuits and Equipment

To determine if the source of the ignition was of electric origin, MSHA personnel, assisted by personnel from the VDMME, and officials and employees of Southmountain, tested and examined the electric equipment and cables located in areas of the mine in which evidence of heat or flame was found. The summary results of the examinations and tests of the electric circuits and electric equipment located where evidence of heat or flame was found are:

High-Voltage Cable

Approximately 6,000 feet of shielded high-voltage cable connected the surface disconnects to the section power center. The high-voltage cable was lying on the mine floor against the coal rib in the No. 4 entry. The cable passed through the feed-through circuits of the Nos. 2, 3, and 4 belt drive power centers. Also, seven open-type visual disconnects were installed in the circuit. The high-voltage cable and open-type visual disconnects were damaged in numerous locations; however, the damage appeared to have been caused by falling roof and ribs, flying objects, and force that occurred during and after the explosion.

Information gathered during the investigation revealed that the high-voltage circuit was energized at the time of the explosion. The high-voltage breaker apparently deenergized the circuit when the monitor and ground wires were separated by the forces of the explosion. Target flags were not observed on the high voltage-circuit breaker and associated relays to indicate that an over-current, short circuit, or ground fault had occurred.

The point of origin of the explosion forces was not located near the high-voltage cable. Investigators did not find any evidence that the high-voltage power cable or visual disconnects provided the ignition source for the explosion.

Belt Drive Power Centers

Three nonpermissible feed-through belt power centers ranged in size from 150 kVA to 300 kVA. Each power center provided a feed-through high-voltage circuit and supplied 480 volts, resistance grounded, three-phase power to their respective belt drives. The power circuits were provided with power conductors of proper ampacity and electrical protection that provided a ground-check monitor, overcurrent, short-circuit, grounded-phase, and under-voltage protection.

Physical damage to the power centers was minimal to Nos. 2 and 3 and severe to No. 4. The power centers were not located near the point of origin. Investigators did not find any evidence that the power centers provided the ignition source for the explosion.

Belt Drives

Three nonpermissible belt drives were located in the No. 3 entry of the Mains. The belt drives consisted of 150-horsepower, 460-volt wound rotor motors, belt controllers, and associated control circuits for the belt slippage and sequence switches and deluge fire suppression system.

Physical damage to the belt drives consisted of minor damage to No. 2 and extensive damage to Nos. 3 and 4. The belt drives were not located near the point of origin. Investigators did not find any evidence that the belt drives provided the ignition source for the explosion.

Section Power Center

The nonpermissible 750 kVA section power center was located at the No. 83 crosscut between the Nos. 1 and 2 entries of the Mains. The section power center reduced the 4,160 VAC to 575 VAC power for utilization by the continuous mining machine on the section. The section power center also provided 480 VAC power for utilization by two shuttle cars, a battery charger, and a belt feeder.

The high-voltage load-break switch and the emergency stop switch were found in the closed position indicating the transformers were energized at the time of the explosion. All circuits providing power to the section equipment were supplied from a resistance grounded circuit. Each circuit supplying power to the section equipment was equipped with a ground-check monitor and was protected by molded-case circuit breakers and associated circuitry to provide overcurrent, grounded-phase, and under-voltage protection.

Physical damage consisted of a plexiglass viewing window on the high-voltage section of the power center being forced inward. Evidence of abnormal arcing or heat inside the power center was not found by the investigators. The point of origin of the explosion forces was located inby the section power center and the damaging forces also indicated that the explosion did not originate inside the power center. Evidence indicated that the section power center did not provide the ignition source.

Nonpermissible Electric Section Equipment At Or Near the Section

The nonpermissible electric equipment located at or near the section consisted of the following:

1. Owens Manufacturing Company, Belt Feeder, Type FPHH 34140

2. Simmons-Rand Company, S&S Battery Charger, Model No. 438A

3. West Virginia Armature, Rail Runner, Type No. 6JSMUXYK36

4. Pyott-Boone, Model 113, Page Boss (See Appendix H)

The nonpermissible equipment contained switches, relays, and circuit breakers that in normal operation could create arcing with sufficient energy to ignite an explosive methane-air mixture. However, evidence of abnormal arcing or heat inside the equipment was not found by the investigators. The equipment was not near the point of origin and the damaging forces also indicated that the explosion originated outside the equipment. Based on these facts, it was reasonable to conclude the equipment did not provide the ignition source of the explosion.

Permissible Equipment Away From the Point of Origin

The permissible equipment, on the section, not in the vicinity of the point of origin consisted of the following:

1. Joy Manufacturing Company Shuttle Car Model No. 10SC22-56AHE-1

2. Joy Manufacturing Company Shuttle Car Model No. 10SC22-56AXHE-1

3. Simmons-Rand Company, S & S Scoop, Model No. BMUAT86

4. Jeffrey Manufacturing, Continuous Mining Machine, Model No. 1036

5. Acme Machinery Company, Dual Head Roof Bolter, Model No. d12L (Not in use at time of explosion)

6. Seven Koehler Manufacturing Company Cap Lamps (See Appendix H)

7. Koehler Manufacturing Company Flame Safety Lamp (See Appendix H)

Inspections were performed on the permissible mining equipment that was on the section when the explosion occurred. The packing glands were checked to ascertain proper assembly. All accessible flame-path fits were checked. The machine components were checked for signs of abnormal arcing or burning. The cap lamps and flame safety lamp were examined by MSHA Approval and Certification Center.

The inspections revealed areas where the equipment did not meet Title 30 Code of Federal Regulations (30 CFR) requirements. However, the visual inspections identified not any evidence that the ignition source of the explosion occurred internal to the enclosures. Combustible material in the enclosures was not charred, discolored, or deformed. Indications of carbon tracking along any flanges were not found. Indications external to the flame paths of any flame or explosion exiting the enclosures were also not found. The equipment was not located near the point of origin. Based on these facts, the ignition of the explosion did not occur at any of the machines or devices.

Permissible Equipment Near The Point Of Origin

The following permissible equipment was located in the vicinity of the point of origin:

Simmons-Rand Company, S & S Scoop, Model 488

The battery-powered scoop, serial no. 488-1737, Approval No. 2G-2831-4, was located in the No. 2 crosscut between the Nos. 1 and 2 entries of 1 Left. The scoop was not maintained in permissible condition. The main circuit breaker was in the open (tripped) position. The directional pump motor switch and light switch were in the off position. The batteries were connected to the scoop.

The examination to determine the condition of the scoop for compliance with 30 CFR 75.503 revealed the batteries and covers were in good condition and sign of arcing were not observed. The following conditions, found on the scoop, were not in compliance with permissibility standards:

1. The battery covers were not secured in place;

2. Bolts used to fasten the cover of the circuit breaker compartment and the motor controller were not as uniform in size as practicable;

3. Three bolts were missing in the pump motor inspection cover;

4. A splice was made in the battery end headlight cable that was not in an explosion-proof splice box;

5. The conduit protecting the bucket end headlight cable was not provided mechanical protection for the cable for a distance of approximately three inches;

6. Three entrance glands and one plug used on the main controller were not secured against loosening; and,

7. The lighting circuit was not properly fused in that 30-ampere fuses were used in place of the 10-ampere fuses approved for the circuit.

An inspection was conducted of the interior of the explosion-proof enclosures for any signs of charred, discolored or deformed combustible material or carbon tracking along any flanges of explosion-proof compartments. None were discovered. The scoop components were also checked for signs of abnormal arcing or burning and none were found. The position of the switches indicate that the scoop was parked and not in use at the time of the explosion.

As a result of bolts missing in the pump motor inspection cover, a sample of material from the pump motor was taken for analysis. Test results indicate that an ignition had not occurred in the compartment (See Appendix I). There was nothing found during the examination of the scoop that would indicate the ignition source of the explosion originated from the subject scoop.

Koehler Manufacturing Company, Cap Lamp

The cap lamp from the victim located at the point of origin (MSHA Exhibit No. EM-4) was examined. This examination revealed:

1. The cap lamp was not as approved due to a rod being used to secure the cap hook to the head piece;

2. Flash current tests were performed after completely charging the battery. The battery did not have the capacity to ignite an explosive methane/air atmosphere due to arcing caused by a short across the battery terminals; and,

3. The cap lamp bulb envelope was intact with the filament not exposed and the cap lamp was found to be built according to the approval drawings.

Through testing and evaluation, it was determined that the cap lamp was not the ignition source of the explosion (See Appendix H).

Methane Monitor

The continuous mining machine was equipped with an MSHA approved General Monitors, model no. 420d, certification no. 32A-16/MS-2 methane monitor. The monitor was properly installed with the control unit located in the operator's deck. The power supply was mounted in the main controller and the sensor housing was located on the operator's side of the continuous mining machine approximately 10 feet from the front of the cutting drum and approximately 30 inches vertically from the bottom. The control unit was properly connected to the power supply and sensor housing. The cutoff relay was properly connected into the control circuit of the continuous mining machine and was adjusted to provide deenergization of the continuous mining machine when 1.9 percent methane/air mixture was detected by the monitor.

The investigation revealed that the screen in the dust cover for the methane sensor had been replaced with a rag approximately one week prior to the explosion. Testimony revealed that an electrician had discovered the screen missing and in order to prevent water from causing erratic operation of the monitor a rag was inserted into the dust cover. He then checked the calibration after inserting the rag to assure the monitor would operate properly. The electrician testified that the monitor was within calibration at the time and was recalibrated on Thursday prior to the explosion and at that time found to be working properly.

Tests were conducted by MSHA's Approval and Certification Center to determine the condition of the monitor and what affects the rag located in the dust cover might have on the performance of the monitoring system. The testing indicated that the monitor, as received, was calibrated to read 0.6 percent methane when zero percent test gas was used for the zero adjustment and 3 percent when 2 percent test gas was applied to the sensor. These tests were made with the rag in place and dry.

Further testing indicated that when the rag was dampened, the accuracy of the monitor was reduced. Indications were that the wetter the rag became the less accurate were the monitor output readings, and revealed that there was a point at which methane would not be detected.

The exact atmospheric and operating conditions that the monitor was exposed to in the hours prior to the explosion cannot be determined; however, it is important to note the following:

1. The continuous mining machine was using a water spray system with 27 water sprays which created a spray mist around the head and in the throat of the miner;

2. The sensor was located approximately 30 inches from the mine floor in a mining height of 6.5 feet;

3. The continuous mining machine had been operating for approximately six hours on the midnight shift prior to the explosion; and,

4. Statements by company personnel indicated water hit directly on the sensor when the cutting head was lowered.

The above factors and results of the laboratory testing indicate that the methane monitor likely was in a condition that would not have allowed for accurate atmospheric monitoring of the area prior to and at the time of the explosion (See Appendix H).

Smoking Related Issues

The operator's Smoking Search Program was approved by the MSHA District 5 Manager on March 2, 1992. The program required a systematic examination of contents of lunch containers and clothing of all persons regularly entering the underground portions of the mine. All examinations were to be conducted weekly on each shift at staggered intervals and a record of the searches maintained on the surface. An inspection of the smoking search records revealed that examinations were recorded as required and in some instances exceeded the minimum frequency requirements of the program.

On December 12, 1992, the victims were brought to the surface. Three of the victims had carried smoking materials in the mine. One pack containing nine unsmoked cigarettes was found on the victim in the No. 2 crosscut between the Nos. 1 and 2 entries. The butts of ten smoked cigarettes were also found in the victim's pockets. Some of the butts were in the container used to transport the victim to the medical examiner's office. One pack of cigarettes and one butane cigarette lighter were found on the victim outby the pillar line in the No. 2 entry between Nos. 1 and 2 crosscuts. One pack of cigarettes and one butane cigarette lighter were found on the victim in the No. 2 crosscut between Nos. 3 and 4 entries.

On December 18, 1992, two unopened packs of cigarettes and two butane cigarette lighters were found in a lunch container located in the operator's deck of the S & S battery scoop located in the No. 2 crosscut between the Nos. 1 and 2 entries. The butt of one smoked cigarette was found in the operator's deck and another cigarette butt was found in the intersection of No. 2 entry and No. 2 crosscut. One butane cigarette lighter was found lying on the mine floor at the rear of the scoop. This lighter displayed evidence of heating and when later tested by the investigators was found to be functional.

When asked during interviews if anyone had observed or suspected persons smoking underground at the #3 Mine, four employees and one foreman declined to answer the question and two other foremen, including the superintendent, stated they suspected it but could not prove it. All other employees stated they did not have any knowledge of smoking underground.

Interviews and investigative findings established that the operator's smoking prohibition and resultant discipline for infractions of the non-smoking policy was poorly administered.

<u>Examinations</u>

Weekly Examinations

A review of the weekly examination record book and information provided during interviews revealed that small concentrations of methane had been detected. Recorded in the weekly examination record book was traces of methane in the Mains and at the return bleeder evaluation point at the discharge end of the bleeder line. Methane was regularly recorded as a trace in these areas from May 1992 until August 1992. A review of the record books indicated methane was not detected from August until November 21, 1992. Deatherage stated that when he recorded a trace of methane it ranged from 0.1 to 0.3 percent.

For July 14, 1992, the weekly examination record book indicates water backing up in the 1 Right. Deatherage said this occurred at the return bleeder evaluation point in 1 Right and the evaluation point was subsequently moved two crosscuts outby the original location.

An air reading of 17,470 cfm was taken near the return bleeder evaluation point by Deatherage on October 21, 1992. Deatherage stated, during interviews, that he would normally measure around 11,000 to 12,000 cfm at the return bleeder evaluation point. Air measurements were not taken in the intake end of the pillar line. Bad roof conditions and roof falls stopped the investigation team from traveling inby the No. 86 crosscut in the Mains to the return bleeder evaluation point in 1 Right. The inability of the examiner to travel or properly evaluate the airflow in the bleeder entry leaves in question whether the area was ventilated.

On November 13, 1992, Deatherage and Ramey traveled the No. 1 entry of the 1 Left bleeder to the back of the No. 6 entry of 1 Left. Deatherage stated that Ramey stopped because of bad roof and he traveled approximately four crosscuts further. Ramey and Deatherage returned down the No. 1 entry without traveling the entire bleeder entry.

The barrier block between 1 Right and 2 Right was mined in September and October 1992. Deatherage stated that the bleeder had not been traveled in its entirety after the barrier block was mined. Undetected roof falls, accumulations of water, and failures of ventilation controls could have occurred in the bleeder entry that would have rendered the system ineffective. A review of the weekly examination record book for November 13, 1992, indicated that the examination of the bleeder system was completed and conditions were recorded to be "OK".

Deatherage stated that on November 21, 1992, he traveled in the No. 1 Bleeder entry not any further than the Nos. 9 or 10 crosscuts because of bad roof. However, a review of the weekly examination record book for November 21, 1992, indicated that the examination of the bleeder system was completed and conditions were recorded to be "OK" with the comment "Trace CH4 .3". Action was not taken to correct the adverse roof conditions.

Deatherage stated that on November 30, 1992, he again traveled in the No. 1 Bleeder entry not any further than the Nos. 9 or 10 because of bad roof. A review of the weekly examination record book for November 30, 1992, indicated that the examination of the bleeder system was completed and conditions were recorded to be "OK" with the comment "Bad Top". Deatherage stated that when he found and recorded bad roof on November 30, 1992, he did not give instructions to resupport the area. When asked what could be the consequences of a roof fall in the bleeder system in that location, he stated, "It would've short circuited your air out above instead of going all the way around". When asked again if he gave instructions to resupport the area, he stated, "No. It was all the way, you know, for a long distance". The investigation team was stopped by a roof fall in the No. 1 Bleeder entry of 1 Left at the No. 6 crosscut which is the approximate location where Deatherage stated he encountered bad roof.

A review of the weekly examination record book indicated that the weekly examination was not conducted at least every seven days. The most recent examination was not conducted for a nine day period. The record books indicated that this practice occurred at least 18 times in calendar year 1992.

Preshift - On-shift Examinations

A review of the preshift and on-shift examination record books and information provided during interviews revealed that methane was not normally encountered during the preshift and on-shift examinations. However, in April 1992, methane was recorded as a trace during 37 separate examinations and in quantities ranging from .01 (sic) to 0.3 percent during six separate examinations. On April 20, 1992, methane was recorded as "9 & 9/10" percent during the evening shift on-shift examination by Goode. It also indicated that the methane was "ventilated out". This record was countersigned by Deatherage. In August 1992, methane was recorded as a trace during three separate examinations. In September

1992, methane was recorded as a trace during 45 separate examinations and as 0.1 percent during two separate examinations.

Five instances were reported to investigators where methane concentrations were greater than 1 percent; one instance was in the developing Mains section where 2.1 percent was found; two instances were in the developing 1 Right section where in excess of 5 percent were found; one instance in the developing 2 Right section where in excess of 5 percent was found, and one instance approximately two weeks prior to the explosion where in excess of 5 percent was found in the retreating 1 Left section.

Only one of these five reported methane occurrences were recorded in the preshift and on-shift record books. However, investigators were unable to determine if the other four occurrences were encountered during the preshift or on-shift examinations.

Interviews revealed that on December 6, 1992, Brooks did not examine the Nos. 1, 5, and 6 entries during his preshift examination for the on-coming midnight shift. Methane had accumulated in the No. 1 entry prior to the explosion. Although he indicated that air was going into the bleeders, he did not travel into the No. 1 entry to check for methane. He conducted the preshift examination from 9:30 p.m. to 10:30 p.m. He indicated that methane checks were made and methane was not detected. An air measurement of 29,460 cfm was taken in the No. 2 entry of 1 Left inby the Mains.

Vanover's methane detector was not found during the investigation. Reportedly, this instrument would have been either on top of the power center or in Vanover's possession. Investigators were able to examine all areas within several hundred feet of the power center and did not find the methane detector; however, a flame safety lamp was found approximately 200 feet inby the power center. A methane detector could have been in Vanover's possession. During rescue operations, Vanover's body was found approximately 100 feet inby the continuous mining machine in the No. 3 entry. The secondary force from the coal dust explosion generated a pressure wave of about 12 pounds per square inch (psi) heading inby in the No. 3 entry. This pressure was of sufficient magnitude to possibly cause a methane detector to be blown further inby. The unstable roof conditions in this area forced the investigators to abandon additional searches for the methane detector.

Coal Dust, Loose Coal, and Rock Dust

During the investigation, a mine dust survey was conducted to determine the incombustible content of the mine dust. The survey was conducted in the Mains and 1 Left entries from the drift opening to the active pillar line. A total of 252 samples were collected. Two hundred twenty-eight of the samples analyzed were below the minimum level for incombustible content, i.e., 65 percent incombustible in the intake entries and 80 percent incombustible in the return entries. The samples not meeting the required level ranged from 64.3 to 27 percent of incombustible content in the intake entries and from 59.4 to 28 percent of incombustible content in the return entries. The average incombustible content for the intake entries' samples was 49.5 percent and for the return entries, samples was 46.4 percent. The locations where the mine dust samples were collected can be found in Appendix F.

The mine dust survey samples were also analyzed for the presence of coke. The results of coke analysis, reported in amounts of trace, small, large, and extra large, can be found in Appendix F. Coke was present in all of the samples from the active section to the surface.

On December 19, 1992, a channel sample was collected from the coal seam in the explosion area to determine the percentage of moisture, volatile matter, fixed carbon, and ash present in the coal and to determine a volatile ratio. The sample was analyzed by MSHA's Technical Support. The results of this analysis were:

INGREDIENT	COMPOSITION, %
Moisture	1.07
Volatile Matter	29.47
Fixed Carbon	68.54
Ash	10.93

The test results indicate that the coal would be classified as medium-volatile bituminous coal with a volatile ratio of 0.33. Bituminous coal is considered to present an explosion hazard if it has a volatile ratio of in excess of 0.12. The volatile ratio is the volatile matter divided by the fixed carbon plus the volatile matter. The location where the channel sample was taken can be found in Appendix F.

MSHA inspectors had collected few mine dust samples prior to the explosion because the areas required to be surveyed were either too wet to collect samples or retreat mining was being conducted.

The investigation did not reveal whether there was a written program at the #3 Mine for the regular cleanup and removal of accumulations of coal and float coal dust, loose coal, and other combustibles. However, testimony indicated that many of the employees understood and had received instructions to cleanup accumulations of coal and to apply rockdust when needed. According to the miners interviewed, rockdust would be applied by hand on the section and occasionally a hydraulic rockdusting machine, carried in the bucket of a scoop, would be utilized. On occasions, the roadways would be watered-down. Dust created by mining was suppressed with water sprays installed on the continuous mining machine. Water sprays were also installed at the conveyor belt transfer points where water was sprayed on the bottom belt.

The evening shift had the primary responsibility for rockdusting the mine. Goode utilizing a rockdust machine, applied rockdust in the No. 3 entry of the Mains from the surface to the No. 32 crosscut on the shift prior to the explosion. In the No. 3 entry from the drift opening to the No. 45 crosscut, a total of 12 mine dust samples were taken with an average incombustible content of 74.6 percent. The investigators believe this application of rock dust contributed to Fleming surviving the explosion.

Goode said the No. 4 entry was dusted by hand about a month before the explosion. He indicated that the area in the No. 3 entry between the Nos. 39 and 60 crosscuts was "dirty" and needed rockdusting at the end of the evening shift on December 6. He stated that the only accumulations of coal and coal dust he observed underground on his shift prior to the explosion was the normal amount found around the section feeder and that the coal was wet. He believed he rockdusted the return entries about four days prior to the explosion. Rockdust was applied in the return entries utilizing a hydraulic duster in the bucket of a scoop. He could not recall the last time the intake entries were rockdusted.

Fleming stated that on the midnight shift the No. 3 entry appeared well rockdusted from the drift opening to the No. 39 crosscut. He spent the entire shift shoveling normal spillage on both sides of the belt from the drift opening to the No. 39 crosscut. He also serviced the Nos. 2 and 3 belt drives and aligned the belt at the No. 2 drive where coal was spilling off the side of the tail piece. He stated he cleaned up this spillage.

Extent of Flame and Forces

Investigators determined the ignition source of the explosion, and estimated the total quantity, concentration, and location of methane accumulations prior to the explosion. Additionally, the likelihood that coal dust contributed to the development and continued propagation of the explosion was determined. Evidence to support these determinations was gathered during the underground investigation, interviews, post-mortem reports, and the results of all laboratory work.

Flame

Investigators determined that the extent of flame occurred as shown on the map in Appendix F. A discussion of the incombustible content of the mine dust is contained in the section of this report titled, "Coal Dust, Loose Coal, and Rock Dust". The 252 mine dust samples were all analyzed for incombustible content and for the presence of coking. The average incombustible content of the mine dust samples taken throughout the Main entries and crosscuts was insufficient to prevent propagation of a coal dust explosion. Mine dust samples were also taken throughout the 1 Left section. One sample taken in the No. 1 entry had a total of 37.3 percent incombustible content. Two samples were taken in each of the Nos. 2, 3, 4, 5, and 6 entries with average incombustible contents of 41.5 percent, 32.0 percent, 31.5 percent, 35.8 percent, and 36.3 percent, respectively. In the No. 1 crosscut of 1 Left, six mine dust samples were taken with an average incombustible content of 32.8 percent. In the No. 2 crosscut of 1 Left, three mine dust samples were taken with an average incombustible content of 34.3 percent. The average incombustible content of the mine dust samples taken throughout 1 Left was insufficient to prevent propagation of an explosion.

The results of the Alcohol Coke Test show that coke existed throughout the entire underground workings. These results, along with the evidence of burns on the victims and the survivor after the explosion, and with the additional evidence of material affected by the flame, indicated that the flame of the explosion extended from 1 Left to the surface areas of the mine.

The continuous mining machine had been exposed to flames and forces coming from the No. 2 crosscut between the Nos. 1 and 2 entries. Based on the extent of flame in the underground workings and the magnitude of the forces, it is believed that the initial quantity of methane available for the explosion was approximately 1,900 cubic feet. The quantity of methane when diluted with air to about 13 percent would affect approximately 14,500 cubic feet of entry, or approximately 140 linear feet of entry. This accumulation occurred in the No. 1 entry and in the No. 2 crosscut between the Nos. 1 and 2 entries of 1 Left. It was not likely that an explosive quantity of methane extended to the location of the continuous mining machine based upon a study of airflow patterns. Upon ignition, a fireball expanded and involved up to 71,960 cubic feet of entry or about 700 linear feet of entry. This distance, affected by the initial methane explosion, did not extend into the Mains but was limited to 1 Left.

Flame temperatures during an explosion can exceed 3,000° F. The flame speed during the initial methane explosion is estimated to be about 300 feet per second. Calculations show that each foot of entry exposed to this flame speed would have been exposed to the flame for a duration of 0.2 second. This short duration prevents more significant effects from occurring to combustible materials. For example, the heat of the explosion flame would not act on brattice material for a long enough duration to cause the complete decomposition of the brattice. It is reasonable to expect that any large combustible materials, such as check curtains on 1 Left, would still be near their original location after the explosion although some heating would be observable.

Additional methane accumulations inby the No. 2 crosscut in 1 Left did not contribute to the explosion. Most of the inby methane accumulations exceeded the upper explosive limit of 15 percent and were, therefore, not explosive. The methane that had accumulated in the inby worked out area did not enter into the explosion due to its being above the explosive limit and the lack of sufficient oxygen.

Sufficient force was associated with the methane explosion to place coal dust into suspension ahead of the flame front. Ignition of the coal dust cloud allowed immediate propagation of the explosion to continue to the surface areas of the mine. The flame speed that occurred during the propagation of the coal dust explosion along the Main entries is estimated to range from 800 to 1,000 feet per second.

The investigators believe that if any of the miners had survived the affects of the methane explosion, and some may have, they succumbed to the affects of the coal dust explosion which instantly followed. The cause of death of seven of the victims was listed as the inhalation of flame and hot gases and carbon monoxide poisoning. The remaining victim died as a result of a massive skull fracture.

Forces

The actual point of ignition of an explosive mixture will occur at a very specific point. The point of ignition must be located within a body of fuel that occurs at a concentration within its explosive limits. The explosive limits of methane are approximately 5 percent to 15 percent. Immediately after the ignition of the fuel occurs, a fireball develops. This development of the fireball occurs prior to propagation. After the fireball development is complete, propagation of the flame through the fuel mixture occurs in all directions.

Pressure development in an underground coal mine explosion is caused by heating of the atmosphere during the combustion process. The heating of the atmosphere causes the involved gases to expand. This expansion causes the air ahead of the flame front to compress which exerts a force on objects and mine surfaces. The primary forces generated during an explosion always travel away from the point of ignition in all directions; thus, establishing a transition zone. However, even after the flame is extinguished, the primary explosion forces continue to travel away from the source of ignition. A mine map detailing the direction of the primary explosion forces is shown in Appendix F.

The effects of the explosion forces were seen from surface areas of the mine property along the entire length of the mains and throughout 1 Left. Extensive damage occurred to structures located on the surface of the mine property including the wreckage of the motor barn/office building, the displacement of the fan housing and destruction of the fan's explosion doors, and the destruction of the canopies at the portals. Although a significant quantity of debris on the surface was blown for distances to about 1,000 feet, the greatest explosion forces on the surface were those that occurred in close proximity to the mine portals. After exiting the portals, the explosion forces were very directional; however, rapid dissipation of the pressure wave occurred.

The damage observed throughout the surface areas of the mine gave a clear indication that explosion forces exited all four entries. The motor barn/office building is the structure closest to the portals. The main vertical posts supporting these facilities were large wooden columns approximately 7.25 by 5 inches, or a cross-sectional area of 36.25 square inches. This area dimension is similar to that of a seven inch diameter telephone pole. Test results on the shear strength of similarly-sized telephone poles indicates that a minimum pressure of between five to eight psi is required to shear each pole. Several columns of the motor barn/office building displayed complete shearing at the base of the column where they passed through the concrete floor pad. This would be indicative of dynamic forces of about 10-12 psi impacting on the motor barn/office building. This facility was in direct line with the No. 2 entry, therefore; the pressure wave exiting this entry would have been on the order of 12 psi.

With a dynamic pressure of 12 psi traveling outby past the last four crosscuts in each of the four main entries, a static pressure of about six psi would have been generated in each of the last four crosscuts. The track and belt were in the No. 3 entry with the No. 2 belt drive located about four crosscuts into the mine. This is the vicinity where the only survivor of the explosion was reportedly working at the time of the explosion. Fleming reported that initially he was engulfed in a cloud of dust. He felt the heat of the explosion but did not actually see any flames. The force of the explosion blew his hard hat off and knocked him down. He stated that he had popping in his ears and experienced a temporary loss of hearing as a result of the explosion.

Tests by researchers on the physiological effects of blast pressure have shown that a peak overpressure of about one psi will knock a person down, five psi is the minimum pressure that will cause damage to the eardrums, and 15 psi results in lung damage. The dynamic pressure of 12 psi in the entries and a static pressure of six psi in the crosscuts outby and including the No. 4 crosscut would correlate with the condition of Fleming after the explosion.

Between the Nos. 4 and 5 crosscuts there is a change in direction of the Mains of approximately 55 degrees. This change in direction would result in a pressure loss of about 31 percent as the forces traveled outby. With a pressure of 12 psi outby the No. 4 crosscut, a correlating pressure of 17 psi existed just inby the No. 5 crosscut. The lack of sufficient incombustible content in the dust along the entries and in the crosscuts from the No. 79 crosscut outby to the No. 5 crosscut allowed coal dust participation in propagating the explosion throughout this length of the explosion zone. A pressure wave averaging about 17 psi traveled from the No. 79 crosscut to the No. 5 crosscut. However, based on the participation of additional fuel in some areas and the lack of fuel in other areas, the dynamic pressures along the six entries in the Mains are estimated to vary from 15 to 20 psi. Similarly, the destruction of stoppings in the crosscuts occurred due to an estimated static pressure of between 7.5 to 10 psi.

Accessible connections to 1 Left occurred at the Nos. 81, 82, 83, 84, and 85 crosscuts. The observed primary forces resulting from the explosion were heading in the outby direction away from the section through these connections. The magnitude of these primary forces remained relatively low on the order of five psi. In the No. 2 crosscut in 1 Left between the Nos. 1 and 2 entries, a transition zone was identified from which all forces propagated. Low magnitude forces propagate along the No. 2 crosscut towards the continuous mining machine and shuttle car. At that point, the forces split with pressure heading inby across the continuous mining machine and pressure heading outby across the shuttle car. This is evidenced by the fact that only the side of the continuous mining machine and shuttle car closest to the source of ignition displayed dust accumulations from the explosion. Also, a partial load of coal in the shuttle car showed signs of scouring which would only have resulted from a force heading outby across the shuttle car.

The methane accumulation was ignited in the No. 2 crosscut between the Nos. 1 and 2 entries. Although it is probable that the 1 Left pillared area contained a large volume of high concentrations of methane, only a limited quantity of methane in the explosive range was available. This factor prohibited the explosion flame from propagating off of 1 Left to the Mains. Sufficient quantities of incombustibles were not available in 1 Left to arrest the participation of coal dust in the explosion. The evidence of flame throughout the section was indicative of the fact that coal dust became involved in the explosion prior to the flame front reaching the Mains. As the explosion entered the

Mains, the forces generally increased as additional coal dust fueled the explosion. A pressure wave, associated with the flame front, traveled outby in the Mains and generated an average of 17 psi. A secondary force reentered 1 Left. This secondary force with a magnitude of 10 to 12 psi, occurred as a result of the coal dust explosion that was intensified in the Mains. The secondary force, caused by the coal dust explosion heading into the section, was greater than the primary force caused by the initial methane explosion that had exited the section. The lack of oxygen throughout 1 Left prevented the flame of the coal dust explosion from propagating back into 1 Left. However, the forces associated with the coal dust explosion in the Mains did propagate towards and into 1 Left. This is evidenced by the significant amount of material that was blown into 1 Left including but not limited to; various first aid materials, hand tools, personal items such as hard hats and thermos bottles, and Person Wearable Self-Contained Self-Rescuers.

Point of Origin

The list of potential ignition sources is limited to those that are located within the transition zone in 1 Left. This zone has been identified as the area between the Nos. 1 and 2 entries in the No. 2 crosscut of 1 Left and is the location of the point of origin. To determine this location, the following factors were evaluated:

1. The location of the victims after the explosion;
2. The magnitude and direction of primary forces and the extent of flame;
3. The location of potential ignition sources located throughout 1 Left;
4. The location of roof falls, water accumulations, and other obstructions to ventilation;
5. The lack of sufficient rock dust throughout the Mains and 1 Left;
6. The condition of approved equipment used in 1 Left;
7. The presence of smoking materials in 1 Left; and,
8. Ventilation factors throughout the mine that would have allowed methane accumulations to occur.

In summary, after evaluating all of these factors, it was concluded that the explosion originated between the Nos. 1 and 2 entries in the No. 2 crosscut of 1 Left.

Potential Ignition Sources

The potential ignition sources were those located at the point of origin. These potential ignition sources were the:

1. S & S Model 488 Scoop

2. Cap Lamp

3. Smoking Articles

Simmons-Rand Company, S & S Scoop, Model 488

Through testing and evaluation, it was determined that conditions found on the S & S Model 488 Scoop were not the originating ignition source of the explosion. (See discussion page 25)

Koehler Cap Lamp

The cap lamp from the victim located at the point of origin was examined. Through testing and evaluation, it was determined that the cap lamp was not the originating source of the explosion. (See discussion page 26)

Smoking Articles

One cigarette pack containing nine unsmoked cigarettes was found on the victim located at the point of origin. The butts of ten smoked cigarettes were also found in the victim's pockets. Some of the butts were in the container used to transport the victim to the medical examiner's office. A cigarette lighter was not found in his pockets. A butane cigarette lighter was found lying on the mine floor at the rear of the scoop. This lighter displayed evidence of heating and when later tested by the investigators was found to be functional.

SUMMARY AND CONCLUSIONS

Methane Accumulations

The #3 Mine began to be effected by methane liberations from the closely overlying Kelly Rider Seam in October 1991. Pillar mining in 1 Right, 2 Right, and 1 Left areas resulted in roof falls in the pillared areas which increasingly exposed the Kelly Rider Seam. This, in turn, increased the amount of methane liberation.

The removal of the methane was dependent upon establishing and maintaining a bleeder system around the 1 Right, 2 Right, and 1 Left pillared areas. An approved bleeder system was initially established; however, as pillar mining was conducted, roof conditions in the bleeder entry became hazardous and the entry was not maintained and traveled.

The bleeder system for the pillared areas was not maintained and became ineffective to continuously move methane-air mixtures away from the active faces. Methane accumulated over a period of time.

Five instances were reported to the investigators where methane concentrations greater than 1 percent were detected by mine personnel. Two instances were in the developing 1 Right where 5 percent and in excess of 5 percent were found. A third instance was in the developing 2 Right where in excess of 5 percent was found. The fourth instance was in the developing Mains where 2.1 percent was found. The fifth instance, approximately two weeks prior to the explosion, was on the retreating 1 Left section where in excess of 5 percent was found. In all instances, the methane was removed by utilizing ventilation controls.

In order to maintain adequate ventilation for the 1 Left section, it would have been necessary to install and maintain ventilation controls to separate intake and return entries. The investigation revealed that some of these ventilation controls were not in place prior to the explosion.

The No. 1 Bleeder entry of 1 Left was at the highest elevation of the pillared area. The coal seam dipped from this entry toward the furthest point of advance in 1 Right and 2 Right. When little ventilation is directed through an area, methane can accumulate and will migrate to the highest elevation. Therefore, with inadequate ventilation in the pillared area and bleeder entry, methane would accumulate in or near the No. 1 entry of 1 Left.

A significant drop in the barometric pressure occurred in the hours prior to the explosion. This would increase the likelihood of methane migrating from the pillared areas.

An explosive methane-air mixture accumulated in the No. 1 entry and in No. 2 crosscut between the Nos. 1 and 2 entries of 1 Left. The explosive accumulation of methane did not extend to the location of the continuous miner due to the pattern of air flow on the section.

Mine Examinations

Mine examination record books indicated that a nine day period elapsed between the most recent weekly examinations. Prior weekly examinations were also not conducted at least every seven days. The record books indicated that this practice occurred at least 18 times in calendar year 1992.

The record books indicated that the bleeder system was examined on November 13, 21, and 30, 1992, and the bleeder was "OK". However, during interviews the weekly examiner indicated the bleeder was not and could not be traveled in its entirety on these dates because of hazardous roof conditions. Action was not taken to correct the roof conditions. The investigation team was stopped by a roof fall in the No. 1 Bleeder entry of 1 Left at the No. 6 crosscut. This is the approximate location where the examiner indicated he encountered bad roof.

Methane concentrations from 0.1 percent to in excess of 5 percent were detected during examinations and the typical methane concentrations found were from 0.1 percent to 0.3 percent.

The preshift examination for the midnight shift of December 7, 1992, did not include tests for methane in the Nos. 1, 5, and 6 entries of 1 Left. Methane may have been present at this time in the No. 1 entry.

Source of Ignition

A transition zone was identified in the area between the Nos. 1 and 2 entries in the No. 2 crosscut of 1 Left. The transition zone identified the location of the point of origin of the explosion.

The potential ignition sources, located at the point of origin, were a S & S Model 488 Scoop, a Koehler cap lamp, and smoking articles.

Through testing and evaluation, it was determined that the S & S Model 488 Scoop and the Koehler cap lamp were not the originating ignition source of the explosion.

Persons were smoking in the mine and the operator's Smoking Search Program was not effective. One cigarette pack, containing nine unsmoked cigarettes, was found on the victim located at the point of origin. The butts of ten smoked cigarettes were also found in the victim's pockets. Some of the butts were in the container used to transport the victim to the medical examiner's office. A functional butane cigarette lighter was found on the mine floor at the rear of the scoop located at the point of origin.

The investigators believe that the open flame from this butane cigarette lighter was the ignition source for the December 7, 1992, explosion.

Propagation of the Explosion

The methane accumulation was ignited in the No. 2 crosscut between the Nos. 1 and 2 entries. A low order explosion began to propagate. Only a limited quantity of methane in the explosive range was available. This factor prohibited the methane explosion flame from propagating off of 1 Left to the Mains.

However, sufficient quantities of incombustibles were not available in 1 Left to arrest the participation of coal dust in the explosion. Coal dust became involved in the explosion prior to the flame front reaching the Mains. As the explosion entered the Mains, it increased in magnitude as additional coal dust fueled the explosion.

The lack of oxygen, after the initial methane explosion, throughout 1 Left prevented the flame of the coal dust explosion from propagating back into 1 Left. However, the forces associated with the coal dust explosion in the Mains did extend back into 1 Left.

The lack of sufficient incombustible content in the mine dust along the entries and in the crosscuts of the Mains allowed continuing participation of coal dust in the explosion throughout the Main entries to the surface. A total of 252 mine dust samples were collected by the investigators. Two hundred twenty-eight of the samples analyzed were below the required level for incombustible content.

Damage observed throughout the surface areas of the mine gave a clear indication that explosion forces exited all four entries.

CONTRIBUTING VIOLATIONS

Eight of the conditions and practices noted in the Summary and Conclusions contributed to the explosion and constituted violations of the Federal Mine Safety and Health Act of 1977, and the mandatory standards contained in 30 CFR Part 75.

30 CFR 75.364

The weekly examinations for the #3 Mine and 001 section were not conducted in its entirety on November 21, and November 30, 1992. The certified examiner failed to travel the bleeder system in its entirety due to adverse roof conditions. The weekly examination record indicated that the examinations were conducted.

30 CFR 75.1702

The smoking search program for the Southmountain Coal Co., Inc., #3 Mine, and the 001 section was neither adequate nor conducted in its entirety based on the following:

1. Smoking materials in the form of cigarettes and/or lighters were found in three deceased underground employees in the 1 Left, 001 section.

2. A lunch container found on the S & S battery scoop located in the No. 2 entry of 001 section contained two full packs of cigarettes and two butane cigarette lighters.

Based on testimony of at least two underground employees, lunch containers were not regularly examined as prescribed in the operator's approved plan.

30 CFR 75.360(b)(3)

The 001 section preshift examination conducted between the hours of 9:30 p.m. and 10:30 p.m. on December 6, 1992 for the oncoming midnight shift on the 1 Left 001 section, was not conducted in its entirety. The No. 1 entry (intake) and Nos. 5 and 6 entries (return) at the pillar line were not examined. Methane may have been present in the No. 1 entry at this time.

30 CFR 75.330(b)(1)

Ventilation control devices in the form of check or block curtains were not placed or maintained so as to direct and provide adequate ventilation to dilute, render harmless, and carry away flammable and explosive gases in the working places from the 001 section dumping point inby to the pillar line, a distance of approximately 300 feet.

30 CFR 75.403

The incombustible content of all 73 of the combined mine dust samples collected in the return air course, Nos. 5 and 6 entries, from the portal inby to the 1 Left 001 section pillar line, was less than 80 per centum, averaging 46.4 percent. The incombustible content of 155 of 179 samples taken in the intake air course, Nos. 1, 2, 3, and 4 entries, from the portal inby to the 1 Left 001 section pillar line, were less than 65 per centum in incombustible content, averaging 49.5 percent.

30 CFR 75.370(a)

The approved ventilation plan was not being followed in the bleeder system inby 1 Left 001 section. The bleeder entry was not maintained in safe and travelable condition due to adverse roof conditions in various locations. Article "G" page 3 of the approved ventilation plan stipulates that roof and ribs in the bleeder entry will be controlled to provide safe travel.

30 CFR 75.321(c)

The volume and velocity of air ventilating the 1 Left 001 section was not sufficient to dilute, render harmless, and carry away flammable and explosive gases that were liberated.

30 CFR 75.364(b)

The weekly examinations for the #3 Mine were not conducted at least every seven days. The most recent exam was not conducted and/or recorded for a nine day period. This practice is indicated in the record book for at least 18 occurrences in calendar year 1992.

Respectfully submitted,

Timothy J. Thompson
District Manager

Edward R. Morgan
Staff Assistant

Clete R. Stephan
Principal Mining Engineer

Joseph O. Vallina, Jr.
Supervisory Mine Safety and
Health Specialist
(Electrical)

John M. Pyles
Chief Engineering Services

Robert Painter
Mine Safety and Health Specialist

John E. Urosek
Supervisory Mining Engineer

Robert W. Rhea
Supervisory Coal Mine Inspector

Approved by:

Marvin W. Nichols, Jr.
Administrator
For Coal Mine Safety and Health

APPENDIX A

Persons working underground at the time of the explosion:

Victims

David K. Carlton	Shuttle Car Operator
Danny Ray Gentry	Continuous Miner Helper
James E. Mullins	Roof Bolter Operator
Mikell D. Mullins	Continuous Miner Operator
Brian S. Owens	Scoop Operator
Claude L. Sturgill	Electrician
Palmer E. Sturgill	Shuttle Car Operator
Norman D. Vanover	Section Foreman

Survivor

Robert Kevin Fleming	Beltman

APPENDIX B

List of persons who participated in mine rescue and recovery and establishment of ventilation:

Westmoreland Coal Company - Virginia Division

Gene Winebarger
Scott Kremm
Charles Ruterford
Keith Smith
Keith Hargrove
James Skaroupa
Frank Linkous
Doug Lester
Teddy Starnes
Terry Bryant
Gerald Thompson
Mack Wright
Frank Jervis
Gerald Tate
Gary Whisman

Paramont Coal Corporation Mine Rescue Teams

Mike Clark
Gary Sweeney
Jim Rose
Rick Shelton
Jerry Bledsoe
Leroy Mullins
Lloyd Robinette
Mike Reed
Jeff Petro
Kyle Walker
William Adams
Jerry Perkins
Charles Ray
Robert Mitchell
John Richardson
Donnie Ratliff
Wendell Collinsworth
Tim Vicars
Hughie Carter

Clinchfield Coal Company Mine Rescue Teams

Gary Austin
Danny Mann
Ed Rudder
Milton Kiser
Tom Asbury
Wayne Fields
Ronnie Stevenson
John Crawford
Barry Compton
Danny Cromer
David Asbury
Ray Robinette
Jeb Turner
James Stanley
Kay Poole

Jewell Smokeless Mine Rescue Teams

Bill Messick
Michael Altizer
Randy Taylor
John Parris
Steve Ratliff
Wayne Dye
Rick Waddle
Steve Vance
Paul Thornsbury
Elmer Vandyke
Jessie Elswick
Tim Edwards
Bill Salyer

APPENDIX B (cont.)

Mine Technologies Mine Rescue Teams

John K. Polly	Phillip R. Rumley
Larry G. Miller, Jr.	Robert Lee Dollarhyde
Steven G. Countiss	Ernie D. Sexton
James C. Summer	Gerald Vanoy
James K. Taylor	John M. Moneyhan
Gary Hill	Danny Hicks
Fred Dotson	Dan Vires

MSHA Mine Emergency Unit

Charles Pogue	Lincoln Selfe
Clyde Turner	Joseph Trybus
Theodore Glusko	Richard Zilka
Allen Dupree	Ronald Hixson
Robert Swarrow	Joseph Yudasz
Clint Fabry	Thomas Todd
Thomas McCort	Ronald Costlow
Richard Vasicek	

MSHA Headquarters' Personnel

William Tattersall	Assistant Secretary for Mine Safety & Health
Robert A. Elam	Deputy Administrator for Field Operations
Jack E. Tisdale	Chief Accident Investigation Program Coordinator
Thomas A. Brown	Public Affairs Specialist
Katharin Snyder	Public Affairs Specialist

MSHA District 5 Personnel
District Office

Michael J. Lawless	District 5 Manager
Jesse Cole	District 6 Manager (Backup District 5 Manager)
Ronald W. Franks	Supervisory Coal Mine Safety & Health Specialist
James A. Kiser	Supervisory Coal Mine Safety & Health Inspector
Andrew C. Moore III	Supervisory Coal Mine Safety & Health Specialist
Elmer Simmons	Supervisory Mining Engineer
James A. Baker	Coal Mine Safety & Health Inspector
Arnold D. Carico	Mining Engineer
Charles D. Cooper	Coal Mine Safety & Health Inspector
Roy D. Davidson	Electrical Engineer
Douglas G. Evans	Coal Mine Safety & Health Inspector
John F.Godsey	Coal Mine Safety & Health Inspector
Benjamin S. Harding	Mining Engineer

APPENDIX B (cont.)

Gary W. Jessee	Coal Mine Safety & Health Inspector
Richard G. Salyers	Coal Mine Safety & Health Inspector
Larry N. Stanley	Coal Mine Safety & Health Inspector

Norton Subdistrict Personnel

Frank C. Young, Jr.	Assistant District Manager
Larry A. Coeburn	Supervisory Coal Mine Safety & Health Inspector
Eugene W. Graham	Supervisory Coal Mine Safety & Health Inspector
James S. Hicks, Jr.	Supervisory Coal Mine Safety & Health Inspector
Kennith Owens	Supervisory Coal Mine Safety & Health Inspector
Don R. Salyers	Supervisory Coal Mine Safety & Health Inspector
Jack Bartley	Coal Mine Safety & Health Inspector
Mattie R. Beaty	Coal Mine Safety & Health Inspector
Joseph Brown	Coal Mine Safety & Health Inspector
Fred L. Buck	Coal Mine Safety & Health Inspector
Kenneth L.Card	Coal Mine Safety & Health Inspector
Dennis Carter	Coal Mine Safety & Health Inspector
Wade Gardner	Coal Mine Safety & Health Inspector
Daniel Graybeal	Coal Mine Safety & Health Inspector
Vearl Hileman	Coal Mine Safety & Health Inspector
Henry C. Meade	Coal Mine Safety & Health Inspector
Larry V. Meade	Coal Mine Safety & Health Inspector
Margaret R. Owens	Coal Mine Safety & Health Inspector
Luther Pinkston	Coal Mine Safety & Health Inspector
Paul J. Porter	Coal Mine Safety & Health Inspector
Ralph P. Reasor	Coal Mine Safety & Health Inspector
Marshall Roberson	Coal Mine Safety & Health Inspector
Gary L. Roberts	Coal Mine Safety & Health Inspector
Raymond N. Rogers	Coal Mine Safety & Health Inspector
Thomas B. Slemp	Coal Mine Safety & Health Inspector
Clarence E. Slone	Coal Mine Safety & Health Inspector
Gene L. Stanley	Coal Mine Safety & Health Inspector
Pat Stenski	Coal Mine Safety & Health Inspector
William H. Strength	Coal Mine Safety & Health Inspector
Joseph Tankersley	Coal Mine Safety & Health Inspector
John Wampler	Coal Mine Safety & Health Inspector
Charles Upchurch	Coal Mine Safety & Health Inspector
Lester A. Watson	Coal Mine Safety & Health Inspector

APPENDIX B (cont.)

Richlands Subdistrict Personnel

Charles E. McGraw	Supervisory Coal Mine Safety & Health Inspector (Subdistrict Manager)
Jerry Wiley	Supervisory Coal Mine Safety & Health Inspector
George Stewart	Supervisory Coal Mine Safety & Health Inspector
John Griffith	Coal Mine Safety & Health Inspector
Randall Ball	Coal Mine Safety & Health Inspector
Clarence Boone	Coal Mine Safety & Health Inspector
Carl Coleman	Coal Mine Safety & Health Inspector
Paul McGraw	Coal Mine Safety & Health Inspector
Glenn Deel	Coal Mine Safety & Health Inspector

MSHA Mine Emergency Technology Team

Jeffery Kravitz
William Francart
Gary Wirth
Timothy Watkins
John Baran
Mark Schroeder
James Lohrett
John Urosek
Linda Zeiler
Richard Stoltz
Mark Schultz
Dennis Beiter
David Zuchelli

APPENDIX C

Personnel Who Participated In The Underground Investigation:

Southmountain Coal Co., Inc. - Officials

William Ridley Elkins	Consultant for Apple Coal
Donnie F. Short, Sr.	General Superintendent
Dale Meade	EMD Rebuild
Dane Meade	Maintenance Foreman
Freddie Deatherage	Superintendent

Southmountain Coal Co., Inc. - Employees

Jessee Darrell Cooke	Continuous Miner Operator
Jackie E. Davis	Electrician
Donnie Mullins	Electrician

Virginia Department of Mines, Minerals and Energy

Harry Childress	Chief, Division of Mines
Opie McKinney	Mine Inspector Supervisor
Wayne Davis	Coal Mine Technical Specialist- (Ventilation)
John Thomas	Mine Inspector
Zane Scott	Assistant Attorney General
David Elswick	Coal Mine Technical Specialist
Joseph Altizer	Mine Inspector
Jerry Looney	Mine Inspector
Danny Altizer	Mine Inspector
Sammy Fleming	Mine Inspector
Vernon Johnson	Mine Inspector
Dwight Miller	Coal Mine Technical Specialist
Jerry Scott	Mine Inspector

MSHA Investigation Team

Timothy Thompson	District Manager, District 7
John Pyles	Chief Engineering Services, District 7
Edward Morgan	Staff Assistant, District 7
Robert Rhea	Supervisory Coal Mine Safety & Health Inspector, District 7
Robert Painter	Mine Safety and Health Specialist, Headquarters
John Urosek	Supervisory Mining Engineer, Technical Support
Clete Stephan	Principal Mining Engineer, Technical Support
Joseph Vallina, Jr.	Supervisory Mine Safety and Health Specialist (Electrical), District 4
Jack Tisdale	Accident Investigation Program Manager, Headquarters

APPENDIX C (cont.)

Layton Farley	Deputy Chief, Technical Compliance and Investigations Division, Headquarters

Office of the Solicitor (DOL)

Jerald Feingold	Attorney

MSHA District 5 Personnel

Dennis Carter	Coal Mine Safety and Health Inspector
Billy Chandler	Coal Mine Safety and Health Inspector
Michael Clements	Coal Mine Safety and Health Inspector
Roy Davidson	Electrical Engineer
Doug Evans	Coal Mine Safety and Health Inspector
Ben Harding	Mining Engineer
Michael Jackson	Electrical Engineer
Gary Jessie	Coal Mine Safety and Health Inspector
Larry Meade	Coal Mine Safety and Health Inspector
Harold Musick	Coal Mine Safety and Health Inspector
Earl Owens	Coal Mine Safety and Health Inspector
Ruby Owens	Coal Mine Safety and Health Inspector
Teddy Phillips	Education and Training Specialist
Ralph Reasor	Coal Mine Safety and Health Inspector
Marshall Roberson	Coal Mine Safety and Health Inspector
Clarence Slone	Coal Mine Safety and Health Inspector
William Strength	Coal Mine Safety and Health Inspector
Charles Upchurch	Coal Mine Safety and Health Inspector
John Wampler	Coal Mine Safety and Health Inspector

MSHA District 7 Personnel

Dewey Dunford	Coal Mine Safety and Health Inspector
Charles Grace	Mining Engineer
Tom Meredith	Coal Mine Safety and Health Inspector
Albert McFarland	Supervisory Mine Safety and Health Specialist

MSHA Technical Support Personnel

Allen Dupree	Mining Engineer
William Francart	Supervisory Mining Engineer
Mark Schultz	Mining Engineer
Timothy Watkins	Mining Engineer

APPENDIX D

Mine Map (Affected Area)
#3 Mine, ID. No. 44-06594
Southmountain Coal Co., Inc.
Major information gathered by the investigation team in No. 1 West Mains

APPENDIX E

Mine Map (Affected Area)
#3 Mine, ID. No. 44-06594
Southmountain Coal Co., Inc.
Major information gathered by the investigation team in 1 Left

APPENDIX F

Mine Map (Affected Area)
#3 Mine, ID. No. 44-06594
Southmountain Coal Co., Inc.
Direction of Forces, Extent of Flame, and Location of Mine Dust Samples and Coal Channel Sample Collected during the Investigation

APPENDIX G

Personnel Interviewed As Part Of The Investigation:

Southmountain Coal Co., Inc. - Officials

William Ridley Elkins	Consultant for Apple Coal
Donnie F. Short, Sr.	General Superintendent
Kenneth Brooks	Section Foreman
Dane Meade	Maintenance Foreman
Freddie Deatherage	Superintendent
Paul D. Ramey	Section Foreman
Charles Earnest Duncan	Former Section Foreman

Southmountain Coal Co., Inc. - Employees

David L. Goode	General Inside
Tony Parrigan	Roof Bolter Operator
Richard Adams	General Inside
George Shortt	Outside Loader Operator
Gleason Silcox	General Inside
Jessee Darrell Cooke	Continuous Miner Operator
Robert Kevin Fleming	Belt Cleaner
Jackie E. Davis	Electrician
Donnie Mullins	Electrician
Dannie Mullins	Outside Loader Operator
Joseph Steele	Roof Bolter Operator
Isaac Willis	Roof Bolter Operator
Dewey B. Cox	Shuttle Car Operator
Mark Sutherland	Shuttle Car Operator
James E. Mullins	Belt Cleaner
Shane Adams	Belt Cleaner
Billy Ray Davis	Shuttle Car Operator
Larry Mullins	Outside
Roger Combs	Scoop Operator
Allen Gene Conley	Outside Loader Operator
Clearsy France	Continuous Miner Operator
Ronnie Hensley	Continuous Miner Operator Helper

VICC - Employees

Ed Burns	Mining Engineer
Ray Lawson	Production Engineer

APPENDIX H

U.S. Department of Labor

Mine Safety and Health Administration
Industrial Park Road
RR 1, Box 251
Triadelphia, West Virginia 26059

April 15, 1993

MEMORANDUM FOR TIMOTHY THOMPSON
District Manager
Coal Mine Safety and Health, District 7

FROM: PETER TURCIC Peter M. Turcic
Chief, Approval and Certification Center

SUBJECT: Executive Summary of Investigation of Equipment Recovered from South Mountain Coal Company's No. 3 Mine

The Approval and Certification Center (A&CC), as requested by Coal Mine Safety and Health, conducted an investigation of equipment recovered from a mine explosion at the South Mountain Coal Company's No. 3 Mine on December 7, 1992. The investigation included:

A. Inspections, tests, and evaluations to identify any potential spark or ignition sources capable of igniting an explosive methane-air atmosphere,

B. performance tests, and

C. MSHA approval conformance evaluations.

Cap Lamps

The investigation of the eight Koehler cap lamps determined that defects noted during inspection were attributable to use, improper maintenance or the explosion. In addition, no manufacturing discrepancies from the approved design were identified. The cap lamps were judged not capable of igniting an explosive methane-air atmosphere based on testing of the most severe available sparking and thermal ignition hazards.

Flame Safety Lamp

The investigation of the Koehler flame safety lamp determined that it was assembled properly and that no defects were identified in any of its components or assembly that could affect its performance.

Gas Calibration Tank
The investigation of the National Service Center methane gas calibration tank determined that the volumetric methane-in-air concentration was within accepted accuracy limits and could be used to calibrate the methane monitor.

Methane Monitor
The investigation of the methane monitor determined that defects noted during inspection and testing were attributable to use, improper maintenance or the explosion. The only manufacturing discrepancy from the approved design was the omission of the extension identification of the MSHA certification number on the certification plate. The methane monitor was not maintained as approved due to the use of a rag in place of the sintered metal screen filter in the dust guard. The methane monitor was not properly calibrated, as received. If this condition existed at the time of the explosion, the methane monitor would not have been able to accurately detect the presence of methane.

The request for investigation of the methane monitor included performance testing to determine:

(1) The operation of the methane monitor using the rag in the dust guard, as received;

(2) the operation of the methane monitor using the sintered metal screen in the dust guard with the calibration, as received; and

(3) the effect of water on the response when either the rag or metal screen was used in the dust guard.

During the initial testing performed for this investigation, the methane monitor display indicated a higher gas concentration than that of the test gas when either the dry rag or dry metal screen was used in the dust guard. The use of the metal screen resulted in higher displays than when using the rag, for each test gas concentration.

The initial testing to ascertain the effect of water on the response of the methane monitor revealed that water saturation had a significant effect on the response when either the rag or metal screen was used. Therefore, additional testing procedures were developed to assess the effect of varying degrees of dampness on the response of the methane monitor using either the rag or metal screen in the dust guard. As a preliminary step, a small chamber and a hand-operated spray bottle were used. The spray was applied from three directions:

(1) Directly on the face (rag or screen) of the sensor,

(2) perpendicular to the face of the sensor, and

(3) from above and behind the sensor.

The preliminary testing in the small chamber with the hand-operated spray bottle demonstrated that each of the following affected the change in response to a test gas concentration from time responses obtained in the initial testing (i.e., dry rag/dry screen): (1) The direction from which the water spray was applied, (2) the number of water sprays applied, and, (3) whether the rag or metal screen was used in the dust guard. However, these tests did not accurately reflect the actual in-mine conditions.

To simulate the water spray conditions that may be encountered on a mining machine, tests were developed using a larger test gallery with a conical spray. In these tests, the gallery and methane monitor were allowed to stabilize at approximately 4% methane-in-air prior to the start of each test. The water spray was initiated at the beginning of each test. The methane monitor response was compared with a gas sample monitored in the proximity of the methane monitor sensor. Tests were performed with the sensor in various recessed and exposed positions and with the water spray nozzle in various locations. These tests were conducted with a continuous spray for the duration of the test as well as with a water spray on-off cycle to approximate the operating cycle in the working face of a coal mine. Tests were conducted with durations up to 420 minutes, using both the rag and sintered metal screen.

Following some tests, the dust guard was allowed to set overnight in either the sealed, humid gallery or in ambient conditions. The methane monitor's response to a test gas was then verified the next morning.

In tests conducted, the performance of the methane monitor was shown to be adversely affected by the presence of water on either the rag or sintered metal screen in the sensor. When either the rag or sintered metal screen was wetted with water, the response time increased and the display decreased for a specific test gas concentration. In this investigation, the rag in the dust guard was observed to be more susceptible to the effects of water and the effects were more severe than the sintered metal screen in the dust guard. Once wet, the rag did not recover (dry out) as quickly as the sintered metal screen. The effect of intermittent spraying had a cumulative wetting effect on the rag that was not observed on the screen in the dust guard. The orientation of the water sprays used in the tests had a significant effect on the wetting of the sensor and, therefore, the methane monitor's performance. The adverse affect was proportional to how quickly the face of the sensor was wetted. However, the testing results demonstrated that the sensors of methane monitors can operate in the proximity of water sprays without an adverse affect, under certain conditions.

The degree to which the rag in the sensor would have become wet in use could not be verified in this investigation. All sources of water, such as splashing, sprays, wash-down hoses and moisture in the air that could have wet the rag when installed on the mining machine could not be duplicated. However, it was concluded that the performance of the methane monitor would have been adversely affected by the wetting of the rag in the sensor.

It was also concluded that the adverse effect of the wetting of the rag could become severe enough that the methane monitor would not provide an indication of the presence of methane when the gas was present. If the presence of methane were not indicated, the warning indications and machine shutdown activation features would not operate although they performed as designed and approved in the tests of the methane monitor. The tests verified that the rag could be wetted sufficiently to prevent these functions from performing.

Paging Telephone
The investigation of the Pyott-Boone paging telephone determined that the defects noted during the inspection were attributable to use, improper maintenance, or the explosion. The paging telephone was not intended to be, nor represented as, an MSHA-approved design. Although documentation specific to the subject paging telephone was not available to verify the existence of any manufacturing discrepancies, the design conformed to approval documentation on file at the A&CC for a similar, MSHA-approved paging telephone. No manufacturing discrepancies in common design areas were noted for the subject paging telephone when compared to documentation on file.

A final determination could not be made for the possibility of arcing and sparking at the paging line binding posts. These binding posts are the connecting point for the wires that carry the paging and communication signals to and from the paging telephone. The binding posts and wiring could not be inspected for evidence of arcing and sparking because they were no longer attached to the paging telephone. No evidence of arcing and sparking was noted in the area around the openings for the binding posts. Therefore, it was concluded that arcing and sparking capable of igniting an explosive methane-air atmosphere probably did not occur at the paging line binding posts. No conclusion could be made concerning ignition sources in the wiring and circuitry external to the paging telephone.

Two elements of the design of the paging telephone differed from the MSHA-approved design that had the potential to ignite an explosive methane-air mixture: A loudspeaker and an incandescent indicator light. Based on this potential, spark ignition tests were performed on the loudspeaker and thermal ignition tests (surface temperature and bulb-crush) were performed on the light bulb. These tests determined that the loudspeaker was not capable of igniting an explosive methane-air atmosphere. However, tests on the light bulb determined it does present a thermal ignition hazard capable of igniting an explosive methane-air atmosphere if broken while illuminated.

It was concluded that no explosion was initiated in this device.

Comprehensive test results can be obtained from the Administrator of Coal Mine Safety and Health, MSHA, 4015 Wilson Boulevard, Arlington, Virginia, 22203-1984.

United States Department of the Interior

TAKE PRIDE IN AMERICA

BUREAU OF MINES
Pittsburgh Research Center
Cochrans Mill Road
Post Office Box 18070
Pittsburgh, Pennsylvania 15236-0070

April 2, 1993

Clete R. Stephan
Senior Mining Engineer
Mine Safety and Health Administration
Bruceton Safety Technology Center
P.O. Box 18233
Pittsburgh, Pennsylvania 15236

Dear Mr. Stephan:

This letter is in response to the request sent to the Research Director of the Pittsburgh Research Center (PRC) by Dr. Stephen G. Sawyer, Chief, Industrial Safety Division, Mine Safety and Health Administration (MSHA) for the microscopic examination of a sample recovered after an explosion in the Southmountain No. 3 coal mine, to determine if there is evidence of burning in the sample area. A sample of pieces of strand and particulate matter taken from the pump motor enclosure on #488 scoop in Southmountain coal mine No. 3, was received on March 2, 1993 for microscopic and x-ray analysis using PRC's scanning electron microscope (SEM). In addition, pieces of coal from this mine were supplied by MSHA. Some of the latter material was crushed in a mortar, and SEM photomicrographs and x-ray spectra were taken after mounting the particles on an aluminum disk and coating the specimen with a thin conductive film of a gold/palladium alloy. The enclosed photomicrographs of such "virgin" coal particles taken at 100 to 1000 X magnification (figure 1) show many smooth faced chunky particles with fracture marks. Another such particle is shown at 3500 X magnification together with an x-ray spectrum taken from a small area (marked by a + on the photomicrograph) near its edge (figure 2). Strong to moderate carbon (C) and sulfur (S) peaks, and a weak to moderate oxygen (O) peak are evident, in addition to the strong aluminum (Al) peak from the aluminum disk substrate, and the gold (Au) and palladium (Pd) peaks from the conductive coating. All the "virgin" coal particles that were examined showed a weak to moderate sulfur peak. When such particles were placed on an aluminum disk whose underside was heated briefly by a match to a temperature of less than 400° C, no significant surface change in appearance or x-ray spectra was noted. The presence of Southmountain coal particles not heated above 400° C is therefore indicated by the presence of a strong carbon peak, a weak to moderate sulfur peak, and weak to moderate "mineral" peaks in their x-ray spectra, together with the presence of sharp edges and relatively smooth faces.

On this basis, the examination of some 50 particles from the sample taken from inside the pump motor enclosure, revealed only 1 or 2 that could be identified as intact coal particles. On the other hand, coal particles subjected to flame and explosion temperatures show blow holes and a porous or hollow structure, as shown in the enclosed photomicrograph and x-ray spectrum of Pittsburgh seam coal particles that were subjected to a moderate explosion in the presence of rock dust (figure 3). No such explosion residue was evident in the particles and agglomerates that were examined. The individual particles in the Southmountain mine sample, as exemplified by the enclosed photomicrographs (figure 4), were either low-sulfur organic, copper, or other inorganic material.

The strands taken from inside the pump motor enclosure offer key additional information on the thermal history of the sample. The strands consist of braided substrands of clear monofilaments of about 24 m diameter. The filaments are organic, as evidenced by the strong C peak in their x-ray spectra (figure 5). They, furthermore, flared up and shriveled to a ball when contacted by a flame, and partially melted when heated briefly by a match to less than 400° C, as above (figure 6). No sign of similar exposure to 400° C temperatures is evident in photomicrographs of the as-received strand sample. There is also evidence of the deposition of copper particles throughout the sample.

In summary, we do not see any indication of high temperature involvement of the strand sample. The strands consist of thermoplastic organic filaments which would melt if contacted by a flame for any significant time period. The presence of coal particles is a rarity in the sample, but copper particles are widely distributed.

The analysis presented above is based on a limited sample and should be viewed as exploratory in nature. A more definitive investigation will require additional samples and information on their nature, function, and environment.

Sincerely,

Isaac A. Zlochower

Isaac A. Zlochower
Research Chemist
Fires and Explosions

Enclosures