United States
Department of Labor
Mine Safety and Health Administration
Office of the Administrator
Coal Mine Safety and Health

Report of Investigation
Underground Coal Mine Explosion
Greenwich Collieries No. 1 Mine - I.D. No. 36-02405
Greenwich Collieries Division of Pennsylvania Mines Corporation
Green Township, Indiana County, Pennsylvania
February 16, 1984

by

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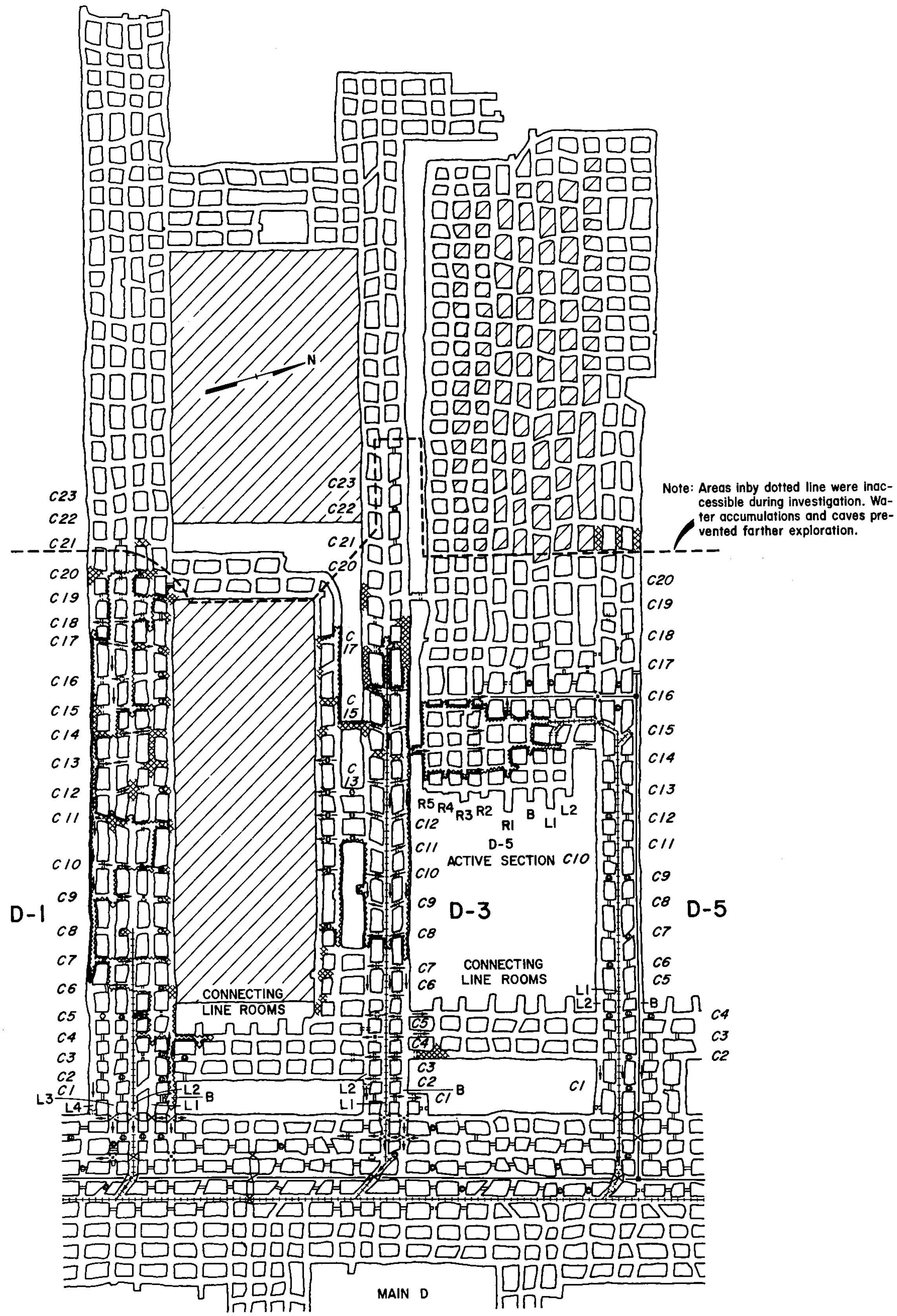

APPENDIX S - MINE MAP (Affected Area)

Direction and extent of forces, extent of flame, and information gathered during the investigation.

Greenwich Collieries No. 1 Mine, ID No. 36-02405,
Greenwich Collieries Division of Pennsylvania Mines Corporation

LEGEND

Symbol	Meaning
	Stopping intact
	Stopping partially out
	Stopping with door
	Stopping with door out
	Stopping out
	Stopping partially out before explosion
R	Regulator
R	Regulator out
	Overcast
	Overcast out
L2	Entry number
C10	Crosscut number
	Track
	Belt
	Extent of flame
	Direction of force
	Roof fall
	Track door out

0 200 400 600
Scale, ft

Abstract of Investigation

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

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

Section A—Identification Data

1. Title of investigation: Underground Coal Mine Explosion
2. Date MSHA investigation started: February 25, 1984
3. Report release date: September 6, 1985
4. Mine: Greenwich Collieries No. 1
5. Mine ID number: 36-02405
6. Company: Greenwich Collieries Division of Pennsylvania Mines Corporation
7. Town, County, State: Uniontown, Indiana County, Pennsylvania
8. Author(s): George M. Fesak, Dale R. Cavanaugh

Section B—Mine Information

9. Daily production: 4,000 tons
10. Surface employment: 7
11. Underground employment: 463
12. Name of coalbed: Freeport D
13. Thickness of coalbed: 42 inches (average)

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

14. Industry: 9.11
15. This operation: 19.67
16. Training program approved: January 16, 1984
17. Mine Profile Rating: N/A

Section D—Originating Office

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

Section E—Abstract

At about 4:30 a.m., February 16, 1984, an explosion occurred in the D-1, D-3, and D-5 areas in the Greenwich Collieries No. 1 mine, Greenwich Collieries Division of Pennsylvania Mines Corporation, Green Township, Indiana County, Pennsylvania. Fourteen miners were present in the D-3 and D-5 areas at the time of the explosion. The three miners in the D-3 area died as a result of the explosion. The eleven miners in D-5 were exposed to heat, smoke, dust, and forces but survived the explosion. Four of these miners, however, suffered severe burns. The names of the miners who were in D-3 and D-5, their ages, job classifications, and mining experience are listed in Appendix A.

Prior to the explosion, water was allowed to accumulate in the D-1/D-3 longwall gob areas and bleeder entries. This water accumulation together with stoppings constructed in the two connecting entries (cut-throughs) between D-3 and D-5, blocked or severely restricted the air traveling inby the No. 6 crosscut in the D-3 entries allowing methane to accumulate in the D-3 entries between the Nos. 11 and 14 crosscuts. MSHA investigators concluded that the explosive methane-air mixture was ignited by electrical arcing created by the normal operation of a nonpermissible, battery-powered locomotive.

Section F—Mine Organization

Company officials:	Name	Address
19. President:	Richard Herron	P.O. Box 367, Ebensburg, PA 15931
20. Superintendent:	Donald Lowmaster	P.O. Box 367, Ebensburg, PA 15931
21. Safety Director:	Joseph Kreutzberger	P.O. Box 367, Ebensburg, PA 15931
22. Principle officer—H&S:	Donald Lowmaster	P.O. Box 367, Ebensburg, PA 15931
23. Labor Organization:	United Mine Workers of America	900 Fifteenth Street, N.W. Washington, D.C. 20005
24. Chairman—H&S Committee:	Kenneth L. Smith	RD 2, Cherry Tree, PA 15724

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GENERAL INFORMATION

The Greenwich Collieries No. 1 mine is located in the vicinity of Uniontown, Green Township, Indiana County, Pennsylvania. The mine is operated by the Greenwich Collieries Division of Pennsylvania Mines Corporation. The Pennsylvania Mines Corporation is a wholly-owned subsidiary of Pennsylvania Power & Light Company. The principal corporate officers of the Pennsylvania Mines Corporation at the time of the explosion were:

Pennsylvania Mines Corporation

Richard Herron	President
John Kierzkowski	Vice President
Jack Tisdale	Vice President - Mining Operations
Joseph Kreutzberger	Vice President - Safety
Barry Woolbert	Vice President - Finance and Treasurer
Joseph Kosek	Counsel and Secretary

The principal management officials of the Greenwich Collieries Division of Pennsylvania Mines Corporation and the Greenwich Collieries No. 1 mine at the time of the explosion were:

Greenwich Collieries Division

John Ruszkowski	General Manager

Greenwich Collieries No. 1 Mine

Leonard Ellis	Mine Manager
Donald Lowmaster	Mine Superintendent
Malcolm Poulter	Longwall Superintendent
Richard Endler	General Mine Foreman
Paul Somogyi	Assistant Mine Foreman

At the time of the explosion, the mine employed 470 miners, with 463 working underground on three coal-producing shifts a day, five days a week. Production averaged 4,000 tons of coal per day.

Mining Methods

The mine, at a surface elevation of approximately 1,550 feet above sea level, was opened in 1969 into the Freeport D coalbed by four drift entries, one triple compartment shaft, one intake shaft, and one return shaft. The three shafts were approximately 450 feet in depth. The drift openings were developed west for 7,600 feet and then turned southwest for an additional 12,800 feet. The mine extended over an area of approximately 5 square miles. A map of the entire mine is in Appendix P.

A block system of mining was employed. Multiple entries were developed with the main entries approximately 20 feet in width. Main entries were normally driven on 60-foot centers with connecting crosscuts on 100-foot centers.

At the time of the explosion, there were 12 active working sections in the mine. There were ten active continuous mining machine sections that utilized shuttle car haulage, one auger mining machine section with continuous conveyor haulage, and one longwall mining section. Normally, eight sections produced coal while the remaining sections were idled for maintenance during each shift. The type of mining being performed on each of the active sections was as follows:

Active Section	Mining Type
Main A	Pillar Development, Continuous Mining Machine (CM)
A-3	Pillar Development (CM)
A4-7	Pillar Development (CM)
A4-7	Retreating Longwall
A4-11	Longwall Development (CM)
A6-3	Pillar Development (CM)
D-5	Pillar Development (CM)
D-8	Longwall Development (CM)
D-9	Pillar Development, Auger Mining Machine
E-6	Longwall Development (CM)
F-4	Longwall Development (CM)
F-6	Longwall Development (CM)

Federal Mine Inspections

The last Mine Safety and Health Administration (MSHA) inspection of the entire Greenwich Collieries No. 1 mine was conducted from October 3, 1983, through December 30, 1983. During this inspection, 58 citations were issued.

An MSHA safety and health inspection was begun on January 3, 1984, and was in progress at the time of the explosion. During the day shifts on February 13 and 14, 1984, a Federal inspector was on the D-5 working section performing inspection activities. The inspector was on the Main A working section during the day shift on February 15, 1984. A total of 31 citations were issued during this inspection, which was terminated on February 16, 1984.

Section 103(i) of the Federal Mine Safety and Health Act of 1977 directs MSHA to conduct a minimum number of spot inspections at mines which liberate certain quantities of methane or other explosive gases. Mines liberating more than 1 million cubic feet of methane during a 24-hour period (ft^3/day) receive a spot inspection a minimum of once each 5 working days. Mines liberating more than 500,000 ft^3/day of methane receive a spot inspection a minimum of once each 10 working days and mines liberating more than 200,000 ft^3/day of methane receive a spot inspection a minimum of once each 15 working days. The Greenwich Collieries No. 1 mine was placed on a 5-day spot inspection schedule on October 1, 1979, after air samples collected by MSHA showed that the mine was liberating more than 1 million ft^3/day of methane.

Roof Support

Generally, the immediate roof over the coalbed consisted of 5 to 10 feet of shale. The main roof consisted of laminated shale or sandstone. The roof was supported throughout most of the mine with 36- to 72-inch resin grouted rods and conventional roof bolts installed on 4-foot centers. In areas where additional roof support was necessary, rails supported by roof straps or posts were installed.

On the A4-7 longwall section, 25-ton jacks were installed in the headgate entry and tailgate entry at 5-foot by 5-foot intervals from the longwall face to 50 feet outby. In addition, three cribs were installed and maintained in the two crosscuts outby the longwall face in the headgate and tailgate entries.

Ventilation and Examinations

There were seven openings into the mine: one triple compartment shaft, one intake shaft, one return shaft, and four drift entries. Mine ventilation was induced by two exhaust fan installations located on the surface at the top of the return shaft (North fan) and triple compartment shaft (Main A fan). The installations included automatic-closing and explosion-relief doors. The North fan was a Jeffrey Model 12A83 Aerodyne fan, driven at 850 rpm by an 800-horsepower, electric motor. Pressure and air quantity measurements made at the fan during the investigation indicated the fan was operating in the 4C blade position at a pressure of 7.67 inches of water. During an inspection made prior to the explosion, an air measurement made at the North fan indicated 478,745 cubic feet per minute (cfm) were exhausted from the mine at this location. The Main A fan was also a Jeffrey Model 12A83 Aerodyne fan, driven at 910 rpm by an 800-horsepower, electric motor. Pressure and air quantity measurements made at the fan during the investigation indicated the fan was operating in the 3D blade position at a pressure of 6.93 inches of water. During an inspection made prior to the explosion, an air measurement made at the Main A fan indicated 442,620 cfm were exhausted from the mine at this location. The methane liberation was 2.4 million ft^3/day during the MSHA inspection ending in December 1983.

Permanent stoppings, overcasts, and undercasts were used to provide the required separation between the various aircourses. The stoppings were constructed of dry-stacked, masonry blocks coated with a sealant or masonry blocks set in mortar. Timbers were also used for stoppings in caving areas. Where feasible, both sides of timber stoppings were coated with a sealant. Overcasts and undercasts were constructed using a combination of masonry blocks set in mortar, corrugated aluminum covered with 1-1/2 to 2 inches of concrete, and 60- and 90-pound steel rails.

Entries in the mine were identified as follows. The entry in which the belt conveyor was located was designated as the B entry. An entry to the left of the B entry (facing inby) was designated by the letter "L" and a number indicating the number of entries this entry was to the left of the B entry. An entry to the right of the B entry (facing inby) was designated by the letter "R" and a number indicating the number of entries this entry was to the right of the B entry. For example, the L3 entry would be the third entry to the left of the B entry.

The three entries of D-3 and five entries of D-1 were driven approximately 3,200 feet and connected to set up a longwall panel. The longwall panel was mined in the outby direction approximately 800 feet when roof and water conditions caused the mining to be abandoned. Later, another set of connecting line rooms were driven between D-1 and D-3 along with two entries driven parallel to the D-3 entries to set up another longwall panel. This outby longwall panel was then mined until December 1983.

Before the explosion, the three entries of D-3 along with the longwall entry parallel to these entries were ventilated with intake air which entered through the mouth of D-3. A split of intake air also entered the D-1 area and traveled through the connecting line rooms from D-1 to D-3 and joined the D-3 intake. Permanent stoppings removed or partially removed between the L1 and L2 entries of D-3 from the No. 6 crosscut inby made the intake air common except for the intake air in the B entry. The intake air in the B entry was made common with the other entries of D-3 at the No. 15 crosscut. This air was used to ventilate the outby longwall gob area, the D-3 entries, and the inby longwall gob area. The air returned through D-1 in the L4 entry where it entered the Main D return.

D-5 was developed by driving three entries to the left off Main D. From these entries, approximately 1,500 feet from Main D, entries were driven 530 feet to the left toward D-3. Entries were then driven 1,500 feet inby from these entries and then pillared. Development was then reversed to its present direction toward Main D. Intake air entered D-5 through the L1 entry, which also contained the track. The air in the B entry was also used as intake air. This air was then used to ventilate the eight faces of D-5 by means of check curtains and line brattice. The air then traveled past the edge of the D-5 gob and into the L2 entry where it was coursed into the Main D return. The D-5 gob ventilation was evaluated by means of one inlet and one outlet bleeder evaluation point, both of which were located at the advancing edge of the water.

Two cut-throughs were also made between D-5 and D-3. According to statements of mine officials and miners, the first cut-through was made at the No. 19 crosscut at the end of December 1983 and the second cut-through was made at the No. 14 crosscut at the end of January 1984.

Preshift, on-shift, and weekly examinations were to be made by certified persons. The results of these examinations were to be recorded in mine record books on the surface. However, on numerous occasions prior to the explosion, preshift and weekly examinations were not conducted.

The Ventilation System and Methane and Dust Control Plan in effect for the mine at the time of the explosion was approved on September 21, 1983. The plan required a minimum of 5,000 cfm of air to be maintained in each working place of the D-5 continuous mining machine section. The plan required a minimum of 3,400 cfm of air to be maintained in each working place of the other continuous mining machine sections, except in areas where adverse roof conditions required additional roof support such as rails or planks. Three thousand cfm of air was required in these areas. Line brattice or other approved devices were required to be maintained to within 10 feet of the area of deepest penetration to which any portion of the working face was advanced, except where approved fan spray systems were used. Line brattice was then required to be maintained to within 17 feet of the area of deepest penetration to which any portion of the working face was advanced. The plan required a minimum of 14,000 cfm of air at the intake end of the longwall face on the A4-7 longwall section.

Combustible Material/Rock Dusting

The application of rock dust was the primary means used for inerting coal dust. Rock dust was applied to the underground areas of the mine, including all working places to within 40 feet of the faces and all crosscuts less than 40 feet from the working faces. Rock dust was applied by hand in the immediate face areas. Rock dust machines were used to apply rock dust in the outby areas and to reapply rock dust on the working sections.

Water lines were extended to the working sections and each section was equipped with sufficient hose to reach each working face. The hose was available for use to abate dust in the working places. Dust created by mining in the face areas was controlled by water sprays on the equipment and by ventilation directed to the working faces by line curtains. Dust at conveyor belt transfer points was controlled by water as needed.

The operator had established a program to prevent the accumulation of loose coal, coal dust, float coal dust, and other combustible materials in the active workings and on electric equipment. However, during the investigation, accumulations of loose coal and coal dust were found at several locations.

Electricity

Three-phase power was purchased from the Pennsylvania Electric Company at 34,500 volts and transmitted to a surface substation near the North Portal. The 34,500-volt, three-phase power was reduced to 12,470-volt, three-phase power by two 5,000 kVA, three-phase transformers in the surface substation. Under normal conditions, each transformer supplied one underground circuit and one surface fan circuit.

Each 5,000 kVA transformer was connected delta-wye. Both secondary neutrals were properly grounded through 25-ampere, current-limiting resistors to a single safety ground field. Each underground high-voltage circuit contained a grounding circuit, originating at the grounded side of the grounding resistor, to ground the metallic frames and enclosures of all electric equipment receiving power from the circuit.

Each surface fan circuit was protected by an individual 560-ampere, oil circuit recloser located in the substation. Each recloser was equipped with relays designed to provide overcurrent and grounded-phase protection for the circuit. Each fan circuit extended from the substation by means of overhead power lines to an 800-horsepower, fan installation.

Each underground high-voltage circuit was protected by an individual 1,200-ampere, oil circuit breaker located in the substation. Each circuit breaker was equipped with a ground check monitor and relays designed to provide overload, short-circuit, grounded-phase, and undervoltage protection for the circuit.

Sets of single-pole, knife-blade switches were provided in the substation to allow disconnecting the phase conductors of each surface and underground high-voltage circuit originating in the substation.

Both underground, high-voltage circuits entered the mine through a borehole within the substation. One underground circuit supplied seven portable power centers and three trolley rectifiers located in the Main A, Main B, and Main C areas of the mine. The portable power centers reduced the 12,470-volt, three-phase power to 600-volt, three-phase power for utilization by conveyor belt drive units, pumps, and battery chargers. The rectifiers converted the 12,470-volt, three-phase power to 300-volt, direct-current power for utilization by the trolley system. Since this high-voltage circuit did not extend into the explosion area, it will not be described in detail in this report.

The other underground, high-voltage circuit supplied 13 section power centers, 37 portable power centers, and 8 trolley rectifiers located in the Main A, A-3, A-4, A4-7, A4-9, A4-11, A6-3, Main D, D-3, D-5, D-8, D-9, Main E, E-6, Main F, F-4, and F-6 areas of the mine. The section power centers reduced the 12,470-volt, three-phase power to the utilization voltages of the electric equipment on the active sections. The portable power centers reduced the 12,470-volt power to 600-volt, three-phase power for utilization by conveyor belt drive units, pumps, and battery chargers. The trolley rectifiers converted the 12,470-volt, alternating-current power to 300-volt, direct-current power for utilization by the trolley-powered equipment.

The second high-voltage circuit contained approximately 58,000 feet of shielded, three-conductor, 15 kV, mine power cable. The phase conductors in the mine power cable were either No. 4/0 AWG aluminum, No. 2/0 AWG copper, No. 2 AWG aluminum, or No. 2 AWG copper. A dual vacuum circuit breaker was installed in the high-voltage circuit near the bottom of the borehole. In addition, a vacuum circuit breaker was installed at the beginning of each underground branch circuit. Each vacuum circuit breaker was equipped with a ground check monitor and relays designed to provide overload, short-circuit, grounded-phase, and undervoltage protection for the branch circuit. Each vacuum circuit breaker also contained a three-phase, visible disconnect switch for the branch circuit.

The section power center for the A4-7 longwall mining section supplied 1,000-volt, three-phase power and 600-volt, three-phase power for utilization by the electric equipment on the section. The other section power centers supplied 600-volt, three-phase power and, generally, 300-volt, direct-current power for utilization by the electric equipment on the other sections. The portable power centers in the mine supplied 600-volt, three-phase power for utilization by conveyor belt drive units, pumps, and battery chargers. The low-voltage, three-phase, secondary circuits of the section power centers and portable power centers were resistance grounded. A three-pole, molded case circuit breaker was provided for each low-voltage, three-phase circuit originating at a section power center or portable power center. Each circuit breaker was equipped with a ground check monitor and devices to provide overcurrent, grounded-phase, and undervoltage protection for the circuit. A direct-current contactor with a magnetic overcurrent relay provided short-circuit protection for each direct-current circuit originating at a section power center. A cable coupler was provided for each low-voltage, three-phase circuit and each direct-current circuit originating at a section power center or portable power center to provide visual evidence that the power was disconnected when the cable plug was withdrawn from the receptacle.

A 300-volt, direct-current, trolley haulage system was provided for the transportation of miners and materials in the Main A, A-4, Main B, Main D, Main E, and Main F areas of the mine. The trolley system did not extend into the entries developed off of the mains. Battery-powered personnel carriers and locomotives were used for the transportation of miners and materials in these areas.

Eleven 300 kW trolley rectifiers supplied the trolley system. A direct-current circuit breaker in each rectifier provided short-circuit protection for the portion of the system supplied from the rectifier.

The electric face equipment was of a permissible type and, according to the mine record books, was examined weekly. A record of these examinations was kept in books at the North Portal mine office.

Fire Protection

The operator's program of firefighting and evacuation instruction for the miners included the location and use of firefighting equipment and self-rescuers, the location of escapeways and facilities, the mine layout in general, the mine ventilation system, the mine communication system, and the mine electrical system. The program in effect at the time of the explosion was approved by MSHA on December 3, 1974.

Firefighting facilities provided for the underground portion of the mine included 6- and 4-inch fiberglass water lines installed along the main line belts. Two-inch branch lines were installed from the main-line belts to the belt tailpieces on the working sections. Water outlets were installed at the belt tailpieces on the working sections and at 300-foot intervals along the water lines. Firehose of sufficient length to reach the working faces was located near the belt tailpiece on each working section, and 1-inch lines were used to supply water to the continuous mining machines. Rock dust and dry chemical fire extinguishers were also available on the working sections. Fire extinguishers of adequate size were provided at electrical installations and on mobile equipment operated in the outby areas of the mine. Two 1,000-gallon, track-mounted water cars were also available for firefighting.

Designated escapeways were maintained continuously to the surface. The results of escapeway examinations conducted by certified persons were recorded in a book kept on the surface. Maps showing the designated escapeways were available on the working sections and on the surface. Fire drills were conducted by the foremen supervising the section crews, and a record was kept in a book on the surface.

Explosives

Explosives were not used on the working sections in the production of coal, but were used occasionally on the longwall face and in outby areas for construction work. Supplies of permissible-type explosives and electric detonators were stored in a surface storage magazine about 750 feet from the drift openings. Explosives and detonators were transported into the mine in closed containers. Explosives were also stored underground in substantially constructed magazines.

Transportation and Haulage

Personnel were transported into the mine by automatic elevators located at the North Portal and Main A Portal. Supplies were transported into the mine by means of rail cars through the drift openings and by means of the automatic elevators. Personnel and materials were transported from the elevators and the outside supply yard by trolley-powered and battery-powered, track-mounted equipment.

On the continuous mining machine sections, coal was loaded at the faces into shuttle cars and transported to the section loading point where it was discharged onto the conveyor belt system, except on the D-9 section where a continuous conveyor haulage system was used. The conveyor belt system transported the coal to a preparation plant. After being cleaned and processed, the coal was loaded into railroad cars.

Communication

Two-way voice communication was provided by a telephone system containing pager telephones located on the surface, at the elevator shaft bottoms, on the working sections, and at other appropriate locations underground. On the longwall section, a permissible telephone system supplied with the longwall controls was used for communication across the longwall face. In addition, a permissible pager telephone system was used for communication between the longwall headgate and tailgate. Both longwall telephone systems were independent of the pager telephone system used for communication throughout the remainder of the mine complex. Trolley phones were installed on most of the trolley-powered vehicles.

Oil Wells and Gas Wells

There were no oil wells on the mine property. Numerous gas wells were present on the mine property although none were located in the D-1, D-3, and D-5 areas. Mining was arranged to avoid mining through these wells.

Smoking

The search program to prevent smoking articles from being taken into the mine in effect at the time of the explosion was approved on October 27, 1970, by the MSHA District Manager. The plan required a monthly search of all persons before they entered the mine and two spot checks at random intervals during each month. Records revealed that several searches for smoking articles were made weekly and recorded in a book on the surface.

Mine Rescue and Self-Rescuers

The Pennsylvania Mines Corporation maintained four trained mine rescue teams equipped with four-hour, self-contained breathing apparatuses. The four teams provided service for all of the corporation's four mines, which were located within two hours ground travel time from the main mine rescue station at the Greenwich complex. The Pennsylvania Mines Corporation also maintained satellite mine rescue stations at the Rushton and Tunnelton mines.

The investigation revealed that both filter and self-contained self-rescuers were provided for all underground employees. Each employee had been trained in the use of the self-rescuers.

Identification Check System

A check-in and check-out system was provided at the mine consisting of a checkboard at both portals and brass tags corresponding to similar tags worn on the miners' belts.

Training Program

The training and retraining plan that met the requirements of 30 CFR Part 48 was approved by the MSHA District Manager on January 16, 1984. The program for training and retraining of certified and qualified persons and for training and retraining of selected supervisors in first aid, mine rescue, gas detecting devices, self-rescuers, ventilation, roof and rib control, and the Federal Mine Safety and Health Act of 1977 was approved on August 6, 1982.

Emergency Medical Assistance

The operator had made arrangements with the Miners Hospital of Northern Cambria in Spangler, Pennsylvania, for emergency medical assistance for the employees at the mine. Emergency transportation for injured persons was provided by four ambulance service companies.

Illumination

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

Mine Drainage System

Mine water was pumped into one of four major underground sumps. Water pumped into the Main D sump (located near the mouth of Main D) and the C-2 sump (located in Main E at the intersection of C-2), in turn, was pumped to the A-2 sump located between A-2 right and Main A. Water was pumped to the surface from the A-2 sump and the B-16 sump (located in Main B near the mouth of B-16).

EXPLOSION, RECOVERY, AND INVESTIGATION

Explosion

The information obtained from MSHA's underground observations and from the voluntary sworn statements of the miners and mine officials during the investigation revealed the following activities and sequence of events. The information about the activities in the D-3 entries on the midnight to 8:00 a.m. shift on February 16, 1984, is limited. All three miners who were working in the D-3 entries were fatally injured as a result of the explosion. The eleven miners working in the adjacent D-5 section were exposed to heat, smoke, dust, and forces but survived the explosion. Four of these miners, however, suffered severe burns to their hands and faces. The names of the miners who were working in D-3 and D-5 when the explosion occurred, their ages, job classifications, and mining experience are listed in Appendix A.

The two crews included the following individuals:

D-3 Entries

Walter S. Depto (Victim)	Pumper
Gary L. Miller (Victim)	Pipeman
Stephen M. Parzatka (Victim)	Pipeman

D-5 Section

Paul W. Stafford (Burned)	Section Foreman
Robert J. Babiak	Roof Bolter Helper
Randy J. Henico	Supplyman
Thomas L. Hilliard	Roof Bolter Operator
Frederick C. Johnson (Burned)	Shuttle Car Operator
Timothy J. Kline (Burned)	Shuttle Car Operator
Edward P. Lacko	Mechanic
Henry J. Lefebure	Mechanic
James Nadolsky (Burned)	Continuous Miner Operator
Thomas A. Pittman	Mechanic
Ronald Westover	Continuous Miner Helper

Depto entered the mine at about 11:00 p.m. on Wednesday, February 15, 1984, one hour before the normal shift change, and traveled to the pipeman's shanty where he was working when the regular shift began.

Miller and Parzatka entered the mine on Thursday, February 16, 1984, at 12:00 midnight. They traveled to the pipeman's shanty from the elevator shaft bottom by trolley-powered locomotive. They arrived at the pipeman's shanty at approximately 12:30 a.m. and began their normal duties.

Merl Pierce, Belt Extension Foreman and the supervisor of the two pipemen, arrived at the pipeman's shanty a short time later and instructed Miller and Parzatka to help Depto make a 20-foot strainer and install it on the 100-horsepower, Labour pump that was located in the L1 entry of D-3 at the No. 17 crosscut. The strainer was made by grinding 6- to 8-inch long by 1/4-inch wide longitudinal slots in a 20-foot long section of 8-inch diameter fiberglass water line. One-inch diameter holes were then drilled in approximately 25 of the slots to increase flow capacity. Pierce left the pipeman's shanty at approximately 2:00 a.m. with the strainer near completion. No other contact was made with the three miners.

Apparently Depto, Miller, and Parzatka finished making the strainer, loaded it on a trolley-powered locomotive, and, at approximately 2:30 a.m., traveled to the mouth of D-3. The trolley wire did not extend into the D-3 entries, so the locomotive was parked at the mouth of D-3. Depto, Miller, and Parzatka then traveled in a battery-powered locomotive to the Labour pump located on a track-mounted flatcar in the L1 entry of D-3. Depto left his lunch bucket and flame safety lamp on the trolley-powered locomotive at the mouth of the D-3 entries. The evidence indicated that Miller and Parzatka put on chest waders, waded into the water, removed the old strainer, and installed the new strainer on the end of the suction line in the L1 entry at the No. 20 crosscut.

The examination of the accident area and the condition and position of the victims' bodies indicated that Depto and Parzatka were in the locomotive with Depto at the controls at the time of the explosion. Miller was either in or near the locomotive. The investigation team concluded that the locomotive was located in or near the No. 14 crosscut when the explosion occurred.

The D-5 section crew entered the mine at 12:00 midnight and, with the exception of Lefebure and Pittman, was transported to the mouth of the D-5 entries by a trolley-powered locomotive. Since the trolley wire did not extend into the section, the crew transferred to a battery-powered locomotive for the last 1500 feet into the working section. The crew arrived on the section at approximately 12:20 a.m. Lefebure and Pittman traveled to the mechanic's shanty and the wireman's shanty, respectively. After receiving work assignments and acquiring the necessary tools, they traveled to D-5, arriving about 2:30 a.m.

Upon reaching the section, the D-5 crew began their assigned duties under the supervision of Stafford. After the face examination was made by Stafford, Babiak and Hilliard began roof bolting operations at the face of the L1 entry, and Nadolsky and Westover began loading coal in the L2 entry with Johnson operating the off-standard shuttle car. Lacko, with the assistance of Kline, began changing a brake unit on the standard shuttle car that was to be operated by Kline. Henico left the section to pick up a new brake unit at about 1:00 a.m. Henico, accompanied by Lefebure and Pittman, returned to the section at about 2:30 a.m. with the new brake unit. Lefebure began changing a defective tram switch on the Kersey tractor and Pittman helped Henico unload supplies.

At about 2:30 a.m., the roof bolting machine was trammed into the L2 entry and the continuous mining machine was moved into the L1 entry. Kline began hauling coal with the standard shuttle car at about 3:00 a.m. At about 3:45 a.m., Henico and Lacko relieved Johnson and Westover for lunch. Fifteen minutes later the roof bolting machine was moved to the L1 entry after the continuous mining machine was moved into the B entry. At about the same time, Pierce arrived on the section with a belt crew. He was informed by Pittman that the tractor was inoperative which prevented his crew from moving belt structure. Pierce left the D-5 section with his crew at about 4:15 a.m. At about 4:20 a.m., Johnson and Westover relieved Kline and Nadolsky for lunch.

When the explosion occurred at approximately 4:30 a.m., Stafford, Kline, and Nadolsky were eating lunch while seated around the inby end of the power center in the intersection of the B entry and the No. 15 crosscut; Pittman was getting his lunch bucket in the No. 15 crosscut about 100 feet outby the power center; Lefebure was working on the Kersey tractor located in the L2 entry between the Nos. 14 and 15 crosscuts; Babiak and Hilliard were beside the roof bolting machine bolting in the face area of the L1 entry; Henico was operating the standard shuttle car which was in position for loading just outby the continuous mining machine in the face area of the B entry; Lacko was just outby the continuous mining machine beside the shuttle car; Westover was in the mining machine operator's compartment; and Johnson was operating the off-standard shuttle car, which was discharging coal onto the belt feeder in the R2 entry at the No. 16 crosscut.

Immediately before the explosion forces reached the power center, Kline told Stafford and Nadolsky that he heard something and that he was getting out of there. As he stood up, the forces of the explosion knocked him to the floor.

Pittman was standing in the track entry about 100 feet outby the power center with his back to the power center when the explosion occurred. He stated that he didn't see any flame, but the forces knocked him to the floor. It took him a few minutes to find his hat and light and make it back to the power center where he found that Stafford, Nadolsky, and Kline had been badly burned. Stafford instructed Pittman to leave the section and call for help.

Lefebure was kneeling beside the tractor when the air started rushing by him. He said he got behind the tractor and felt the heat travel in both directions. While holding his breath, he tried to remove the filter self-rescuer from his belt. He couldn't get it off so he ran a short distance to his self-contained self-rescuer but couldn't get that open. He was forced to breathe and, since he felt no ill effects, he didn't put on either device. He then led Kline and Nadolsky out to the battery-powered locomotive located just inby the No. 14 crosscut in the L1 entry of the original D-5 entries.

At the face of the B entry, the impact of the explosion knocked Lacko to the floor and covered him with brattice cloth. The force of the explosion also blew Westover out of the continuous mining machine operator's compartment. After recovering, Westover hit the panic bar on the machine and started out with Henico and Lacko. After a short distance, Lacko became disoriented, sat down, and put on his filter self-rescuer. Instead of trying to follow Henico and Westover, Lacko followed the shuttle car trailing cable to the power center. There he met Stafford who asked him for assistance in putting on his self-contained self-rescuer. After assisting Stafford with the self-contained self-rescuer, Lacko told Stafford that he was going to get his own self-contained self-rescuer that he had left on the battery-powered locomotive. Stafford told Lacko to trip the incoming power at the power center, which Lacko did. Lacko then walked to the battery-powered locomotive where he found and put on his self-contained self-rescuer. Lacko then assisted Nadolsky, Kline, and Lefebure in putting on their self-contained self-rescuers.

Henico and Westover, after being separated from Lacko, put on their filter self-rescuers and crawled toward the L2 entry where they met Babiak and Hilliard. After hearing the blast and encountering smoke, dust, and heat, Babiak and Hilliard traveled through the last open crosscut into the L2 entry.

Babiak and Hilliard were putting on their filter self-rescuers when Henico and Westover approached. The four miners then made their way to the area just outby the power center where the self-contained self-rescuers were stored. Henico, Hilliard, and Westover put on the only three available self-contained self-rescuers. Babiak attained and put on a self-contained self-rescuer a short time later at the battery-powered locomotive.

The miners near the power center then heard Johnson calling out. Stafford told Johnson to keep talking and he would come and get him. Stafford found Johnson, told him to grab his arm, and assisted him back to the power center. When Stafford determined that all persons on the crew were accounted for, the miners joined the other crew members at the battery-powered locomotive. Before starting out with the crew on the locomotive, Stafford took a final head count and a methane reading. After traveling about seven crosscuts, Stafford stopped the locomotive and the crew walked the rest of the way to the bottom of the Main A elevator and rode to the surface.

Following Stafford's instructions, Pittman had left the section before the rest of the crew to call for help. He ran to the mouth of the D-5 entries, but he didn't use the phone there because there was still dust in suspension and he had no way to check for methane. Pittman ran to the mouth of D-3 where he saw the pumper's trolley-powered locomotive. After calling for Depto, Miller, and Parzatka and getting no answer, he ran to D-1. There he reported that there had been an ignition in D-5 and that some miners had been burned. He traveled to the bottom of the Main A elevator, described the condition in D-5 to George Kohan, Mine Examiner, and rode to the surface.

The forces of the explosion diverged from the Nos. 13 and 14 crosscuts of D-3, damaging all stoppings in the D-3 entries between and including the Nos. 2 and 20 crosscuts. Four overcasts and the regulator at the mouth of D-3 were also damaged. The forces entered the D-5 section through both cut-throughs, but primarily through the cut-through at the No. 14 crosscut, completely disintegrating the newly constructed permanent stopping. The forces entering D-5 also damaged nine stoppings and both overcasts on the section. The regulator and corrugated metal roof panels at the track doors near the mouth of the D-5 entries were also damaged. The forces in the D-1 entries damaged all stoppings in the D-1 entries between the Nos. 6 and 19 crosscuts. The brattice cloth regulator and six overcasts at the mouth of D-1 were also damaged.

David L. Radomsky, Shift Foreman, was in the D-8 section when the explosion occurred. After a sudden gust of air and dust entered the section, Radomsky left the section to investigate. He met a number of miners near the mouth of D-8 at the Main D track including James Martin, Track Foreman, and George Bugay, Shift Maintenance Foreman. Initial reports indicated that a roof fall had occurred in the return of the D-9 section. Radomsky instructed John Gresko, D-8 Section Foreman, to measure the air entering the D-8 section while he walked to the D-9 section. Shortly after arriving at D-9, Radomsky heard Pittman reporting an ignition in D-5 and that all power should be cut off. Radomsky then called the surface and mechanic's shanty and gave instructions to disconnect the power to the mine; to contact Richard Endler, General Mine Foreman, and Leonard Ellis, Mine Manager; to call the ambulance; and to evacuate the mine.

The D-9 section crew then left the section in a battery-powered locomotive. Radomsky walked in front of the locomotive making methane checks until three percent combustible was detected approximately 200 feet outby the D-8 switch in the track entry of Main D. The locomotive was stopped and the miners walked the rest of the way to the elevator. By 5:45 a.m., all miners were on the surface except for the three victims and two motormen.

Recovery

Activities of MSHA Personnel

At 5:30 a.m., February 16, 1984, Pierce notified Albert Gobert, Supervisory Coal Mine Safety and Health Inspector, Hastings, Pennsylvania, that an ignition had occurred at approximately 4:45 a.m. in the D-5 working section and that four persons had been burned. Gobert notified Paul Lenyo, Acting Subdistrict Manager, in Johnstown, Pennsylvania. Gobert dispatched Harry Rorabaugh, Coal Mine Safety and Health Inspector, to the mine with instructions to issue the appropriate orders.

Rorabaugh notified Gobert from the mine at approximately 6:50 a.m. that an explosion, not an ignition, had occurred, four miners had been burned, and three miners were unaccounted for. Gobert relayed the additional information to Lenyo at the Johnstown office and dispatched other MSHA personnel to the mine. At approximately 7:00 a.m., Lenyo notified the MSHA District office in Pittsburgh, Pennsylvania, and the following personnel: Donald W. Huntley, District Manager, who was in Nashville, Tennessee, on official business; James L. Banfield, Jr., Chief, Ventilation Division, Pittsburgh Health Technology Center (PHTC); and George Hazuza, MSHA mine rescue team member. At approximately 7:15 a.m., William Devett, Subdistrict Manager, Johnstown, Pennsylvania, who was in Beckley, West Virginia, on official business, was also notified of the occurrence. Lenyo notified Herschel H. Potter, Chief, Division of Safety, Arlington, Virginia, at approximately 8:00 a.m. Alex O'Rourke, Acting District Manager, who was in Greensburg, Pennsylvania, on official business, was notified by the District office at approximately 8:00 a.m. O'Rourke left immediately for the mine.

The first MSHA employee to arrive at the mine following the explosion was Rorabaugh. He arrived at the mine at approximately 6:35 a.m. and issued a Section 103(j) Order which was later modified to a Section 103(k) Order. The Section 103(k) Order covered the entire mine and permitted only those persons necessary for the rescue operations to enter the mine. A Section 107(a) imminent danger Order was issued by Michael Bondra, Coal Mine Safety and Health Inspector, at 10:15 a.m. to assure the safety of any persons in the mine until an examination was made to determine if the entire mine was safe.

Copies of the Section 103(j) Order, the modification to the Section 103(j) Order, and the Section 107(a) Order are in Appendix O.

At approximately 7:20 a.m., Gene Ray, Ronald Gresh, Gary Boring, William Davis, and Leroy Niehenke, Coal Mine Safety and Health Inspectors, and Gobert arrived at the mine. A surface control center was established in the mine office and Gobert assumed direction of MSHA activities. Gresh was assigned to check the Main A and North fans for methane, carbon monoxide, and oxygen. Both fans were operational and no smoke was observed at this time at either location.

Following are the initial readings reported at the fans:

	Time	Methane	Carbon Monoxide	Oxygen
Main A Fan	8:15 a.m.	0.0%	0 ppm	20.9%
	8:45 a.m.	0.2%	25 ppm	20.9%
	9:15 a.m.	0.2%	10 ppm	20.9%
North Fan	8:25 a.m.	0.1%	0 ppm	20.9%
	8:45 a.m.	0.1%	0 ppm	20.9%
	9:15 a.m.	0.1%	5 ppm	20.9%

At approximately 10:30 a.m., O'Rourke arrived at the mine and assumed the direction of MSHA activities. Other MSHA personnel arrived throughout the recovery operations and were assigned various duties. Huntley arrived at the mine at approximately 2:30 p.m. and assumed the direction of MSHA activities.

The MSHA mine rescue teams were placed on alert at 7:00 a.m. The team from Pittsburgh was dispatched at 9:00 a.m. and arrived at approximately 11:00 a.m. At approximately 3:30 p.m., Huntley requested that the MSHA mine rescue team from West Virginia be dispatched to the site. The team arrived at the mine at 9:00 p.m. Teams members were assigned shift schedules on a continuous basis throughout the recovery operations.

During the recovery operations, MSHA mine rescue team members manned the fresh air bases and established and operated six underground gas monitoring stations. Air samples were taken from the designated areas through flexible tubing and the results called to the surface at 30 minute intervals or immediately if there were any changes. Vacuum bottle air samples were collected from sampling chambers at each station at least once every 6 hours and transported to the mobile gas chromatograph on the surface where they were analyzed.

Mine Emergency Operations (MEO)

At approximately 7:00 a.m. on February 16, 1984, Banfield was notified that assistance would be needed from the PHTC at a mine explosion at the Greenwich Collieries No. 1 mine. Banfield notified Robert G. Peluso, Chief, PHTC, and Madison McCulloch, Director of Technical Support, who were attending a meeting at the Bruceton Safety Technology Center. He also notified Jeffrey H. Kravitz, Chief, MEO, PHTC.

Electronic equipment to continuously measure air contaminants at the mine fans; a mobile van containing a gas chromatograph for analyzing vacuum bottle air samples; and a team to install, operate, and maintain the equipment were dispatched to the mine site. The equipment and personnel arrived at the mine about 12:00 noon on February 16 and remained on site until February 23.

The MEO team was also dispatched to the mine site. The communication and control vehicle and the rescue team support truck, along with personnel to maintain and operate this equipment, arrived at the mine at approximately 1:00 p.m. on February 16 and remained on site until April 6.

Recovery and Reestablishment of Ventilation

At approximately 5:45 a.m. on February 16, 1984, Paul Enedy, Mike Mandrick, Alex Kotrick, George Hoover, Jim Martin, and John Gresko entered the mine in an attempt to locate the three missing miners in D-3, to determine the condition of the overcasts and ventilation at the mouth of the D-1 and D-3 entries, and to locate the two motormen who were also unaccounted for at this time. The six foremen traveled together from the Main A shaft until they reached the Main D switch, where they separated. Martin and Gresko traveled outby along the Main A track from the Main D switch and found the two motormen safe, sitting on their locomotive at the R2 motorbarn.

The other four foremen traveled inby on the Main D track, checking the ventilation as they traveled. They first observed explosion damage in the intersection of the Main D and D-1 track entries. Concrete blocks and tins were blown out of the Main D return overcast onto the D-1 track. They measured approximately 50,000 cfm of air entering the D-1 section, most of which was entering the damaged return overcast. They also measured 24,000 cfm of air traveling inby D-1 on the Main D track toward D-3. No carbon monoxide was found at any of the locations examined. This information was called to the surface from the telephone at the D-1 track switch.

The foremen continued their exploration inby on the Main D track toward D-3. They monitored the direction of air and made checks for carbon monoxide and methane as they traveled. Upon arriving at the intersection of the Main D and D-3 track entries, they observed the pumper's trolley-powered locomotive parked in the D-3 switch. The doors that had been installed in the D-3 track entry between the Main D track entry and the Main D belt overcast were blown off their hinges, and both the belt overcast and Main D return overcast over the D-3 track entry were damaged. They measured approximately 12,000 cfm of air entering the D-3 entries and found no air movement in D-3 inby the damaged return overcast. It appeared that all the air was entering the Main D return at that location. They also measured 10,000 cfm of air traveling inby D-3 on the Main D track toward the D-5 section. No methane or carbon monoxide was found at any of the locations examined in the D-3 area. After calling their findings to the surface they traveled out the track entry to the Main A portal and exited the mine.

At approximately 8:00 a.m., a meeting was held at the control center. The foremen briefed the group on the conditions they observed. The Greenwich Collieries Nos. 1 and 2 mine rescue teams, under the direction of Kruetzberger, along with representatives of Pennsylvania Mines Corporation (PMC), Pennsylvania Department of Environmental Resources (PDER), and MSHA entered the mine at 8:45 a.m. and traveled to the intersection of Main D and D-1. They disconnected the telephone line extending inby the D-1 area and proceeded to the mouth of D-3, arriving at approximately 10:30 a.m. After examining the area in the vicinity of the Main D and D-3 track entries, they reconnected a telephone and called their location to the surface. The Greenwich Collieries No. 1 team explored inby the intersection and reported the following:

(a) The two doors installed between the Main D track and the belt overcast over the D-3 track entry were down;

(b) The Main D intake escapeway overcast over the D-3 track entry had the top blown off;

(c) The Main D return overcast over the D-3 track entry had three concrete blocks missing; and

(d) The D-3 belt overcasts over the Main D return and intake escapeway were damaged.

They continued inby and reported that the stoppings left and right of the L1 entry at the No. 1 crosscut of D-3 were intact; however, the stoppings left and right at the No. 2 crosscut were blown out. There was a perceptible movement of air and no methane or carbon monoxide was detected in the B entry and the L2 entry at the No. 2 crosscut. The Main D return was checked for gases inby D-3 and no air movement, methane, or carbon monoxide was detected. They also determined that there was approximately 10,000 cfm of air traveling inby the D-3 area in the Main D track entry.

While the team was exploring in the D-3 area, personnel at the surface control center decided to make preparations to energize electric power to the Main D area of the mine not affected by the explosion so that pumping operations could be resumed. They decided to disconnect all power conductors extending inby D-1 in Main D. They also decided that the high-voltage circuits and belt drive fire suppression systems should be disconnected near the mouth of D-3 and D-5 so that pumps could later be energized, if needed. This work could be accomplished without apparatus.

The Greenwich Collieries No. 2 team, with the help of other miners, disconnected the circuits at D-3 and D-5. The No. 1 team, also accompanied by additional personnel, returned to D-1 and severed all power conductors immediately outby the D-1 switch with the exception of the high-voltage cable. They also disconnected the Main D track outby the D-1 switch. While the power conductors were being severed, the team checked the D-1 return entry (L4) inby the Main D return. They measured approximately 14,800 cfm of air returning from D-1 which contained 0.8 percent methane and 2000 ppm carbon monoxide. They measured 36,000 cfm of air going in towards D-1, the majority of which was entering the damaged D-1 track and Main D return overcast. There was a perceptible movement of air in the outby direction in the D-1 track entry (L2), which also was entering the damaged overcast. The air returning from D-3 in the Main D return at the D-1 belt overcast contained no methane and just a trace of carbon monoxide.

Both teams returned to the track entry of D-3 and established a fresh air base at the No. 1 crosscut immediately outby the missing stoppings. There was 6,730 cfm of air moving inby at that location. At approximately 1:45 p.m., the Greenwich Collieries No. 1 mine rescue team, using apparatus, explored outby in the L2 entry of D-3 from the No. 2 crosscut and found the regulator blown out. They also explored the R1 entry from the No. 1 crosscut and found the stopping partially out. The team explored the L1 entry to the No. 6 crosscut. They found that all the stoppings between the Nos. 2 and 6 crosscuts right and left of the L1 entry were out. Gas readings taken at the No. 6 crosscut in the L1 entry indicated 9.1 percent methane, over 3,000 ppm carbon monoxide, and 14 percent oxygen. There was light haze and no perceptible air movement. A vacuum bottle air sample was collected and the team returned to the fresh air base. The bottle sample was taken to the surface and analyzed by the mobile gas chromatograph. The results of the analysis were as follows: 7.96 percent methane, 12,400 ppm carbon monoxide, and 14.3 percent oxygen.

At approximately 3:15 p.m., the Greenwich Collieries No. 2 mine rescue team started inby the fresh air base to continue the exploration in the L1 entry. They explored inby the No. 6 crosscut to just inby the No. 12 crosscut. There they encountered hazardous roof conditions and were instructed to return to the fresh air base. The Greenwich Collieries No. 2 team reported posts blown out from underneath crossbars in the No. 7 crosscut, cribs blown out in the L1 entry between the Nos. 8 and 9 crosscuts, a damaged power center in the No. 11 crosscut between the L1 and B entries, and all stoppings between the Nos. 6 and 13 crosscuts right and left of the L1 entry blown out. The team also collected an air sample at the No. 10 crosscut while returning to the fresh air base. The results of the analysis of the sample were as follows: 15.35 percent methane, 9600 ppm carbon monoxide, and 13.63 percent oxygen.

The Tunnelton mine rescue team traveled inby the fresh air base to explore the B and L2 entries to the No. 13 crosscut, including the crosscuts between the L2 and L3 entries. After their exploration, they installed check curtains across the L2, L1, and B entries between the Nos. 10 and 11 crosscuts and returned to the fresh air base. While the rescue team was exploring, a remote monitoring station was established by MSHA mine rescue team members. A sampling probe was installed in the L4 entry of D-1 to monitor the return air at that location. Another sampling probe was installed outby D-1 in the R4 entry of Main D to monitor the return air on the right side of Main D. The No. 1 (D-1) monitoring station reported 1.2 percent methane, over 600 ppm carbon monoxide, and 20.5 percent oxygen at approximately 5:00 p.m. The No. 2 (Main D) monitoring station reported 0.35 percent methane, 10 ppm carbon monoxide, and 20.5 percent oxygen at 6:00 p.m.

The Helvetia mine rescue team left the fresh air base at 7:15 p.m. and installed check curtains at the following locations:

(a) In the seven crosscuts to the left of the L2 entry of D-3 between the Nos. 1 and 8 crosscuts;

(b) Across the three connecting line rooms to the right of the B entry of D-3 at the Nos. 3, 4, and 5 crosscuts;

(c) In the connecting entry to the right of the B entry of D-3 at the No. 1 crosscut;

(d) In the return entry of Main D, immediately outby the D-3 track overcast; and

(e) In the return entry of Main D inby the D-3 belt overcast.

The purpose of the two check curtains in the Main D return was to direct more air into D-3. This work was completed at approximately 9:00 p.m., and an air reading taken in the track entry at the fresh air base indicated 5,400 cfm of air entering D-3.

The Florence No. 1 mine rescue team entered the mine at 9:14 p.m. At approximately 10:00 p.m., a third monitoring station was established at the fresh air base to sample the air returning in the L2 entry of D-3 at the No. 1 crosscut. The check curtains installed across the D-1 track entry were closed completely which increased the air quantity to 8,700 cfm at the fresh air base at the No. 1 crosscut of D-3.

Starting at 10:30 p.m., check curtains were installed between the L1 and L2 entries, up to the No. 7 crosscut. Check curtains were also installed between the L1 and the B entries up to the No. 7 crosscut. The fresh air base was then advanced to the No. 7 crosscut in the track entry at 2:16 a.m. on February 17. During the ventilation of the area, the No. 3 (D-3) monitoring station reported 0.5 percent methane, 300 ppm carbon monoxide, and 20.0 percent oxygen. The No. 1 monitoring station reported 2.1 percent methane, 800 ppm carbon monoxide, and 19.7 percent oxygen. The readings at the No. 2 monitoring station had not changed.

The Rushton mine rescue team started inby the fresh air base at 3:10 a.m. on February 17. They traveled the B entry inby to the cut-through into the D-5 section at the No. 14 crosscut. They reported 5.0 percent methane, 3,000 ppm carbon monoxide, and 18.0 percent oxygen in both the cut-through and the B entry. The stopping that had been installed in the cut-through at the No. 14 crosscut was blown out. The No. 14 crosscut was caved between the B and L1 entries so the team traveled inby to the No. 15 crosscut. They reported that the posts supporting the roof rails in the crosscut between the L1 and B entries were blown out and they continued to the No. 16 crosscut. They found the No. 16 crosscut partially caved and what appeared to be a fall inby the No. 17 crosscut in the B entry. They returned to the No. 15 crosscut and, after further examination of the roof, found the crosscut was roof bolted and the rails were held in place by metal roof straps. They tested the roof and determined that the crosscut was safe to travel. The team moved from the B entry to the L1 entry where, at 4:20 a.m., they observed a battery-powered locomotive just outby the No. 15 crosscut with Parzatka (victim) lying in the inby passenger compartment. They discovered Depto (victim) lying beside the locomotive and Miller (victim) lying approximately 48 feet outby the locomotive in the L1 entry at the No. 14 crosscut. After reporting their findings, the team returned to the fresh air base.

At approximately 5:15 a.m. on February 17, the Florence No. 1 mine rescue team started installing check curtains between the L1 and L2 entries at the No. 8 crosscut in an attempt to clear the area up to the No. 10 crosscut. Readings taken at the No. 9 crosscut indicated 0.2 percent methane, 1,000 ppm carbon monoxide, and 19.0 percent oxygen. The air quantity at the fresh air base at the No. 7 crosscut was only 4,300 cfm. Readings near the air locks between the Nos. 10 and 11 crosscuts indicated 6.7 percent methane, 3,000 ppm carbon monoxide, and 18.0 percent oxygen. Additional air was needed to ventilate the area inby the air locks so that the victims could be recovered without apparatus. Stoppings and overcasts were repaired along Main D between D-1 and D-3 to reduce air loss. The Florence No. 2 and Keystone mine rescue teams installed check curtains across the Main D return entry inby the D-1 belt overcast and removed a check curtain across the Main D equalizing overcasts between D-1 and D-3 to utilize the right return air courses of Main D. These changes increased the air quantity to 10,000 cfm and permitted the fresh air base to be moved inby to between the Nos. 9 and 10 crosscuts in the L1 entry.

Between 12:15 p.m. and 10:00 p.m., the mine rescue teams installed check curtains at the following locations:

(a) In the B and L1 entries inby the No. 15 crosscut;

(b) In the Nos. 9, 10, 11, 12, 13, and 15 crosscuts between the L1 and L2 entries;

(c) In the L3 entry between the Nos. 13 and 14 crosscuts;

(d) In the remaining crosscuts into the outby longwall gob between the Nos. 8 and 13 crosscuts; and

(e) In the cut-through at the No. 14 crosscut.

The area was ventilated, and at approximately 11:00 p.m., the victims were recovered and transported to the surface via the Main A portal. The medical examiner's report indicated that two of the victims died from the combined effects of burns, blast injury, shock, and carbon monoxide poisoning and that the third victim died from the combined effects of burns, blast injury, fractures, and carbon monoxide poisoning.

The location of each victim is shown on the map in Appendix U. The age, job classification, and mining experience of each victim are listed in Appendix A.

At approximately 2:00 a.m. on February 18, mine rescue teams began exploring inby the No. 15 crosscut in all three entries. They explored to the No. 17 crosscut in the L1 entry where they located the Labour pump. They reported that the crosscuts right and left of the L1 entry at the No. 17 crosscut were caved and that the toe of the water was between the Nos. 17 and 18 crosscuts. The water appeared to get progressively deeper inby. They reported 2.5 percent methane, no carbon monoxide, and 20.0 percent oxygen. The team collected an air sample and returned to the fresh air base. The results of the analysis of the sample were as follows: 3.05 percent methane, 66 ppm carbon monoxide, and 20.23 percent oxygen. Since D-3 had now been explored, the mine rescue teams returned to the intersection of the Main D and D-3 track entries. They measured approximately 9,500 cfm of air entering the D-3 section and approximately 20,000 cfm of air traveling inby D-3 in the Main D track entry. The No. 3 monitoring station remained at the No. 1 crosscut in the L1 entry to monitor the D-3 return. The 6:00 a.m. readings at the three monitoring stations were as follows:

Station	Methane	Carbon Monoxide	Oxygen
No. 1	1.75%	80 ppm	20.5%
No. 2	0.0%	0 ppm	20.9%
No. 3	1.2%	11 ppm	20.1%

Mine rescue teams explored inby in Main D between D-3 and D-5 without the use of apparatus. They checked the conditions of the stoppings and made gas checks as they traveled. They established telephone communications to the

D-5 track switch and established a fresh air base. The Main D track was reconnected at D-1 to provide battery-powered transportation to the D-5 switch. The rescue teams explored the area around the intersection of Main D and D-5 and the only damage reported was a 4-inch gap between the deck and wall on the outby end of the D-5 belt overcast at the Main D return. The team explored, with apparatus, all three entries of D-5 inby to the No. 6 crosscut. They explored the connecting line rooms between D-5 and D-3. They reported no other damage, and the highest gas readings were 0.5 percent methane, no carbon monoxide, and 20.5 percent oxygen. The team reported a battery-powered locomotive on the track in the L1 entry between the Nos. 6 and 7 crosscuts. Air locks were installed across all three entries of D-5 between the Nos. 6 and 7 crosscuts and the stopping at the No. 6 crosscut between the L1 and L2 entries was partially removed. A check curtain was installed in the Main D return entry immediately inby the D-5 belt overcast and the two check curtains in the Main D return entry inby the D-1 and D-3 belt overcasts were removed. These changes directed 13,000 cfm of air to the No. 6 crosscut of D-5. The fresh air base was established at this location at approximately 9:30 p.m. and the No. 4 monitoring station was established in the L2 entry.

At approximately 10:00 p.m., exploration was continued inby the fresh air base. The team reported 1.2 percent methane, 10 ppm carbon monoxide, and 20.5 percent oxygen between the Nos. 9 and 14 crosscuts in the L2 entry. The B and L1 entries were relatively clear. They explored the B and L1 entries and encountered water between the Nos. 15 and 16 crosscuts. They could see that the stopping between the Nos. 16 and 17 crosscuts in the belt entry and the stopping between the Nos. 15 and 16 crosscuts in the L1 entry were intact. They reported finding a flame safety lamp belonging to Stafford in the L1 entry at the No. 14 crosscut. They reported that the top deck of the track undercast at the L2 entry was blown out and the water level was 12 inches from the top of the undercast walls. The belt undercast was also full of water. The team removed part of the stopping in the No. 14 crosscut between the L1 and L2 entries and traveled into the L2 entry of the D-5 working section. They reported that the stopping at that location was blown out and what appeared to be a damaged, battery charging station. Check curtains were installed between the Nos. 13 and 14 crosscuts across all three entries. Part of the stopping was removed in the No. 13 crosscut between the L1 and L2 entries, and the area was ventilated at 4:00 a.m. on February 19. The fresh air base was moved to the No. 13 crosscut in the L1 entry. At this time, the monitoring stations reported the following readings:

Station	Methane	Carbon Monoxide	Oxygen
No. 1	2.7%	42 ppm	20.2%
No. 2	0.3%	0 ppm	20.9%
No. 3	0.1%	2 ppm	20.9%
No. 4	0.3%	6 ppm	20.5%

Between 4:30 a.m. and 12:30 p.m. on February 19, mine rescue teams explored the D-5 section. They systematically explored right and left of the No. 14 crosscut until they reached the cut-through into the D-3 entries. They reported that the stoppings in the Nos. 14, 15, and 16 crosscuts between the R2 and R3 entries were blown out; that the stoppings right and left of the No. 16 crosscut in the R1 entry were blown out; and that the stopping located in the L1 entry between the Nos. 15 and 16 crosscuts was blown out. The majority of the

line curtains extending from the No. 12 crosscut to the working faces were blown down. Methane accumulations, ranging from 1.5 percent at the face of L2 to 2.6 percent at the cut-through at the No. 14 crosscut were detected. The oxygen content ranged from 19.0 percent to 20.5 percent and only a trace of carbon monoxide was detected. At 11:58 a.m., the readings at the monitoring stations were as follows:

Station	Methane	Carbon Monoxide	Oxygen
No. 1	2.0%	8 ppm	20.0%
No. 2	0.3%	0 ppm	20.5%
No. 3	0.0%	0 ppm	20.9%
No. 4	0.1%	0 ppm	20.5%

At this time, all parties agreed that the need for further exploration for possible fire no longer existed and that ventilation should be established in the remaining areas of Main D inby the D-5 section.

At approximately 5:00 p.m. on February 19, the teams retreated to Main D at the D-5 track switch. The Nos. 2, 3, and 4 monitoring stations were discontinued and two other remote stations were established. The No. 5 monitoring station was located so that it monitored the right return of Main D between D-3 and D-5 in the R3 entry and the No. 6 monitoring station was located so that it monitored the Main D left return inby D-5. Initial methane readings at the No. 6 station were 4.0 percent. Extensive ventilation changes were made in the D-1, D-3, and D-5 areas of the mine so that additional air was directed into the D-5 section. Air was coursed through the D-5 section and into D-3 through the cut-throughs. The air swept the edge of the water in D-3 and was directed so that it ventilated the D-3 side of the outby longwall gob. Intake air was also directed into the D-1 and D-3 entries so that all entries were ventilated. The ventilation changes were completed by about 12:30 p.m. on February 20, and all persons and electric power were removed from the mine. The check curtain located inby the D-5 belt overcast in the Main D return entry was removed just prior to evacuation. This opened the Main D return inby D-5 and air was coursed into the D-7 and D-9 entries.

Persons re-entered the mine at 6:30 p.m. on the same date and re-established the Nos. 1, 5, and 6 monitoring stations. The methane reading at the No. 6 station had dropped to 1.6 percent. Between the period of 8:00 p.m. on February 20 and 2:00 a.m. on February 21, the mine rescue teams explored the areas inby D-5 to the D-7 entries. They encountered 4.2 percent methane inby the stopping line at the intersection of the D-7 and D-9 entries. The exploration of the remaining areas inby D-5 was completed at 5:00 a.m. on February 23. Additional repairs were performed on the damaged ventilation controls in the D-1 and D-3 areas of Main D. Mine rescue teams then explored all five entries of D-1 up to the No. 5 crosscut. Water prevented exploration inby the No. 5 crosscut and the mine rescue teams were withdrawn from the mine at 9:30 a.m. on February 23.

The names of the mine rescue team members who participated in the recovery operations are in Appendix B.

Investigation

Participants

Shortly after the explosion, MSHA organized an investigation team and appointed Cecil E. Lester, Mine Safety and Health Specialist, team leader. The investigators assembled at the MSHA field office in Indiana, Pennsylvania, on February 21, 1984, and developed detailed plans and procedures for investigating the explosion. The investigation was conducted jointly with the Pennsylvania Department of Environmental Resources, Office of Deep Mine Safety. Officials and employees of the Pennsylvania Mines Corporation (PMC) and the Greenwich Collieries No. 1 mine and officials of the United Mine Workers of America also participated in the investigation. The names of the persons who participated in the underground investigation are in Appendix C.

Underground Investigation

The underground investigation was begun on February 25, 1984, and was completed on April 5, 1984. Insufficient and unstable ventilation in the Main D and adjoining areas prevented the investigation team from entering the mine between February 25 and March 6. The unstable ventilation was caused by leakage through ventilation controls and accumulations of water in the D-1, D-3, and D-5 areas of the mine; along the Main D track; and at the mouth of D-5. Extra pumps and discharge lines were installed to alleviate this situation. On March 1, rehabilitation of the intake escapeway stopping lines from the Main A portal to the mouth of D-5 was begun in order to ensure a primary escapeway for the investigation team and to reduce the amount of leakage in the airway. During this same period, the quantity of air entering D-5 was reduced because water was collecting in the low areas at the return overcasts at the mouth of the D-5 entries. It was then discussed and agreed upon by all parties that intake air would be coursed into D-3 and through the connecting line rooms between D-3 and D-5, thus by-passing the water problem at the mouth of D-5. To direct the air into D-5, check curtains were installed in D-3 inby the connecting line rooms.

On March 6, 1984, the underground investigation continued. Water levels were gradually dropping and the ventilation system had stabilized. On March 8, 1984, it was decided that the water would be maintained at its current level. This was done so that the ventilation in the explosion area would remain stable. Later in the same day, 1.4 percent methane was detected in the R1 entry of the D-5 section at the No. 16 crosscut. The investigation team withdrew from the mine. It was noticed upon arrival on the surface that a sudden drop in barometric pressure had occurred shortly before the 1.4 percent methane was detected.

To maintain positive pressure against the D-5 gob, check curtains were installed to direct air past the gob after it had been coursed to the eight working faces of D-5. These check curtains were installed between the Nos. 13 and 14 crosscuts in the R3, R4, and R5 entries of the D-5 section. These changes reduced the methane to below 1.0 percent and the investigation was able to continue the following morning. On March 12, 1984, the investigation was again delayed until the water was pumped to a lower level. This allowed access to additional inby areas of D-1 and D-5. As the water level was lowered, line brattice was moved inby to maintain ventilation to the water's edge. A check curtain was also installed in the B entry of D-3 just outby the outby cut-through to direct more air to the inby areas of D-3.

On March 21, 22, and 23, the investigation continued. During this time, the water level stablized in D-1 and D-3 with a 2-inch-deep stream of water flowing into D-5 through the inby cut-through. This was the level of the water 36 hours before the explosion. In addition to examining inby areas and equipment that had been inaccessible due to the water, such as the Labour pump and the pump starter, the ventilation inby the inby cut-through was evaluated and checked for perceptible air movement.

The investigation was again delayed until the water at the mouth of D-1 could be pumped to a lower level. On April 3, the investigation team entered the mine to gather further information. The investigation team encountered an explosive methane-air mixture in the L4 entry of D-1 inby the No. 10 crosscut. That evening, curtains were installed between the L2 and L3 entries in the Nos. 6, 7, 9, 10, and 11 crosscuts which directed the air over the caved areas in the Nos. L1 and L2 entries. On April 5, the investigation team was able to travel inby the No. 10 crosscut in D-1 to the No. 20 crosscut. Curtains were installed between the L2 and L3 entries in the Nos. 12 through 19 crosscuts. Water was encountered at the No. 20 crosscut and prevented observations in D-1 inby the No. 22 crosscut. A map showing the ventilation of the affected area during the investigation is in Appendix R.

The investigation was conducted in the affected areas of the mine and all existing conditions were evaluated and recorded by team members on maps or in notebooks. Maps, showing detailed information gathered in the affected areas, are contained in Appendices T, U, and V. Photographs and sketches were made of conditions, equipment, and other articles as were necessary. Several of the photographs appear in Appendix N.

An Absolute Mine Ventilation Pressure-Air Quantity Survey was conducted and the results of this survey are contained in Appendix E. A Methane Liberation Study was conducted and the results of this study are contained in Appendix F. Copies of the fan pressure recording charts for February 16, 1984, are contained in Appendix G.

Sworn Statements

Beginning on March 27, 1984, and continuing to April 27, 1984, representatives from MSHA, Pennsylvania Department of Environmental Resources, PMC and United Mine Workers of America received sworn statements from 66 persons who participated in the mine recovery operations or persons who could have had knowledge of the conditions in the affected areas prior to the explosion. Officials and employees of PMC and the Greenwich Collieries No. 1 mine and MSHA personnel provided testimony voluntarily. The names of these persons are in Appendix D.

Copies of the sworn statements were made available to all interested parties. The transcripts of all the statements were released to the general public on June 15, 1984.

DISCUSSION AND EVALUATION

Ventilation of D-1, D-3, and D-5

The five entries of D-1 were started about August 1979 and were driven a distance of approximately 3,400 feet from Main D. The three entries of D-3, along with a fourth entry that was only driven one crosscut, were started about June 1980 and were driven approximately 3,200 feet from Main D. D-1 and D-3 were connected with three connecting line rooms near Main D, leaving a 100-foot wide barrier pillar. These connecting line rooms were driven for the proposed longwall. D-1 and D-3 were also connected at the inby end to form the setup entries for the longwall. The inby longwall began operation in June 1982 and was removed by March 1983. According to sworn statements, longwall operations were discontinued because of adverse roof and water conditions. Around June 1983, setup entries for the outby longwall were driven. The outby longwall began operation around August 1983 and was removed during December 1983. The D-1 and D-3 areas were not mined between this time and the time of the explosion.

D-5 was initially developed by three entries driven 2,150 feet to establish a longwall panel. Because of adverse roof conditions, no longwall mining was begun; instead, five entries (C14-C18) were driven toward D-3, extending the Nos. 14 through 18 crosscuts. From these entries, a total of eight entries were driven in the same direction as the original three entries extending D-5 to a total distance of about 3,000 feet. Rooms were then driven to the left and the area pillared back to the No. 19 crosscut. The section was then turned 180 degrees and was being driven toward Main D with eight entries at the time of the explosion.

Intake air entered D-3 through the L1 (track) and B (old belt) entries. A closed regulator was located in the L2 entry between the Nos. 1 and 2 crosscuts. According to sworn statements, no one other than Endler had taken an air reading in D-3 during the month preceding the explosion. Endler measured 9,000 cfm of air on February 13, 1984, in the L1 entry of D-3 just outby the No. 2 crosscut. The quantity of air entering D-3 in the B entry had not been measured since some time in December 1983. Endler also indicated that when the outby longwall equipment was being pulled off the panel roughly 3,000 or 4,000 cfm of air was entering D-3 from D-1 through the connecting line rooms between D-1 and D-3.

Several miners traveled in D-3 during the month prior to the explosion, but no one knew for sure how D-3 was ventilated. Johnson stated that he was in D-3 early in the week before the explosion and that the track doors were closed and two check curtains were installed across the L1 entry. He also said that stoppings were out or partially out between the L1 and L2 entries inby the No. 6 crosscut. Gordon Shaffer, Shift Foreman, walked the D-3 track from Main D to the cut-through at the No. 14 crosscut and could not recall any check curtains across the track on February 13, 1984. Except for the three victims, Harry J. Miller, Kersey Operator, was probably the last person to ride into D-3 before the explosion, and he remembered running through at least one check curtain. Edward J. Blazosky and Marlin T. Bougher, Pumpers, along with Pierce were probably in the D-3 area more than any other persons during the month prior to the explosion. They stated that two check curtains were installed across the D-3 track entry. Henry Carpinello, Longwall Setup

Foreman, and Robert S. Nagle, Section Foreman, who worked on removing longwall equipment on the D-3 side, also indicated that there were two check curtains installed in the L1 entry. Both foremen stated that there was at least one open crosscut between the L1 and L2 entries between the two check curtains in the L1 entry.

The investigation team believes that one or two check curtains were installed across the L1 entry in D-3 at the time of the explosion, one located outby the No. 6 crosscut and the other located two or three crosscuts inby.

The check curtains in the L1 entry of D-3 regulated the amount of air that entered D-3. Although there were open crosscuts between L1 and L2, the open crosscuts did not aid the ventilation of D-3 because they were inby a check curtain. Air entering the old belt entry of D-3 was also regulated. Box checks were located just outby and inby the mouth of D-3 in the Main D belt entry.

Air entered D-1 in the B, L1, L2, and L3 entries. The L4 entry was used as a return aircourse and contained a brattice cloth regulator just outby the No. 1 crosscut. Endler said he measured 20,000 cfm of air at this regulator on February 13, 1984. As stated before, 3,000 or 4,000 cfm of air entered the B entry of D-1 and was coursed through the connecting line rooms to D-3. A check curtain was installed inby the No. 4 crosscut in the B entry of D-1 to direct the air toward the connecting line rooms. According to Endler, a check curtain was also located in the L1 entry of D-1 between the Nos. 5 and 6 crosscuts. A stopping was located in the L1 entry one crosscut outby the check curtain.

Endler also stated that track doors were located in the L2 (track) entry of D-1, a permanent stopping was located in the L3 entry inby the No. 5 crosscut, and stoppings were located between the L1 and L2 entries from the No. 18 crosscut outby to Main D. Endler stated that the air that entered D-1 through the check curtains across the D-1 entries and the air that came across the outby longwall gob was coursed inby to the No. 18 crosscut. He said that the air then returned in the L2, L3, and L4 entries to the No. 5 crosscut, where it was coursed into the L4 entry and entered the Main D return. During the investigation, however, numerous stoppings in this area were found to be partially out or had blocks missing, but not as a result of the explosion. Much of the 20,000 cfm of air that Endler measured in the L4 entry was coursed no farther inby than the No. 11 crosscut in D-1.

According to sworn statements and underground observations, air entered the D-5 entries in the L1 (track) entry and in the B (belt) entry. Air entered the D-5 active section from the original D-5 entries through overcasts at the Nos. 14 and 15 crosscuts. The use of belt air at the face was permitted provided a 50-foot per minute (fpm) air velocity was maintained near the belt tailpiece. The air was then coursed across the eight active faces of D-5, toward the D-5 gob, across the water, and across the return overcasts in the L2 entry. It was then coursed through the return regulator located between the Nos. 1 and 2 crosscuts and entered the Main D return.

Endler and Shaffer had both measured the air in the D-5 return on February 13 near the No. 5 crosscut. Endler stated that he measured 27,000 cfm of air while Shaffer stated that he measured 25,000 cfm of air.

Russell measured 11,000 cfm of air entering D-5 in the L1 entry at the No. 14 crosscut about a week prior to the explosion. Stafford tried to measure the air in this same location on February 12, but the air velocity was less than 75 fpm, and he estimated that 9,200 cfm of air was entering D-5. Stafford said he normally measured 17,000 cfm of air in the return at the belt overcast and 10,000 cfm of air in the last open crosscut.

The D-5 gob ventilation was to be evaluated by means of bleeder evaluation points located at the edge of the advancing water. The inlet point was set up in the R5 entry, and the outlet point was established in the B entry of the original D-5 entries.

Cut-Throughs Between D-3 and D-5

During the last week in December 1983, an entry was driven at the No. 19 crosscut that connected the D-5 section to the D-3 entries. According to Endler, this cut-through was developed to provide a means to drain the water being produced in the pillared areas of D-5 into the D-3 entries, where the water was to be removed by the Labour pump.

George Kohan, Mine Examiner, was the D-5 section foreman when the cut-through was made. He had temporarily replaced Stafford who was off for the holidays. At the time the entry was cut through, Kohan stated that there was air movement through the cut-through traveling from D-3 toward D-5 and that the air from D-3 smelled stale. Kohan said he checked for methane and oxygen deficiency and took an air reading in the cut-through. Kohan could not remember the exact readings, but he did recall that he found no unusual conditions or significant changes in the ventilation of D-5. He also stated that there was a check curtain installed in the cut-through when his crew left the D-5 section on the day the cut-through was made.

Approximately one month after the cut-through at the No. 19 crosscut was completed, a second connecting entry was driven between the D-5 section and the D-3 entries at the No. 14 crosscut. According to Endler, this second cut-through was to provide access to the edge of the water in D-5 after the mining in D-5 was completed. The water level in D-5 would be a convenient measure of the effectiveness of the pump in the D-3 entries. Stafford was the D-5 section foreman at the time this cut-through was completed. He stated that at that time there was air movement from the D-3 entries into the D-5 section through the cut-through and that a check curtain was installed after the mining machine was removed.

Preparations for the construction of permanent stoppings in the cut-throughs began on Monday, February 13, 1984. Miller delivered a load of concrete blocks and a man door to the outby cut-through at the No. 14 crosscut and Robert Mitchell, Precision Mason, constructed the stopping just prior to the end of the day shift. Mitchell stated that there was a significant amount of air leaking around the check curtain at the time the stopping was being built.

The following day, Mitchell and Miller were instructed to build a crib block stopping in the inby cut-through at the No. 19 crosscut. They obtained a load of crib blocks in the D-3 entries and attempted to travel to the inby cut-through through the B entry of D-3. They encountered water between the Nos. 16 and 17 crosscuts. Mitchell and Miller waded to a point where the water was up to the top of their boots, yet they still were not within sight of the cut-through. They then decided to haul the crib blocks to the inby cut-through through the D-5 section. Mitchell and Miller encountered water in the R5 entry of D-5 at about the No. 17 crosscut, but the water was not so deep as to prevent the passage of the supply tractor. The stopping was about 70 percent complete at the end of the shift. Mitchell stated that he returned to the D-5 section and finished building the stopping during the day shift on Wednesday, February 15.

Air entering D-5 from D-3 through the cut-throughs at the Nos. 14 and 19 crosscuts affected the ventilation in both the D-3 entries and the D-5 section. After the cut-throughs were driven, normal air readings in the last open crosscut of D-5 were around 10,000 cfm. Russell said his average last open crosscut air reading was 10,500 cfm and Stafford reported an average air reading of 10,000 cfm in the last open crosscut. As stated previously, Stafford normally measured 17,000 cfm of air in the return at the section belt overcast. In Stafford's opinion, the difference in the normal last open crosscut and return readings was the air entering the section through the cut-throughs. Russell measured only 12,000 cfm of air in the last open crosscut of D-5 on February 14, after stoppings on the section were patched, an overcast was repaired, and a door was installed in a stopping where a hole was located. On the shift of the explosion, Stafford measured 17,000 cfm of air in the last open crosscut after stoppings were installed in both cut-throughs. Stafford said he believed the increase in air was due to the stoppings that had been installed in the cut-throughs.

According to sworn statements, sufficient air measurements to evaluate the ventilation in the D-1 and D-3 areas were not made during the month preceding the explosion. Air movement in outby areas of D-1 and D-3 would not necessarily ensure that a ventilating current was traveling in D-1 inby the No. 11 crosscut or in D-3 inby the No. 6 crosscut. Much of the air movement in the D-3 entries inby the No. 6 crosscut was eliminated when the stoppings were constructed in the cut-throughs.

Water Accumulations in D-1, D-3, and D-5

John Matthew, Lampman, worked in the D-1 and D-3 areas as a Pumper when the first longwall was installed. According to Matthew, water became a problem within two weeks of the start of the panel, which was about June 1, 1982. As many as 13 pumps had been installed along the longwall face. Matthew stated that the pumps were pumping the water to the rear of the longwall gob only to have it flow back to the face and that he had reported this situation to Ellis and Ruszkowski. Matthew believed that the primary reason the inby longwall advanced only 800 feet in 9 months and was prematurely removed from operation was the failure to keep the longwall face free of water. He stated that the D-3 entries near the beginning of the inby longwall panel were lower than the surrounding area and that the water was roofed in these entries shortly after the panel was started. Matthew also stated that he remembered Ellis traveling the longwall face during the time the longwall was in operation.

Pierce stated that on or about December 13, 1983, a 100-horsepower, Labour pump was installed in the track entry of D-3 at the No. 17 crosscut, replacing four smaller pumps. At that time, the edge of the water in the D-3 entries was about 30 feet inby the No. 17 crosscut. Pierce believed that this pump, rated at 750 gallons per minute (gpm), could at peak capacity control the water being produced in D-3.

After the cut-through was made at the No. 19 crosscut, a 15-horsepower, Prosser pump was installed in D-5 just inby the cut-through in the R5 entry to pump water from D-5 into D-3. Pierce said that, with the shallow head and short discharge line, this pump added 700 to 800 gpm more water into D-3. This resulted in about twice as much water entering D-3 than the Labour pump could remove and most of the water that was being pumped into D-3 flowed back into D-5 through the inby cut-through. Pierce researched higher capacity pumps and discussed the need for a larger pump in D-3 with Endler and Ronald Riva, Chief Mine Electrician. Pierce said he got no response, so he tried to increase the capacity of the Labour pump. The Saturday before the explosion, the pump head, including the impeller, was changed. Pierce said he also tightened the packing and adjusted the gate valve on the following Tuesday. The work performed by the three victims just before the explosion occurred was yet another attempt to increase the capacity of the Labour pump.

From the time the inby cut-through was made until the stopping was started in the cut-through, the water level in D-3 could not rise significantly above the inby cut-through since any excess water could drain freely into D-5 where the water level was lower. Mitchell stated that the water level in the inby cut-through rose between 4 and 6 inches from the time he started the stopping on Tuesday to the time he finished the stopping the following afternoon. After the stopping was started in the cut-through on Tuesday, the water could not flow back into D-5. Judging from the rate of the rise of the water level in D-3 during construction of the inby stopping, the increase in the water level could have been as much as 9 inches over the 36 hours immediately preceding the explosion.

After the explosion, the power was disconnected from the D-1, D-3, and D-5 areas of the mine and remained off for several days. This allowed the water in these areas to rise until it began to drain into the Main D entries.

During the investigation, water was pumped out of D-5 until a 2-inch deep stream of water flowed from D-3 into D-5. This was the level of the water 36 hours before the explosion when Mitchell began building the stopping in the inby cut-through. The following observations were made with the water at this level:

1) The edge of the water was 6 feet inby the No. 17 crosscut. in the L1 entry of D-3.

2) Four stoppings were intact in D-3 between the L1 and B entries at the Nos. 21, 22, 23, and 24 crosscuts.

3) The edge of the water in the L3 entry of D-3 was located just inby the No. 17 crosscut. The water was roofed at the No. 20 crosscut.

4) The edge of the water in the L2 entry of D-1 was located at the intersection with the No. 20 crosscut. The water was roofed in the area of the No. 22 crosscut.

Water had affected the mining operations in the D-5 section also. Russell stated that he had to move pumps all over the place to keep the water low in the areas where mining was being conducted. At the time of the explosion, five pumps were in operation on the D-5 section. Four others were on the section but were not being used. Of the five pumps that were in operation, one or two were periodically idled due to the limited number of receptacles available at the power center. A distribution box to provide additional receptacles had been delivered to the section but had not been installed prior to the explosion. According to Pierce, continuous operation of all five pumps was needed to stabilize the water level in D-5.

Atmospheric Pressure

Atmospheric pressures recorded by the National Weather Service at the Pittsburgh International Airport and adjusted for the higher elevation at the Main A portal from 7:00 p.m., February 13 to 7:00 p.m., February 17 were as follows:

Date	Time	Atmospheric Pressure
February 13	7:00 p.m.	28.34
February 14	7:00 p.m.	28.37
February 15	7:00 p.m.	28.52
	8:00 p.m.	28.53
	9:00 p.m.	28.54
	10:00 p.m.	28.54
	11:00 p.m.	28.54
February 16	12:00 a.m.	28.51
	1:00 a.m.	28.51
	2:00 a.m.	28.52
	3:00 a.m.	28.51
	4:00 a.m.	28.53
	5:00 a.m.	28.53
	6:00 a.m.	28.52
February 17	7:00 p.m.	28.30

In the opinion of the MSHA investigators, these slight fluctuations of the atmospheric pressure had no bearing on the explosion.

Source of Methane

The coalbed in the D-1, D-3, and D-5 area is relatively level. The difference in elevation between the highest and lowest levels was about 25 feet. The highest point in this area was located in D-3 at the No. 13 crosscut. In addition, two intersections near this high area in the L1 (track) entry were higher due to roof falls. The dome-shaped roof in the L1 entry at the No. 13 crosscut was approximately 15 feet high prior to the explosion. The roof of the intersection at the No. 14 crosscut was approximately 12 feet high. The down slope of the L1 entry in the inby direction from the No. 13 crosscut was about 4 percent for a distance of 400 feet. The down slope of the L1 entry in the outby direction was about 2 percent. All three gob areas were 5 to 15 feet lower than this high area.

MSHA investigators concluded that the rising water in D-3 increasingly restricted the air flow to the inby longwall gob and outby longwall bleeder entries. Air moving in the D-3 entries was further restricted when the stoppings were constructed in the two cut-throughs. The majority of the air that leaked through the curtains installed across the mouth of D-3 travelled across the face of the outby longwall gob to the D-1 return. The air movement in the D-3 entries inby the No. 6 or 7 crosscut was not sufficient to prevent methane from migrating up the sloped roof primarily from the outby longwall gob and accumulating in the higher D-3 entries between the Nos. 11 and 14 crosscuts.

Examinations

The middle mine management structure consisted of a general mine foreman, an assistant mine foreman, three shift foremen, and three general assistants. Each of the three shift foremen and each of the three general assistants was assigned two coal-producing sections. Each of these management employees was of the opinion that his primary responsibilities were safety and coal production on his two assigned sections. A shift foreman or general assistant was not assigned to be directly responsible for areas of the mine other than the coal-producing sections, even though areas such as D-1 and D-3 were crucial to the safety of all miners in the mine. As a result of this management practice, areas such as D-1 and D-3 were generally ignored by the shift foremen and general assistants.

A preshift examination of the D-3 area was not made by a certified person within 3 hours preceding the entry of the three victims into D-3. This was determined by examining the preshift examination books; by the absence of dates, times, and initials in the D-3 entries; and by the sworn statements given during the investigation.

Pumpers and pipemen were trained and qualified in the use of a methane detector and in the use of a flame safety lamp for detecting oxygen deficiency. According to sworn statements, however, these persons were not trained or instructed in when and where to make checks for methane and oxygen deficiency or in the detection of other hazards inherent in entering into or working in an area of the mine that was not routinely examined by a certified person. Blazosky and Bougher could not remember being instructed to make checks for methane and oxygen deficiency in nonproducing areas such as D-3. They did state, however, that they each started carrying a methane detector and flame safety lamp when they started their jobs as pumpers.

Although all three victims were trained and qualified in the use of a methane detector and in the use of a flame safety lamp, only one had any detecting devices with him upon entering D-3. A methane detector was found in Depto's clothing, but his flame safety lamp was found on the trolley-powered locomotive located at the mouth of D-3.

Prior to the explosion, preshift examinations were performed on coal-producing sections to aid production. The section foremen, after performing their preshift examinations, called their findings to the surface where the results of the examinations were recorded. These callouts, which included reports about coal production, delays, needed supplies, and the condition of production equipment, were made to the portal where that particular foreman entered the mine. When the oncoming section foreman entered the mine through a different portal, he had no way to be sure that a preshift examination had been performed. The accepted practice was for the oncoming foremen to assume all examinations had been performed unless notified otherwise. An examination of the mine record books indicated that many required examinations were not made, including the preshift examination for the D-5 midnight to 8:00 a.m. shift on February 16, 1984.

The required weekly examinations of the bleeder entries in the D-1 and D-3 areas were not being performed. Water in this area prevented anyone from walking the bleeder entries, and a method for evaluating the effectiveness of the bleeder system was never established. Endler said he spoke with the mine engineers about establishing bleeder evaluation points for these areas in the fall of 1983 but no request to establish these points was made to the MSHA District Manager. Bleeder evaluation points were not shown on the revised Ventilation System and Methane and Dust Control Plan submitted to MSHA on the day prior to the explosion.

According to sworn statements, certified persons making pump runs on the weekends did travel to the Labour pump in D-3. None of the certified persons considered this a weekly examination and, therefore, did not record these trips in the weekly examination record books. The mine examiners assigned to examine the other bleeder entries and evaluation points stated that they were not instructed to examine the bleeder entries in the D-1 and D-3 areas.

A new system for assuring that the required examinations were made was established after the explosion. All foremen were instructed on how to make preshift examinations. A separate record book was provided for each section and located at the portal where all foremen for that section were required to enter the mine. There was also a separate record book provided for belt examinations. This new system was created to ensure that all pump locations and other nonproducing areas were examined prior to miners entering the areas to perform work.

Coal Dust

During the investigation, two standard channel samples of coal were taken by MSHA. The first sample was taken from the right rib of the L1 entry in the D-5 working section, 22 feet outby survey station No. 10552. The second sample was taken from the right rib of the L1 entry of D-3, 27 feet inby the No. 13 crosscut. The locations of the samples are shown on the map in Appendix Q.

These samples were analyzed by the MSHA Bruceton Safety Technology Center. The results of analyses of the two samples were as follows:

	Sample No. 1	Sample No. 2
Moisture	1.10%	1.33%
Volatile Matter	24.05%	22.71%
Fixed Carbon	59.59%	58.52%
Ash	15.26%	17.44%
Volatile Ratio	0.29	0.28

Numerous tests by the Bureau of Mines have established that coal dust having a volatile ratio of 0.12 and higher is explosive. The results of the analyses of the two samples revealed that the average volatile ratio of the coal in the explosion area of D-3 and D-5 at the time of the explosion was 0.28. The volatile ratio (VR) is the ratio of volatile matter (V) to fixed carbon (FC) plus volatile matter:

$$VR = \frac{V}{FC + V}$$

The analyses of the two channel samples is described in Appendix H. Since the volatile ratio of the coal in the mine exceeded 0.12, the coal dust was required to be inerted. The application of rock dust was the primary means used for inerting coal dust in this mine.

During the safety and health inspection of the entire mine being conducted at the time of the explosion, 31 citations were issued throughout the mine. Of these citations, five were issued for violations of 30 CFR 75.400 (accumulations of loose coal, coal dust, or float coal dust) and one was issued for a violation of 30 CFR 75.403 (inadequate application of rock dust).

The belt entry (C16) of the D-5 section was rock dusted shortly before the explosion. Mitchell stated that after he finished building the crib-block stopping in the inby cut-through, he rock dusted the D-5 section belt entry before leaving the section. This was about 13 hours prior to the explosion.

During the investigation, MSHA also conducted a mine dust survey in the area of the mine affected by the explosion. Samples were collected in the Main D entries; in the accessible areas of the D-1, D-3, and D-5 entries; in the D-5 section entries; and in the line rooms connecting the D-1, D-3, D-5, and D-7 entries.

A total of 414 mine dust samples were collected. Entry samples were collected between crosscuts in the entries in the sampled area. Samples were also collected between the entries in every third crosscut. Samples were not collected in the described areas if the area did not contain enough dust to sample or if the area was too wet to sample. In addition, samples were not collected in some areas due to hazardous roof conditions and roof falls. Samples collected in the D-1, D-3, and D-5 entries; the D-5 section entries; and the line rooms connecting the D-1, D-3, D-5, and D-7 entries were analyzed for incombustible content and the presence of coke. Most of the samples collected in the Main D entries were analyzed only for incombustible content because they were collected in areas remote from the explosion. The results of the analyses and a map showing the locations of these samples are in Appendices I and Q, respectively.

The incombustible content of the 19 samples collected in the B and L1 (intake) entries of D-3 averaged 63.7 percent. Forty-seven percent of these samples were below 65 percent incombustible content. The incombustible content of the 9 samples collected in the L2 (return) entry of D-3 averaged 67.5 percent. Nearly 78 percent of these samples were below 80 percent incombustible content. The incombustible content of the 12 samples collected in the L3 (return) entry of D-3 averaged 32.6 percent. All 12 samples were below 80 percent incombustible content. In addition to the low incombustible content of the mine dust in the L3 entry, a large amount of loose coal and coal dust was stockpiled between the Nos. 8 and 9 crosscuts. The pile of loose coal and coal dust was about 80 feet long and up to 3 feet high. The damp conditions in this area prevented this coal from being suspended during the explosion and possibly propagating the explosion.

The incombustible content of the 24 samples collected in the intake entries of the D-5 section averaged 51.6 percent. Twenty-one (88 percent) of the intake samples were below 65 percent incombustible content. The incombustible content of the 19 samples collected in the return entries of the D-5 section averaged 46.8 percent. All 19 of the return samples were below 80 percent incombustible content.

Coke was present in 60 percent of the samples collected in the D-1, D-3, and D-5 areas inby the return entry of Main D. Coke was present in 96 percent of the samples collected in the D-3 entries and D-5 section entries. A breakdown of the incombustible content and the comparative amount of coke (extra large, large, small, trace, and none) in the mine dust samples follows.

	No. of Samples	Average Incombustible Content	No. of Samples Below 65% (Intake)	No. of Samples Below 80% (Return)	No. of Samples with Coke	Coke In Samples XL L S T
			Main D Entries			
L3 Entry (Return)	26	78.5%	-	12	2	0 0 0 2
L2 Entry (Return)	22	76.9%	-	11	1	0 0 0 1
L1 Entry (Intake)	24	71.8%	8	-	0	0 0 0 0
B Entry (Belt Intake)	38	90.5%	0	-	0	0 0 0 0
R1 Entry (Track Intake)	40	81.9%	6	-	0	0 0 0 0
R2 Entry (Intake)	32	70.7%	8	-	0	0 0 0 0
R3 Entry (Intake)	19	84.9%	1	-	0	0 0 0 0
R3 Entry (Return)	20	76.5%	-	12	0	0 0 0 0
R4 Entry (Return)	15	88.6%	-	1	0	0 0 0 0
R5 Entry (Return)	4	85.2%	-	0	0	0 0 0 0
Total	240	80.2%	23	36	3	0 0 0 3
			D-1 Entries			
L4 Entry (Return)	5	79.0%	-	2	5	0 0 0 5
L3 Entry (Intake)	6	78.3%	1	-	5	0 0 0 5
L3 Entry (Intake)	5	74.2%	0	-	5	0 2 2 1
L1 Entry (Intake)	4	68.0%	2	-	4	0 3 1 0
B Entry (Intake)	3	37.9%	3	-	3	3 0 0 0
Total	23	70.5%	6	2	22	3 5 3 11
			Connecting Line Rooms Between D-1 and D-3			
No. 1 Room (Intake)	0	Wet	-	-	-	- - - -
No. 2 Room (Intake)	2	78.3%	0	-	1	1 0 0 0
No. 3 Room (Intake)	5	74.4%	0	-	0	0 0 0 0
Total	7	75.5%	0	-	1	1 0 0 0

	No. of Samples	Average Incombustible Content	No. of Samples Below 65% (Intake)	No. of Samples Below 80% (Return)	No. of Samples with Coke	Coke In Samples XL L S T
D-3 Entries						
L3 Entry (Return)	12	32.6%	-	12	12	9 3 0 0
L2 Entry (Return)	9	67.6%	-	7	9	5 1 1 2
L1 Entry (Intake)	7	73.4%	1	-	6	0 1 4 1
B Entry (Intake)	12	58.1%	8	-	10	7 1 0 2
Total	40	55.3%	9	19	37	21 6 5 5
Connecting Line Rooms Between D-3 and D-5						
No. 1 Room (Return)	9	73.4%	-	6	0	0 0 0 0
No. 2 Room (Return)	9	70.0%	-	7	0	0 0 0 0
No. 3 Room (Return)	7	77.3%	-	3	0	0 0 0 0
Total	25	73.3%	-	16	0	0 0 0 0
D-5 Entries						
L2 Entry (Return)	13	86.9%	-	2	1	0 0 0 1
L1 Entry (Intake)	4	85.3%	0	-	0	0 0 0 0
B Entry (Intake)	0	Wet	-	-	-	- - - -
Total	17	86.5%	0	2	1	0 0 0 1
Connecting Line Rooms Between D-5 and D-7						
No. 1 Room (Return)	7	79.8%	-	3	0	0 0 0 0
No. 2 Room (Return)	8	86.0%	-	2	0	0 0 0 0
No. 3 Room (Return)	4	92.5%	-	0	0	0 0 0 0
Total	19	85.1%	-	5	0	0 0 0 0
D-5 Section Entries						
L2 Entry (Intake)	3	43.4%	3	-	3	1 0 1 1
L1 Entry (Intake)	3	49.6%	3	-	3	0 1 1 1
B Entry (Intake)	5	53.2%	5	-	5	2 1 2 0
R1 Entry (Intake)	6	60.3%	3	-	6	4 2 0 0
R2 Entry (Intake)	7	47.5%	7	-	7	7 0 0 0
R3 Entry (Return)	7	45.6%	-	7	7	7 0 0 0
R4 Entry (Return)	7	48.8%	-	7	7	6 1 0 0
R5 Entry (Return)	5	45.5%	-	5	5	5 0 0 0
Total	43	49.5%	21	19	43	32 5 4 2

Extent of Flame and Forces

The determination of the extent of flame and forces of the explosion was made primarily from underground observations of the investigation team. The results of the mine dust survey were also used in these determinations.

Flame

The extent of flame travel was determined from melted brattice cloth; charred paper and cable hangers; melted telephone and belt control cables; coke deposits on timbers, cribs, and equipment; and from laboratory analyses of mine dust samples collected during the investigation.

In the D-3 entries, evidence of flame was present in the B entry from the No. 7 crosscut inby to the caved area between the Nos. 16 and 17 crosscuts, in the L1 entry from just outby the No. 7 crosscut inby to the No. 17 crosscut, in the L2 entry from just outby the No. 8 crosscut inby to the caved area at the No. 15 crosscut, and in the L3 entry from the No. 8 crosscut inby to the No. 18 crosscut. There was also evidence of flame entering the outby longwall gob from the L3 entry through the Nos. 9 through 18 crosscuts. There was little or no evidence of flame in D-3 outby the No. 7 crosscut indicating that the flame did not enter the connecting line rooms between D-3 and D-5. There was also no evidence of flame in the L3 entry outby the No. 6 crosscut indicating that flame did not enter the connecting line rooms between D-1 and D-3 from the D-3 entries.

In the D-1 entries, evidence of flame was present in the B entry at the No. 19 crossccut and between the Nos. 1 and 6 crosscuts; in the L1 entry between the Nos. 17 and 19 crosscuts, at the No. 15 crosscut, between the Nos. 10 and 11 crosscuts, and between the Nos. 3 and 7 crosscuts; in the L2 entry between the Nos. 15 and 20 crosscuts, between the Nos. 10 and 11 crosscuts, and between the Nos. 6 and 7 crosscuts; in the L3 entry between the Nos. 14 and 20 crosscuts, between the Nos. 9 and 11 crosscuts, and between the Nos. 6 and 7 crosscuts; and in the L4 entry between the Nos. 6 and 18 crosscuts. There was no evidence of flame in the L3 entry of Main D or in the B entry of D-1 outby the return overcast between the L3 and L4 entries of Main D indicating that the flame did not enter the Main D entries.

In the connecting line rooms between D-1 and D-3, evidence of flame was present in the No. 1 (eastern-most) room from the B entry of D-1 for 120 feet. There was no other evidence of flame in these connecting line rooms indicating the flame did not travel from D-1 to D-3 through the connecting line rooms.

In the D-5 section entries, evidence of flame was present in the No. 13 crosscut between the R1 and R5 entries, in the No. 14 crosscut between the B entry of D-3 and the L2 entry of D-5, in the No. 15 crosscut between the L1 and L5 entries, and in the No. 16 crosscut between the R2 and R5 entries. There was little or no evidence of flame north of the L2 entry indicating the flame did not enter the original D-5 entries. There was also very little evidence of flame in the No. 12 crosscut indicating the flame did not enter the last open crosscut and face areas of the D-5 section.

The extent of flame travel is shown on a map in Appendix S.

An analysis of the ventilation of the D-5 section entries indicates that an explosive concentration of methane was not present in the D-5 section entries outby the No. 19 crosscut immediately before the explosion occurred. MSHA investigators concluded that the presence of flame in these locations resulted from the combustion of methane that was pushed there from D-3 by the expansion of the gases and the pressure wave that preceded the flame during the explosion.

Research on coke formation in experimental coal mine explosions has shown that coke indicates the passage of flame and that coke is produced by a relatively slow-moving flame where the mine dust contains less than 50 percent incombustible. Coke deposits were observed at several locations in the D-1 and D-3 areas, primarily at the extreme limits of flame travel where lower flame speeds are expected. Coke deposits were observed in D-3 in the L1 entry inby the No. 16 crosscut and in the L3 entry at the No. 15 crosscut. Coke deposits were also observed on cribs located in the crosscuts between the L3 entry and outby longwall gob in D-3. In D-1, coke deposits were observed in the B and L1 entries at the No. 19 crosscut and in the B entry between the Nos. 1 and 4 crosscuts.

Many of the mine dust samples collected for analysis of incombustible content were also analyzed for coke. Chemical analysis for coke is extremely sensitive and coking was found by chemical analysis beyond the areas where evidence of flame travel was visually observed. The investigators believe that the traces of coke found by chemical analysis in areas where other evidence of flame travel was not observed were carried by air movement during the explosion.

The magnitude of the forces and the relatively small amounts of coke observed in the explosion area indicate that the explosion did not develop into a propagating coal dust explosion. However, the burning of coal dust lengthened the extent of flame. This conclusion is supported by the coke deposits observed at several locations, the coke found by chemical analysis of the mine dust samples, and the amount of incombustible content in the mine dust samples. Mine explosion research has shown that coal dust in a mine entry, although inerted to 65 percent incombustible, causes an increase in the flame length when methane is burned.

It was not possible to accurately determine the total extent of flame travel from observations made in the mine. Flame entered areas inaccessible to MSHA investigators such as caved areas and the outby longwall gob. Calculations of the original explosive gas volume from the extent of flame travel would have been based on assumptions and was not attempted.

Forces

The magnitude and direction of the forces of the explosion were determined from the effects of the forces on equipment, permanent stoppings, and roof support and other materials and from the direction dust and debris were impacted on timbers, roof-bolt plates, roof straps, and equipment. The major forces of the explosion were confined to the D-1 entries, D-3 entries, and the D-5 section. Evidence of minor forces was also observed in the D-5 entries and in the Main D entries near the mouth of the D-1, D-3, and D-5 entries.

Major forces diverged from a 120-foot length of the L1 entry of D-3 between the Nos. 13 and 14 crosscuts. Damage caused by violent forces moving away from this area was observed in the L1 entry inby the No. 14 crosscut and outby the No. 13 crosscut. Very little damage was observed in the L1 entry between the Nos. 13 and 14 crosscuts. Damage caused by the forces entering the B entry and L2 entry from the L1 entry was also observed in the Nos. 11, 12, 13, 15, and 16 crosscuts. The No. 14 crosscut was caved on both sides of the L1 entry and very little evidence of force was observed.

In the L1 entry of D-3, the major forces of the explosion were in the inby direction from the No. 14 crosscut inby. Although the exact location of the battery-powered locomotive at the time of the explosion is not known, it was found just outby the No. 15 crosscut in the L1 entry of D-3. The battery-powered locomotive was exposed to forces traveling inby. Both outby headlights were broken and dust was impacted on the outby end of the vehicle. The inby headlights were intact. The flatcar containing the Labour pump located at the No. 17 crosscut in the L1 entry was blown inby approximately 10 feet. The original pump location was indicated by the location of the anchored discharge line. The major forces of the explosion were in the outby direction in L1 entry from the No. 13 crosscut outby. The forces of the explosion pulled roof bolts partially out of the roof, ripped roof straps away from the roof bolts, and dislodged posts and cross entry beams between the Nos. 12 and 13 crosscuts.

In the B entry of D-3, the major forces of the explosion were in the inby direction from the No. 15 crosscut inby. The major forces of the explosion were in the outby direction from the No. 12 crosscut outby. The forces of the explosion pulled out roof bolts and ripped away roof straps primarily between the Nos. 7 and 10 crosscuts. The forces of the explosion in the B entry between the Nos. 12 and 15 crosscuts were bidirectional.

In the L2 entry of D-3, the major forces of the explosion were in the outby direction from the No. 13 crosscut outby. Minor damage was observed to roof straps caused by the impact of objects blown in the outby direction between the Nos. 11 and 13 crosscuts. The forces of the explosion in the L2 entry inby the No. 13 crosscut were weak due to the caved areas in the No. 14 crosscut and in the L3 entry at the No. 15 crosscut.

In the L3 entry of D-3, the forces of the explosion were comparatively weak with very little force indication observed. The forces, however, entered the crosscuts between the L3 entry and the outby longwall gob and damaged cribs and impacted debris on the edge of the gob.

All permanent stoppings in the D-3 entries between and including the Nos. 2 and 20 crosscuts were damaged or destroyed by the forces of the explosion. Stoppings between the B and L1 entries in the Nos. 21, 22, 23, and 24 crosscuts were intact.

Blocks from the stoppings between the L1 and L2 entries in all crosscuts except the No. 10 crosscut were blown toward the L2 entry. Blocks from the stopping in the No. 10 crosscut were blown toward the L1 entry.

Blocks from the stoppings between the B and L1 entries inby and including the No. 11 crosscut along with the stoppings in the Nos. 1, 2, and 4 crosscuts were blown toward the B entry. Blocks from the stoppings in the Nos. 3, 5, 6, 7, 8, 9, and 10 crosscuts were blown toward the L1 entry. Blocks from the stoppings separating the B entry from the connecting line rooms between D-3 and D-5 in the Nos. 3, 4, and 5 crosscuts were blown toward D-5. The overcasts at the mouth of D-3 all sustained at least partial damage from the forces of the explosion. Blocks from the closed regulator located between the Nos. 1 and 2 crosscuts in L2 were blown in an outby direction toward Main D.

In the D-1 entries, the major forces of the explosion were in the outby direction from the No. 18 crosscut outby. Although there was no evidence of major forces entering the D-1 entries, forces increased in magnitude as the flame found explosive mixtures of methane. The outby moving forces in D-1 were directed over and concentrated into the L4 entry at the No. 12 crosscut by extensive roof falls in the L1, L2, and L3 entries. These forces damaged roof bolts, roof straps, posts, and cross entry beams in the L4 entry out to the No. 7 crosscut. The major forces of the explosion were bidirectional in the L4 entry between the Nos. 11 and 12 crosscuts.

All stoppings in the D-1 entries between the Nos. 7 and 19 crosscuts were damaged although many of the stoppings were partially or completely out prior to the explosion. Major forces also traveled outby the No. 7 crosscut to the mouth of D-1 partially damaging stoppings, the D-1 regulator, and overcasts.

The major forces of the explosion traveled from D-3, through the cut-throughs at the Nos. 14 and 19 crosscuts, and into the D-5 working section. Blocks from the stoppings in the two cut-throughs, the four stoppings between the R2 and R3 entries, and the stopping in the No. 14 crosscut which separated the L2 entry of the active section and the L2 entry of the original entries were blown toward the original D-5 entries. The overcasts at the Nos. 15 and 16 crosscuts at the mouth of the D-5 active section were also damaged. Blocks from stoppings in the D-5 section between the Nos. 14 and 15 crosscuts in the L1 entry and between the Nos. 15 and 16 crosscuts in the R1 entry were blown toward the D-5 gob. The return regulator in the L2 entry and the track doors in the L1 entry at the mouth of the original D-5 entries were damaged by minor forces.

The direction and extent of forces are shown on the map in Appendix S.

The direction of the major forces of an explosion cannot be used to determine the precise point of ignition. Nevertheless, several general conclusions about the point of ignition can be drawn from the directions of the major forces in the explosion area. The directions of the major forces in the D-5 working section indicated that the point of ignition was not in the D-5 section or the original D-5 entries. The directions of the major forces in D-3 outby the No. 13 crosscut and inby the No. 14 crosscut indicated that the point of ignition was in one of the crosscuts or between them. The blocks from the stoppings on both sides of the L1 entry between the Nos. 11 and 17 crosscuts were blown away from the L1 entry. MSHA investigators concluded that the point of ignition was in the L1 entry of D-3 in or between the Nos. 13 and 14 crosscuts.

The magnitude of the forces observed in the explosion area suggests a low concentration of methane of approximately 7 percent when compared to past research and mine explosions. The magnitude of the forces and the relatively small amounts of coke observed in the explosion area indicated that the explosion did not develop into a propagating coal dust explosion. If a propagating coal dust explosion had occurred, then flame speeds in excess of 800 feet per second would have been encountered. This flame speed corresponds to a static pressure of about 15 psi and a dynamic pressure of about 30 psi. Such pressures would have produced considerably more damage than was observed in the explosion area. MSHA investigators believe, however, that burning coal dust contributed to the total flame expansion during the explosion and significantly increased the flame speed in the B entry of D-3 around the No. 11 crosscut. The increased flame speed resulted in heavy damage to roof support material in this area and caused the pressure differential between the L1 and B entries to reverse at the No. 10 crosscut.

Self-Rescuers

Both Drager W-65, filter self-rescuers (FSR's) and Ocenco EBA 6.5, self-contained self-rescuers (SCSR's) were used by the D-5 section crew as they evacuated the section. The six miners who were located near the faces and at the dumping point put on their FSR's before returning to the areas where their SCSR's were stored. Before leaving the section, all but two miners had on an SCSR. One miner left the section using his FSR. One miner left the section carrying his SCSR and wearing his FSR on his belt, but he did not use either unit.

The crew experienced a number of problems with the SCSR's. To prevent accidental opening, tape had been placed around the units over the rubber strip that holds the cover in place. The four miners who sustained burns to their hands could not open their SCSR's. Two other miners abandoned their attempt to use the units after initial attempts to open them failed. All D-5 crew members stated that they had trouble opening the units.

Four members of the crew stated that they had to take an occasional breath around the SCSR mouthpiece because they were not getting enough air from the SCSR. Self-rescuer use was discontinued shortly after leaving the affected area of the Main D entries.

The Pittsburgh Research Center of the Bureau of Mines tested the 17 SCSR's that were in the D-3 and D-5 areas at the time of the explosion. Most of the units sustained damage of some kind including shifted oxygen bottle bands, cracked outer cases, dented carbon dioxide absorbent canisters, and lithium hydroxide in the breathing bags and mouthbit. One SCSR had a demand valve requiring an abnormally high negative pressure to activate. The work rate of a person who wore this SCSR would have been limited. Another SCSR had a constant oxygen flow rate below its rated value which would result in the demand valve being activated more frequently. This may have had the effect of tiring the wearer given the effort required to activate the demand valve. Both of these units also had a shifted bottle band. Most of the SCSR's had sustained damage significant enough to require removal from service if the damage occurred before the explosion.

The Bureau of Mines letter describing the condition of the 17 SCSR's is in Appendix J.

Potential Ignition Sources

D-3 Electric Circuits and Equipment

Since the directions of the explosion forces indicated that the explosion originated in the D-3 entries, MSHA investigators carefully examined and tested the electric circuits and equipment that were located in the D-3 entries for any evidence that the circuits and equipment provided the ignition source for the explosion. The results of these examinations and tests are summarized below. A detailed description and analysis of the examinations and tests of the D-3 electric circuits and equipment as well as other pertinent information provided by officials and employees of the Pennsylvania Mines Corporation is in Appendix K.

The investigation revealed that the following electric circuits and equipment were present in the D-3 entries at the time of the explosion:

1. Approximately 1,500 feet of No. 2 AWG aluminum, 15 kV, three-conductor, mine power cable. The cable supplied 12,470-volt, three-phase power from a vacuum circuit breaker located in Main D near the mouth of the D-3 entries to a 400 kVA portable power center located in D-3.

2. 400 kVA, portable power center located in the No. 11 crosscut of D-3 between the L1 and B entries.

3. Approximately 450 feet of No. 4/0 AWG, 2,000-volt, three-conductor, type G-GC, portable power cable supplying 600-volt, three-phase power from the portable power center to a five-circuit distribution box.

4. A five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts.

5. Approximately 200 feet of No. 2/0 AWG, 2,000-volt, three-conductor, type G-GC, portable power cable supplying 600-volt, three-phase power from the distribution box to a Labour pump installation.

6. A Labour pump installation consisting of the following:

    (a) A Labour, 4- by 3-inch, centrifugal pump with a 100-horsepower, 575-volt, three-phase motor mounted on a flatcar and located in the L1 entry of D-3 near the No. 17 crosscut.

    (b) A full-voltage, magnetic starter located on the mine floor just inby the flatcar with the Labour pump.

    (c) A mercury switch mounted on a check valve in the 6-inch discharge line for the Labour pump and connected to the pump starter with approximately 100 feet of No. 12/3, type SO cord.

7. Approximately 475 feet of No. 12/5, type SO cord supplying 600-volt, three-phase power from the distribution box to a Flygt pump installation.

8. A Flygt pump installation consisting of the following:

   (a) A Flygt Corporation, permissible, 5-horsepower, submergible pump located in the L1 entry of D-3 inby the No. 19 crosscut.

   (b) A Flygt Corporation, permissible, manual, pump starter located outby the Flygt pump.

   (c) Approximately 50 feet of No. 12 AWG, 7-conductor, permissible-pump cable connecting the Flygt pump to the starter.

9. A battery-powered locomotive located in the L1 entry of D-3 in or near the No. 14 crosscut.

10. Three permissible electric cap lamps worn by Depto, Miller, and Parzatka.

11. A permissible methane detector on Depto's belt.

Except for the Flygt pump, the Flygt pump starter, the three cap lamps, and the methane detector, the electric equipment that was present in the D-3 entries at the time of the explosion was not approved by MSHA as permissible. Permissible equipment was not required in these instances because the equipment was not taken into or used inby the last open crosscut, in return air, or within 150 feet of pillar workings.

Examination of the five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts revealed that electrical arcing occurred in the distribution box when the explosion damaged the distribution box. The evidence of explosion-induced arcing in the distribution box indicated that the D-3 high-voltage cable, the 400 kVA portable power center, the No. 4/0 AWG portable power cable supplying the distribution box, and the distribution box were energized when the explosion occurred. MSHA investigators also concluded that the No. 2/0 AWG cable supplying the Labour pump installation was energized when the explosion occurred. MSHA investigators could not determine conclusively if the No. 12/5, type SO cord supplying the Flygt pump installation was energized when the explosion occurred.

High-Voltage Circuit and Equipment

The D-3 high-voltage circuit originated at a vacuum circuit breaker located in Main D near the mouth of the D-3 entries and supplied 12,470-volt, three-phase power to a 400 kVA, portable power center located in the D-3 entries.

Information gathered during the investigation indicated that the D-3 high-voltage circuit was energized and that the D-3 vacuum circuit breaker tripped when the explosion occurred. Consequently, MSHA investigators carefully examined and tested the D-3 high-voltage circuit and equipment to determine why the D-3 vacuum circuit breaker tripped and if a fault in the D-3 high-voltage cable or the high-voltage portion of the D-3 portable power center could have provided the ignition source for the explosion.

Vacuum Circuit Breaker

The D-3 vacuum circuit breaker contained a manually-operated, air-break switch and a vacuum circuit breaker equipped with a ground check monitor and relays designed to provide overcurrent, grounded-phase, and undervoltage protection for the D-3 high-voltage circuit.

Since the D-3 vacuum circuit breaker was located outside of the area affected by the explosion, it was not considered a potential ignition source. However, the condition of the D-3 vacuum circuit breaker was relevant in determining if the high-voltage circuit and equipment in the D-3 entries could have provided the ignition source for the explosion.

Examination and testing of the vacuum circuit breaker during the investigation revealed that the ground check monitor and protective relays were operative and that the circuit breaker tripped as a result of an open ground check monitor circuit.

High-Voltage Cable

The high-voltage circuit from the D-3 vacuum circuit breaker to the D-3 portable power center contained approximately 1,500 feet of No. 2 AWG aluminum, 15 kV, three-conductor, mine power cable. The high-voltage cable was installed in the L1 entry of D-3 and was originally supported from a messenger wire with cable hangers. The circuit contained two lengths of cable connected together by a cable coupler located near the No. 8 crosscut in D-3.

Examination of the high-voltage cable during the investigation revealed that the forces of the explosion had severed the cable about 20 feet outby the cable coupler near the No. 8 crosscut and had damaged the cable near the No. 10 crosscut. Evidence of electrical arcing was not observed at either location indicating that the cable was not energized when the damage occurred.

Portable Power Center; High-Voltage Portion

A 400 kVA, portable power center was located in the No. 11 crosscut of D-3 between the L1 and B entries. The power center reduced 12,470-volt, three-phase power to 600-volt, three-phase power to supply a five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts.

The power center had been damaged severely by the explosion. Two of the three top covers had been blown off the power center. Both the low-voltage end and the high-voltage end as well as many internal components of the power center had been damaged. The physical damage to the power center indicated that the explosion originated outside of the power center and that the forces of the explosion approached the power center from both the L1 entry side (low-voltage end) and the B entry side (high-voltage end). (See photographs in Appendix N.)

Conclusions

After analyzing the information gathered during the investigation, MSHA investigators concluded the following about the D-3 high-voltage circuit and equipment:

1. The high-voltge circuit supplying the D-3 vacuum circuit breaker was energized when the explosion occurred.

2. The D-3 vacuum circuit breaker was closed when the explosion occurred.

3. The D-3 high-voltage cable and the high-voltage portion of the D-3 portable power center were energized when the explosion occurred.

4. The low-voltage portion of the D-3 portable power center was energized when the explosion occurred.

5. The D-3 vacuum circuit breaker tripped and deenergized the D-3 high-voltage cable and the D-3 portable power center when the forces of the explosion caused the interruption of the ground check circuit by blowing the covers off of the power center.

6. The damage to the D-3 high-voltage cable and the D-3 portable power center was caused by the explosion.

7. The D-3 high-voltage cable was severed near the No. 8 crosscut of D-3 after the cable was deenergized by the D-3 vacuum circuit breaker indicating that the forces of the explosion reached the No. 11 crosscut before they reached the No. 8 crosscut.

In summary, MSHA investigators concluded that neither the D-3 high-voltage cable nor the high-voltage portion of the D-3 portable power center provided the ignition source for the explosion.

Low-Voltage AC Circuits and Equipment

Portable Power Center; Low-Voltage Portion

Since the portable power center was not permissible, arcing caused by a fault within the power center or by manual or automatic operation of one of the circuit breakers, relays, and switches in the power center could have released sufficient energy to ignite an explosive methane-air mixture. MSHA investigators found no evidence of a short circuit or ground fault in the low-voltage portion of the portable power center. The locations of the miners in the D-3 entries when the explosion occurred indicated that none of the miners was in a position to operate any of the circuit breakers or switches in the power center. Examination of the distribution box that was supplied from the portable power center revealed evidence of multiple faults that occurred when the forces of the explosion damaged the distribution box. These faults may have caused automatic operation of the main and "A" circuit breakers in the portable power center. However, since the faults occurred when the forces of the explosion damaged the distribution box, both circuit breakers had to have been closed when the explosion originated. Consequently, arcing from the automatic operation of the circuit breakers in the power center could not have provided the ignition source for the explosion.

In summary, MSHA investigators concluded that the low-voltage portion of the portable power center did not provide the ignition source for the explosion. MSHA investigators also concluded that the explosion originated inby the location of the portable power center (No. 11 crosscut) since the forces of the explosion damaged the distribution box before they damaged the power center and caused interruption of the incoming high-voltage circuit.

No. 4/0 AWG Cable

Approximately 450 feet of No. 4/0 AWG, 2,000-volt, three-conductor, type G-GC, portable power cable was installed to supply 600-volt, three-phase power from the 400 kVA portable power center to a five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts. The cable was installed in the L1 entry of D-3 and was originally supported from roof supports with insulated cable hangers. Evidence of explosion-induced arcing in the distribution box supplied by the cable indicated that the cable was energized when the explosion occurred. Examination and testing of the No. 4/0 AWG cable during the investigation revealed the the cable did not provide the ignition source for the explosion.

Five-Circuit Distribution Box

A five-circuit distribution box was located in the L1 entry of D-3 approximately 62 feet inby the No. 15 crosscut. The distribution box was installed to provide electrical protection for two, 600-volt, three-phase circuits: one supplying a Labour pump installation and the other supplying a Flygt pump installation.

The distribution box contained five, 600-volt, three-phase receptacles ("A," "B," "C," "D," and "E"). Each receptacle circuit was protected by an individual, three-pole, molded-case circuit breaker. The circuit breaker for the "A" receptacle was rated 225 amperes. The circuit breakers for the "B," "C," "D," and "E" receptacles were each rated 50 amperes. Each circuit breaker was equipped with a ground check monitor and devices to provide overcurrent and undervoltage protection for the receptacle circuit.

Examination of the five-circuit distribution box during the investigation revealed the following:

1. The distribution box had been rotated approximately 180 degrees about its vertical axis, turned on its back, and moved approximately 4 feet inby its original location by the explosion forces.

2. The No. 4/0 AWG cable from the 400 kVA portable power center was connected to the distribution box. However, the cable had been pulled out of the strain-relief fitting on the distribution box approximately 2 inches when the explosion forces moved the distribution box inby. (See photograph in Appendix N.)

This damaged the insulation on the black phase conductor and caused a phase-to-ground fault in the strain-relief fitting. Evidence of electrical arcing was present on the black phase conductor and on the inside of the fitting.

3. The emergency stop switch was in the open (off) position.

4. The plug on the outby end of the cable to the Labour pump installation was found approximately 8 feet inby the distribution box. The plug was compatible only with the "A" receptacle on the distribution box. The nylon restraining rope had been pulled away from its attachment to the plug. The other end of the rope was still attached to the distribution box near "A" receptacle. Two of the pins in the plug had been bent. The bolts that once held the hinge plate to the top of the plug had been sheared off and the hinge plate was missing. The hinge pin and side latch on the receptacle had been bent.

5. The plug on the outby end of the cable to the Flygt pump installation was still connected to the "B" receptacle on the distribution box.

6. Dust covers were in place on receptacles "C," "D," and "E." MSHA investigators did not observe any other cables that could have been supplied by the distribution box at the time of the explosion.

7. The distribution box had been severely damaged by the explosion.

The damage observed by MSHA investigators included the following:

1. The back cover had been bent in (approximately 5 inches at the center) and had been ripped off of the enclosure. Evidence of electrical arcing on the inside of the back cover indicated that the cover had contacted the center bus bar (white phase conductor) and the terminal used to connect the incoming red phase conductor to the bottom bus bar resulting in phase-to-ground faults involving the white and red phases. Evidence of electrical arcing also indicated that the back cover had pushed the three bus bars back to the extent that the bottom bus bar contacted a line-side stud on the "A" circuit breaker resulting in a phase-to-phase fault between the white and red phases.

2. The left side of the enclosure (facing the front) had also been bent in. Evidence of electrical arcing indicated that all three bus bars had arced to the left side of the enclosure.

3. The right side of the enclosure (facing the front) had also been bent in. Evidence of electrical arcing indicated that a screw through the side of the enclosure had contacted the bottom bus bar resulting in a phase-to-ground fault involving the red phase.

4. The left door had been bent in to the extent that it broke the operating handle for the "A" circuit breaker. A mark on the inside of the door indicated that the circuit breaker was in either the closed position or the tripped position when the door struck the handle. (See photograph in Appendix N.)

5. The hinge on the right door had been broken and the door had been pushed in past the sealing lip on the enclosure.

MSHA investigators concluded that the damage to the distribution box was caused by the static and dynamic pressures developed by the explosion. The distribution box enclosure was reasonably airtight since the doors and back cover were provided with foam rubber gaskets. The static overpressure would have exerted tremendous forces on the exterior surfaces of the enclosure until the interior and exterior pressures equalized. The deformations observed in the exterior surfaces of the enclosure are consistent with the effects of an explosion on a reasonably airtight enclosure of the size and construction of the distribution box. The dynamic pressure developed by the explosion could also be expected to move the distribution box and thereby place strain on the incoming cable.

It is evident that the distribution box was energized when the explosion occurred. Evidence of electrical arcing in the distribution box indicated that multiple faults occurred when the static and dynamic forces developed by the explosion damaged the insulation on the incoming black phase conductor and deformed the enclosure to the extent that the clearances around the energized bus bars were eliminated. Since the distribution box was energized, the emergency stop switch must have been closed (on) when the explosion occurred. Most likely, the explosion forces opened the emergency stop switch. The limited damage caused by electrical arcing at the fault locations indicated the circuit was deenergized shortly after the faults occurred. This could have happened when the circuit breaker in the portable power center tripped as a result of the faults in the distribution box, when the emergency stop switch opened, or when the D-3 vacuum circuit breaker tripped as a result of explosion damage to the portable power center.

The damage to the plug and receptacle for the cable to the Labour pump installation indicated that the plug was connected to the receptacle when the explosion occurred. MSHA investigators believe that the explosion forces pulled the plug from the receptacle and caused the damage to the plug and receptacle.

The mark on the inside of the left door on the distribution box indicated that the "A" circuit breaker was in either the closed position or the tripped position when the explosion occurred. However, MSHA investigators found no evidence of a fault in the Labour pump circuit that could have caused the circuit breaker to trip. (See following sections.) Consequently, MSHA investigators concluded that the circuit breaker was closed and the cable to the Labour pump installation was energized when the explosion occurred. MSHA investigators could not determine conclusively the position of the "B" circuit breaker when the explosion occurred.

MSHA investigators collected a dust sample from the distribution box enclosure. The sample was analyzed by the MSHA Bruceton Safety Technology Center. The analysis revealed a trace of coke confirming that flame was present at the distribution box. The analysis result is reported in Appendix H.

Since the distribution box was not permissible, arcing caused by a fault in the distribution box or by manual or automatic operation of one of the circuit breakers, switches, and relays in the distribution box could release sufficient energy to ignite an explosive methane-air mixture. Except for the faults that were caused by the explosion, MSHA investigators found no evidence of a short circuit or ground fault in the distribution box. The locations of the miners in the D-3 entries when the explosion occurred indicated that none of the miners was in a position to operate any circuit breakers or switches in the distribution box. Examination and testing of the circuits and equipment supplied from the distribution box revealed no evidence of a fault that could have caused automatic operation of one of the circuit breakers or relays in the distribution box. The effects of the explosion forces on the distribution box also indicated that the explosion did not originate in the distribution box. In summary, MSHA investigators concluded that the distribution box did not provide the ignition source for the explosion.

No. 2/0 AWG Cable

Approximately 200 feet of No. 2/0 AWG, 2,000-volt, three-conductor, type G+GC, portable power cable was installed in the L1 entry of D-3 to supply 600-volt, three-phase power from the five-circuit distribution box to the Labour pump installation located in the L1 entry near the No. 17 crosscut. Examination of the five-circuit distribution box indicated that the cable was energized when the explosion occurred. Examination and testing of the No. 2/0 AWG cable during the investigation revealed that the cable did not provide the ignition source for the explosion.

Labour Pump Installation

A Labour pump installation was located in the L1 entry of D-3 at the No. 17 crosscut. The installation consisted of the following:

1. A Labour Type LV, 4- by 3-inch, centrifugal pump. The pump was driven by a 100-horsepower, 575-volt, three-phase motor. The pump and motor were mounted on a flatcar located in the L1 entry at the No. 17 crosscut.

2. A full-voltage, magnetic starter used to control the 100-horsepower, pump motor.

3. A mercury switch attached to the external arm of a check valve in the 6-inch discharge line for the Labour pump. The check valve was located in the L1 entry about 20 feet inby the No. 16 crosscut. The mercury switch was originally connected to the pump starter with approximately 100 feet of No. 12/3, type SO cord.

According to Pierce, the Labour pump was installed on or about December 13, 1984, to replace four smaller pumps. Pierce also stated that the pump starter was located on the mine floor on the right side of the track just inby the flatcar and that the mercury switch was connected into the pump starter to automatically shut down the pump if it went on air.

Examination and testing of the Labour pump installation during the investigation revealed the following:

1. The new 20-foot strainer was found installed on the inby end of the suction line for the Labour pump indicating that Depto, Miller, and Parzatka had been to the pump and had completed the job of changing the strainer. A used 10-foot strainer was found near the pump. (See photograph in Appendix N.)

2. The 6-inch gate valve in the pump discharge line was halfway between the fully closed and fully opened positions. This valve was used to adjust the discharge head on the pump.

3. The 2-inch gate valve used to bleed the Labour pump was closed.

4. The 3-inch gate valve between the discharge line from the Flygt pump and the suction of the Labour pump was closed. This valve was opened only when the Flygt pump was used to prime the suction line for the Labour pump.

5. The flatcar was on the track with a skid under the right inby wheel. The flatcar had been moved inby approximately 10 feet by the force of the explosion. The fiberglass, discharge line had been broken off at the discharge flange on the pump. The fiberglass, suction line on the inby end of the flatcar had been smashed by the force of the flatcar moving inby. (See photographs in Appendix N.)

6. The installation was under water during the flooding that occurred after the explosion.

7. The 100-horsepower, induction motor had been damaged slightly by the explosion. The connection box cover on the motor appeared to have been struck by a force moving inby. The cover was gapped open about two inches. There was no evidence of electrical arcing inside the junction box. Insulation resistance measurements indicated low-resistance (800 ohms) from the motor stator windings to ground. The motor was removed from the mine, taken to the Main Complex Shop, and disassembled. Approximately 2 to 3 gallons of water drained from the motor when the rotor was removed. Close, visual examination revealed no evidence of electrical arcing on the motor stator and rotor windings. After drying the stator with a 1,000-watt heater for approximately 20 hours, insulation resistance measurements of the stator winding were repeated. The measurements increased to 30 megohms indicating that the stator windings were free from ground faults. MSHA investigators concluded that the initial, low insulation resistance readings were caused by the wet condition of the stator.

8. The cable from the pump starter to the pump motor had been pulled out of the strain-relief fitting on the starter approximately 12 inches by the force of the explosion. Otherwise, the cable had not been damaged by the explosion. Examination of the cable revealed no evidence of a short circuit or ground fault. Insulation resistance measurements confirmed that the cable did not contain a short circuit or ground fault. Continuity measurements indicated that the phase conductors and grounding conductors in the cable were continuous.

9. The magnetic starter for the Labour pump was found near the left inby corner of the flatcar.

10. The starter had been damaged by the explosion. The starter door had been knocked off and was found approximately 25 feet inby the starter on the left side of the entry. One corner of the starter enclosure had been bent in approximately 2 inches as though the corner had struck a solid object. The right side of the enclosure had been bent in approximately 1-1/2 inches. None of the other walls of the enclosure had been bent; however, the door had been bent out approximately 1-1/2 inches. The ammeter and voltmeter had been destroyed and pushed back into the enclosure. Both meter lenses had been broken; however, no glass was found inside the enclosure. The manual on/off control switch had also been pushed back into the enclosure. The overload relay block on the bottom of the linestarter had been broken and pulled to the right. This damage occurred when the cable to the pump motor was pulled out of the strain-relief fitting approximately 12 inches. The cord to the mercury flow switch had been pulled completely out of the starter.

11. The starter control circuit was found properly connected for manual control of the pump motor. The mercury flow switch had been connected in parallel with a spring-loaded, normally open, start switch in the pump starter. As connected, the pump was started by holding in the start switch until the pump produced sufficient water flow to close the mercury flow switch. Then the pump would continue to run until the water flow stopped or someone opened the molded case circuit breaker or the manual on/off control switch on the starter.

12. The molded case circuit breaker was found in the tripped position. However, the force of the explosion could have caused the circuit breaker to trip. All four control fuses in the starter were found intact. The manual on/off control switch was found in the closed (on) position. The normally open, spring-loaded, start switch was found in the open position.

13. No evidence of a short circuit or ground fault was found in the starter. Insulation resistance measurements confirmed that the starter did not contain a short circuit or ground fault.

14. The wiring near the top of the starter had been scorched indicating that flame had entered the enclosure.

15. The mercury flow switch consisted of a mercury switch attached with two hose clamps to the operating arm of a 6-inch check valve installed in the discharge line of the pump. The switch contacts had been connected in parallel with the normally open, spring-loaded, start switch in the pump starter. The switch contacts were enclosed in a sealed, plastic tube. The tube was not broken or cracked. The No. 12/3 type SO cord between the mercury flow switch and the starter had been pulled completely out of the starter. The entire length of cable was examined and no evidence of a short circuit was found.

16. MSHA investigators collected two dust samples from the pump installation; one from the starter door and one from inside the motor connection box. The samples were analyzed by the MSHA Bruceton Safety Technology Center. Both analyses revealed traces of coke confirming that flame was present at the pump installation. The analysis results are reported in Appendix H.

Earlier, MSHA investigators concluded that the No. 2/0 AWG cable supplying the Labour pump installation was energized when the explosion occurred. Except for the position of the circuit breaker in the pump starter, the electric controls and the valves at the pump installation were found in the proper positions for normal operation of the pump. The circuit breaker in the starter was found in the tripped position; however, the circuit breaker could have tripped when the force of the explosion hurled the starter inby. Depto, Miller, and Parzatka had completed the installation of the new strainer on the end of the pump suction line and were at least 250 feet outby the pump when the explosion occurred. Considering the water problem in D-3, it is likely that they restarted the pump before they left the installation. Although these factors are not conclusive, MSHA investigators believe that the pump was in operation when the explosion occurred.

Since the components of the Labour pump installation were not permissible, arcing caused by a fault in one of the components or by manual or automatic operation of the circuit breaker, linestarter, switch, or relays in the pump starter could have released sufficient energy to ignite an explosive methane-air mixture. However, MSHA investigators found no evidence of a short circuit or ground fault in any of the components of the pump installation. Since the pump motor does not arc during normal operation, MSHA investigators concluded that the motor did not provide the ignition source for the explosion. Since the mercury flow switch contacts were enclosed within a sealed, plastic tube, MSHA investigators concluded that arcing during the normal operation of the flow switch did not provide the ignition source for the explosion. The locations of the miners in the D-3 entries when the explosion occurred indicated that none of the miners was in a position to operate the circuit breaker or switches in the pump starter when the explosion occurred. If the pump was running and for some reason the water flow stopped, the starter would shut the pump down. If this happened, electrical arcing of sufficient energy to ignite an explosive methane-air mixture would occur when the linestarter opened the power circuit to the motor. Consequently, automatic operation of the pump starter was capable of providing the ignition source for the explosion.

However, MSHA investigators could not determine conclusively whether or not the pump starter provided the ignition source for the explosion solely from the examinations and tests that were conducted on the pump starter.

No. 12/5, Type SO Cord

Approximately 475 feet of No. 12/5, type SO cord was installed in the L1 entry of D-3 to supply 600-volt, three-phase power from the five-circuit distribution box to the Flygt pump installation located in the L1 entry inby the No. 19 crosscut. MSHA investigators could not determine conclusively if the cord was energized when the explosion occurred. Examination and testing of the No. 12/5, type SO cord during the investigation revealed that the cord did not provide the ignition source for the explosion.

Flygt Pump Installation

A Flygt pump installation was located in the L1 entry of D-3 inby the No. 19 crosscut. The installation consisted of the following:

1. A Flygt Corporation Type DBF-75-GR, 5-horsepower, 575-volt, three-phase, submergible pump located inby the No. 19 crosscut. The pump had been approved by MSHA as permissible (Approval No. 2G-2658A-1).

2. A Flygt Corporation Model 2051.080, manual starter located near the No. 19 crosscut. The starter enclosure had been certified by MSHA as explosion proof (Certification No. X/P-1895).

3. Approximately 50 feet of No. 12 AWG, seven-conductor, permissible-pump cable connecting the pump to the starter.

The Flygt pump was connected into the suction line for the Labour pump with approximately 190 feet of flexible, plastic waterline. According to Pierce, Boucher, and Blazosky, the pump was not operated continuously but was operated only when it was necessary to prime the Labour pump. Since the starter for the Flygt pump was a manual type, the pump could have been controlled either by operating the circuit breaker in the starter or by operating the "B" circuit breaker in the five-circuit distribution box.

Examination of the Flygt pump installation during the investigation revealed that the 3-inch gate valve in the discharge line for the pump at the Labour pump installation was closed and the circuit breaker in the manual starter was in the open (off) position. Consequently, MSHA investigators concluded that the Flygt pump was not in operation when the explosion occurred. Examination and testing of the Flygt pump installation revealed that the pump installation did not provide the ignition source for the explosion.

<u>Battery-Powered Equipment</u>

Battery-Powered Locomotive

During the recovery, a nonpermissible, 5-ton, battery-powered locomotive was found on the D-3 track (L1 entry) just outby the No. 15 crosscut. One inby corner of the locomotive frame was resting on one of several roof-support rails that had fallen across the track. The inby, operator-side wheel was approximately 1 inch above the track. The other three wheels were resting on the track. (See photograph in Appendix N.)

Parzatka was found lying in the inby passenger compartment of the locomotive. Depto was found lying along the operator's side of the locomotive. Miller was found lying approximately 48 feet outby the locomotive at the No. 14 crosscut.

The locomotive was examined and tested by MSHA investigators both underground and on the surface at the Main Complex Shop. The examinations and tests revealed the following.

Brakes and Controls. - The hydraulic brake was found in the released position. The mechanical brake was found in the released position. This brake could be used as a parking brake by pulling either of the two brake handles and dropping a latch in place to hold the handle in position. Both latches were found in the released position. A sprag that was also used as a parking brake was found in the raised position pointing outby. This was the normal position for traveling in the inby direction. (See photograph in Appendix N.)

The circuit breaker for the main power circuit from the battery was found in the tripped position. The control circuit fuse was continuous. The safe-off switch was found in the closed (on) position. This switch was used to turn the control power for the locomotive on and off and must be in the closed position to operate the locomotive. The switch for the inby headlights was found in the closed (on) position. The switch for the outby headlights was found in the open (off) position. The self-centering tram control lever was found in the centered (off) position. This tram control lever controlled both the acceleration and dynamic braking and also served as the directional control switch. The locomotive was not equipped with a separate directional control switch.

Damage. - The damage to the locomotive included the following. The bulbs in both outby headlights had been smashed and debris had been blown into the enclosures. The loosely mounted outby headlight enclosure on the operator's side had been blown into the outby passenger compartment. The inby headlights were intact. All of the plastic reflectors on the locomotive had been exposed to heat. The condition of the reflectors indicated that the outby reflectors had been exposed to more heat than the inby reflectors. The outby sand box on the operator's side had been pushed inby, the mounting bolts had been sheared, the cover had been blown off, and the plunger assembly had been broken. The lid on the outby sand box opposite the operator's side had been bent inby and the lid hinge had been damaged. A pillow-block bearing for the outby sander linkage had been broken, apparently by a falling roof-support rail. The operating handle for the sanders had been bent down approximately 6 inches over the tram control lever.

Arcing Components. - The following components produced electrical arcing during normal operation of the locomotive: three switches in the master control station, the switches in the tram control station, four contactors in the contactor panel, and the 18-horsepower, direct-current motor. In addition, the main circuit breaker would produce electrical arcing if it were opened manually under load or if it opened automatically as a result of an overcurrent condition.

None of the arcing components of the locomotive was in an explosion-proof enclosure. However, the enclosures for the master control station and tram control station were reasonably sealed with gasketed covers. There was no evidence of an internal methane-air ignition in either enclosure. In fact, the explosion had forced dust into the master control station through the cutouts in the gaskets for the switch handles and into the tram control station where the enclosure had been bent. (See photograph in Appendix N.)

The direct-current motor was designed to be watertight. The cover over the commutator was gasketed. Two watertight fittings were provided for the cable entrances to the motor. However, the bushings in the fittings did not seal around the two, single-conductor cables entering through each fitting. Also, there was an open 3/8-inch diameter hole through the motor enclosure. There was a heavy layer of dust in the bottom of the motor. Most of the dust appeared to be carbon dust from brush wear. There was no evidence of a methane-air ignition in the motor.

Both the contactor panel and the main circuit breaker were provided with loosely-fitting, metal covers. The contactor panel was located behind the outby passenger compartment on the operator's side of the locomotive. The cover for the panel had three sides and a top and fit loosely over the contactor panel. The cover was not designed to be bolted on and was found lifted up approximately 1/4 inch and moved inby approximately 1/4 inch. (See photograph in Appendix N.) There was also an opening of approximately 1 1/2 inches between the bottom edges of the cover and a 4-inch layer of mine dust on the floor of the locomotive. The circuit breaker was provided with a loosely-fitting, U-shaped, metal cover with cutouts for the line and load conductors and the circuit breaker handle. This cover was bolted on. Both the circuit breaker and the components of the contactor panel were coated with a moderate layer of dust. There was no visible evidence of a methane-air ignition in either enclosure. However, visible evidence of a methane-air ignition would not necessarily have been present due to the open construction of the enclosures.

<u>Other Components.</u> - MSHA investigators carefully examined and tested the components of the locomotive that did not arc during normal operation for any evidence of a short circuit or other abnormal arcing that could have provided the ignition source for the explosion.

There was no evidence of electrical arcing on the inside of the battery-tray cover, battery-cell terminals, or intercell connections. Current measurements from the positive and negative battery terminals to the frame of the vehicle indicated that the battery was tracking to the frame. MSHA investigators believe, however, that the tracking was caused by dust, moisture, and battery acid that accumulated on the battery after the explosion.

There was evidence of electrical arcing on the metal cover for the main circuit breaker at the cutout for one of the line-side conductors to the circuit breaker. There was no corresponding evidence of arcing on the conductor indicating that the arcing occurred prior to the explosion before the present conductor was installed.

The locomotive was equipped with an ampere-hour meter to monitor the charge on the battery. There was a small, irregular hole in the plastic cover for the meter that had been made from the outside. A current-carrying strap from the external shunt on the meter to the internal meter movement had faulted to the metal frame of the meter. The strap had melted and was spattered throughout the inside of the enclosure. The meter was connected in series with the positive conductor from the battery. Resistance readings indicated that the negative circuit from the battery was not faulted to the frame of the vehicle. Consequently, MSHA investigators concluded that the fault in the ampere-hour meter occurred prior to the explosion.

Evidence of arcing was observed inside both inby headlight enclosures where the lamp terminals had faulted to the enclosures. There was no corresponding evidence of arcing on the lamp terminals indicating that the arcing occurred prior to the explosion before the present lamps were installed. There was no evidence of electrical arcing inside the outby headlight enclosures.

In addition to the contactor panel, the locomotive was provided with a solid state controller to control acceleration and deceleration. The controller was housed in a gasketed metal enclosure. There was no evidence of electrical arcing in the controller and the power fuse in the controller was intact. There was no evidence of an internal methane-air ignition in the controller enclosure. In fact, tracking on the enclosure cover indicated that the explosion forced dust past the gasket and into the enclosure.

The locomotive was equipped with a 550-volt, 3-phase, onboard battery charger. The input section of the battery charger was not energized when the explosion occurred. The output section, however, was connected to the battery. There was no evidence of electrical arcing in the output section of the battery charger and the output fuse was intact.

The locomotive was equipped with a dynamic braking resistor located under the outby end. There was no evidence of electrical arcing on the resistor.

Insulation resistance measurements indicated that the circuits and components of the locomotive were free from short circuits. After replacing the lamps in the outby headlights and charging the battery, the locomotive was operated in the Main Complex Shop. The locomotive operated normally. Electrical arcing was observed during the normal operation of the forward and reverse contactors on the locomotive.

Dust Samples. - MSHA investigators collected 12 dust samples from various components of the locomotive. The samples were analyzed by the MSHA Bruceton Safety Technology Center. Three samples were too small to analyze. The samples from inside the motor enclosure and from the underside of the cover over the motor did not contain coke. The samples from the contactor panel cover, from the contactor panel surfaces, and from the main frame of the locomotive between the battery and the motor contained a trace of coke. The samples from the outby passenger compartment, from the outby coupler, from on and around the motor, and from on top of battery charger transformer contained a small amount of coke. The presence of coke in the dust samples confirmed that the locomotive was engulfed in flame. However, MSHA investigators do not believe that the samples conclusively indentify the locomotive as the ignition source due to the open construction of the locomotive and the locations where coke was found. The analyses results are reported in Appendix H.

Conclusions. - The slope of the L1 entry of D-3 between the Nos. 13 and 15 crosscuts was approximately 4 percent. Considering this grade, it is very unlikely that the locomotive was left unattended without any of the parking brakes being set. Based on the above, and on the relative locations of Depto, Miller, and Parzatka, MSHA investigators concluded that Depto was at the controls of the locomotive when the explosion occurred. MSHA investigators also concluded that Parzatka was in the inby passenger compartment and Miller was either on the locomotive or near the locomotive when the explosion occurred.

Because the locomotive was not provided with a separate directional control switch, MSHA investigators were not able to determine conclusively the direction the locomotive was traveling immediately before the explosion. Since Depto, Miller, and Parzatka had completed the job of installing the new strainer, it is reasonable to assume that they were traveling outby when the explosion occurred. However, the position of the headlight switches and the sprag that was used as a parking brake indicated that the locomotive had been traveling inby, was traveling inby, or was about to travel inby when the explosion occurred.

Since the locomotive was not permissible, and since it contained several components that arced during normal operation, MSHA investigators concluded that the locomotive could have provided the ignition source for the explosion. However, MSHA investigators were not able to determine conclusively that the locomotive provided the ignition source for the explosion solely from the examinations and tests that were conducted on the locomotive. There was no conclusive evidence that a specific component of the locomotive provided the ignition source for the explosion. However, the contactor panel was the most likely ignition source on the locomotive. The loosely-fitting metal cover over the panel would permit methane to migrate readily into the panel. In addition, the contactors in the panel produced electrical arcing of sufficient energy to ignite an explosive methane-air mixture during normal operation of the locomotive.

Cap Lamps and Methane Detector

Three permissible electric cap lamps were recovered by MSHA investigators. The first cap lamp was removed from Depto's belt and was missing the headpiece. The second cap lamp was removed from Miller's belt and was also missing the headpiece. The third cap lamp was removed from Parzatka's belt. This cap lamp was complete; however, the headpiece lens was broken.

A permissible methane detector was also recovered by MSHA investigators. The methane detector was found inside its carrying case attached to Depto's belt indicating that it was not in use when the explosion occurred.

The cap lamp and methane detector were sent to the MSHA Approval and Certification Center for testing and evaluation to determine if one of the devices could have provided the ignition source for the explosion. Although two of the cap lamps were missing headpieces, the Center found no indication that the devices were not maintained in permissible condition. A summary of the results of the testing and evaluation of these devices is in Appendix L. A complete report on the testing and evaluation of these devices is on file at the MSHA Approval and Certification Center under Investigation No. X-163. Based on the Approval and Certification Center's findings, MSHA investigators concluded that neither the cap lamps nor the methane detector provided the ignition source for the explosion.

D-1 Electric Circuits and Equipment

The evidence of forces observed in the affected area indicated that the explosion originated in the D-3 entries. Nevertheless, MSHA investigators examined and tested the electric circuits and equipment that were located in the D-1 entries since evidence of flame was observed throughout these entries. MSHA investigators found no evidence to indicate that any of the D-1 electric circuits or equipment provided the ignition source for the explosion.

D-5 Electric Circuits and Equipment

The evidence of forces observed in the affected area indicated that the explosion originated in the D-3 entries. Nevertheless, MSHA investigators examined and tested the electric circuits and equipment that were located in the D-5 area of the mine since evidence of flame was observed in the D-5 working section and in the D-5 rooms. MSHA investigators found no evidence to indicate that any of the D-5 electric circuits or equipment provided the ignition source for the explosion.

Smoking Materials

No smoking materials were found in the lunch buckets on the D-5 section or in the personal effects of the victims. Furthermore, MSHA investigators found no evidence to indicate that smoking materials were being taken or used underground. Consequently, MSHA investigators concluded that the use of smoking materials did not provide the ignition source for the explosion.

Flame Safety Lamps

MSHA invesigators recovered three permissible flame safety lamps. The first flame safety lamp was marked "J. Nadolsky" and was found in the operator's compartment of the continuous mining machine in the face of the B entry in the D-5 section. The second flame safety lamp was marked "T. Hilliard" and was found on the roof bolting machine in the face of the L1 entry in the D-5 section. The third flame safety lamp was marked "Dino" and was found on the trolley-powered locomotive that was parked just inby the D-3 track switch in Main D at the time of the explosion. According to Pierce, this flame safety lamp was not burning when he observed the lamp on the locomotive at approximately 3:00 a.m. on the night of the explosion.

The flame safety lamps were not located in areas of the mine in which evidence of flame was observed. Nevertheless, the three flame safety lamps were sent to the MSHA Bruceton Safety Technology Center for testing and evaluation to determine if any of the lamps were capable of causing an external ignition of flammable concentrations of methane gas in air. The testing and evaluation revealed that the three lamps were free from defects and assembled in a permissible manner. Moreover, the lamps did not ignite external flammable concentrations of methane gas in air during the testing. The results of the testing and evaluation of the flame safety lamps are reported in Appendix M. Based on these results, MSHA investigators concluded that the flame safety lamps did not provide the ignition source for the explosion.

Torch Igniters

Two torch igniters were found in the outby passenger compartment of the battery-powered locomotive that was found in the L1 entry of D-3 just outby the No. 15 crosscut. Both torch igniters were found under a self-contained self-rescuer with a number of hand tools. As found, each torch igniter was capable of producing a spark that could ignite an explosive methane-air atmosphere. However, no torch, tank, or other burning and cutting equipment was found on the locomotive or in the D-3 entries. There was no reason for any of the victims to strike a torch igniter. Finally, the location of the torch igniters indicated that neither was in use when the explosion occurred. Based on the above, MSHA investigators concluded that the torch igniters did not provide the ignition source for the explosion.

Probable Point of Origin

In attempting to determine the probable point of origin of the explosion, MSHA investigators carefully considered the following factors:

1. The magnitude and direction of the explosion forces in the D-1, D-3, and D-5 areas of the mine.

2. The effect of the water accumulation in the D-3 entries and the effect of the erection of the stoppings in the cut-throughs at the Nos. 14 and 19 crosscuts on the ventilation of the D-1, D-3, and D-5 areas of the mine.

3. The extent of flame in the D-1, D-3, and D-5 areas of the mine.

4. The locations of the potential ignition sources in the D-1, D-3, and D-5 areas of the mine.

The magnitude and direction of forces in the affected area indicated that the explosion originated in the L1 entry of D-3 between the Nos. 13 and 14 crosscuts. The explosion forces radiated from this area. Outby the No. 13 crosscut, the forces in the D-3 entries were consistently in the outby direction. Inby the No. 14 crosscut, the forces in the D-3 entries were consistently in the inby direction. In addition, the forces in the Nos. 11 through 16 crosscuts radiated from the L1 entry toward the L2 and B entries.

MSHA investigators concluded that the rising water in D-3 increasingly restricted the air flow to the inby longwall gob and outby longwall bleeder entries. Air moving in the D-3 entries was further restricted when the stoppings were constructed in the two cut-throughs. The majority of the air that leaked through the curtains installed across the mouth of D-3 travelled across the face of the outby longwall gob to the D-1 return. The air movement in the D-3 entries inby the No. 6 or 7 crosscut was not sufficient to prevent methane, with a specific gravity of 0.554, from migrating up the sloped roof primarily from the outby longwall gob and accumulating in the higher D-3 entries between the Nos. 11 and 14 crosscuts.

The extent of flame in the D-3 entries indicated that a relatively small body of methane was present in this area. If the explosive body of methane had extended significantly outby the No. 11 crosscut or significantly inby the

No. 14 crosscut, the extent of the flame observed in the D-3 entries and D-5 section would have been significantly greater.

MSHA investigators found two potential ignition sources in the D-3 entries. The potential ignition sources were: (1) the nonpermissible, magnetic starter for the Labour pump located in the L1 entry near the No. 17 crosscut and (2) the nonpermissible, battery-powered locomotive found in the L1 entry just outby the No. 15 crosscut. The magnetic starter was capable of igniting an explosive methane-air mixture during normal operation. However, MSHA investigators eliminated the starter as the ignition source because the direction of forces observed in the D-3 entries indicated that the explosion originated at least three crosscuts outby the starter and because the contour of the D-3 entries indicated that an explosive methane-air mixture could not have been present near the floor of the entry at the starter. Consequently, MSHA investigators concluded that the explosive methane-air mixture was ignited by electrical arcing during normal operation of the nonpermissible, battery-powered locomotive in the L1 entry of D-3 in or near the No. 14 crosscut.

FINDINGS OF FACT

Findings

1. At about 4:30 a.m., February 16, 1984, an explosion occurred in the D-1 and D-3 entries and the D-5 working section of the Greenwich Collieries No. 1 mine, Greenwich Collieries Division of Pennsylvania Mines Corporation, Green Township, Indiana County, Pennsylvania.

2. Fourteen miners were present in the D-3 and D-5 areas at the time of the explosion. The three miners in the D-3 area died as a result of the explosion. The eleven miners in D-5 were exposed to heat, smoke, dust, and forces but survived the explosion. Four of these miners, however, suffered severe burns.

3. The victims were recovered and transported to the surface at the Main A portal at approximately 11:00 p.m. on February 17, 1984. The medical examiner's report indicated that two of the victims died from the combined effects of burns, blast injury, shock, and carbon monoxide poisoning and that the third victim died from the combined effects of burns, blast injury, fractures, and carbon monoxide poisoning.

4. An MSHA safety and health inspection was begun on January 3, 1984, and was in progress at the time of the explosion. During the day shifts on February 13 and 14, 1984, a Federal inspector was on the D-5 working section performing inspection activities. The inspector was on the Main A working section during the day shift on February 15, 1984. A total of 31 citations were issued during this inspection, which was terminated on February 16, 1984.

5. There were seven openings into the mine: one triple compartment shaft, one intake shaft, one return shaft, and four drift entries. Mine ventilation was induced by two exhaust fan installations located on the surface at the top of the return shaft (North fan) and triple compartment shaft (Main A fan). The installations included automatic-closing and explosion-relief doors.

6. The North fan was a Jeffrey Model 12A83 Aerodyne fan, driven at 850 rpm by an 800-horsepower, electric motor. Pressure and air quantity measurements made at the fan during the investigation indicated the fan was operating in the 4C blade position at a pressure of 7.67 inches of water. During an inspection made prior to the explosion, an air measurement made at the North fan indicated 478,745 cfm were exhausted from the mine at this location.

7. The Main A fan was also a Jeffrey Model 12A83 Aerodyne fan, driven at 910 rpm by an 800-horsepower, electric motor. Pressure and air quantity measurements made at the fan during the investigation indicated the fan was operating in the 3D blade position at a pressure of 6.93 inches of water. During an inspection made prior to the explosion, an air measurement made at the Main A fan indicated 442,620 cfm were exhausted from the mine at this location.

8. The methane liberation was 2.4 million ft^3/day during the MSHA inspection ending in December 1983.

9. The Ventilation System and Methane and Dust Control Plan in effect for the mine at the time of the explosion was approved on September 21, 1983. The plan required a minimum of 5,000 cfm of air to be maintained in each working place of the D-5 continuous mining machine section. The plan required a minimum of 3,400 cfm of air to be maintained in each working place of the other continuous mining machine sections, except in areas where adverse roof conditions required additional roof support such as rails or planks. Three thousand cfm of air was required in these areas. Line brattice or other approved devices were required to be maintained to within 10 feet of the area of deepest penetration to which any portion of the working face was advanced, except where approved fan spray systems were used. Line brattice was then required to be maintained to within 17 feet of the area of deepest penetration to which any portion of the working face was advanced. The plan required a minimum of 14,000 cfm of air at the intake end of the longwall face on the A4-7 longwall section.

10. The five entries of D-1 were started about August 1979 and were driven a distance of approximately 3,400 feet from Main D. The three entries of D-3, along with a fourth entry that was only driven one crosscut, were started about June 1980 and were driven approximately 3,200 feet from Main D. D-1 and D-3 were connected with three connecting line rooms near Main D, leaving a 100-foot wide barrier pillar. These connecting line rooms were driven for the proposed longwall. D-1 and D-3 were also connected at the inby end to form the setup entries for the longwall. The inby longwall began operation in June 1982 and was removed by March 1983. According to sworn statements, longwall operations were discontinued because of adverse roof and water conditions. Around June 1983, setup entries for the outby longwall were driven. The outby longwall began operation around August 1983 and was removed during December 1983. The D-1 and D-3 areas were not mined between this time and the time of the explosion.

11. D-5 was initially developed by three entries driven 2,150 feet to establish a longwall panel. Because of adverse roof conditions, no longwall mining was begun; instead, five entries (C14-C18) were driven toward D-3, extending the Nos. 14 through 18 crosscuts. From these entries, a total of eight entries were driven in the same direction as the original three entries extending D-5 to a total distance of about 3,000 feet. Rooms were then driven to the left and the area pillared back to the No. 19 crosscut. The section was then turned 180 degrees and was being driven toward Main D with eight entries at the time of the explosion.

12. Intake air entered D-3 through the L1 (track) and B (old belt) entries. A closed regulator was located in the L2 entry between the Nos. 1 and 2 crosscuts. According to sworn statements, no one other than Endler had taken an air reading in D-3 during the month preceding the explosion. Endler measured 9,000 cfm of air on

February 13, 1984, in the L1 entry of D-3 just outby the No. 2 crosscut. The quantity of air entering D-3 in the B entry had not been measured since some time in December 1983. Endler also indicated that when the outby longwall equipment was being pulled off the panel roughly 3,000 or 4,000 cfm of air was entering D-3 from D-1 through the connecting line rooms between D-1 and D-3. Several miners traveled in D-3 during the month prior to the explosion, but no one knew for sure how D-3 was ventilated.

13. The investigation team believes that one or two check curtains were installed across the L1 entry in D-3 at the time of the explosion, one located outby the No. 6 crosscut and the other located two or three crosscuts inby. The check curtains in the L1 entry of D-3 regulated the amount of air that entered D-3. Although there were open crosscuts between L1 and L2, the open crosscuts did not aid the ventilation of D-3 because they were inby a check curtain. Air entering the old belt entry of D-3 was also regulated. Box checks were located just outby and inby the mouth of D-3 in the Main D belt entry.

14. Endler stated that the air that entered D-1 through the check curtains across the mouth of the D-1 entries and the air that came across the outby longwall returned in the L2, L3, and L4 entries to the No. 5 crosscut, where it was coursed into the L4 entry and entered the Main D return. During the investigation, however, numerous stoppings in this area were found to be partially out or had blocks missing, but not as a result of the explosion. Much of the air entering the Main D return from the L4 entry was coursed no farther inby than the No. 11 crosscut in D-1.

15. Air entered the D-5 entries in the L1 (track) entry and in the B (belt) entry. Air entered the D-5 active section from the original D-5 entries through overcasts at the Nos. 14 and 15 crosscuts. The use of belt air at the face was permitted provided a 50-fpm air velocity was maintained near the belt tailpiece. The air was then coursed across the eight active faces of D-5, toward the D-5 gob, across the water, and across the return overcasts in the L2 entry. It was then coursed through the return regulator located between the Nos. 1 and 2 crosscuts and entered the Main D return.

16. During the last week in December 1983, an entry was driven at the No. 19 crosscut that connected the D-5 section to the D-3 entries. According to Endler, this cut-through was developed to provide a means to drain the water being produced in the pillared areas of D-5 into the D-3 entries, where the water was to be removed by the Labour pump. Kohan was the D-5 section foreman when the cut-through was made. He had temporarily replaced Stafford who was off for the holidays. At the time the entry was cut-through, Kohan stated that there was air movement through the cut-through traveling from D-3 toward D-5 and that the air from D-3 smelled stale. Kohan said he checked for methane and oxygen deficiency and took an air reading in the cut-through. Kohan could not remember the exact readings, but he did recall that he found no

unusual conditions or significant changes in the ventilation of D-5. He also stated that there was a check curtain installed in the cut-through when his crew left the D-5 section on the day the cut-through was made.

17. Approximately one month after the cut-through at the No. 19 crosscut was completed, a second connecting entry was driven between the D-5 section and the D-3 entries at the No. 14 crosscut. According to Endler, this second cut-through was to provide access to the edge of the water in D-5 after the mining in D-5 was completed. The water level in D-5 would be a convenient measure of the effectiveness of the pump in the D-3 entries. Stafford was the D-5 section foreman at the time this cut-through was completed. He stated that at that time there was air movement from the D-3 entries into the D-5 section through the cut-through and that a check curtain was installed after the mining machine was removed.

18. Preparations for the construction of permanent stoppings in the cut-throughs began on Monday, February 13, 1984. Miller delivered a load of concrete blocks and a man door to the outby cut-through at the No. 14 crosscut, and Mitchell constructed the stopping just prior to the end of the day shift. Mitchell stated that there was a significant amount of air leaking around the check curtain at the time the stopping was being built. The following day, Mitchell and Miller were instructed to build a crib block stopping in the inby cut-through at the No. 19 crosscut. The stopping was about 70 percent complete at the end of the shift. Mitchell stated that he returned to the D-5 section and finished building the stopping during the day shift on Wednesday, February 15.

19. Air entering D-5 from D-3 through the cut-throughs at the Nos. 14 and 19 crosscuts affected the ventilation in both the D-3 entries and the D-5 section. After the cut-throughs were driven, normal air readings in the last open crosscut of D-5 were around 10,000 cfm. Russel said his average last open crosscut air reading was 10,500 cfm and Stafford reported an average air reading of 10,000 cfm in the last open crosscut. Stafford normally measured 17,000 cfm of air in the return at the section belt overcast. In Stafford's opinion, the difference in the normal last open crosscut and return readings was the air entering the section through the cut-throughs. On the shift of the explosion, Stafford measured 17,000 cfm of air in the last open crosscut after stoppings were installed in both cut-throughs. Stafford said he believed the increase in air was due to the stoppings that had been installed in the cut-throughs.

20. According to sworn statements, sufficient air measurements to evaluate the ventilation in the D-1 and D-3 areas were not made during the month preceding the explosion. Air movement in outby areas of D-1 and D-3 would not necessarily ensure that a ventilating current was traveling in D-1 inby the No. 11 crosscut or in D-3 inby the No. 6 crosscut. Much of the air movement in the D-3 entries inby the No. 6 crosscut was eliminated when the stoppings were constructed in the cut-throughs.

21. Pierce stated that on or about December 13, 1983, a 100-horsepower, Labour pump was installed in the track entry of D-3 at the No. 17 crosscut, replacing four smaller pumps. At that time, the edge of the water in the D-3 entries was about 30 feet inby the No. 17 crosscut. After the cut-through was made at the No. 19 crosscut, a 15-horsepower, Prosser pump was installed in D-5 just inby the cut-through in the R5 entry to pump water from D-5 into D-3. Pierce said that, with the shallow head and short discharge line, this pump added 700 to 800 gpm more water into D-3. This resulted in about twice as much water entering D-3 than the Labour pump could remove, and most of the water that was being pumped into D-3 flowed back into D-5 through the inby cut-through.

22. Pierce researched higher capacity pumps and discussed the need for a larger pump in D-3 with Endler and Riva. Pierce said he got no response, so he tried to increase the capacity of the Labour pump. The Saturday before the explosion, the pump head, including the impeller, was changed. Pierce said he also tightened the packing and adjusted the gate valve on the following Tuesday. The work performed by the three victims just before the explosion occurred was yet another attempt to increase the capacity of the Labour pump.

23. From the time the inby cut-through was made until the stopping was started in the cut-through, the water level in D-3 could not rise significantly above the inby cut-through since any excess water could drain freely into D-5 where the water level was lower. Mitchell stated that the water level in the inby cut-through rose between 4 and 6 inches from the time he started the stopping on Tuesday to the time he finished the stopping the following afternoon. After the stopping was started in the cut-through on Tuesday, the water could not flow back into D-5. Judging from the rate of the rise of the water level in D-3 during construction of the inby stopping, the increase in the water level could have been as much as 9 inches over the 36 hours immediately preceding the explosion.

24. MSHA investigators concluded that the rising water in D-3 increasingly restricted the air flow to the inby longwall gob and outby longwall bleeder entries. Air moving in the D-3 entries was further restricted when the stoppings were constructed in the two cut-throughs. The majority of the air that leaked through the curtains installed across the mouth of D-3 travelled across the face of the outby longwall gob to the D-1 return. The air movement in the D-3 entries inby the No. 6 or 7 crosscut was not sufficient to prevent methane from migrating up the sloped roof primarily from the outby longwall gob and accumulating in the higher D-3 entries between the Nos. 11 and 14 crosscuts.

25. The middle mine management structure consisted of a general mine foreman, an assistant mine foreman, three shift foremen, and three general assistants. Each of the three shift foremen and each of the three general assistants was assigned two coal-producing sections. Each of these management employees was of the opinion that

his primary responsibilities were safety and coal production on his two assigned sections. A shift foreman or general assistant was not assigned to be directly responsible for areas of the mine other than the coal-producing sections, even though areas such as D-1 and D-3 were crucial to the safety of all miners in the mine. As a result of this management practice, areas such as D-1 and D-3 were generally ignored by the shift foremen and general assistants.

26. A preshift examination of the D-3 area was not made by a certified person within 3 hours preceding the entry of the three victims into D-3.

27. Pumpers and pipemen were trained and qualified in the use of a methane detector and in the use of a flame safety lamp for detecting oxygen deficiency. According to sworn statements, however, these persons were not trained or instructed in when and where to make checks for methane and oxygen deficiency or in the detection of other hazards inherent in entering into or working in an area of the mine that was not routinely examined by a certified person.

28. Although all three victims were trained and qualified in the use of a methane detector and in the use of a flame safety lamp, only one had any detecting devices with him upon entering D-3. A methane detector was found in Depto's clothing, but his flame safety lamp was found on the trolley-powered locomotive located at the mouth of D-3.

29. The required weekly examinations of the bleeder entries in the D-1 and D-3 areas were not being performed. Water in this area prevented anyone from walking the bleeder entries, and a method for evaluating the effectiveness of the bleeder system was never established. Endler said he spoke with the mine engineers about establishing bleeder evaluation points for these areas in the fall of 1983 but no request to establish these points was made to the MSHA District Manager. Bleeder evaluation points were not shown on the revised Ventilation System and Methane and Dust Control Plan submitted to MSHA on the day prior to the explosion.

30. Near the beginning of the midnight shift on Thursday, February 16, 1984, Pierce instructed Miller and Parzatka to help Depto make a 20-foot strainer and install it on the 100-horsepower, Labour pump that was located in D-3. Apparently Depto, Miller, and Parzatka finished making the strainer, loaded it on a trolley-powered locomotive, and, at approximately 2:30 a.m., traveled to the mouth of D-3. Depto, Miller, and Parzatka then traveled in a battery-powered locomotive to the Labour pump located on a track-mounted flatcar in the L1 entry of D-3. The evidence indicated that Miller and Parzatka put on chest waders, waded into the water, removed the old strainer, and installed the new strainer on the end of the suction line in the L1 entry at the No. 20 crosscut. The examination of the accident area and the condition and position of the victims' bodies indicated that Depto and Parzatka were in the locomotive with Depto at the controls at the time of the explosion. Miller was either in

or near the locomotive. The investigation team concluded that the locomotive was located in or near the No. 14 crosscut when the explosion occurred.

31. Both Drager W-65 FSR's and Ocenco EBA 6.5 SCSR's were used by the D-5 section crew as they evacuated the section. The six miners who were located near the faces and at the dumping point put on their FSR's before returning to the areas where their SCSR's were stored. Before leaving the section, all but two miners had on an SCSR. One miner left the section using his FSR; one miner left the section carrying both his FSR and SCSR and did not use either one.

32. In the D-3 entries, evidence of flame was present in the B entry from the No. 7 crosscut inby to the caved area between the Nos. 16 and 17 crosscuts, in the L1 entry from just outby the No. 7 crosscut inby to the No. 17 crosscut, in the L2 entry from just outby the No. 8 crosscut inby to the caved area at the No. 15 crosscut, and in the L3 entry from the No. 8 crosscut inby to the No. 18 crosscut. There was also evidence of flame entering the outby longwall gob from the L3 entry through the Nos. 9 through 18 crosscuts.

33. In the D-1 entries, evidence of flame was present in the B entry at the No. 19 crosscut and between the Nos. 1 and 6 crosscuts; in the L1 entry between the Nos. 17 and 19 crosscuts, at the No. 15 crosscut, between the Nos. 10 and 11 crosscuts, and between the Nos. 3 and 7 crosscuts; in the L2 entry between the Nos. 15 and 20 crosscuts, between the Nos. 10 and 11 crosscuts, and between the Nos. 6 and 7 crosscuts; in the L3 entry between the Nos. 14 and 20 crosscuts, between the Nos. 9 and 11 crosscuts, and between the Nos. 6 and 7 crosscuts; and in the L4 entry between the Nos. 6 and 18 crosscuts.

34. In the D-5 section entries, evidence of flame was present in the No. 13 crosscut between the R1 and R5 entries, in the No. 14 crosscut between the B entry of D-3 and the L2 entry of D-5, in the No. 15 crosscut between the L1 and L5 entries, and in the No. 16 crosscut between the R2 and R5 entries.

35. In the L1 entry of D-3, the major forces of the explosion were in the inby direction from the No. 14 crosscut inby. The major forces of the explosion were in the outby direction in the L1 entry from the No. 13 crosscut outby.

36. In the B entry of D-3, the major forces of the explosion were in the inby direction from the No. 15 crosscut inby. The major forces of the explosion were in the outby direction from the No. 12 crosscut outby. The forces of the explosion in the B entry between the Nos. 12 and 15 crosscuts were bidirectional.

37. In the L2 entry of D-3, the major forces of the explosion were in the outby direction from the No. 13 crosscut outby. The forces of the explosion in the L2 entry inby the No. 13 crosscut were weak due to the caved areas in the No. 14 crosscut and at the No. 15 crosscut.

38. In the L3 entry of D-3, the forces of the explosion were comparatively weak with very little force indication observed. The forces, however, entered the crosscuts between the L3 entry and the outby longwall gob.

39. All permanent stoppings in the D-3 entries between and including the Nos. 2 and 20 crosscuts were damaged or destroyed by the forces of the explosion.

40. In the D-1 entries, the major forces of the explosion were in the outby direction from the No. 18 crosscut outby. The outby moving forces in D-1 were directed over and concentrated into the L4 entry at the No. 12 crosscut by extensive roof falls in the L1, L2, and L3 entries. The major forces of the explosion were bidirectional in the L4 entry between the Nos. 11 and 12 crosscuts. All stoppings in the D-1 entries between the Nos. 7 and 19 crosscuts were damaged although many of the stoppings were partially or completely out prior to the explosion. Major forces also traveled outby the No. 7 crosscut to the mouth of D-1 partially damaging stoppings, the D-1 regulator, and overcasts.

41. The major forces of the explosion traveled from D-3 through the cut-throughs at the Nos. 14 and 19 crosscuts in the the D-5 working section. Blocks from the stoppings in the two cut-throughs, the four stoppings between the R2 and R3 entries, and the stopping in the No. 14 crosscut which separated L2 of the active section and L2 of the original entries were blown toward the original D-5 entries. The overcasts at the Nos. 15 and 16 crosscuts at the mouth of the D-5 active section were also damaged.

42. The direction of the major forces of an explosion cannot be used to determine the precise point of ignition. Nevertheless, several general conclusions about the point of ignition can be drawn from the directions of the major forces in the explosion area. The directions of the major forces in the D-5 working section indicated that the point of ignition was not in the D-5 section or in the original D-5 entries. The directions of the major forces in D-3 outby the No. 13 crosscut and inby the No. 14 crosscut indicated that the point of ignition was in one of the crosscuts or between them. The blocks from the stoppings on both sides of the L1 entry between the Nos. 11 and 17 crosscuts were blown away from the L1 entry. MSHA investigators concluded that the point of ignition was in the L1 entry of D-3 in or between the Nos. 13 and 14 crosscuts.

43. Numerous tests by the Bureau of Mines have established that coal dust having a volatile ratio of 0.12 and higher is explosive. The results of the analyses of the two samples revealed that the average volatile ratio of the coal in the explosion area of D-3 and D-5 at the time of the explosion was 0.28.

44. The magnitude of the forces observed in the explosion area suggests a low concentration of methane of approximately 7 percent when compared to past research and mine explosions. The magnitude of the

forces and the relatively small amounts of coke observed in the explosion area indicated that the explosion did not develop into a propagating coal dust explosion.

45. MSHA investigators found two potential ignition sources in the D-3 entries. The potential ignition sources were: (1) the nonpermissible, magnetic starter for the Labour pump located in the L1 entry near the No. 17 crosscut and (2) the nonpermissible, battery-powered locomotive found in the L1 entry just outby the No. 15 crosscut. The magnetic starter was capable of igniting an explosive methane-air mixture during normal operation. However, MSHA investigators eliminated the starter as the ignition source because the direction of forces observed in the D-3 entries indicated that the explosion originated at least three crosscuts outby the starter and because the contour of the D-3 entries indicated that an explosive methane-air mixture could not have been present near the floor of the entry at the starter. Consequently, MSHA investigators concluded that the explosive methane-air mixture was ignited by electrical arcing during normal operation of the nonpermissible, battery-powered locomotive in the L1 entry of D-3 in or near the No. 14 crosscut.

Contributory Violations

Five of the conditions and practices in the Findings 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. They are listed below.

30 CFR 75.301 - The volume and velocity of air ventilating the D-3 area off Main D was not sufficient to dilute, render harmless, and carry away flammable and harmful gases which permitted methane to accumulate in explosive quantities in this area. On February 16, 1984, at approximately 4:30 a.m., the methane accumulation was ignited causing an explosion which resulted in the deaths of three miners in this area and injuries to other miners in the adjacent D-5 working section and caused property damage in D-1, D-3, and D-5. This condition was observed during the investigation of the multiple fatal mine explosion which occurred in the D-1, D-3, and D-5 areas of the mine.

30 CFR 75.303(a) - According to the preshift examination books, sworn statements given voluntarily during the investigation, and the absence of initials, times, and dates in the D-3 area, a preshift examination was not made by a certified person within three hours immediately preceding the entry of three miners into this area to perform work on the water pumping system on the 12:00 midnight shift, February 16, 1984. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3, and D-5 areas of the mine.

30 CFR 75.316 - The Ventilation System and Methane and Dust Control Plan, Review No. 23, approved September 21, 1983, was not being complied with in that the air was not traveling in its proper course and direction to ensure that the entire D-1 and D-3 areas of the mine were properly ventilated. The ventilation system was not maintained as provided in the approved plan.

Water was permitted to accumulate in the air courses in the D-1 and D-3 areas which severely restricted air movement and which permitted methane to accumulate in an explosive quantity in D-3. Furthermore, permanent stoppings installed to maintain the air in its proper course had been removed. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in D-1, D-3, and D-5 areas of the mine.

30 CFR 75.316 - The Ventilation System and Methane and Dust Control Plan, Review No. 23, approved September 21, 1983, was not being complied with. The bleeder entries for the D-1 and D-3 areas were not being examined at least weekly to determine whether the areas were free from explosive methane-air mixtures or oxygen deficiency and whether the bleeders were functional as provided in the approved plan. The bleeder entries were filled with water which prohibited a certified person from examining this bleeder system. A method of evaluating the effectiveness of the bleeder system when it could not be examined was not approved by the District Manager. According to sworn statements by company officials and the absence of a record of the weekly examinations in the mine record books, the D-1 to D-3 bleeder system was not being examined weekly. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3, and D-5 areas of the mine.

30 CFR 75.322 - Changes in ventilation which materially affected the split of air in the D-1 and D-3 entires which affected the safety of the miners were made while the mine was not idle. The power circuits to the Labour pump were not deenergized before these changes were made. The D-3 area was not examined after completion of the change by a certified person to determine if the affected area was safe. These changes were as follows: (1) During the period December 26, 1983, to January 1, 1984, a connection was made between the active D-5 section and the idle D-3 area at the No. 19 crosscut; (2) Water restricted the air movement in the D-1 and D-3 areas, causing the majority of the ventilating current of air in D-3 to pass through the connection at the No. 19 crosscut; (3) On February 14 and 15, 1984, a permanent stopping was constructed in the connection at the No. 19 crosscut which materially reduced the ventilation in D-3 permitting methane to accumulate in an explosive quantity in D-3. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3, and D-5 areas of the mine.

CONCLUSION

MSHA investigators concluded that failure to maintain an effective bleeder system for the longwall gob areas between D-1 and D-3 materially affected the movement of air in the D-3 entries inby the No. 6 crosscut. Rising water in D-3 increasingly restricted the air flow to the inby longwall gob and outby longwall bleeder entries. Air moving in the D-3 entries was further restricted when permanent stoppings were constructed in the two cut-throughs connecting the D-3 entries and the D-5 section. The volume and velocity of air became inadequate to dilute, render harmless, and carry away flammable and explosive gases which were liberated in the gob areas. The failure to maintain the air flow in its proper volume and direction in the D-3 entries, inby longwall gob bleeder entries, outby longwall gob bleeder entries, and D-1 entries allowed an explosive methane-air mixture to accumulate in the D-3 entries between the Nos. 11 and 14 crosscuts. MSHA investigators concluded that the explosive methane-air mixture was ignited by electrical arcing created by the normal operation of a nonpermissible, battery-powered locomotive in the L1 entry of D-3 in or near the No. 14 crosscut.

The primary cause of the explosion was the failure of mine management to maintain a sufficient volume and velocity of air in the D-3 entries to dilute, render harmless, and carry away the methane gas being liberated in the longwall gob. The following factors contributed to the occurrence of the explosion:

1. The failure to maintain the D-1 and D-3 bleeder entries free of water to permit safe travel as required by the approved Ventilation System and Methane and Dust Control Plan.

2. The failure to properly evaluate the effects of the stoppings constructed in the two cut-throughs between the D-3 entries and the D-5 section on the ventilation in the D-3 entries.

3. The failure to fully recognize the effects of the rising water level on the ventilation in the D-3 entries.

4. The failure to have a preshift examination performed in the D-3 entries before a pumper and two pipemen began working in the D-3 entries.

5. The failure to assign responsibility to management personnel for the maintenance of areas other than coal-producing sections such as D-1 and D-3.

Respectfully submitted,

George M. Fesak
Electrical Engineer

Dale R. Cavanaugh
Mechanical Engineer

Approved by:

Joseph A. Lamonica
Administrator
for Coal Mine Safety and Health

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APPENDICES

Appendix A

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Appendix A

Data Sheet

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

Section A—Victim Data

1. Name: Walter Depto (Victim)
2. Sex: ☒ Male ☐ Female
3. Social Security Number: 0514
4. Age: 47
5. Job Classification: Pumper
6. Experience at this Classification: 3 Years
7. Total Mining Experience: 12 Years
8. What activity was being performed at time of accident? Operating Locomotive
9. Victim's Experience at this Activity: 12 Years
10. Was victim trained in this task? Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
11.	Methane Detection	March 1982
12.	Electrical Qualification	03/06/81
13.	Annual Refresher Training	04/07/83
14.	Electrical Retraining	03/18/83

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Merl Pierce
16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 10 Years
18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
19.	Methane Detection and Oxygen Deficiency	September 1983
20.	Annual Refresher Training	12/07/83
21.	Electrical Qualification Retraining	06/17/83
22.		

23. When was the supervisor last present at accident scene prior to the accident? Pierce was in D-3 on February 14, 1984
24. What did he do when he was there? Checked Labour pump; made methane test in cavity in track entry of D-3 at crosscut 13
25. When was he last in contact with the victim? 12:01 a.m., February 16, 1984
26. Did he issue instructions relative to the accident? Instructed victim to change strainer on Labour pump in D-3
27. Was he aware of or did he express an awareness of any unsafe practice or condition? No

Data Sheet

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name	2. Sex	3. Social Security Number
Gary Miller (Victim)	☒ Male ☐ Female	8015

4. Age	5. Job Classification
34	Pipeman

6. Experience at this Classification	7. Total Mining Experience
8 Years	13 Years

8. What activity was being performed at time of accident?	9. Victim's Experience at this Activity	10. Was victim trained in this task?
Standing near or Riding in Locomotive	13 Years	Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
11. Methane Detection	March 1982
12. Annual Refresher Training	03/22/83
13.	
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name	16. Certified
Merl Pierce	☒ Yes ☐ No

17. Experience as Supervisor	18. Total Mining Experience
10 Years	14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
19. Methane Detection and Oxygen Deficiency	September 1983
20. Annual Refresher Training	12/07/83
21. Electrical Qualification Retraining	06/17/83
22.	

23. When was the supervisor last present at accident scene prior to the accident?	24. What did he do when he was there?
Pierce was in D-3 on February 14, 1984	Checked Labour pump; made methane test in cavity in track entry of D-3 at crosscut 13

25. When was he last in contact with the victim?	26. Did he issue instructions relative to the accident?
12:01 a.m., February 16, 1984	Instructed victim to change strainer on Labour pump in D-3

27. Was he aware of or did he express an awareness of any unsafe practice or condition?

No

MSHA Form 2000-58, June 83 (Revised)

Data Sheet

U.S. Department of Labor Appendix A (Cont.)

Mine Safety and Health Administration

Section A—Victim Data

1. Name: Stephan Parzatka (Victim)	2. Sex: ☒ Male ☐ Female	3. Social Security Number: 0108
4. Age: 31	5. Job Classification: Pipeman	
6. Experience at this Classification: 2-1/2 Years	7. Total Mining Experience: 13 Years	
8. What activity was being performed at time of accident? Riding Locomotive	9. Victim's Experience at this Activity: 13 Years	10. Was victim trained in this task? Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
11. Methane Detection	March 1982
12. Annual Refresher Training	05/10/83
13. Electrical Qualification Retraining	02/03/84
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Merl Pierce	16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 10 Years	18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
19. Methane Detection and Oxygen Deficiency	September 1983
20. Annual Refresher Training	12/07/83
21. Electrical Qualification Retraining	06/17/83
22.	

23. When was the supervisor last present at accident scene prior to the accident? Pierce was in D-3 on February 14, 1984

24. What did he do when he was there? Checked Labour pump; made methane test in cavity in track entry of D-3 at crosscut 13

25. When was he last in contact with the victim? 12:01 a.m., February 16, 1984

26. Did he issue instructions relative to the accident? Instructed victim to change strainer on Labour pump in D-3

27. Was he aware of or did he express an awareness of any unsafe practice or condition? No

Data Sheet

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

Section A—Victim Data

1. Name: Paul W. Stafford (Burned)
2. Sex: ☒ Male ☐ Female
3. Social Security Number: 3462
4. Age: 36
5. Job Classification: Section Foreman
6. Experience at this Classification: 8 Years
7. Total Mining Experience: 14 Years
8. What activity was being performed at time of accident? Eating Lunch
9. Victim's Experience at this Activity: DNA
10. Was victim trained in this task? DNA

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
11.	Methane Detection	March 1975
12.	Required Training for Certified Persons	10/19/83
13.		
14.		

Section C—Supervisor Data *(supervisor of victim)*

15. Name: David L. Radomsky
16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 9-1/2 Years
18. Total Mining Experience: 16 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
19.	Required Training for Certified Persons	12/15/83
20.		
21.		
22.		

23. When was the supervisor last present at accident scene prior to the accident? Could not remember; 2 or more months before explosion
24. What did he do when he was there? Unknown
25. When was he last in contact with the victim? At the beginning of the shift
26. Did he issue instructions relative to the accident? No
27. Was he aware of or did he express an awareness of any unsafe practice or condition?

No

MSHA Form 2000-58, June 83 (Revised)

Data Sheet

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name	2. Sex	3. Social Security Number
Robert J. Babiak	☒ Male ☐ Female	0023

4. Age	5. Job Classification
24	Roof Bolter Helper

6. Experience at this Classification	7. Total Mining Experience
10 Months	5 Years 9 Months

8. What activity was being performed at time of accident?	9. Victim's Experience at this Activity	10. Was victim trained in this task?
Helping Roof Bolter	10 Months	Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
11. Oxygen Deficiency Detection	October 1979
12. Methane Detection	March 1981
13. Annual Refresher Training	05/17/83
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name	16. Certified
Paul Stafford	☒ Yes ☐ No

17. Experience as Supervisor	18. Total Mining Experience
8 Years	14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
19. Required Training for Cerified Persons	10/19/83
20.	
21.	
22.	

23. When was the supervisor last present at accident scene prior to the accident? Present at Time of Accident

24. What did he do when he was there? Supervised Section Activities

25. When was he last in contact with the victim? 1 Hour before Accident

26. Did he issue instructions relative to the accident? No

27. Was he aware of or did he express an awareness of any unsafe practice or condition?
No

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Data Sheet

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

Section A—Victim Data

1. Name: Randy J. Henico
2. Sex: ☒ Male ☐ Female
3. Social Security Number: 7855
4. Age: 28
5. Job Classification: Supply Man
6. Experience at this Classification: 2 Years
7. Total Mining Experience: 9 Years
8. What activity was being performed at time of accident? Operating Shuttle Car
9. Victim's Experience at this Activity: 5 Years
10. Was victim trained in this task? Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
11.	Methane Detection	October 1976
12.	Annual Refresher Training	03/15/83
13.		
14.		

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Paul Stafford
16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 8 Years
18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
19.	Required Training for Certified Persons	10/19/83
20.		
21.		
22.		

23. When was the supervisor last present at accident scene prior to the accident? Present at time of Accident

24. What did he do when he was there? Supervised Section Activities

25. When was he last in contact with the victim? 30 Minutes before Accident

26. Did he issue instructions relative to the accident? No

27. Was he aware of or did he express an awareness of any unsafe practice or condition?
No

MSHA Form 2000-58, June 83 (Revised)

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name: Thomas L. Hilliard
2. Sex: ☒ Male ☐ Female
3. Social Security Number: 9379
4. Age: 56
5. Job Classification: Roof Bolter
6. Experience at this Classification: 10 Years
7. Total Mining Experience: 20 Years
8. What activity was being performed at time of accident? Installing Roof Bolts
9. Victim's Experience at this Activity: 10 Years
10. Was victim trained in this task? Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
11. Methane Detection	March 1975
12. Annual Refresher Training	03/15/83
13.	
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Paul Stafford
16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 8 Years
18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
19. Required Training for Certified Persons	10/19/83
20.	
21.	
22.	

23. When was the supervisor last present at accident scene prior to the accident? Present at Time of Accident
24. What did he do when he was there? Supervised Section Activities
25. When was he last in contact with the victim? 1 Hour before Accident
26. Did he issue instructions relative to the accident? No
27. Was he aware of or did he express an awareness of any unsafe practice or condition? No

Data Sheet

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name: Frederick C. Johnson (Burned)	2. Sex: ☒ Male ☐ Female	3. Social Security Number: 7075
4. Age: 40	5. Job Classification: General Laborer	
6. Experience at this Classification: 4 Years	7. Total Mining Experience: 15 Years	
8. What activity was being performed at time of accident? Operating Shuttle Car	9. Victim's Experience at this Activity: 7 Years	10. Was victim trained in this task? Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
11. Annual Refresher Training	04/07/83
12.	
13.	
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Paul Stafford	16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 8 Years	18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
19. Required Training for Certified Persons	10/19/83
20.	
21.	
22.	

23. When was the supervisor last present at accident scene prior to the accident? Present at Time of Accident

24. What did he do when he was there? Supervised Section Activities

25. When was he last in contact with the victim? A few minutes before Accident

26. Did he issue instructions relative to the accident? No

27. Was he aware of or did he express an awareness of any unsafe practice or condition?
No

MSHA Form 2000-58, June 83 (Revised)

Section A—Victim Data

1. Name: Timothy J. Kline (Burned)
2. Sex: ☒ Male ☐ Female
3. Social Security Number: 1884
4. Age: 25
5. Job Classification: Shuttle Car Operator
6. Experience at this Classification: 2 Years
7. Total Mining Experience: 6 Years
8. What activity was being performed at time of accident? Eating Lunch
9. Victim's Experience at this Activity: DNA
10. Was victim trained in this task? DNA

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
11. Methane Detection	March 1981
12. Annual Refresher Training	03/15/83
13.	
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Paul Stafford
16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 8 Years
18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
19. Required Training for Certified Persons	10/19/83
20.	
21.	
22.	

23. When was the supervisor last present at accident scene prior to the accident? Present at Time of Accident
24. What did he do when he was there? Supervised Section Activities
25. When was he last in contact with the victim? At time of Accident
26. Did he issue instructions relative to the accident? No
27. Was he aware of or did he express an awareness of any unsafe practice or condition? No

Data Sheet

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name	2. Sex	3. Social Security Number
Edward P. Lacko	☒ Male ☐ Female	5519

4. Age	5. Job Classification
41	Mechanic

6. Experience at this Classification	7. Total Mining Experience
6 Years	10 Years

8. What activity was being performed at time of accident?	9. Victim's Experience at this Activity	10. Was victim trained in this task?
Miner Helper	1 Year 9 Months	Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*	Date Received
11. Annual Refresher Training	03/15/83
12. Electrical Qualification Retraining	05/19/83
13.	
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name	16. Certified
Paul Stafford	☒ Yes ☐ No

17. Experience as Supervisor	18. Total Mining Experience
8 Years	14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*	Date Received
19. Required Training for Certified Persons	10/19/83
20.	
21.	
22.	

23. When was the supervisor last present at accident scene prior to the accident?	24. What did he do when he was there?
Present at Time of Accident	Supervised Section Activities

25. When was he last in contact with the victim?	26. Did he issue instructions relative to the accident?
A few minutes prior to the Accident	No

27. Was he aware of or did he express an awareness of any unsafe practice or condition?

No

MSHA Form 2000-58, June 83 (Revised)

Data Sheet

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name	2. Sex	3. Social Security Number
Henry J. Lefebure	☒ Male ☐ Female	7623

4. Age	5. Job Classification
36	Mechanic

6. Experience at this Classification	7. Total Mining Experience
11 Years	12 Years

8. What activity was being performed at time of accident?	9. Victim's Experience at this Activity	10. Was victim trained in this task?
Repairing Equipment	11 Years	Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*	Date Received
11. Methane Detection	March 1975
12. Electrical Qualification Retraining	07/17/83
13.	
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name	16. Certified
Larry Myers	☒ Yes ☐ No

17. Experience as Supervisor	18. Total Mining Experience
10 Years	13 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*	Date Received
19. Electrical Qualification Retraining	04/29/83
20. Annual Refresher Retraining	10/13/83
21. Self-Contained Self-Rescuers (Ocenco)	10/07/82
22.	

23. When was the supervisor last present at accident scene prior to the accident?	24. What did he do when he was there?
In D-5 working section approximately 10 months prior to Accident	Performed maintenance work on equipment

25. When was he last in contact with the victim?	26. Did he issue instructions relative to the accident?
12:01 a.m., February 16, 1984	Was to go to D-5 working section to perform maintenance work on battery-powered tractor

27. Was he aware of or did he express an awareness of any unsafe practice or condition?

No

MSHA Form 2000-58, June 83 (Revised)

Data Sheet

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

Section A—Victim Data

1. Name: James Nadolsky (Burned)
2. Sex: ☒ Male ☐ Female
3. Social Security Number: 7615
4. Age: 26
5. Job Classification: Miner Operator
6. Experience at this Classification: 3-1/2 Years
7. Total Mining Experience: 7 Years
8. What activity was being performed at time of accident? Eating Lunch
9. Victim's Experience at this Activity: DNA
10. Was victim trained in this task? DNA

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
11. Methane Detection	March 1981
12. Annual Refresher Training	03/15/83
13.	
14.	

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Paul Stafford
16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 8 Years
18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Date Received
19. Required Training for Certified Persons	10/19/83
20.	
21.	
22.	

23. When was the supervisor last present at accident scene prior to the accident? Present at Time of Accident
24. What did he do when he was there? Supervised Section Activities
25. When was he last in contact with the victim? At time of Accident
26. Did he issue instructions relative to the accident? No
27. Was he aware of or did he express an awareness of any unsafe practice or condition? No

Data Sheet

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name: Thomas A. Pittman
2. Sex: [X] Male [ ] Female
3. Social Security Number: 3052
4. Age: 40
5. Job Classification: Mechanic
6. Experience at this Classification: 9 Years
7. Total Mining Experience: 12 Years
8. What activity was being performed at time of accident? Preparing to Eat Lunch
9. Victim's Experience at this Activity: DNA
10. Was victim trained in this task? DNA

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

	Course	Date Received
11.	Electrical Qualification Retraining	10/07/83
12.	Annual Refresher Training	05/03/83
13.	Self-Rescuer Training	09/30/82
14.		

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Merl Pierce
16. Certified: [X] Yes [ ] No
17. Experience as Supervisor: 10 Years
18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

	Course	Date Received
19.	Annual Refresher Training	12/07/83
20.	Methane Detection and Oxygen Deficiency	September 1983
21.	Electrical Qualification Retraining	06/17/83
22.		

23. When was the supervisor last present at accident scene prior to the accident? Pierce was in D-5 about 15 minutes prior to the Accident
24. What did he do when he was there? Gave Instructions to Victim
25. When was he last in contact with the victim? 15 Minutes prior to the Accident
26. Did he issue instructions relative to the accident? No
27. Was he aware of or did he express an awareness of any unsafe practice or condition? No

MSHA Form 2000-58, June 83 (Revised)

Data Sheet

U.S. Department of Labor Appendix A (Cont.)
Mine Safety and Health Administration

Section A—Victim Data

1. Name: Ronald D. Westover
2. Sex: ☒ Male ☐ Female
3. Social Security Number: 8691
4. Age: 34
5. Job Classification: Miner Helper
6. Experience at this Classification: 8 Years
7. Total Mining Experience: 9-1/2 Years
8. What activity was being performed at time of accident? Operating Mining Machine
9. Victim's Experience at this Activity: 3-1/2 Years
10. Was victim trained in this task? Yes

Section B—Victim Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
11.	Methane Detection	March 1981
12.	Annual Refresher Training	03/15/83
13.	Task Training Operating Continuous Miner	08/27/80
14.		

Section C—Supervisor Data *(supervisor of victim)*

15. Name: Paul Stafford
16. Certified: ☒ Yes ☐ No
17. Experience as Supervisor: 8 Years
18. Total Mining Experience: 14 Years

Section D—Supervisor Data for Health and Safety Courses/Training Received *(related to accident)*

		Date Received
19.	Required Training for Certified Persons	10/19/83
20.		
21.		
22.		

23. When was the supervisor last present at accident scene prior to the accident? Present at Time of Accident
24. What did he do when he was there? Supervised Section Activities
25. When was he last in contact with the victim? 1 Hour before Accident
26. Did he issue instructions relative to the accident? No
27. Was he aware of or did he express an awareness of any unsafe practice or condition?
No

MSHA Form 2000-56, June 83 (Revised)

Appendix B

Appendix B - Rescue Team Members who Participated in the Recovery Operations.

Greenwich No. 1 Team

Allen Jones (Team Captain)
Fred Bender
Eugene Cunningham, Jr.
Paul Enedy, Sr.
Roger Leamer
Raymond Letizia
Joseph D. Mantini
Joseph Weber
Andrew Smilo (Trainer)

Greenwich No. 2 Team

Thomas Grattan (Team Captain)
Tony Barczak
Kevin Fowler
William Garay, Jr.
Raymond Noon, Jr.
James Roman
Mathew Rorabaugh
Richard Pesarchick (Trainer)

Rushton Team

Edward Albright (Team Captain)
Robert Baughman
Robert Dillon
James Hutton
David Phillips
Thomas Smith
Thomas Stodart
David Stoneberg
Richard Baker (Trainer)

Tunnelton Team

Gerald Shugars (Team Captain)
Robert Condor
Robert Dice
James Gradwell
Edward Jones
Ronald Lupyan
Andrew Pavlik
Joseph Kubin (Trainer)

Florence No. 1 Team

Gary Buckles (Team Captain)
Barry Henderson
Albert Michalides
Norman Thompson
Chris Yeager
Edward Skvarch (Trainer)
Merle Baird

Florence No. 2 Team

Dwight Hess, Jr. (Team Captain)
Dave Betts
Kevin Hess
Edward Houser, Sr.
Larry Pelipesky
Marvin Lichtenfels (Trainer)

Helen Mining Team

Frank Horrell (Team Captain)
John Dzimiera
Michael Gearhard
Steve Kasperik
Dale Montgomery
Michael Smith
James Stipcak
David Turner, Jr.
Lynn Harding (Trainer)

Helvetia Team

Thomas Zack (Team Captain)
Robert Anderson
James Buterbaugh
Robert Clendenen
Robert Frantz
Richard Radakovich
John Rhodes
Jack Swan
Richard Flack
Frank Petro (Trainer)
Robert Nastase

Barnes and Tucker Team

Nestor Paronish (Team Captain)
Robert Ashurst
Raymond Arotin
James Bender
James DeSalvo
San LaMagna
David Mikitko
Kenneth Rager
William DePetro (Trainer)

Keystone No. 1 Team

Michael Kaskan (Team Captain)
Raymond Bashline
John Bertolino
Dorman Nicholson
Joseph Pasterick
Ronald VanHorne
David Wells
Carl Bullers
James Futscher (Trainer)
George Nadzadi

Appendix C

Appendix C - Persons Who Participated in the Investigation.

Pennsylvania Mines Corporation

Headquarters

Joseph E. Kreutzberger	Vice-President of Safety
Joseph Cook	Mine Manager - Rushton Mine
Joseph Kubin	Assistant to Vice-President of Safety
Dan Kerfoot	Assistant Chief Electrical Engineer
John Hollmann	Planning Engineer
Robert Joseph	Maintenance Engineer
C. William Parisi	Consultant

Greenwich Collieries No. 1 Mine

Eugene Rogal	Power Foreman
Paul Enedy, Sr.	General Assistant Mine Foreman

United Mine Worker of America

Officials

Dave Shreve	Investigation Coordinator - International Health and Safety Representative
Thomas J. Rabbitt	Investigation Assistant Coordinator - International Board Member, District 2
Harry Nicklow	Administrative Staff Assistant
C. A. Phillips	International Health and Safety Representative
J. C. Lambert	International Health and Safety Representative
Jonathan Williams	International Teller and Health and Safety Representative
William Willis	International Health and Safety Representative
Henry Yaskowitz	International Health and Safety Representative
Nick Molnar	District 2 Vice-President
John McCullough	District 2 Board Member

Greenwich Collieries No. 1 Mine

William Buckley	Mobile Bridge Operator
Edward R. Cann	Longwall Shearer Helper
Robert H. Deyarmin	Miner Operator
Paul Farabough	Mechanic
Doug Horne	Longwall Mechanic
Dennis J. Kopp	Air Course Laborer
Roger A. Leamer	Rock Miner Operator
Sherm Link	Battery Repairman
Joe Mantini	Longwall Set-Up
John Messina	Longwall Helper
Paul Ondecko	Beltman
Joseph Rabatin	Section Mechanic
Kenneth L. Smith	Pipeman

Pennsylvania Department of Environmental Resources

James G. Richards	Chairman
Mike Anderson	Electrical Inspector
Gary G. Berkheimer	Electrical Inspector
Charles Fenchak	Electrical Inspector
Steve Gaida	Electrical Inspector
Mike Scarton	Electrical Inspector
Ellsworth R. Pauley	Inspector
John Swick	Inspector
Jerry Wilders	Engineer

Department of Labor

Office of the Solicitor

Edward H. Fitch IV, Esquire	Trial Attorney

Mine Safety and Health Administration

Office of Information

Francis E. O'Gorman	Public Affairs Specialist
Mary Wells	Public Affairs Specialist

Technical Support

Richard L. Reynolds	Chief, Mine Electrical System Division
Clete R. Stephan	Mining Engineer
Kevin G. Stricklin	Mining Engineer
John E. Urosek	Mining Engineer

Coal Mine Safety and Health - District 2

William R. Devett	Subdistrict Manager
Willis E. Cupp	Mine Safety and Health Specialist (Electrical)
Theodore W. Glusko	Supervisory Coal Mine Safety and Health Inspector
Joseph S. Tortorea	Mining Engineer
Michael Bondra	Coal Mine Safety and Health Inspector
Gerry L. Boring	Coal Mine Safety and Health Inspector
Gerald E. Davis	Coal Mine Safety and Health Inspector (Electrical)
Ronald J. Gossard	Electrical Engineer
Ronald E. Gresh	Coal Mine Safety and Health Inspector
Nicholas G. Kohart, Jr.	Coal Mine Safety and Health Inspector (Electrical)
Paul Krivokuca	Coal Mine Safety and Health Inspector (Electrical)
James E. Lough	Coal Mine Safety and Health Inspector
James K. Moore, Sr.	Coal Mine Safety and Health Inspector
Reed L. Schuller	Coal Mine Safety and Health Inspector
Lloyd D. Smith	Coal Mine Safety and Health Inspector
George E. Tersine	Coal Mine Safety and Health Inspector
Timothy J. Thompson	Mining Engineer

Coal Mine Safety and Health - Headquarters

Cecil Lester	Mine Safety and Health Specialist
Harry J. Carter	Mine Safety and Health Specialist
Dale R. Cavanaugh	Mechanical Engineer
Clifford E. Ellis	Mine Safety and Health Specialist
George M. Fesak	Electrical Engineer
William E. Humbert	Mine Safety and Health Specialist

National Mine Safety and Health Academy

Eugene R. Rapp, Jr.	Audio-visual Production Specialist

Appendix D

Appendix D - Persons who Provided Sworn Statements during the Investigation.

Greenwich Collieries No. 1 Mine

George R. Bugay, Jr.	Shift Maintenance Foreman
Henry Carpinello	Longwall Setup Foreman
Robert L. Carson	General Assistant Mine Foreman
Victor G. Cordek	Section Foreman
Dominic DelRosso, Jr.	Mine Examiner
Richard W. Endler	General Mine Foreman
Paul A. Enedy, Sr.	General Assistant Mine Foreman
Leonard M. Ellis	Mine Manager
Walter G. Foreback	Section Foreman
John C. Hicks, Jr.	Section Foreman
John K. Hollmann	Mine Planning Engineer
Lester Kline	Shift Foreman
George P. Kohan	Mine Examiner
Joseph E. Kreutzberger	Vice President - Safety
Raymond V. Letizia	Safety Inspector
Donald C. Lowmaster	Mine Superintendent
Larry D. Luther	Transitman
Daniel L. McCullough	Chainman
Hugh P. Mulraney	Section Foreman
Robert S. Nagle	Section Foreman
Dean R. Owens	Section Foreman
Merl J. Pierce	Belt Extension Foreman
David L. Radomsky	Shift Foreman
Ronald G. Riva	Chief Mine Electrician
Eugene Rogal	Power Foreman
Walter E. Roof	Track Foreman
Gerald L. Russell	Section Foreman
John E. Ruszkowski	General Manager
Gordon B. Shaffer	Shift Foreman
Andy Smilo	Chief Safety Inspector
Paul F. Somogyi, Jr.	Assistant Mine Foreman
Paul W. Stafford	Section Foreman
Ricky L. Sutter	Section Foreman
Mark E. Thomas	Section Foreman
Jack E. Tisdale	Vice President - Mining Operations
Vernon L. Troup	Section Foreman
David R. Zuchelli	Ventilation Engineer

United Mine Workers of America

Edward D. Albright	General Laborer
Robert J. Babiak	Roof Bolter Helper
Thomas Bernatzky	Mechanic
Edward D. Blazosky	Pumper
Marlin T. Bougher	Pumper
Robert H. Deyarmin	Continuous Miner Operator
Randy J. Henico	Supply Man
Thomas L. Hilliard	Roof Bolter
Frederick C. Johnson	General Laborer
Timothy J. Kline	Shuttle Car Operator
Edward P. Lacko	Mechanic
Henry J. Lefebure	Mechanic
James C. Martin	Track Foreman
John T. Matthew	Lampman
Joseph S. Milchak	Pipeman
Harry J. Miller	Kersey Operator
Robert S. Mitchell	Precision Mason
James Nadolsky	Continuous Miner Operator
Paul J. Ondecko	Beltman
Thomas A. Pittman	Mechanic
Gerald F. Shugars	Continuous Miner Helper
Kenneth L. Smith	Pipeman
David M. Stalker	Mechanic
Richard C. Yeckley	Precision Mason
Ronald Westover	Continuous Miner Helper

Mine Safety and Health Administration

Harry E. Rorabaugh	Coal Mine Safety and Health Inspector
Richard G. Schilling	Coal Mine Safety and Health Inspector
Raymond D. Stockley	Coal Mine Safety and Health Inspector
Roger W. Uhazie, Jr.	Supervisory Coal Mine Safety and Health Inspector

Appendix E

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UNITED STATES DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION

Investigative Report No. P234-V140

Absolute Mine Ventilation Pressure-Air Quantity Survey

Greenwich Collieries No. 1 Mine - ID No. 36-02405
Greenwich Collieries Division
Cookport, Indiana County, Pennsylvania

March 7-20, 1984

by

Joseph D. Hadden, Jr.[1/], Robert A. Haney[2/], Kevin R. Burns[3/],
Stephen J. Gigliotti[3/] and Gary E. Smith[3/]

Originating Office

Pittsburgh Health Technology Center
Ventilation Division
James L. Banfield, Jr., Chief
Pittsburgh, Pennsylvania

ABSOLUTE MINE VENTILATION PRESSURE-AIR QUANTITY SURVEY

Investigative Report P234 - V140

Greenwich Collieries No. 1 Mine - ID No. 36-02405
Greenwich Collieries Division
Cookport, Indiana County, Pennsylvania

March 7-20, 1984

by

Joseph D. Hadden, Jr.[1/], Robert A. Haney[2/], Kevin R. Burns[3/],
Stephen J. Gigliotti[3/], and Gary E. Smith[3/]

INTRODUCTION

From March 7 through 20, 1984, an absolute mine ventilation pressure-air quantity distribution study was made at the Greenwich Collieries No. 1 Mine, Indiana County, Pennsylvania, by the Ventilation Division, Pittsburgh Health Technology Center (PHTC). A listing of personnel from the Mine Safety and Health Administration (MSHA), who participated in the survey is contained in the appendix.

The study was requested by the District Manager, Coal Mine Safety and Health (CMS&H), District 2, Pittsburgh, Pennsylvania, following an explosion in the mine on February 16, 1984. The purpose of the study was to measure the air pressures and quantities necessary to describe and analyze the existing ventilation system at the Greenwich Collieries No. 1 Mine and provide a base for digital computer simulations of proposed changes to the system. This report summarizes the results of the study.

GENERAL INFORMATION

The Greenwich Collieries No. 1 Mine was opened by one triple compartment shaft, one intake shaft, one return shaft, and four drift entries into the Lower Freeport coalbed which was approximately 42 inches in thickness in the working areas. The mine was idle during the study, but normally produced 4,000 tons of coal per day, from 12 continuous mining machine sections and one longwall system. Coal was transported from underground work areas to surface preparation and storage facilities by a belt conveyor haulage system. A battery and trolley wire haulage system was used for transporting personnel and supplies to the operating sections underground. The daily methane liberation from the mine was approximately 2.2 million cubic feet.

1/ Senior Mining Engineer, Ventilation Division, PHTC
2/ Supervisory Mining Engineer, Ventilation Division, PHTC
3/ Mining Engineer, Ventilation Division, PHTC

MINE VENTILATION

Airflow was induced into the Greenwich Collieries No. 1 Mine by two surface-mounted exhausting mine fans. The North fan, a Jeffrey Model 12A83 Aerodyne mine fan, was connected by suitable ducting to the No. 1 return airshaft which was 24 feet in diameter and 386 feet deep. The Main 'A' fan, also a Jeffrey Model 12A83 Aerodyne mine fan, was connected by suitable ducting to the Main 'A' return side of the triple compartment Main 'A' shaft which was an elliptical shaft 455 feet deep. This fan had a noise silencer installed on the evase with a static pressure loss of +0.65 inches of water. The fan characteristic curves, mine resistance curves and indicated operating points for the North and Main 'A' fans are shown in figures 1 and 2 respectively. Both mine fans are operating in the stable portion of their respective characteristic curves, exhausting a total air quantity of 840,000 cfm from the mine.

MINE AIR QUANTITY

Figure 3 is a ventilation schematic illustrating mine airflow direction and quantity throughout the mine. Also shown are the ventilation pressures (inches of water) at various locations throughout the mine. The indicated air quantities have been divided by 100,000 (100,000 cfm is shown as 1.00) and are balanced and suitable for computer forecasting of mine ventilation system modifications.

Airflow into Main 'E', Main 'F', Main 'A' west of Main 'D' and the west side of Main 'D' was induced by Main 'A' fan. The airflow in the remaining portion of Main 'A', the east side of Main 'D', A-4, Main 'B' and the drift entries was induced by the North fan. Airflow was induced in the gob area south of Main 'A' between Main 'E' and the drift entries by both fans.

A summary of the distribution of the total air-volume (840,000 cfm) induced into the mine is as follows:

1. Air quantity available in the face area of each of the production sections.

a)	E-6	39,000
b)	F-6	21,000
c)	F-4	17,000
d)	A-3	7,000
e)	Main 'A' (north split)	17,000
	Main 'A' (south split)	19,000
f)	A6-3	22,000
g)	D-5	14,000
h)	D-9	9,000
i)	D-8	17,000
j)	A4-11	22,000
k)	A4-9	16,000
l)	Longwall	16,000
m)	A4-7	16,000
		252,000 cfm (30 percent)

2. Intake air quantity used to ventilate idle areas and gobs.

a)	Main 'C'	29,000
b)	Main 'B'	122,000
c)	Gob areas off drift entries	38,000
		189,000 cfm (23 percent)

3. Intake to return leakage. 399,000 cfm (47 percent)

Total intake air available 840,000 cfm (100 percent)

The airflow distribution shows that of the total airflow (840,000 cfm) 30 percent reached the face areas of the coal producing sections in the mine and 47 percent was lost through stopping and overcast leakage to the return aircourses. The remaining 23 percent was directed to idle and gob areas. However because of changes made in the Main 'D' area to facilitate the recovery and investigation following the mine explosion, the ventilation system at the time of this study was not exactly the same as that in use when the mine was in operation.

MINE AIR QUALITY

Figure 4 is a mine map showing the locations of vacuum bottle air samples collected during the study. The numbered locations on the map correspond with the numbers on the chart which gives the results of analysis of the air samples. The highest methane concentration (3.26 volume percent) was found at bleeder evaluation point No. 14 in the A4-5 gob. The air quality was acceptable at all other active workings traveled during the study.

VENTILATION PRESSURE GRADIENTS AND SECTION AIRFLOW REGULATION

Figures 5 through 10 show the total ventilation pressure losses incurred by airflow in six of the airsplits in the coal producing areas of the mine. The gradients were constructed by plotting the total ventilation pressure at selected locations against the distance of the location from a given reference. A steep slope on the pressure gradient indicates an area in the mine with a high pressure loss per unit length. High pressure losses may be the result of an area with a high resistance to airflow or a high air quantity flowing through a limited number of entries.

The gradients used in figures 5 through 10 start at the top of the Main 'A' or No. 1 intake shafts and were plotted to the face of the selected sections. From the face area of the section the gradient was plotted through the return entries to the mine fan that induced airflow into that area of the mine. The 6 gradients illustrated were F-6, F-4, D-9, D-8, A4-7 and A4-11.

Table 1 summarizes the total pressure consumed as the airflow travels from the top of the intake airshaft to the face of the section, and then to the return fan that induced the airflow. The pressure loss from the top of the intake airshaft to the face of the section is the intake pressure loss, and the pressure loss from the face of the section to the top of the return airshaft is the return pressure loss. The "Regulator pressure differential" column on the table gives the measured pressure differential on the regulators in those splits.

TABLE 1. - Ventilation pressure loss in the intake and return aircourses

Section	Intake pressure loss (inches of water)	Regulator pressure differential (inches of water)	Return pressure* loss (inches of water
F-6	1.68	0.00**	4.60
F-4	1.58	0.75	3.95
D-9	2.09	0.04	4.15
D-8	2.05	0.12	5.50
A4-7	2.23	2.00	3.44
A4-11	2.11	1.80	3.76
Average	1.96		4.23

* Does not include regulator loss
** F-6 Section was not regulated (open split)

The pressure losses in the intake aircourses ranged from 1.58 to 2.23 inches of water and the losses in the return aircourses from these sections ranged from 3.44 to 5.50 inches of water. The average pressure loss in the return aircourses was approximately twice the average loss in the intake aircourses. In the mine return aircourses there were several locations that attributed to the return entries having a higher pressure loss than the intakes. As illustrated in figures 5, 6 and 7 the ventilation pressure loss for the single approach entry 70 feet in length at the bottom of the return side of Main 'A' Shaft was 1.91 inches of water. Figure 8 shows that the pressure loss in the east return of Main 'D' between the equalizing overcasts and Main A was 1.37 inches of water. This pressure loss was the result of roof falls. Figures 8, 9 and 10 show that a pressure loss of 1.0 inch of water occurred in the north return aircourses of Main 'A' from a location approximately 400 feet from the bottom of the North return shaft. This loss was attributed to the high air quantity in a limited number of entries, these entries were further restricted by roof falls and unnecessary stoppings. A pressure loss was also caused by portions of stoppings in return aircourses near the junction of Main 'F' and Main 'A'.

The ventilating pressure differentials at section regulators for the coal producing sections are shown in Table 2.

TABLE 2. - Pressure differentials at section regulators

Section	Pressure differential (inches of water)
E-6	1.00
F-6	0.00*
F-4	0.75
A-3	1.20
Main 'A' (north split)	1.80
Main 'A' (south split)	0.20
A6-3	1.28
D-5	0.28
D-9	0.04
D-8	0.12
A4-11	1.80
A4-9	0.48
Longwall	0.00*
A4-7	2.00

* No regulation in the section return aircourse

Airflow was returned from the 13 coal producing sections through 14 section return airsplits. The pressure differential across the regulators in 12 of the return airsplits ranged from 0.04 to 2.00 inches of water. The remaining two return airsplits for the F-6 and Longwall sections did not have regulators for maintaining control of the airflow.

PILLARED AND ABANDONED AREAS

At the time of the investigation Greenwich Collieries No. 1 Mine had 14 pillared and 2 abandoned areas. In addition to traveling and examining portions of the bleeder entries around these areas, 32 bleeder evaluation points had been established to assist in the evaluation of the performance of bleeder entries. At eleven of the 32 bleeder evaluation points a number of problems were encountered during the study. Four bleeder evaluation points (BE 2, 28, 29 and 31) were inaccessible during this study due to water accumulations. Two of these (BE 28 and 29) were located in the explosion area. The methane concentration at BE 14 was 3.26 volume percent and at BE 3 the airflow was in the wrong direction. Five evaluation points (BE 4,18, 19, 20 and 22) were not being examined at the proper locations. Additionally, the bleeder entries around the one pillared and one abandoned area located east of the drift entries were not being traveled.

DISCUSSION

At the time of this investigation, significant volumes of air were lost due to leakage. Mine wide, the intake to return air leakage accounted for approximately 47 percent of the total air induced by the main fans. On the A-3 Section only 23 percent of the air available at the mouth of the section reached the last open crosscut. The measured air quantity in the last open crosscut was 7,000 cfm while 30,000 cfm was measured at the mouth of the section (26,000 cfm in the intake aircourse and 4,000 cfm in the belt entry). The remainder of the air (23,000 cfm) was lost through leakage into the return (8000 cfm) or was used for gob ventilation (15,000 cfm). Improvement in the system could be made by reducing the amount of air lost by leakage through stoppings and overcasts. When possible return airflow should be used for gob ventilation.

Another method for improving the ventilation system would be to reduce the resistance to airflow in the return aircourses by cleaning up roof falls in return entries and/or developing additional return entries. The ventilation pressure loss in the return airways was approximately twice the pressure loss in the intake aircourses. A new airshaft, depending on the area of future mining, could also reduce resistance to airflow and improve the performance of the mine ventilation system. A reduction in the number of operating sections, thus reducing the number of airsplits in the mine, should increase the air quantity available for the remaining sections. The air quantity induced into the mine could be increased by making a fan blade change. However due to the air leakage in the system this would probably produce a minimal increase in air available for the operating sections. In addition, the mine fans are presently operating at approximately 90 percent capacity of the fan motors. The mine fans are powered by direct-driven 800 horsepower electrical motors. Calculations made from electrical measurements at the time of the survey indicate that the fan motors were operating at approximately 700 horsepower and increasing the fan blades one setting would operate the fan motors at their rated horsepower.

All of the production sections except Main 'A' had a single split system for face ventilation. This system usually had the intake aircourse next to a solid coal rib where methane liberating from the coalbed would be carried by intake airflow to the face area. The F-4 and F-6 sections had single split ventilation with the intake aircourse next to a solid coal rib. On the F-4 section the air quantity in the intake entry where it entered the face area was 7,000 cfm with a methane concentration of 0.5 volume percent. This section had 17,000 cfm air quantity in the last open crosscut. The F-6 section had an air quantity in the intake entry near the face area of 10,000 cfm with a methane concentration of 0.8 volume percent. Although there was 21,000 cfm of air available in the face area, a roof fall near the face in the intake aircourse restricted airflow in this entry. Using intake air to dilute methane liberated from the solid ribs reduces a systems ability to dilute methane liberated during mining.

Numerous ventilation controls were constructed with brattice cloth. Ventilation controls that are not substantially constructed are more prone to damage or change that could have an adverse effect on the ventilation system.

During this study the Ventilation System and Methane and Dust Control Plan, Review No. 24, was used as a guide in selecting the locations for survey stations. All areas of the mine were examined where ventilation controls were shown on this map. In many areas, the location of stoppings or regulators were either not shown or were shown incorrectly. Inaccurately located ventilation controls on the mine map contributed to the effort required to make the survey.

CONCLUSIONS

1. The air quantity available in the face areas of the 13 sections was 252,000 cfm. This quantity was 30 percent of the 840,000 cfm induced into the mine.

2. The air leakage from the intake to return aircourses was 47 percent of the total induced into the mine.

3. The highest methane concentration (3.26 volume-percent) was found at bleeder evaluation point No. 14. This was one of the evaluation points used to evaluate the A4-5 gob area.

4. The average ventilation pressure loss in the return aircourses was approximately twice the average pressure loss in the intake aircourses.

5. Roof falls and portions of ventilation control devices left in return aircourses contributed to the ventilation pressure loss.

6. To assist in determining if the bleeder entry performance was adequate, 32 bleeder evaluation points were established. During the survey problems were encountered at 11 of these points.

7. The A-3 section had 7,000 cfm in the last open crosscut, and the F-6 and Longwall sections had no section regulators (open splits).

8. On most of the coal production sections the intake aircourse was next to a solid coal rib where methane liberating from the coalbed would be carried to the face area. Methane readings indicated that where intake airflow entered the face area of F-4 and F-6 sections the methane concentration was 0.5 and 0.8 volume-percent respectively.

9. Numerous ventilation controls were not substantially constructed.

10. In many areas, the location of stoppings or regulators were either not shown or were shown incorrectly on Review No. 24 of the Ventilation System and Methane and Dust Control Plan.

RECOMMENDATIONS

1. To improve the efficiency of the primary mine ventilation system, air leakage should be reduced by repairing or resealing stoppings and overcasts.

2. One or more of the following improvements to the ventilation system should be considered to increase and maintain the air quantities available for present mining:

   a) clean up roof falls in return aircourses

   b) develop additional return entries

   c) reduce the number of production sections

   d) construct a new return airshaft

   e) remove completely unnecessary stoppings, regulators and other ventilation controls in return aircourses.

3. Bleeder evaluation points should be located and maintained to permit proper evaluation of bleeder entry performance.

4. All sections should use a double split system for face ventilation that utilizes the outside entries as return aircourse.

5. Ventilation controls such as regulators and doors should be substantially constructed of incombustible material.

6. Mine maps should accurately indicate the exact location of all ventilation control devices.

APPENDIX

MSHA personnel participating in the ventilation study at the Greenwich Collieries No. 1 Mine, March 7-20, 1984

Ventilation Division, Pittsburgh Health Technology Center

Joseph D. Hadden, Jr.	Senior Mining Engineer
Robert A. Haney	Supervisory Mining Engineer
Kevin R. Burns	Mining Engineer
Gary E. Smith	Mining Engineer
Stephen J. Gigliotti	Mining Enginner

Coal Mine Safety and Health, District 2

Samuel J. Brunatti	Coal Mine Inspector
John A Kuzar	Coal Mine Inspector
Richard G. Schilling	Coal Mine Inspector
Carl R. Sensabaugh	Coal Mine Inspector
William D. Sparvieri, Jr.	Coal Mine Inspector
Ellsworth Yankuskie	Coal Mine Inspector

ACKNOWLEDGEMENT

The cooperation and courtesies extended by mine management and union members during the survey is greatly appreciated.

Joseph D. Hadden, Jr., Senior Mining Engineer

Robert A. Haney, Supervisory Mining Engineer

Kevin R. Burns, Mining Engineer

Gary E. Smith, Mining Engineer

Stephen J. Gigliotti, Mining Engineer

Approved by:

James L. Banfield, Jr., Chief
Ventilation Division

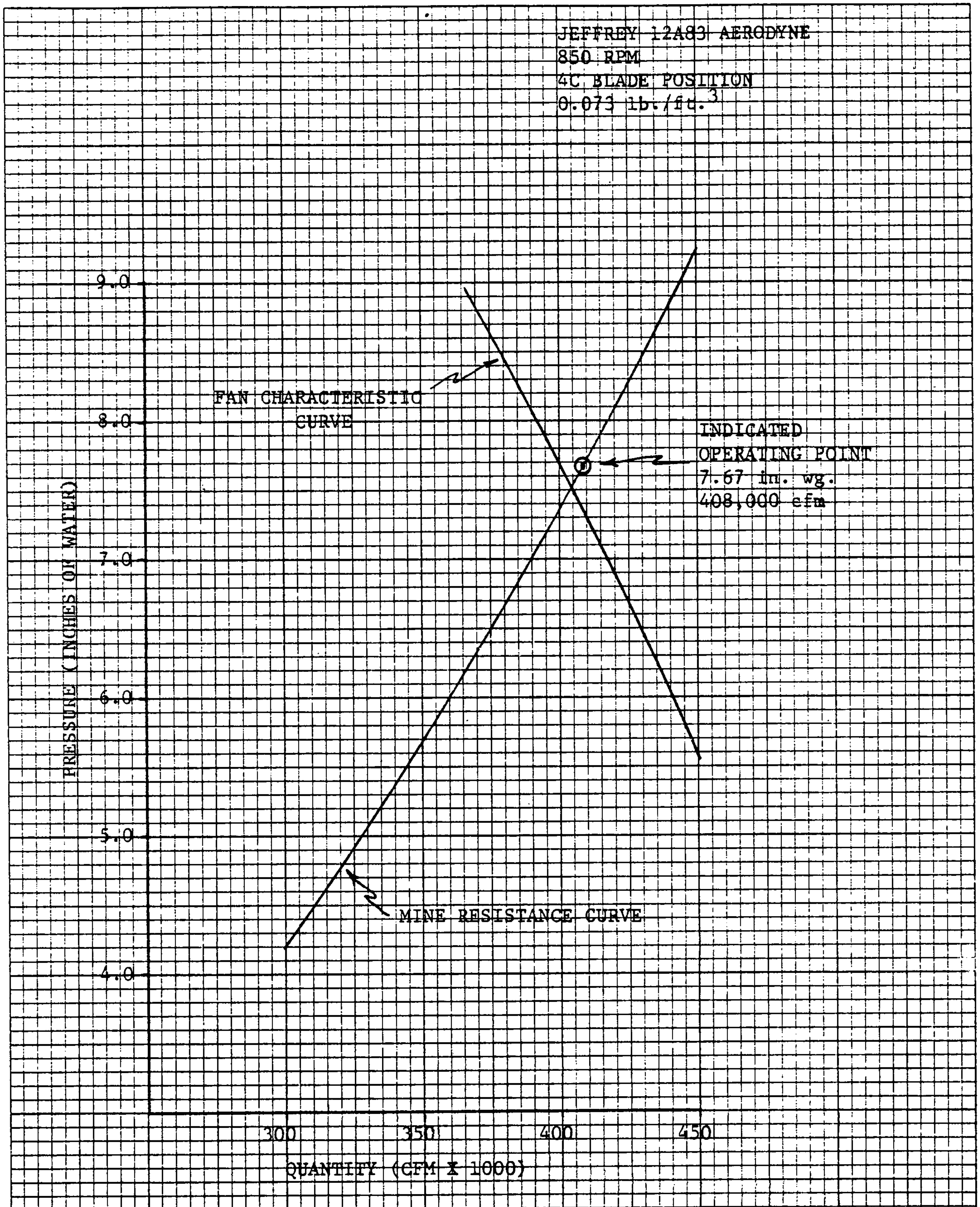


FIGURE 1. — NORTH FAN Characteristic Curve, Mine Resistance Curve, and Indicated Operating Point. Greenwich No. 1 Mine, Greenwich Collieries, March 1984.

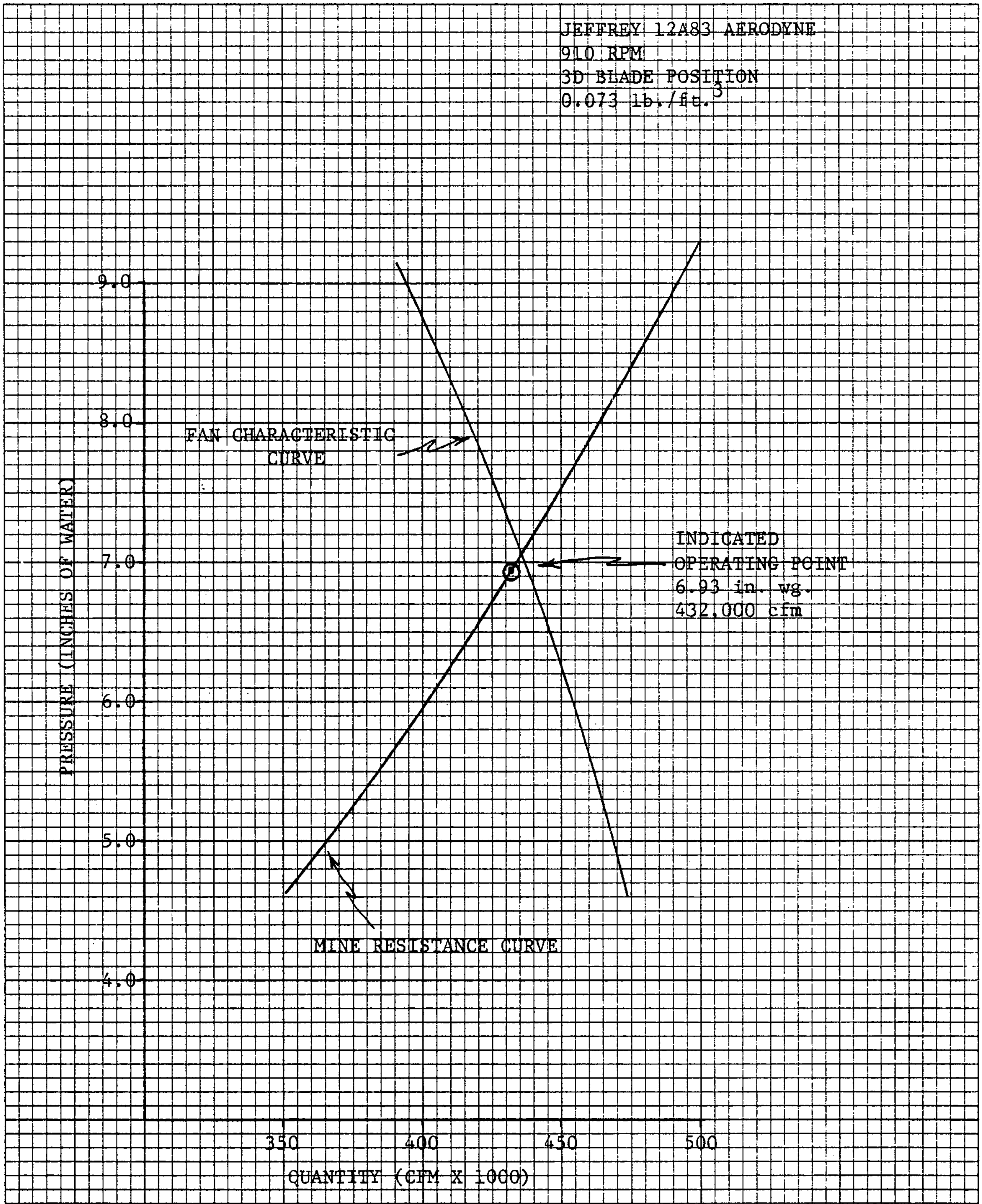
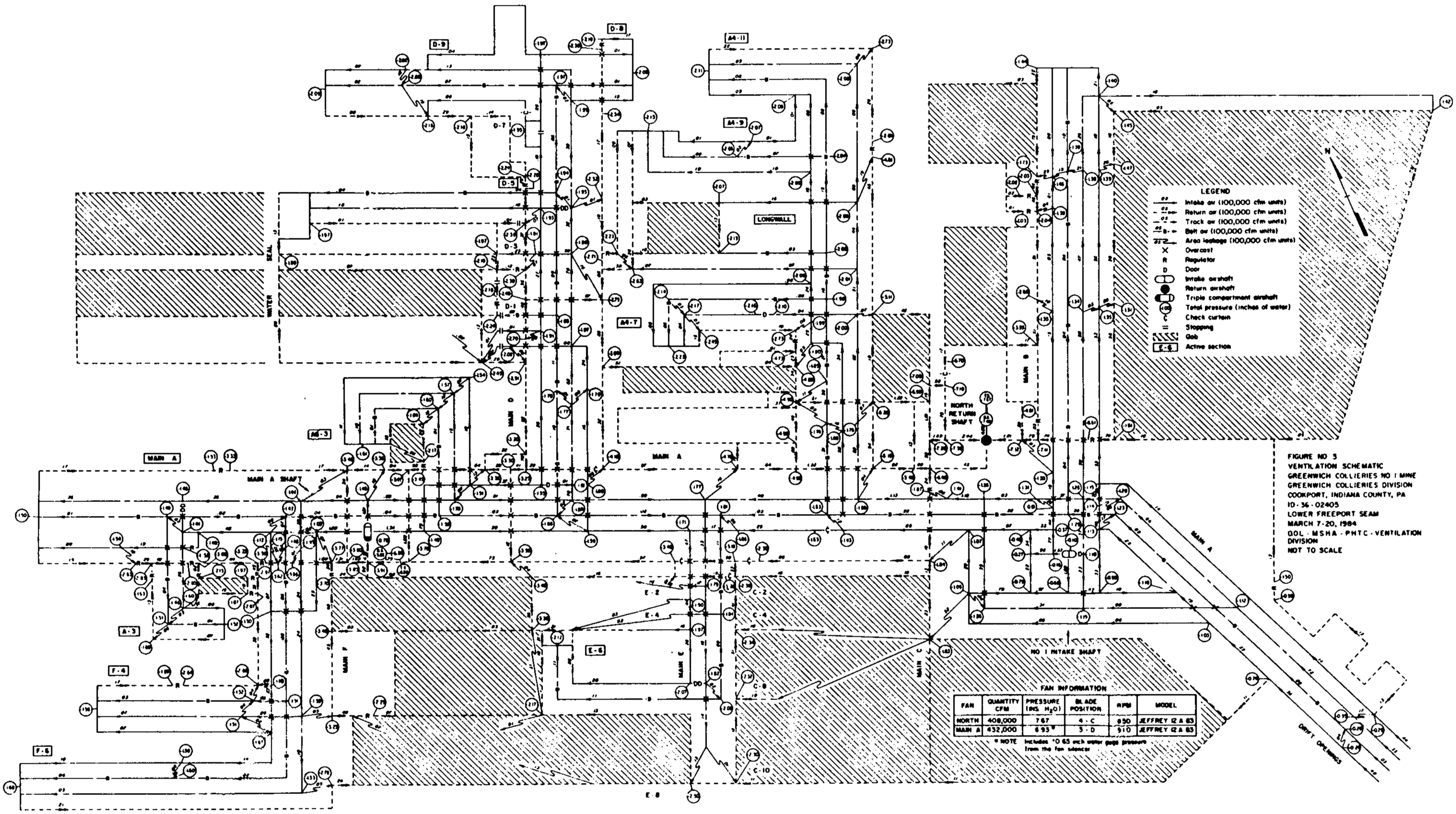


FIGURE 2. - MAIN A FAN Characteristic Curve, Mine Resistance Curve, and Indicated Operating Point. Greenwich No. 1 Mine, Greenwich Collieries, March 1984.



FAN INFORMATION

FAN	QUANTITY CFM	PRESSURE (INS. H_2O)	BLADE POSITION	RPM	MODEL
NORTH	408,000	7.67	4 - C	850	JEFFREY 12 A 83
MAIN A	432,000	6.93*	3 - D	910	JEFFREY 12 A 83

* NOTE Includes *0.65 inch water gage pressure from the fan silencer

FIGURE NO 3
VENTILATION SCHEMATIC
GREENWICH COLLIERIES NO 1 MINE
GREENWICH COLLIERIES DIVISION
COOKPORT, INDIANA COUNTY, PA
ID - 36 - 02405
LOWER FREEPORT SEAM
MARCH 7-20, 1984
DOL - MSHA - PHTC - VENTILATION DIVISION
NOT TO SCALE

LOCATION	SAMPLE NUMBER	PERCENT O_2	PERCENT CO_2	PERCENT CH_4	PPM CO
F6 TRACK	1	20.95	0.11	40 PPM	
F4 FACE RETURN	2	20.95	0.04	0.23	
F4 RETURN AT MOUTH	3	20.95	0.06	32 PPM	
D.E. # 26	4	20.95	0.06	0.01	
F6 FACE RETURN	5	20.95	0.04	0.43	
F4 RETURN	6	20.95	0.04	0.26	
F4 INTAKE	7	20.95	0.06	0.43	
A3 RETURN REGULATOR	8	20.95	0.04	0.02	
A MAINS RETURN REGULATOR	9	20.95	0.04	0.40	
A MAINS RETURN REGULATOR	10	20.95	0.06	0.08	
A3 INLET D.E.	11	20.95	0.09	10PPM	
A3 RETURN	12	20.95	0.08	0.03	
B7 RETURN	13	20.85	0.13	0.41	
B MAINS RETURN	14	20.90	0.13	0.24	
B7 RETURN	15	20.82	0.11	0.36	
D8 RETURN	16	20.95	0.11	0.10	
B7 RETURN	17	20.93	0.09	0.21	
A4-7 RETURN	18	20.94	0.10	0.15	
A MAINS RETURN	19	20.95	0.09	47PPM	
A6 LEFT REGULATOR	20	20.95	0.04	0.35	
A6-7	21	20.95	0.06	0.51	
D3 RETURN	22	20.95	0.09	0.10	
B MAINS RETURN	23	20.85	0.12	0.44	
D.E. # 19	24	20.88	0.13	0.28	
D1 RETURN	25	20.77	0.12	0.83	
D.E. # 21	26	20.92	0.10	0.22	
E MAINS	27	20.95	0.03	27PPM	

LOCATION	SAMPLE NUMBER	PERCENT O_2	PERCENT CO_2	PERCENT CH_4	PPM CO
F6 INTAKE	28	20.95	0.05	0.68	
F6 BELT	29	20.95	0.06	25PPM	
F6 RETURN	30	20.95	0.04	0.52	
MAIN F RETURN	31	20.95	0.04	0.18	
MAIN A RETURN	32	20.95	0.04	0.11	
MAIN B RETURN	33	20.95	0.15	38PPM	
MAIN B INTAKE	34	20.93	0.15	0.01	
F6 TRACK	35	20.95	0.07	0.01	
D.E. # 31	36	20.68	0.14	0.60	3
D.E. # 32	37	20.98	0.04	0.03	1
MAIN F RETURN	38	20.94	0.05	0.20	1
D.E. # 17	39	20.72	0.17	0.31	1
D.E. # 20	40	20.82	0.06	0.01	1
D.E. # 23	41	20.87	0.01	0.02	6
D.E. # 15	42	20.37	0.26	1.10	1
D.E. # 13	43	20.82	0.05	0.46	6
D.E. # 16	44	20.78	0.13	0.41	1
D.E. # 12	45	20.95	0.04	TRACE	1
D.E. # 18	46	20.95	0.05	0.26	1
D.E. # 9	47	20.75	0.17	0.25	TRACE
D.E. # 6	48	20.95	0.04	0.04	1
D.E. # 7	49	20.95	0.04	TRACE	2
D.E. # 2	50	20.95	0.40	TRACE	1
D.E. # 1	51	20.95	0.05	TRACE	4
D.E. # 10	52	20.95	0.05	0.02	2
D.E. # 24	53	20.95	0.08	TRACE	1
D.E. # 8	54	20.95	0.05	0.11	TRACE
D.E. # 14	55	19.85	0.24	3.26	8

Figure 4 - Bottle Sample Location Map, Greenwich No. 1 Mine.

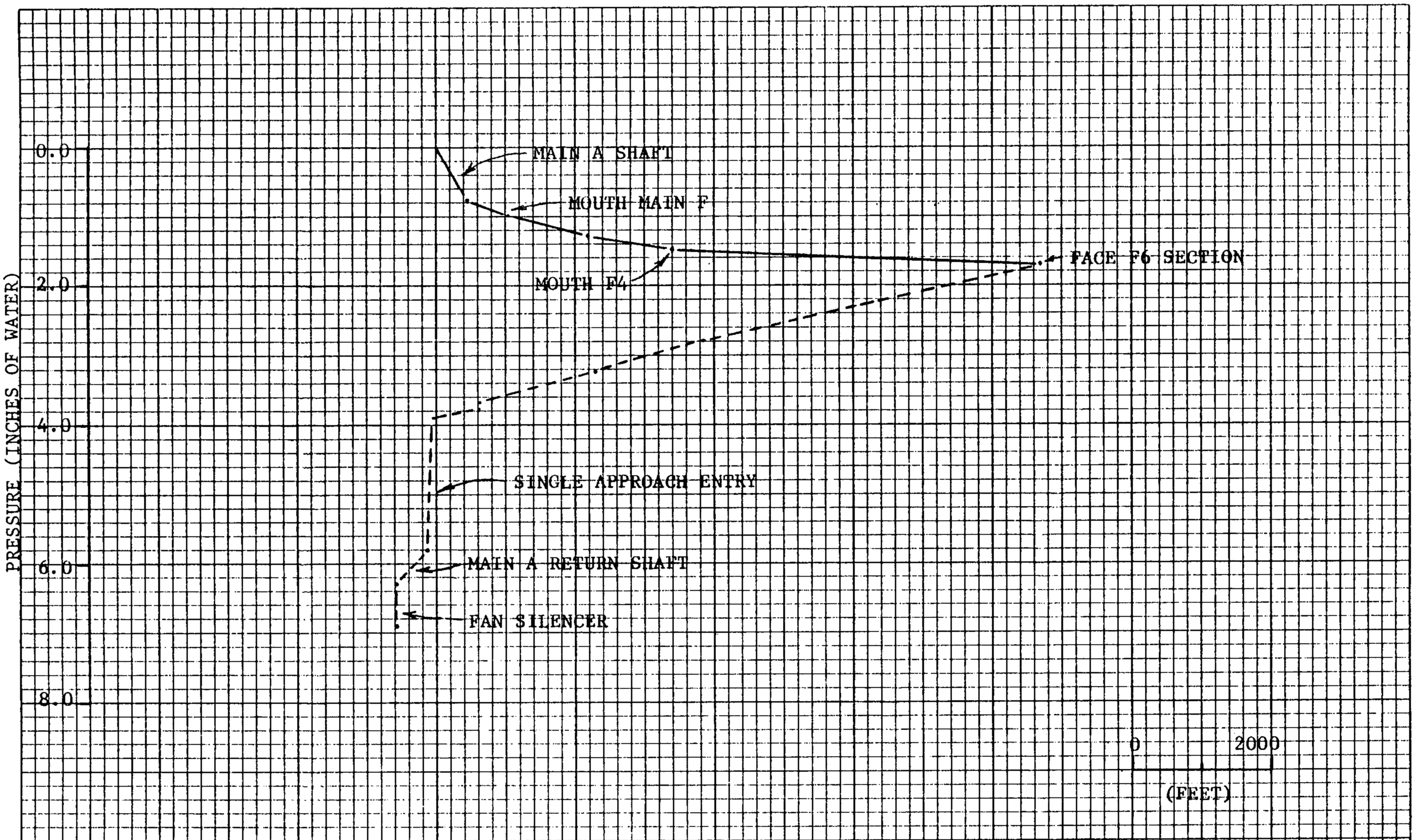


FIGURE 5 - Pressure Gradient of F6 Section, Greenwich No. 1 Mine, Greenwich Collieries, March 1984.

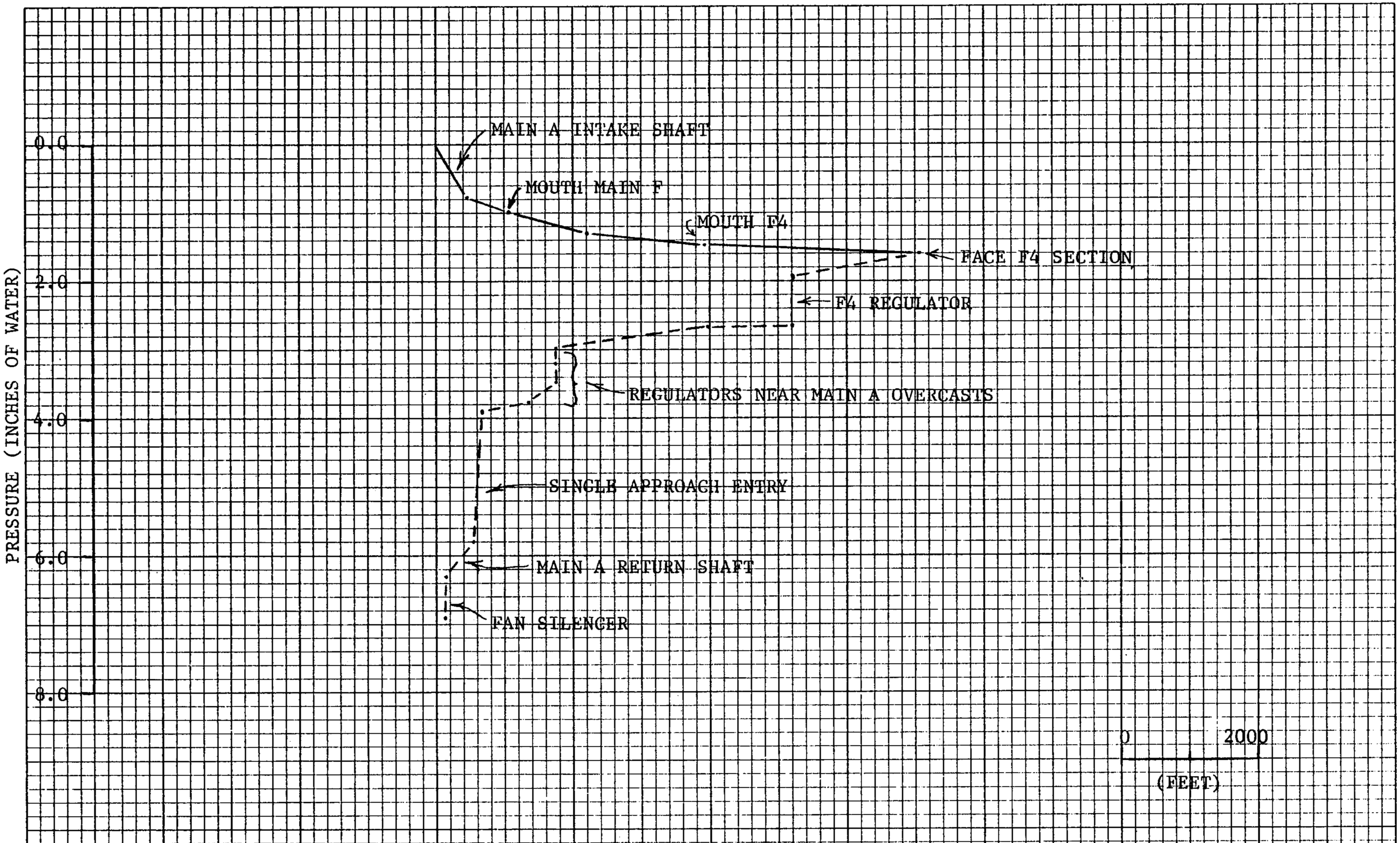


FIGURE 6 - Pressure Gradient of F4 Section, Greenwich No. 1 Mine, Greenwich Collieries, March 1984.

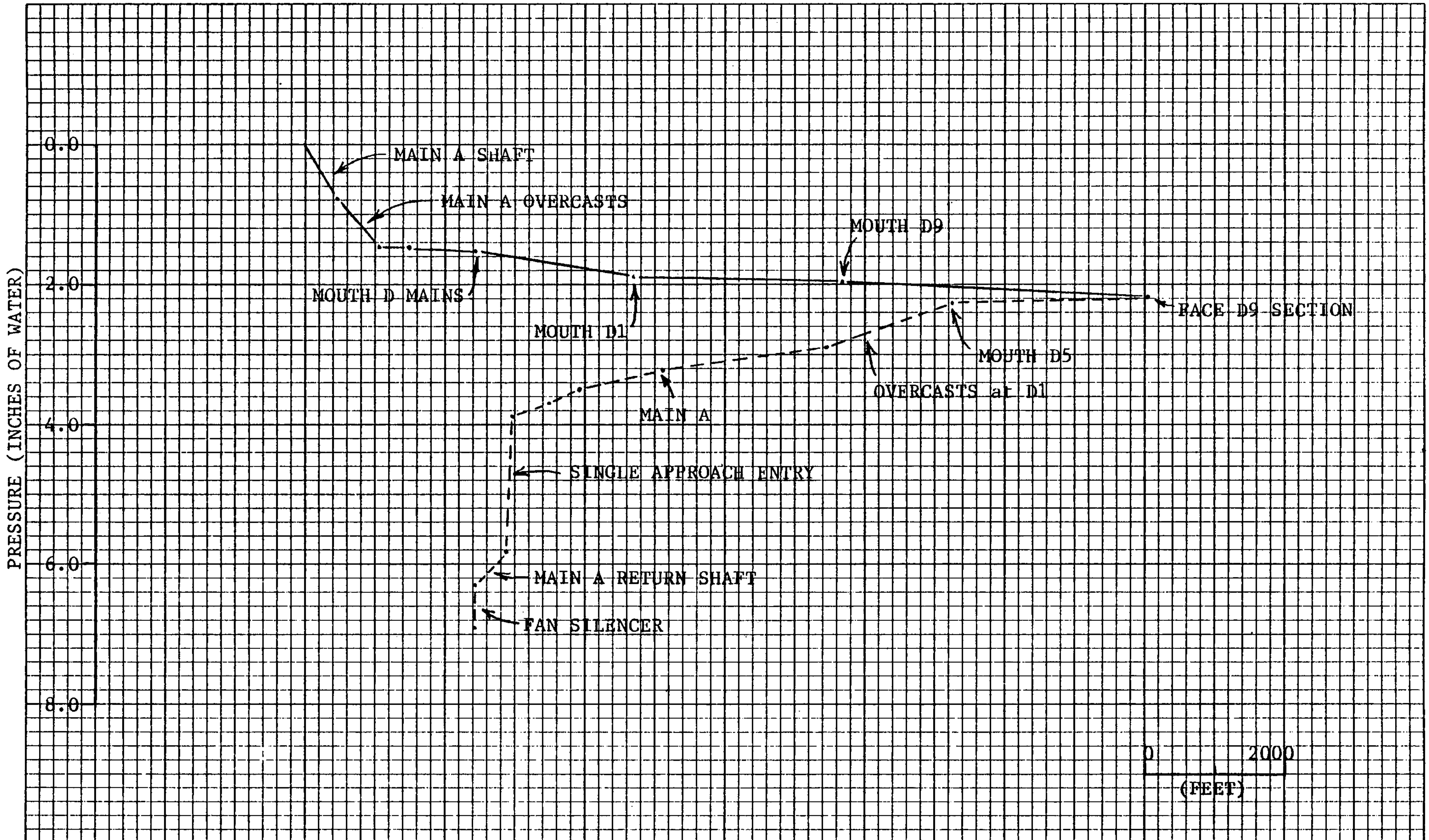


FIGURE 7 - Pressure Gradient of D9 Section, Greenwich No. 1 Mine, Greenwich Collieries, March 1984.

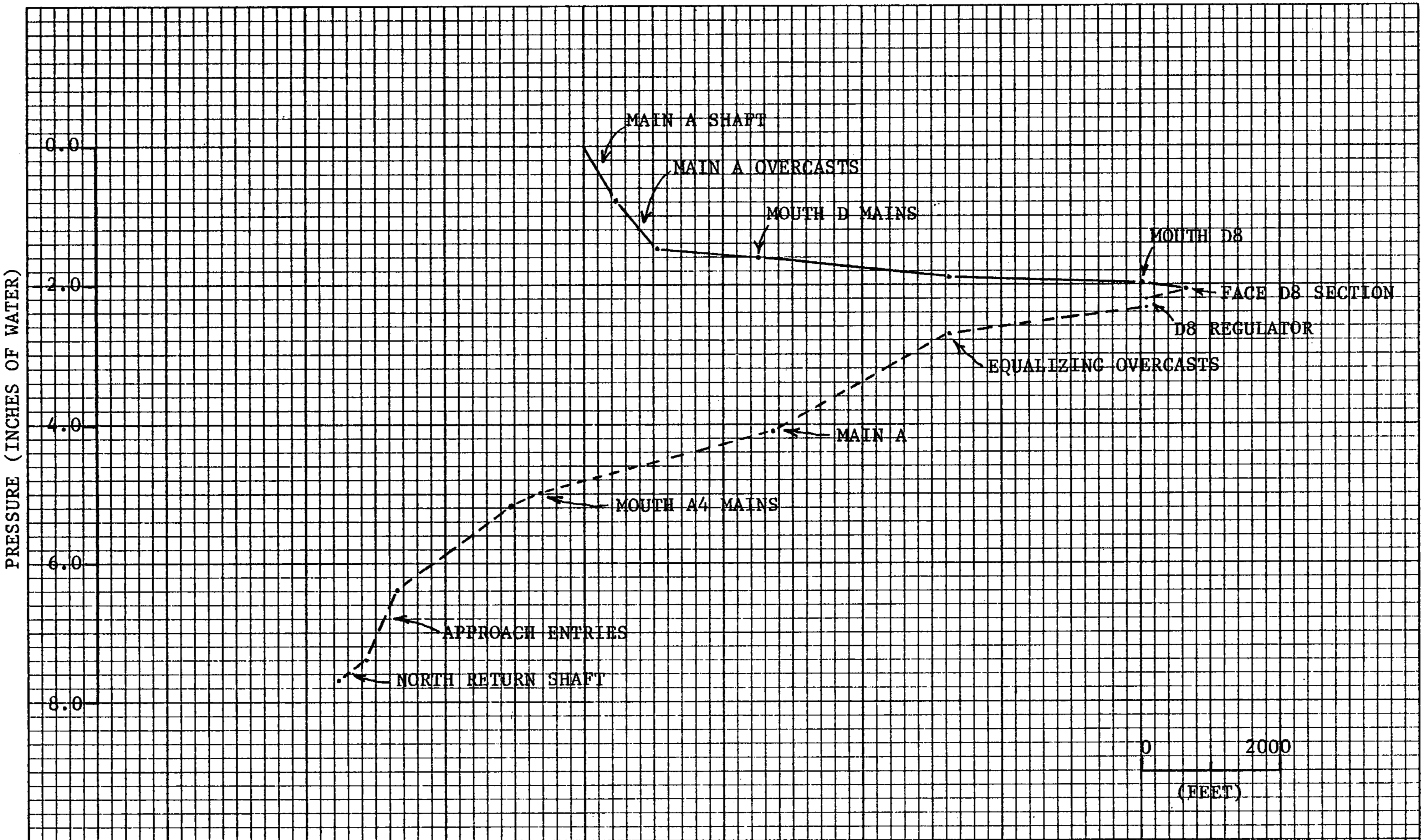


FIGURE 8- Pressure Gradient of D8 Section, Greenwich No. 1 Mine, Greenwich Collieries, March 1984.

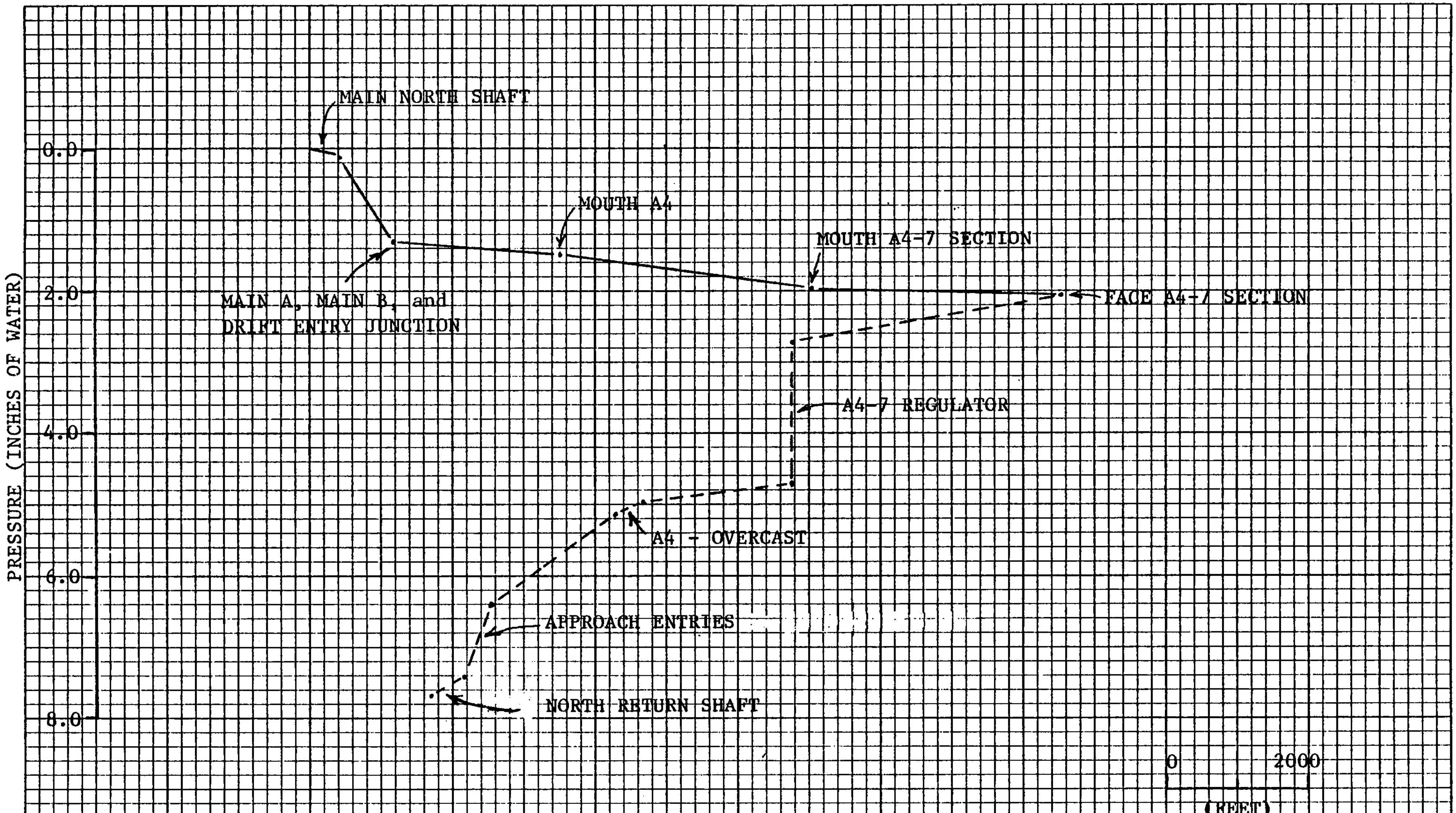


FIGURE 9 - Pressure Gradient of A4-7 Section, Greenwich No. 1 Mine, Greenwich Collieries, March 1984.

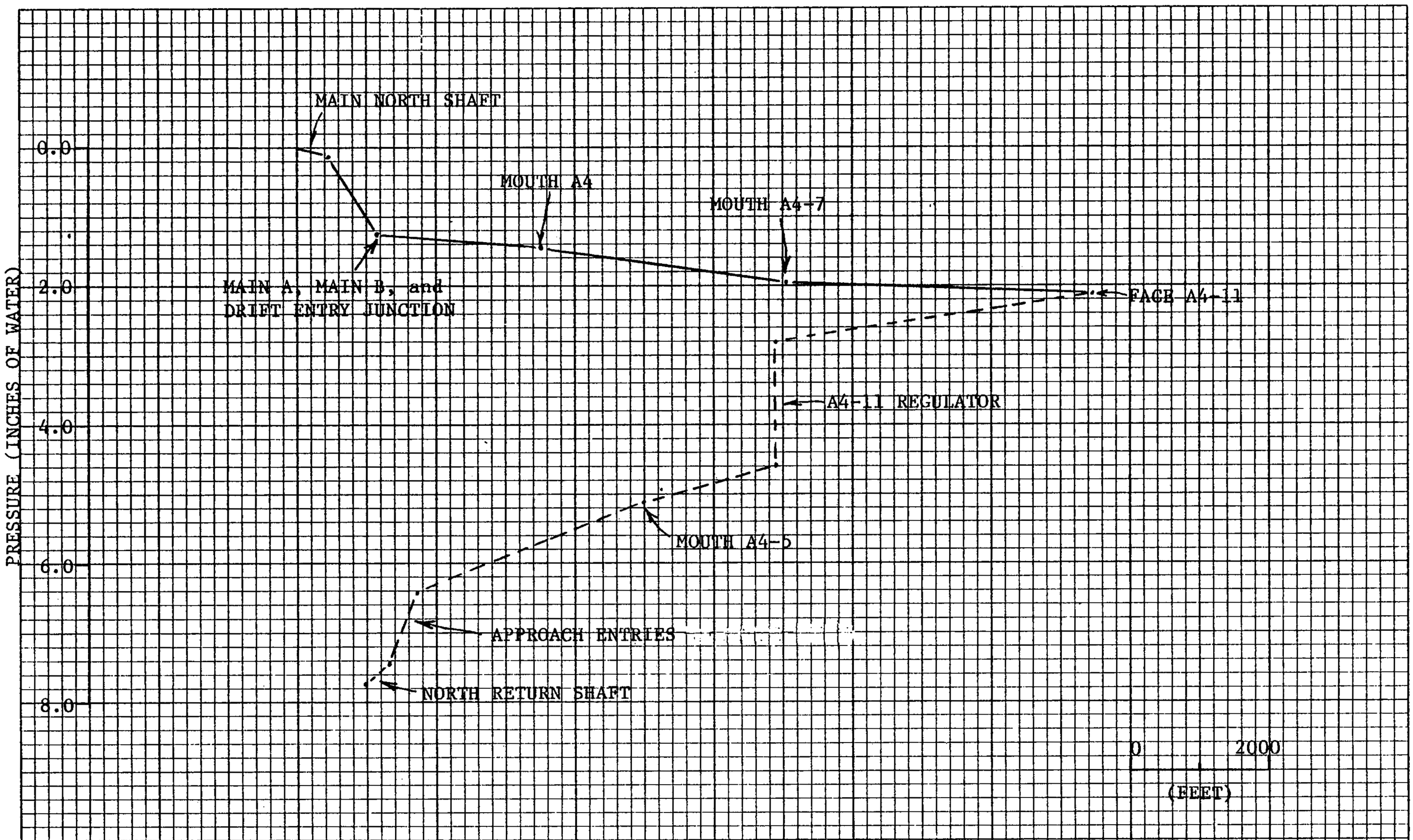


FIGURE 10— Pressure Gradient of A4-11 Section, Greenwich No. 1 Mine, Greenwich Collieries, March 1984.

Appendix F

U. S. Department of Labor

Mine Safety and Health Administration
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213
Pittsburgh Health Technology Center
Ventilation Division

July 27, 1984

MEMORANDUM FOR: DONALD W. HUNTLEY
District Manager
Coal Mine Safety and Health
District 2

THROUGH : for ROBERT G. PELUSO
Chief, Pittsburgh Health Technology Center

JAMES L. BANFIELD, JR.
Chief, Ventilation Division

For JOSEPH D. HADDEN, JR.
Supervisory Mining Engineer

FROM : STEPHEN J. GIGLIOTTI *Stephen J. Gigliotti*
Mining Engineer

SUBJECT : Methane Liberation Study at Greenwich Collieries No. 1 Mine, Greenwich Collieries Division (I.D. No. 36-02405)

From May 1-15, 1984, a methane liberation study was made at the Greenwich Collieries No. 1 mine, Greenwich Collieries Division, Cookport, Pennsylvania. This study was requested by Coal Mine Safety and Health (CMS&H), District 2. The purpose of this study was to evaluate the methane liberation from the face during mining, and measure the methane liberation rate from the ribs along the intake and return airways. Assistance during the survey was received from the company, union, and CMS&H, District 2 personnel. Appendix I is a list of the MSHA participants.

The study was conducted on the Longwall Section and the following continuous mining sections: A6-3, A-3, A4-11, A4-7, D-8 and E-6. On all the sections except E-6 and the Longwall, a continuous recording methane detector was positioned behind the line curtain to monitor methane concentrations in the face return. (The E-6 Section was on retreat mining and continuous recording methanometers could not be placed behind the line curtain.) A continuous recording methane detector was also placed in the intake just outby where the shuttle cars were being loaded. The detectors had ranges of 0.0 to 2.0 volume percent full scale with strip chart recorders operating at a chart speed of 4 inches per hour. Figure 1 shows typical results obtained from the continuous methane recorders at monitoring locations. Calibration curves were used to convert the chart readings to volume percent of methane detected at each location. Methane recorder performance was verified by vacuum bottle air samples taken at the recorder location. Each predominant peak on the strip chart corresponds to the cutting of coal and loading of it onto a shuttle car.

On the Longwall Section, continuous recording methanometers were located at the tailgate and headgate entries adjacent to the longwall face which used a homotropol ventilating system. Vacuum bottle air samples and air quantity measurements were taken at both locations before and during mining.

The peak methane concentrations and face air quantities for each shuttle car loaded in each section are listed at the end of the report, along with the air quantities and methane concentrations measured on the Longwall Section. The peak face area methane liberation rate is also listed in the tables and was calculated by subtracting the face intake concentration from the face return concentration, and multiplying by the measured air quantity passing over the recorders.

The study was conducted in the following sections:

Section A6-3 - This section was developing four entries by first mining to a depth of 17 feet on the brattice side, then squaring the face by mining the off brattice side. A spray fan system was used to assist the single split exhaust line brattice in ventilating the working faces. The machine-mounted methane monitor was located on the off brattice, or right side, of the continuous miner. The belt air in this section was directed into the return before entering the face area.

This section had its intake airway adjacent to a solid rib and had an average intake methane concentration of 0.20 volume percent, and an average air quantity at the inby end of the line curtain of 6,000 cfm during the study. The average peak methane concentration in the return airflow behind the line curtain was 0.88 volume percent. The peak face area methane liberation rate ranged from 19.0 to 66.7 cfm and averaged 42.1 cfm with a standard deviation of ± 17.7.

Section A-3 - Section A-3 was developing five entries by initially mining to a depth of 10 feet on the brattice side, then 10 feet on the off brattice side. A spray fan system was used to assist the single split exhaust line brattice in ventilating the working faces. The machine-mounted methane monitor was located adjacent to the brattice on the right side. The belt air in this section was directed into the return before it reached the face area.

The average methane concentration of the intake airflow used to ventilate the face was 0.07 volume percent. The average air quantity at the inby end of the line curtain was 8,500 cfm, and the average peak methane concentration in the return airflow from the face was 0.56 volume percent. The average peak face area methane liberation rate was 34.3 cfm with a standard deviation of ± 12.9 and ranged from 13.7 to 75.3 cfm.

Section A4-11 - Four entries were being developed by using a single split exhaust line curtain with a spray fan system to ventilate the active faces. The machine-mounted methane monitor was located on the right or brattice side of the miner. The belt air in this section was used at the face. The sequence of mining consisted of first mining to a depth of 17 feet on the brattice side, then mining the off brattice side to the same depth.

The intake airway, which was against a solid rib, had an average methane concentration of 0.24 volume percent during the study. The average air quantity at the inby end of the line curtain was 12,600 cfm, and the average peak methane concentration in the face return was 0.33 volume percent. The average peak face area methane liberation rate was 14.9 cfm with a standard deviation of ± 5.3 and ranged from 8.8 to 33.0 cfm.

Section A4-7 - The active faces were being ventilated by using a spray fan system to assist a single split exhaust line brattice. The machine-mounted methane monitor was located on the right side of the miner opposite the brattice. The belt air was coursed into the return before it could reach the working faces. The four faces were mined by starting on the brattice side and sumping in 17 feet and then squaring the face on the off brattice side.

The average methane concentration in the intake airflow to the face was 0.02 volume percent, and the average air quantity at the inby end of the line curtain was 6,200 cfm. The average peak methane concentration in the return airflow from the face was 0.32 volume percent. The average peak face area methane liberation rate was 18.7 cfm with a standard deviation of ± 6.1 and ranged from 8.8 to 29.7 cfm.

Section D-8 - This section used a spray fan system to assist the single split exhaust line brattice to ventilate five advancing rooms. The section return was located on the left and a reduced airsplit was located on the right. The belt air was dumped into the return aircourse before reaching the face area. Rooms were developed 17 feet on the brattice side first, and then 17 feet on the off brattice side. The machine-mounted methane monitor was located on the right or off brattice side of the miner.

The average methane concentration in the intake air to the face was 0.04 volume percent. The average air quantity at the inby end of the line curtain was 4,100 cfm, and the average methane concentration in the return air from the face was 0.42 volume percent. The average peak face area methane liberation rate was 16.3 cfm with a standard deviation of ± 4.9 and ranged from 8.7 to 24.3 cfm.

Section E-6 - The section was on retreat mining and used a single split exhaust line curtain to ventilate the active area. The airflow in the belt entry was used at the face.

The methane concentration in the intake airflow measured at the last permanent stopping outby the face area was 0.01 volume percent. Accurate measurements of air quantity and methane concentration in the return airflow from the face were not made. The section was on retreat and the line curtain was adjacent to the gob.

Longwall - Coal was cut in both directions along the 600-foot face of the longwall. Intake air entered the face from the tailgate and traveled the length of the face to the headgate. The direction of airflow in the belt entry on the headgate side of the longwall face and in the intake entries on the tailgate side was from the mouth of the section toward the gob.

The average methane concentration in the intake air to the face (tailgate side) was 0.01 volume percent. The average air quantity entering the longwall face was 22,500 cfm, and the average air quantity reaching the monitoring location on the headgate side of the longwall was 18,100 cfm. The average peak methane concentration at the headgate side was 0.27 volume percent, and the average methane liberated across the face during mining was 39.8 cfm.

Table 1 is a summary of the methane and air quantity face information discussed for the continuous miner sections. In addition, the average peak face area methane liberation rate along with one and two standard deviations are shown where applicable.

From a statistical analysis, 95 percent of the data collected lies within two standard deviations of the mean with 2.5 percent of the data above this range and 2.5 percent of the data below this range. By taking the average peak face area methane liberation rate plus two standard deviations, the air quantity required to maintain the methane concentration behind the line curtain below 1.0 volume percent, 97.5 percent of the time can be calculated. The required air quantities for each of the sections studied at various intake methane concentrations are given in Table 2.

The information in Tables 1 and 2 indicates that in order to keep the methane concentration behind the line brattice below 1.0 volume percent in Section A6-3, 9,700 cfm would be required with a methane concentration of 0.2 volume-percent in the intake. The tables also show that Section A-3 would need 6,500 cfm to keep the methane concentration to below 1.0 volume percent behind the line brattice with a methane concentration of 0.07 volume percent in the intake airflow.

Continuous recording methane detectors were also placed at the mouth and face (intake and/or return) of five of the six continuous mining sections.

These recorders were installed to measure the methane liberated from the ribs. Using results of air quantity measurements and corresponding vacuum bottle air samples, rib liberations were calculated by taking the difference in the total methane present at two locations. The total methane present is found by multiplying the methane concentration (expressed as a decimal) by the air quantity at that location. Table 3 gives a summary of the methane liberated along intake and return ribs for each section.

RECOMMENDATIONS

1. To maintain the methane concentration behind the line brattice below 1.0 volume percent in Section A6-3, 9,700 cfm would be required when the methane concentration of the intake air was 0.2 volume percent.

2. An air quantity of 6,500 cfm would be required at the end of the line brattice at Section A-3 in order to keep the methane behind the line brattice to below 1.0 volume percent when the methane concentration of the intake air was 0.07 volume percent.

3. To reduce the intake methane concentrations a double split system of section ventilation should be considered.

4. For exhaust face ventilation systems, the machine-mounted methane monitor should monitor methane concentrations on both sides of the continuous miner to accommodate a right or left handed line brattice and be mounted as close to the face as possible.

APPENDIX I

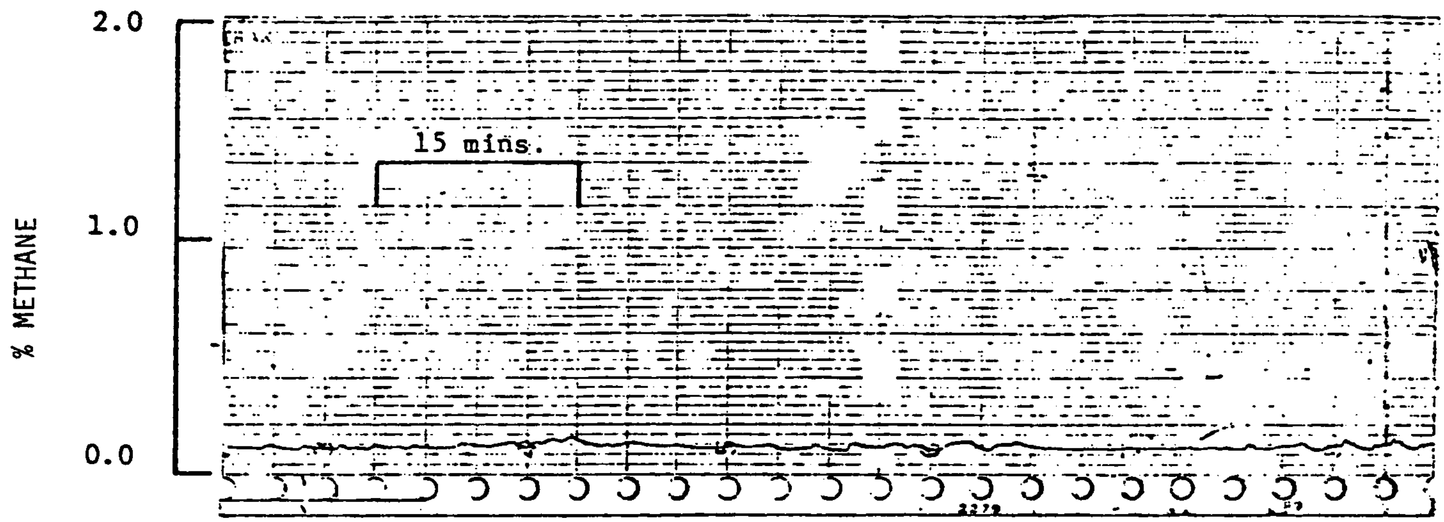
MSHA personnel participating in the face ventilation investigation at the Greenwich Collieries No. 1 Mine, May 1 through May 15, 1984, are as follows:

Ventilation Division--Pittsburgh Health Technology Center

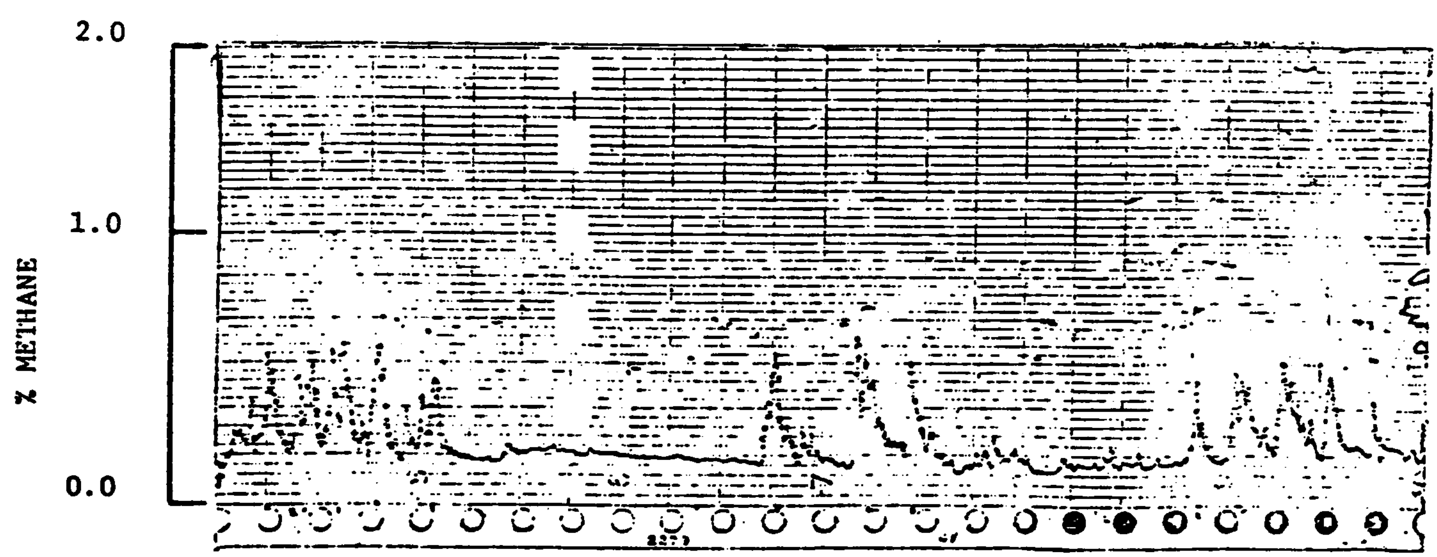
Stephen J. Gigliotti, Mining Engineer

Coal Mine Safety and Health, District 2

Richard G. Schilling, CMS&H, Inspector
James V. Lallemand, Mine Safety and Health Specialist
Carl R. Sensabaugh, CMS&H, Inspector



INTAKE RECORDER



FACE RETURN RECORDER

Figure 1. - Examples of continuous methane recorder tapes in the face area during mining cycle.

TABLE 1. - Average face intake methane concentration, average peak face return concentration, and peak face area methane liberation rate (range and average) for each section

*Section	Average face intake methane concentration, percent (%)	Average quantity at end of line brattice (cfm)	Average peak face return concentration, percent (%)	Peak face area methane liberation rate (cfm)		
				Range	Average ± standard deviation	Average + two standard deviations
A6-3	.20	6,000	.88	19.0 - 66.7	42.1 ± 17.7	77.5
A-3	.07	8,500	.56	13.7 - 75.3	34.3 ± 12.9	60.1
A4-11	.24	12,600	.33	8.8 - 33.0	14.9 ± 5.3	25.5
A4-7	.02	6,200	.32	8.8 - 29.7	18.7 ± 6.1	30.9
D-8	.04	4,100	.42	8.7 - 24.3	16.3 ± 4.9	26.1

* Section E-6 was on retreat mining.

TABLE 2. - Air quantity required to maintain the methane concentration behind the line curtain below 1.0 volume percent for various intake methane concentrations

	A6-3	A-3	A4-11	A4-7	D-8
Face area methane liberation rate, (cfm)	77.5	60.1	25.5	30.9	26.1
Intake methane concentration, percent (%)					
0.00	7,800	6,000	3,000*	3,100	3,000*
0.10	8,600	6,700	3,000*	3,400	3,000*
0.20	9,700	7,500	3,200	3,900	3,300
0.30	11,100	8,600	3,600	4,400	3,700
0.40	12,900	10,000	4,300	5,200	4,400
0.50	15,500	12,000	5,100	6,200	5,200

*Note: Minimum air quantity unless otherwise specified in Ventilation Plan

TABLE 3. - Methane liberation rates along intake and return ribs

	Intake Rib			Return Rib			
Section	Monitor distance feet (ft)	Total (cfm)	Per 1000' (cfm)	Monitor distance feet (ft)	Total (cfm)	Per 1000' (cfm)	Section total* (cfm)
A4-11	2,600	35.2	13.5	3,100	33.8	10.9	90.2
A-3				950	13.3	14.0	---
A4-7				2,800	6.6	2.4	---
A6-3	1,800	35.1	19.5				
E-6	900	**					

* Includes face area

** Data indicates that no measurable amount of methane was generated since the concentration remained the same (0.01 volume percent) and the air quantity decreased from 17,000 cfm to 10,000 cfm.

Appendix F (Cont.)

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A6-3
NO. 4 (R2) Entry

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.31	0.82	3,885	3,885	19.8
2	.31	1.09			30.3
3	.31	1.18			33.8
4	.31	1.07			29.5
5	.31	.88			22.1
6	.31	.80			19.0
7	.31	.88			22.1
8	.31	.88			22.1
9	.31	.82			19.8
10	.31	.94			24.5
11	.31	.92			23.7
12	.31	.84			20.6
13	.31	1.03			28.0
Average	.31	.93			24.3

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A6-3
NO. 3 (R1) Entry

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.10	0.87	7,760	7,760	59.8
2	.10	.88			60.5
3	.10	.88			60.5
4	.10	.96			66.7
5	.10	.90			62.1
6	.10	.68			45.0
7	.10	.80			54.3
8	.10	.84			57.4
9	.10	.76			51.2
10	.10	.75			50.4
11	.10	.84			57.4
12	.10	.87			59.8
13	.10	.80			54.3
14	.10	.84			57.4
15	.10	.94			65.2
Average	.10	.84			57.5

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A-3
NO. 5 (R3) Entry

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.02	0.12	13,689	13,689	13.7
2	.02	.21			26.0
3	.02	.17			20.5
4	.02	.37			47.9
5	.02	.57			75.3
6	.02	.29			37.0
7	.02	.49			64.3
8	.02	.37			47.9
9	.02	.33			42.4
10	.02	.25			31.5
11	.02	.28			35.6
12	.02	.32			41.1
13	.02	.24			30.1
Average	.02	.31			39.5

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A-3
Crosscut No. 4 to No. 5 (R2 to R3)

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.10	0.65	4,800	4,800	26.4
2	.10	.77			32.2
3	.10	.81			34.1
4	.10	.91			38.9
5	.10	.59			23.5
6	.10	.45			16.8
7	.10	.63			25.4
8	.10	.67			27.4
9	.10	.67			27.4
10	.10	.83			35.0
11	.10	1.15			50.4
12	.10	.93			39.8
13	.10	.61			24.5
14	.10	.67			27.4
15	.10	.76			31.7
16	.10	.74			30.7
Average	.10	.74			30.7

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A-3
Crosscut No. 3 to No. 4 (R1 to R2)

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.08	0.68	4,500	4,500	27.0
* 2	.08	.75			30.2
Average	.08	.72			28.6

* Section was idle

Appendix F (Cont.)

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A4-11
No. 4 Entry (R2)

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.21	0.28	17,803	22,004	15.4
2	.21	.25			8.8
3	.21	.26			11.0
4	.21	.30			19.8
5	.21	.28			15.4
6	.21	.25			8.8
7	.21	.26			11.0
8	.21	.28			15.4
9	.21	.28			15.4
10	.21	.30			19.8
11	.21	.36			33.0
Average	.21	.28			15.8

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A4-11
Crosscut No. 2 to No. 1 (Belt to L1)

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.27	0.34	7,338	13,727	9.6
2	.27	.36			12.4
3	.27	.36			12.4
4	.27	.36			12.4
5	.27	.40			17.9
6	.27	.37			13.7
7	.27	.39			16.5
8	.27	.40			17.9
9	.27	.40			17.9
10	.27	.36			12.4
11	.27	.35			11.0
Average	.27	.37			14.0

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A4-7
Crosscut No. 3 Room to No. 4 Room

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.02	0.19	6,296	6,296	10.7
2	.02	.16			8.8
3	.02	.30			17.6
4	.02	.27			15.7
5	.02	.21			12.0
6	.02	.30			17.6
7	.02	.29			17.0
8	.02	.26			15.1
9	.02	.30			17.6
10	.02	.16			8.8
11	.02	.21			12.0
12	.02	.24			13.9
13	.02	.19			10.7
Average	.02	.24			13.7

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section A4-7
Crosscut No. 2 Room to No. 3 Room

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.02	0.40	6,195	6,195	23.5
2	.02	.43			25.4
3	.02	.40			23.5
4	.02	.47			27.9
5	.02	.47			27.9
6	.02	.33			19.2
7	.02	.45			26.6
8	.02	.50			29.7
9	.02	.40			23.5
10	.02	.33			19.2
11	.02	.36			21.1
12	.02	.41			24.2
13	.02	.35			20.4
14	.02	.27			15.5
Average	.02	.40			23.4

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section D-8
Crosscut No. 4 Room to No. 3 Room

Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.05	0.45	3,559	3,817	15.3
2	.05	.41			13.7
3	.05	.37			12.2
4	.05	.37			12.2
5	.05	.41			13.7
6	.05	.51			17.6
7	.05	.53			18.3
8	.05	.68			24.1
9	.05	.45			15.3
10	.05	.29			9.2
11	.05	.31			9.9
Average	.05	.43			14.7

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Section D-8
No. 5 Room

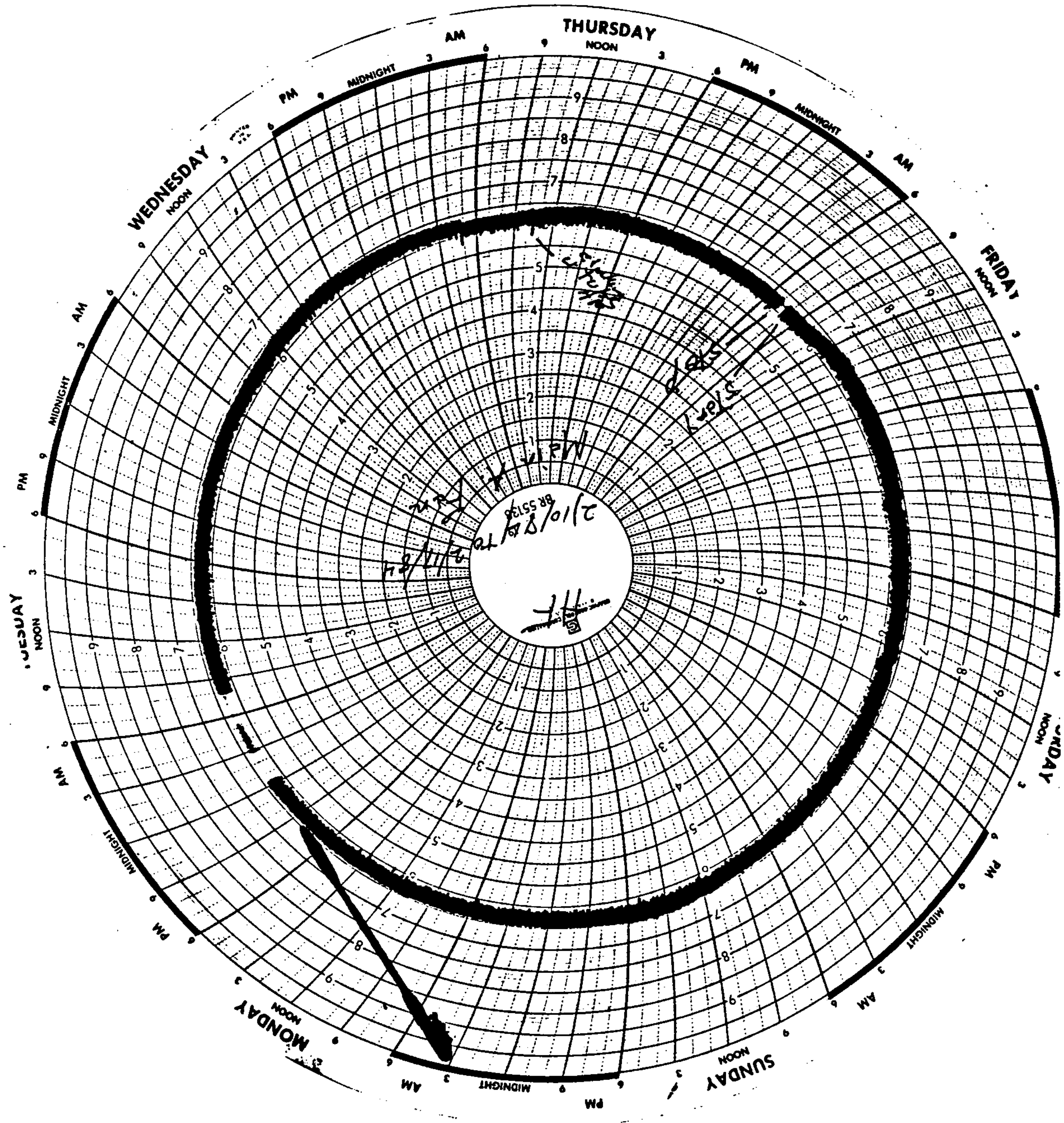
Number of shuttle cars loaded	Face intake methane concentration, percent (%)	Peak face return concentration, percent (%)	Face air quantity at end of line brattice (cfm)	Air quantity passing over return recorders (cfm)	Peak face area methane liberation rate (cfm)
1	0.03	0.26	4,589	4,589	10.6
2	.03	.42			17.9
3	.03	.38			16.1
4	.03	.56			24.3
5	.03	.56			24.3
6	.03	.50			21.6
7	.03	.30			12.4
8	.03	.22			8.7
9	.03	.34			14.2
10	.03	.46			19.7
11	.03	.46			19.7
12	.03	.40			17.0
13	.03	.54			23.4
Average	.03	.42			17.7

Greenwich Collieries No. 1 Mine
Greenwich Collieries Division
Longwall Section

Tailgate Entry		**Headgate Entry		
Intake airflow (cfm)	Average intake methane concentration, percent (%)	Return airflow (cfm)	Average return methane concentration, percent (%)	Average methane liberation rate across face (cfm)
22,540	0.01	18,086	0.21	30.5
22,540	0.01	18,086	*.27	*39.8

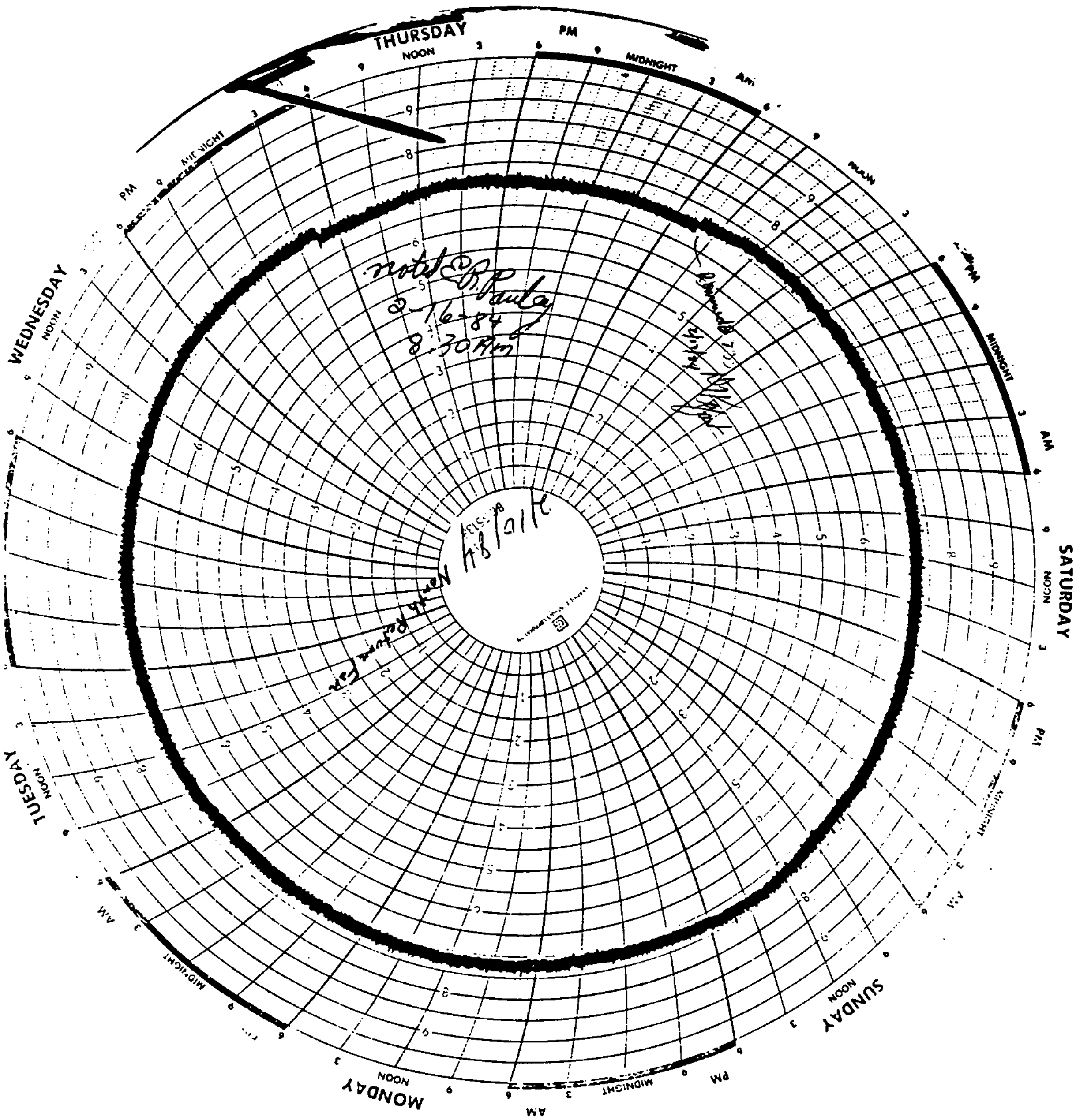
* During mining.
** Include belt air.

Appendix G



Fan Pressure Recording Chart

Main A Fan
2/10/84 - 2/17/84



Fan Pressure Recording Chart

North Fan
2/10/84 - 2/17/84

Appendix H

UNITED STATES DEPARTMENT OF LABOR
Mine Safety and Health Administration

BRUCETON SAFETY TECHNOLOGY CENTER
Industrial Safety Division

LABORATORY REPORT OF MATERIAL(S) SUBMITTED FOR TESTING

Sample Number: ISB 288-311

Material: Coal and Coke Dust

Manufacturer: (or where sample was taken)
Greenwich Collieries No. 1 Mine
ID #36-02405
Cookport, Pennsylvania

Submitted By:
Clete R. Stephan
Mining Engineer
Industrial Safety Division

Richard L. Reynolds
Chief, Mine Electrical Systems Division

Description: ISB 288-304 - Collected by Clete Stephan

ISB 288: Locomotive Sample No. 1, D-3 Entry #2 just outby x-cut 15, accumulated dust in the outby seating compartment taken from the right side of the back support.
ISB 289: Locomotive Sample No. 2, sample taken from accumulated dust on the outby coupler.
ISB 290: Locomotive Sample No. 3, sample taken from inside the lid of the main contactor panel.
ISB 291: Locomotive Sample No. 4, dust sample of tracking paths on the inside of the door on the tram control station.
ISB 292: Locomotive Sample No. 5, sample taken from inside the main circuit breaker.
ISB 293: Locomotive Sample No. 7, dust sample taken from the inside surfaces of the main contactor panel.
ISB 294: Locomotive Sample No. 8, dust sample taken from inside the motor housing on the right side of the locomotive.
ISB 295: D-1 Section, stopping in x-cut #3, #5 Entry side, sample from door and frame.
ISB 296: D-1, E4, x-cut 5, inby side of posts across entry.
ISB 297: D-1, sample from cable hanging from roof to floor, just inby #4 Entry, x-cut #3.
ISB 298: D-1, E-5, x-cut 4, sample from outby edge of crib, crib at outby edge of x-cut 4.
ISB 299: D-1, E-4, x-cut 5, inby side of posts across E-4, unburned paper and dust stuck on post.
ISB 300: D-3 Section, distribution box, inby x-cut 15, Entry #2.
ISB 301: D-3 Section, Entry #2, sample from inby side of posts just inby x-cut 16.
ISB 302: SS 10518, inter L4-C14 on D-3 side of post
ISB 303: D-5 Section, x-cut 14 and L4

ISB Sample No.: 288-311
Date: 4/16/84

Description:

ISB 304: Section D-5, Load Center, X-cut 15, between L2 and L3

ISB 310: Channel Sample No. 1, 22 feet outby survey station #10552 on right rib, D-5, L-5 Room

ISB 311: Channel Sample No. 2, 27 feet inby #13 x-cut on the right rib in No. 2 Entry (track) of D-3

Samples Submitted by Richard Reynolds

ISB 305: Sample taken from underside battery cover, 5-ton, 3/13/84, M.S.

ISB 306: Sample taken from 5-ton, cover lid (underside) traction motor, 3/13/84, M.S.

ISB 307: Sample taken from 5-ton, on and around traction motor, 3/13/84, M.S.

ISB 308: Sample taken from main frame of 5-ton between batteries and traction motor (motor side), 3/13/84, M.S.

ISB 309: Sample taken from 5-ton charger compartment, top of transformers, 3/13/84, M.S.

ISB 317: Sample No. 1 (3/27/84), 9:27a, taken from lid to starter box, A-70 pump

ISB 318: (3/27/84), sample from inside of motor junction box on the A-70 pump removed from D-3 Section, sample taken by Ronald J. Gossard, MSHA

ISB 319: Submitted by John Urosek, Mining Engineer, Ventilation Division, PHTC; D-1 Section, C-18, E-4, inter. rgt. outby corner

Laboratory Tests:

Tests were conducted to determine the amount of coking present in the samples. The Alcohol Coking Test is a qualitative test designed to determine the extent of coking by visual observation of a 1-gram sample of "as received" dust dispersed into a test tube containing ethanol. The amount of coking reported is based on the following criteria:

1. Trace - 4 or 5 pieces floating at the top of the liquid
2. Small - Outer edge of meniscus lined with particles
3. Large - One-half the top surface covered with particles
4. Extra-Large - Entire top surface covered with particles

A proximate analysis test was also conducted on two channel samples and on samples which indicated large or extra-large quantities of coking as per the Alcohol Coking Test. To prepare the samples for this test, they were ground so that the entire sample passed through a 60 mesh sieve (particles smaller than 250 microns). Test procedures were basically in accordance with ASTM D-3172, Standard Method for Proximate Analysis of Coal and Coke. Coking in pure coal samples is indicated, generally, by a slight reduction in volatile matter and fixed carbon and a marked increase in ash.

Test Results

Sample Number	Alcohol Test For Presence of Coke
ISB 288	Small
ISB 289	Small
ISB 290	Trace
ISB 291	-------Insufficient Sample-------
ISB 292	-------Insufficient Sample-------
ISB 293	Trace
ISB 294	None
ISB 295	-------Insufficient Sample-------
ISB 296	Trace
ISB 297	Small
ISB 298	Large
ISB 299	Small
ISB 300	Trace
ISB 301	X-Large
ISB 302	Large
ISB 303	Trace
ISB 304	X-Large
ISB 305*	-------Insufficient Sample-------
ISB 306*	None
ISB 307*	Small
ISB 308*	Trace
ISB 309*	Small
ISB 317	Trace
ISB 318	Trace
ISB 319	Small

*Samples appeared to be contaminated with organic material.

Proximate Analysis of Selected Samples

Sample Number	% Moisture	% Volatile Matter	% Fixed Carbon	% Ash
ISB 298	1.86	20.25	37.79	40.10
ISB 301	1.33	23.72	44.25	30.70
ISB 304	0.93	20.44	40.65	37.98
ISB 310 (channel)	1.10	24.05	59.59	15.26
ISB 311 (channel)	1.33	22.71	58.52	17.44

Comments: The proximate analysis conducted on the three samples, found to contain large or extra-large coke particles, displayed a large increase in ash concentration, slight reduction in volatile matter and marked decrease in fixed carbon. This is consistent with what would be expected with coal dust exposed to heat and flame. A proximate analysis was not conducted on ISB 302 because of insufficient sample.

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Appendix I

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Appendix I

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		Main D Entries		
		L3 Entry, Return		
1A1	No Sample	0 + 00 feet, Hard		
1A2	Band	0 + 100 feet		92
1A3	Band	0 + 200 feet		75.5
1A3X	Band	0 + 260 feet		46
1A4	Band	0 + 300 feet		71.5
1A5	Band	0 + 400 feet		99
1A6	Band	0 + 500 feet		91
1A6X	No Sample	0 + 550 feet, Stopping too Close to Entry		
1A7	Band	0 + 600 feet	Trace	70
1A8	Band	0 + 670 feet	Trace	56
1A9	No Sample	0 + 730 feet, Gob		
1A9X	No Sample	0 + 760 feet, Gob		
1A10	No Sample	0 + 790 feet, Gob		
1A11	Band	0 + 850 feet	None	90
1A12	Band	0 + 950 feet		72.9
1A12X	Band	0 + 1020 feet		74.7
1A13	Band	0 + 1060 feet		80.2
1A14	Band	0 + 1150 feet		87
1A15	Band	0 + 1250 feet		71
1A15X	Band	0 + 1275 feet		60
1A16	No Sample	0 + 1300 feet, Hard		
1A17	Band	0 + 1380 feet		57

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1A18	Band	0 + 1470 feet	None	61
1A18X	No Sample	0 + 1500 feet, Hard		
1A19	Band	0 + 1530 feet	None	92
1A20	No Sample	0 + 1590 feet, Hard		
1A21	Band	0 + 1680 feet		87
1A21X	Band	0 + 1750 feet		96
1A22	Floor, Rib	0 + 1770 feet		95
1A23	Band	0 + 1870 feet		95
1A24	Band	0 + 1930 feet		98
1A24X	No Sample	0 + 1970 feet, Hard		
1A25	Band	0 + 2040 feet		81
1A26	Band	0 + 2100 feet		57
1A27	Band	0 + 2200 feet	None	85
1A27X	No Sample	0 + 2270 feet, Wet		
1A28	No Sample	0 + 2300 feet, Wet		
1A29	No Sample	0 + 2370 feet, Wet		
1A30	No Sample	0 + 2450 feet, Wet		
1A30X	No Sample	0 + 2490 feet, Wet		
1A31	No Sample	0 + 2550 feet, Wet		
1A32	No Sample	0 + 2630 feet, Wet		
		L2 Entry, Return		
1B1	Band	0 + 00 feet		84.1
1B2	Band	0 + 100 feet		76.4
1B3	Band	0 + 200 feet		82
1B3X	No Sample	0 + 260 feet, Stopping too Close to Entry		
1B4	Band	0 + 300 feet		85

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ______ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1B5	Band	0 + 400 feet		85
1B6	Band	0 + 500 feet		60
1B6X	No Sample	0 + 550 feet, Stopping too Close to Entry		
1B7	No Sample	0 + 600 feet, Hard		
1B8	No Sample	0 + 670 feet, Hard		
1B9	Band	0 + 730 feet	Trace	79.6
1B9X	Band	0 + 760 feet	None	63
1B10	Band	0 + 790 feet	None	59
1B11	Band	0 + 850 feet	None	89
1B12	Band	0 + 950 feet		77.2
1B12X	Band	0 + 1020 feet		76.4
1B13	Band	0 + 1060 feet		81.9
1B14	Band	0 + 1150 feet		79.2
1B15	Band	0 + 1250 feet		40
1B15X	Band	0 + 1275 feet		84
1B16	No Sample	0 + 1300 feet, Hard		
1B17	Band	0 + 1380 feet		85
1B18	No Sample	0 + 1470 feet, Hard		
1B18X	No Sample	0 + 1500 feet, Gob		
1B19	No Sample	0 + 1530 feet, Hard		
1B20	No Sample	0 + 1590 feet, Bottom Covered With Scale		
1B21	No Sample	0 + 1680 feet, Bottom Covered With Scale		
1B21X	No Sample	0 + 1750 feet, Bottom Covered With Scale		
1B22	No Sample	0 + 1770 feet, Hard		
1B23	Band	0 + 1870 feet		99
1B24	Band	0 + 1930 feet		51
1B24X	No Sample	0 + 1970 feet, Hard		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1B25	Band	0 + 2040 feet		76.7
1B26	Band	0 + 2100 feet		90
1B27	Band	0 + 2200 feet	None	90
1B27X	No Sample	0 + 2270 feet, Wet		
1B28	No Sample	0 + 2300 feet, Wet		
1B29	No Sample	0 + 2370 feet, Wet		
1B30	No Sample	0 + 2450 feet, Wet		
1B30X	No Sample	0 + 2490 feet, Wet		
1B31	No Sample	0 + 2550 feet, Wet		
1B32	No Sample	0 + 2630 feet, Wet		
		L1 Entry, Intake		
1C1	Floor	0 + 00 feet		77.
1C2	Floor	0 + 100 feet		82
1C3	No Sample	0 + 200 feet, Hard		
1C3X	No Sample	0 + 260 feet, Hard		
1C4	Floor	0 + 300 feet		67
1C5	No Sample	0 + 400 feet, Hard		
1C6	Floor	0 + 500 feet		40
1C6X	No Sample	0 + 550 feet, Stopping too Close to Entry		
1C7	Band	0 + 600 feet	None	53
1C8	Band	0 + 670 feet	None	49
1C9	Band	0 + 730 feet	None	85
1C9X	Floor	0 + 760 feet	None	35
1C10	No Sample	0 + 790 feet, Hard		
1C11	No Sample	0 + 850 feet, Hard		
1C12	Floor	0 + 950 feet		61.2

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1C12X	Floor	0 + 1020 feet		60.2
1C13	No Sample	0 + 1060 feet, Hard		
1C14	Floor	0 + 1150 feet		70
1C15	Band	0 + 1250 feet		94
1C5X	Floor	0 + 1275 feet		60.5
1C16	No Sample	0 + 1300 feet, Hard		
1C17	No Sample	0 + 1380 feet, Hard		
1C18	No Sample	0 + 1470 feet, Hard		
1C18X	Floor	0 + 1500 feet	None	76
1C19	Band	0 + 1530 feet	None	71
1C20	Band	0 + 1590 feet	None	61.3
1C21	Band	0 + 1680 feet		87
1C21X	Band	0 + 1750 feet		100
1C22	Floor	0 + 1770 feet		80
1C23	Floor	0 + 1870 feet		92
1C24	Floor	0 + 1930 feet		75
1C24X	Band	0 + 1970 feet		70
1C25	Floor	0 + 2040 feet		97
1C26	Floor	0 + 2100 feet		80
1C27	No Sample	0 + 2200 feet, Wet		
1C27X	No Sample	0 + 2270 feet, Wet		
1C28	No Sample	0 + 2300 feet, Wet		
1C29	No Sample	0 + 2370 feet, Wet		
1C30	No Sample	0 + 2450 feet, Wet		
1C30X	No Sample	0 + 2490 feet, Wet		
1C31	No Sample	0 + 2550 feet, Wet		
1C32	No Sample	0 + 2630 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		B Entry, Intake (Beltline)		
1D1	Band	0 + 00 feet		87
1D2	Band	0 + 100 feet		97
1D3	Band	0 + 200 feet		88
1D3X	Band	0 + 260 feet		92
1D4	Band	0 + 300 feet		92
1D5	Band	0 + 400 feet		94
1D6	Band	0 + 500 feet		87
1D6X	Band	0 + 550 feet		92
1D7	Band	0 + 600 feet		98
1D8	Band	0 + 670 feet		95
1D9	Band	0 + 730 feet		91
1D9X	Band	0 + 760 feet		90.
1D10	Band	0 + 790 feet		96
1D11	Band	0 + 850 feet		82
1D12	Band	0 + 950 feet		82
1D12X	Band	0 + 1020 feet		80
1D13	Band	0 + 1060 feet		82
1D14	Band	0 + 1150 feet		87
1D15	Band	0 + 1250 feet		92
1D15X	No Sample	0 + 1275 feet, Stopping too Close to Entry		
1D16	Band	0 + 1300 feet		90
1D17	Band	0 + 1380 feet		79
1D18	Band	0 + 1470 feet		87
1D18X	Band	0 + 1500 feet		92
1D19	Band	0 + 1530 feet		82
1D20	Band	0 + 1590 feet		95

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1D21	Band	0 + 1680 feet		92
1D21X	Band	0 + 1750 feet		100
1D22	Band	0 + 1770 feet		92
1D23	Band	0 + 1870 feet		94
1D24	Band	0 + 1930 feet		96
1D24X	Band	0 + 1970 feet		90
1D25	Band	0 + 2040 feet		90
1D26	Band	0 + 2100 feet		86
1D27	Band	0 + 2200 feet		90
1D27X	Band	0 + 2270 feet		92
1D28	Band	0 + 2300 feet		95
1D29	Band	0 + 2370 feet		92
1D30	Band	0 + 2450 feet		92
1D30X	No Sample	0 + 2490 feet, Wet		
1D31	No Sample	0 + 2550 feet, Wet		
1D32	No Sample	0 + 2630 feet, Wet		
		R1 Entry, Intake (Track)		
1E1	Band	0 + 00 feet		81
1E2	Band	0 + 100 feet		92
1E3	Band	0 + 200 feet		95
1E3X	Band	0 + 260 feet		53
1E4	Band	0 + 300 feet		92
1E5	Band	0 + 400 feet		92
1E6	Band	0 + 500 feet		86
1E6X	Band	0 + 550 feet		53
1E7	Band	0 + 600 feet		82

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE______ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1E8	Floor, Ribs	0 + 670 feet		96
1E9X	Floor, Ribs	0 + 710 feet		72
1E9	Floor, Ribs	0 + 730 feet		71
1E10	Band	0 + 790 feet		85
1E11	Band	0 + 850 feet		93
1E12	Band	0 + 950 feet		87
1E12X	Band	0 + 1020 feet		60.3
1E13	Band	0 + 1060 feet		100
1E14	Band	0 + 1150 feet		75
1E15	Band	0 + 1250 feet		84
1E15X	Band	0 + 1275 feet		62
1E16	Band	0 + 1300 feet		84
1E17	Band	0 + 1380 feet		75
1E18	Band	0 + 1470 feet		83
1E18X	Band	0 + 1500 feet		64.2
1E19	Band	0 + 1530 feet		97
1E20	Band	0 + 1590 feet		95
1E21	Band	0 + 1680 feet		95
1E21X	Band	0 + 1750 feet		67.9
1E22	Ribs	0 + 1770 feet		90
1E23	Floor, Ribs	0 + 1870 feet		91
1E24	Band	0 + 1930 feet		80
1E24X	Band	0 + 1970 feet		80
1E25	Floor, Ribs	0 + 2040 feet		72
1E26	Floor, Ribs	0 + 2100 feet		87
1E27	Band	0 + 2200 feet		92
1E27X	Band	0 + 2270 feet		67.3

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE______- ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1E28	Band	0 + 2300 feet		99
1E29	Roof, Ribs	0 + 2370 feet		92
1E30	Roof, Ribs	0 + 2450 feet		92
1E30X	Band	0 + 2490 feet		60.4
1E31	No Sample	0 + 2550 feet, Wet		
		R2 Entry, Intake		
1F1	Band	0 + 00 feet		95
1F2	Band	0 + 100 feet		46
1F3	Band	0 + 200 feet		69
1F3X	Band	0 + 260 feet		72
1F4	Band	0 + 300 feet		63.3
1F5	No Sample	0 + 400 feet, Caved		
1F6	Band	0 + 500 feet		90
1F6X	Band	0 + 550 feet		67
1F7	Band	0 + 600 feet		82
1F8	Band	0 + 670 feet		95
1F9	Band	0 + 730 feet		89
1F10	Band	0 + 790 feet		64.7
1F11	Band	0 + 850 feet		67
1F12	Band	0 + 950 feet		69
1F12X	Band	0 + 1020 feet		70
1F13	Band	0 + 1060 feet		55
1F14	Band	0 + 1150 feet		80
1F15	Band	0 + 1250 feet		57
1F15X	Band	0 + 1275 feet		69
1F16	Band	0 + 1300 feet		77

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1F17	Band	0 + 1380 feet		52
1F18	Band	0 + 1470 feet		59.7
1F18X	Band	0 + 1500 feet		52
1F19	Floor	0 + 1530 feet		85
1F20	Floor	0 + 1590 feet		73
1F21	Floor	0 + 1680 feet		75
1F21X	No Sample	0 + 1750 feet, Cribbed		
1F22	Band	0 + 1770 feet		75
1F23	No Sample	0 + 1870 feet, Wet		
1F24	No Sample	0 + 1930 feet, Wet		
1F24X	Band	0 + 1970 feet		74
1F25	No Sample	0 + 2040 feet, Hard		
1F26	No Sample	0 + 2100 feet, Hard		
1F27	No Sample	0 + 2200 feet, Wet		
1F27X	Band	0 + 2270 feet		75
1F28	Band	0 + 2300 feet		69
1F29	Band	0 + 2370 feet		65
1F30	Band	0 + 2450 feet		67.8
1F30X	Band	0 + 2490 feet		63.5
1F31	No Sample	0 + 2550 feet, Hard		
		R3 Entry, Intake		
1G1	Band	0 + 00 feet		92
1G2	Band	0 + 100 feet		98
1G3	Band	0 + 200 feet		90
1G3X	Band	0 + 260 feet		82
1G4	Band	0 + 300 feet		93

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1G5	Band	0 + 400 feet		100
1G6	Band	0 + 500 feet		100
1G6X	Band	0 + 560 feet		97
1G7	Band	0 + 600 feet		89
1G8	Band	0 + 670 feet		90
1G9	Band	0 + 730 feet		79
1G10	Band	0 + 790 feet		80
1G9X	Band	0 + 820 feet		70
1G11	No Sample	0 + 850 feet, Inaccessible		
1G12	No Sample	0 + 950 feet, Inaccessible		
1G12X	No Sample	0 + 1020 feet, Inaccessible		
1G13	No Sample	0 + 1060 feet, Inaccessible		
1G14A	Band	0 + 1150 feet		67
1G14B	Band	0 + 1200 feet		87
1G15	Band	0 + 1250 feet		87
1G15X	Band	0 + 1275 feet		90
1G16	Band	0 + 1300 feet		52
1G17	Band	0 + 1380 feet		71
		R3 Entry, Return		
1G18	Band	0 + 1470 feet		55
1G18X	Band	0 + 1500 feet		92
1G19	Band	0 + 1530 feet		97
1G20	Band	0 + 1590 feet		97
1G21	Band	0 + 1680 feet		99
1G21X	Band	0 + 1750 feet		65
1G22	Band	0 + 1770 feet		65

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1G23	Band	0 + 1870 feet		100
1G24	Band	0 + 1930 feet		70
1G24X	Band	0 + 1970 feet		95
1G25	Band	0 + 2040 feet		65
1G26	Band	0 + 2100 feet		56
1G27	Band	0 + 2200 feet		67
1G27X	Band	0 + 2270 feet		79
1G28	Band	0 + 2300 feet		89
1G29	Band	0 + 2370 feet		62
1G30	Band	0 + 2450 feet		60
1G30X	Band	0 + 2490 feet		62
1G31	Band	0 + 2550 feet		71
1G32	Band	0 + 2630 feet		85
		R4 Entry, Return		
1H1	Band	0 + 00 feet		96
1H2	Band	0 + 100 feet		92
1H3	Band	0 + 200 feet		85
1H3X	Band	0 + 260 feet		87
1H4	Band	0 + 300 feet		85
1H5	No Sample	0 + 400 feet, Caved		
1H6	Band	0 + 500 feet		91
1H6X	Band	0 + 550 feet		87
1H7	No Sample	0 + 600 feet, Bad Roof		
1H8	Band	0 + 670 feet		90
1H9	Band	0 + 730 feet		90
1H10	Band	0 + 790 feet		92

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
1H9X	Band	0 + 820 feet		66
1H11	Band	0 + 850 feet		97
1H12	Band	0 + 950 feet		87
1H12X	No Sample	0 + 1020 feet, Wet		
1H13	No Sample	0 + 1060 feet, Hard		
1H14A	No Sample	0 + 1150 feet, Hard		
1H14B	No Sample	0 + 1200 feet, Hard		
1H15	No Sample	0 + 1250 feet, Hard		
1H15X	No Sample	0 + 1275 feet, Bad Roof		
1H16	No Sample	0 + 1300 feet, Wet		
1H17	No Sample	0 + 1380 feet, Cribbed		
1H18	No Sample	0 + 1470 feet, Bad Roof		
1H19	No Sample	0 + 1530 feet, Bad Roof		
1H20	No Sample	0 + 1590 feet, Bad Roof		
1H21	No Sample	0 + 1680 feet, Caved		
1H22	No Sample	0 + 1770 feet, Caved		
1H23	No Sample	0 + 1870 feet, Caved		
1H24	No Sample	0 + 1930 feet, Caved		
1H25	No Sample	0 + 2040 feet, Caved		
1H26	No Sample	0 + 2100 feet, Caved		
1H27	No Sample	0 + 2200 feet, Caved		
1H27X	No Sample	0 + 2270 feet, Caved		
1H28	No Sample	0 + 2300 feet, Caved		
1H29	No Sample	0 + 2370 feet, Caved		
1H30	No Sample	0 + 2450 feet, Caved		
1H30X	No Sample	0 + 2490 feet, Caved		
1H31	Band	0 + 2550 feet		90
1H32	Band	0 + 2630 feet		95

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE______ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		R5 Entry, Return		
1I1	No Sample	0 + 00 feet, Caved		
1I2	Band	0 + 100 feet		80
1I3	Band	0 + 200 feet		82
1I4	Band	0 + 300 feet		87
1I5	Band	0 + 400 feet		92
1I6	No Sample	0 + 500 feet, Hard		
1I7	No Sample	0 + 600 feet, Bad Roof		
1I8	No Sample	0 + 670 feet, Bad Roof		
1I9	No Sample	0 + 730 feet, Bad Roof		
1I10	No Sample	0 + 790 feet, Bad Roof		
1I11	No Sample	0 + 850 feet, Bad Roof		
1I12	No Sample	0 + 950 feet, Bad Roof		
1I13	No Sample	0 + 1060 feet, Bad Roof		
1I14A	No Sample	0 + 1150 feet, Bad Roof		
1I14B	No Sample	0 + 1200 feet, Bad Roof		
1I15-1I25	No Samples	Not Developed		
1I26	No Sample	0 + 2100 feet, Caved		
1I27	No Sample	0 + 2200 feet, Caved		
1I28	No Sample	0 + 2300 feet, Caved		
1I29	No Sample	0 + 2370 feet, Caved		
1I30	No Sample	0 + 2450 feet, Caved		
1I31	No Sample	0 + 2550 feet, Caved		
1I32	No Sample	0 + 2630 feet, Caved		

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		D-1 Entries		
		L4 Entry, Return		
2A1	Band	0 + 00 feet	Trace	87
2A2	Band	0 + 70 feet	Trace	87
2A3	Band	0 + 140 feet	Trace	74.3
2A3X	Floor, Ribs	0 + 175 feet	Trace	66
2A4	Floor	0 + 190 feet	Trace	80.5
2A5	No Sample	0 + 250 feet, Wet		
2A6	No Sample	0 + 300 feet, Wet		
		L3 Entry, Intake		
2B1	Band	0 + 00 feet	Trace	89
2B2	Band	0 + 70 feet	Trace	85
2B3	Band	0 + 140 feet	Trace	72
2B3X	Floor, Ribs	0 + 175 feet	Trace	72
2B4	Band	0 + 190 feet	None	55
2B5	Band	0 + 250 feet	Trace	97
2B6	No Sample	0 + 300 feet, Wet		
		L2 Entry, Intake		
2C1	Floor, Ribs	0 + 00 feet	Trace	77
2C2	Band	0 + 70 feet	Small	67.2
2C3	Floor, Ribs	0 + 140 feet	Small	68.3
2C3X	No Sample	0 + 175 feet, Hard		

UNITED STATES DEPARTMENT OF LABOR
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COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
2C4	Band	0 + 190 feet	Large	81.5
2C5	Band	0 + 250 feet	Large	77.2
2C6	No Sample	0 + 300 feet, Wet		
		L1 Entry, Intake		
2D1	Floor, Ribs	0 + 00 feet	Small	62.8
2D2	No Sample	0 + 70 feet, Hard		
2D3	Band	0 + 140 feet	Large	80.2
2D3X	Floor, Ribs	0 + 160 feet	Large	58.8
2D4	Band	0 + 190 feet	Large	70.7
2D5	No Sample	0 + 250 feet, Wet		
2D6	No Sample	0 + 300 feet, Wet		
		No. 5 Entry, Intake		
2E1	Floor, Ribs	0 + 00 feet	Extra Large	39.2
2E2	Band	0 + 70 feet	Extra Large	37.3
2E3	Band	0 + 140 feet	Extra Large	37.9
2E4	No Sample	0 + 190 feet, Wet		
2E5	No Sample	0 + 250 feet, Wet		
2E6	No Sample	0 + 300 feet, Wet		

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ______ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		Connecting Line Rooms From D-1 to D-3		
		No. 1 Room, Intake		
3A1	No Sample	0 + 00 feet, Wet		
3A2	No Sample	0 + 70 feet, Wet		
3A3	No Sample	0 + 160 feet, Wet		
3A3X	No Sample	0 + 220 feet, Wet		
3A4	No Sample	0 + 250 feet, Wet		
3A5	No Sample	0 + 330 feet, Wet		
3A6	No Sample	0 + 400 feet, Wet		
3A6X	No Sample	0 + 480 feet, Wet		
3A7	No Sample	0 + 500 feet, Wet		
		No. 2 Room, Intake		
3B1	Band	0 + 00 feet	Extra Large	72.6
3B2	No Sample	0 + 70 feet, Chocks		
3B3	Floor, Ribs	0 + 160 feet	None	84
3B3X	No Sample	0 + 220 feet, Wet		
3B4	No Sample	0 + 250 feet, Wet		
3B5	No Sample	0 + 330 feet, Wet		
3B6	No Sample	0 + 400 feet, Wet		
3B6X	No Sample	0 + 480 feet, Wet		
3B7	No Sample	0 + 500 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE____- ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		No. 3 Room, Intake		
3C1	No Sample	0 + 00 feet, Gob		
3C2	Band	0 + 70 feet	None	67
3C3	Band	0 + 160 feet	None	70
3C3X	Band	0 + 220 feet	None	67
3C4	Band	0 + 250 feet	None	77
3C5	Band	0 + 330 feet	None	91
3C6	No Sample	0 + 400 feet, Wet		
3C6X	No Sample	0 + 480 feet, Wet		
3C7	No Sample	0 + 500 feet, Wet		

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		D-3 Entries		
		L2 Entry, Return		
4A1	Band	0 + 00 feet	Trace	83
4A2	Floor	0 + 50 feet	Trace	85
4A3	No Sample	0 + 100 feet, Wet		
4A3X	No Sample	0 + 150 feet, Wet		
4A4	No Sample	0 + 180 feet, Wet		
4A5	No Sample	0 + 250 feet, Wet		
4A6	No Sample	0 + 300 feet, Wet		
4A6X	No Sample	0 + 350 feet, Hard		
4A7	No Sample	0 + 400 feet, Hard		
4A8	Band	0 + 450 feet	Extra Large	64.3
4A9	Band	0 + 550 feet	Extra Large	62
4A9X	No Sample	0 + 610 feet, Hard		
4A10	No Sample	0 + 650 feet, Hard		
4A11	Band	0 + 750 feet	Extra Large	60.1
4A12	No Sample	0 + 850 feet, Hard		
4A12X	Band	0 + 900 feet	Extra Large	50.6
4A13	Band	0 + 950 feet	Extra Large	58.8
4A14	Band	0 + 1050 feet	Large	69
4A15	Band	0 + 1100 feet	Small	76.2
4A15X	No Sample	0 + 1150 feet, Bad Roof		
4A16	No Sample	0 + 1200 feet, Bad Roof		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		L1 Entry, Intake		
4B1	No Sample	0 + 00 feet, Wet		
4B2	Band	0 + 50 feet	Trace	82
4B3	Band	0 + 100 feet	None	92
4B3X	No Sample	0 + 150 feet, Wet		
4B4	No Sample	0 + 180 feet, Wet		
4B5	No Sample	0 + 250 feet, Wet		
4B6	No Sample	0 + 300 feet, Hard		
4B6X	No Sample	0 + 350 feet, Wet		
4B7	Band	0 + 400 feet	Large	68.1
4B8	Band	0 + 450 feet	Small	66.9
4B9	Band	0 + 550 feet	Small	68.6
4B9X	No Sample	0 + 610 feet, Wet		
4B10	No Sample	0 + 650 feet, Hard		
4B11	No Sample	0 + 750 feet, Wet		
4B12	Band	0 + 850 feet	Small	78
4B12X	Band	0 + 900 feet	Small	58.3
4B13	No Sample	0 + 950 feet, Hard		
4B14	No Sample	0 + 1050 feet, Hard		
4B15	No Sample	0 + 1100 feet, Bad Roof		
4B15X	No Sample	0 + 1150 feet, Bad Roof		
4B16	No Sample	0 + 1200 feet, Wet		
		B Entry, Intake		
4C1	Band	0 + 00 feet	None	70
4C2	Band	0 + 50 feet	None	87
4C3	No Sample	0 + 100 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
4C4	Band	0 + 180 feet	Trace	41
4C5	Band	0 + 250 feet	Trace	52
4C6	No Sample	0 + 300 feet, Wet		
4C7	Band	0 + 400 feet	Large	58.8
4C8	Band	0 + 450 feet	Extra Large	48.8
4C9	Band	0 + 550 feet	Extra Large	63.1
4C10	Band	0 + 650 feet	Extra Large	46.8
4C11	Band	0 + 750 feet	Extra Large	75.6
4C12	Band	0 + 850 feet	Extra Large	40.6
4C13	Band	0 + 950 feet	Extra Large	67.7
4C14	Band	0 + 1050 feet	Extra Large	45.4
4C15	No Sample	0 + 1100 feet, Bad Roof		
4C16	No Sample	0 + 1200 feet, Wet		

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MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		Connecting Line Rooms From D-3 To D-5		
		No. 1 Room, Return		
5A1	Band	0 + 00 feet	None	65
5A2	Band	0 + 100 feet	None	89
5A3	Band	0 + 190 feet	None	91
5A3X	Band	0 + 250 feet	None	79.2
5A4	Band	0 + 280 feet	None	87
5A5	Band	0 + 360 feet	None	43
5A6	Band	0 + 450 feet	None	67
5A6X	Band	0 + 520 feet	None	65
5A7	Band	0 + 550 feet	None	74.6
		No. 2 Room, Return		
5B1	Band	0 + 00 feet	None	67
5B2	Band	0 + 100 feet	None	86
5B3	Roof, Ribs	0 + 190 feet	None	72.4
5B3X	Roof, Ribs	0 + 250 feet	None	73.9
5B4	Roof, Ribs	0 + 280 feet	None	75.1
5B5	Band	0 + 360 feet	None	89
5B6	Band	0 + 450 feet	None	63
5B6X	Band	0 + 520 feet	None	39
5B7	Band	0 + 550 feet	None	65

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		No. 3 Room, Return		
5C1	No Sample	0 + 00 feet, Caved		
5C2	No Sample	0 + 100 feet, Caved		
5C3	Roof, Ribs	0 + 190 feet	None	85
5C3X	Band	0 + 250 feet	None	79.5
5C4	Band	0 + 280 feet	None	90
5C5	Band	0 + 360 feet	None	39
5C6	Band	0 + 450 feet	None	88
5C6X	Band	0 + 520 feet	None	73.1
5C7	Band	0 + 550 feet	None	87

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		D-5 Entries		
		L2 Entry, Return		
6A1	Band	0 + 00 feet	None	88
6A2	Band	0 + 100 feet	None	83
6A3	No Sample	0 + 180 feet, Wet		
6A3X	No Sample	0 + 220 feet, Wet		
6A4	Band	0 + 250 feet,	None	83
6A5	Band	0 + 300 feet	None	94
6A6	Band	0 + 370 feet	None	94
6A6X	Band	0 + 450 feet	None	64
6A7	Band	0 + 460 feet	None	92
6A8	Band	0 + 550 feet	None	87
6A9	No Sample	0 + 650 feet, Wet		
6A9X	No Sample	0 + 700 feet, Wet		
6A10	No Sample	0 + 730 feet, Wet		
6A11	Band	0 + 780 feet	None	97
6A12	Band	0 + 840 feet	None	94
6A12X	Band	0 + 900 feet	None	71.5
6A13	Band	0 + 920 feet	None	87
6A14	Band	0 + 1010 feet	Trace	95
6A15	No Sample	0 + 1090 feet, Wet		
6A16	No Sample	0 + 1200 feet, Wet		

Appendix I (Cont.)

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TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

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CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		L1 Entry, Intake		
6B1	No Sample	0 + 00 feet, Wet		
6B2	No Sample	0 + 100 feet, Wet		
6B3	No Sample	0 + 180 feet, Wet		
6B3X	Band	0 + 220 feet	None	81
6B4	No Sample	0 + 250 feet, Wet		
6B5	No Sample	0 + 300 feet, Wet		
6B6	Band	0 + 370 feet	None	89
6B6X	No Sample	0 + 450 feet, Wet		
6B7	Band	0 + 460 feet	None	81
6B8	No Sample	0 + 550 feet, Wet		
6B9	No Sample	0 + 650 feet, Wet		
6B9X	No Sample	0 + 700 feet, Wet		
6B10	No Sample	0 + 730 feet, Wet		
6B11	No Sample	0 + 780 feet, Wet		
6B12	No Sample	0 + 840 feet, Wet		
6B12X	No Sample	0 + 900 feet, Wet		
6B13	Band	0 + 920 feet	None	90
6B14	No Sample	0 + 1010 feet, Wet		
6B15	No Sample	0 + 1090 feet, Wet		
6B16	No Sample	0 + 1200 feet, Wet		
		No. 3 Entry, Intake		
6C1	No Sample	0 + 00 feet, Wet		
6C2	No Sample	0 + 100 feet, Wet		
6C3	No Sample	0 + 180 feet, Wet		
6C3X	No Sample	0 + 220 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
6C4	No Sample	0 + 250 feet, Wet		
6C5	No Sample	0 + 300 feet, Wet		
6C6	No Sample	0 + 370 feet, Wet		
6C7	No Sample	0 + 460 feet, Wet		
6C8	No Sample	0 + 550 feet, Wet		
6C9	No Sample	0 + 650 feet, Wet		
6C10	No Sample	0 + 730 feet, Wet		
6C11	No Sample	0 + 780 feet, Wet		
6C12	No Sample	0 + 840 feet, Wet		
6C13	No Sample	0 + 920 feet, Wet		
6C14	No Sample	0 + 1010 feet, Wet		
6C15	No Sample	0 + 1090 feet, Wet		
6C16	No Sample	0 + 1200 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE______- ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		Connecting Line Rooms From D-5 To D-7		
		No. 1 Room, Return		
7A1	No Sample	0 + 00 feet, Wet		
7A2	Band	0 + 100 feet	None	90
7A3	Band	0 + 180 feet	None	84
7A3X	Band	0 + 220 feet	None	74.4
7A4	Band	0 + 250 feet	None	77.4
7A5	Band	0 + 360 feet	None	45
7A6	Band	0 + 420 feet	None	95
7A7	Band	0 + 520 feet	None	93
		No. 2 Room, Return		
7B1	No Sample	0 + 00 feet, Wet		
7B2	Band	0 + 100 feet	None	83
7B3	Band	0 + 180 feet	None	75
7B3X	Band	0 + 220 feet	None	72.5
7B4	Band	0 + 250 feet	None	82
7B5	Band	0 + 360 feet	None	98
7B6	Band	0 + 420 feet	None	93
7B6X	Band	0 + 500 feet	None	87
7B7	Band	0 + 520 feet	None	98
		No. 3 Room, Return		
7C1	No Sample	0 + 00 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
7C2	No Sample	0 + 100 feet, Caved		
7C3	No Sample	0 + 180 feet, Caved		
7C3X	Band	0 + 220 feet	None	86
7C4	No Sample	0 + 250 feet, Bad Roof		
7C5	No Sample	0 + 360 feet, Wet		
7C6	Band	0 + 420 feet	None	94
7C6X	Band	0 + 500 feet	None	96
7C7	Band	0 + 520 feet	None	94
		No. 4 Room		
7D1	No Sample	0 + 00 feet, Wet, No Sample		
		No. 5 Room		
7E1	No Sample	0 + 00 feet, Wet		

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		D-5 Section Entries		
		L2 Entry, Intake		
8A1	No Sample	0 + 00 feet, Wet		
8A2	No Sample	0 + 70 feet, Wet		
8A3	No Sample	0 + 150 feet, Wet		
8A3X	No Sample	0 + 180 feet, Wet		
8A4	No Sample	0 + 230 feet, Wet		
8A5	Band	0 + 300 feet	Trace	41
8A6	Band	0 + 370 feet	Extra Large	53.3
8A6X	Band	0 + 400 feet	Small	36
		L1 Entry, Intake		
8B1	No Sample	0 + 00 feet, Wet		
8B2	No Sample	0 + 70 feet, Wet		
8B3	No Sample	0 + 150 feet, Wet		
8B3X	No Sample	0 + 180 feet, Wet		
8B4	No Sample	0 + 230 feet, Wet		
8B5	Band	0 + 300 feet	Large	51.9
8B6	Band	0 + 370 feet	Small	45
8B6X	Band	0 + 400 feet	Trace	52
		B Entry, Intake		
8C1	No Sample	0 + 00 feet, Wet		
8C2	No Sample	0 + 70 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
8C3	No Sample	0 + 150 feet, Wet		
8C3X	Band	0 + 180 feet	Large	63.6
8C4	Band	0 + 230 feet	Extra Large	52.8
8C5	Band	0 + 300 feet	Extra Large	55
8C6	Band	0 + 370 feet	Small	50.1
8C6X	Band	0 + 400 feet	Small	44.5
		R1 Entry, Intake		
8D1	No Sample	0 + 00 feet, Wet		
8D2	No Sample	0 + 70 feet, Wet		
8D3	Band	0 + 150 feet	Large	69.4
8D3X	Band	0 + 200 feet	Extra Large	78.8
8D4	Band	0 + 230 feet	Extra Large	53.2
8D5	Band	0 + 300 feet	Extra Large	39.1
8D6	Band	0 + 370 feet	Extra Large	50.8
8D6X	Band	0 + 400 feet	Large	70.2
		R2 Entry, Intake		
8E1	No Sample	0 + 00 feet, Wet		
8E2	No Sample	0 + 70 feet, Wet		
8E3	Band	0 + 150 feet	Extra Large	53.8
8E3X	Band	0 + 165 feet	Extra Large	36.4
8E4	Band	0 + 230 feet	Extra Large	55.3
8E5A	Band	0 + 280 feet	Extra Large	45.9
8E5B	Band	0 + 300 feet	Extra Large	49
8E6	Band	0 + 365 feet	Extra Large	39.6
8E6X	Band	0 + 400 feet	Extra Large	52.8

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE_____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		R3 Entry, Return		
8F1	No Sample	0 + 00 feet, Wet		
8F2	No Sample	0 + 70 feet, Wet		
8F3	Band	0 + 150 feet	Extra Large	50.5
8F3X	Band	0 + 165 feet	Extra Large	39
8F4	Band	0 + 215 feet	Extra Large	51.9
8F5A	Band	0 + 280 feet	Extra Large	39.4
8F5B	Band	0 + 300 feet	Extra Large	49.6
8F6	Band	0 + 365 feet	Extra Large	41.9
8F6X	Band	0 + 400 feet	Extra Large	47.1
		R4 Entry, Return		
8G1	No Sample	0 + 00 feet, Wet		
8G2	No Sample	0 + 70 feet, Wet		
8G3	Band	0 + 150 feet	Extra Large	58.4
8G3X	Band	0 + 165 feet	Extra Large	52.2
8G4	Band	0 + 215 feet	Extra Large	40.3
8G5A	Band	0 + 280 feet	Extra Large	46.7
8G5B	Band	0 + 300 feet	Extra Large	49.9
8G6	Band	0 + 365 feet	Extra Large	41.3
8G6X	Band	0 + 400 feet	Large	52.8
		R5 Entry, Return		
8H1	No Sample	0 + 00 feet, Wet		
8H2	No Sample	0 + 70 feet, Wet		

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE______ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
8H3	Band	0 + 150 feet	Extra Large	59.6
8H4	Band	0 + 230 feet	Extra Large	43
8H5A	Band	0 + 290 feet	Extra Large	32.7
8H5B	Band	0 + 330 feet	Extra Large	37.4
8H6	Band	0 + 390 feet	Extra Large	54.6

Appendix I (Cont.)

UNITED STATES DEPARTMENT OF LABOR
MSHA LABORATORIES - MOUNT HOPE, WEST VIRGINIA

TABLE ____ - ANALYSES OF DUST SAMPLES COLLECTED February 25 through March 6, 1984

MINE Greenwich Collieries No. 1 COMPANY Greenwich Collieries, Division of Pa. Mines Corporation

COLLECTED BY Investigation Team

CAN NUMBER	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	PERCENT INCOMBUSTIBLE
		EXPLOSION INVESTIGATION		
		D-3 L3 Entry		
		L3 Entry, Return		
9A1	No Sample	0 + 00 feet, Wet and Gob		
9A2	No Sample	0 + 60 feet, Gob		
9A2X	No Sample	0 + 120 feet, Caved		
9A3	Band	0 + 150 feet	Extra Large	20.5
9A3X	Band	0 + 200 feet	Large	57.4
9A4	Band	0 + 230 feet	Large	17.9
9A4X	Band	0 + 270 feet	Large	23.6
9A5	Band	0 + 300 feet	Extra Large	27.9
9A6	Band	0 + 380 feet	Extra Large	40.5
9A7	Band	0 + 480 feet	Extra Large	34.7
9A8	Band	0 + 580 feet	Extra Large	43.1
9A8X	Band	0 + 620 feet	Extra Large	39.2
9A9	Band	0 + 650 feet	Extra Large	28
9A10	Band	0 + 750 feet	Extra Large	33.9
9A11	Band	0 + 850 feet	Extra Large	21.8
9A12	No Sample	0 + 950 feet, Bad Roof		

Appendix J

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United States Department of the Interior

BUREAU OF MINES

PITTSBURGH RESEARCH CENTER
COCHRANS MILL ROAD
POST OFFICE BOX 18070
PITTSBURGH, PENNSYLVANIA 15236

June 27, 1984

Mr. Robert G. Peluso
Mine Safety and Health Administration
4800 Forbes Avenue
Pittsburgh, PA 15213

Dear Mr. Peluso:

We received on May 4, 1984, from MSHA investigator Joseph Tortorea 17 Ocenco Self-Contained Self-Rescuers which were used during the explosion at the Greenwich Collieries No. 1 mine on February 16, 1984. A thorough inspection of each of the apparatus provided the information contained in the enclosed table. We found that most of the apparatus sustained damage of some sort including shifted oxygen bottle bands, cracked outer cases, dented CO_2-absorbent canisters and LiOH (lithium hydroxide) in the breathing bag and mouthbit. In the cases where LiOH was found in the breathing circuit, damage to the apparatus was obvious. It would be difficult to say for certain whether the damage occurred to the apparatus before, during, or after use, but we have seen similar damage on other apparatus while still in their cases. If the damage occurred before use, while the units were still in their cases, then the apparatus which showed shifted oxygen bottle bands and cracked cases, which are more obvious than dented canisters, should have been removed from service. There were twelve units where the damage should have been obvious before the case was opened.

The testimonies of the 12 miners who used some of the apparatus for actual escape showed that some problems were experienced with opening the apparatus cases, with the demand valve, and one complaint of the apparatus burning the user's tongue and lips. The apparatus apparently were wrapped with duct tape to keep the foil seals over the latch-release rod intact. This, of course, made the opening procedure more difficult and time consuming. In addition, there was some difficulty in pulling the two halves of the case apart. While the case halves are very tightly sealed, we feel that better training would solve the latter problem.

With regard to the demand valve, there were many complaints to the effect that the user "couldn't get enough air." Since these complaints occurred when the user was breathing heavily, we can be certain that the problem is with the demand valve which requires a rather high negative pressure to elicit an adequate quantity of oxygen from the bottle. We have pointed out this problem in Bureau publications (RIs 8839 and 8876) and to NIOSH, MSHA and the manufacturer for some time. Unfortunately, 30 CFR 11, which does cover demand valve activation pressure for open-circuit apparatus, omits a similar requirement for closed-circuit apparatus, such as the Ocenco EBA 6.5. We feel that as long as training makes it clear just what to expect from the apparatus, there will be no problem; however, if a user is unaccustomed to breathing apparatus in general and has never worn the apparatus, he might well think that the apparatus is malfunctioning and remove it. If this occurs in an irrespirable atmosphere, the user will be in trouble.

Several excerpts from the testimonies which detail these complaints are included.

One miner complained that his lips and tongue were burned from the SCSR. It would be impossible for the apparatus to have heated up this quickly so we must interpret the word 'burn' to mean something other than irritation from high temperature. It is possible that this miner could have inhaled some LiOH from the apparatus if he used one of the apparatus in which we found LiOH in the breathing circuit. We have not been able to determine which miner used which apparatus. As earlier stated, the apparatus which had LiOH in the circuit were obviously damaged and this damage very possibly occurred before use. In this case, which we have seen before, the apparatus should have been removed from service.

We found one apparatus which had a demand valve requiring an even greater negative pressure to activate than normal which is already very high. This apparatus (#2E031615) had a shifted bottle band. Anyone wearing this apparatus would have been limited in their work rate. Another apparatus (#2E031682) had a constant oxygen flow rate below its rated value but this would mean only that the demand valve would be activated more frequently. This may have had the effect of tiring the wearer given the effort required to activate the demand valve. This apparatus had a shifted bottle band and a cracked case.

We can conclude from our inspection of the apparatus and study of the testimonies that problems arose in the use of the SCSRs for three reasons: 1) The apparatus were wrapped with duct tape which delayed opening of the cases. This should not be permitted; 2) Some of the miners took outside breaths while wearing the apparatus because they felt they could not get enough air. This is due primarily to lack of actual-use/training which we feel would solve the problem; 3) Most of the apparatus had sustained damage significant enough to require removal from service if it occurred before use. This is not without precedent and we recommend strongly that inspection procedures be tightened. This would have prevented such situations where LiOH was found in the breathing circuit and a demand valve was damaged.

George R. Bockosh

George R. Bockosh
Research Supervisor, IS&TS

Greenwich Collieries
Ocenco EBA 6.5 SCSR Inspection Results

Serial Number	O_2 Gage	Visible Damage: Shifted Bottle Band	Cracked Case	Dented Canister	LiOH	No Damage	O_2 Flow Rate L/Min.
2E031531	1900 psi	X		X			1.56
2E031615	2850	X		X -	X -		1.75
2E031682	2400	X	X	X -			1.21
2E032087	0			X -			1.70
2F036123	0	X +					1.80
2F036546	2200	X +	X	X -			1.70
2F039368	2300	X -	X	X -			1.77
2F039372	2550	X	X	X	X		1.72
2F039404	2800				X -	X	1.76
2F039478	2400					X	1.77
2F039512	2050		X				1.74
2F039536	2400	X +	X	X +	X +		1.69
2F039713	2300			X -			1.68
2F039723	2200		X	X -			1.67
2F039961	2950	X	X	X +	X +		1.81
2F039999	2550	X		X			1.58
2K066555	3100					X	1.87
TOTAL		10	8	12	5	3	

Judgemental Qualifiers

X + = Significant

X - = Slight

The modifiers + and - are strictly subjective and are meant to give more information regarding the severity of damage or the extent of occurrence of an item.

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

NIOSH Reference: 5072

Centers for Disease Control
National Institute for Occupational
Safety and Health – ALOSH
944 Chestnut Ridge Road
Morgantown, WV 26505–2888

July 24, 1984

Mr. Pat Droppleman
Ocenco, Incorporated
400 Academy Drive
Northbrook, IL 60062

Dear Mr. Droppleman:

This letter is in reference to the visit of Samuel Terry to your facility on July 23, 1984. Mr. Terry was investigating the cause of an apparent defect in an Ocenco EBA 6.5 self-contained self rescuer, reported by a miner who used the self rescuer during an explosion at the Greenwich Collieries No. 1 Mine on February 16, 1984.

Mr. Terry has reported that Ocenco identified the defect as incorrect assembly of the check valve system, which prevented passage of oxygen to the breathing bag during use of the self rescuer. In view of the critical nature of this defect, we request that you immediately take the following actions:

1. Institute 100% inspection for this possible problem,

2. Review your quality control records to determine how many units were rejected for this cause, and

3. Obtain at least 30 EBA 6.5 self-contained self rescuers, with serial numbers close to that of the defective self rescuer, and disassemble those devices to determine if the defect is present.

Please provide us with a report on your findings by August 24, 1984. Following receipt of your report, we will determine our further action on this matter.

Sincerely yours,

John B. Moran
Director
Division of Safety Research

United States Department of the Interior

BUREAU OF MINES

PITTSBURGH RESEARCH CENTER
COCHRANS MILL ROAD
POST OFFICE BOX 18070
PITTSBURGH, PENNSYLVANIA 15236

July 27, 1984

Mr. Robert G. Peluso
MSHA
4800 Forbes Avenue
Pittsburgh, PA 15213

Dear Mr. Peluso:

This is a follow-up to a previous letter to you dated June 27, 1984, which detailed our findings on the 17 Ocenco EBA 6.5 self-contained self-rescuers which were used in the Greenwhich Collieries No. 1 Mine on February 16, 1984. It concerns the apparatus number 2E031615 which exhibited extraordinarily high negative pressure to open the demand valve. We took the apparatus to Ocenco, Inc. headquarters in Northbrook, Illinois on July 23, 1984 in order to have them verify that the apparatus was out of spec and to determine what the problem was. Nicholas Kyriazi of the Bureau and Sam Terry of NIOSH attended for the government.

We found that the problem was caused by reversed check valves in the mouthbit. The demand valve was not at fault; it required extra effort to open the demand valve because of the flow path reversal. It seems to be a quality control problem and NIOSH is working it out with Ocenco.

As far as use of the apparatus goes, it would have been possible to use the apparatus more or less normally until the oxygen consumption rate of the user rose above the constant flow rate of oxygen, in this case, approximately 1.75 lpm. At that point the user would have been severely limited in his activity and would have felt that he wasn't getting enough air. Since a number of users complained about this problem, it would be impossible to tell which one used the apparatus. The bottle pressure on the apparatus was at 2850 psi; since full pressure is between 2500 and 3000, we can tell that the apparatus was not used for an extended period.

Sincerely,

George R Bockosh

George R. Bockosh
Research Supervisor, IS&TS

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Appendix K

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Appendix K - Discussion and Evaluation of Potential Electrical Ignition Sources in the D-3 Entries.

Introduction

Since the directions of the explosion forces indicated that the explosion originated in the D-3 entries, MSHA investigators carefully examined and tested the electric circuits and equipment that were located in the D-3 entries for any evidence that the circuits and equipment provided the ignition source for the explosion. These examinations and tests were conducted by George M. Fesak, Electrical Engineer; Willis E. Cupp, Coal Mine Technical Specialist (Electrical); Gerald E. Davis, Coal Mine Safety and Health Inspector (Electrical); Paul Krivokuca, Coal Mine Safety and Health Inspector (Electrical); Ronald J. Gossard, Electrical Engineer; and Richard L. Reynolds, Electrical Engineer. MSHA personnel were assisted by personnel from the Pennsylvania Department of Environmental Resources, Office of Deep Mine Safety; officials and employees of the Pennsylvania Mines Corporation; and officials of the United Mine Workers of America. A detailed description and analysis of the examinations and tests of the D-3 electric circuits and equipment as well as other pertinent information provided by officials and employees of the Pennsylvania Mines Corporation follows.

D-3 Circuits and Equipment

The investigation revealed that the following electric circuits and equipment were present in the D-3 entries at the time of the explosion:

1. Approximately 1,500 feet of No. 2 AWG aluminum, 15 kV, three-conductor, mine power cable. The cable supplied 12,470-volt, three-phase power from a vacuum circuit breaker located in Main D near the mouth of the D-3 entries to a 400 kVA portable power center located in D-3.

2. A Line Power Manufacturing Company, 400 kVA, portable power center located in the No. 11 crosscut of D-3 between the L1 and B entries.

3. Approximately 450 feet of No. 4/0 AWG, 2,000-volt, three-conductor, type G-GC, portable power cable supplying 600-volt, three-phase power from the portable power center to a five-circuit distribution box.

4. A Hubbell Ensign, five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts.

5. Approximately 200 feet of No. 2/0 AWG, 2,000-volt, three-conductor, type G-GC, portable power cable supplying 600-volt, three-phase power from the distribution box to a Labour pump installation.

6. A Labour pump installation consisting of the following:

   (a) A Labour, 4- by 3-inch, centrifugal pump with a 100-horsepower, 575-volt, three-phase motor mounted on a flatcar and located in the L1 entry of D-3 near the No. 17 crosscut.

(b) A Jabco, Incorporated, full-voltage, magnetic starter located on the mine floor just inby the flatcar with the Labour pump.

(c) A mercury switch mounted on a check valve in the 6-inch discharge line for the Labour pump and connected to the Jabco starter with approximately 100 feet of No. 12/3, type SO cord.

7. Approximately 475 feet of No. 12/5, type SO cord supplying 600-volt, three-phase power from the distribution box to a Flygt pump installation.

8. A Flygt pump installation consisting of the following:

   (a) A Flygt Corporation, permissible, 5-horsepower, submergible pump located in the L1 entry of D-3 inby the No. 19 crosscut.

   (b) A Flygt Corporation, permissible, manual, pump starter located outby the Flygt pump.

   (c) Approximately 50 feet of No. 12 AWG, 7-conductor, permissible-pump cable connecting the Flygt pump to the starter.

9. A National Mine Service Company, battery-powered locomotive located in the L1 entry of D-3 in or near the No. 14 crosscut.

10. Three permissible electric cap lamps worn by Depto, Miller, and Parzatka.

11. A permissible methane detector on Depto's belt.

Except for the Flygt pump, the Flygt pump starter, the three cap lamps, and the methane detector, the electric equipment that was present in the D-3 entries at the time of the explosion was not approved by MSHA as permissible. Permissible equipment was not required in these instances because the equipment was not taken into or used inby the last open crosscut, in return air, or within 150 feet of pillar workings.

Examination of the five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts revealed that electrical arcing occurred in the distribution box when the explosion damaged the distribution box. The evidence of explosion-induced arcing in the distribution box indicated that the D-3 high-voltage cable, the 400 kVA portable power center, the No. 4/0 AWG portable power cable supplying the distribution box, and the distribution box were energized when the explosion occurred. MSHA investigators also concluded that the No. 2/0 AWG cable supplying the Labour pump installation was energized when the explosion occurred. MSHA investigators could not determine conclusively if the No. 12/5, type SO cord supplying the Flygt pump installation was energized when the explosion occurred.

High-Voltage Circuit and Equipment

The D-3 high-voltage circuit originated at a vacuum circuit breaker located in Main D near the mouth of the D-3 entries and supplied 12,470-volt, three-phase power to a 400 kVA, portable power center located in the D-3 entries.

Information gathered during the investigation indicated that the D-3 high-voltage circuit was energized and that the D-3 vacuum circuit breaker tripped when the explosion occurred. Consequently, MSHA investigators carefully examined and tested the D-3 high-voltage circuit and equipment to determine why the D-3 vacuum circuit breaker tripped and if a fault in the D-3 high-voltage cable or the high-voltage portion of the D-3 portable power center could have provided the ignition source for the explosion.

Vacuum Circuit Breaker

The D-3 vacuum circuit breaker (General Electric Company, Serial No. 4129, Company No. SB-28) contained a manually-operated, air-break switch and a vacuum circuit breaker equipped with a ground check monitor and relays designed to provide overcurrent, grounded-phase, and undervoltage protection for the D-3 high-voltage circuit.

Since the D-3 vacuum circuit breaker was located outside of the area affected by the explosion, it was not considered a potential ignition source. However, the condition of the D-3 vacuum circuit breaker was relevant in determining if the high-voltage circuit and equipment in the D-3 entries could have provided the ignition source for the explosion.

Examination and testing of the D-3 vacuum circuit breaker during the investigation revealed the following:

1. The manually-operated, air-break switch was in the closed (on) position.
2. The vacuum circuit breaker was in the open (off) position.
3. The manually-operated, circuit breaker control switch showed a red indicator.
4. The overcurrent, grounded-phase, and undervoltage relays were operative.
5. The ground check monitor would trip (open) the circuit breaker when the ground check circuit was interrupted.
6. The overcurrent and grounded-phase relays did not show targets.
7. The ground check monitor and undervoltage relays were not provided with targets.

The presence of the red indicator on the circuit breaker control switch indicated that the control switch was not used to manually trip the D-3 vacuum circuit breaker. The absence of targets on the overcurrent and grounded-phase relays indicated that the circuit breaker did not trip as a result of an overcurrent or grounded-phase condition in the D-3 high-voltage circuit. The fact that the Main D high-voltage circuit remained energized after the explosion occurred indicated that the circuit breaker did not trip as a result of an undervoltage condition. Consequently, MSHA investigators concluded that the D-3 vacuum circuit breaker tripped as a result of an open ground check monitor circuit.

High-Voltage Cable

The high-voltage circuit from the D-3 vacuum circuit breaker to the D-3 portable power center contained approximately 1,500 feet of No. 2 AWG aluminum, 15 kV, three-conductor, mine power cable. The high-voltage cable was installed in the L1 entry of D-3 and was originally supported from a messenger wire with cable hangers. The circuit contained two lengths of cable connected together by a cable coupler located near the No. 8 crosscut in D-3.

Examination and testing of the D-3 high-voltage cable during the investigation revealed the following:

1. The cable had been torn down from the messenger wire by the force of the explosion from the No. 7 crosscut inby.

2. The cable had been severed about 20 feet outby the high-voltage cable coupler located near the No. 8 crosscut. The inby end of the outby length of cable had been carried outby to the No. 6 crosscut by the force of the explosion. MSHA investigators carefully examined both ends of the break in the cable. No evidence of electrical arcing was observed on either end of the break in the cable indicating that the cable was not energized when the break occurred.

3. The cable had been damaged at a point just outby the No. 10 crosscut. The outer jacket had been cut, the ground check conductor had been severed, and some of the shielding drain wires around one of the phase conductors had been dislocated. The damage to the cable appeared to have occurred when the force of the explosion pulled the cable from a cable hanger. MSHA investigators cut the damaged section of cable open and observed no evidence of electrical arcing.

4. Insulation resistance measurements revealed that the entire high-voltage cable from the D-3 vacuum circuit breaker to the D-3 portable power center was free from ground faults.

Portable Power Center; High-Voltage Portion

A 400 kVA, portable power center (Line Power Manufacturing Company Model 400PC, Serial No. 1503, Company No. BT-212) was located in the No. 11 crosscut of D-3 between the L1 and B entries. The power center reduced 12,470-volt, three-phase power to 600-volt, three-phase power to supply a five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts.

Examination and testing of the portable power center during the investigation revealed the following:

1. The incoming high-voltage cable from the D-3 vacuum circuit breaker was connected.

2. The high-voltage feed-through receptacle was capped.

3. The manually-operated high-voltage disconnect switch was in the closed (on) position.

4. All three high-voltage fuses were intact.

5. The emergency-stop switch was in the closed (on) position.

6. There was no evidence of electrical arcing in the high-voltage portion of the power center.

7. Insulation resistance measurements revealed that the high-voltage portion of the power center was free from ground faults.

8. The power center was provided with 14 interlock switches: 6 under the top covers and 8 behind the side covers. Tests indicated that all of the interlock switches were properly connected in series with the incoming ground check conductor so that removal of a cover would interrupt the incoming ground check circuit and cause the D-3 vacuum circuit breaker to trip. At least six of the interlock switches were open when MSHA investigators examined the power center.

9. The power center had been damaged severely by the explosion.

The damage observed by MSHA investigators included the following:

1. Two of the three top covers had been blown off the power center. Five of the six bolts that originally fastened the covers to the power center were still in place. The bolts had pulled through the bolt holes in the covers.

2. The two glass observation windows (one for the high-voltage disconnect switch and one for the high-voltage fuses) had been broken and blown into the power center.

3. One surge arrester had been broken.

4. Two high-voltage phase conductors from the surge arresters to the disconnect switch had been pulled out of the pressure connectors on the surge arresters.

5. Two of the arcing contacts on the high-voltage disconnect switch had been bent and two of the insulating barriers had been broken.

6. Both insulators on one high-voltage fuse holder and the bottom insulator on another high-voltage fuse holder had been broken.

7. Both doors on the low-voltage end of the power center had been bent inward indicating that the doors were closed when the forces of the explosion reached the power center.

8. The top brace on the low-voltage end of the power center had been bent inward approximately 10 inches near the center of the brace.

9. The low-voltage circuit breaker panel had been bent inward approximately 18 inches at the top center of the panel.

10. One ground check monitor access door had been blown off and the ground check monitor panel had been broken loose from the frame of the power center.

11. Both lower braces in the transformer section had been bent into the enclosure. A weld on one of the braces had been broken.

The observed condition of the portable power center was consistent with the conclusion that the unit was energized when the explosion occurred. The physical damage to the power center indicated that the explosion originated outside of the power center and that the forces of the explosion approached the power center from both the L1 entry side (low-voltage end) and the B entry side (high-voltage end). (See photographs in Appendix N.)

Conclusions

After analyzing the information gathered during the investigation, MSHA investigators concluded the following about the D-3 high-voltage circuit and equipment:

1. The high-voltge circuit supplying the D-3 vacuum circuit breaker was energized when the explosion occurred.

2. The D-3 vacuum circuit breaker was closed when the explosion occurred.

3. The D-3 high-voltage cable and the high-voltage portion of the D-3 portable power center were energized when the explosion occurred.

4. The low-voltage portion of the D-3 portable power center was energized when the explosion occurred.

5. The D-3 vacuum circuit breaker tripped and deenergized the D-3 high-voltage cable and the D-3 portable power center when the forces of the explosion caused the interruption of the ground check circuit by blowing the covers off of the power center.

6. The damage to the D-3 high-voltage cable and the D-3 portable power center was caused by the explosion.

7. The D-3 high-voltage cable was severed near the No. 8 crosscut of D-3 after the cable was deenergized by the D-3 vacuum circuit breaker indicating that the forces of the explosion reached the No. 11 crosscut before they reached the No. 8 crosscut.

In summary, MSHA investigators concluded that neither the D-3 high-voltage cable nor the high-voltage portion of the D-3 portable power center provided the ignition source for the explosion.

Low-Voltage AC Circuits and Equipment

A low-voltage, ac circuit originated at the 400 kVA, portable power center located in the No. 11 crosscut of D-3 between the L1 and B entries and supplied 600-volt, three-phase power to a five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts. The five-circuit distribution box supplied 600-volt, three-phase power to a Labour pump installation located in the L1 entry of D-3 near the No. 17 crosscut and a Flygt pump installation located in the L1 entry of D-3 inby the No. 19 crosscut.

Examination of the five-circuit distribution box revealed that electrical arcing occurred in the distribution box when the explosion damaged the distribution box. The evidence of explosion-induced arcing in the distribution box indicated that the portable power center, the circuit supplying the distribution box, and the distribution box were energized when the explosion occurred. MSHA investigators also concluded that the circuit supplying the Labour pump installation was energized when the explosion occurred. MSHA investigators could not determine conclusively if the circuit supplying the Flygt pump installation was energized when the explosion occurred. MSHA investigators carefully examined and tested the D-3, low-voltage, ac circuits and equipment to determine if any of the circuits or equipment could have provided the ignition source for the explosion.

Portable Power Center; Low-Voltage Portion

The D-3 portable power center contained three, 600-volt, three-phase receptacles: "A," "B," and "C." The "A" receptacle was labeled with a brass tag marked "DIST BOX FOR A-70." The "B" receptacle was labeled with a brass tag marked "DIST BOX." The "C" receptacle was labeled with a brass tag marked "5 TON CHARGER." The power center also contained one 240-volt, single-phase receptacle and one 120-volt, single-phase, duplex receptacle.

The supply cable for the distribution box that was located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts was not connected to the portable power center when MSHA investigators examined the power center during the investigation. However, evidence of explosion-induced electrical arcing in the distribution box indicated that the cable was connected to the "A" receptacle on the portable power center at the time of the explosion. Most likely, the cable for the distribution box was disconnected from the power center during the recovery operations following the explosion. MSHA investigators did not observe any other cables that could have been supplied from the portable power center at the time of the explosion.

The portable power center contained four, three-pole, molded-case circuit breakers. One circuit breaker was installed in the main 600-volt, three-phase, secondary circuit of the power transformer and one circuit breaker was installed for each of the three, 600-volt, three-phase receptacles on the power center. The main circuit breaker was equipped with devices to provide backup overcurrent, grounded-phase, and undervoltage protection for the three, 600-volt, three-phase circuits that could be supplied from the power center. The other circuit breakers were equipped with ground check monitors and devices to provide overcurrent, grounded-phase, and undervoltage protection for the three receptacle circuits.

All four, three-pole circuit breakers were in the tripped position when MSHA investigators examined the portable power center during the investigation. However, evidence of electrical arcing in the distribution box indicated that the main and "A" circuit breakers were closed (on) when the explosion occurred.

Since the portable power center was not permissible, arcing caused by a fault within the power center or by manual or automatic operation of one of the circuit breakers, relays, and switches in the power center could have released sufficient energy to ignite an explosive methane-air mixture. MSHA investigators found no evidence of a short circuit or ground fault in the low-voltage portion of the portable power center. The locations of the miners in the D-3 entries when the explosion occurred indicated that none of the miners was in a position to operate any of the circuit breakers or switches in the power center. Examination of the distribution box that was supplied from the portable power center revealed evidence of multiple faults that occurred when the forces of the explosion damaged the distribution box. These faults may have caused automatic operation of the main and "A" circuit breakers in the portable power center. However, since the faults occurred when the forces of the explosion damaged the distribution box, both circuit breakers had to have been closed when the explosion originated. Consequently, arcing from the automatic operation of the circuit breakers in the power center could not have provided the ignition source for the explosion.

In summary, MSHA investigators concluded that the low-voltage portion of the portable power center did not provide the ignition source for the explosion. MSHA investigators also concluded that the explosion originated inby the location of the portable power center (No. 11 crosscut) since the forces of the explosion damaged the distribution box before they damaged the power center and caused interruption of the incoming high-voltage circuit.

No. 4/0 AWG Cable

Approximately 450 feet of No. 4/0 AWG, 2,000-volt, three-conductor, type G-GC, portable power cable was installed to supply 600-volt, three-phase power from the 400 kVA portable power center to a five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts. The cable was installed in the L1 entry of D-3 and was originally supported from roof supports with insulated cable hangers. Evidence of explosion-induced arcing in the distribution box supplied by the cable indicated that the cable was energized when the explosion occurred.

Examination and testing of the No. 4/0 AWG cable during the investigation revealed the following:

1. The entire length of cable had been torn down from the cable hangers by the force of the explosion.

2. The cable had been pulled out of the strain-relief fitting on the distribution box approximately 2 inches when the force of the explosion moved the distribution box inby. This damaged the insulation on the black phase conductor and caused a phase-to-ground fault in the strain-relief fitting. Evidence of electrical arcing (melted metal) was present on the black phase conductor and on the inside of the fitting. The arcing was more severe than would be expected from a single phase-to-ground fault on a resistance grounded system indicating that one or both of the other phase conductors were grounded when the fault occurred. (See following section.)

3. There was no evidence of electrical arcing in the cable plug on the outby end of the cable.

4. During the investigation, a major roof fall occurred at the intersection of the L1 entry and the No. 13 crosscut preventing MSHA investigators from examining this portion of the cable. Examination of the remainder of the cable revealed no evidence of a short circuit or ground fault.

5. Continuity tests indicated that all conductors in the cable were continuous from the cable plug at the portable power center to the distribution box.

6. Insulation resistance measurements indicated that the red and black phase conductors in the cable were free from short circuits and ground faults. However, the measurements indicated low resistance (1,000 ohms) from the white phase conductor to the grounding conductors in the cable. MSHA investigators determined that the cause of the low resistance reading was a poorly insulated splice in the cable near the No. 12 crosscut. Friction tape that had been used to reinsulate the white phase conductor had drawn moisture resulting in the low measurement.

Removal of the friction tape resulted in a satisfactory insulation resistance measurement on the white phase conductor. There was no evidence of electrical arcing in the poorly insulated splice.

MSHA investigators concluded that the phase-to-ground fault in the strain-relief fitting on the distribution box was caused by the explosion. In summary, MSHA investigators concluded that the No. 4/0 AWG cable did not provide the ignition source for the explosion.

Five-Circuit Distribution Box

A five-circuit distribution box (Hubbell Ensign Class 1400, Serial No. 460047405, Company No. LD-17) was located in the L1 entry of D-3 approximately 62 feet inby the No. 15 crosscut. The distribution box was installed to provide electrical protection for two, 600-volt, three-phase circuits: one supplying a Labour pump installation and the other supplying a Flygt pump installation.

The distribution box contained five, 600-volt, three-phase receptacles ("A," "B," "C," "D," and "E"). Each receptacle circuit was protected by an individual, three-pole, molded-case circuit breaker. The circuit breaker for the "A" receptacle was rated 225 amperes. The circuit breakers for the "B," "C," "D," and "E" receptacles were each rated 50 amperes. Each circuit breaker was equipped with a ground check monitor and devices to provide overcurrent and undervoltage protection for the receptacle circuit.

Examination of the five-circuit distribution box during the investigation revealed the following:

1. The distribution box had been rotated approximately 180 degrees about its vertical axis, turned on its back, and moved approximately 4 feet inby its original location by the explosion forces.

2. The No. 4/0 AWG cable from the 400 kVA portable power center was connected to the distribution box. However, the cable had been pulled out of the strain-relief fitting on the distribution box approximately 2 inches when the explosion forces moved the distribution box inby. (See photograph in Appendix N.) This damaged the insulation on the black phase conductor and caused a phase-to-ground fault in the strain-relief fitting. Evidence of electrical arcing was present on the black phase conductor and on the inside of the fitting.

3. The emergency stop switch was in the open (off) position.

4. All five circuits breakers were in the tripped position.

5. The "A" receptacle and the "A" circuit breaker were labeled with brass tags marked "LB-1-7."

6. The plug on the outby end of the cable to the Labour pump installation was found approximately 8 feet inby the distribution box. The plug was labeled with a brass tag marked "LB-1-7" and was compatible only with the "A" receptacle on the distribution box. The nylon restraining rope had been pulled away from its attachment to the plug. The other end of the rope was still attached to the distribution box near "A" receptacle. Two of the pins in the plug had been bent. The bolts that once held the hinge plate to the top of the plug had been sheared off and the hinge plate was missing. The hinge pin and side latch on the receptacle had been bent.

7. The plug on the outby end of the cable to the Flygt pump installation was still connected to the "B" receptacle on the distribution box. The plug was labeled with a brass tag marked "FL-1-49," the "B" receptacle was labeled with a brass tag marked "FL 149," and the "B" circuit breaker was labeled with a brass tag marked "FL-1-49."

8. Dust covers were in place on receptacles "C," "D," and "E." MSHA investigators did not observe any other cables that could have been supplied by the distribution box at the time of the explosion.

9. The distribution box had been severely damaged by the explosion.

The damage observed by MSHA investigators included the following:

1. The back cover had been bent in (approximately 5 inches at the center) and had been ripped off of the enclosure. Evidence of electrical arcing on the inside of the back cover indicated that the cover had contacted the center bus bar (white phase conductor) and the terminal used to connect the incoming red phase conductor to the bottom bus bar resulting in phase-to-ground faults involving the white and red phases. Evidence of electrical arcing also indicated that the back cover had pushed the three bus bars back to the extent that the bottom bus bar contacted a line-side stud on the "A" circuit breaker resulting in a phase-to-phase fault between the white and red phases.

2. The left side of the enclosure (facing the front) had also been bent in. Evidence of electrical arcing indicated that all three bus bars had arced to the left side of the enclosure.

3. The right side of the enclosure (facing the front) had also been bent in. Evidence of electrical arcing indicated that a screw through the side of the enclosure had contacted the bottom bus bar resulting in a phase-to-ground fault involving the red phase.

4. The left door had been bent in to the extent that it broke the operating handle for the "A" circuit breaker. A mark on the inside of the door indicated that the circuit breaker was in either the closed position or the tripped position when the door struck the handle. (See photograph in Appendix N.)

5. The hinge on the right door had been broken and the door had been pushed in past the sealing lip on the enclosure.

MSHA investigators concluded that the damage to the distribution box was caused by the static and dynamic pressures developed by the explosion. The distribution box enclosure was reasonably airtight since the doors and back cover were provided with foam rubber gaskets. The static overpressure would have exerted tremendous forces on the exterior surfaces of the enclosure until the interior and exterior pressures equalized. The deformations observed in the exterior surfaces of the enclosure were consistent with the effects of an explosion on a reasonably airtight enclosure of the size and construction of the distribution box. The dynamic pressure developed by the explosion could also be expected to move the distribution box and thereby place strain on the incoming cable.

It is evident that the distribution box was energized when the explosion occurred. Evidence of electrical arcing in the distribution box indicated that multiple faults occurred when the static and dynamic forces developed by the explosion damaged the insulation on the incoming black phase conductor and deformed the enclosure to the extent that the clearances around the energized bus bars were eliminated. Since the distribution box was energized, the emergency stop switch must have been closed (on) when the explosion occurred. Most likely, the explosion forces opened the emergency stop switch.

The limited damage caused by electrical arcing at the fault locations indicated the circuit was deenergized shortly after the faults occurred. This could have happened when the circuit breaker in the portable power center tripped as a result of the faults in the distribution box, when the emergency stop switch opened, or when the D-3 vacuum circuit breaker tripped as a result of explosion damage to the portable power center.

The damage to the plug and receptacle for the cable to the Labour pump installation indicated that the plug was connected to the receptacle when the explosion occurred. MSHA investigators believe that the explosion forces pulled the plug from the receptacle and caused the damage to the plug and receptacle.

The mark on the inside of the left door on the distribution box indicated that the "A" circuit breaker was in either the closed position or the tripped position when the explosion occurred. However, MSHA investigators found no evidence of a fault in the Labour pump circuit that could have caused the circuit breaker to trip. (See following sections.) Consequently, MSHA investigators concluded that the circuit breaker was closed and the cable to the Labour pump installation was energized when the explosion occurred. MSHA investigators could not determine conclusively the position of the "B" circuit breaker when the explosion occurred.

MSHA investigators collected a dust sample from the distribution box enclosure. The sample was analyzed by the MSHA Bruceton Safety Technology Center. The analysis revealed a trace of coke confirming that flame was present at the distribution box. The analysis result is reported in Appendix H.

Since the distribution box was not permissible, arcing caused by a fault in the distribution box or by manual or automatic operation of one of the circuit breakers, switches, and relays in the distribution box could release sufficient energy to ignite an explosive methane-air mixture. Except for the faults that were caused by the explosion, MSHA investigators found no evidence of a short circuit or ground fault in the distribution box. The locations of the miners in the D-3 entries when the explosion occurred indicated that none of the miners was in a position to operate any circuit breakers or switches in the distribution box. Examination and testing of the circuits and equipment supplied from the distribution box revealed no evidence of a fault that could have caused automatic operation of one of the circuit breakers or relays in the distribution box. The effects of the explosion forces on the distribution box also indicated that the explosion did not originate in the distribution box. In summary, MSHA investigators concluded that the distribution box did not provide the ignition source for the explosion.

No. 2/0 AWG Cable

Approximately 200 feet of No. 2/0 AWG, 2,000-volt, three-conductor, type G+GC, portable power cable was installed in the L1 entry of D-3 to supply 600-volt, three-phase power from the five-circuit distribution box to the Labour pump installation located in the L1 entry near the No. 17 crosscut. Examination of the five-circuit distribution box indicated that the cable was energized when the explosion occurred.

Examination and testing of the No. 2/0 AWG cable during the investigation revealed the following:

1. The plug on the outby end of the cable was found approximately 8 feet inby the five-circuit distribution box. However, damage to the plug and the "A" receptacle on the distribution box indicated that the plug was connected to the "A" receptacle when the explosion occurred.

2. Waterline marks on the ribs indicated that the cable was submerged in water from the No. 16 crosscut inby during the flooding that occurred after the explosion.

3. There was no evidence of electrical arcing in the cable plug on the outby end of the cable or at the terminations in the Jabco magnetic starter on the inby end of the cable.

4. Examination of the entire length of cable revealed no evidence of a short circuit or ground fault.

5. Continuity tests indicated that all conductors in the cable were continuous.

6. Insulation resistance measurements indicated that the red and white phase conductors were free from short circuits and ground faults. However, the measurements indicated that the black conductor was faulted to the grounding conductors in the cable. The fault was located at a damaged place in the cable about 40 feet from the inby end of the cable. The cable jacket was not punctured; however, the insulation on the black phase conductor was broken. Separation of the damaged black phase conductor from the grounding conductors at this location resulted in a satisfactory insulation resistance measurement on the black phase conductor. There was no evidence of electrical arcing at the damaged place in the cable.

The absence of evidence of electrical arcing at the damaged place in the cable indicated that the damage occurred after the cable was deenergized. MSHA investigators concluded that the cable damage occurred as a result of the explosion or as a result of rough handling when the cable was removed from the mine during the investigation. In summary, MSHA investigators concluded that the No. 2/0 AWG cable did not provide the ignition source for the explosion either directly by electrical arcing at a fault or indirectly by causing automatic operation of the "A" circuit breaker in the five-circuit distribution box.

Labour Pump Installation

A Labour pump installation was located in the L1 entry of D-3 at the No. 17 crosscut. The installation consisted of the following:

1. A Labour Type LV, Serial No. PE10692-1, Company No. LB-1-7, 4- by 3-inch, centrifugal pump. The pump was driven by a 100-horsepower, 575-volt, three-phase motor. The pump and motor were mounted on a flatcar located in the L1 entry at the No. 17 crosscut.

2. A Jabco, Incorporated, Type FVP-60, Serial No. 5593, full-voltage, magnetic starter used to control the 100-horsepower, pump motor.

3. A mercury switch attached to the external arm of a check valve in the 6-inch discharge line for the Labour pump. The check valve was located in the L1 entry about 20 feet inby the No. 16 crosscut. The mercury switch was originally connected to the Jabco starter with approximately 100 feet of No. 12/3, type SO cord.

According to Pierce, the Labour pump was installed on or about December 13, 1983, to replace four smaller pumps. Pierce also stated that the pump starter was located on the mine floor on the right side of the track just inby the flatcar and that the mercury switch was connected into the pump starter to automatically shut down the pump if it went on air.

Examination and testing of the Labour pump installation during the investigation revealed the following:

1. The new 20-foot strainer was found installed on the inby end of the suction line for the Labour pump indicating that Depto, Miller, and Parzatka had been to the pump and had completed the job of changing the strainer. A used 10-foot old strainer was found near the pump. (See photograph in Appendix N.)

2. The 6-inch gate valve in the pump discharge line was halfway between the fully closed and fully opened positions. This valve was used to adjust the discharge head on the pump.

3. The 2-inch gate valve used to bleed the Labour pump was closed.

4. The 3-inch gate valve between the discharge line from the Flygt pump and the suction of the Labour pump was closed. This valve was opened only when the Flygt pump was used to prime the suction line for the Labour pump.

5. The flatcar was on the track with a skid under the right inby wheel. The flatcar had been moved inby approximately 10 feet by the force of the explosion. The fiberglass, discharge line had been broken off at the discharge flange on the pump. The fiberglass, suction line on the inby end of the flatcar had been smashed by the force of the flatcar moving inby. (See photographs in Appendix N.)

6. The installation was under water during the flooding that occurred after the explosion.

7. The 100-horsepower, induction motor had been damaged slightly by the explosion. The connection box cover on the motor appeared to have been struck by a force moving inby. The cover was gapped open about two inches. There was no evidence of electrical arcing inside the junction box. Insulation resistance measurements indicated low-resistance (800 ohms) from the motor stator windings to ground. The motor was removed from the mine, taken to the Main Complex Shop, and disassembled. Approximately 2 to 3 gallons of water drained from the motor when the rotor was removed. Close,visual examination revealed no evidence of electrical arcing on the motor stator and rotor windings. After drying the stator with a 1,000-watt heater for approximately 20 hours, insulation resistance measurements of the stator winding were repeated. The measurements increased to 30 megohms indicating that the stator windings were free from ground faults. MSHA investigators concluded that the initial, low insulation resistance readings were caused by the wet condition of the stator.

8. The cable from the pump starter to the pump motor had been pulled out of the strain-relief fitting on the starter approximately 12 inches by the force of the explosion. Otherwise, the cable had not been damaged by the explosion. Examination of the cable revealed no evidence of a short circuit or ground fault. Insulation resistance measurements confirmed that the cable did not contain a

short circuit or ground fault. Continuity measurements indicated that the phase conductors and grounding conductors in the cable were continuous.

9. The Jabco, Incorporated, magnetic starter for the Labour pump was labled with a brass tag marked "LB-1-7." The starter was found near the left inby corner of the flatcar.

10. The starter had been damaged by the explosion. The starter door had been knocked off and was found approximately 25 feet inby the starter on the left side of the entry. One corner of the starter enclosure had been bent in approximately 2 inches as though the corner had struck a solid object. The right side of the enclosure had been bent in approximately 1-1/2 inches. None of the other walls of the enclosure had been bent; however, the door had been bent out approximately 1-1/2 inches. The ammeter and voltmeter had been destroyed and pushed back into the enclosure. Both meter lenses had been broken; however, no glass was found inside the enclosure. The manual on/off control switch had also been pushed back into the enclosure. The overload relay block on the bottom of the linestarter had been broken and pulled to the right. This damage occurred when the cable to the pump motor was pulled out of the strain-relief fitting approximately 12 inches. The cord to the mercury flow switch had been pulled completely out of the starter.

11. The starter control circuit was found properly connected for manual control of the pump motor. The mercury flow switch had been connected in parallel with a spring-loaded, normally open, start switch. As connected, the pump was started by holding in the start switch until the pump produced sufficient water flow to close the mercury flow switch. Then the pump would continue to run until the water flow stopped or someone opened the molded case circuit breaker or the manual on/off control switch on the starter.

12. The molded case circuit breaker was found in the tripped position. However, the force of the explosion could have caused the circuit breaker to trip. All four control fuses in the starter were found intact. The manual on/off control switch was found in the closed (on) position. The normally open, spring-loaded, start switch was found in the open position.

13. No evidence of a short circuit or ground fault was found in the starter. Insulation resistance measurements confirmed that the starter did not contain a short circuit or ground fault.

14. The wiring near the top of the starter had been scorched indicating that flame had entered the enclosure.

15. The mercury flow switch consisted of a mercury switch attached with two hose clamps to the operating arm of a 6-inch check valve installed in the discharge line of the pump. The switch contacts had been connected in parallel with the normally open, spring-loaded, start switch in the pump starter. The switch contacts were enclosed in a sealed, plastic tube. The tube was not broken or cracked. The No. 12/3 type SO cord between the mercury flow switch and the starter had been pulled completely out of the starter. The entire length of cable was examined and no evidence of a short circuit was found.

16. MSHA investigators collected two dust samples from the pump installation; one from the starter door and one from inside the motor connection box. The samples were analyzed by the MSHA Bruceton Safety Technology Center. Both analyses revealed traces of coke confirming that flame was present at the pump installation. The analysis results are reported in Appendix H.

Earlier, MSHA investigators concluded that the No. 2/0 AWG cable supplying the Labour pump installation was energized when the explosion occurred. Except for the position of the circuit breaker in the pump starter, the electric controls and the valves at the pump installation were found in the proper positions for normal operation of the pump. The circuit breaker in the starter was found in the tripped position; however, the circuit breaker could have tripped when the force of the explosion hurled the starter inby. Depto, Miller, and Parzatka had completed the installation of the new strainer on the end of the pump suction line and were at least 250 feet outby the pump when the explosion occurred. Considering the water problem in D-3, it is likely that they restarted the pump before they left the installation. Although these factors are not conclusive, MSHA investigators believe that the pump was in operation when the explosion occurred.

Since the components of the Labour pump installation were not permissible, arcing caused by a fault in one of the components or by manual or automatic operation of the circuit breaker, linestarter, switch, or relays in the pump starter could have released sufficient energy to ignite an explosive methane-air mixture. However, MSHA investigators found no evidence of a short circuit or ground fault in any of the components of the pump installation. Since the pump motor does not arc during normal operation, MSHA investigators concluded that the motor did not provide the ignition source for the explosion. Since the mercury flow switch contacts were enclosed within a sealed, plastic tube, MSHA investigators concluded that arcing during the normal operation of the flow switch did not provide the ignition source for the explosion. The locations of the miners in the D-3 entries when the explosion occurred indicated that none of the miners was in a position to operate the circuit breaker or switches in the pump starter when the explosion occurred. If the pump was running and for some reason the water flow stopped, the starter would shut the pump down. If this happened, electrical arcing of sufficient energy to ignite an explosive methane-air mixture would occur when the linestarter opened the power circuit to the motor. Consequently, automatic operation of the pump starter was capable of providing the ignition source for the explosion. However, MSHA investigators could not determine conclusively whether or not the pump starter provided the ignition source for the explosion solely from the examinations and tests that were conducted on the pump starter.

No. 12/5, Type SO Cord

Approximately 475 feet of No. 12/5, type SO cord was installed in the L1 entry of D-3 to supply 600-volt, three-phase power from the five-circuit distribution box to the Flygt pump installation located in the L1 entry inby the No. 19 crosscut. MSHA investigators could not determine conclusively if the cord was energized when the explosion occurred.

Examination and testing of the No. 12/5, type SO cord during the investigation revealed the following:

1. The plug on the outby end of the cord was still connected to the "B" receptacle on the five-circuit distribution box.

2. Waterline marks on the ribs indicated that the cord was submerged in water from the No. 16 crosscut inby during the flooding that occurred after the explosion.

3. There was no evidence of electrical arcing in the plug on the outby end of the cord or in the Flygt manual starter on the inby end of the cord.

4. Examination of the entire length of the cord revealed no evidence of a short circuit or ground fault.

5. Insulation resistance measurements indicated that the black and white phase conductors were free from short circuits and ground faults. However, the measurements indicated low resistance (180 kilohms) from the red phase conductor to the grounding conductor in the cable. MSHA investigators determined that the low insulation resistance measurement was caused by two damaged places in the cord. At one damaged place, located approximately 3 inches from the strain clamp on the Flygt manual starter, the cord jacket and the insulation on the red (phase) and green (grounding) conductors had been cut. Examination of the damaged place indicated that the damage occurred during the investigation when the Flygt pump, Flygt pump starter, and the cord were moved to the No. 17 crosscut for examination. There was no evidence of electrical arcing in this damaged place in the cord. At the other damaged place, located approximately 137 feet outby the Flygt manual starter, the cord jacket and the insulation on the red phase conductor had been cut. There was no evidence of electrical arcing in this damaged place either. Water was present inside the cord at both damaged places. MSHA investigators measured satisfactory insulation resistance on the red phase conductor after drying the conductor out at the first damaged place and removing the second damaged place in the cord.

In summary, MSHA investigators concluded that the No. 12/5, type SO cord did not provide the ignition source for the explosion either directly or indirectly by causing automatic operation of the "B" circuit breaker in the five-circuit distribution box.

Flygt Pump Installation

A Flygt pump installation was located in the L1 entry of D-3 inby the No. 19 crosscut. The installation consisted of the following:

1. A Flygt Corporation Type DBF-75-GR, Serial No. 663849, Company No. FL-1-49, 5-horsepower, 575-volt, three-phase, submergible pump located inby the No. 19 crosscut. The pump had been approved by MSHA as permissible (Approval No. 2G-2658-A-1).

2. A Flygt Corporation Model 2051.080, Serial No. 5050, manual starter located near the No. 19 crosscut. The starter enclosure had been certified by MSHA as explosion proof (Certification No. X/P-1895).

3. Approximately 50 feet of No. 12 AWG, seven-conductor, permissible-pump cable connecting the pump to the starter.

The Flygt pump was connected into the suction line for the Labour pump with approximately 190 feet of flexible, plastic waterline. According to Pierce, Boucher, and Blazosky, the pump was not operated continuously but was operated only when it was necessary to prime the Labour pump. Since the starter for the Flygt pump was a manual type, the pump could have been controlled either by operating the circuit breaker in the starter or by operating the "B" circuit breaker in the five-circuit distribution box. MSHA investigators could not conclusively determine if the No. 12/5, type SO cord supplying the pump installation was energized when the explosion occurred. Nevertheless, the pump installation was examined and tested to determine if it could have provided the ignition source for the explosion.

Examination and testing of the Flygt pump installation during the investigation revealed the following:

1. Both the pump and the manual starter were labeled with brass tags marked "FL-1-49."

2. The 3-inch gate valve in the discharge line for the pump at the Labour pump installation was closed.

3. The circuit breaker in the manual starter was in the open (off) position.

4. The pump had not been damaged by the explosion. From the water level at the time of the investigation, MSHA investigators determined that the pump was entirely submerged in water at the time of the explosion. No permissibility deficiencies were observed on the pump. Insulation resistance measurements indicated that the pump motor windings were free from ground faults.

Resistance measurements indicted that the pump motor windings were not open or short circuited.

5. The manual starter had not been damaged by the explosion. However, the starter was found lying on the mine floor and submerged in water. The starter enclosure was provided with a screw-type cover. The cover was not secured against loosening and was not screwed on tight. The cover lacked about two threads of the minimum six-thread engagement specified by the manufacturer. When the cover was removed, the enclosure was found full of water. MSHA investigators found no evidence of electrical arcing or of an internal methane-air ignition in the enclosure. Both packing glands entering the enclosure were properly packed, tight, and secured against loosening.

6. The No. 12 AWG, seven-conductor pump cable had not been damaged by the explosion. Examination of the entire length of the cable revealed no evidence of a short circuit or ground fault. Insulation resistance measurements confirmed that the cable was free from short circuits and ground faults. Continuity measurements indicated that the phase conductors, grounding conductor, and ground check monitor conductor in the cable were continuous.

From the position of the gate valve in the pump discharge line and the position of the circuit breaker in the starter, MSHA investigators concluded that the Flygt pump was not in operation when the explosion occurred. In summary, MSHA investigators concluded that the Flygt pump installation did not provide the ignition source for the explosion.

Battery-Powered Equipment

The battery-powered equipment that was in the D-3 entries at the time of the explosion consisted of a battery-powered locomotive; three permissible electric cap lamps worn by Depto, Miller, and Parzatka; and a permissible methane detector on Depto's belt.

MSHA investigators carefully examined and tested the D-3, battery-powered equipment to determine if any of the equipment could have provided the ignition source for the explosion.

Battery-Powered Locomotive

During the recovery, a nonpermissible, 5-ton, battery-powered locomotive (National Mine Service Company Model 5TMEL, Serial No. 3354, Company No. L-49) was found on the D-3 track (L1 entry) just outby the No. 15 crosscut. One inby corner of the locomotive frame was resting on one of several roof-support rails that had fallen across the track. The inby, operator-side wheel was approximately 1 inch above the track. The other three wheels were resting on the track. (See photograph in Appendix N.)

Parzatka was found lying in the inby passenger compartment of the locomotive. Depto was found lying along the operator's side of the locomotive. Miller was found lying approximately 48 feet outby the locomotive at the No. 14 crosscut.

The locomotive was examined and tested by MSHA investigators both underground and on the surface at the Main Complex Shop. The examinations and tests revealed the following.

Brakes and Controls

The hydraulic brake was found in the released position. The mechanical brake was found in the released position. This brake could be used as a parking brake by pulling either of the two brake handles and dropping a latch in place to hold the handle in position. Both latches were found in the released position. A sprag that was also used as a parking brake was found in the raised position pointing outby. This was the normal position for traveling in the inby direction. (See photograph in Appendix N.)

The circuit breaker for the main power circuit from the battery was found in the tripped position. The control circuit fuse was continuous. The safe-off switch was found in the closed (on) position. This switch was used to turn the control power for the locomotive on and off and must be in the closed position to operate the locomotive. The switch for the inby headlights was found in the closed (on) position. The switch for the outby headlights was found in the open (off) position. The self-centering tram control lever was found in the centered (off) position. This tram control lever controlled both the acceleration and dynamic braking and also served as the directional control switch. The locomotive was not equipped with a separate directional control switch.

Damage

The damage to the locomotive included the following. The bulbs in both outby headlights had been smashed and debris had been blown into the enclosures. The loosely mounted outby headlight enclosure on the operator's side had been blown into the outby passenger compartment. The inby headlights were intact. All of the plastic reflectors on the locomotive had been exposed to heat. The condition of the reflectors indicated that the outby reflectors had been exposed to more heat than the inby reflectors. The outby sand box on the operator's side had been pushed inby, the mounting bolts had been sheared, the cover had been blown off, and the plunger assembly had been broken. The lid on the outby sand box opposite the operator's side had been bent inby and the lid hinge had been damaged. A pillow-block bearing for the outby sander linkage had been broken, apparently by a falling roof-support rail. The operating handle for the sanders had been bent down approximately 6 inches over the tram control lever.

Arcing Components

The following components produced electrical arcing during normal operation of the locomotive: three switches in the master control station, the switches in the tram control station, four contactors in the contactor panel, and the 18-horsepower, direct-current motor. In addition, the main circuit breaker would produce electrical arcing if it were opened manually under load or if it opened automatically as a result of an overcurrent condition.

None of the arcing components of the locomotive was in an explosion-proof enclosure. However, the enclosures for the master control station and tram control station were reasonably sealed with gasketed covers. There was no evidence of an internal methane-air ignition in either enclosure. In fact, the explosion had forced dust into the master control station through the cutouts in the gaskets for the switch handles and into the tram control station where the enclosure had been bent. (See photograph in Appendix N.)

The direct-current motor was designed to be watertight. The cover over the commutator was gasketed. Two watertight fittings were provided for the cable entrances to the motor. However, the bushings in the fittings did not seal around the two, single-conductor cables entering through each fitting. Also, there was an open 3/8-inch diameter hole through the motor enclosure. There was a heavy layer of dust in the bottom of the motor. Most of the dust appeared to be carbon dust from brush wear. There was no evidence of a methane-air ignition in the motor.

Both the contactor panel and the main circuit breaker were provided with loosely-fitting, metal covers. The contactor panel was located behind the outby passenger compartment on the operator's side of the locomotive. The cover for the panel had three sides and a top and fit loosely over the contactor panel. The cover was not designed to be bolted on and was found lifted up approximately 1/4 inch and moved inby approximately 1/4 inch. (See photograph in Appendix N.) There was also an opening of approximately 1 1/2 inches between the bottom edges of the cover and a 4-inch layer of mine dust on the floor of the locomotive. The circuit breaker was provided with a loosely-fitting, U-shaped, metal cover with cutouts for the line and load conductors and the circuit breaker handle. This cover was bolted on. Both the circuit breaker and the components of the contactor panel were coated with a moderate layer of dust. There was no visible evidence of a methane-air ignition in either enclosure. However, visible evidence of a methane-air ignition would not necessarily have been present due to the open construction of the enclosures.

Other Components

MSHA investigators carefully examined and tested the components of the locomotive that did not arc during normal operation for any evidence of a short circuit or other abnormal arcing that could have provided the ignition source for the explosion.

There was no evidence of electrical arcing on the inside of the battery-tray cover, battery-cell terminals, or intercell connections. Current measurements from the positive and negative battery terminals to the frame of the vehicle indicated that the battery was tracking to the frame. MSHA investigators believe, however, that the tracking was caused by dust, moisture, and battery acid that accumulated on the battery after the explosion.

There was evidence of electrical arcing on the metal cover for the main circuit breaker at the cutout for one of the line-side conductors to the circuit breaker. There was no corresponding evidence of arcing on the conductor indicating that the arcing occurred prior to the explosion before the present conductor was installed.

The locomotive was equipped with an ampere-hour meter to monitor the charge on the battery. There was a small, irregular hole in the plastic cover for the meter that had been made from the outside. A current-carrying strap from the external shunt on the meter to the internal meter movement had faulted to the metal frame of the meter. The strap had melted and was spattered throughout the inside of the enclosure. The meter was connected in series with the positive conductor from the battery. Resistance readings indicated that the negative circuit from the battery was not faulted to the frame of the vehicle. Consequently, MSHA investigators concluded that the fault in the ampere-hour meter occurred prior to the explosion.

Evidence of arcing was observed inside both inby headlight enclosures where the lamp terminals had faulted to the enclosures. There was no corresponding evidence of arcing on the lamp terminals indicating that the arcing occurred prior to the explosion before the present lamps were installed. There was no evidence of electrical arcing inside the outby headlight enclosures.

In addition to the contactor panel, the locomotive was provided with a solid state controller to control acceleration and deceleration. The controller was housed in a gasketed metal enclosure. There was no evidence of electrical arcing in the controller and the power fuse in the controller was intact. There was no evidence of an internal methane-air ignition in the controller enclosure. In fact, tracking on the enclosure cover indicated that the explosion forced dust past the gasket and into the enclosure.

The locomotive was equipped with a 550-volt, 3-phase, onboard battery charger. The input section of the battery charger was not energized when the explosion occurred. The output section, however, was connected to the battery. There was no evidence of electrical arcing in the output section of the battery charger and the output fuse was intact.

The locomotive was equipped with a dynamic braking resistor located under the outby end. There was no evidence of electrical arcing on the resistor.

Insulation resistance measurements indicated that the circuits and components of the locomotive were free from short circuits. After replacing the lamps in the outby headlights and charging the battery, the locomotive was operated in the Main Complex Shop. The locomotive operated normally. Electrical arcing was observed during the normal operation of the forward and reverse contactors on the locomotive.

Dust Samples

MSHA investigators collected 12 dust samples from various components of the locomotive. The samples were analyzed by the MSHA Bruceton Safety Technology Center. Three samples were too small to analyze. The samples from inside the motor enclosure and from the underside of the cover over the motor did not contain coke. The samples from the contactor panel cover, from the contactor panel surfaces, and from the main frame of the locomotive between the battery and the motor contained a trace of coke. The samples from the outby passenger compartment, from the outby coupler, from on and around the motor, and from on top of battery charger transformer contained a small amount of coke. The presence of coke in the dust samples confirmed that the locomotive was engulfed in flame. However, MSHA investigators do not believe that the samples conclusively indentify the locomotive as the ignition source due to the open construction of the locomotive and the locations where coke was found. The analyses results are reported in Appendix H.

Conclusions

The slope of the L1 entry of D-3 between the Nos. 13 and 15 crosscuts was approximately 4 percent. Considering this grade, it is very unlikely that the locomotive was left unattended without any of the parking brakes being set. Based on the above, and on the relative locations of Depto, Miller, and Parzatka, MSHA investigators concluded that Depto was at the controls of the locomotive when the explosion occurred. MSHA investigators also concluded that Parzatka was in the inby passenger compartment and Miller was either on the locomotive or near the locomotive when the explosion occurred.

Because the locomotive was not provided with a separate directional control switch, MSHA investigators were not able to determine conclusively the direction the locomotive was traveling immediately before the explosion. Since Depto, Miller, and Parzatka had completed the job of installing the new strainer, it is reasonable to assume that they were traveling outby when the explosion occurred. However, the position of the headlight switches and the sprag that was used as a parking brake indicated that the locomotive had been traveling inby, was traveling inby, or was about to travel inby when the explosion occurred.

Since the locomotive was not permissible, and since it contained several components that arced during normal operation, MSHA investigators concluded that the locomotive could have provided the ignition source for the explosion. However, MSHA investigators were not able to determine conclusively that the locomotive provided the ignition source for the explosion solely from the examinations and tests that were conducted on the locomotive. There was no conclusive evidence that a specific component of the locomotive provided the ignition source for the explosion. However, the contactor panel was the most likely ignition source on the locomotive. The loosely-fitting metal cover over the panel would permit methane to migrate readily into the panel. In addition, the contactors in the panel produced electrical arcing of sufficient energy to ignite an explosive methane-air mixture during normal operation of the locomotive.

Cap Lamps and Methane Detector

Three Koehler Manufacturing Company, permissible, electric cap lamps were recovered by MSHA investigators. The first cap lamp (Approval No. 6D-36, Company No. 70) was removed from Depto's belt and was missing the headpiece. The second cap lamp (Approval No. 6D-36-15, Company No. 179) was removed from Miller's belt and was also missing the headpiece. The third cap lamp (Approval No. 6D-36, Company No. 253) was removed from Parzatka's belt. This cap lamp was complete; however, the headpiece lens was broken.

A CSE, Incorporated, Model No. 102, Approval No. 8C-37-4, Serial No. 41425, permissible methane detector was also recovered by MSHA investigators. The methane detector was found inside its carrying case attached to Depto's belt indicating that it was not in use when the explosion occurred.

The cap lamp and methane detector were sent to the MSHA Approval and Certification Center for testing and evaluation to determine if one of the devices could have provided the ignition source for the explosion. Although two of the cap lamps were missing headpieces, the Center found no indication that the devices were not maintained in permissible condition. A summary of the results of the testing and evaluation of these devices is in Appendix L. A complete report on the testing and evaluation of these devices is on file at the MSHA Approval and Certification Center under Investigation No. X-163. Based on the Approval and Certification Center's findings, MSHA investigators concluded that neither the cap lamps nor the methane detector provided the ignition source for the explosion.

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Appendix L

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U.S. Department of Labor

Mine Safety and Health Administration
Industrial Park Road
RR1, Box 251
Triadelphia, West Virginia 26059

September 28, 1984

MEMORANDUM FOR: GEORGE M. FESAK
Electrical Engineer, Division of Safety
Coal Mine Safety and Health

THROUGH: ROBERT W. DALZELL
Chief, Approval and Certification Center

ROBERT E. MARSHALL
Chief, Division of Electrical Safety

FROM: CAROL M. BORING
Chief, Electrical Power Systems Branch

KENNETH A. SPROUL
Chief, Intrinsic Safety and Instrumentation Branch

SUBJECT: Report of investigation on equipment from Greenwich Collieries No. 1 (North) explosion.

Enclosed is a copy of the final report on the investigation of equipment recovered from a recent mine explosion at Greenwich Collieries No. 1 (North) in Indiana County, Pennsylvania. A permanent record of the investigation has been filed at the Approval and Certification Center under Investigation No. X-163.

If you need more information or clarification, you may contact Mr. William Savatt for information pertaining to the Euclid sequence switch, or Mr. Robert Bradburn for information on any of the other equipment.

SPECIAL INVESTIGATION X-163

Evaluation of equipment recovered from Greenwich Collieries No. 1 (North), Indiana County, Pennsylvania

Summary and Findings:

Twelve items of mine equipment, recovered from Greenwich Collieries No. 1 (North), following an explosion that took place in that mine on February 16, 1984, were investigated by the Division of Electrical Safety at the Approval and Certification Center. The investigation included preliminary and detailed inspections, comparisons with MSHA approval records to determine the permissibility of the equipment, performance tests, and, except as noted below, circuit evaluations and ignition tests to determine if the evaluated equipment was capable of causing an ignition of an atmosphere of explosive methane gas.

The individual items of equipment that were evaluated are compiled on the accompanying pages. The two volt-ohmmeters (Exhibits P-22 and P-23) and the three page phones (Exhibits P-54, P-58, and Z-1) were not evaluated for ignition hazards in accordance with instructions from Mr. George M. Fesak of the Division of Safety, MSHA Coal Mine Safety and Health.

Based on the inspections, evaluations, and tests performed, the findings of this investigation are summarized as follows:

1. No source of ignition of an external explosive methane atmosphere could be found in any of the equipment evaluated for methane ignition hazards.

2. There is no evidence that an explosion had taken place inside any of the evaluated equipment.

3. Four items of equipment (one electric cap lamp and three methane detectors) were identified as having been approved by MSHA.

4. Two items of equipment (cap lamp batteries, each with a missing headpiece) were identified as components of MSHA-approved units.

5. The remaining equipment (two volt-ohmmeters, three page phones, and a Euclid sequence switch) could not be identified as having been approved by MSHA.

6. The three page phones (Exhibits P-54, P-58, and Z-1), all of identical type, had no markings identifying their manufacturer.

7. The units, identified as being MSHA-approved (or components thereof), were found to have been constructed in accordance with the approval drawings on file at the Approval and Certification Center.

8. Two of the methane detectors (Exhibits P-15 and P-51) were capable, in their received condition, of detecting methane gas within the accuracy limits prescribed in 30 CFR, Section 22.7(d). The third methane detector (Exhibit P-52) was similarly capable, but only after charging the battery.

9. The electric cap lamp (Exhibit P-21) had a broken lens. However, the bulb was intact and its base was pushed away from the socket terminals indicating that the ejection mechanism worked effectively.

10. As a result of mechanical damage to the reflector positioning mechanism in the electric cap lamp (Exhibit P-21), one of the two filament circuits was short circuited in the headpiece resulting in that filament not working.

11. By the nature of the damage to the reflector positioning mechanism (Exhibit P-21), it is the investigator's conclusion that it resulted from the same impact that caused the lens to break.

12. Two of the evaluated page phones (Exhibits P-54 and Z-1) had discharged batteries and were non-functional as received. One of the page phones (Exhibit P-58) was in working order although its speaker volume was weak and the charge in one of its batteries was low.

A separate report describing the tests performed on the Euclid sequence switch is appended.

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Appendix M

UNITED STATES DEPARTMENT OF LABOR
Mine Safety and Health Administrtion

BRUCETON SAFETY TECHNOLOGY CENTER
Industrial Safety Division

Special Investigation: Koehler Flame Safety Lamps

Object: To determine if the lamps were capable of causing external ignitions of flammable concentrations of methane gas in air.

Introduction

Three flame safety lamps were taken from the Greenwich Collieries No. 1 Mine, Identification Number 36-02405, Cookport, Indiana County, Pennsylvania, during the post-explosion underground investigation conducted after February 16, 1984. Two series of tests were conducted to determine the effect of exposing the lighted lamps to increasing concentrations of methane and the effect of relighting the lamps in flammable concentrations of methane in air.

Description (All three lamps were manufacturered by Koehler)

Lamp No. 1 - DINO - recovered from Trolley Jeep parked in D-1, Received by Ron Gresh, Unique identifier - (9-REQ)

Lamp No. 2 - #7 - taken from continuous mining machine in D-5 Section, P-50 Exhibit number, Unique identifier - (J. Napolsky)

Lamp No. 3 - #8 - taken from roof bolting machine (RB-12) on D-5 Section, P-53 Exhibit number, Unique identifier - (T. Hilliard)

Test Procedures

The lamps were examined for defects prior to receipt by our laboratory. They were found to be free from defects and assembled in a permissible manner.

The first series of tests investigated the effect of subjecting a lighted lamp to an increasing concentration of methane. The lamps were lighted and the flame height adjusted to approximately 3/4-inch. The lamps were then placed in a small enclosure and methane gas was slowly admitted into the enclosure. A mixing fan was started to insure that a homogeneous mixture existed. Methane concentration was detected with a continuous infrared analyzer which sampled gas from the enclosure.

The second series of tests simulated a relighting operation in a flammable atmosphere of methane in air. To accomplish this, a specially constructed fuel fount is substituted for the fuel fount of the subject lamps. This fuel fount has its relighter assembly replaced with a nichrome electrode assembly encased in a ceramic tube attached with a 3/16-inch swagelock fitting at the base of the fount. The wick is also removed and a methane sampling line installed in its place. The base of the fount is sealed to prevent flame or gases from emanating from the inner chamber of the lamp (Figure 1). The lamp is placed in the gas zone and the concentration is steadily increased to the desired limits. When sampling lines inside and outside the lamp indicate that the concentrations have equalized, a small amount of energy is discharged through the electrodes inside the lamp chamber. This energy is generated by discharging a 30 microfared capacitor charged to approximately 190 volts through the electrodes within the lamp. The external body of flammable methane gas which surrounds the lamp could ignite if there is a defect in the lamp or if it is assembled improperly. The occurrence of an external ignition would result in the lamp being considered as a possible ignition source if a relighting operation were to take place in a flammable atmosphere of methane in air. The energy delivered by the spark is approximately 500 millijoules. After the spark ignites the body of gas within the enclosure, the concentration of methane is allowed to build back-up through the vacuum action of the sampling line within the lamp. When the concentrations have again stabilized, the test is repeated. Two tests are conducted for each of three methane concentrations.

Test Results

Series I

Test 1 - DINO marked on brass tag of lamp

Run 1: Flame elongated to above glass at 2.5% methane. When flame was above the glass, black smoke appeared out the top of lamp. Flame went out at 5.4%.

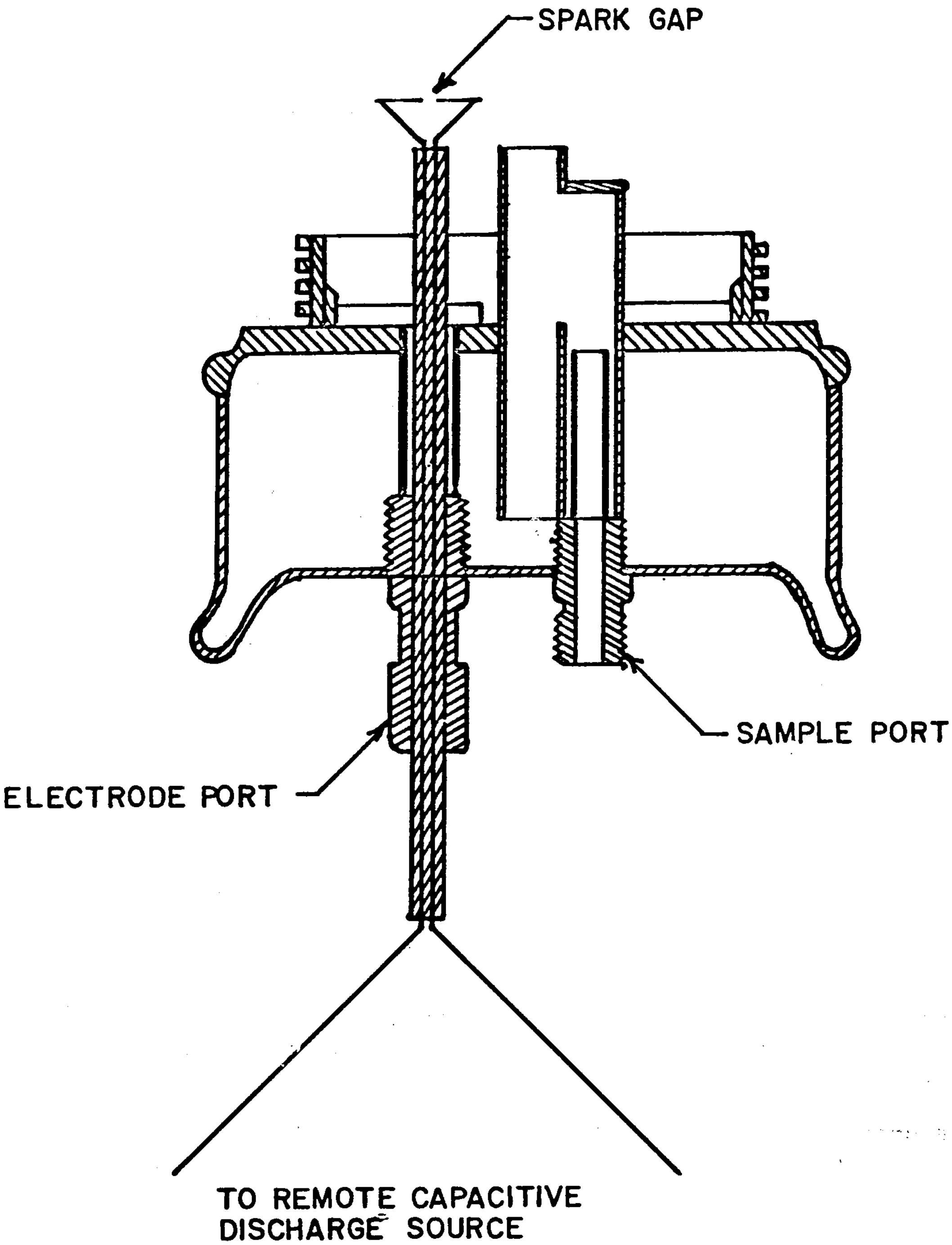
Run 2: Flame elongated to above glass at 3.7% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.3%.

Run 3: Flame elongated to above glass at 2.3% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.2%.

Test 2 - #7 marked on brass tag of lamp

Run 1: Flame elongated to above glass at 3.1% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.3%.

Run 2: Flame elongated to above glass at 2.4% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.2%.



SPECIALLY CONSTRUCTED FUEL FOUNT
FOR SIMULATED RE-LIGHTING EXPERIMENTS
SCALE: 1"=1" FIG. 1
5-3-84 TMF187

Run 3: Flame elongated to above glass at 2.3% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.1%.

Test 3 - #8 marked on brass tag of lamp

Run 1: Flame elongated to above glass at 3.3% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.1%.

Run 2: Flame elongated to above glass at 2.7% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.2%.

Run 3: Flame elongated to above glass at 3.1% methane. When flame was above the glass, black smoke appeared out the top of the lamp. Flame went out at 5.1%.

Tests Performed by Thomas M. Fircak, Steven J. Luzik, and Joseph Janosik.

Series II

Lamp	Test	% Methane	Results
DINO	1	7.1	Small internal ignition
DINO	2	7.2	Small internal ignition
DINO	3	8.1	Small internal ignition
DINO	4	8.2	Small internal ignition
DINO	5	9.1	Small internal ignition
DINO	6	9.2	Small internal ignition
#7	7	7.0	Small internal ignition
#7	8	7.1	Small internal ignition
#7	9	8.0	Small internal ignition
#7	10	8.1	Small internal ignition
#7	11	9.0	Small internal ignition
#7	12	9.1	Small internal ignition
#8	13	7.2	Small internal ignition
#8	14	7.2	Small internal ignition
#8	15	8.0	Small internal ignition
#8	16	8.0	Small internal ignition
#8	17	9.2	Small internal ignition
#8	18	9.1	Small internal ignition

Comments: No external ignitions were observed with any of the three lamps tested.

Tests Performed by Thomas M. Fircak and Steven J. Luzik.

Comments: The three flame safety lamps examined did not ignite surrounding flammable mixtures of methane in air under the given conditions of the two test series.

Report Prepared by Steven J. Luzik, Chemical Engineer

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Appendix N

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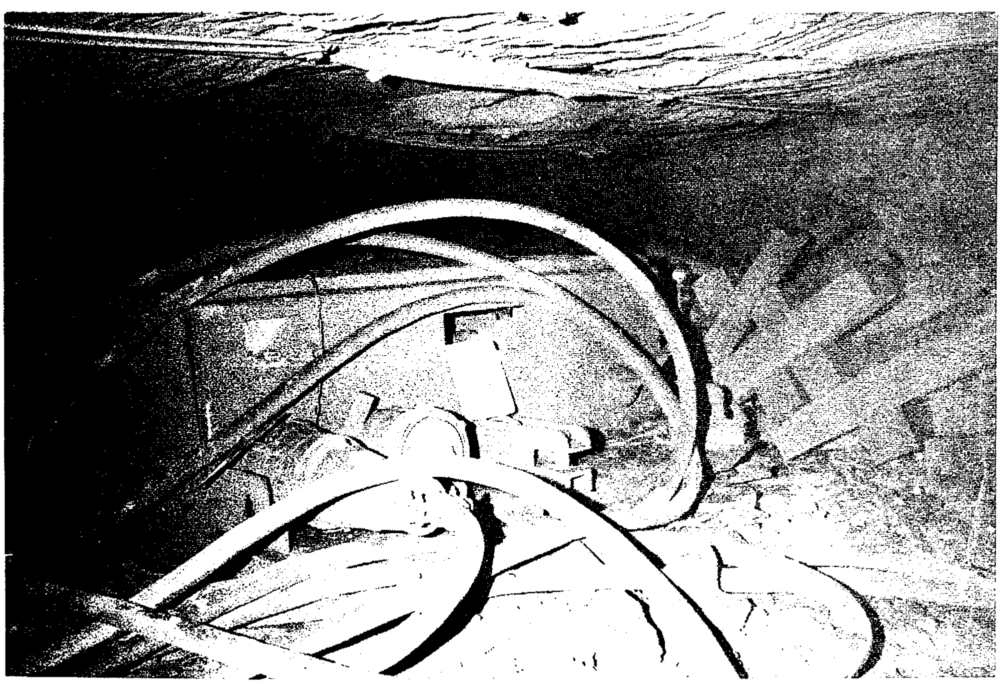
Appendix N - Selected Photographs Taken during the Investigation.

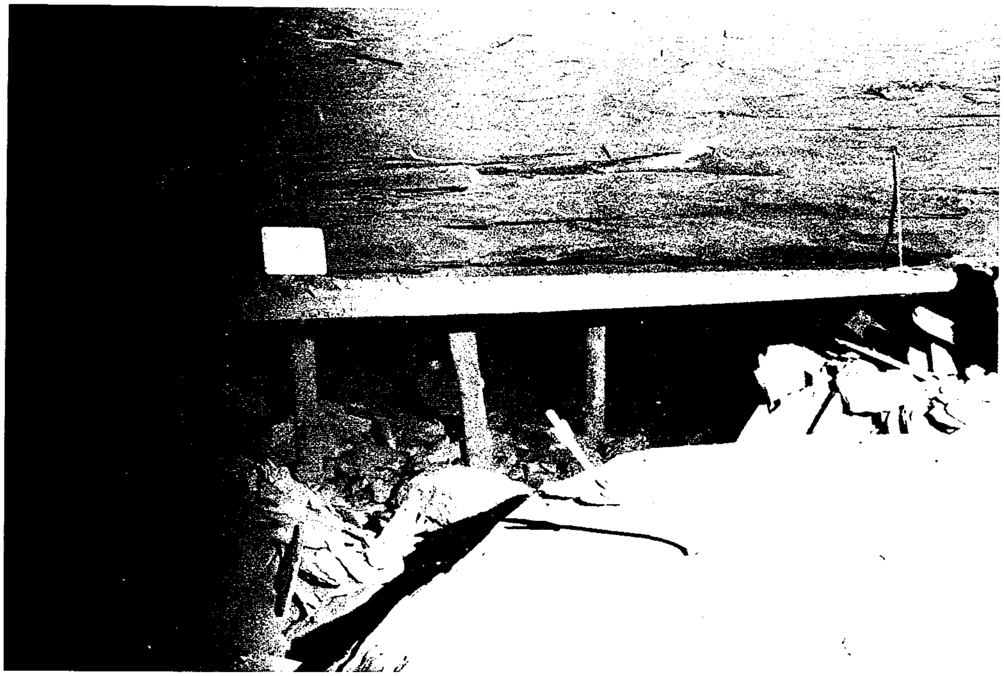
View in outby direction of damaged roof support in the B entry of D-3 at the No. 10 crosscut.



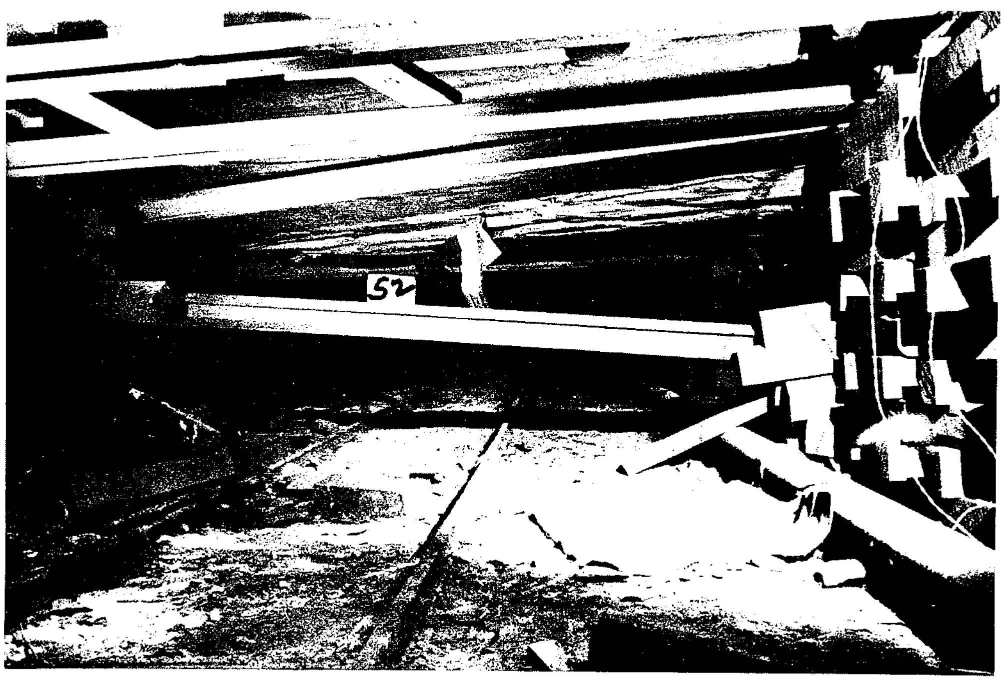
High-voltage end of the portable power center located in the No. 11 crosscut of D-3 between the L1 and B entries.

Low-voltage end of the portable power center located in the No. 11 crosscut of D-3 between the L1 and B entries.

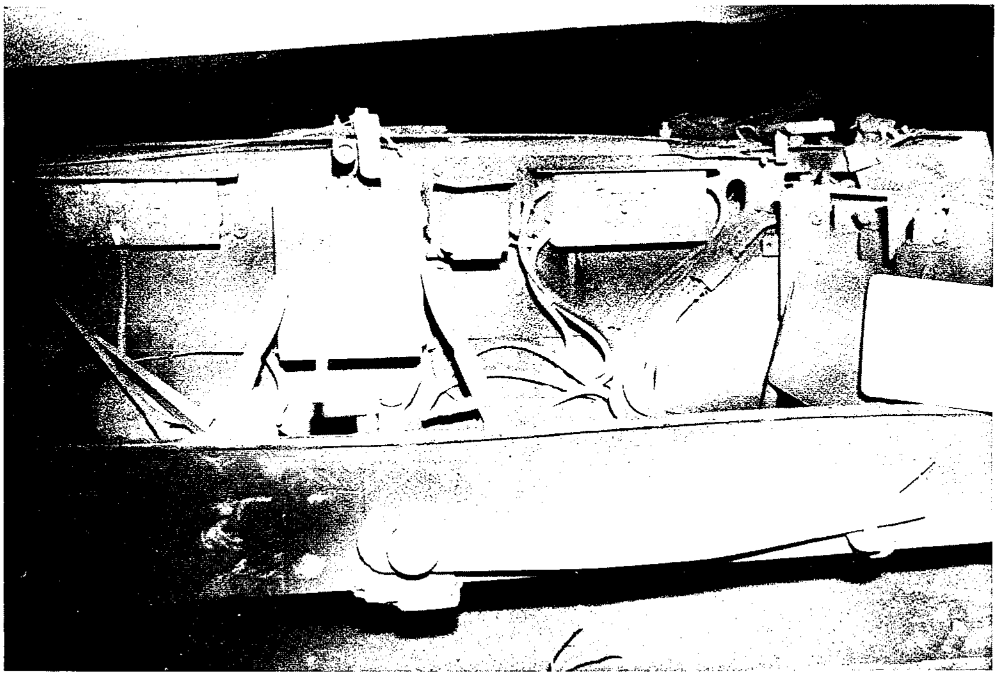
View in the outby direction of damaged roof support in the L1 entry of D-3 at the No. 12 crosscut.



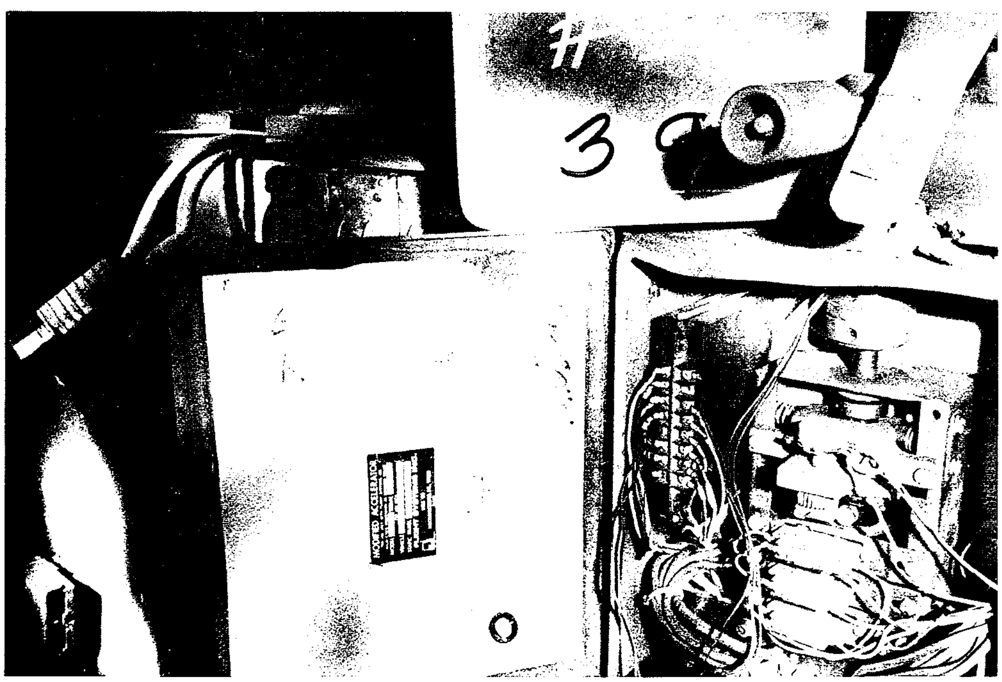
View toward the B entry of the fall and high intersection in the L1 entry of D-3 at the No. 13 crosscut.



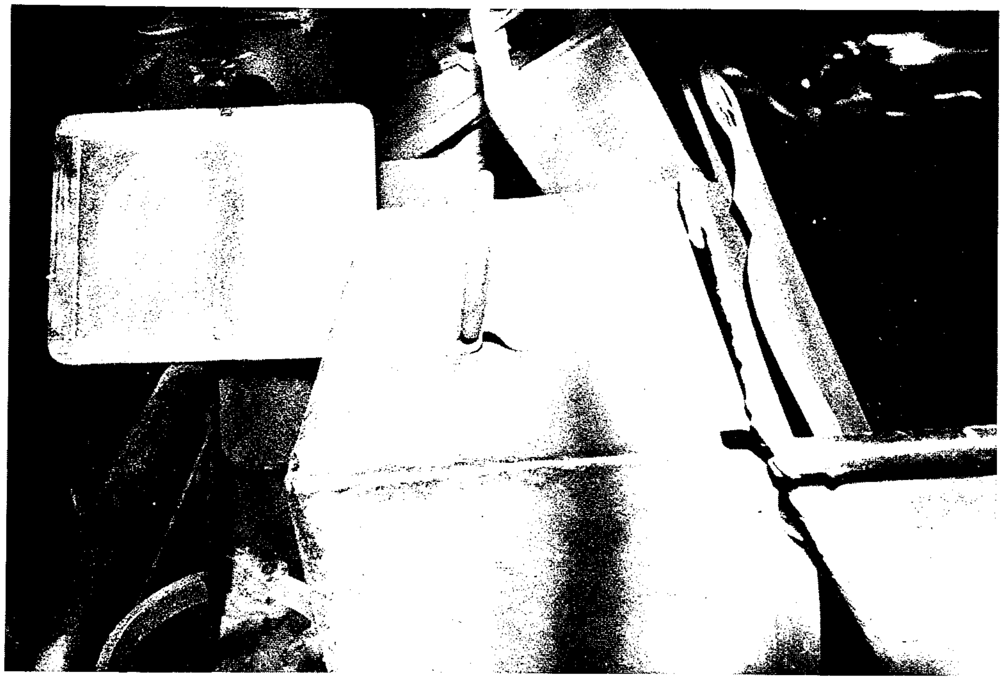
View in the inby direction of high intersection in the L1 entry of D-3 at the No. 14 crosscut.



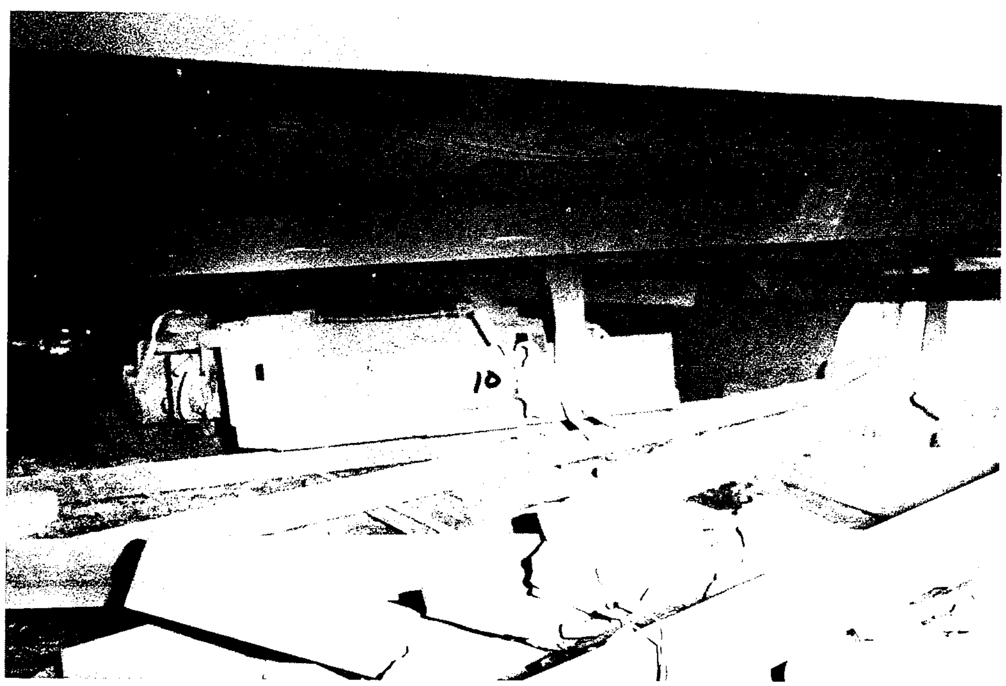
Operator's compartment of the battery-powered locomotive in the L1 entry of D-3 near the No. 15 crosscut.



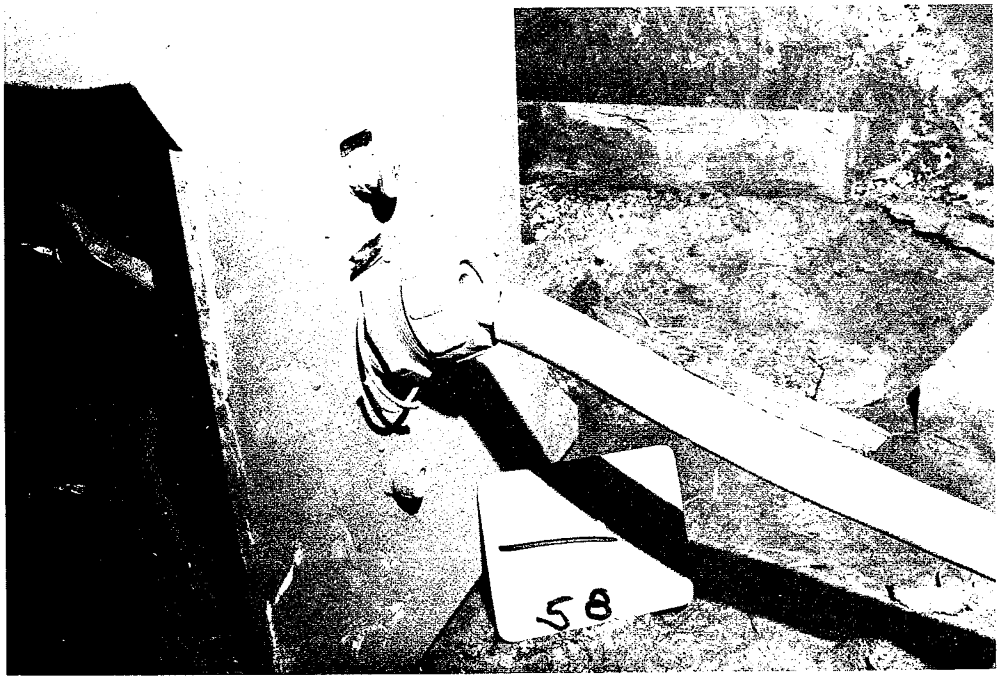
Tram control station on the battery-powered locomotive in the L1 entry of D-3 at the No. 15 crosscut.



Loosely-fitting metal cover over the contactor panel on the battery-powered locomotive in the L1 entry of D-3 at the No. 15 crossccut.

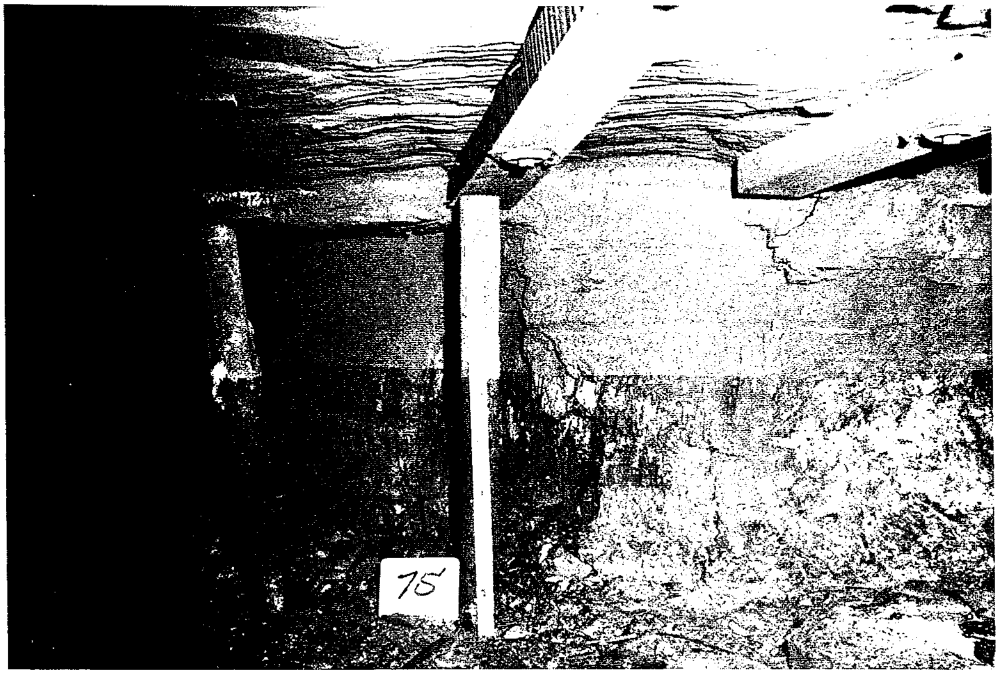


View in the outby direction of damaged roof support and inby end of locomotive in the L1 entry of D-3 at the No. 15 crosscut.

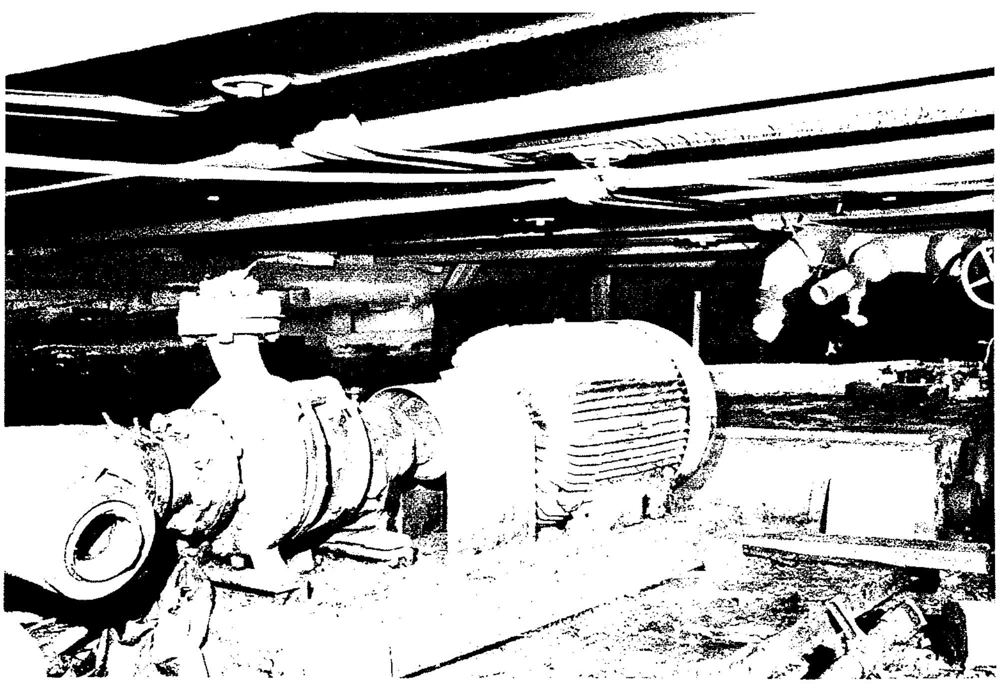


Left end of the five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts.

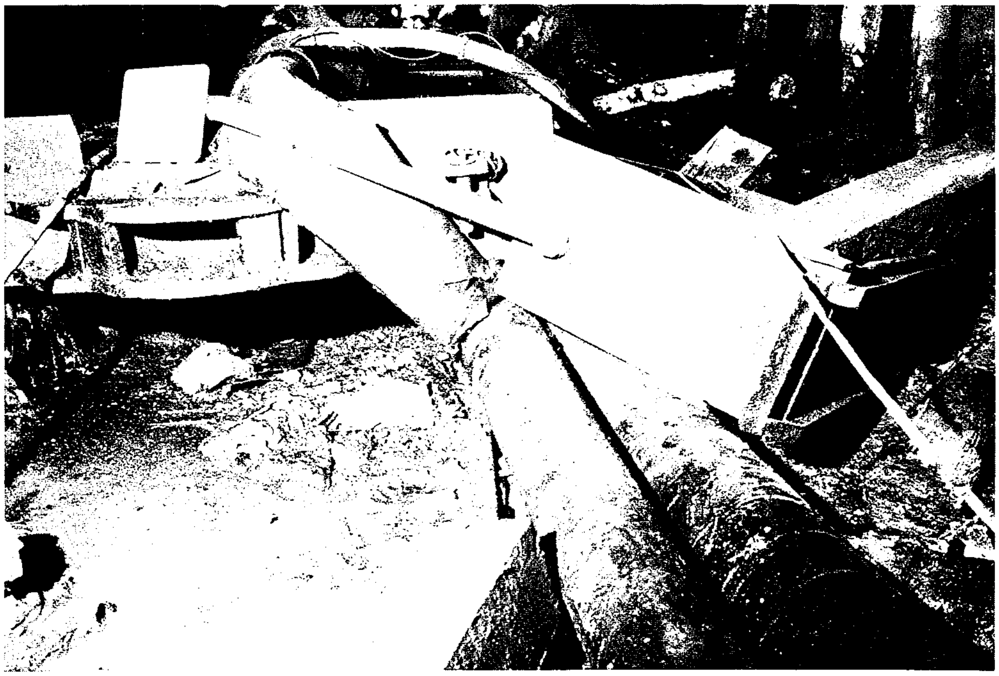
Front of the five-circuit distribution box located in the L1 entry of D-3 between the Nos. 15 and 16 crosscuts.



High water level line on rib near the Labour pump in the L1 entry of D-3 at the No. 17 crosscut.



View in outby direction of the flatcar-mounted Labour pump and both ends of broken discharge line in the L1 entry of D-3 at the No. 17 crosscut.



View in outby direction of the edge of the water, the inby end of the Labour pump flatcar, and the pump starter box (right center) in the L1 entry of D-3 just inby the No. 17 crosscut.

Part of the 10-foot strainer that the three victims removed from the intake line just prior to the explosion, located in the L1 entry of D-3 just inby the No. 17 crosscut.

Appendix O

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Mine Citation/Order

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

Appendix O

Section I—Violation Data

1. Type of issuance (check one): Citation ☐ Order ☒ Safeguard ☐
2. Date: 02 16 84 (Mo. Da. Yr.)
3. Time (24 hr. clock): 0700
4. Citation/Order Number: 2254355
5. Served To: DON LOWMASTER (SUPT.)
6. Operator: GREENWICH COLLIERIES DIV. OF PA. MINES CORP.
7. Mine: GREENWICH COLLIERIES NO. 1 MINE
8. Mine ID: 36-02405 (Contractor)
9. Type of Action: 103-J-
10. Violation: A. Health ☐ Safety ☐ Other ☐ B. Section of Act C. Part/Section of Title 30 CFR
11a. Significant and Substantial (see reverse) ☐
11b. Written Notice ☐

12. Condition or Practice

A METHANE IGNITION AND/OR EXPLOSION HAS OCCURED AT APPROXIMATELY 5:00 AM IN AND AROUND THE ACTIVE D-5 (037) WORKING SECTION. THREE MINERS WHO WERE WORKING IN THE D-3 SECTION ARE NOT ACCOUNTED FOR. THE FOLLOWING PERSONS ARE PERMITTED TO ENTER OR REMAIN IN THE MINE FOR THE PURPOSE OF RESCUE OPERATIONS: STATE AND MSHA OFFICIALS, COMPANY OFFICIALS AND UNION PERSONNEL WHO ARE NECESSARY TO CONDUCT THE RESCUE OPERATIONS.

13. Area or Equipment: ENTIRE MINE.

14. Initial Action: Citation ☐ Order ☐ Safeguard ☐ Written Notice ☐
15. Citation/Order Number:
16. Dated: Mo. Da. Yr.
17. Termination Due: A. Date Mo. Da. Yr. B. Time (24 hr. clock) C. Signature: [signature] D. AR Number: 20243 ☐ See continuation form (MSHA Form 7000-3a)

Section II—Termination Action

18. Action to Terminate

19. Terminated: A. Date Mo. Da. Yr. B. Time (24 hr. clock) C. Signature D. AR Number

Section III—Inspector's Evaluation

20. Negligence (check one): A. None ☐ B. Low ☐ C. Moderate ☐ D. High ☐ E. Reckless Disregard ☐

21. Gravity

A. The occurrence of the event against which the cited standard is directed was:
No Likelihood ☐ Unlikely ☐ Reasonably Likely ☐ Highly Likely ☐ Occurred ☐

B. The injury resulting from or contemplated by the occurrence of the event could reasonably be expected to be:
No lost workdays ☐ Lost workdays or restricted duty ☐ Permanently Disabling ☐ Fatal ☐

C. Number of persons who would be affected if the event occurred or were to occur:

22. Good Faith
A. Failure to abate within the time period given ☐
B. Signature
C. AR Number

Section IV—Automated System Data

23. Type of Inspection (activity code): ABC
24. Event Number: 5147612
25. Primary or Mill

MSHA Form 7000-3, Apr 82, (revised)

Mine Citation/Order Continuation

U.S. Department of Labor Mine Safety and Health Administration Appendix O (Cont.)

1. Dated (original issue) 02 16 84 (Mo. Da. Yr.)	2. Citation/Order Number 2254355-01		
3. Subsequent Action ☒ Continuation ☐	4. Date 02 16 84 (Mo. Da. Yr.)	5. Time (24 hr. clock) 1400	6. Served To Don Baumaster - Supt
7. Operator Greenwich Collieries Div of Pa Mines Corp.	Mine Greenwich Collieries No 1 Mine	8. Mine ID 36-02405-	(Contractor)

Justification For Action

The 103(J) order No 2254355 issued on 2-16-84 is hereby modified to show the order as a 103(K) order instead of a 103(J) order

Extended To: ☐	9a. Date (Mo. Da. Yr.)	9b. Time (24 hr. clock)	10. Vacated ☐ Terminated ☐ Modified ☒
11. See Continuation Form ☐	12. Type of Inspection ABC	13. Event Number 5147612	
14. Signature Michael Bondra	AR Number 20248		

MSHA Form 7000-3a., Apr 82 (revised)

Section I—Violation Data

1. Type of issuance (check one) Citation ☐ Order ☒ Safeguard ☐
2. Date 02 16 84 (Mo. Da. Yr.)
3. Time (24 hr. clock) 1015
4. Citation/Order Number 2254681
5. Served To Don Lissmaster – Supt
6. Operator Greenwich Collieries Div. of Pa. Mines Co.
7. Mine Greenwich Collieries No. 1 Mine
8. Mine ID 36-02405 (Contractor)
9. Type of Action 107-a
10. Violation A. Health ☐ Safety ☒ Other ☐ B. Section of Act C. Part/Section of Title 30 CFR
11a. Significant and Substantial (see reverse) ☐
11b. Written Notice ☐

12. Condition or Practice

An underground mine explosion has occurred in this mine. This Order is issued to secure the safety of any persons in the mine until an examination is made to determine if the entire mine is safe.

13. Area or Equipment

The operator shall withdraw all persons from the mine except those referred to in Section 104(c) of the Federal Coal Mine Safety and Health Act of 1977.

14. Initial Action: Citation ☐ Order ☐ Safeguard ☐ Written Notice ☐
15. Citation/Order Number
16. Dated Mo. Da. Yr.
17. Termination Due: A. Date Mo. Da. Yr. B. Time (24 hr. clock) C. Signature Michael Bondra D. AR Number 20248 ☐ See continuation form (MSHA Form 7000-3a)

Section II—Termination Action

18. Action to Terminate

19. Terminated: A. Date Mo. Da. Yr. B. Time (24 hr. clock) C. Signature D. AR Number

Section III—Inspector's Evaluation

20. Negligence (check one) A. None ☐ B. Low ☐ C. Moderate ☐ D. High ☐ E. Reckless Disregard ☐

21. Gravity
A. The occurrence of the event against which the cited standard is directed was:
No Likelihood ☐ Unlikely ☐ Reasonably Likely ☐ Highly Likely ☐ Occurred ☐
B. The injury resulting from or contemplated by the occurrence of the event could reasonably be expected to be:
No lost workdays ☐ Lost workdays or restricted duty ☐ Permanently Disabling ☐ Fatal ☐
C. Number of persons who would be affected if the event occurred or were to occur:

22. Good Faith
A. Failure to abate within the time period given ☐
B. Signature
C. AR Number

Section IV—Automated System Data

23. Type of Inspection (activity code) ABC
24. Event Number 5147612
25. Primary or Mill

MSHA Form 7000-3, Apr 82, (revised)

Mine Citation/Order

U.S. Department of Labor — Appendix 0 (Cont.)

Mine Safety and Health Administration

Section I—Violation Data

1. Type of issuance (check one): Citation ☐ Order ☒ Safeguard ☐
2. Date: 03 29 85 (Mo. Da. Yr.)
3. Time (24 hr. clock): 1405
4. Citation/Order Number: 2256015
5. Served To: Richard Endler - Mine Foreman
6. Operator: Greenwich Collieries, Div. of Pa. Mines Corp.
7. Mine: Greenwich Collieries No. 1 Mine
8. Mine ID: 36-02405 (Contractor)
9. Type of Action: 104-d-1,
10. Violation: A. Health ☐ Safety ☒ Other ☐ B. Section of Act — C. Part/Section of Title 30 CFR: 75.301-

11a. Significant and Substantial (see reverse) ☒

11b. Written Notice ☐

12. Condition or Practice

The volume and velocity of air ventilating the D-3 area off Main D on February 16, 1984, was not sufficient to dilute, render harmless and carry away flammable and harmful gases which permitted methane to accumulate in explosive quantities in this area. On February 16, 1984, at approximately 4:30 a.m., the methane accumulation was ignited causing an explosion which resulted in the death of three miners in this area and injuries to other miners in the adjacent D-5 working section and caused property damage in D-1, D-3 and D-5. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3 and D-5 areas of the mine on February 16, 1984.

13. Area or Equipment

Entire mine.

14. Initial Action: Citation ☒ Order ☐ Safeguard ☐ Written Notice ☐
15. Citation/Order Number: 2016261
16. Dated: 02 24 84 (Mo. Da. Yr.)
17. Termination Due: A. Date ___ B. Time (24 hr. clock) ___ C. Signature: *Theodore W. Glusko* D. AR Number: 20218 ☐ See continuation form (MSHA Form 7000-3a)

Section II—Termination Action

18. Action to Terminate

The operator established a volume and velocity of air in the D-3 area off Main D which was sufficient to dilute, render harmless, and carry away flammable, explosive, and harmful gases.

19. Terminated: A. Date 03 29 85 (Mo. Da. Yr.) B. Time (24 hr. clock) 1405 C. Signature *Theodore W. Glusko* D. AR Number 20218

Section III—Inspector's Evaluation

20. Negligence (check one): A. None ☐ B. Low ☐ C. Moderate ☐ D. High ☒ E. Reckless Disregard ☐

21. Gravity

A. The occurrence of the event against which the cited standard is directed was: No Likelihood ☐ Unlikely ☐ Reasonably Likely ☐ Highly Likely ☐ Occurred ☒

B. The injury resulting from or contemplated by the occurrence of the event could reasonably be expected to be: No lost workdays ☐ Lost workdays or restricted duty ☐ Permanently Disabling ☐ Fatal ☒

C. Number of persons who would be affected if the event occurred or were to occur: 003

22. Good Faith

A. Failure to abate within the time period given ☐ B. Signature *Theodore W. Glusko* C. AR Number 20218

Section IV—Automated System Data

23. Type of Inspection (activity code): CAA
24. Event Number: 5372441
25. Primary or Mill:

MSHA Form 7000-3, Apr 82, (revised)

U.S. Department of Labor Appendix O (Cont.)
Mine Safety and Health Administration

Section I—Violation Data

1. Type of issuance (check one)	Citation ☐ Order ☒ Safeguard ☐
2. Date	03 (Mo.) 29 (Da.) 85 (Yr.)
3. Time (24 hr. clock)	1400
4. Citation/Order Number	2256016
5. Served To	Richard Endler - Mine Foreman
6. Operator	Greenwich Collieries, Div. of Pa. Mines Corp.
7. Mine	Greenwich Collieries No. 1 Mine
8. Mine ID	36-02405 (Contractor)
9. Type of Action	104-d-1,
10. Violation	A. Health ☐ Safety ☒ Other ☐; B. Section of Act; C. Part/Section of Title 30 CFR 75.303-a
11a. Significant and Substantial (see reverse)	☒
11b. Written Notice	☐

12. Condition or Practice

According to the preshift examination books, sworn statements given voluntarily during the investigation, and the absence of initials, times and dates in the D-3 area, a preshift examination was not made by a certified person within 3 hours immediately preceding the entry of three miners into this area to perform work on the water pumping system on the 12:01 a.m. shift, February 16, 1984. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3 and D-5 areas of the mine on February 16, 1984.

13. Area or Equipment

Entire mine.

14. Initial Action	Citation ☒ Order ☐ Safeguard ☐ Written Notice ☐
15. Citation/Order Number	2016261
16. Dated	02 (Mo.) 24 (Da.) 84 (Yr.)
17. Termination Due	A. Date: (Mo.) (Da.) (Yr.); B. Time (24 hr. clock): ; C. Signature: Theodore W. Glusko; D. AR Number: 20218; ☐ See continuation form (MSHA Form 7000-3a)

Section II—Termination Action

18. Action to Terminate

All certified persons responsible for conducting preshift examinations were made aware of the importance of conducting adequate preshift examinations and the manner in which the examinations are to be conducted.

19. Terminated	A. Date: 03 (Mo.) 29 (Da.) 85 (Yr.); B. Time (24 hr. clock): 1400; C. Signature: Theodore W. Glusko; D. AR Number: 20218

Section III—Inspector's Evaluation

20. Negligence (check one): A. None ☐ B. Low ☐ C. Moderate ☐ D. High ☒ E. Reckless Disregard ☐

21. Gravity

A. The occurrence of the event against which the cited standard is directed was:
No Likelihood ☐ Unlikely ☐ Reasonably Likely ☐ Highly Likely ☐ Occurred ☒

B. The injury resulting from or contemplated by the occurrence of the event could reasonably be expected to be:
No lost workdays ☐ Lost workdays or restricted duty ☐ Permanently Disabling ☐ Fatal ☒

C. Number of persons who would be affected if the event occurred or were to occur: 003

22. Good Faith
A. Failure to abate within the time period given ☐
B. Signature: Theodore W. Glusko
C. AR Number: 20218

Section IV—Automated System Data

23. Type of Inspection (activity code)	CAA
24. Event Number	5372441
25. Primary or Mill	

MSHA Form 7000-3, Apr 82, (revised)

Mine Citation/Order

U.S. Department of Labor Appendix O (Cont.)

Mine Safety and Health Administration

Section I—Violation Data

1. Type of issuance (check one)	Citation ☐ Order ☒ Safeguard ☐
2. Date	03 (Mo.) 29 (Da.) 85 (Yr.)
3. Time (24 hr. clock)	1415
4. Citation/Order Number	2256017
5. Served To	Richard Endler - Mine Foreman
6. Operator	Greenwich Collieries, Div. of Pa. Mines Corp.
7. Mine	Greenwich Collieries No. 1 Mine
8. Mine ID	36-02405 (Contractor)
9. Type of Action	104-d-1,
10. Violation	A. Health ☐ Safety ☒ Other ☐; B. Section of Act; C. Part/Section of Title 30 CFR 75.316
11a. Significant and Substantial (see reverse)	☒
11b. Written Notice	☐

12. Condition or Practice

The Ventilation System, Methane and Dust control plan Review No. 23, approved September 21, 1983, was not complied with in that the air was not traveling in its proper course and direction to assure that the entire D-1 and D-3 areas of the mine were properly ventilated. The ventilation system was not maintained as provided in the approved plan in that, water was permitted to accumulate in the air courses in the D-1 and D-3 areas which severely restricted air movement, which permitted methane to accumulate in explosive quantity in D-3. Furthermore, permanent stoppings, installed to maintain the air in its proper course, through the D-1/D-3 entries had been removed. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3 and D-5 areas of the mine.

13. Area or Equipment

Entire mine.

14. Initial Action	Citation ☒ Order ☐ Safeguard ☐ Written Notice ☐
15. Citation/Order Number	2016261
16. Dated	02 (Mo.) 24 (Da.) 84 (Yr.)
17. Termination Due	A. Date: Mo. Da. Yr.; B. Time (24 hr. clock):
C. Signature	Theodore W. Glusko
D. AR Number	20218
☐ See continuation form (MSHA Form 7000-3a)	

Section II—Termination Action

18. Action to Terminate

The ventilation was re-established in the D-1 and D-3 areas to comply with the approved ventilation system, methane and dust control plan.

19. Terminated: A. Date	03 (Mo.) 29 (Da.) 85 (Yr.)
B. Time (24 hr. clock)	1415
C. Signature	Theodore W. Glusko
D. AR Number	20218

Section III—Inspector's Evaluation

20. Negligence (check one): A. None ☐ B. Low ☐ C. Moderate ☐ D. High ☒ E. Reckless Disregard ☐

21. Gravity

A. The occurrence of the event against which the cited standard is directed was: No Likelihood ☐ Unlikely ☐ Reasonably Likely ☐ Highly Likely ☐ Occurred ☒

B. The injury resulting from or contemplated by the occurrence of the event could reasonably be expected to be: No lost workdays ☐ Lost workdays or restricted duty ☐ Permanently Disabling ☐ Fatal ☒

C. Number of persons who would be affected if the event occurred or were to occur: 003

22. Good Faith

A. Failure to abate within the time period given ☐

B. Signature: Theodore W. Glusko

C. AR Number: 20218

Section IV—Automated System Data

23. Type of Inspection (activity code)	CAA
24. Event Number	5372441
25. Primary or Mill	

MSHA Form 7000-3, Apr 82, (revised)

Section I—Violation Data

1. Type of issuance (check one): Citation ☐ Order ☒ Safeguard ☐

2. Date: 03 (Mo.) 29 (Da.) 85 (Yr.)

3. Time (24 hr. clock): 1420

4. Citation/Order Number: 2256019

5. Served To: Richard Endler - Mine Foreman

6. Operator: Greenwich Collieries, Div. of Pa. Mines Corp.

7. Mine: Greenwich Collieries No. 1 Mine

8. Mine ID: 36-02405 (Contractor)

9. Type of Action: 104-d-1,

10. Violation: A. Health ☐ Safety ☒ Other ☐ — B. Section of Act — C. Part/Section of Title 30 CFR: 75.316

11a. Significant and Substantial (see reverse) ☒

11b. Written Notice ☐

12. Condition or Practice

The ventilation system, methane and dust control plan review No. 23 approved September 21, 1983, was not complied with. The bleeder entries for D-1 and D-3 areas were not being examined at least weekly to determine whether the area was free from explosive mixtures or oxygen deficiency and whether the bleeders were functional as provided in the approved plan. The bleeder entries were filled with water which prohibited a certified person from examining this bleeder system. A method of evaluating the effectiveness of the bleeder system when it could not be examined was not approved by the District Manager. According to sworn statements by company officials and the absence of a record of the weekly examinations in the mine record books, the D-1 to D-3 bleeder system was not being examined weekly. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3 and D-5 areas of the mine on February 16, 1984.

13. Area or Equipment: Entire mine.

14. Initial Action: Citation ☒ Order ☐ Safeguard ☐ Written Notice ☐

15. Citation/Order Number: 2016261

16. Dated: 02 (Mo.) 24 (Da.) 84 (Yr.)

17. Termination Due: A. Date ___ Mo. ___ Da. ___ Yr. B. Time (24 hr. clock) ___ C. Signature: Theodore W. Glusko D. AR Number: 20218 ☐ See continuation form (MSHA Form 7000-3a)

Section II—Termination Action

18. Action to Terminate

All certified persons responsible for assuring the bleeder entries are examined at least weekly and are functional were made aware of the requirements and importance of conducting these examinations. Bleeder evaluation points were approved for this area by the District Manager.

19. Terminated: A. Date 03 (Mo.) 29 (Da.) 85 (Yr.) B. Time (24 hr. clock) 1420 C. Signature: Theodore W. Glusko D. AR Number: 20218

Section III—Inspector's Evaluation

20. Negligence (check one): A. None ☐ B. Low ☐ C. Moderate ☐ D. High ☒ E. Reckless Disregard ☐

21. Gravity

A. The occurrence of the event against which the cited standard is directed was: No Likelihood ☐ Unlikely ☐ Reasonably Likely ☐ Highly Likely ☐ Occurred ☒

B. The injury resulting from or contemplated by the occurrence of the event could reasonably be expected to be: No lost workdays ☐ Lost workdays or restricted duty ☐ Permanently Disabling ☐ Fatal ☒

C. Number of persons who would be affected if the event occurred or were to occur: 003

22. Good Faith: A. Failure to abate within the time period given ☐ B. Signature: Theodore W. Glusko C. AR Number: 20218

Section IV—Automated System Data

23. Type of Inspection (activity code): CAA

24. Event Number: 5372441

25. Primary or Mill:

MSHA Form 7000-3, Apr 82, (revised)

Mine Citation/Order

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

Appendix O (Cont.)

Section I—Violation Data

1. Type of issuance (check one)	Citation ☐ Order ☒ Safeguard ☐
2. Date	Mo. 03 Da. 29 Yr. 85
3. Time (24 hr. clock)	1410
4. Citation/Order Number	2256018
5. Served To	Richard Endler - Mine Foreman
6. Operator	Greenwich Collieries, Div. of Pa. Mines Corp.
7. Mine	Greenwich Collieries No. 1 Mine
8. Mine ID	36-02405 (Contractor)
9. Type of Action	104-d-1,
10. Violation	A. Health ☐ Safety ☒ Other ☐; B. Section of Act; C. Part/Section of Title 30 CFR 75.322
11a. Significant and Substantial (see reverse)	☒
11b. Written Notice	☐

12. Condition or Practice

Changes in ventilation, which materially affected the split of air in the D-1/D-3 entries which affected the safety of the miners, were made while the mine was not idle. The power circuits to the Labour A70 pump were not deenergized before these changes were made. The D-3 area was not examined after completion of the change by a certified person to determine if the affected area was safe. These changes were as follows: (1) During the period December 26, 1983, to January 1, 1984, a connection was made between the active D-5 section and the idle D-3 area at crosscut 19; (2) Water restricted the air movement in the D-1 and D-3 area, causing the majority of the ventilating current of air in D-3 to pass through the connection at crosscut 19; (3) On February 14 and 15, 1984, a permanent stopping was constructed in the connection at crosscut 19 which materially reduced the ventilation in D-3 which permitted methane in explosive quantity to accumulate in D-3. This condition was observed during the investigation of a multiple fatal mine explosion which occurred in the D-1, D-3 and D-5 areas of the mine on February 16, 1984.

13. Area or Equipment

Entire mine.

14. Initial Action	Citation ☒ Order ☐ Safeguard ☐ Written Notice ☐
15. Citation/Order Number	2016261
16. Dated	Mo. 02 Da. 24 Yr. 84
17. Termination Due	A. Date: Da. Yr. ; B. Time (24 hr. clock):
C. Signature	Theodore W. Glusko
D. AR Number	20218
☐ See continuation form (MSHA Form 7000-3a)	

Section II—Termination Action

18. Action to Terminate

All persons responsible for making ventilation changes which could affect the safety of the miners were made aware of the hazards which could exist when ventilation changes are made.

19. Terminated: A. Date	Mo. 03 Da. 29 Yr. 85
B. Time (24 hr. clock)	1410
C. Signature	Theodore W. Glusko
D. AR Number	20218

Section III—Inspector's Evaluation

20. Negligence (check one) A. None ☐ B. Low ☐ C. Moderate ☐ D. High ☒ E. Reckless Disregard ☐

21. Gravity

A. The occurrence of the event against which the cited standard is directed was:
No Likelihood ☐ Unlikely ☐ Reasonably Likely ☐ Highly Likely ☐ Occurred ☒

B. The injury resulting from or contemplated by the occurrence of the event could reasonably be expected to be:
No lost workdays ☐ Lost workdays or restricted duty ☐ Permanently Disabling ☐ Fatal ☒

C. Number of persons who would be affected if the event occurred or were to occur: 003

22. Good Faith
A. Failure to abate within the time period given ☐
B. Signature: Theodore W. Glusko
C. AR Number: 20218

Section IV—Automated System Data

23. Type of Inspection (activity code)	CAA
24. Event Number	5372441
25. Primary or Mill	

MSHA Form 7000-3, Apr 82, (revised)