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Mine Safety and Health Administration
Office of the Administrator
Coal Mine Safety and Health

REPORT OF INVESTIGATION
NOVEMBER 30, 1993
UNDERGROUND COAL MINE EXPLOSION
ELMO #5 MINE - I.D. NO. 15-16856
A.A.& W. COALS, INC.
FEDS CREEK, PIKE COUNTY, KENTUCKY

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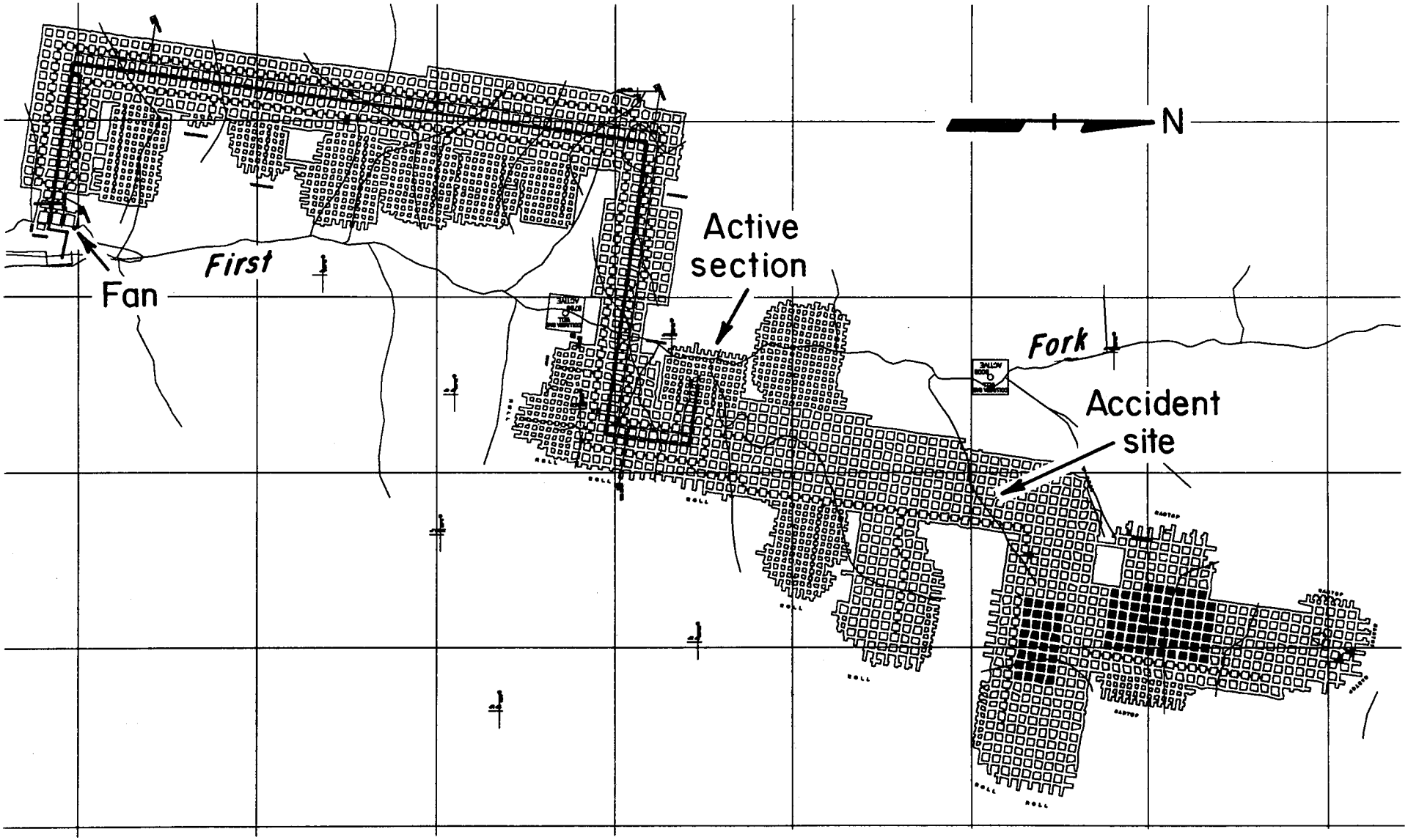
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OVERVIEW

Abstract of Explosion

At approximately 1:20 p.m., on November 30, 1993, an explosion occurred in the worked-out area inby the active section of A.A.& W. Coals, Inc.'s Elmo #5 mine, which resulted in the death of one miner and serious injuries to a second miner. Seventeen miners and two contract surveyors were working underground when the explosion occurred. The names of these miners are listed in Appendix A.

A permanent stopping line, required to direct airflow to worked-out areas inby the active section, was not maintained. Seventeen permanent ventilation controls had been removed prior to the explosion in the main entries inby the active section, creating a short circuit of ventilation for the worked-out areas. Due to the removal of the permanent stoppings, the volume and velocity of the air current was insufficient to dilute, render harmless, and carry away methane liberated from the area of the pillared panels.

A methane-air mixture migrated from the pillared panels in a layered form and extended into a roof cavity located in the No. 7 entry just inby spad No. 948. The explosive methane-air mixture was ignited by the open flame of a butane cigarette lighter. The resulting methane explosion created sufficient forces and flames to suspend and ignite coal dust in the worked-out area.

Background

The Elmo #5 mine (I.D. No. 15-16856) was opened in April, 1990 near Feds Creek, Pike County, Kentucky. The mine was opened through four drift entries into the Glamorgan coal seam, which averages 30 inches (in) in height. A.A.& W. Coals, Inc. was listed as the "operator" of the mine on the Mine Safety and Health Administration (MSHA) mine identification form. Harold Akers is the President/Co-owner of A.A.& W. Coals, while Jim Akers serves as the Vice President/Co-owner of A.A.&W. Coals. At the time of the explosion, Harold Coleman served as Superintendent of the mine, and James Stump served as the mine foreman.

Based on the information obtained during the investigation, MSHA identified Berwind Natural Resources Corporation, Kyber Coal Company, Jesse Branch Coal Company, Berwind Land Company, and A.A.& W. Coals, Inc., as operators of the mining operations at the Elmo #5 mine. Following the investigation, MSHA obtained additional information regarding these entities and determined that Kentucky Berwind Land Company, as opposed to Berwind Land Company, was an operator of the Elmo #5 mine. Thus, MSHA modified all violations of the Mine Act to identify Kentucky Berwind Land Company as one of the five mine operators.

At the time of the explosion, the mine employed 21 miners, 17 of whom worked underground. There was one conventional mining section, which utilized two cutting machines and five scoops, located approximately 6,700 feet from the surface. The mine was normally operated one shift a day, six days per week.

MSHA completed a safety and health inspection (AAA) of the Elmo #5 mine between July 23, 1993 and August 30, 1993. A Noise and Respirable Dust Technical Inspection was conducted on September 14, 1993.

EVENTS PRECEDING THE EXPLOSION

On Tuesday, November 30, 1993, Norman B. Stump, section foreman, allegedly entered the mine at 4:45 a.m. to conduct a preshift examination. Reportedly, no hazards were found and at 5:50 a.m., the results of the examination were phoned to the surface to Johnny Sawyers, rock picker. The day shift crew, consisting of 15 miners, was then transported to their respective under-ground work locations by one diesel and two battery-powered mantrips. Personnel were taken to the Nos. 3, 4, and 5 belt drive locations as well as to the active section. Shortly afterward, James H. Lyons, scoop operator, entered the mine. At about 10:00 a.m., two surveyors also entered the mine.

According to Stump, after the employees began coal production, he traveled across the section to check on the crew and make sure the necessary materials were available. He also stated that a

scoop began malfunctioning, and that he, Lyons, and Clarence D. Coleman, mechanic/electrician, worked to make the needed repairs. After repairs were made, Lyons then operated the battery scoop and started loading coal at the faces. At this time, C. Coleman went to the battery-charging station outby No. 5 belt drive. Between 12:00 noon and 12:30 p.m., Stump made another evaluation across the active section. He then proceeded to the power center to charge one of the battery-powered personnel carriers. Mining continued normally until about 1:20 p.m. when the explosion occurred. Stump, still at the power center, stated that the air current changed direction and visibility was greatly reduced by dust. In order to help locate all the workers on the active section, Stump moved the personnel carrier in the entry and turned the lights "on".

Following the explosion, the crew gathered at the power center and determined that two persons were missing; Alton Wolford, cutting machine operator, who was soon located in the intake air course, and Lyons (victim). Reportedly, C. Coleman, who was at the battery-charging station, had been injured during the explosion when the forces knocked him to the floor. Randy Blackburn, scoop operator, informed Stump that Lyons was in the worked-out area of the mine inby the active section. Upon learning this, Stump instructed everyone to get their self-contained self-rescuers (SCSR's) and install check curtains in order to improve the visibility. Blackburn and Larry Hylton, scoop operator, were instructed to take all remaining brattice material to the main entries of the worked-out area in order to reestablish ventilation. The SCSR's were obtained but not utilized at any time.

At the time of the explosion, H. Coleman, Sawyers, William May, rock picker, Clifford Tussey and Fonso Fields, truck drivers, were located on the surface about 180 feet from the No. 3 drift opening repairing a front end loader. They observed a large cloud of dust exit the mine and heard the air lock doors crash against the metal frame of the canopy and slam shut. The surface equipment and structures were not damaged, however, a thin layer of black dust settled over the entire area. H. Coleman proceeded underground where he subsequently met Stump and began searching for Lyons inby the active section.

RECOVERY OPERATIONS

At approximately 3:15 p.m. on November 30, 1993, Jim Akers contacted MSHA's Elkhorn City field office to inform them that an explosion had occurred at the Elmo #5 mine. MSHA personnel were immediately dispatched to the mine to assist in recovery operations. A 103(k) order was issued under the Coal Mine Health and Safety Act of 1977.

MSHA Headquarters in Arlington, Virginia, was notified and subsequently dispatched MSHA's Mine Emergency Unit (MEU) and Pittsburgh Safety and Health Technology Center's Ventilation Division to the site. A list of persons from the MEU and the Ventilation Division are listed in Appendix B.

Officials from MSHA and the Kentucky Department of Mines and Minerals (KDMM) began arriving at the mine site. By this time, Stump and H. Coleman had explored approximately 920 feet of the mine entries inby the active section when they were instructed, via mine telephone by David Phillips, District Supervisor, KDMM, to come to the surface.

At about 3:55 p.m., rescue and recovery operations began and the following events took place:

1. A command center was organized at the mine office. The following officials comprised the command center: Jim Akers, Elmo #5 mine; Phillips, KDMM; and Raymond McKinney, Subdistrict Manager, MSHA. The operator was informed that its rescue and recovery plans had to be approved by MSHA, in consultation with KDMM, as provided by Section 103(k) of the Mine Act.

2. A decision was made by individuals in the command center to withdraw all remaining persons from the underground portions of the mine. By 4:22 p.m., the mine was totally evacuated.

3. Continuous gas monitoring equipment was obtained from MSHA's Norton, Virginia District Office and preparations were made to monitor the mine atmosphere at the main fan exhaust. Initial readings from the main fan indicated 360 parts per million (ppm) carbon monoxide (CO), 20.8 percent oxygen, and 0.0 percent methane.

About 6:00 p.m., KDMM's Pikeville Office Rescue Team members were briefed and prepared to enter the mine. After an initial period in which air quality readings were analyzed, a decision was made to send KDMM's Pikeville Office Rescue Team underground to explore areas of the mine. A list of personnel who participated in the mine rescue and recovery and establishment of ventilation are listed in Appendix B.

At about 8:00 p.m., a fresh air base was established at spad No. 820, and 0.0 percent methane, 20.7 percent oxygen, and 0 ppm CO were reported. The rescue team advanced inby the fresh air base under oxygen and, at four crosscuts inby spad No. 821, reported 1.2 percent methane, 19.7 percent oxygen, and 1300 ppm CO. At approximately 9:00 p.m., the rescue team captain reportedly observed a light inby spad No. 845 in the No. 7 entry. Individuals in the command center made the decision to advance the rescue team into the area to determine if this was the location of the scoop and the missing person (See Appendix E).

At about 9:40 p.m., the rescue team had advanced nine crosscuts inby spad No. 820 in the No. 7 entry to a location within approximately 200 feet of a battery-powered scoop. They reported methane in excess of 5.0 percent, CO levels in excess of 2000 ppm, and that the ventilation current had diminished. Because of concern about the explosive methane/air mixture and the possibility of a fire, the rescue team was instructed to return to the surface.

The operator submitted a plan, approved by the MSHA District Manager, to drill a borehole into the worked-out area. This borehole was to be used for remote air quality monitoring of the mine atmosphere. On December 1, 1993, at about 3:10 p.m., drilling operations began. An eight inch diameter hole penetrated the mine in the No. 7 entry near spad No. 948, approximately 40 feet outby the scoop.

Continuous monitoring of the mine atmosphere through the borehole began on December 2, 1993 at about 12:07 a.m. The initial readings were reported to be 7700 ppm CO, 17.55 percent oxygen, and 1.41 percent methane. By 8:30 a.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 made to send the rescue team back underground to continue exploration and search for the missing miner.

The KDMM rescue team, accompanied by several MSHA MEU members, entered the mine and established a fresh air base at spad No. 831. The team donned their breathing apparatus and advanced nine crosscuts. The victim was observed approximately 40 feet inby spad No. 948, lying on the mine floor adjacent to the scoop operator's compartment. The entire scoop was located under a seven-foot high cavity. The mine roof in this area had been blasted while mining in the Mains to install a battery-charging station. The team reported an air quality reading of 2.9 percent methane, an off scale CO reading in excess of 2000 ppm, and 18.0 percent oxygen in the vicinity of the scoop. The victim was recovered and brought to the surface at approximately 12:00 noon on December 2.

The victim was transported to the Pikeville Methodist Hospital morgue and, later, to the University of Kentucky, in Lexington, Kentucky. John C. Hunaker, Chief Medical Examiner for the Commonwealth of Kentucky, performed a post-mortem examination and all personal effects were removed.

To facilitate recovery of the mine, a decision was made to drill a second borehole to ventilate the areas inby the active section, including the pillared area. Drilling started on December 17, 1993. On December 21, 1993, after drilling to a depth of 685 feet, a mud-like substance was encountered. On December 22, 1993, after numerous unsuccessful attempts to clear the drill

hole, drilling was suspended and the drill rig was removed from the mine property.

The operator then submitted a plan to recover the mine systematically using rescue teams. On January 11, 1994 mine rescue teams comprised of personnel from KDMM and MSHA's MEU entered the mine. The teams were briefed prior to entering the mine and debriefed upon return to the surface each day. Their findings were recorded on a mine map located in the command center. During the course of the exploration and recovery operations, the mine rescue teams were in constant communication with the surface command center. The recovery operations continued systematically and all accessible areas were explored. The areas inby spad No. 991 could not be explored due to adverse roof conditions. Upon completion of the exploration, the accessible areas were ventilated and the conditions were considered safe to proceed with the investigation.

INVESTIGATION OF THE EXPLOSION

Following the recovery, MSHA and KDMM cooperated to conduct a joint investigation. Management personnel from A.A.& W. Coals, Inc. and a representative of the miners pursuant to Title 30 Code of Federal Regulations (CFR) Part 40, were recognized as parties to the investigation. Richard Vasicek was appointed Chief Investigator for MSHA and Jack Tisdale acted as MSHA's technical advisor. A list of those persons who participated in the investigation are listed in Appendix C.

Before investigative teams entered the mine a plan for the systematic investigation of the affected areas was established and discussed. The primary focus of the investigation was to determine the role, source, and location of the explosive methane gas, to determine whether coal dust was involved in the explosion, and to identify the ignition source of the explosion.

The on-site investigation began December 1, 1993. At that time, surface areas of the mine were photographed and record books were reviewed. The underground investigation began on January 25, 1994. The physical examination of the underground areas of the mine began with investigative teams entering the mine to examine and record the evidence. Evidence was collected, identified, and tagged for further inspection, testing, and/or analysis. The "ventilation team" conducted an evaluation of the ventilation system. The location of ventilation controls prior to the explosion, pressure drops, and direction of airflow were determined. This data was used to perform computer simulations that depicted various ventilation changes. The "mapping team" located and recorded information within the affected area.

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 of the flame. The "electrical team" examined and tested electrical equipment and circuitry in the mine as part of determining the source of the ignition. The "mine dust survey team" collected mine dust samples from the surface to the No. 11 pillared panel, including the active section. A total of 416 mine dust samples were collected for laboratory analysis to determine the percentage of incombustible content and the presence of coke.

As a part of the investigation, MSHA and KDMM conducted interviews with persons knowledgeable of the facts surrounding the explosion. Interviews were conducted with 25 individuals between February 23 and March 23, 1994 in the MSHA, District 6 office, located in Pikeville, Kentucky. All interviews were recorded and transcribed. Those persons interviewed are listed in Appendix I.

DISCUSSION

Mine Development

The mine had commenced development from the surface through four drift openings in a westerly direction (See Appendix D). The No. 4 drift was mined for one crosscut in order to establish a diversion entry to facilitate the mine fan installation. During development of the third connecting crosscut, the Mains were expanded to seven entries. Mining continued in the Mains for approximately 1100 feet and the No. 2 belt drive was installed.

Mining then continued north of the No. 2 belt drive for approximately 3200 feet. During October, 1991, mining commenced in the eastern direction for approximately 1600 feet. During the early part of 1992, the active section was relocated and mining began in the northwest direction for approximately 2400 feet. Twelve panels were mined during the advance of the Mains (See Appendix D). The Nos. 11 and 12 panels were designed and mined to establish a bleeder system for the pillar recovery in this area. Approximately 700 feet of the area was pillared and the active section was then moved outby in the Mains to begin mining the No. 13 panel. Upon completion of the No. 13 panel, the active section then moved immediately outby and began development of a new panel. This was the location of the active section at the time of the explosion.

Roof Control and Pillar Recovery

The approved roof control plan required the use of roof bolts ranging from 36-inch to 48-inch mechanical bolts and 48-inch resin bolts. Entries and crosscuts were developed to a width of

20 feet. The approved pillar recovery system permitted only partial pillar extraction. Two separate partial pillar recovery plans addressed a three and four cut sequence respectively, with both plans requiring pillar extraction to be conducted in areas where minimum 40 foot by 40 foot pillar blocks existed.

The geological conditions of the overlying strata included an immediate roof consisting of 20 feet of firm shale, and a firm shale secondary roof of varying thickness. Unintentional roof falls, above roof bolt anchorage, were observed by the investigators in the No. 11 panel. These roof falls impeded the travel and evaluation of the bleeder system, during the investigation.

Gas Wells

Four active gas wells (Wells No. 8786, 9009, 9010, and 9176) owned by Columbia Natural Resources, Inc. (CNR), were located in close proximity to the mine (See Appendix D). Title 30 CFR, Section 75.1700 requires a minimum barrier of 300 feet in diameter around each well. A.A.& W. Coals, Inc. had submitted requests to MSHA seeking permission to reduce the coal barrier size surrounding each of these wells to 200 feet. These requests were approved on August 27, 1991 for well No. 8786 and on August 13, 1992 for well No. 9009. The remaining two wells were located at distances greater than 300 feet from the workings.

The possibility that natural gas entered the mine from the gas wells was evaluated by CNR. Each of these wells had been examined and tested at least monthly by CNR employees prior to the explosion. The results of these examinations, including the pressure of the producing well, were recorded in monthly well tending reports. Two CNR employees stated in interviews that any communication of natural gas between an active gas well and the mine would result in immediate loss of pressure at the affected well. The well tending reports from January, 1993 through December, 1993 for the four wells located near the mine were reviewed by MSHA investigators. The reports indicated that a significant loss in pressure was not recorded for any of the wells located in the vicinity of the mine. Therefore, communication between the active gas wells and the mine did not exist during that period.

The possibility of natural gas entering the mine through the strata from the reservoirs beneath the mine was also examined. A document prepared by the chief geologist employed by CNR concluded that leakage of natural gas through the strata and into the mine was not possible, since the confining pressure from the overburden keeps fractures closed. This pressure is greater than the reservoir gas pressure and thus, creates a seal. If any openings were present, the natural gas would have leaked through the strata and gas production in these areas would not be

possible. Natural gas from the nearby wells did not enter the mine through the strata at any time prior to the November 30, 1993 explosion and was not a factor in the explosion.

Ventilation

Mechanical ventilation for the mine was provided by a Spendrup 80-inch diameter exhaust fan connected to the No. 4 entry, and offset from the main entries. Power to the fan was supplied by a 150 horsepower (hp), 480 Volt Alternating Current (VAC) motor. Air measurements taken during the investigation indicated that the fan was producing approximately 127,000 cubic feet per minute (cfm) of air at a fan rated static pressure of approximately -4.0 inches of water gauge (wg).

Ventilation Plan

The approved ventilation plan required a minimum of 9,000 cfm of air to be maintained in the last open crosscut of the active section. It also required that a minimum of 4,500 cfm of air be maintained at faces where coal was being cut, mined, loaded, drilled for blasting, and at all times during the roof bolting cycle. The maximum allowable distance from the point of deepest penetration to the end of the line curtain was 10 feet.

Permanent stoppings were required to separate the intake and return entries and were to be maintained up to and including the third crosscut outby the working faces. Permanent stoppings were to be constructed between the intake and belt haulage entries up to the section dumping point.

Active Section

The approved ventilation plan required that permanent stoppings be built up to and including the third crosscut outby the working faces. At the time of the underground investigation, the last permanent stoppings installed on the active section were located six crosscuts outby the working faces. Although a series of check curtains were found in place on the active section during the investigation (See Appendix F), testimony revealed that these curtains had been installed after the explosion. The ventilation plan required that line brattice be maintained in the faces where coal was being cut, mined, loaded, drilled, or where the roof was being bolted. During the investigation, evidence of line brattice could not be found in any of the faces or in any working places.

Worked-Out Areas Inby the Section

The main entries inby the active section were to be utilized as return air courses. A row of permanent stoppings was required to be maintained to direct airflow through the worked-out areas inby the active section, including the two panels where second mining had been completed. The investigation revealed that several of these permanent stoppings were not in place prior to the explosion.

According to witness testimony, permanent stoppings in the Nos. 11 and 12 panels were removed during the retreat mining cycle. An inspection of the stopping line inby the active section by MSHA investigators revealed that additional stoppings outby the Nos. 11 and 12 panels had been removed prior to the explosion.

Main Mine Fan

The approved ventilation plan required that the mine fan be operated continuously and that the fan operating pressure be measured by a pressure recording gauge. During the investigation, a review of the fan recording charts indicated that several ventilation interruptions had occurred at regular intervals prior to the explosion. The investigation also revealed problems with the pressure recorder installation.

A Dickson Company pressure recorder with an operating range of 0 to 10 inches wg had been installed at the fan. To measure the correct operating pressure of an exhausting fan, the point of measurement should be at some location through the fan housing on the inby side of the fan blades. The pressure recorder had been installed on the outby side of the fan blades and indicated an operating pressure of +1.4 inches wg. During the investigation, the actual operating pressure of this fan was measured to be -4.0 inches wg.

A review of the fan recording charts was conducted. A pattern of interruptions was evident on the fan pressure chart for several periods prior to the explosion. The charts indicate a recurrent increase and decrease in pressure of approximately 0.4 inch wg, which equals the total pressure the fan generated on the outby side of the blades. In contrast, patterns of interruption were not present on the charts recorded during the weeks following the explosion. MSHA personnel were on site continuously during this time period and these charts indicated a continuous and consistent pattern by the recorder pen.

During the recovery and investigation, the pressure recorder hose was disconnected to simulate a fan stoppage. This action caused the recorder to indicate a pressure of approximately +1.0 inch wg. This reading is very similar to the reading indicated on fan charts in the days prior to the explosion at times when the fan

may have been turned off. Thus MSHA investigators believe that the mine fan was not continuously operated as required in the approved ventilation plan.

Bleeder System

Second mining was conducted in the Nos. 11 and 12 panels early in September, 1993 (See Appendix D). The approved ventilation plan for the mine required a bleeder system to control the air passing through the worked-out areas in order to continuously dilute and move methane and other gases, dust and fumes from the worked-out areas into the return air course. The mine employed a "wrap-around" bleeder system which utilized two rows of unmined pillars around the right side of the area where pillars had been partially extracted. One line of permanent ventilation controls was required to be maintained in conjunction with the unmined pillars. Examiners were required to travel the entire bleeder system. The investigation revealed that the examiners did not travel the entire length of the bleeder system or properly evaluate the airflow in the bleeder entries for approximately three months prior to the explosion. MSHA investigators could not evaluate the effectiveness of the bleeder system during the investigation due to extensive roof falls in the No. 11 pillared panel.

Information obtained through interviews revealed that the required permanent ventilation controls were intentionally removed as second mining was being conducted. However, adverse roof conditions, roof falls, and extensive accumulations of waste material in the form of coal, rock and debris prevented the investigation team from traveling inby spad No. 991 to examine the condition of the bleeder entries.

Methane Liberation

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

Table 1 - Methane Liberation at the Elmo #5 Mine

DATE	01/92	04/92	07/92	12/92	1/93	4/93	8/93
METHANE, %	0.01	0.02	0.02	0.01	0.01	0.03	0.02
LIBERATION (24 hours)	7360	21600	27650	20217	19673	56983	30246

Methane was not detected in MSHA samples taken at the mine fan until around May 1991, when mining was being conducted in the Mains near the No. 4 panel.

Methane Migration\Layering

During the investigation, continuous recording methane monitors (CSE 180-R) were used to measure methane concentrations at several locations in the mine. One recorder was placed near the roof of the cavity inby spad No. 948. Two additional recorders were positioned on the return side of the pillared panels near spad No. 991. These recorders were operated continuously for a five day period.

The first recorder indicated that a measurable quantity of methane was not being liberated within the cavity. However, concentrations of methane were detected by the recorders positioned near the pillared panels. As expected, the methane concentrations increased during periods of decreasing barometric pressure. During the investigation, although temporary ventilation controls had been installed to spad No. 983, methane readings in excess of one percent were detected with a hand-held detector at several locations just outby the pillared panels. A reading of 1.3 percent methane was detected with a hand-held detector in the No. 10 entry cut-through (between spad Nos. 995 and 1273), which connected the Mains with the pillared panels.

The coal seam dipped from the active section inby toward the pillared panels. When insufficient ventilation is directed through an area, methane can accumulate and migrate to the highest elevation. In the absence of adequate ventilation, methane accumulations in the pillared panels would migrate toward the outby areas including the roof cavity near spad No. 948. MSHA investigators determined that the removal of seventeen permanent stoppings in the worked-out area outby the Nos. 11 and 12 panels resulted in airflow that was not of a sufficient volume and velocity to prevent accumulations of methane. A methane-air mixture migrated from the pillared panels in the form of a layer and extended into the cavity located in the No. 7 entry just inby spad No. 948.

Barometric Pressure

Atmospheric weather conditions for the Feds Creek, Kentucky area are recorded hourly by the National Weather Service station located at the Huntington, West Virginia airport, approximately seventy miles north of the mine. A review of this information was conducted to determine if any significant decrease in barometric pressure had occurred prior to the explosion. Figure 1 is a graph of the barometric pressure from November 27-30, 1993.

FIGURE 1

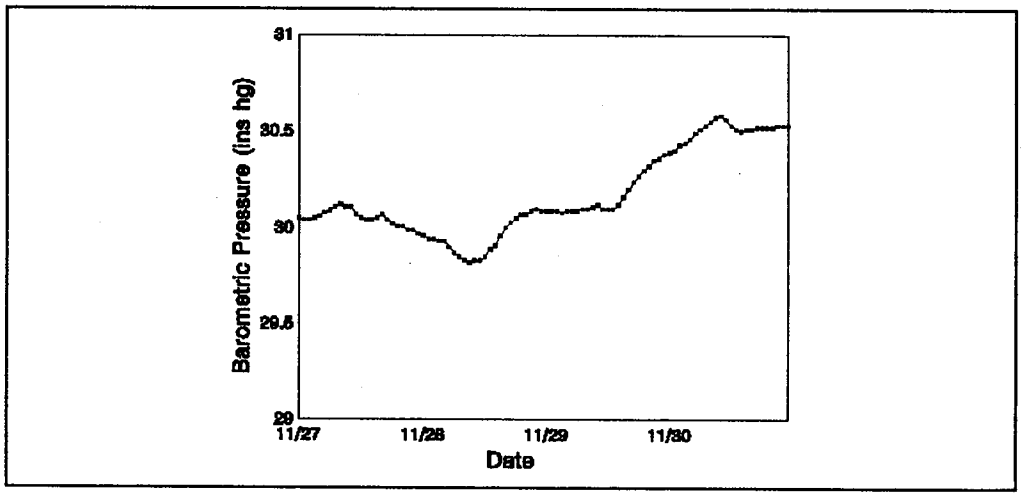

Figure 1 illustrates a slight drop in barometric pressure which occurred immediately prior to the explosion. A decrease in barometric pressure prior to the explosion would have increased the potential for methane to migrate from the pillared panels to outby areas.

Return Stopping Line Inby Section

To direct ventilation inby the active section, it was essential to maintain at least a single row of permanent stoppings extending from the active section return to the furthest point of penetration of the pillared panels. This stopping line was shown on the mine map to be located between the Nos. 9 and 10 entries in the Mains and then extend east into the pillared panels. Successful ventilation in the worked-out areas and the pillared panels inby the action section was dependent upon the integrity of this stopping line. The stopping line inby spad No. 991 could not be examined due to adverse roof conditions (See Appendix E).

The investigation determined that when second mining was completed in the No. 11 panel, the active section was relocated outby approximately 1500 feet to begin the No. 13 panel. To relocate the battery charging station, two permanent stoppings were removed between the Nos. 9 and 10 entries and the battery charging station was transported using the No. 10 entry (return) as a travelway. Several witnesses testified that the No. 10 entry (return) proved to be the least obstructed entry. When the active section was moved to its present location, the battery charging station was again transported through the No. 10 entry. Subsequently, a third permanent stopping was removed (left of spad No. 673) when the battery charger was relocated.

Testimony revealed that when a permanent stopping was removed during relocation of the battery charging station, a check curtain was installed in its place. During the investigation a computerized mine map was obtained from the company. This map indicated that in three crosscuts (left of spad No. 673, left of spad No. 756, and left of spad No. 975) check curtains were shown where permanent stoppings were required. This information correlates with that obtained during interviews. During the underground investigation, an examination of the return stopping line was conducted. Although check curtains were not permitted as replacement for permanent stoppings, the examination revealed that check curtains were probably in place to the left of spad No. 673 and to the left of spad No. 756 at the time of the explosion. However, evidence could not be found that would indicate a check curtain was present near spad No. 975.

The forces generated during the explosion were estimated to be on the order of 2-4 psi. This force is not sufficient to transport concrete blocks over significant distances nor to break the concrete blocks into large pieces. It is the opinion of MSHA investigators that individual concrete blocks were not disintegrated during the explosion and that stoppings did not exist at the time of the explosion in areas where an insufficient number of concrete blocks were found. It was determined that seventeen permanent stoppings had been removed prior to the explosion. The removal of these stoppings prior to the explosion created a short circuit of ventilation, causing the majority of the area inby the active section to be minimally ventilated. As a result, there was insufficient airflow to dilute, render harmless and carry away methane gas liberated inby the active section.

Electricity

Electric power for the mine was purchased from Kentucky Power Company and was transmitted to the mine through overhead high-voltage lines at 7200 VAC. The 7200 VAC was fed to a surface substation that contained a 1000 kilovolt-ampere (KVA) delta-wye connected three-phase transformer. This transformer supplied one underground circuit that entered the mine through the No. 3 entry. The high-voltage system was protected by a 400 ampere vacuum circuit breaker located in the surface substation. The vacuum 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 provided power to five power centers supplying separate conveyor belt drives, one power center supplying a pump, and the active section power center. Each power center reduced the 7200 VAC to 480 VAC. A circuit breaker was provided for each power circuit. Each circuit was equipped with a ground-check monitor and relays to provide overcurrent,

short-circuit, grounded-phase, and under-voltage protection.

Electric Circuits and Equipment

MSHA personnel, assisted by personnel from KDMM and employees of A. A. & W. Coals, Inc., tested and examined the following electric equipment and cables.

High-Voltage Cable

Approximately 6800 feet of #2 American Wire Gauge (AWG), Type SHD-GC cable connected the surface disconnects to the section power center. The high-voltage cable was hung from the mine roof near the coal rib in the No. 3 entry. The cable passed through the feed-through circuits of the Nos. 2, 3, 4, 5, and 6 belt drive power centers and one pump power center.

Information gathered during the investigation revealed that the high-voltage circuit was energized at the time of the explosion. The vacuum circuit breaker for the 7200 VAC circuit was still in the closed position. Target flags were not observed on the high-voltage circuit breaker or the associated relays. This indicated that an overcurrent, short circuit, or ground fault had not 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.

Power Centers

Five nonpermissible feed-through belt power centers and one pump power center were each rated at 150 KVA. Each of these power centers provided a feed-through high-voltage circuit and supplied 480 volts to their respective loads. 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.

The MSHA investigators did not observe any physical damage to the power centers. These 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.

Kris Electric 150 KVA, 7200/480 VAC power center

The nonpermissible 150 KVA section power center was located at the fifth crosscut outby the face in No. 6 entry of the active section. The section power center reduced the 7200 VAC to 480 VAC power for utilization by the active section equipment. 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 section equipment were supplied from a resistance grounded circuit. Each circuit was equipped with a ground-check monitor with overcurrent, grounded-phase, and under-voltage protection. Investigators did not observe any physical damage to the section power center and abnormal arcing or heat was not evident. The point of origin of the explosion was located inby the section, indicating that the explosion did not originate inside the power center. Investigators did not find any evidence to indicate that the section power center provided the ignition source for the explosion.

Belt Drives

Five nonpermissible belt drives were located in the No. 3 entry of the Mains. Each belt drive consisted of a 480-volt wound rotor motor; belt controller; and associated control circuits for the belt slippage and sequence switches and sprinkler-type fire suppression systems. Of the five belt drives, three were rated at 100-hp, one was rated at 150-hp, and one was rated at 50-hp. 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.

Charging Station

Six battery charging units; including five 480-volt units and one 240-volt unit, a distribution box, and a sprinkler-type fire suppression system made up the charging station located at spad No. 597. The charging units were not located near the point of origin. Investigators did not find any evidence that the chargers provided the ignition source for the explosion.

Nonpermissible-Type Electric Equipment At Or Near the Section

The following nonpermissible-type electric equipment was located at or near the section:

1. Owens Manufacturing Company, 100 hp belt feeder
2. No. 6 belt drive unit, 100 hp, 480 VAC.
3. Kris Electric 150 KVA, 7200/480 VAC power center
4. Pyott-Boone, Model 113, Page Boss Telephone
5. Four Koehler Manufacturing Company cap lamps
6. Koehler Manufacturing Company flame safety lamp

Some nonpermissible equipment contains various contactors that could create arcing with sufficient energy to ignite an explosive methane-air mixture. However, the equipment was not near the

point of origin of the explosion and evidence of abnormal arcing or heat inside the equipment was not found by the investigators. Based on these facts, it was reasonable to conclude that this equipment did not provide the ignition source for the explosion.

Permissible-Type Electric Equipment At or Near the Section

The following permissible-type electric equipment was located at or near the section:

1. Simmons-Rand Company, S&S Scoop, Model 482, SN 482-1553
2. Simmons-Rand Company, S&S Scoop, Model 482, SN 482-1747
3. Simmons-Rand Company, S&S Scoop, Model 482, SN 482-2079
4. Simmons-Rand Company, S&S Scoop, Model 482, SN 482-1881
5. Joy Manufacturing Company, 16-RB Cutting Machine, SN 17973
6. Joy Manufacturing Company, 16-RB Cutting Machine, SN 17473
7. Long Airdox, LRB-15A Roof Bolting Machine, SN 52-1165
8. Long Airdox, LRB-15A Roof Bolting Machine, SN 52-1152
9. Long Airdox, LRB-15A Roof Bolting Machine, SN 62-580
10. Long Airdox, TDF-24B Coal Drill, SN 52-1299
11. Fourteen Koehler Manufacturing cap lamps

Post-explosion inspections were performed on the permissible mining equipment. 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 inspections revealed areas where the equipment did not meet Title 30 CFR requirements. However, the visual inspections did not identify any evidence that the ignition source of the explosion occurred within the permissible enclosures. Combustible material, located in the enclosures, was not charred, discolored, or deformed. Indications of carbon tracking did not exist along any flanges. Indications of the presence of flame within or exiting the enclosures did not exist. The equipment was not located near the point of origin. Based on these facts, MSHA investigators have determined that the explosion was not caused by the operation of any permissible electric equipment located at, or near, the active section.

Permissible-Type Equipment Near The Point Of Origin

The permissible battery-powered S&S Model 482 scoop, SN 482-1946, was located 40 feet inby spad No. 948 in the No. 7 entry of the worked-out area. This scoop was not maintained in permissible condition. The main circuit breaker was in the "Open" (tripped) position. The directional pump motor switch was in the "OFF" position and the light switch was in the "Forward-ON" position. The batteries were connected to the scoop.

A post-explosion examination of the scoop revealed 33 conditions where the scoop did not meet Title 30 CFR permissibility requirements. An examination 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. None were observed. The scoop components were also checked for signs of abnormal arcing or burning. The position of the switches indicated that the forward lights were on and the main breaker had been tripped by the panic bar. The left battery cover lid was not in place and had been removed prior to the explosion. MSHA investigators observed this cover at the battery charging station outby the No. 5 belt drive. Nothing was found during the examination that indicated the explosion originated from the scoop.

Battery Connector/Plug on the S&S Model 482 Scoop

Due to the visible appearance of the battery connector/plug and the missing lock ring, testing was conducted at MSHA's Approval and Certification Center on the plug and receptacle. Test results indicate that the plug and receptacle were not the source of the explosion (See Appendix J).

Koehler Manufacturing Company, Cap Lamp

An examination of the victim's cap lamp revealed:

1. One of the two screws securing the battery top cover was missing;

2. The bezel sealing screw was broken off and not engaged in the bezel; and

3. The cord jacket was not seated properly in the cord lock ring in the headpiece, exposing the individual insulated conductors.

Through the testing and evaluation, as summarized in Appendix J, it was determined that the cap lamp was not the ignition source of the explosion.

CSE Model 102 Hand-Held Methane Detection Device

A CSE Model 102 hand-held methane detector was retrieved from the container used to transport the victim to the medical examiner's office. When tested, the methane detector operated within calibration specifications without adjustment except for charging the battery. Test results indicated that the detector was not the ignition source for the November 30, 1993 explosion (See Appendix J).

Smoking Related Issues

The operator's search program for smoking articles was approved by MSHA's District 6 Manager on April 18, 1990. The program required that each employee be searched at least once every week at irregular intervals to prevent smoking materials, matches, and lighters from being carried underground and that a written record of such searches be maintained.

The approved search program required that searches be conducted at the portal immediately prior to employees going underground and called for additional searches to be conducted if evidence indicated that the plan was inadequate. Interviews and investigative findings established that the operator's smoking search program, as well as corrective action for infractions of the "no smoking" policy, was not carried out. During interviews, five miners, each of whom had worked in the mine for more than six months, stated that they had never been searched before they entered the mine. Two miners stated that they carried cigarettes and lighters in their lunch containers; these smoking materials remained undetected during searches. Four employees admitted to smoking underground during the month of November 1993 and one admitted to smoking on the day of the explosion.

When the victim's body was recovered, one full pack of cigarettes was observed in the victim's left shirt pocket. The victim's shirt was burnt and the right shirt pocket was missing. Investigators found an empty cigarette package in the lunch container in the operator's deck of the scoop which was located approximately 40 feet inby spad No. 948. A disposable butane cigarette lighter was found lying under water on the mine floor adjacent to the operator's compartment. The lighter was discovered when an investigator's footprint displaced some of the water exposing the lighter. The lighter displayed evidence of heating. A KDMM inspector stated that he had removed a piece of burnt material from the panic bar for the scoop and placed it near the coal rib. MSHA investigators examined the piece of burnt material and found that it contained twelve filtered cigarette butts. A subsequent examination of the material revealed that it was a pocket from the victim's shirt.

MSHA investigators reviewed the weekly records of searches for smoking articles. The records show that Norman Stump conducted searches for the period April 1993 through and including November 29, 1993. In addition, the record books showed that searches were conducted on the surface and smoking articles were never found. However, the daily examination record dated October 25, 1993 shows that Stump observed a miner smoking underground. The miner reportedly received a verbal reprimand.

Examinations

Weekly Examinations

A review of the weekly examination record book along with information provided during interviews, revealed that the bleeder entries for the pillared panels were not being evaluated. Pillaring was completed in the area during the latter part of September, 1993.

On the day of the explosion, Stump indicated that he conducted examinations up to the pillar line. He stated that he did not travel inby the pillar line due to adverse roof conditions. Action had not been taken to correct these conditions. It was determined that approximately three months elapsed during which examinations of the bleeder system were not conducted. Alternative methods of evaluation for this area had not been approved in the mine ventilation plan. Failure to evaluate for methane and determine airflow in the bleeder entries contributed to the explosion on November 30, 1993.

Preshift/On-shift Examinations

MSHA investigators reviewed the preshift and on-shift examinations record books. Reportedly, methane was not normally encountered during preshift examinations. During the period from February 17 to November 30, 1993, entries in the record books for on-shift methane examinations were recorded and ranged from "00 to 06".

A preshift examination was not conducted inby the active section on November 30, 1993, for a distance of approximately 2000 feet prior to Lyons travelling into the area. This area was regularly travelled by miners to retrieve conveyor belt and conveyor structure. Failure to conduct a preshift examination contributed to the occurrence of the explosion on November 30, 1993.

The review of preshift mine examination records revealed several examination deficiencies:

1) The results and locations of methane tests had not been recorded in the record book for the time period between June 17, 1993 and November 30, 1993.

2) The record for preshift examinations conducted on July 7, 1993, and July 12, 1993, were incomplete because they were not signed by the certified person who conducted the examinations.

3) There were not any certification evidence to indicate that a preshift examination was conducted along the belt conveyor systems where one belt cleaning employee and two belt drive attendants were regularly assigned to work. However, the section foreman stated that preshift examinations were performed in the area of the belt conveyor drives.

4) The investigators did not observe any evidence underground (i.e. dates, times, and initials) to indicate that a preshift examination was conducted on November 30, 1993, from the No. 3 to the No. 5 belt conveyor drives. Three employees were assigned to work in this area.

5) There was not any evidence to indicate that a preshift examination was conducted at the underground battery charging station, located approximately 200 feet outby No. 5 belt conveyor drive. The investigators did not observe any evidence, dates, times, and initials, at the charging station. Employees would secure their scoops at the battery charging station with the beginning of each production shift and return to charge the scoop batteries during the shift.

6) An entry was not recorded into the record book on June 19, 1993, to indicate that a preshift mine examination was conducted prior to eight miners going underground.

7) The preshift mine examination recorded for October 23, 1993, did not show the time when the examination was conducted, and did not show if the report was phoned outside or who may have received the report. The entry for October 23, 1993, indicates "making belt move-#9 12,500". There were not any notations to determine the entries or areas examined.

8) The preshift mine examination recorded for November 6, 1993, did not show the time of examination and does not show if the report was phoned outside, or who may have received the report. The recorded examination for November 6, 1993, shows "moving section, LOCC 35,000".

9) The preshift mine examination recorded for November 20, 1993, did not show the time of examination and did not show if report was phoned outside, or who may have received the report. The recorded examination for

November 20, 1993, shows "making belt move, #9 10,000"; notations were not made to determine what entries or areas were examined.

10) A record was not entered on November 27, 1993, to indicate that a preshift mine examination was conducted prior to miners going underground.

Methane Monitor

The scoop, located 40 feet inby spad No. 948, was equipped with an MSHA-approved General Monitors, Model No. 420d methane monitor. The monitor was installed with the control unit and power supply located in the operator's compartment. The sensor housing was located 3 feet, 5 inches from the left front end, 9 feet from the front of the bucket and approximately 15 inches vertically above the mine floor. The control unit was connected to the power supply and sensor housing.

The sensor was evaluated and tested by MSHA's Approval and Certification Center (A&CC). The sensor dust guard was clogged with dust. The detection element was completely separated from it's mounting posts.

The unit's control module was delivered to National Mine Service repair facility in Beckley, West Virginia by A&CC. When tested with a functional sensor head, the display read "0.0%" after application of 2.5% gas. The power shut off relay did not operate. After the "ZERO" and "SPAN" potentiometers were adjusted properly, the 2.5% gas was again applied and the unit functioned properly.

Coal Dust, Loose Coal, and Rock Dust

During the underground investigation, it was necessary to take a sample of the coal in order to establish the composition of the particular coal seam in which the accident occurred. A standard channel sample, 6-inches wide by 2-inches deep, the full height of the coal seam, was taken on February 1, 1994 near the location of the point of origin of the explosion. A mine map showing the location of the channel sample is contained in Appendix H.

A Proximate Analysis on the channel sample was conducted to identify the percentage of moisture, ash, volatile matter, and fixed carbon present in the sample. The volatile matter and fixed carbon totals were used to calculate the volatile ratio.

The results the proximate analysis are as follows:

Ingredient	Percentage
Moisture	0.89
Volatile Matter	30.97
Fixed Carbon	56.37
Ash	11.77

The volatile ratio is a value established by the Bureau of Mines to evaluate the explosive nature of United States coals based on large-scale explosion tests in the Experimental Coal Mine at Bruceton, Pennsylvania. The volatile ratio (VR) of coal is defined as the ratio of its volatile matter (VM) to the sum of its volatile matter and fixed carbon (FC) contents or VR = VM/(VM + FC). This method for calculating the volatile ratio produces a value independent of the natural or added incombustibles in the coal. It has been established that all United States coals having a volatile ratio in excess of 0.12 are considered to present an explosion hazard. If the volatile ratio of coal exceeds 0.12, it must be rendered inert according to Title 30 CFR, Part 75, Mandatory Safety Standards - Underground Coal Mines, Subpart E.

The volatile ratio of the channel sample was calculated to be 0.35, which would present an explosion hazard and must be rendered inert.

During the underground investigation, a mine dust survey was conducted to determine the incombustible content of the mine dust. A total of 412 mine dust samples were collected between the drift openings and the No. 11 pillared panel and analyzed for incombustible content. A total of 392 mine dust samples were below the minimum required incombustible content. In addition 391 mine dust samples were analyzed for coking by means of the Alcohol Coke Test (See Appendix H).

The investigation revealed that a written program, undated and unsigned, was available at the mine for the regular cleanup and removal of accumulations of loose coal. According to the miners interviewed, rock dust would be applied by hand on the roof, ribs, and floor of the working section during the production shift. On weekends, rock dust would be applied utilizing an electric rock dusting machine.

Extent of Flame and Forces

Evidence regarding the flames and primary explosion forces was gathered during the underground investigation, and was also derived from interviews, autopsy reports provided by the Medical Examiner, and the results of all laboratory work performed on evidence. After evaluating all of the evidence, MSHA investigators have made determinations regarding the extent of flame and the direction of the primary forces. These determinations are shown on the map in Appendix H.

The extent of flame and the magnitude and direction of primary explosion forces are factors which assisted investigators to determine: the ignition source responsible for the explosion; the total quantity, concentration, and location of any methane accumulations prior to the explosion; and the likelihood that coal dust contributed to the development and continued propagation of the explosion.

The extent of flame, along with the limited explosion forces, has led MSHA investigators to believe that a layered accumulation of methane was present in the vicinity of the victim at the time of the explosion.

From the point of ignition, just inby spad No. 948, a fireball developed which initially expanded equally in all directions. Research has shown that ignition of only 13 cubic feet of methane is necessary to initiate a coal dust explosion. A total volume of approximately 50 cubic feet of methane, which was diluted to about 6.5 percent, existed in the immediate vicinity of the cavity. The flame extension from ignition of this accumulation was limited to within 75 feet of the source of the ignition. Since the total flame that occurred during the propagation of the explosion exceeded this 75 feet radius, additional fuel must have been present to allow continued propagation.

MSHA investigators believe that additional limited methane accumulations existed within the explosive range, layered near the cavity and were ignited by the propagating flame front. Also, the explosion generated sufficient force to cause suspension of the mine dust. The incombustible content requirements set forth in Title 30 CFR, Subpart E are sufficient to eliminate the involvement of coal dust and float coal dust in an explosion. However, with incombustible contents below those specified in Subpart E, coal dust and float coal dust can ignite and contribute flames and explosion forces to a methane explosion. The analysis of this mine dust indicated a lack of adequate incombustible content which allowed coal dust to suspend and ignite. Evidence indicates that the additional fuel for propagation of this explosion included methane and coal dust.

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.

Tests by researchers on the physiological effects of blast pressure have shown that a peak overpressure of about 1 psi will knock a person down, 5 psi is the minimum pressure that will cause damage to the eardrums, 15 psi will cause lung damage, 35 psi is the threshold for fatalities, and 65 psi will result in fatalities to 99% of the people exposed to such pressures. The post-mortem examination indicated the victim suffered burns, smoke inhalation, and acute carbon monoxide poisoning. MSHA investigators believe that the forces generated during this explosion were on the order of 2-4 psi.

Point of Origin

The following factors were evaluated to determine the point of origin:

1) Location of the victim after the explosion;

2) Magnitude and direction of primary forces and extent of flame;

3) Location of potential ignition sources located throughout the explosion zone;

4) The location of roof falls, water accumulations, and other obstructions to ventilation;

5) The lack of sufficient rock dust throughout the mine;

6) The condition of approved equipment;

7) The presence of smoking materials;

8) Ventilation factors throughout the mine that would have allowed methane accumulations to occur; and

9) The condition of the victim's clothing and the seat cushion for the scoop.

After evaluating all of these factors, it was concluded that the explosion originated approximately 40 feet inby spad No. 948, in

the No. 7 entry. The location of the victim and scoop.

Potential Ignition Sources

The potential ignition sources were those located at the point of origin. These potential ignition sources are listed and discussed as follows:

1. Simmons-Rand Company, S&S Model 482, Battery Powered Scoop;
2. Battery Plug on the S&S Model 482 Scoop;
3. Koehler Cap Lamp;
4. CSE Model 102 hand-held Methane Detection Device; and
5. Smoking Articles.

Simmons-Rand Company, S&S Model 482, Battery Powered Scoop

Through testing and evaluation, it was determined that permissibility deficiencies on the S&S Model 482 Scoop were not the source of the explosion.

Battery Plug on the S&S Model 482 Scoop

Through testing and evaluation, it was determined that the battery plugs on the S&S Model 482 Scoop were not the source of the explosion.

Koehler Cap Lamp

Through testing and evaluation, it was determined that the victim's cap lamp was not the source of the explosion.

CSE Model 102 Hand-Held Methane Detection Device

Through testing and evaluation, it was determined that the CSE Model 102 hand-held methane detection device was not the source of the explosion.

Smoking Articles

One cigarette pack containing twenty unsmoked cigarettes was found on the victim at the point of origin. A charred shirt pocket containing twelve filtered cigarette butts was found in the operator's compartment of the battery powered S&S Scoop at the point of origin. A lunch container located in the operator's compartment of the battery powered S&S scoop contained one empty cigarette package. A cigarette lighter was not found on the victim, however a disposable butane cigarette lighter, which

displayed evidence of heating, was found on the mine floor near the operator's compartment. Results of tests performed on this lighter are contained in Appendix K. MSHA investigators have determined that the open flame from this lighter was the ignition source for the explosion that occurred on November 30, 1993.

SUMMARY AND CONCLUSIONS

Ventilation

The investigation revealed that prior to the explosion seventeen permanent ventilation controls had been removed in the Mains inby the active section. These changes in the ventilation system permitted a significant portion of the ventilating current to leave its designated and approved route of direction and short-circuit into the main return air course. The failure to maintain the permanent stopping line resulted in inadequate ventilation for the worked-out area inby the active section, including the pillared panels.

The approved bleeder system for the areas where second mining had been conducted required permanent ventilation controls around the Nos. 11 and 12 panels. The bleeder system was initially established, however as second mining was conducted, the permanent ventilation controls were removed making the system ineffective.

Methane Accumulations

The coal seam dipped from the accident area toward the furthest point of advance in the No. 12 panel. When little ventilation is directed through an area methane will accumulate and can migrate to the highest elevation. Due to the removal of permanent ventilation controls prior to the explosion, the area inby the active section, including the Nos. 11 and 12 pillared panels, was insufficiently ventilated. Prior to the explosion, methane migrated in a layered form from the pillared panels and extended into the cavity located in the No. 7 entry approximately 40 feet inby spad No. 948.

Mine Examinations

There were not any notations in the record books to indicate that weekly examinations were being conducted of the bleeder system from early September, 1993 up to, and including, November 30, 1993. The review of the weekly examination record book along with information provided by Stump revealed that the bleeder entries for Nos. 11 and 12 pillared panels had not been evaluated for approximately three months prior to the accident. The record books also indicated that the return air courses were not being examined and travelled to the areas of deepest penetration for the purpose of measuring for methane and oxygen concentrations

and to determine whether the air was moving in its proper direction.

The weekly examiner indicated that the bleeder was not and could not be travelled in its entirety because of hazardous roof conditions. Action was not taken to correct these conditions. The investigation team was stopped by hazardous roof conditions and one entry was blocked with loose mine material.

Smoking Related Issues

Persons were smoking in the mine, and the operator's smoking search program was not effective. The investigation revealed that four employees carried and used smoking materials underground on days prior to the explosion. One employee smoked cigarettes underground on November 30, 1993.

One full pack of cigarettes was found in the shirt pocket of the victim who was located near the battery powered scoop approximately 40 feet inby Spad No. 948. There were twelve filtered cigarette butts inside a piece of charred material which was determined to be the other pocket from the victim's shirt. A lunch container, located in the operator's compartment of the battery powered scoop, contained an empty cigarette package. A butane cigarette lighter was found on the mine floor in the vicinity of the victim near the operator's compartment of the battery powered scoop.

Source of Ignition

A transition zone was identified at a location 40 feet inby spad No. 948 in the worked-out area of the mine. 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 battery powered S&S Model 482 Scoop, a battery connector/ plug taken from the S&S Model 482 Scoop, a Koehler cap lamp, and smoking materials. With the exception of the butane cigarette lighter, all of the potential ignition sources were eliminated as the originating ignition source of the explosion. The investigators have concluded that the open flame from the butane cigarette lighter found on the mine floor near the scoop operator's compartment was the ignition source for the November 30, 1993 explosion.

Propagation of the Explosion

The extent of flame, along with the limited explosion forces, has led MSHA investigators to believe that a layered accumulation of methane was present in the vicinity of the victim at the time of the explosion. This accumulation of methane was ignited approximately 40 feet inby Spad No. 948.

From the point of ignition, a fireball developed which initially expanded equally in all directions. Additional methane accumulations, within the explosive range, layered near the cavity were ignited by the propagating flame front.

Also, the explosion generated sufficient force to cause suspension of the mine dust. Sufficient quantities of incombustibles were not available to arrest the participation of coal dust in the explosion. Evidence indicated that the additional fuel for propagation of this explosion included methane and coal dust. The heating of the atmosphere caused the involved gases to expand. This expansion caused the air ahead of the flame front to compress which exerted a force on objects and mine surfaces. MSHA investigators believe that the forces generated during this explosion were on the order of 2 - 4 psi.

CONTRIBUTING VIOLATIONS

The following conditions 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 75.370(a)(1)

The approved Ventilation Plan was not being followed in the 001-0 Mains and the No. 11 panel pillared area. Seventeen permanent stoppings along the main return entry were intentionally removed prior to the explosion. The bleeder entries of the No. 11 pillared panel and panel advanced left off the No. 11 pillared panel were not maintained in a safe and travelable condition due to adverse roof conditions and extensive accumulations of waste material in the form of coal, rock, and debris.

30 CFR 75.360(b)(1)

A Preshift examination was not conducted in the active Mains headings where miners were routinely scheduled to work. An examination by a certified person was not conducted on November 30, 1993, of the area 2,000 feet inby spad No. 688 in the No. 1 Mains entry. Failure to conduct a preshift examination contributed to the occurrence of an explosion on November 30, 1993, that resulted in the death of one miner.

30 CFR 75.1702-1

The smoking search program for the A.A.& W. Coals, Inc., Elmo #5 mine, and the 001-0 Section was neither adequate nor conducted in its entirety based on the following: Smoking materials in the form of cigarettes were found in the shirt pocket of the victim who was at the battery powered scoop located about 40 feet inby spad No. 948. Charred material that appeared to be a shirt pocket containing twelve (12) filtered cigarette butts was found adhered to the panic bar in the operator's compartment on the battery powered scoop. A lunch container, located in the operator's compartment of the battery powered scoop, contained an empty cigarette pack. A functional butane cigarette lighter was found on the mine floor near the battery powered scoop.

Based on testimony, three underground employees carried and used smoking materials underground on days prior to the explosion. One of these employees smoked cigarettes underground on November 30, 1993. The operator's searches for smoking materials were not regularly made prior to persons entering the mine. Reportedly, searches were made either at the end of or late in the working shift. The operator's searches for smoking materials did not include the examination of the contents of lunch containers carried underground.

30 CFR 75.403

The incombustible content of all 139 of the combined mine dust samples collected in the intake air course as part of the mine dust survey (Explosion Area) was less than 65 percentum, ranging from 8.0 percent to 36.0 percent. The incombustible content of 29 combined mine dust samples collected in the return air course as part of the mine dust survey (Explosion Area) was less than 80 percentum, ranging from 15.0 percent to 31 percent.

30 CFR 75.321

The volume and velocity of air current ventilating the areas inby the active 001-0 Section was not sufficient to dilute, render harmless, and carry away flammable and explosive gases that were liberated.

30 CFR 75.364(a)(2)(iii)

The bleeder entries for the No. 11 pillared panel, used as part of the mine's bleeder system, were not being evaluated, travelled, or examined at least once each week in its entirety for the purpose of measuring for methane and oxygen concentrations and testing to determine if the air was moving in its proper direction. An alternative method of evaluation for this area had not been approved in the mine ventilation plan.

30 CFR 75.364(b)(2)

An examination for hazardous conditions was not being conducted at least every seven days in the return air courses in the No. 11 pillared panel and the panel advanced left off the No. 11 pillared panel. Dates, times, nor initials, that would indicate examinations were conducted in the return air course, were not present inby spad No. 720 to spad No. 995, a distance of about 1800 feet

30 CFR 75.364(a)(1)

The No. 9 and No. 10 panels, and the panel adjacent to the active section beginning at spad No. 1282, were not being examined and travelled to the areas of deepest penetration for the purpose of measuring for methane and oxygen concentrations, and to test to determine if the air was moving in its proper direction. Dates, times, nor initials, that would indicate examinations, and travel was conducted, including the area from spad No. 709 to spad No.995, were not present.

30 CFR 75.342(a)(4)

The General Monitors Model 420d methane monitor system mounted on the No. 3 scoop, serial No. 482-1946, was not maintained in proper operating condition. When tested with a known methane-air mixture of 2.5 percent methane, the monitor would not indicate the presence of methane. Further testing of the monitor components found that the sensing device was inoperative. The control module's zero and span potentiometers, located inside an enclosure with a Lexan window assembly cover secured by four screws, were adjusted to positions that served to defeat the monitors system's ability to automatically de-energize the machine, when the monitor is not operating properly, and destroy its ability to properly indicate the amount of methane in the mine atmosphere.

Other conditions referenced in this report which constituted violations of the mandatory standards contained in 30 CFR Part 75 and were considered not to have contributed to the explosion, were the subject of citations and orders issued under a separate inspection event.

Respectfully submitted,

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Supervisory Coal Mine Inspector

Clete R. Stephan
Principal Mining Engineer

Nicholas D. Rasnick
Coal Mine Inspector

William A. Dupree, Jr.
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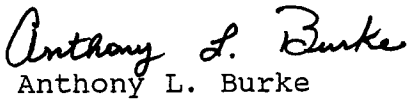

Anthony L. Burke
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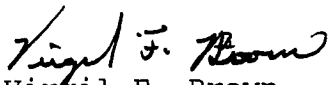
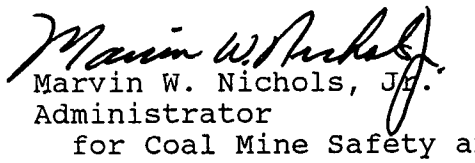


Virgil F. Brown
Coal Mine Inspector
(Electrical)

Approved by:



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

APPENDICES

APPENDIX A

APPENDIX A

Persons working underground at the time of the explosion:

Victim

James H. Lyons	Scoop Operator

Injured

Clarence D. Coleman	Mechanic/Electrician

Survivors

Jeffery L. Adams	Belt Attendant
Randy B. Blackburn	Scoop Operator
Mac K. Blankenship	Roof Bolter Operator
Michael Blankenship	Surveyor, Jesse Branch Coal Co.
Michael R. Chaffins	Roof Bolter Operator
Donnie K. Daniels	Surveyor, Jesse Branch Coal Co.
Willard E. Grizzle	Roof Bolter Operator
Larry D. Hylton	Scoop Operator
Randy Johnson	Scoop Operator
Jerry R. Rowe	Belt Attendant
Dusty O'Brian Scott	Scoop Operator
James W. Standifur	Shot Firer
Jake B. Stump	Cutting Machine Operator
Norman B. Stump	Foreman
Johnny O. Wilson	Coal Drill Operator
Alton J. Wolford	Cutting Machine Operator
Kenneth W. Worrix	Belt Attendant

APPENDIX B

APPENDIX B

Persons who participated in mine rescue and recovery and establishment of ventilation:

A.A.& W. Coals, Inc. - Officials

Jim D. Akers	Vice President/Co-owner
Norman B. Stump	Mine Foreman/Miners' Representative

Kentucky Department of Mines and Minerals

Burl Scott	Commissioner (Lexington, KY)
Leonard Fleming	Deputy Commissioner (Lexington, KY)
David Phillips	District Supervisor (Pikeville, KY)
Roger Reynolds	Supervisor (Hazard, KY)
Richard Watts	Supervisor (Martin, KY)

Pikeville Office Mine Inspectors:	Hazard Office Mine Inspectors:	Martin Office Mine Inspectors:
Raymond Slone	Alexander Johnson	Bobby Sexton
Johnny Ratliff	Benny Stone	Claude Hall
Chester Flint	Curtis Hall	Earl Smith
Bill Cantrell	Johnny Greene	John Runyan
Larry Scott	David Mullins	Kenny Meade
Charles Cantrell	Wesley Gearheart	David Martin
Worley Checks	Frank Reed	Larry Sexton
Nagrattis Chapman	Eugene Lewis	Hershell Tackett
Teddy Akers		
Don Walker		
Kenneth Kelly		
Tony Casebolt		
Edmond Ratliff		
Robert Smith		
Lloyd Woody		

MSHA Mine Emergency Unit (MEU):

CMS&H, District 3 MEU:	CMS&H, District 2 MEU:
Richard Vasicek (Unit Supervisor)	Ronald Costlow (Trainer)
Virgil Brown (Captain)	Allen Dupree
Clint Fabry	Ronald Hixson
Thomas McCort	Charles Pogue (Captain)
Lincoln Selfe	Robert Swarrow
Ronald Tulanowski	Joseph Trybus
Ronald Wyatt	Thomas Todd
Joseph Yudasz	Greg Turner (Captain)
	Richard Zilka

MSHA Headquarters Personnel

Jack E. Tisdale	Accident Investigation Program Manager
Ronald L. Keaton	Coordinator of Mine Emergency Response Office
Spencer Shriver	Electrical Engineer
Katharine Snyder	Public Affairs Specialist

MSHA District 6 Personnel
District Office

Jesse P. Cole	District 6 Manager
Thomas H. Griffith	Ventilation Supervisor
Norman L. Page	Ventilation Specialist
Jerry Bellamy	Ventilation Specialist
Anthony Webb	Ventilation Specialist
Robert Bates	Electrical
Robert H. Bellamy	Special Investigator
John South	Supervisory Special Investigator

Pikeville Subdistrict Personnel

Ray McKinney	Subdistrict Manager
Herman Lucas	Supervisory Coal Mine Safety and Health Inspector
Danny Harmon	Supervisory Coal Mine Safety and Health Inspector
Jerry Taylor	Supervisory Coal Mine Safety and Health Inspector
James Poynter	Supervisory Coal Mine Safety and Health Inspector
Bennett Hylton	Coal Mine Safety and Health Inspector
Michael Belcher	Coal Mine Safety and Health Inspector

Paintsville Subdistrict Personnel

Sandy Barber	Supervisory Coal Mine Safety and Health Inspector
Donald Baker	Coal Mine Safety and Health Inspector
David Ison	Coal Mine Safety and Health Inspector

MSHA District 5 Personnel

Michael J. Lawless	District 5 Manager
Doug Carico	Ventilation Specialist
Larry Stanley	Ventilation Specialist

MSHA Mine Emergency Technology Team

John Urosek	William Francart
Clete Stephan	Gary Wirth
Dennis Beiter	Mark Schultz
Timothy Watkins	Michael Snyder
Mark Schroeder	Edward Chuhta
James Lohrett	Linda Zeiler
Estelle Eleftheriou	Wayne Woodruff

APPENDIX C

APPENDIX C

Personnel who participated in the investigation:

A.A.& W. Coals, Inc. - Officials

Jim D. Akers	Vice President/Co-Owner
Harold Coleman	Superintendent
Norman Stump	Mine Foreman/Miners' Representative

Kentucky Department of Mines and Minerals

Burl Scott	Commissioner
Leonard Fleming	Deputy Commissioner
David Phillips	District Supervisor
Raymond Slone	Mine Inspector
Edmond Ratliff	Mine Inspector

MSHA Investigation Team

Richard Vasicek	Supervisory Coal Mine Safety and Health Inspector, District 3
Clete Stephan	Principal Mining Engineer, Technical Support
Allen Dupree	Mining Engineer Technical Support
Cheryl McGill	Mine Safety and Health Specialist, Headquarters
Anthony Burke	Coal Mine Safety and Health Inspector, District 6
Nicholas Rasnick	Coal Mine Safety and Health Inspector, District 6
Virgil Brown	Coal Mine Safety and Health Inspector, District 3

Office of the Solicitor (DOL)

Gretchen Lucken	Attorney

MSHA District 3 Personnel

Ronald Tulanowski	Coal Mine Safety and Health Inspector
Ronald Wyatt	Mining Engineer

MSHA District 6 Personnel

Norman Page	Coal Mine Safety and Health Specialist
Donald Baker	Coal Mine Safety and Health Inspector
James Frazier	Special Investigator
David Ison	Coal Mine Safety and Health Inspector
John Hendley	Coal Mine Safety and Health Specialist
Benny Freeman	Coal Mine Safety and Health Inspector

MSHA Technical Support Personnel

John Urosek	Supervisory Mining Engineer
William Francart	Supervisory Mining Engineer
Dennis Beiter	Mining Engineer
Edward Chuhta	Mining Engineering Technician
Mark Schroeder	Mining Engineer
Mark Schultz	Mining Engineer
Michael Snyder	Mining Engineer
Timothy Watkins	Mining Engineer
Gary Wirth	Mining Engineer

MSHA Approval and Certification Center

David C. Chirdon	Supervisory Electrical Engineer

APPENDIX I

APPENDIX I

Persons who were interviewed as part of the investigation:

A.A.& W. Coals, Inc. - Officials

Jim D. Akers	Vice President/Co-owner
Harold Coleman	Superintendent
Norman Stump	Mine Foreman/Miners' Representative
Sherman Combs	Trainer

A.A.& W. Coals, Inc. - Employees

Jeffrey L. Adams	Belt Attendant
Randy B. Blackburn	Scoop Operator
Mac K. Blankenship	Roof Bolter Operator
Michael R. Chaffins	Roof Bolter Operator
Clarence D. Coleman	Mechanic
Sonny Dales	Roof Bolter Operator
Willard E. Grizzle	Roof Bolter Operator
Larry D. Hylton	Scoop Operator
Randy Johnson	Scoop Operator
William K. May	Rock Picker (surface)
Jerry R. Rowe	Belt Attendant
Johnny E. Sawyers	Rock Picker (surface)
Dusty O. Scott	Scoop Operator
James W. Standifur	Shot Firer
Jake B. Stump	Cutting Machine Operator
Johnny O. Wilson	Coal Drill Operator
Alton J. Wolford	Cutting Machine Operator
Kenneth W. Worrix	Belt Attendant

Jesse Branch Coal Company

Stephen F. Looney	Vice President of Operation
Michael Blankenship	Environmental Technician

Berwind Land Company

Steven V. Dale	Chief Inspector

Columbia Natural Resources

Donnie W. Meade	Production Supervisor
Joseph E. Spears	Well Tender

Kentucky Department of Mines and Minerals

Bill Cantrell	Inspector

APPENDIX J

Executive Summary - Testing of Equipment

APPENDIX J

U.S. Department of Labor

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

April 8, 1994

MEMORANDUM FOR RICHARD J. VASICEK
Supervisory Coal Mine Safety and Health Inspector
District 3

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

SUBJECT: Executive Summary of Investigations of Equipment Recovered from A. A. & W. Coal Company, Elmo #5 Mine

The Approval and Certification Center (A&CC), as requested by Coal Mine Safety and Health, conducted an investigation of the following equipment recovered from a fatal accident at the A. A. & W. Coal Company, Elmo #5 Mine. The investigation included performance tests and MSHA approval conformance evaluations.

1. One CSE Model 102 Methane Detector, Serial No. 72653, MSHA Approval No. 8C-37-4, recovered from the victim (Exhibit P-1).

2. One Koehler Model 5100-G1 Cap Lamp, MSHA Approval No. 6D-30-46, recovered from the victim (Exhibit P-2).

3. One General Monitors Model 420d Methane Monitor, Serial No. 0777, MSHA Certification No. 32A-16/MS-2, recovered from a scoop.

4. One J & R Manufacturing, Incorporated, Battery Connector, recovered from a scoop.

CSE Model 102 Methane Detector

The methane detector, in the received condition, operated within calibration specifications without adjustment except for the battery charging. The device was built according to the drawings and specifications on file at the A&CC and, when tested, operated within the performance limits specified in Title 30 Code of Federal Regulations, Part 22. There was no evidence that the methane detector initiated an explosion; therefore, no spark ignition tests were conducted.

Koehler Model 5100-G1 Cap Lamp

The investigation identified a number of permissibility discrepancies that were attributable to improper maintenance, misuse, or manufacturing discrepancies which deviated from the approved design. A list of these discrepancies is attached.

During laboratory testing, the cap lamp did not present either a spark-ignition hazard in methane-air mixtures or a hazard for thermal ignition of coal dust or methane-air mixtures even after the battery was fully charged. There was no evidence that the cap lamp initiated an explosion.

The headpiece lens-retaining bezel of the cap lamp recovered from the victim was found to be distorted; the lens was unbroken. The distortion was determined to be caused by heat conduction of coal particles which were possibly deposited by an ignition/explosion.

General Monitors Model 420d Methane Monitor

The investigation identified a number of permissibility discrepancies that were attributable to improper maintenance, misuse, or manufacturing discrepancies which deviated from the approved design. A list of these discrepancies is attached.

The General Monitors Model 420d did not respond to methane as received. The active sensor element of the monitor was found to be defective. It was determined that the element was broken (open-circuited). It was probable that the element was broken before the explosion.

The calibration controls of the monitor were adjusted in a manner that affected the way the monitor responded to a fault in the sensor head circuitry. An open-circuit in the sensor head circuit connected to a properly calibrated monitor will cause the light-emitting diode (led) indicating "malfunction" to illuminate and cause the power shut-off component to trip. The potentiometers used to set the "zero" and "span" settings during calibration were adjusted, as received, such that the defective sensor head did not evoke these responses. However, even with these improper adjustments, pressing the "test" button gave the impression that the monitor was fully functional.

The monitor responded properly to methane when fitted with a functional sensor head and after calibration. It gave the correct display readings; the "low" methane warning led illuminated at 0.9%, and the "high" methane warning led illuminated at 1.4% (and the power shut-off component tripped).

The dust guard on the sensor head of the methane monitor was clogged with dust. It was determined that the monitor, fitted with a functional sensor and properly calibrated, would not accurately respond to methane when fitted with this dust guard.

The power shut-off relay of the methane monitor was wired incorrectly. The NO (normally open) contacts of the relay were wired to the NC (normally closed) terminals on the power supply and vice versa. This is a self-revealing fault; the machine would not have operated had it been connected to the proper terminals.

It was not possible to view the display of the methane monitor due to distortion of a large portion of the illuminated window on the control module. It was determined that the window had been heated to temperatures between 150°C and 420°C, due to heating by small coal or coke particles.

There was no evidence that any component of the methane monitor initiated an explosion.

J & R Battery Connector

The battery connector investigation included a detailed inspection of the connector, as well as several explosion tests, to determine the connector's ability to contain an internal explosion and whether arcing internal to the connector was a possible source of explosion.

The investigation revealed that the connector was manufactured in accordance with the manufacturing specifications with the exception of the locking ring, which was missing. Evidence existed showing that a minimal amount of internal arcing of the contacts that separated first, had occurred at an undetermined time.

Under test conditions, the connector was able to withstand explosion pressures at three times the typical values and under extreme conditions of separation without discharge to or ignition of the surrounding explosive atmosphere. Attempts were also made to explosively separate the connector through internal ignition. The results of the tests indicated that if any arcing had occurred at the time of the accident, the resultant explosion would not have escaped to ignite the surrounding explosive atmosphere of the mine environment.

Comprehensive test results can be obtained from the Chief of the A&CC, RR 1, Box 251, Industrial Park Road, Triadelphia, West Virginia 26059.

Attachment

DISCREPANCIES NOTED

The following discrepancies were noted as a result of the inspections: (All of the items noted here are considered permissibility discrepancies, as the equipment was not maintained in strict accordance with the drawings and specifications on file at the A&CC for the subject approvals.)

1. CSE Model 102 Methane Detector, Serial No. 72653, Approval No. 8C-37-4, Exhibit P-1:

   None.

2. Koehler Model 5100-G1 Cap Lamp, Approval No. 6D-30-46, Exhibit No. P-2 (recovered from victim):

   a. One of the two screws securing the battery top cover was missing.

   b. The bezel sealing screw was broken off and not engaged in bezel.

   c. The cord jacket was not seated properly in the cord lock ring in the headpiece, exposing the individual insulated conductors.

3. General Monitors Model 420d Methane Monitor, Serial No. 0777, Certification No. 32A-16/MS-2:

   a. The power shut-off relay of the methane monitor was wired incorrectly. The NO (normally open) contacts of the relay were wired to the NC (normally closed) terminals on the power supply and vice versa.

   b. Capacitors C13 and C15 on the Logic Board (CCA 20211) in the control module were rated at 35 V instead of 50 V as specified in the approval documentation.

4. J & R Manufacturing, Incorporated, Battery Connector:

   The locking ring used for securing the plug to the receptacle was missing.

APPENDIX K

Executive Summary - Testing of Other Evidence

APPENDIX K

U.S. Department of Labor

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

May 4, 1994

MEMORANDUM FOR RICHARD J. VASICEK
Supervisory Coal Mine Safety and Health Inspector
Coal Mine Safety and Health, District 3

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

SUBJECT: Executive Abstract of Investigation of Evidence Taken From Elmo No. 5 Mine Accident

The Approval and Certification Center, as requested by Coal Mine Safety and Health, conducted an investigation of evidence recovered from the Elmo No. 5 Mine accident that occurred on 11/30/93. The following is a summary of the tests conducted:

1. Melting point tests were made to determine the temperature necessary to damage the seat cushion (Exhibit No. P15) taken from the battery scoop tractor. The melting point tests indicate that the seat cushion began to soften at about 180°C and melt at about 264°C. Confirmation of the melting point test data was made by differential scanning calorimetry which indicated reaction and material changes occurring in the range from about 180°C through 250°C. It is apparent that the heat damage to the seat cushion was from a flame due to the surface charring appearance. The outlined areas on the seat cushion where heat damage did not occur were due to protection of the seat cushion material by the person sitting on the cushion at the time of flame event (hot gases from a fireball). Further details about the appearance of the seat cushion are discussed below.

2. Analysis of the seat cushion indicated that an individual was sitting on it at the time of the flame event. This was determined from visual inspection of the seat cushion for undamaged and heat damaged areas and comparing to the profile the victim's body would have made sitting on the cushion. Also, a dimensional comparison was made of the impression imbedded on the seat cushion by what appeared to be a self-rescuer. The victim was wearing a self-rescuer. The strap tab of the same type of self-rescuer (MSA W-65) was measured and compared to the impression on the seat cushion that appeared to be from a strap tab. The width of the impression (strap tab) on the seat cushion measured 14mm. The width of the strap tab of the same type of self-rescuer measured 14mm. This analysis indicates that the

impression on the seat cushion was made by a self-rescuer from the heat of the fireball while the victim was sitting on the seat cushion. The heat of the fireball softened the vinyl-type covering of the seat cushion causing an impression of the strap tab portion of the self-rescuer to be made.

3. Microscopic examination was made of the burnt material adhered to the top right side of the seat cushion and indicates that the burnt material that adhered to the top of the right side of the seat cushion is of the same material as the burnt material (Exhibit No. P14) containing 12 cigarette butts. Photographs taken at a magnification of 8 times for both materials, illustrate the same size, type, and style of weave pattern and fiber appearance. Visual examination of the seat cushion, with the burnt material adhering to the top right side, indicates that a portion of the victim's shirt from the right shoulder area adhered to the seat cushion from the heat generated by the flame event.

4. Microscopic and visual examination indicate that the burnt material (P14), with a black beveled button attached, is a pocket. Photographs were taken of the material using a microscope. The overall pattern of the sample, a double seam and thread stitching, is suggestive of a shirt pocket. Also, microscopic examination indicated a charred button hole in the material.

In addition, a second piece of material included with Sample P14 was examined by microscope. It had a light blue rounded button attached to it. It appeared to be a different color, type and weave of material than the pocket material with the black beveled button. The material was light gray in color. The victim was reported to have been wearing two shirts. This material may have been a portion of the inner shirt.

5. A temperature exceeding 250°C would be needed for the seat cushion material to melt to the point that a portion of the victim's shirt material would adhere to it.

6. Melting point tests were made to determine the temperature necessary to damage the jacket (Exhibit No. P17). Visual and microscopic examination of the jacket indicates it was comprised of an outer and inner close weaved fabric, a fibrous insulation material, and an open-celled foam material. The close weave fabric material melted about 248 to 252°C. The fibrous insulation material melted at about 253 to 257°C. The foam material began melting at about 284°C.

The jacket is not the same material as Exhibit No. P14. The jacket is composed of several different materials, as indicated above by visual and microscopic examination.

7. The burnt material on the rubber handle (Exhibit No. P18) appears to be the same as from the jacket (Exhibit No. P17). Microscopic examination of the material on the rubber handle shows fibrous insulation and open-celled foam material that closely resemble these same materials from the jacket.

8. The light blue plastic lighter (Exhibit No. P13) was examined and a fingerprint appeared to be at the bottom of the lighter. The lighter was subsequently inspected by a police detective who works for the City of Wheeling, WV. The police detective indicated a visible latent fingerprint was apparent at the bottom of the lighter. Although checks were made, fingerprints were not available for the victim. Identity of the fingerprint found on the lighter could not be determined.

It appears that the lighter was held in the hand when the flame event (fireball) occurred. Examination of the lighter indicates heating (charring) that conforms to areas exposed around the fingers as the lighter would normally have been held. The lighter is undamaged from heat, char and coal/coke dust in the areas where the fingers may have been in contact with it.

9. The lighter (Exhibit No. P13) was examined to determine if it was functional. The lighter was identified as a "BIC" lighter by wording viewed on it under a microscope at low power (7X). The lighter was weighed and cleaned around the gas nozzle to remove debris. A needle was inserted into the nozzle in an attempt to clear it of debris. A pressurized air hose was also used to clean debris from around the nozzle. The lighter flint wheel was struck, using the investigator's thumb, over 25 times to attempt to light the lighter without success. The lighter was shaken and it appeared to have some liquified gas (butane) in it. A small finishing nail was used to pierce through the bottom of the lighter. Upon piercing the bottom of the lighter, gas began escaping around the finishing nail. During the initial escape of the gas, the lighter was very cold to the touch. Approximately 90 percent of the gas escaped in about 15 minutes. The complete escape of the gas from the lighter took about 1-1/2 hours. Weight measurements indicate that the lighter was about 1/4 full (based on comparison weights taken from a similar model lighter). If the gas valve mechanism would have been fully functional, the lighter would have been expected to produce a flame by striking the flint wheel.