Reports

Dated
1954

Jamison #9 Mine

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

District C

FINAL REPORT ON MAJOR EXPLOSION AND FIRE DISASTER
NO. 9 MINE
JAMISON COAL AND COKE COMPANY
FARMINGTON, MARION COUNTY, WEST VIRGINIA

November 13, 1954

By

W. R. Park
District Supervisor

W. Dan Walker, Jr.
District Supervisor

John J. Dougherty
Subdistrict Supervisor

M. L. Davis
Safety Representative

Originating Office - Bureau of Mines
Morgantown, West Virginia
John J. Dougherty, Subdistrict Supervisor
Morgantown, West Virginia Subdistrict, Health and Safety District C

CONTENTS

	Page
Introduction	1
General information	2
Mining methods, conditions, and equipment	4
Mining methods	4
Explosives and blasting	5
Ventilation and mine gases	6
Coal and rock dust	9
Transportation	12
Electricity	12
Illumination and smoking	13
Mine rescue	13
Story of explosion and recovery operations	13
Participating organizations	13
Activities of Bureau of Mines personnel	14
Mining conditions immediately prior to explosion	16
Story of explosion	17
Recovery operations	20
Investigation of cause of explosion	33
Investigation committee	33
Methane as a factor in the explosion	35
Flame	36
Forces	39
Evidence of activities	44
Point of origin	46
Factors preventing spread of explosion	46
Summary of evidence	47
Cause of explosion	50
Recommendations	51
Acknowledgment	53

Appendix
- A - Victims of explosion
- B - 500-foot mine map showing ventilation, extent of flame, forces, dust sampling locations, etc.
- C - Location and condition of various pieces of mining equipment
- D - Report on relationship of petroleum and natural gas operations to the explosions and fires
- E - Geologic aspects of the No. 9 mine explosion
- F - Fan pressure charts
- G - Map of 4 left off 2 north section
- H - Location of bodies in 1 south entries
- I - Map showing fire area near man shaft
- J - Map of No. 8 entry of 4 left off 2 north - point of origin

TABLES

		Follows page
1.	Analytical results of air samples collected	22
2.	Analyses of air samples from fire area	30
3.	Analyses of mine dust samples	53

ILLUSTRATIONS

Fig.		
1.	Surface buildings at man shaft before explosion	ii
2.	Surface buildings at man shaft after explosion	ii
3.	No. 2 fan after explosion	ii
4.	Battery ends of blasting cable and part of shuttle-car trailing cable, showing nails through cable, used for firing shots in No. 7 pillar place	6
5.	End view of trailing cable with nails through positive and negative conductors	6
6.	Waiting room and elevator at top of man shaft before explosion	12
7.	Top of man shaft and bucket used for handling men during recovery operations	12
8.	Elevator and man-trip station at bottom of man shaft before explosion	12
9.	Bottom of man shaft during recovery operations	12
10.	Timbering in fire area	30
11.	Timbering in fire area	30

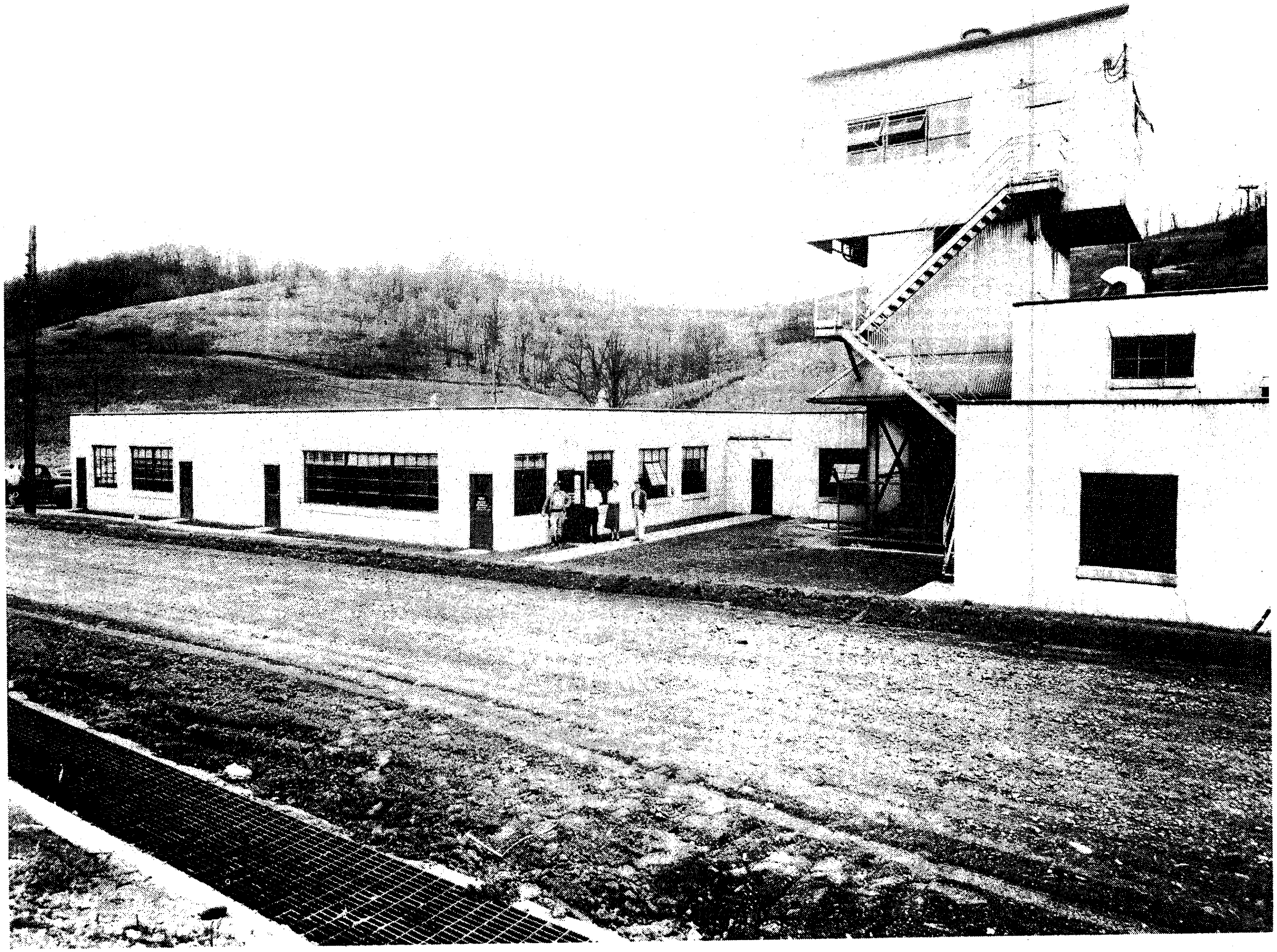


Figure 1. - Surface buildings at man shaft before explosion.

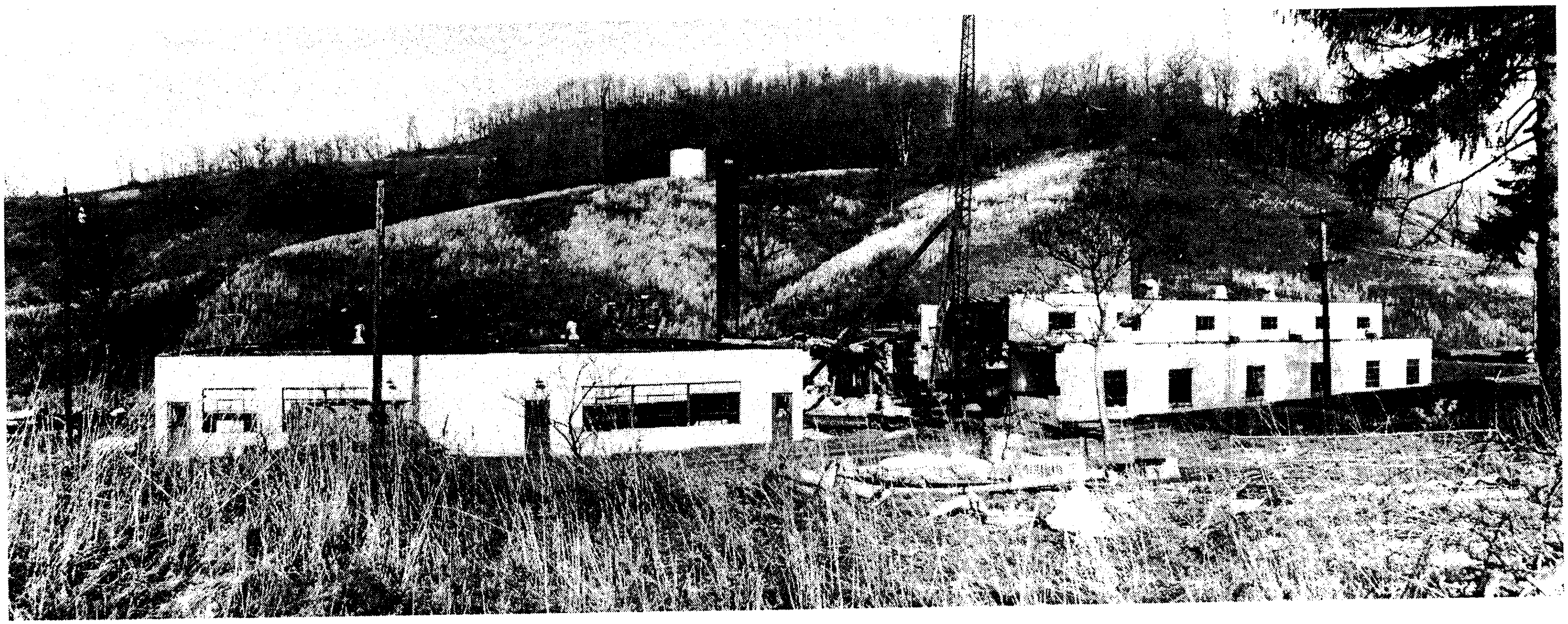


Figure 2. - Surface buildings at man shaft after explosion.

Figure 3. - No. 2 fan after explosion.

FINAL REPORT ON MAJOR EXPLOSION AND FIRE DISASTER
NO. 9 MINE
JAMISON COAL AND COKE COMPANY
FARMINGTON, MARION COUNTY, WEST VIRGINIA

November 13, 1954

By

W. R. Park
District Supervisor

W. Dan Walker, Jr.
District Supervisor

John J. Dougherty
Subdistrict Supervisor

M. L. Davis
Safety Representative

INTRODUCTION

A gas and dust explosion followed by a series of mine fires and explosions occurred in the No. 9 mine, Jamison Coal and Coke Company, near Farmington, West Virginia, about 1:45 p.m., Saturday, November 13, 1954, and caused the death of 16 persons. Two of the seventeen men in the mine at the time escaped injury and made their way to the surface unaided; 12 were killed instantly by burns and violence; and 3, who lived for perhaps 90 minutes after the initial explosion but made no attempt to erect a barricade, died from the effects of afterdamp. The sixteenth victim, who was employed as a lampman in a room adjacent to the man-shaft portal, was killed instantly when struck by a steel structural member dislodged by the explosion.

The names of the victims, their ages, marital status, occupations, and the number of their dependents are listed in Appendix A of this report.

A mine rescue team accompanied by company, State, and Federal officials entered the mine about 4 hours after the initial explosion, and a second team entered within the next 30 minutes. Two hours later, all the men were withdrawn when the methane content of return air at the one fan that remained in operation indicated a dangerous condition underground.

A second explosion occurred in the mine about 10:30 p.m., the same day; a third, at 4:10 a.m., November 15; and a fourth explosion of somewhat less violence, about 5 minutes later. Minor explosions, forces of which were not noticeable on the surface, may have occurred underground during the same period. Except for the 15 men entrapped and/or killed by the first explosion, no one was underground at the time nor was anyone on the surface injured by the subsequent explosions.

Hoisting equipment in and above the man shaft and one of the two main fans (No. 2 fan) were destroyed by the first explosion, and thereafter dense smoke continued to pour from this fan shaft. Following the second explosion, dense smoke poured from either or both of these shafts and was being drawn from the mine by the No. 1 fan, and smoke and fumes containing carbon monoxide began to flow from the slope portal, the only means of ingress. In a conference of responsible officials of the company, the United Mine Workers of America, the West Virginia Department of Mines, and the Bureau of Mines, convened at 12:30 a.m., November 14, it was decided to seal the mine at the surface openings.

Sealing of the mine at 5 surface openings was first completed at 1:30 a.m., November 15, but 2 of the seals were broken by the third and fourth explosions, and final sealing was effected at 2:00 p.m., November 17, 1954. The first seal, at the No. 1 fan shaft, was removed at 12:15 p.m., March 10, 1955. The No. 1 fan was put in operation shortly thereafter, and the No. 2 fan was started at 9:38 p.m., March 12. Underground recovery operations, begun March 14, were retarded by a fire which rekindled near the man shaft; the fire was discovered March 19, and required sealing of the affected area. Recovery work had not been completed at the time this report was released; however, production of coal was first resumed, in 2 of the 6 working sections, July 24, 1955.

Bureau of Mines investigators believe that the initial explosion originated in 4 left section of 2 north when an explosive mixture of methane-air was ignited by blasting in a nonpermissible manner and that the explosion was propagated by methane and coal dust. Forces of the first explosion were the greatest; this was the only one that was recorded by a seismograph at the University of West Virginia in Morgantown, about 17 air-miles distant. The duration of the tremor is recorded as 17 seconds. Evidence of forces of this explosion extended to the surface through the man shaft, No. 2 fan shaft, the slope, and Plum Run borehole, and windows were broken and pictures jarred from the walls in houses on the surface in Plum Run.

GENERAL INFORMATION

The No. 9 mine of the Jamison Coal and Coke Company is about 2 miles north of Farmington, Marion County, West Virginia, and it is served by the Baltimore and Ohio Railroad. The majority interest of the capital stock of the Jamison Coal and Coke Company was purchased by the Pittsburgh Consolidation Coal Company shortly before the date of the disaster. The operating officials of the Jamison Coal and Coke Company on November 13, 1954 were:

R. E. Jamison	President	Greensburg, Pennsylvania
W. B. Jamison	Vice President	Greensburg, Pennsylvania
George W. McCaa	General Manager	Farmington, West Virginia
George Cain	Superintendent	Farmington, West Virginia
John M. Neer	General Mine Foreman	Farmington, West Virginia

A total of 443 men was employed; 355 of them worked underground 3 shifts a day and produced an average of 6,000 tons of coal daily. Most of the 88 surface employees were engaged in construction work. Production for the year 1954 was 970,415 tons of coal. The last Federal inspection of this mine prior to the disaster was made October 6, 8, 11-14, and 18-20, 1954.

The mine was opened in 1910 by the Jamison Coal and Coke Company into the Pittsburgh coal bed, which averages 96 inches in thickness in the area being mined and dips about 1.5 percent to the northwest. Four shafts and a slope provide access to the mine workings. A fifth shaft, an original opening into the mine, was abandoned and filled in 1953. The shafts are 334 to 591 feet in depth, and the slope is 1,468 feet in length on 16° dip. Two of the shafts, near which the main fans are located, serve only as return airways; one serves only as an intake airway, and the other, nearest the active workings, serves as a man shaft and an intake airway. All coal is transported to the surface by means of a conveyor belt installed in the slope. Necessary use of the slope for travel into and out of the mine slowed initial entrance by recovery workers immediately following the explosion and for a few days in March 1955, when final recovery operations were begun.

The immediate roof is usually 12 to 14 inches of coal left to support 10 to 30 inches of draw rock; the main roof is shale and sandstone. Occasional slips, rolls, horsebacks, and clay veins are encountered. The cover ranges from 300 to 800 feet in thickness. The floor is medium soft fire clay, 2 to 6 feet in thickness. The analysis of a coal sample from the Pittsburgh coal bed in this mine. as listed in Technical Paper 626, "Analyses of West Virginia Coals," published by the United States Department of the Interior, Bureau of Mines, is as follows:

	Percent
Moisture	2.1
Volatile Matter	36.8
Fixed Carbon	54.4
Ash	6.7
	100.0

Numerous tests by the Bureau of Mines have shown that coal dust having a volatile ratio of 0.12 is explosive and that the explosibility increases with an increase in the volatile ratio. The volatile ratio of the coal in this mine as determined from the above-mentioned analysis is 0.40, indicating that the dust from this coal is highly explosive.

A fire or an explosion involving loss of life had not occurred previously in this mine; however, a gas explosion, said to have been caused by firing an unconfined shot in loose roof material, happened therein on October 11, 1951; and an explosion resulting in the death of 19 men occurred January 14, 1926, in the Jamison No. 8 mine, which adjoins and had been connected to the No. 9 mine. Other major mine explosions that have occurred in nearby mines include:

Mine	Date	Location	Lives Lost
Chatham	May 15, 1901	Farmington, W. Va.	10
Monongah Nos. 6 & 8	December 6, 1907	Monongah, W. Va.	361
Jamison No. 7	October 19, 1916	Barrackville, W. Va.	10
Barrackville	March 17, 1925	Barrackville, W. Va.	33
Federal No. 3	April 30, 1927	Everettville, W. Va.	97
No. 1	June 20, 1928	National, W. Va.	7
Yukon	March 26, 1930	Arnettsville, W. Va.	12
Christopher No. 3	May 12, 1942	Osage, W. Va.	56
No. 2	July 9, 1942	Pursglove, W. Va.	20
Katherine No. 4	March 25, 1944	Shinnston, W. Va.	16
Bunker	October 15, 1951	Cassville, W. Va.	10

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods. A block system of mining was followed. Multiple entries in sets of 7 to 9, turned at various intervals, were driven 14 to 16 feet wide on approximately 70-foot centers, and crosscuts were about 80 feet apart. Pillars were generally recovered by a pocket-and-fender method. Pillar lifts were 18 to 21 feet in width and each 8- to 8-1/2-foot cut was double-sheared, one shear in the middle and the other angled toward and cut through to the gob. With the first cut in each lift taken from the entry side of the pillar, a triangular stump about 6 feet wide at the outby end was left for support at the corner nearest the gob. With each succeeding cut except the last, the triangular stump left was 3 to 4 feet in width at the outby end, and a rectangular stump 3 feet in width was left in the middle of the last cut. Shot holes in these 6 or 7 stumps were drilled generally as the face was advanced, they were blasted on retreat, and the coal therefrom was not recovered.

Bolts were used for roof support in face areas and along recently developed haulageways and air courses; they had also been installed at various places along older haulageways, air courses, and other places in the mine. With few exceptions, bolts were installed in full compliance with the recommendations of the Bureau's roof-control representative and State roof-bolting permit No. 619. Wooden timbers were used for breaker posts in pillar sections and to supplement roof bolts where abnormal roof conditions were encountered in other face areas. Wooden timbers and steel beams were also used for support along haulageways and return air courses, but roof along the greater part of the haulageways and air courses was not supported artificially. Coal was topcut and sheared by rubber-tired universal mining machines and loaded into rubber-tired shuttle cars with tractor-mounted loading machines.

Explosives and Blasting. Permissible-type explosives were used for blasting, and the blasting supplies were transported underground in a specially constructed explosives car and stored temporarily in suitable section boxes. Coal faces were topcut and sheared to a depth of 8 to 8-1/2 feet, then blasted on shift by authorized shot firers. The cuts were sheared off center, two shot holes were drilled on the wide side and one on the narrow side, and not more than 5-1/2 cartridges of explosive, less than 3 pounds, was supposed to be used in each hole. However, in one instance observed during the October 1954 Federal inspection, a shot hole was charged with more than 3 pounds of explosive. Incombustible material was used for stemming. Shot holes, except those used in blasting stumps, were blasted singly, beginning with the holes next to the shear. At the time of the October 1954 Federal inspection, shots were fired promptly after charging and suitable roof and gas tests were made before and after blasting.

Immediately after the disaster parts of 8 cases of the explosive used in the mine, Monobel AA, from 7 of the manufacturer's lots, were taken from the surface storage magazine at the mine and tested for permissibility requirements in the Bureau of Mines laboratories at Bruceton, Pennsylvania. The explosives from lots No. 11TI0623 and No. 24TI0629 failed to pass the gallery test. After the failures, the manufacturer was requested to remove from the market all the remaining explosives from these lots. One case of the same brand of explosive from each of 3 different lots, taken in March 1955 from the explosives car that had been left on the slope bottom, and a selected amount of the same explosive (lot number unknown) removed from the section storage magazine in 4 left off 2 north were tested in the Bureau laboratories and passed all tests for permissibility. Explosives were not found in the immediate face areas of 4 left entries off 2 north; therefore, it will never be known whether the explosives used for blasting in 4 left section on November 13, 1954, were part of any lot tested.

Insofar as could be ascertained each of the smaller pillar stumps (triangular base measurements about 3.5 x 6 x 7 feet) was generally blasted with one shot hole 6 to 7 feet in depth, drilled through the stump and head-coal roof into the overlying shale to a depth of 8 to 10 inches, and charged with 5 cartridges of explosive. At times, however, when the weakened condition of the stump so warranted, the one shot hole was drilled to a depth of 2 to 3 feet within the stump, or to a depth of less than 5 feet through and over or under the stump, and blasted with 2 or 3 cartridges. The larger corner stumps were usually blasted with 2 shot holes within and/or over the stump, each hole 6 feet or more in depth and charged with not more than 5-1/2 explosive cartridges. Reportedly, such stumps had been blasted occasionally with a single shot hole as much as 9 feet in depth and charged with as much as 12 explosive cartridges.

Although company safety rules required that only one shot be fired at a time, and multiple-blasting units were not provided, it was learned during the investigation that: (1) Shots in pillar stumps were usually fired two at a time, nonpermissibly, with a single-shot blasting unit; (2) 3 or 4 shot-firing cables, each attached to 1 or 2 of the 6 to 8 charges in a series of stumps, were employed in such blasting; (3) frequently tests for gas were not or could not be made, or could not be made safely close to the point of blasting, immediately before shots other than those fired first were blasted; (4) at times charges in stumps were not fired and were lost because roof falls resulting from firing previous shots "rode out" these stumps; and (5) it was not an altogether uncommon practice to connect all the shots in a series of stumps and fire them simultaneously by means of electric power obtained from the 275-volt mine electric circuit, either through an opening in face electrical equipment, nails driven into the trailing cable on such equipment, or the power line in the working section. The last-mentioned information was partly confirmed on September 9, 1955, when a three-conductor trailing cable on a shuttle car, with two 8-penny nails driven through the positive and negative conductors of the cable, was uncovered in cleaning up the large roof fall in No. 8 entry of 4 left off 2 north (See figure 4). The untwisted ends of the blasting cable were within 2 feet of the nails in the trailing cable, and a spool of cotton-insulated copper wire for connecting shots had been found nearby. Examination of trailing cables on the face electrical equipment indicated that shots had been fired similarly in 2 left off 1 south section, as nail holes and a part of a nail were found in the loading-machine cable.

Ventilation and Mine Gases. Ventilation was induced by two electrically driven axial-flow fans, operated exhausting and circulating through the mine approximately 347,800 cubic feet of air a minute. The fans were operated continuously. Each fan was installed in a fireproof housing on the surface, connected by a fireproof air duct to and offset from its air shaft, and provided with explosion doors, a recording pressure gage, and a device to give alarm should the fan slow or stop. Overcasts, stoppings, and regulators were constructed of substantial incombustible material. Doors were used only on the supply track near the slope bottom and for the man-trip station at the foot of the man shaft, and these doors were installed in pairs to form air locks. Check curtains and line brattice were installed to conduct air in the face regions, but the check curtains were rolled up and tied in place to facilitate shuttle-car haulage, and after the explosion the inby ends of unaffected line brattice in 5 left off C face and in 4 right off 3 north were 15 to 50 feet from the faces. Reportedly, line brattice was not used in pillar lifts except when gas was encountered. A fan of 24-inch diameter, the only fan used underground, was installed in fresh air near the foot of the slope and was employed to force about 4,000 cubic feet of air a minute through the slope to the surface. Company officials stated this was done to help prevent roof spalling in the slope, to minimize icing in the slope during the winter, and to insure against fumes or smoke entering the mine in case of a conveyor belt fire.

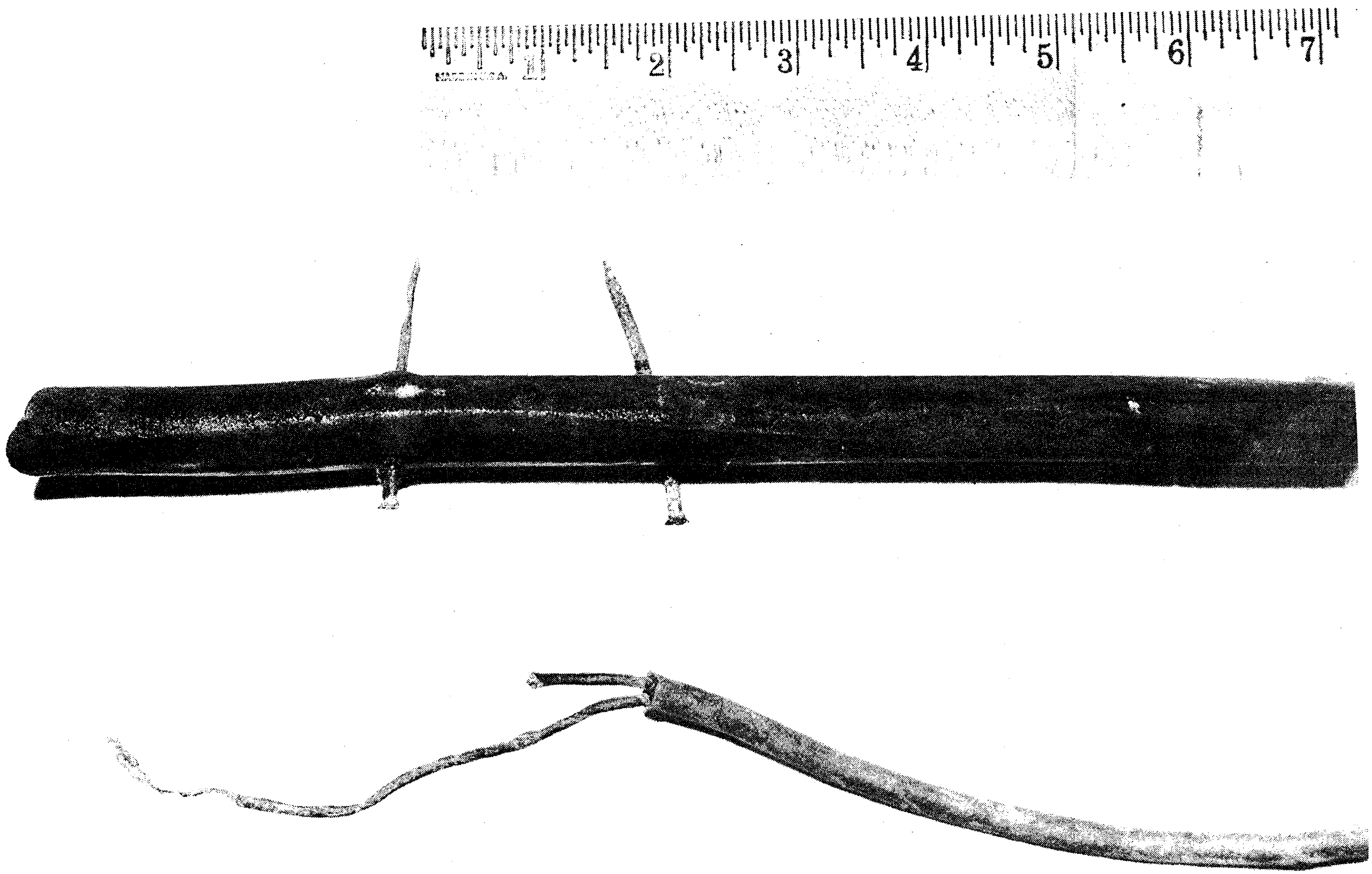


Figure 4. - Battery end of blasting cable and part of shuttle-car trailing cable, showing nails through cable, used for firing shots in No. 7 pillar place.

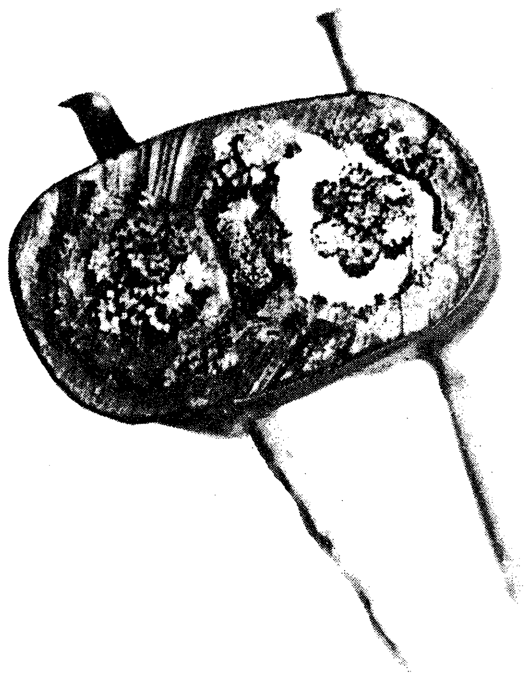


Figure 5. - End view of trailing cable with nails through positive and negative conductors.

The main west intake and return airways (separated by a 400-foot-wide pillar) and all the workings off these airways were ventilated with air that entered the mine through the man shaft and returned to the No. 2 fan. Part of the air from this intake, the 9 right split and the main north split off 10 right, returned to the No. 1 fan. All the air that entered the mine through the No. 1 air shaft, except for the slope split and a small split that was coursed through the pillared area off and west of C face mains, returned to the No. 1 fan. Reportedly, that part of C face main entries from 5 left to 9 right entries was ventilated at times by intake air that entered the mine through either of the 2 intake air shafts.

Each working section was ventilated by a separate split of intake air. The quantities of air reaching the last open entry crosscuts and the intake ends of pillar lines during the October 1954 Federal inspection ranged from 8,000 to 20,000 cubic feet a minute. In the working sections, intake air was coursed through the 4 center entries of each set, split right and left near the faces, and returned by way of the 3 or 4 outside entries and/or adjacent pillared areas.

The following air measurements and methane determinations for the 2 north split were obtained from the company's 1954 records:

	November 13		November 6		October 25	
Location	Air volume c.f.m.	Methane, percent	Air volume c.f.m.	Methane, percent	Air volume c.f.m.	Methane, percent
2 north intake, outby substation	58,132		60,984		60,006	
2 north intake, outby 4 left	47,232		47,040		41,164	
4 left, 2 north return, right side	17,108	0.10	14,100	0.10	16,160	0.10
4 left, 2 north return, left side	19,224	0.30	16,900	0.10	18,118	0.05
2 north return, left side outby 1 left	Not measured		9,940	1.70	9,886	1.65
2 north return, right side, No. 6 heading	do	do	28,756	0.55	29,006	0.45
2 north return, right side, No. 7 heading	do	do	27,840	0.55	25,112	0.45

According to measurements made by the general assistant mine foreman within an hour before the explosion, the quantity of air entering 2 north entries just outby 4 left entries was 47,232 cubic feet a minute. The volumes entering 4 left entries and passing through the 2 north regulator inby 4 left were not measured; however, air volumes measured in the 4 left return entries totalled 36,332 cubic feet a minute. Assuming that the quantity of air passing through the 2 north regulator was 3,000 to 5,000 cubic feet a minute, only a relatively small volume of air could have passed through the 4 left gob area toward the worked-out 3 left section, and, since a bleeder opening was not provided and the entries between the worked-out sections and the 2 north returns were not closed, it is certain that an air current did not pass through the vast gob area on the west side of 2 north entries and that, at best, only the east edge of this area was ventilated. Comparable air measurements were recorded by the officials for each of two previous examinations, October 25 and November 6, and methane in the amount of 1.70 and 1.65 percent was measured in a partial return (9,940 and 9,886 c.f.m.) outby the gob area on these occasions. Furthermore, line brattice was used to ventilate the outby 150 feet of the so-called bleeder entry south of 1 left off 2 north entries, and methane in at least near explosive proportions was found at the end of the brattice before the explosion. Check curtains, stoppings, and line brattice had to be used to keep the east edge of the 2 north gob area clear of gas during and after recovery operations. Therefore, it is believed that the gob area was filled with methane gas within or above the explosive limits.

Air samples were not collected in the split return airways during the October 1954 Federal inspection; however, tests made with an approved electric methane tester on the return side of the last active working place on each split showed methane contents ranging from 0.0 to 0.6 percent.

Air measurements made at the main fans during the four Federal inspections prior to the explosion and during the July 1955 special inspection and the corresponding rate of methane liberation are as follows:

Date	Fan	Cu. ft. air per min.	Cu. ft. methane per 24 hrs.	Total rate of methane liberation
August 1953	No. 1	120,960	566,646	
	No. 2	223,905	2,358,601	2,925,247
January 1954	No. 1	126,200	551,780	
	No. 2	235,300	2,443,348	2,995,128
May 1954	No. 1	113,100	430,099	
	No. 2	234,600	2,939,788	3,369,887
October 1954	No. 1	109,400	415,613	
	No. 2	238,400	2,832,955	3,248,568
*July 1955	No. 1	118,000	303,552	
	No. 2	190,000	2,018,304	2,321,856

*No coal produced at time of special inspection.

The mine is classed gassy by the West Virginia Department of Mines and by the Bureau of Mines. Fire bosses, who traveled by electrically driven jeeps from one working section to another, made preshift examinations for gas and other hazards only on Sunday evenings and at similar times prior to the resumption of operations following a shutdown of more than 4 hours; other preshift examinations for succeeding shifts were made on shift by the section foremen during their regular tour of duty. Onshift and weekly examinations for gas and other hazards were made by fire bosses, section foremen, assistant foremen, and the general mine foreman; however, the finding of gas that was removed during the same work shift, which occurred quite frequently in the 2 north section, was seldom included in the daily mine record book. Also, at the time of the last Federal inspection the records indicated that the return airways of some sections were not examined for intervals of as much as 2 weeks. Many falls were in the return airways before the explosion, and interrogation of employees revealed that perhaps only 1 and certainly not more than 2 of the multiple returns were traveled during such examinations, consequently many of these falls could not have been examined for gas at such times. Operators of electrical face equipment were instructed to make suitable tests for gas, but testimony submitted indicated that tests for gas were not always made immediately before electrical equipment was taken to the working faces. Tests made with a permissible flame safety lamp on pillar falls in active pillar sections during the October 1954 inspection did not indicate any accumulation of methane. Methane detected in one place in 3 north entries, a development section, by the section foreman when making a routine examination during this Federal inspection, was removed promptly by repairing the line brattice. No one was working in the place at the time, and it was the last working place on the air split. Numerous active and inactive gas and oil wells penetrated the coal bed in active and worked-out areas of the mine (and in virgin territory adjacent thereto); however. the mine map indicated that suitable blocks of coal were left around the wells. Tests made with W-8 methane detectors and air measurements made in split returns and at bottom of upcast air shafts by mine officials on November 13, 1954, and completed shortly before the explosion occurred, indicated normal air quantities and percentages of methane at these locations.

Coal and Rock Dust. The following information was obtained from reports on the three Federal inspections completed in 1954 and from company officials and employees. The greater part of the mine surfaces was dry. Water sprays were mounted on mining machines to allay dust; water was used when necessary to allay dust during loading operations, at shuttle-car discharging stations, and at the rotary dump near the slope bottom; and shuttle-car roadways were wetted down occasionally. Dangerous accumulations of loose coal and coal dust were reported at two locations, and these accumulations were removed from the mine promptly. Rock dust had been applied to within 40 feet of all but one of the working faces, and this working place was rock-dusted immediately. Small high-pressure rock-dust distributors transported in shuttle cars were used to rock dust the active sections, and larger rock-dusting machines were used on off shifts for generalized rock-dusting. Rock dust was scattered manually along shuttle-car roadways on shift, and the shuttle-car discharging stations were cleaned up and the areas rerock-dusted as the mine-car loading points were moved. As the working sections were advanced, the floor in the return airways (back entries) was blanket rock-dusted; i.e., covered with a layer of rock dust one to several inches in depth. In addition, parts of the back entries and parallel entries developed several years ago had been rock-dusted recently by hand, and heavy blanket rock-dusting was done at some locations in such areas.

During the period October 1952 to October 1954, 6 Federal inspections of the mine were made, and 72 dust samples were collected at 48 locations in the face regions and along the haulageways. The incombustible content of the samples ranged from 70 percent to 99.9 percent. Federal and State reports on inspections before the explosion indicated the mine was generally well rock-dusted, and a rock-dusting survey completed August 25, 1954, by a representative of the West Virginia Department of Mines indicated adequate rock-dusting at most locations, as only 13 of 115 samples collected contained less than 65 percent incombustible. State and Federal inspectors did not collect dust samples in back entries or in open, trackless parallel entries except near the active working faces.

Company records show that 2,955 tons of rock dust was applied and 970,415 tons of coal was produced in 1954; this amounts to 6.1 pounds of rock dust used per ton of coal produced. During the 4 preceding years, the rate of rock-dust application was at a similar level, which is above the West Virginia average and probably above the National average. The amount of rock dust applied, the high incombustible content of the dust samples collected, the reasonably dust-free condition and good state of rock-dusting on haulageways, as well as the blanket rock-dusting in advancing back entries and in parts of older back and parallel entries, led company officials and employees and many others to believe that the entire mine was well rock-dusted.

If this rock dust was applied fairly uniformly by normal rock-dusting by machines, it would be distributed in the 7-foot by 15-foot entries (from which about 4.3 tons of coal is produced per linear foot of advance) at an average rate of 26 pounds per linear foot. Since about 30 percent of the rock dust applied in this manner adheres to the ribs and roof and 70 percent (18 pounds per foot) falls on the floor, this would provide on the floor of the entries a layer of rock dust with an average thickness of about 1/5-inch. Such rock-dust application on the ribs, roof, and floor would provide good protection against the propagation of an explosion in the area mined in 1954, if such area were reasonably free of fine coal and coal dust.

Despite the large amounts of rock dust used, rock-dusting practices in effect, samples collected, and statements of company officials, employees, and others regarding conditions prior to the explosion, information obtained during the investigation revealed certain deficiencies. A very high proportion of the rock dust was used in blanket rock-dusting on the floor of back entries. In some sections of back entries the thickness of the rock-dust blanket was as much as 4 inches. According to testimony by a company official, it was normal practice to use 100 to 115 eighty-pound bags of rock dust on the floor of a 95-foot length of back entry; this is equivalent to 90 pounds of rock dust per linear foot, giving a layer with an average thickness of slightly more than 1 inch.

According to the mine map, development entries and sections were advanced at least 11,000 linear feet in 1954; this development included about 44,000 feet of intake entries, 39,700 feet of return (back) entries, and 41,000 feet of crosscuts. About 55 percent of the total coal production was obtained from these development entries, and the balance from pillar retreat. Blanket rock-dusting of the 39,700 feet of back entries (from which 170,000 tons or about 18 percent of the total coal production was won) at the indicated rate required 1,800 tons of rock dust or about 60 percent of the total used during the year. This means that only 1,155 tons of rock dust was available for rerock-dusting old entries, for application in newly developed haulage entries, parallels, crosscuts, and pillar sections--from which 800,000 tons of coal (82 percent of total production) was won, as well as for rock-dusting the rib-roof surfaces of the back entries.

Thus during 1954, when a high rate of rock-dusting was performed, the use of large quantities of rock dust for blanketing apparently resulted in deficiencies of rock dust and inadequate protection of some workings. Furthermore, even heavily blanket-rock-dusted entries are not protected properly unless the coal dust on the ribs and roof is also neutralized by adequate application of rock dust thereon.

Judging by the analyses of dust samples collected after the explosions from four of the working sections that were only slightly, if at all, affected by forces of the explosions, it is evident that the incombustible content was high (in the floor dust) in blanket-rock-dusted back entries (all 19 samples contained more than 67 percent incombustible); it was fairly satisfactory in haulage entries (9 samples out of 18 contained more than 65 percent incombustible); but it was entirely too low in parallel intake entries (18 samples out of 19 contained less than 60 percent incombustible).

After the explosions, examination of sections of the mine affected by strong forces, as well as sections affected only slightly by forces, revealed that loose coal and coal dust 3 to 8 inches in depth had been left along the greater part of the ribs, and there was more loose coal and coal dust in the pillar sections than in advancing sections. Larger amounts of loose coal and coal dust (ranging from 1 to 10 inches in depth) were on the floor along the greater part of the older back entries and entries parallel to the haulageways and connected thereto by open crosscuts. In many places rock dust covered the loose coal and coal dust. The loose coal and coal dust on the floor of the parallel and back entries were generally of the same type and texture and were lying on the floor at a generally uniform thickness across the entry. There was little evidence of sloughing of new coal from the roof and ribs. Visual observation indicated that sufficient rock dust had not been applied on the roof and ribs at several places in advancing entries, notwithstanding the large amount of rock dust on the floor at such locations. Furthermore, careful examination showed little evidence of rock dust having been applied at many places in the parallel and older back entries, even though other parts of these entries were blanket-rock-dusted. These observations and the analytical results of dust samples collected after the explosions show clearly that the mine dust in the greater part of the parallel and older back entries did not contain sufficient incombustible to prevent propagation of an explosion.

Transportation. Cable-reel-type shuttle cars were used for face haulage; they discharged the coal directly into 20-ton-capacity steel mine cars, which were hauled by trolley locomotives to the rotary dump at the slope bottom. A well-installed belt conveyor transported the coal from the slope bottom to the coal-storage bins on the surface. A track was also installed in the slope for hauling supplies. Tracks and rolling stock were in reasonably good condition. The clearance space along haulageways was well maintained, and shelter holes were available at frequent intervals except along the slope. Ordinarily, men entered and left the mine by way of the automatic elevator installed in the man shaft and were transported underground in specially constructed covered man cars. In some instances when only 5 or 6 men were transported, they were hauled in a mine jeep. The man-trips were well conducted.

Electricity. Electric power, 110, 220, 440, 2,200, 4,160, and 22,000 volts alternating current, was used on the surface; and 275 volts direct current and 110, 220, 440, 2,200, and 4,160 volts alternating current were used underground. The substation equipment underground was in well-ventilated fireproof rooms, each on a separate air split. The electric face equipment, trolley locomotives, and some pumps were operated from the 275-volt direct-current system. Pumps were operated only in intake airways. Permissible and nonpermissible electric face equipment was used. Two permissible-type cutting machines, two loading machines, and a hand-held electric drill were not in permissible condition at the time of the October 1954 Federal inspection, due to three openings in excess of 0.004-inch into vital electric compartments, four defective conduits, a missing bolt, and a loose boom-light lens. This equipment was placed in permissible condition promptly. Trolley, feeder, and power wires were installed on insulators and sectionalized with cutout switches and circuit breakers. Temporary splices in trailing cables were made with splicing rings and insulated with friction tape. Short-circuit protection was provided. At the time of the October 1954 Federal inspection, operators of electrically driven equipment made suitable tests for gas before taking the equipment into the face regions and at frequent intervals thereafter.

Figure 6. - Waiting room and elevator at top of man shaft before explosion.

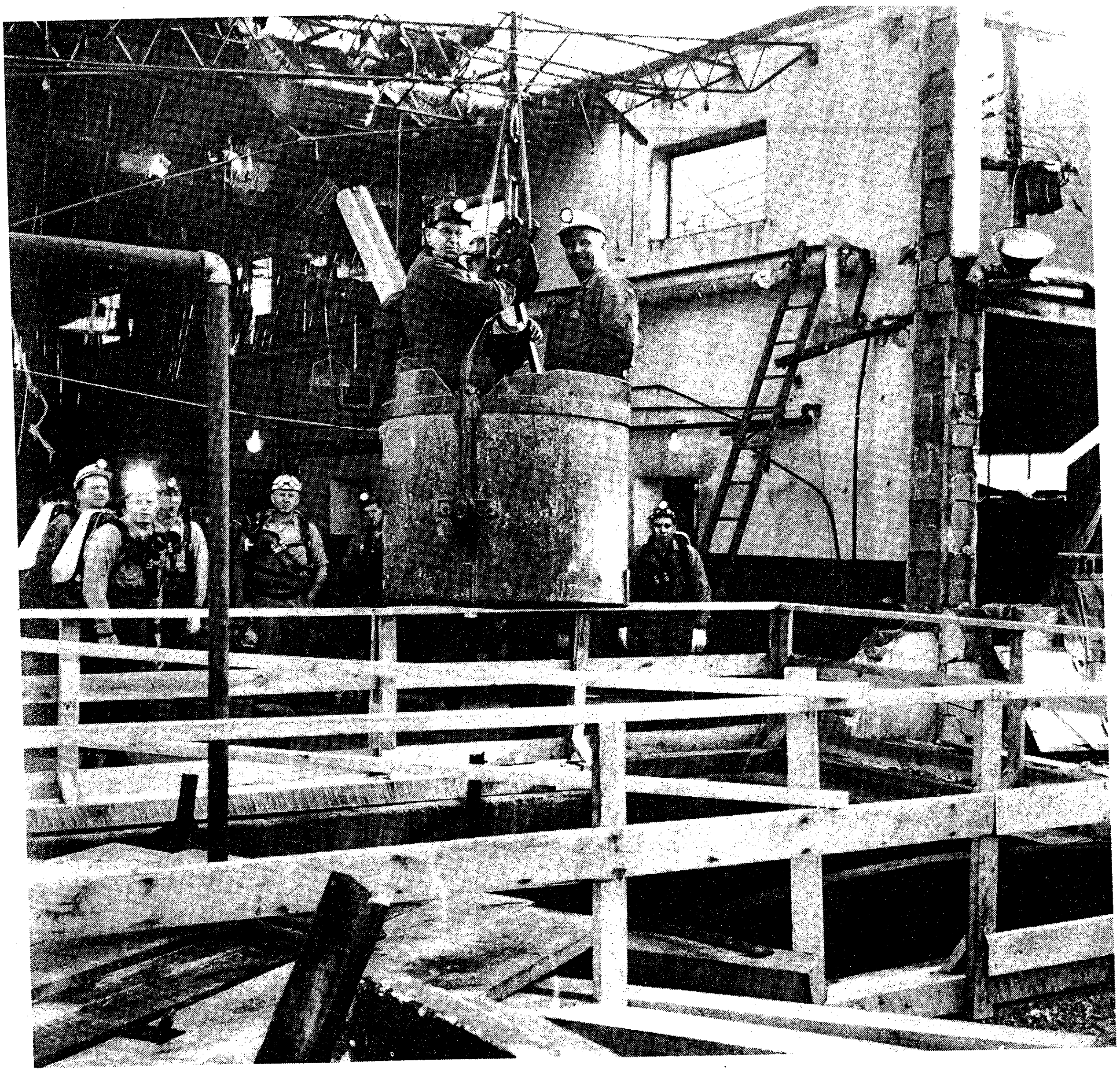


Figure 7. - Top of man shaft and bucket used for handling men during recovery operations.

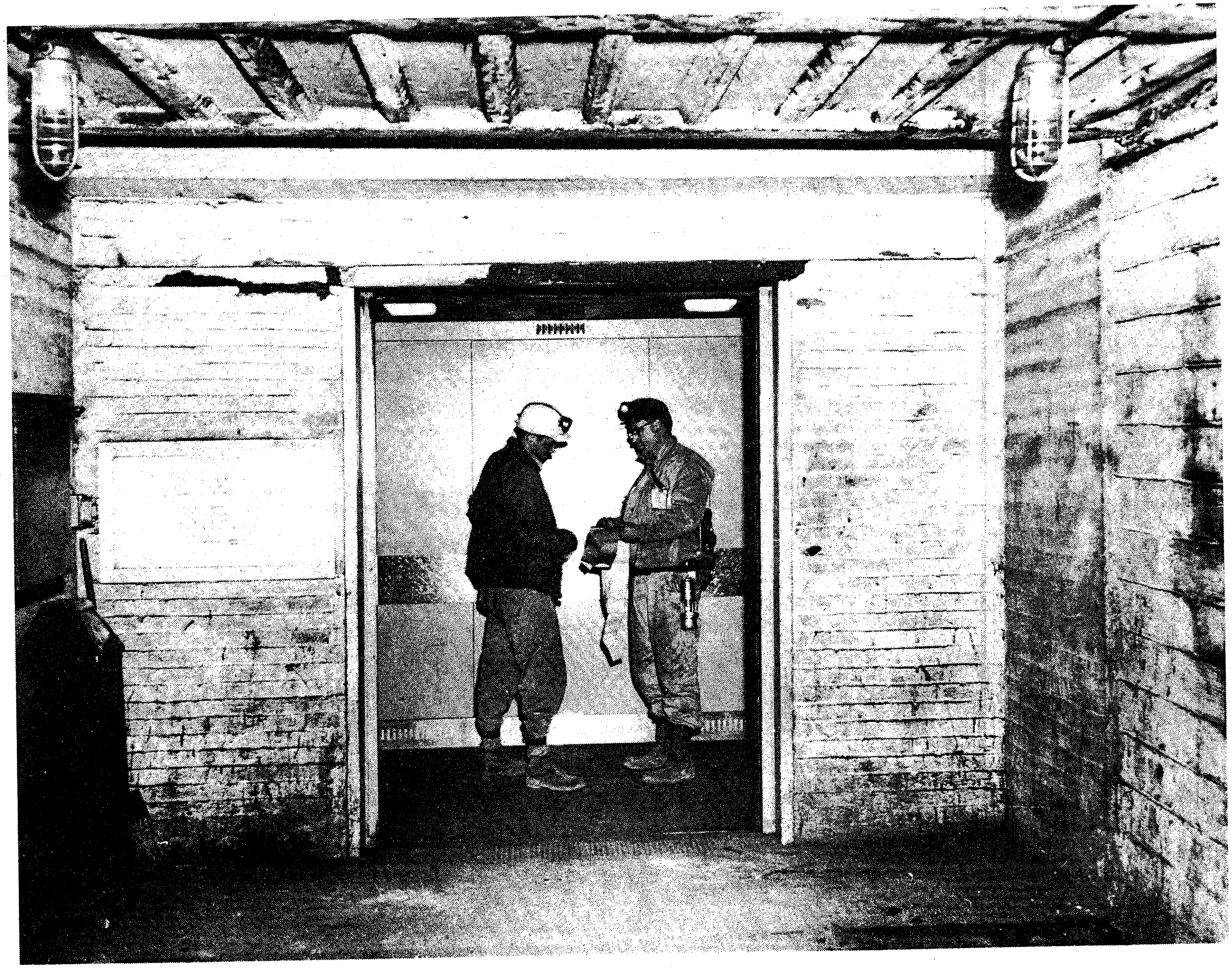


Figure 8. - Elevator and man-trip station at bottom of man shaft before explosion.

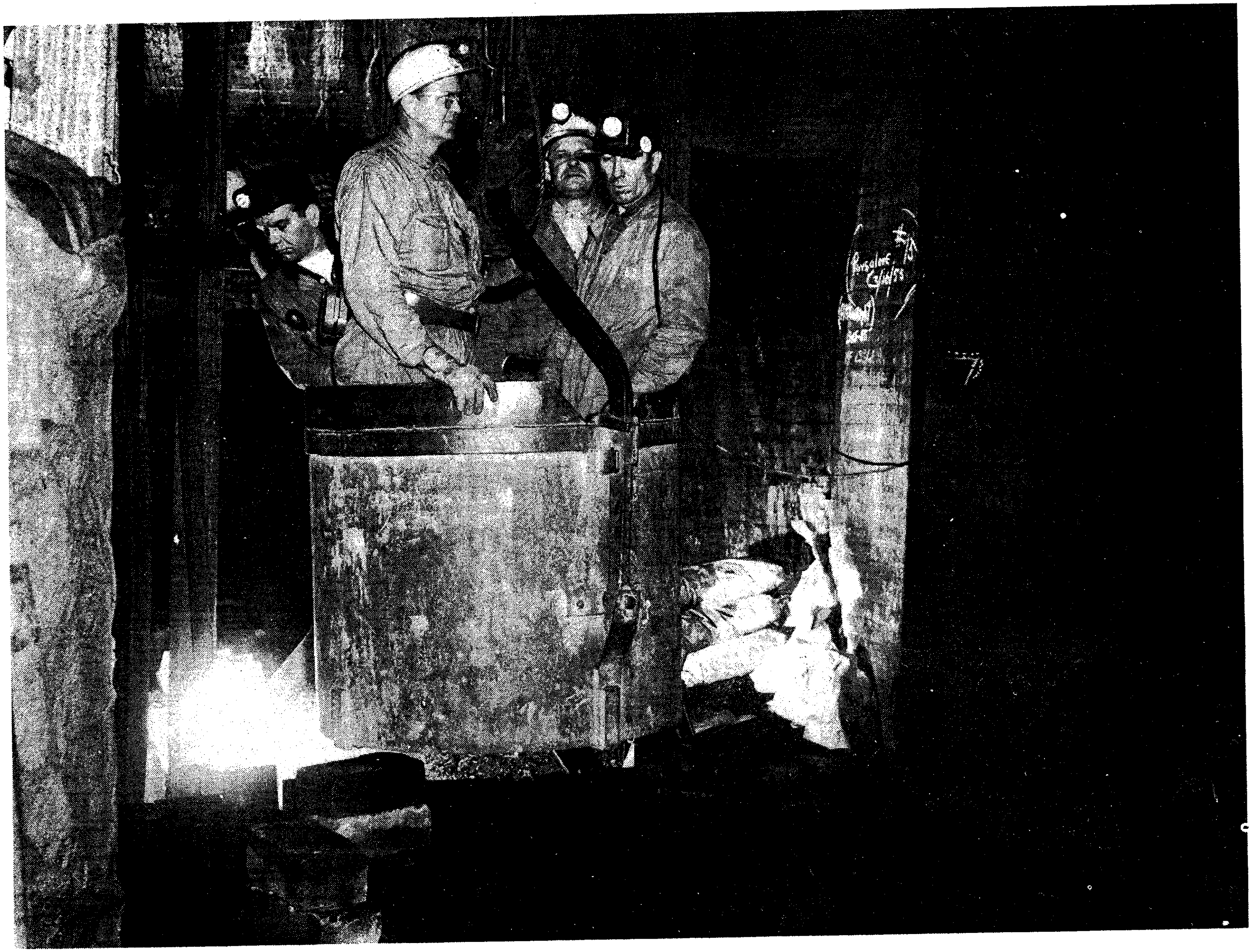


Figure 9. - Bottom of man shaft during recovery operations.

Electric face equipment and trailing cables were examined by a Federal electrical inspector as the working sections were recovered and ventilated. Many pieces of the equipment were moved to various parts of the mine for loading roof falls and for clean-up purposes during recovery work, and some of this equipment was examined a second time. The inspections indicated that most of the permissible-type equipment was not in permissible condition because of one or more deficiencies (See Appendix C).

Illumination and Smoking. All employees used permissible electric cap lamps for portable illumination underground. Fixed electric lights were installed at frequent intervals along the haulageways. Smoking was not permitted or observed underground at the time of the October 1954 Federal inspection, and searches for smokers' articles were conducted daily.

Mine Rescue. A fully equipped State-trained mine-rescue team was maintained at the mine; fully equipped and regularly trained mine-rescue teams were also available at the nearby Nos. 41 and 44 mines of the Bethlehem Mines Corporation and the No. 63 and the Williams mines of the Consolidation Coal Company (W. Va.); and several other mine-rescue teams and a fully equipped State mine-rescue truck were within a 30-mile radius of the mine.

Self-rescuers were provided for all employees underground. Two travelable passageways were available as escapeways from each working section to the surface, and one was ventilated with intake air. A check-in and check-out system was in effect, and each employee carried an identification check on his person while underground.

Fire-fighting equipment readily available underground included two 80-gallon track-mounted fire extinguishers and hose, couplings, brattice cloth, boards, nails, and two universal gas masks kept near the man-shaft bottom; a 40-gallon cart-mounted fire extinguisher, two universal gas masks, and 18 to 24 self-rescuers on each working section; two 5-gallon fire extinguishers and two gas masks on the mine foreman's jeep; a hand-type fire extinguisher on each main-line locomotive; and fire extinguishers at each substation. About 250 pounds of rock dust in open steel containers was kept at each of many strategic locations along all the haulageways. Water lines of 1-inch diameter were extended to all working faces and a static pressure of 100 pounds per square inch maintained.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Participating Organizations. Officials of the several organizations who took part in direction of the recovery work include: W. B. Jamison, vice president, and George W. McCaa, general manager of the operating company; Charles Ferguson, safety director, and C. J. Urbaniak, district president, United Mine Workers of America; Julius C. Olzer, chief, and Frank King, former chief, West Virginia Department of Mines; and James Westfield, assistant director, Bureau of Mines.

Fourteen mine-rescue teams of the following companies assisted: Jamison Coal and Coke Company, Hanna Coal Company, Pittsburgh Coal Company, Mathies Coal Company, Renton Coal Company, Consolidation Coal Company (Ky.), Consolidation Coal Company (W. Va.), and Christopher Coal Company.

Activities of Bureau of Mines Personnel. Inspector W. D. Baldwin of the Bureau of Mines was notified of the explosion by George W. McCaa, general manager of the Jamison Coal and Coke Company at 2:25 p.m., Saturday, November 13, 1954. Federal inspectors Roy C. Estep and W. D. Baldwin arrived at the mine at 3:10 p.m., the same afternoon. John J. Dougherty, subdistrict supervisor, was notified at 3:15 p.m. and arrived at the mine at 4:00 p.m. The times of arrival of other Bureau of Mines officials at the mine are as follows:

W. H. Tomlinson	Chief, Accident Prevention and Health Division, Region VIII	7:00 p.m., November 13
W. Dan Walker, Jr.	District Supervisor	9:00 p.m., November 13
James Westfield	Assistant Director--Health and Safety	11:00 p.m., November 13
H. F. Weaver	Chief, Division of Coal-Mine Inspection	3:00 a.m., November 14

Several additional Bureau of Mines employees rendered assistance in the brief initial recovery operations and the sealing and resealing of the mine entrances.

During the period the mine was sealed, Bureau of Mines employees collected air samples for analyses; and Bureau representatives conferred with and assisted company, United Mine Workers of America, and State representatives in formulating plans for recovery of the mine.

On March 8, 1955, 17 Bureau employees assembled with others at the mine for a conference in which the company's well-planned procedure for recovery was presented in printed form and discussed in detail by a company representative. Among other things this plan provided for around-the-clock recovery work, 7 days a week. Bureau employees assisting with the recovery operations, beginning March 10, 1955, on the various shifts were:

Overall Direction of Bureau Activities

James Westfield

8:00 a.m. to 4:00 p.m.

Franklin Griffith		Roy C. Estep
Harry Burdelsky		T. J. Ward
W. D. Baldwin		C. D. McMaster

4:00 p.m. to 12:00 midnight

W. R. Park		Frank J. Stortz
M. L. Davis	James Haley	W. M. Cordray

12:00 midnight to 8:00 a.m.

W. Dan Walker, Jr.		Joseph Marshalek
John J. Dougherty	W. E. Gaylor	Fred Baker

Shortly after recovery operations were begun and at later dates during recovery operations, additional Bureau representatives assisted with recovery work, fire-fighting operations, and investigation of the explosion. These men, who worked from several days to several months were: H. F. Weaver, Irving Hartman, L. B. Berger, H. A. Watson, Frank Lang, John Nagy, William Rohland, Milton Satterfield, J. F. Orlando, P. M. Shay, George M. Reid, F. E. Kemrite, R. T. Reay, W. R. Melville, Henry Strubeck, J. C. Davis, W. T. Cummings, L. E. O'Connor, W. M. Demkowicz, Anthony Puskas, P. P. Senio, A. J. Lhota, and Francis Henderson. One or more Bureau representatives assisted during each shift with all recovery work, underground sealing of a mine fire near the man shaft, unsealing the fire area, and loading the hot materials in the fire area. After the fire area was recovered completely, June 1, 1955, only one Bureau employee remained at the mine daily to assist with the completion of recovery operations; however, additional Bureau employees made trips underground periodically for various reasons.

Sam S. Taylor, chief of the Petroleum and Natural Gas Branch, rendered advisory assistance, and William E. Eckard, petroleum engineer, and Frank J. Stortz, mining engineer, collected factual data and examined surface installations to determine whether the operation of natural gas transmission lines, natural gas storage pools, gas wells, and oil wells subject to gas drives had any bearing on this explosion. State and company representatives assisted and cooperated in this study. The Bureau engineers' report of their findings, Appendix D, shows that the coal pillars left to protect oil or gas wells were adequate and intact before and after the explosions, and no evidence of gas or oil emission or seepage was found around the pillars. Nothing was found to indicate that the transportation, storage, gas injection, or production of natural gas or oil contributed in any manner to the explosions or fires. Russell G. Wayland, geologist of the U. S. Geological Survey, made a geologic study of the mine area in collaboration with the Bureau engineers for a further determination. His report is included as Appendix E.

Mining Conditions Immediately Prior to the Explosion. The weather on November 13, 1954, was generally fair. The barometric pressures and temperatures as recorded at Monongah, West Virginia, which is near the mine, for nearly 16 hours prior to the explosion were as follows:

Date	Time	Pressure	Temperature
November 12	10:00 p.m.	29.60	39°F.
November 12	12:00 midnight	29.50	35°F.
November 13	4:00 a.m.	29.45	31°F.
November 13	6:00 a.m.	29.45	27°F.
November 13	10:00 a.m.	29.40	37°F.
November 13	12:00 noon	29.40	51°F.
November 13	2:00 p.m.	29.40	58°F.

It is believed that the slight change in atmospheric pressure was not a contributing factor in the explosion.

The mine ventilating pressures from the time the fan charts were changed on the afternoon of November 12 until the time of the explosion are shown in Appendix F. The sharp decrease, from 3.6 to 2.8 inches, in the No. 1 fan pressure during the period 9:00 a.m. to 1:45 p.m. and the somewhat lesser though decided gradual increase, from 2.1 to 2.45 inches, in the No. 2 fan pressure during the same period were attributed to the difference in fan characteristics as affected by the changes in temperature, were not unusual, and were not significant to the explosion. Four times during the fortnight previous to the explosion, similar decreases in the No. 1 fan pressure were accompanied by like increases in the No. 2 fan pressure at the same time of day.

The mine was idle on the day shift Saturday, November 13, except that men entered to do supervisory work, general mine ventilation inspections, maintenance, rock-dusting, surveying, pumping, and to improve the sequence of a pillar line.

The records indicate that each underground working section was fire-bossed and the air measured therein during the 2:00 p.m. to 10:00 p.m. shift November 12, and the mine operating conditions were reported as normal. A fire boss examined all working sections of the mine beginning at 2:00 a.m. and ending at 6:00 a.m., Saturday, November 13, when all sections except 4 left off 2 north were idle; again underground conditions were reported as normal. Four officials who made fire-boss runs after 7:00 a.m., Saturday, in all sections of the mine except 4 left off 2 north section, which was operating, found conditions normal. These men had returned to the surface but did not have time to record their findings before the explosion occurred.

All men entering the mine Saturday morning, November 13 were instructed to be out of the mine before 2:00 p.m., as the underground electric circuits were to be deenergized at that time to permit installation of a temporary air lock over the No. 1 fan shaft preparatory to placing new timbers in this shaft.

The foreman and four men producing coal to straighten the pillar line in 4 left off 2 north section were not regularly employed on the section and normally worked in other sections of the mine. This practice was followed regularly to equalize the work time.

Story of Explosion. The mine was idle the day of the explosion, and 24 men entered the mine that morning to do miscellaneous work as mentioned previously in this report. Four of these men, the general assistant foreman and 3 section foremen, traveled in pairs by electrically operated jeeps to all active sections of the mine. They made their routine semi-monthly measurements of the intake and return air currents, methane-content determinations with W-8 electric methane testers in the return air currents, and fire-boss examinations of all the working sections except 4 left off 2 north, in which another section foreman was working. These 4 foremen stated that they found the air quantities, methane contents, and other mine conditions normal, and they had no occasion to make any change in the ventilation system. They had returned to the surface, 2 of them within 2 or 3 minutes, before the explosion occurred.

The two mining engineers traveled by jeep to the main west and 3 north sections, where they "pointed up" the face areas. They also had returned to the surface before the explosion happened.

The mine foreman traveled throughout much of the mine by jeep, examined and made tests for gas in all the normally active working sections except main west faces, and talked with all the workmen in their working places. He, too, reported all mine conditions and ventilation normal, and had returned to the surface shortly before 1:00 p.m.

Two mechanics had completed their burning and welding operations at the reciprocating feeder near the car dump and the foot of the slope, and were on the slope bottom, awaiting a ride up the slope, for about 15 minutes before the explosion occurred. They noted that the electric lights flickered before they were engulfed in a strong rush of air and rock dust, but they did not smell smoke. One of the men said that boards were flung about them with the rush of air and dust. By that time, the slope hoist engineer signaled the men to get on the man-car and ascend the slope. They managed to find the signaling station, returned the signal, and had ridden 15 or 20 feet up the slope when the mine electric circuit was deenergized by the company's electrical engineer. They then walked out of the slope unassisted.

The section foreman and 4 men who were assigned to complete a pillar lift in 4 left off 2 north section, to improve the sequence of the pillar line, were blasting when the explosion occurred. These men moved very little after the initial blast, as their bodies were found in the same entry within 60 feet of the firing station. The position of the bodies showed that they were moving outby but were killed in their tracks (See Appendix G).

Two mechanics who were given the task of repairing electrical face equipment in 2 left section off 1 south were joined shortly before the explosion by a maintenance foreman, who traveled thereto by a mine jeep from 4 left entries off C face mains. These men had completed their duties and were on a locomotive and the jeep in 2 left haulageway just starting out for the man shaft when the explosion occurred. The locomotive and the derailed jeep were found about 10 blocks outby the face equipment in 2 left. None of these men was injured or burned, and they apparently procured self-rescuers and 2 gas masks from the section "dinner hole" and started on foot toward the man shaft. Forces of the subsequent explosions obliterated much evidence of their travel; it is believed, however, that they reached a point near the junction of 1 south and main west entries, as parts of at least 3 self-rescuers were found in 1 south near this junction, and that they returned to 2 left and proceeded to a crosscut between Nos. 6 and 7 entries one block outby the "dinner hole", where their bodies were found (See Appendix H) The bodies were lying close together on canvas and partly covered with blankets. Indications were that the men had been using self-rescuers, as 3 spent self-rescuers were lying on the floor nearby and a spent self-rescuer was on each body; however, the gas masks had not been used and the victims had made no attempt to erect a barricade or leave a written message. Seven unused self-rescuers were lying on the floor, one of the gas masks had not been removed from its container, and the other gas mask was attached to one of the bodies, but the victim had not donned the facepiece nor broken the cannister seal. It is assumed from the number of self-rescuers used and the distance the men are believed to have traveled that they lived for approximately 90 minutes after the first explosion. There was no possible chance of these men escaping to the surface or of being rescued, as the only means of egress was more than 4 miles distant and the intervening area was contaminated excessively by smoke and other noxious products of the explosion and extensive fires.

Face electric equipment in 4 left off C face mains had been repaired by two other mechanics; these men were on a locomotive en route to the man shaft and had practically reached the underground shop near the man shaft when they were killed by the explosion. Their bodies were found about 70 feet apart under the huge fall in the diagonal entry of the fire area, and their locomotive between the bodies (See Appendix I). Another man, a pumper, after performing his duties in various parts of the mine was en route to and within 600 feet of the man shaft when killed. This body was under the fall in the fire area in the straight entry west of the shaft and about 60 feet outby the wrecked jeep that the victim was using. The other four underground victims distributed rock dust in 3 north and main west sections; these men had completed their duties, had parked their equipment, and were walking and within 400 feet of the man shaft when killed by the explosion. Two of these bodies were found at the northeast corner of the first north diagonal off the west shaft entry; the other two were at the northeast corner of the second diagonal entry. A lampman working in the combination surface building at the man-shaft portal was also killed by the explosion.

The initial explosion was propagated throughout a great part of the mine and forces extended to the surface through the slope, man shaft, and No. 2 fan-shaft openings. Several local mine officials who were in the mine offices at the man-shaft portal when the explosion occurred notified the management officials.

The explosions caused extensive damage underground and on the surface. The concrete linings of the man shaft and No. 2 fan shaft spalled and were chipped and cracked at many places. The No. 2 fan air duct and an end of the fan house were destroyed; the elevator, guides, and the hoisting equipment and housing at the man shaft were destroyed or damaged to the extent that all except the hoist motors had to be replaced. A combination building adjoining the man shaft, housing a bath house, lamp room, waiting room, foremen's offices, boiler room, supply room, clerical offices, engineer's quarters, first-aid room, mine-rescue equipment room, and superintendent's and general manager's offices, was damaged extensively. The first explosion could have caused considerable loss of life on the surface had it occurred on a regular work day when large groups of men preparing to enter the mine for the second shift congregated in the bath house and on benches near the man shaft while waiting for the elevator.

The underground ventilation system was almost completely disrupted, in that about 600 permanent stoppings, 28 overcasts, and many regulators were demolished. Other property damage included blown down power wires, power feeder cables, and trolley wires at numerous places throughout the explosion area. Telephone lines were broken and down along the greater part of the system. Dislodged timbers and concrete piers caused some roof falls, but numerous small to extensive roof falls occurred in areas where the roof was not supported and where fires burned the top-coal roof. The more extensive roof falls occurred near the man shaft, around all entrances to No. 2 fan shaft, at many places in the main west airways east and west of the No. 2 fan shaft, in 2 and 3 north entries, 1 south entries, 10 right entries, main west entries, and north main entries. Smaller roof falls occurred at many locations throughout that part of the mine inby the junction of 9 right entries and C face mains. Damage to the face electric equipment was extensive only in the main west section; such equipment in 2 left off 1 south, in 4 right off 3 north, and in 4 left and 5 left off C face mains was not affected by forces or flame. The substation in 2 north was wrecked, the substation in 3 north was impaired slightly, and the automatic circuit breakers along the haulageways were blown about. Haulage equipment near the main west faces, near the junction of the main west and C face mains, and near the man-shaft bottom was damaged considerably by forces of the explosion, fire, and/or roof falls. The underground shop, waiting rooms near the man shaft, supply station, pump room, and dispatcher's office were wrecked completely. The openings in which the fire rekindled during recovery operations were damaged to the extent that they had to be abandoned and replaced by new openings between the shops and the man shaft and main haulageway. The greater part of the mine surfaces were covered with fine coal dust and soot.

The explosions and fires resulted in loss of production from November 13, 1954, until July 24, 1955, when two sections, 4 and 5 left off C face mains, resumed operations. The 2 left off 1 south section and the main west section were cleaned up and resumed operations November 29, 1955, and January 23, 1956, respectively. The 4 left off 2 north section was rehabilitated but was abandoned without resuming operations; however, a new working section was opened off the east side of 2 north entries outby 1 left on February 10, 1956. Track and all other equipment were removed from the abandoned part of 2 north section. The 4 right off 3 north section was ventilated and examined but had not been recovered when this report was prepared.

Recovery Operations. Following the explosion at 1:45 p.m., November 13, and the arrival of company officials and representatives of the West Virginia Department of Mines and the Bureau of Mines, an organization was set up to direct rescue and recovery work. Direction of the recovery work was turned over to W. M. Berry, inspector-at-large, West Virginia Department of Mines; John J. Dougherty, subdistrict supervisor, Bureau of Mines; and George W. McCaa, general manager, Jamison Coal and Coke Company.

Six mine-rescue teams were available at the mine by 5:00 p.m., November 13, and all the materials necessary for orderly recovery work were available. Police and charitable organizations rendered commendable assistance.

Because the No. 2 fan shaft and the man shaft were rendered inaccessible by the explosion and subsequent fires, recovery operations were started from the slope entrance, which is about 2-1/2 miles from the man shaft and on intake air provided by the No. 1 fan. A mine-rescue team accompanied by representatives of the company, the West Virginia Department of Mines, and the Bureau of Mines entered the mine at 5:40 p.m., with instructions to inspect the slope and the slope bottom and to report conditions to established headquarters on the surface. A standby rescue team was held in readiness at the top of the slope. At 6:00 p.m. the advance rescue team reported that the slope and slope bottom had not been damaged, there was no evidence of fire, and ventilation at the slope bottom was normal; then, a second rescue team and representatives of the aforementioned organizations descended the slope to stand by while the first rescue team examined the several openings around the slope bottom; and a third rescue team was held in readiness at the top of the slope. The first team had completed the exploration of the slope-bottom area as far as the junction of main north entries and the main haulageway and returned to the fresh-air base near the slope bottom by 7:22 p.m. At this time, both teams were instructed to proceed to and establish a fresh-air base at the junction of main north and the main haulageway; this new base was established at 7:50 p.m. Upon checking the ventilation a short distance inby the new fresh-air base, it was found that 23,000 cubic feet of air a minute was traveling into the new haulageway of main north, but an air measurement could not be obtained with an anemometer along the main haulageway inby main north junction, and a trace of carbon monoxide was detected on this haulageway. These findings were reported to the surface headquarters. At 8:05 p.m., just prior to the time the rescue crews reported their findings, the return air at No. 1 fan had a methane content of 2.5 percent, which was approximately 10 times greater than normal, and a carbon monoxide content of 0.02 percent. The increasing amount of methane in the return air and the likelihood of underground fires suggested the possibility of a serious condition developing in the mine, and there was a strong possibility of a high concentration of methane, due to destruction of the ventilating controls in the area to be penetrated by the mine rescue crews. These circumstances and the presence of carbon monoxide just inby the recently established fresh-air base indicated danger of an immediate second explosion, and prompted the officials in charge to direct the mine rescue crews and others to return to the surface. These men had returned to the surface by 8:40 p.m., after having penetrated the mine workings for a distance of 2,900 feet. The expected second explosion occurred about 10:30 p.m., when, according to witnesses flame and smoke burst out of the No. 2 fan shaft to a height of 100 feet or more. At about 11:00 p.m., smoke and fumes containing carbon monoxide began to flow from the slope that had been used as an exploratory travelway, and dense smoke was being exhausted from the mine by the No. 1 fan; this fan was stopped at 11:25 p.m.

After the surface openings of the mine had been examined, a conference of responsible officials was convened at 12:30 a.m., Sunday, November 14, to decide if and what further efforts should be made to recover the entrapped personnel. Those in attendance were:

<u>Jamison Coal and Coke Company</u>

W. B. Jamison	Vice President
George W. McCaa	General Manager
George C. Cain	Superintendent, No. 9 mine

<u>Hanna Coal Company</u>

James Hyslop	President

<u>West Virginia Department of Mines</u>

Frank B. King	Chief
Julius C. Olzer	Administrative Assistant
W. M. Berry	Inspector-at-Large
Roy L. Graham	Director of Mine Rescue and Safety

Table 1 - Analytical Results of Air Samples Collected at
No. 9 Mine, Jamison Coal and Coke Company
Farmington, Marion County, West Virginia

Bottle No.	Date	Location	PERCENT IN VOLUME						
			Carbon Dioxide	Oxygen	Hydrogen	Carbon Monoxide	Methane	Ethane	Nitrogen
F2243	11/14/54	No. 1 Fan	2.05	16.60	0.75	1.06	1.05		78.49
F5252	11/14/54	No. 2 Fan Shaft	8.9	5.5	1.7	1.4	2.9		79.6
F8208	11/14/54	Plum Run Borehole	2.07	17.09	0.66	0.74	0.95		78.49
F6826	11/16/54	No. 2 Fan Shaft	4.3	10.0	0.7	1.3	4.3	0.7	78.7
F6957	11/17/54	No. 2 Fan Shaft	3.6	10.4	0.6	1.3	6.7	0.6	76.8
F8207	11/18/54	Sand Hole	3.8	8.4	0.7	1.5	9.7	0.0	75.9
J1349	11/24/54	Sand Hole	4.0	5.5	0.5	1.4	18.8	0.0	69.8
F7202	12/1/54	Sand Hole	3.1	6.5	0.3	0.9	22.0	0.0	67.2
F6810	12/7/54	Sand Hole	3.2	5.5	0.2	0.7	25.9	0.0	64.5
J1396	12/15/54	Sand Hole	3.6	2.2		0.5	35.7		58.0
J3650	12/22/54	Sand Hole	3.7	1.7		0.5	39.6		54.5
J3186	12/31/54	Sand Hole	3.6	1.6		0.15	42.8		51.85
F7195	1/7/55	Sand Hole	3.7	1.2		0.09	45.9		49.11
F6375	1/17/55	Sand Hole	3.8	0.8	0.0	0.04	49.9		45.46
F5620	1/24/55	Sand Hole	3.9	0.6	0.0	0.02	52.7		42.78

Table 1 - Analytical Results of Air Samples Collected at
No. 9 Mine, Jamison Coal and Coke Company
Farmington, Marion County, West Virginia

Bottle No.	Date	Location	PERCENT IN VOLUME						
			Carbon Dioxide	Oxygen	Hydrogen	Carbon Monoxide	Methane	Ethane	Nitrogen
F5150	2/1/55	Sand Hole	3.8	0.5	0.0	0.01	55.0		40.69
J3453	2/8/55	Sand Hole	3.8	0.9	0.0	0.01	55.6		39.69
F7262	2/16/55	Sand Hole	4.1	1.1	0.0	0.01	56.8		37.99
J3421	2/24/55	Sand Hole	4.0	0.5		*	58.6		36.9
J3651	3/1/55	Sand Hole	4.3	0.9		**	60.2		34.6
J1376	3/8/55	Sand Hole	4.4	0.2		**	62.2		33.2
	3/10/55	Sand Hole	3.7	0.6		0.0	67.5		28.2
	3/10/55	No. 1 Fan Shaft	3.5	5.5		0.0	44.2		46.8
	3/11/55	Core Hole	4.1	0.6			60.7		34.6
	3/11/55	Core Hole	0.0	20.7			1.0		78.3
	3/11/55	Sand Hole	3.1	5.7			47.4		43.8
	3/12/55	Sand Hole	2.6	9.4			38.9		49.1
	3/12/55	No. 2 Fan Shaft	3.7	1.2			67.8		27.3

* Not over 0.001% by modified pyrotannic method.

** Not detectable by modified pyrotannic acid method.

Table 1 - Analytical Results of Air Samples Collected at
No. 9 Mine, Jamison Coal and Coke Company
Farmington, Marion County, West Virginia

Bottle No.	Date	Location	PERCENT IN VOLUME Carbon Dioxide	Oxygen	Hydrogen	Carbon Monoxide	Methane	Ethane	Nitrogen
	3/12/55	No. 1 Fan Shaft	2.2	15.2		0.0	15.8		66.8
	3/14/55	No. 1 Fan Shaft	0.6	19.5		0.0	3.3		76.6
	3/14/55	No. 2 Fan Shaft	0.3	19.6		0.0	3.2		76.9
	3/15/55	No. 1 Fan Shaft	0.6	19.7		0.0	2.7		77.0
	3/15/55	No. 2 Fan Shaft	0.3	19.9		0.0	2.7		77.1
	3/16/55	No. 1 Fan Shaft	0.7	19.3		0.0	3.0		77.0
	3/16/55	No. 2 Fan Shaft	0.3	20.3		0.0	2.3		77.1
	3/16/55	Plum Run Borehole	1.2	17.3		0.0	11.1		70.4

Sheet 1

TABLE 3 ANALYSES OF MINE DUST SAMPLES COLLECTED AFTER EXPLOSION

Can No.	Samples of Dust From	Location in Mine	As Received Percent Incombustible
D-2	Band	Main butt "A" panels, No. 1 entry between Nos. 79 and 80 crosscuts, track entry, ash ballasts	98.4
D-3	Band	Main butt "A" panels, No. 2 entry between Nos. 79 and 80 crosscuts, track entry	99.0
D-1	Band	Main butt "A" panels, No. 2 entry between Nos. 4 and 5 crosscuts (Haulageway)	91.0
D-8	Band	Main butt "A" parallels, No. 3 entry between Nos. 29 and 30 crosscuts (Intake air, back entry, ribs sloughing)	30.0
D-9	Band	Main butt "A" parallels, No. 4 entry between Nos. 29 and 30 crosscuts (Intake airway, back entry, some sloughing)	24.3
D-37	Band	Slope bottom landing	93.8
D-14	Band	Load haulageway, 50 feet inby No. 1 substation borehole	88.7
D-15	Band	Load haulageway, parallel, 50 feet inby No. 1 substation borehole	72.0
D-16	Band	Slope bottom, main empty track No. 1, 100 feet inby first crosscut	90.9
D-17	Band	Slope bottom, main empty track No. 3, 50 feet inby No. 88 crosscut	94.4
D-10	Band	No. 1 loaded track, main slope bottom, 100 feet inby first crosscut, track ballast with slag	99.1
D-11	Band	No. 2 loaded track, main slope bottom, 50 feet inby first crosscut to right, track ballasted with slag	74.5
D-4	Band	Slope bottom supply track between 82 and 83 crosscuts	99.6

Sheet 2

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
S-60	Band	No. 5 heading 4 right off 3 north between 60 and 61 crosscuts (Parallel entry)	39.9	None
S-65	Band	No. 6 heading 4 right off 3 north between 60 and 61 crosscuts (Haulage entry)	64.3	None
S-39	Band	No. 1 heading 4 right off 3 north between 62 and 63 crosscuts (Back entry)	40.9	None
S-33	Band	No. 2 heading 4 right off 3 north between 62 and 63 crosscuts (Back entry)	45.3	None
S-28	Band	No. 3 heading 4 right off 3 north between 62 and 63 crosscuts (Parallel entry)	45.8	None
S-26	Band	No. 4 heading 4 right off 3 north between 62 and 63 crosscuts (Parallel entry)	30.3	None
S-19	Band	No. 5 heading 4 right off 3 north between Nos. 62 and 63 crosscuts (Parallel entry)	29.9	None
S-16	Band	No. 6 heading 4 right off 3 north between 62 and 63 crosscuts (Parallel entry)	36.0	None
S-11	Band	No. 7 heading 4 right off 3 north between 61 and 62 crosscuts (Back entry)	35.2	None

Sheet 3

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-142	Rib & Roof	Main west, No. 4 entry between crosscuts Nos. 332 and 333 (Back entry - Bottom too wet for sampling)	43.7	Large
D-143	Band	Main west, No. 5 entry between crosscuts Nos. 332 and 333 (back entry)	30.7	Large
D-144	Band	Main west, No. 1 entry between crosscuts 353 and 354 (return airway)	43.8	Large
D-145	Bottom & Rib	Main west, No. 2 entry between crosscuts 353 and 354 (Return airway - Top too wet to sample)	60.3	Small
D-146	Band	Main west, No. 3 entry between crosscuts 353 and 354 (haulage track)	25.5	Large
D-147	Band	Main west, No. 4 entry between crosscuts 353 and 354 (back entry)	27.7	Trace
D-148	Band*	Main west, No. 5 entry between crosscuts 353 and 354 (haulageway)	38.9	Small
D-149	Band*	Main west, No. 6 entry between crosscuts 353 and 354 (back entry)	31.9	Small

*Sample from rock-dusted area

Sheet 4

Can No.	Samples of Dust From	Location in Mine	As Received Percent Incombustible
D-5	Band	Main butt "A" parallels, No. 1 entry between second and third crosscuts outby the No. 41 angle entry (Abandoned track entry)	85.5
D-6	Band	Main butt "A" parallels, No. 2 entry opposite Nos. 35 and 36 crosscuts on No. 3 entry (Intake airway, back entry, ribs sloughing)	31.9
D-7	Band	Main butt "A" parallels, No. 3 entry between Nos. 35 and 36 crosscuts (Intake airway, back entry, ribs sloughing)	37.1

Sheet 5

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
152	Band	No. 2 heading main north, between Nos. 52 and 54 crosscuts	40.8	Large
153	Band	No. 3 heading main north, between Nos. 52 and 54 crosscuts	29.7	Small
154	Band	No. 4 heading main north, between Nos. 52 and 54 crosscuts	29.5	Very large
155	Band	No. 5 heading main north, between Nos. 52 and 54 crosscuts	24.6	Large
156	Band	No. 6 heading main north, between Nos. 52 and 54 crosscuts	37.6	Small
149	Band	No. 2 heading main north, between Nos. 57 and 58 crosscuts	36.6	Small
150	Band	No. 3 heading main north, between Nos. 57 and 58 crosscuts	47.3	Small
151	Band	No. 4 heading main north, between Nos. 57 and 58 crosscuts	44.7	Small
145	Band	No. 1 heading main north, between Nos. 69 and 70 crosscuts	68.3	Trace
146	Band	No. 2 heading main north, between Nos. 69 and 70 crosscuts	33.6	Small
147	Band	No. 3 heading main north, between Nos. 69 and and 70 crosscuts	49.4	Small
148	Band	No. 4 heading main north, between Nos. 69 and 70 crosscuts	74.3	Trace

Sheet 6

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
141	Band	No. 1 heading main north, between Nos. 76 and 77 crosscuts	59.3	Small
142	Band	No. 2 heading main north, between Nos. 76 and 77 crosscuts	35.5	Small
143	Band	No. 3 heading main north, between Nos. 76 and 77 crosscuts	34.4	Small
144	Band	No. 4 heading main north, between Nos. 76 and 77 crosscuts	68.7	Trace
139	Band	No. 1 heading main north, at inby corner of No. 185 crosscut	85.6	None
140	Band	No. 2 heading main north, at inby corner of No. 185 crosscut	53.3	None
D-32	Band	Main north between crosscuts Nos. 113 and 114 (Abandoned haulage road)	65.0	None
D-33	Band	Main north, No. 2 entry between crosscuts Nos. 113 and 114 (Back entry)	36.2	None
D-34	Band	Main north, No. 3 entry between Nos. 113 and 114 crosscuts (Back entry)	53.3	None
D-35	Band	Main north, No. 1 entry between crosscuts Nos. 106 and 107, haulageway under construction, cinder ballasts, roof too high to sample	86.4	
D-36	Band	Main north, No. 2 entry between crosscuts Nos. 106 and 107 (Back entry)	54.7	

Sheet 7

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-18	Band	Main north, No. 2 entry, between crosscuts Nos. 101 and 102	56.5	
D-19	Band	Main north, No. 1 entry, 80 feet outby crosscut No. 100	83.1	
157	Band	No. 1 heading of bleeders between extreme east ends of 10 right and main west returns, midway between 10 right and main west	23.9	Small
158	Band	No. 2 heading of bleeders between extreme east ends of 10 right and main west returns, midway between 10 right and main west	21.9	Small
D-27	Band	Main haulage road at its intersection with No. 1 entry of 2 west between crosscuts Nos. 131 and 132	95.1	None
D-26	Band	No. 2 west, No. 3 entry opposite No. 73 crosscut on No. 5 entry (Back entry)*	49.2	
D-25	Band	No. 2 west, No. 4 entry outby No. 73 crosscut (Back entry)*	42.2	
D-24	Band	No. 2 west, No. 5 entry between Nos. 72 and 73 crosscuts (Abandoned haulage entry)*	65.6	
D-23	Band	No. 2 west, No. 3 entry between Nos. 60 and 61 crosscuts (Back entry)	71.6	
D-22	Band	No. 2 west, No. 4 entry between Nos. 60 and 61 crosscuts (Old track entry)*	89.2	
D-21	Band	No. 2 west, No. 5 entry between Nos. 60 and 61 crosscuts (Back entry)*	34.5	

*Sample from rock-dusted area

Can No	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-13	Band	No. 2 west, No. 2 entry, 100 feet of loaded track	72.4	
D-12	Band (12" width)	No. 2 west, No. 4 entry, 150 feet south of end of loaded track	49.9	
D-30	Band	Main haulage road, 9-10 left between Nos. 161 and 162 crosscuts (Track entry)	86.3	None
D-31	Band	No. 9-10 left, No. 4 entry opposite crosscut No. 162 (Back entry)	76.6	None
D-171	Band*	9 and 10 left, No. 5 entry between X-cuts 161 and 162 (Return airway)	36.1	None
D-173	Band	9 and 10 left, No. 1 entry between X-cuts 143 and 144 (Return airway)	82.3	None
D-172	Band*	9 and 10 left, No. 2 entry between X-cuts Nos. 143 and 144 (Return airway)	68.0	None
D-28	Band	Main haulage road in Nos. 9 and 10 left between crosscuts Nos. 143 and 144 (Track entry)	83.9	None
D-29	Band	No. 10 left, No. 4 entry, opposite No. 144 crosscut (Back entry)	66.7	None
D-174	Band	9 and 10 left, No. 5 entry between X-cuts 143 and 144 (Return airway)	20.1	None
D-175	Band	9 and 10 left, No. 6 entry between X-cuts 143 and 144 (Return airway)	48.6	None

*Sample from rock-dusted area

Sheet 9

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-20	Band	Nos. 9 and 10 left butts, No. 3 entry, 10 feet inby second crosscut west of main north haulageway*	60.1	
D-43	Band	Main face "C", No. 4 left, No. 1 entry between 1st and 2nd crosscuts (Return airway)	77.6	None
D-44	Band	Main face "C", No. 4 left, No. 2 entry between 1st and 2nd crosscuts (Return airway)	80.7	None
D-45	Band	Main face "C", No. 4 left, No. 3 entry (Haulageway) between 1st and 2nd crosscuts	92.9	None
D-160	Band	Main face "C", No. 4 left, No. 4 entry between X-cuts Nos. 1 and 2 (Back entry)	37.6	None
D-46	Band	Main face "C", No. 4 left, No. 5 entry (Back entry) between 1st and 2nd crosscuts	89.3	None
D-159	Band	Main face "C", No. 4 left, No. 6 entry between X-cuts Nos. 1 and 2 (Haulage track)	34.3	None
D-47	Band	Main face "C", No. 4 left, No. 7 entry (return airway) between 1st and 2nd crosscuts	98.2	None
D-53	Band	Main face "C", No. 4 left, No. 1 entry (return airway) 50 feet outby 3rd loading point	96.4	
D-52	Band	Main face "C", No. 4 left, No. 2 entry (return airway) 50 feet outby 3rd loading point	95.7	
D-50	Band	Main face "C", No. 4 left, No. 3 entry (haulageway) 50 feet outby 3rd loading point*	86.1	
D-49	Band	Main face "C", No. 4 left, No. 4 entry, 50 feet outby 3rd loading point (back entry)*	59.4	

*Sample from rock-dusted area

Sheet 10

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-161	Band	Main face "C", No. 4 left, No. 5 entry between X-cuts 6 and 7 (Haulage track)	62.5	None
D-48	Band	Main face "C", No. 4 left, No. 6 entry (track entry) 50 feet outby 3rd loading point*	84.9	
D-51	Band	Main face "C", No. 4 left, No. 7 entry (return airway) 50 feet outby 3rd loading point*	76.2	
D-62	Band	Main face "C", No. 5 left, No. 1 entry, 60 feet inby regulator (return airway)*	89.7	None
D-63	Band	Main face "C", 5 left, No. 2 entry, 30 feet inby No. 1 loading point (track entry)*	73.7	None
D-64	Band	Main face "C", 5 left, No. 3 entry, 30 feet inby No. 1 loading point*	51.6	None
D-65	Band	Main face "C", 5 left, No. 4 entry, 30 feet inby No. 1 loading point (track haulage)*	81.4	None
D-157	Band	Main face "C", 5 left, No. 5 entry between X-cuts Nos. 1 and 2 (back entry)	66.2	None
D-66	Band	Main face "C", 5 left, No. 6 entry, 30 feet inby 1st crosscut (back entry)*	79.5	None
D-158	Band	Main face "C", 5 left, No. 7 entry between X-cut Nos. 1 and 2 (return airway)	88.1	None

*Sample from rock-dusted area

Sheet 11

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-67	Band	Main face "C", No. 5 left, No. 1 entry, 70 feet inby No. 3 loading point (return airway)*	93.9	
D-68	Band	Main face "C", No. 5 left, No. 2 entry, 70 feet inby No. 3 loading point*	47.0	
D-69	Band	Main face "C", No. 5 left, No. 3 entry, 70 feet inby 3rd loading point*	35.3	
D-70	Band	Main face "C", No. 5 left, No. 4 entry, 70 feet inby 3rd loading point	51.7	
D-71	Band	Main face "C", No. 5 left, No. 5 entry, 70 feet inby 3rd loading point*	37.9	
D-72	Band	Main face "C", No. 5 left, No. 6 entry, 70 feet inby No. 3 loading point (return airway)	86.7	
D-73	Band	Main face "C", No. 5 left, No. 7 entry, 70 feet inby 3rd loading point (return airway)	67.8	
D-78	Band	Main face "C", No. 2 entry between crosscuts Nos. 229 and 230 (back entry)	34.6	Small
D-79	Band	Main face "C", No. 3 entry between crosscuts Nos. 229 and 230 (sidetrack)	57.6	Small
D-80	Band	Main face "C", No. 4 entry between crosscuts Nos. 229 and 230 (haulageway)*	50.3	Small

*Sample from rock-dusted area

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-81	Band	Main face "C", No. 5 entry between crosscuts Nos. 229 and 230 (back entry)*	30.5	Small
D-82	Band	Main face "C", No. 6 entry between crosscuts Nos. 229 and 230 (back entry)*	29.9	Small
D-83	Band	Main face "C", No. 7 entry between crosscuts Nos. 229 and 230 (back entry)	32.1	Small
D-77	Band	Main face "C", No. 5 entry between crosscuts 220 and 221 (back entry)	29.1	Trace
D-74	Band	Main face "C", No. 1 entry between crosscuts 219 and 220, (return airway)	26.3	Trace
D-75	Band	Main face "C", No. 2 entry between crosscuts 219 and 220 (return airway)	31.8	Trace
D-76	Band	Main face "C", No. 3 entry between 219 and 220 crosscuts (main haulageway)	51.5	Trace
D-55	Band	Main face "C", No. 1 entry, 15 feet outby No. 1 entry of 5 left (back entry)*	75.3	None
D-56	Band	Main face "C", No. 2 entry, 15 feet outby crosscut No. 203 (back entry)*	61.4	None
D-57	Band	Main face "C", No. 3 entry, 15 feet outby crosscut No. 203 (main haulageway)*	84.3	None
D-58	Band	Main face "C", No. 4 entry, 200 feet outby 6 right chute (back entry)	32.8	None

*Sample from rock-dusted area

Sheet 13

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-59	Band	Main face "C", No. 5 entry, 250 feet outby 6 right chute (back entry)*	35.8	None
D-60	Band	Main face "C", No. 6 entry, 250 feet outby 6 right (back entry)*	33.4	None
D-61	Band	Main face "C", No. 7 entry, 250 feet outby No. 6 right (back entry)*	37.2	None
D-54	Band	Main face "C", No. 1 entry, 10 feet inby No. 8 entry, 3 left (back entry)*	73.1	None
D-164	Band	Main face "C", No. 2 entry between X-cuts 191 and 192 (back entry)	53.2	None
D-163	Band	Main face "C", No. 4 entry between X-cuts 190 and 191 (back entry)	52.4	None
D-165	Band	Main face "C", No. 1 entry between X-cuts Nos. 192 and 193 (back entry)	87.0	None
D-166	Band	Main face "C", No. 3 left, first X-cut between Nos. 4 and 5 (return airway)	79.5	None
D-162	Band	Main face "C", No. 5 entry, opposite No. 189 X-cut (back entry)	60.7	None
D-41	Band	Main face "C", No. 6 entry, 150 feet outby No. 4 right (return airway)	43.7	None
D-42	Band	Main face "C", No. 7 entry, 150 feet outby 4 right (back entry)	59.8	None

*Sample from rock-dusted area

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-167	Band*	Main face "C", No. 1 entry between X-cuts 176 and 177 (return airway)	59.1	None
D-168	Band*	Main face "C", No. 2 entry between X-cuts Nos. 176 and 177 (back entry)	66.5	None
D-40	Band	Main face "C", No. 3 entry, 100 feet outby 2 right entry, inby crosscut No. 176 (main haulageway)	85.4	None
D-39	Band	Main face "C", No. 4 entry, 100 feet outby No. 2 right entry (back entry)	37.8	None
D-38	Band	Main face "C", No. 5 entry, 100 feet outby No. 2 right (back entry-bottom cut and heaved)	37.1	None
D-169	Band*	Main face "C", No. 6 entry between X-cuts 176 and 177 (return airway)	25.3	None
D-170	Band*	Main face "C", No. 7 entry between X-cuts 176 and 177 (return airway)	30.9	None
D-109	Band	"D" face, No. 1 entry between crosscuts Nos. 5 and 6 (return airway)*	28.8	Small
D-108	Band	"D" face, No. 2 entry between crosscuts Nos. 6 and 7 (return airway)*	27.0	Small
D-107	Band	"D" face, No. 3 entry between crosscuts Nos. 6 and 7 (return airway)*	25.4	Small
D-106	Band	"D" face, No. 4 entry between crosscuts Nos. 6 and 7 (return airway)	28.7	Small
D-105	Band	"D" face, No. 5 entry between crosscuts Nos. 6 and 7 (return airway)	24.0	Small

*Sample from rock-dusted area

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-104	Band	"D" face, No. 6 entry between crosscuts Nos. 6 and 7 (return airway)	26.6	Small
D-123	Band	"E" face, No. 1 entry between crosscuts Nos. 2 and 3 (return airway)*	44.4	Large
D-122	Band	"E" face, No. 2 entry between crosscuts Nos. 2 and 3 (return airway)*	32.7	Large
D-121	Band	"E" face, No. 3 entry between crosscuts Nos. 2 and 3 (return airway)*	36.5	Small
D-120	Band	"E" face, No. 4 entry between crosscuts Nos. 5 and 6 (return airway)	26.6	Large
D-119	Band	"E" face, No. 5 entry between crosscuts Nos. 5 and 6 (return airway)*	32.3	Small
D-118	Band	"E" face, No. 6 entry between crosscuts Nos. 5 and 6 (return airway)*	33.1	Small
D-117	Band	"E" face, No. 7 entry between crosscuts Nos. 5 and 6 (return airway)*	35.1	Very large
D-131	Band	No. 1 south, No. 2 left, No. 1 entry between crosscuts Nos. 7 and 8 (return airway)	91.0	None
D-132	Band	No. 1 south, No. 2 left, No. 2 entry between crosscuts Nos. 7 and 8 (return airway)	92.6	None
D-133	Band	No. 1 south, No. 2 left, No. 3 entry between crosscuts Nos. 7 and 8 (haulage road)*	76.2	None

*Sample from rock-dusted area

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-150	Band*	No. 1 south, No. 2 left, No. 4 entry between crosscuts 7 and 8 (back entry)	41.6	None
D-151	Rib & Roof	No. 1 south, No. 2 left, No. 5 entry between crosscuts 7 and 8 (back entry - bottom too wet for sampling)	71.5	---
D-152	Band*	No. 1 south, No. 2 left, No. 6 entry between crosscuts 7 and 8 (haulageway)	48.6	None
D-134	Band	No. 1 south, No. 1 entry between crosscuts Nos. 17 and 18 (return airway)*	54.3	Small
D-135	Band	No. 1 south, No. 2 entry between crosscuts Nos. 17 and 18 (return airway)*	27.9	Small
D-136	Band	No. 1 south, No. 3 entry between crosscuts Nos. 17 and 18 (back entry)*	46.7	Trace
D-137	Band	No. 1 south, No. 4 entry between crosscuts Nos. 17 and 18 (haulage track)*	61.2	Trace
D-138	Band	No. 1 south, No. 5 entry between crosscuts Nos. 17 and 18 (back entry)*	36.2	Trace
59	Band	No. 1 heading, 4 left, 2 north, between Nos. 2 and 3 crosscuts	95.1	Small
41	Band	No. 2 heading, 4 left, 2 north, just inby No. 1 crosscut	75.6	Trace
40	Band	No. 3 heading, 4 left, 2 north, between Nos. 2 and 3 crosscuts	56.2	Very large

*Sample from rock-dusted area

Sheet 17

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
39	Band	No. 4 heading, 4 left, 2 north, between Nos. 2 and 3 crosscuts	37.5	Small
38	Band	No. 5 heading, 4 left, 2 north, between Nos. 2 and 3 crosscuts	79.2	Trace
37	Band	No. 6 heading, 4 left, 2 north, between Nos. 2 and 3 crosscuts	36.2	Small
52	Band	No. 7 heading, 4 left, 2 north, between Nos. 2 and 3 crosscuts	95.7	Trace
53	Band	No. 8 heading, 4 left, 2 north, between Nos. 2 and 3 crosscuts	92.6	Trace
57	Band	No. 1 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	93.3	Trace
58	Band	No. 2 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	95.3	Trace
45	Band	No. 3 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	58.5	Small
44	Band	No. 4 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	35.0	Small
43	Band	No. 5 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	46.8	Small
42	Band	No. 6 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	55.2	Small

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
54	Band	No. 7 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	97.1	None
55	Band	No. 8 heading, 4 left, 2 north, between Nos. 4 and 5 crosscuts	98.1	Trace
60	Band	No. 1 heading, 4 left, 2 north, between Nos. 6 and 7 crosscuts (No. 2 heading caved)	87.9	Trace
46	Band	No. 3 heading, 4 left, 2 north, between Nos. 6 and 7 crosscuts	53.4	Small
47	Band	No. 4 heading, 4 left, 2 north, between Nos. 6 and 7 crosscuts	33.2	Large
48	Band	No. 5 heading, 4 left, 2 north, between Nos. 6 and 7 crosscuts	40.8	Small
49	Band	No. 6 heading, 4 left, 2 north, between Nos. 6 and 7 crosscuts	39.0	Small
50	Band	No. 7 heading, 4 left, 2 north, between Nos. 6 and 7 crosscuts	70.0	Small
56	Band	No. 8 heading, 4 left, 2 north, between Nos. 6 and 7 crosscuts	94.0	Small
51	Band	No. 6 heading, 4 left, 2 north, just inby No. 8 crosscut	34.3	Small
81	Floor	No. 1 heading, 2 north between Nos. 14 and 15 crosscuts (Roof and ribs heavily coked, 1/2" coke and roof coal brushed off floor before sampling at this location)	21.1	Small
80	Band	No. 2 heading, 2 north between Nos. 14 and 15 crosscuts	21.2	Small

Sheet 19

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
79	Band	No. 3 heading, 2 north between Nos. 14 and 15 crosscuts	33.4	Trace
17	Band	No. 4 heading (haulage), 2 north, between Nos. 14 and 15 crosscuts	65.8	Trace
1	Band	No. 6 heading, 2 north, between Nos. 14 and 15 crosscuts	24.0	Large
2	Band	No. 7 heading, 2 north, between Nos. 14 and 15 crosscuts	39.6	Small
19	Band	No. 5 heading, 2 north, just outby No. 20 crosscut	44.7	Small
83	Band	No. 2 heading, 2 north between Nos. 20 and 21 crosscuts (No. 1 heading caved at this location)	25.4	Trace
82	Band	No. 3 heading, 2 north between Nos. 20 and 21 crosscuts	38.3	Trace
18	Roof & Rib*	No. 4 heading, 2 north between Nos. 20 and 21 crosscuts	58.2	Trace
3	Band	No. 6 heading, 2 north, between Nos. 20 and 21 crosscuts	35.2	Large
4	Band	No. 7 heading, 2 north, between Nos. 20 and 21 crosscuts	38.4	Trace
84	Band	No. 3 heading, 2 north between Nos. 23 and 24 crosscuts	35.2	Trace
20	Band	No. 4 heading, 2 north, between Nos. 24 and 25 crosscuts	56.5	Trace

*Floor too wet for sampling

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
5	Band	No. 5 heading, 2 north between Nos. 24 and 25 crosscuts (Nos. 6 and 7 headings caved)	49.6	Trace
70	Band	No. 1 crosscut between Nos. 1 and 2 headings 1 left, 2 north	44.5	Small
71	Band	No. 2 crosscut between Nos. 1 and 2 headings, 1 left, 2 north	47.0	Small
72	Band	No. 2 heading, 2 north, between Nos. 31 and 32 crosscuts	44.7	Trace
22	Band	No. 3 heading, 2 north, between Nos. 32 and 33 crosscuts	57.7	Trace
21	Roof & Rib*	No. 4 heading, 2 north, between Nos. 31 and 32 crosscuts	66.8	Trace
6	Band	No. 5 heading, 2 north, between Nos. 31 and 32 crosscuts	42.0	Trace
7	Band	No. 6 heading, 2 north, between Nos. 31 and 32 crosscuts (No. 7 heading caved)	52.1	Trace
69	Band	No. 1 crosscut between Nos. 5 and 6 headings, 1 left, 2 north (No. 2 crosscut wet and No. 3 crosscut bad top at this location)	34.3	Small
73	Band	No. 2 heading, 2 north, between Nos. 36 and 37 crosscuts	95.6	Trace
24	Band	No. 3 heading, 2 north, between Nos. 36 and 37 crosscuts	48.8	Trace

*Floor too wet for sampling

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
23	Roof & Rib*	No. 4 heading, 2 north, just outby No. 37 crosscut	70.4	Trace
8	Band	No. 5 heading, 2 north, between Nos. 36 and 37 crosscuts	53.7	Trace
9	Band	No. 6 heading, 2 north, between Nos. 36 and 37 crosscuts (No. 7 heading caved)	83.2	Trace
67	Band	No. 2 heading, 2 north, between Nos. 43 and 44 crosscuts	67.8	Small
68	Band	No. 2 crosscut between Nos. 2 and 3 headings, 2 left, 2 north (No. 1 crosscut gobbed full and No. 3 crosscut caved)	28.9	Large
26	Band	No. 3 heading, 2 north, between 43 and 44 crosscuts	71.6	Trace
25	Band	No. 4 heading, 2 north, between 43 and 44 crosscuts	72.1	Small
10	Band	No. 5 heading, 2 north, between 43 and 44 crosscuts (Nos. 6 and 7 headings caved)	52.5	Small
66	Band	No. 1 crosscut between Nos. 6 and 7 headings, 3 left, 2 north	45.6	Small
65	Band	No. 2 crosscut between Nos. 6 and 7 headings, 3 left, 2 north	38.1	Small
64	Band	No. 3 crosscut between Nos. 6 and 7 headings, 3 left, 2 north	33.9	Large

*Floor too wet for sampling

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
28	Band	No. 3 heading, 2 north, just inby No. 50 crosscut	51.9	Small
27	Band	No. 4 heading, 2 north, between Nos. 50 and 51 crosscuts	66.3	Small
11	Band	No. 5 heading, 2 north, just outby No. 51 crosscut	33.0	Small
12	Band	No. 6 heading, 2 north, just outby No. 51 crosscut	96.0	Trace
29	Band	No. 4 heading, 2 north, just outby No. 55 crosscut	65.1	Trace
13	Band	No. 5 heading, 2 north, just outby No. 55 crosscut	42.8	Small
14	Band	No. 6 heading, 2 north, just outby No. 55	39.5	Small
62	Band	No. 2 heading on left of No. 183 gas well outby No. 56 crosscut (No. 1 heading caved)	56.2	Large
61	Band	No. 3 heading on left of No. 183 gas well outby No. 56 crosscut	53.8	Small
63	Band	In 45° chute between Nos. 5 and 6 headings, 3 left, 2 north	40.3	Small
30	Band	No. 4 heading, 2 north just inby No. 60 crosscut	61.5	Trace

Sheet 23

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
15	Band	No. 5 heading, 2 north, just inby No. 60 crosscut	61.0	Small
16	Band	No. 6 heading, 2 north, just inby No. 60 crosscut (No. 7 heading caved at locations for cans 11 through 16)	40.3	Large
36	Band	No. 2 heading, 2 north, between Nos. 65 and 66 crosscuts	50.0	Small
31	Band	No. 4 heading, 2 north, between Nos. 65 and 66 crosscuts	61.9	Small
32	Band	No. 5 heading, 2 north, at No. 66 crosscut	54.0	Small
33	Band	No. 6 heading, 2 north, between Nos. 65 and 66 crosscuts	50.4	Trace
35	Band	In No. 72 crosscut between Nos. 5 and 6 headings, 2 north	54.0	Trace
34	Band	No. 6 heading, 2 north between Nos. 71 and 72 crosscuts	86.3	Trace
R-1	Band	3 north, No. 1 back entry between Nos. 8 and 9 crosscuts	50.4	Not run for Coke
R-2	Band	3 north, No. 2 back entry between Nos. 8 and 9 crosscuts	51.6	do
R-3	Band	3 north, No. 3 back entry between Nos. 8 and 9 crosscuts	42.8	do
R-4	Band	3 north, No. 4 parallel entry between Nos. 8 and 9 crosscuts	41.1	do
R-5	Band	3 north, No. 5 parallel entry between Nos. 8 and 9 crosscuts	48.8	do

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
R-6	Band	3 north, No. 7 back entry between Nos. 8 and 9 crosscuts	56.4	Not run for coke
R-7	Band	3 north, No. 2 back entry between Nos. 12 and 13 crosscuts	43.2	do
R-8	Band	3 north, No. 3 back entry between Nos. 12 and 13 crosscuts	44.6	do
R-9	Band	3 north, No. 4 parallel entry between Nos. 12 and 13 crosscuts	39.2	do
R-10	Band	3 north, No. 5 parallel entry between Nos. 12 and 13 crosscuts	47.7	do
R-11	Band	3 north, No. 7 back entry between Nos. 12 and 13 crosscuts	43.5	do
R-16	Band	3 north, No. 4 parallel entry between Nos. 16 and 17 crosscuts	44.9	do
R-15	Band	3 north, No. 5 parallel entry between Nos. 16 and 17 crosscuts	44.0	do
R-14	Band	3 north, No. 6 haulage entry between Nos. 16 and 17 crosscuts	45.2	do
R-13	Band	3 north, No. 7 back entry between Nos. 16 and 17 crosscuts	44.6	do
R-12	Band	3 north, No. 8 back entry between Nos. 16 and 17 crosscuts	50.1	do
R-17	Band	3 north, No. 4 parallel entry between Nos. 20 and 21 crosscuts	51.6	do

Sheet 25

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
R-18	Band	3 north, No. 5 parallel entry at No. 21 crosscut	56.8	Not run for coke
R-19	Band	3 north, No. 7 back entry between Nos. 20 and 21 crosscuts	54.2	do
R-20	Band	3 north, No. 8 back entry between Nos. 20 and 21 crosscuts	79.0	do
R-23	Band	3 north, No. 5 parallel entry between Nos. 23 and 24 crosscuts	30.5	do
R-22	Band	3 north, No. 7 back entry between Nos. 23 and 24 crosscuts	43.7	do
R-21	Band	3 north, No. 8 back entry between Nos. 23 and 24 crosscuts	69.1	do
R-29	Band	3 north, No. 3 parallel entry between Nos. 27 and 28 crosscuts	38.5	do
R-28	Band	3 north, No. 5 parallel entry between Nos. 27 and 28 crosscuts	52.5	do
R-27	Band	3 north, No. 6 haulage entry between Nos. 27 and 28 crosscuts	66.5	do
R-26	Band	3 north, No. 7 parallel entry between Nos. 27 and 28 crosscuts	79.3	do
R-25	Band	3 north, No. 8 back entry between Nos. 27 and 28 crosscuts	86.6	do
R-24	Band	3 north, No. 9 back entry between Nos. 27 and 28 crosscuts	82.7	do

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
159	Band	Main west return, No. 1 heading between Nos. 40 and 41 crosscuts east of main face "C"	34.1	Large
160	Band	Main west return, No. 2 heading between Nos. 40 and 41 crosscuts east of main face "C"	31.9	Very large
161	Band	Main west return, No. 3 heading between Nos. 40 and 41 crosscuts east of main face "C"	29.0	Very large
162	Band	Main west return, No. 4 heading between Nos. 40 and 41 crosscuts east of main face "C"	20.6	Large
163	Band	Main west return, No. 5 heading between Nos. 40 and 41 crosscuts east of main face "C"	27.9	Small
164	Band	Main west return, No. 6 heading between Nos. 40 and 41 crosscuts east of main face "C"	39.8	Large
165	Band	Main west return, No. 7 heading between Nos. 40 and 41 crosscuts east of main face "C"	39.9	Large
166	Band	Main west return, No. 1 heading between Nos. 31 and 32 crosscuts east of main face "C"	35.3	Large
167	Band	Main west return, No. 2 heading between Nos. 31 and 32 crosscuts east of main face "C"	51.0	Small
168	Band	Main west return, No. 3 heading between Nos. 31 and 32 crosscuts east of main face "C"	27.5	Large
169	Band	Main west return, No. 4 heading between Nos. 31 and 32 crosscuts east of main face "C"	25.2	Large

Sheet 27

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
170	Band	Main west return, No. 5 heading between Nos. 31 and 32 crosscuts east of main face "C"	46.7	Large
171	Band	Main west return, No. 6 heading between Nos. 31 and 32 crosscuts east of main face "C"	58.7	Trace
172	Band	Main west return, No. 7 heading between Nos. 31 and 32 crosscuts east of main face "C"	58.7	Small
173	Band	Main west return, No. 1 heading between Nos. 24 and 25 crosscuts east of main face "C"	26.2	Very large
174	Band	Main west return, No. 2 heading between Nos. 24 and 25 crosscuts east of main face "C"	36.8	Very large
175	Band	Main west return, No. 3 heading between Nos. 24 and 25 crosscuts east of main face "C"	26.5	Small
176	Band	Main west return, No. 4 heading between Nos. 24 and 25 crosscuts east of main face "C"	42.8	Large
177	Band	Main west return, No. 5 heading between Nos. 24 and 25 crosscuts east of main face "C"	31.8	Large
178	Band	Main west return, No. 6 heading between Nos. 24 and 25 crosscuts east of main face "C"	27.2	Large
179	Band	Main west return, No. 7 heading between Nos. 24 and 25 crosscuts east of main face "C"	34.2	Small
D-90	Band	Main west airway, No. 1 entry east of No. 2 fan shaft, 50 feet west of No. 1 bleeder entry (return airway)	22.4	Very large

Sheet 28

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-89	Band	Main west airway, No. 2 entry east of No. 2 shaft, 50 feet west of No. 1 bleeder entry (return airway)	21.3	Large
D-88	Band	Main west airway, No. 3 entry east of No. 2 fan shaft, 50 feet west of No. 1 bleeder entry (return airway)*	24.0	Very large
D-87	Band	Main west airway, No. 4 entry east of No. 2 fan shaft, 50 feet west of No. 1 bleeder entry (return airway)*	25.5	Very large
D-86	Band	Main west airway, No. 5 entry east of No. 2 fan shaft between Nos. 1 and 3 bleeder entries turned from No. 10 right, near station 140 (return airway)*	19.8	Small
D-85	Band	Main west airway, No. 6 entry east of No. 2 fan shaft between Nos. 1 and 3 bleeder entries turned from No. 10 right, near station 141 (return airway)*	21.4	Large
D-84	Band	Main west airway, No. 7 entry east of No. 2 fan shaft between Nos. 1 and 3 bleeder entries turned from 10 right, near station 149 (return airway)*	22.3	Small
185	Band	Main west return, No. 2 heading between 3rd and 4th crosscuts east of No. 86 well	23.0	Small
184	Band	Main west return, No. 3 heading between 3rd and 4th crosscuts east of No. 86 well	29.0	Small

*Sample from rock-dusted area

Sheet 29

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
183	Band	Main west return, No. 4 heading between 3rd and 4th crosscuts east of No. 86 well	24.0	Small
182	Band	Main west return, No. 5 heading between 4th and 5th crosscuts east of No. 86 well	37.8	Small
181	Band	Main west return, No. 6 heading between 4th and 5th crosscuts east of No. 86 well	28.4	Small
180	Band	Main west return, No. 7 heading between 4th and 5th crosscuts east of No. 86 well	30.2	Large
78	Band	No. 1 heading, west main return airways, between Nos. 22 and 23 crosscuts	60.4	Trace
77	Band	No. 2 heading, west main return airways, between Nos. 22 and 23 crosscuts	24.7	Small
76	Band	No. 3 heading, west main return airways, between Nos. 22 and 23 crosscuts	25.2	Small
75	Band	No. 4 heading, west main return airways, between Nos. 22 and 23 crosscuts	21.8	Small
74	Band	No. 5 heading, west main return airways, between Nos. 22 and 23 crosscuts	32.0	Large
85	Band	No. 1 heading, main west return, between 6th and 7th crosscuts inby 2 north	30.2	Trace
86	Band	No. 2 heading main west return between 6th and 7th crosscuts inby 2 north	25.4	Trace

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
87	Band	No. 3 heading, main west return, between 6th and 7th crosscuts inby 2 north	18.7	Trace
88	Band	No. 4 heading, main west return, between 6th and 7th crosscuts inby 2 north	23.4	Trace
89	Band	No. 5 heading, main west return, between 6th and 7th crosscuts inby 2 north	30.1	Small
90	Floor	No. 6 heading main west return, between 6th and 7th crosscuts inby 2 north (Roof and ribs heavily coked, 1/2 to 2" coke and roof coal brushed off floor before sampling at this location)	25.2	Small
91	Band	No. 1 heading main west airways, between 13th and 14th crosscuts inby 2 north	25.3	Small
92	Band	No. 2 heading main west airways, between 13th and 14th crosscuts inby 2 north	19.8	Large
93	Band	No. 3 heading main west airways, between 13th and 14th crosscuts inby 2 north	45.8	Trace
94	Band	No. 4 heading main west airways, between 13th and 14th crosscuts inby 2 north	20.2	Small
95	Band	No. 5 heading main west airways, between 13th and 14th crosscuts inby 2 north	25.0	Large
96	Floor	No. 6 heading main west airways, between 13th and 14th crosscuts inby 2 north (Roof and ribs heavily coked, 1/2" coke brushed off floor at this location)	24.1	Large

Sheet 31

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
97	Floor	No. 7 heading main west airways, between 13th and 14th crosscuts, inby 2 north (Roof and ribs heavily coked, 1/2 to 1" coke and roof coal brushed off floor before sampling	23.9	Small
98	Band	No. 1 heading main west airways, between 19th and 20th crosscuts inby 2 north	31.4	Small
99	Band	No. 2 heading main west airways, between 19th and 20th crosscuts inby 2 north	31.4	Small
100	Band	No. 3 heading main west airways, between 19th and 20th crosscuts inby 2 north	26.2	Small
101	Band	No. 4 heading main west airways, between 19th and 20th crosscuts inby 2 north	19.9	Small
102	Floor	No. 5 heading main west airways, between 19th and 20th crosscuts inby 2 north (Roof and ribs heavily coked, 1/2 to 1" coke brushed off floor before sampling at this location)	33.0	Large
103	Floor and Ribs	No. 6 heading main west airways, between 19th and 20th crosscuts inby 2 north (1"coke and roof coal brushed off floor before sampling at this location)	55.3	Large
104	Floor	No. 7 heading main west airways, between 19th and 20th crosscuts inby 2 north (Roof and ribs heavily coked, 1/2 to 1" coke and roof coal brushed off floor before sampling at this location)	42.9	Small

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
105	Band	No. 1 heading main west airways, between 26th and 27th crosscuts inby 2 north	82.4	Small
106	Band	No. 2 heading main west airways, between 26th and 27th crosscuts inby 2 north	80.0	Large
107	Band	No. 3 heading main west airways, between 26th and 27th crosscuts inby 2 north	31.1	Large
108	Band	No. 4 heading main west airways, between 26th and 27th crosscuts inby 2 north	26.0	Large
109	Band	No. 5 heading main west airways, between 26th and 27th crosscuts inby 2 north	29.1	Large
110	Floor & Rib	No. 6 heading main west airways, between 26th and 27th crosscuts inby 2 north (Roof heavily coked, 1" coke and roof coal brushed off floor before sampling at this location)	79.9	Small
D-153	Band*	Main west airways, No. 1 entry, 50 feet west of old 3 north (return airway)	35.1	Very large
D-154	Band*	Main west airways, No. 2 entry, 50 feet west of old 3 north (return airway)	30.4	Large
D-155	Band*	Main west airways, No. 3 entry, 50 feet west of old 3 north (return airway)	35.7	Large
D-156	Band*	Main west airways, No. 4 entry, 50 feet west of old 3 north (return airway)	31.8	Large
118	Band	No. 1 heading 10 right, between Nos. 24 and 25 crosscuts	23.1	Small

*Sample from rock-dusted area

Sheet 33

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
119	Band	No. 2 heading 10 right, between Nos. 24 and 25 crosscuts	20.8	Small
120	Band	No. 3 heading 10 right, between Nos. 24 and 25 crosscuts	25.4	Large
121	Band	No. 4 heading 10 right, between Nos. 24 and 25 crosscuts	25.7	Large
122	Band	No. 5 heading 10 right, between Nos. 24 and 25 crosscuts	40.9	Large
123	Band	No. 6 heading 10 right, between Nos. 24 and 25 crosscuts	24.4	Small
124	Band	No. 7 heading 10 right, between Nos. 24 and 25 crosscuts	25.3	Large
111	Band	No. 1 heading 10 right, between Nos. 16 and 17 crosscuts	23.4	Large
112	Band	No. 2 heading 10 right, between Nos. 16 and 17 crosscuts	22.5	Large
113	Band	No. 3 heading 10 right, between Nos. 16 and 17 crosscuts	26.1	Very large
114	Band	No. 4 heading 10 right, between Nos. 16 and 17 crosscuts	24.0	Large
115	Band	No. 5 heading 10 right, between Nos. 16 and 17 crosscuts	75.2	Small

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
116	Band	No. 6 heading 10 right, between Nos. 16 and 17 crosscuts	22.3	Large
117	Band	No. 7 heading 10 right, between Nos. 16 and 17 crosscuts	25.2	Large
138	Band	No. 1 heading 10 right, between 40 and 41 crosscuts	66.7	Small
137	Band	No. 2 heading 10 right, between 40 and 41 crosscuts	39.4	Small
136	Band	No. 3 heading 10 right, between 40 and 41 crosscuts	36.3	Trace
135	Band	No. 4 heading 10 right, between 40 and 41 crosscuts	32.3	Small
134	Band	No. 6 heading 10 right, between 40 and 41 crosscuts	35.8	Small
133	Band	No. 7 heading 10 right, between 40 and 41 crosscuts	40.5	Large
132	Band	No. 8 heading 10 right, between 40 and 41 crosscuts	46.8	Small
125	Band	No. 1 heading 10 right, between Nos. 31 and 32 crosscuts	25.1	Large
126	Band	No. 2 heading 10 right, between Nos. 31 and 32 crosscuts	24.9	Large
127	Band	No. 3 heading 10 right, between Nos. 31 and 32 crosscuts	44.8	Large

Sheet 35

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
128	Band	No. 4 heading 10 right, between Nos. 31 and 32 crosscuts	25.6	Large
129	Band	No. 5 heading 10 right, between Nos. 31 and 32 crosscuts	51.2	Small
130	Band	No. 6 heading 10 right, between Nos. 31 and 32 crosscuts	32.1	Large
131	Band	No. 7 heading 10 right, between Nos. 31 and 32 crosscuts	26.7	Large
D-94	Band	10 right, No. 1 entry between Nos. 10 and 11 crosscuts (back entry)	22.3	Large
D-93	Band	10 right, No. 2 entry between Nos. 10 and 11 crosscuts (back entry)	40.9	Large
D-92	Band	10 right, No. 3 entry between Nos. 10 and 11 crosscuts (back entry)	31.8	Large
D-91	Band	10 right, No. 5 entry between Nos. 10 and 11 crosscuts (back entry)	31.4	Small
D-96	Band	10 right, No. 4 entry between Nos. 6 and 7 crosscuts (Haulageway under construction, roof too high to sample)	30.0	Trace
D-95	Band	10 right, No. 6 entry between Nos. 6 and 7 crosscuts (back entry)	30.8	Small
D-97	Band	Main west, No. 1 entry between crosscuts Nos. 258 and 259 (back entry)	28.4	Small
D-98	Band	Main west, No. 2 entry between crosscuts Nos. 258 and 259 (back entry)	25.3	Very large

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-99	Band	Main west, No. 3 entry between crosscuts Nos. 258 and 259 (back entry)	44.7	Small
D-100	Band	Main west, No. 4 entry between crosscuts Nos. 258 and 259 (Main haulageway, roof too high to sample)	80.9	Trace
D-101	Band	Main west No. 5 entry between crosscuts Nos. 258 and 259 (back entry)	38.3	Trace
D-102	Band	Main west, No. 6 entry between crosscuts Nos. 258 and 259 (back entry)	30.0	Trace
D-103	Band	Main west, No. 7 entry between crosscuts Nos. 258 and 259 (back entry)	24.2	Trace
D-110	Band	Main west, No. 1 entry between crosscuts Nos. 276 and 277 (back entry)*	75.4	Trace
D-111	Band	Main west, No. 2 entry between crosscuts Nos. 276 and 277 (back entry)*	48.3	Trace
D-112	Band	Main west, No. 3 entry between crosscuts Nos. 276 and 277 (sidetrack)	54.8	Small
D-113	Band	Main west, No. 4 entry between crosscuts Nos. 276 and 277 (main haulageway)*	74.0	Trace
D-114	Band	Main west, No. 5 entry between crosscuts Nos. 276 and 277 (back entry)*	39.2	Small
D-115	Band	Main west, No. 6 entry between crosscuts Nos. 276 and 277 (back entry)*	83.3	Small

*Sample from rock-dusted areas

Sheet 37

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
D-116	Band	Main west, No. 7 entry between crosscuts Nos. 276 and 277 (back entry)*	56.9	Small
D-124	Band	Main west, No. 1 entry between crosscuts Nos. 304 and 305 (return airway)	29.4	Small
D-125	Band	Main west, No. 2 entry between crosscuts Nos. 304 and 305 (return airway)	34.8	Small
D-126	Band	Main west, No. 3 entry between crosscuts Nos. 304 and 305 (back entry)	56.4	Small
D-127	Band	Main west, No. 4 entry between crosscuts Nos. 304 and 305 (main haulage road)	74.5	Large
D-128	Band	Main west, No. 5 entry between crosscuts Nos. 304 and 305 (back entry)	48.3	Small
D-129	Band	Main west, No. 6 entry between crosscuts Nos. 304 and 305 (back entry)	27.4	Very large
D-130	Band	Main west, No. 7 entry between crosscuts Nos. 304 and 305 (back entry)	86.6	Trace
D-139	Band	Main west, No. 1 entry between crosscuts Nos. 332 and 333 (return airway)	40.3	Very large
D-140	Band	Main west, No. 2 entry between crosscuts Nos. 332 and 333 (return airway)	59.7	Small
D-141	Band	Main west, No. 3 entry between crosscuts Nos. 332 and 333 (haulage road)	54.0	Small

*Sample from rock-dusted area

Sheet 38

Can No.	Samples of Dust From	Location in Mine	As Rec'd Percent Incomb.	Alcohol Coke Test Coked Particles Present (Amount)
S-1	Band	No. 7 heading 4 right off 3 north between Nos. 52 and 53 crosscuts (Back entry)	85.6	None
S-2	Band	No. 7 heading 4 right off 3 north between Nos. 54 and 55 crosscuts (Back entry)	84.7	None
S-96	Band	No. 4 heading 4 right off 3 north between Nos. 56 and 57 crosscuts (Haulage entry)	47.3	None
S-93	Band	No. 5 heading 4 right off 3 north between 56 and 57 crosscuts (Parallel entry)	32.2	None
S-88	Band	No. 6 heading 4 right off 3 north between 56 and 57 crosscuts (Haulage entry)	65.0	None
S-81	Band	No. 3 heading 4 right off 3 north between 58 and 59 crosscuts (Haulage entry)	44.8	None
S-74	Band	No. 5 heading 4 right off 3 north between 58 and 59 crosscuts (Parallel entry)	34.8	None
S-69	Band	No. 6 heading 4 right off 3 north between Nos. 58 and 59 crosscuts (Haulage entry)	45.2	None
S-8	Band	No. 7 heading 4 right off 3 north between 58 and 59 crosscuts (Back entry)	80.7	None
S-42	Band	No. 1 heading 4 right off 3 north between 60 and 61 crosscuts (Back entry)	96.0	None
S-47	Band	No. 2 heading 4 right off 3 north between 60 and 61 crosscuts (Back entry)	96.4	None
S-52	Band	No. 3 heading 4 right off 3 north between 60 and 61 crosscuts (Haulage entry)	47.0	None
S-57	Band	No. 4 heading 4 right off 3 north between 60 and 61 crosscuts (Haulage entry)	40.3	None

United Mine Workers of America

Charles Ferguson	Safety Director

United States Bureau of Mines

James Westfield	Assistant Director--Health and Safety
W. H. Tomlinson	Chief, Accident Prevention and Health Division, Region VIII
W. Dan Walker, Jr.	District Supervisor
John J. Dougherty	Subdistrict Supervisor
Roy C. Estep	Federal Coal-Mine Inspector

After serious consideration and deliberation by all present, a decision to seal the mine was reached about 3:00 a.m., November 14.

Sealing of the mine openings began about 4:00 a.m., the same day, and was completed at 1:30 a.m., Monday, November 15; however, at 4:10 a.m., the seal on the No. 2 fan shaft was blown off, and 5 minutes later the seal on the man shaft was ruptured. Resealing of these openings was started shortly thereafter, but because of pressure, heat, and smoke coming out of the No. 2 fan shaft, the final resealing of these openings was not completed until 2:00 p.m., Wednesday, November 17. A pressure-release valve installed in the seal of the No. 2 fan shaft was not closed until 9:45 a.m., Thursday, November 18.

The seals placed at the five mine openings (four shafts and a slope) were quickly effective; an air sample collected on November 18, at the sand hole, midway between the man shaft and the No. 2 fan shaft, showed that the oxygen content of the mine atmosphere had dropped to 8.4 percent (See Table 1). Samples of the air from the sealed mine were collected daily by mine officials and analyzed by State and company personnel with portable water Orsat apparatus. The analytical results of these samples were made readily available to all interested parties. Representatives of the Bureau of Mines also collected mine atmosphere samples from the sealed area several times a week during the period the mine was sealed, November 17, 1954, to March 10, 1955. By December 15, the oxygen content of the mine atmosphere had dropped to 2.2 percent, and it remained under that amount throughout the rest of the period the mine was sealed. The carbon monoxide content of the mine atmosphere decreased rapidly and regularly throughout the sealed period. An air sample collected at the sand hole on November 18 contained 1.5 percent carbon monoxide; another taken at the same location on February 1, 1955, contained 0.01 percent carbon monoxide; and, for the first time, analytical results of air samples collected on March 1 indicated that carbon monoxide had disappeared completely from the mine atmosphere.

There was no physical evidence found to indicate a sudden outburst of gas in the mine, and the gradual increase in the methane content of air samples collected during the sealed period obviates the contention of a sudden release of natural gas into the mine workings as a factor in any of the explosions or fires. Methane contents of air samples collected before and after sealing were: November 14 (before sealing), 3 percent; November 16, 4.3 percent; November 17, 6.7 percent; November 18, 9.7 percent; December 1, 22.0 percent; December 15, 35.7 percent; December 31, 42.8 percent; January 17, 49.9 percent; February 1, 55.0 percent; February 16, 56.8 percent; March 1, 60.2 percent; and March 10, 67.5 percent. Six of the seven samples collected from November 16 to 19 and analyzed for ethane content contained 0.2 to 0.8 percent ethane, which is believed to have been a distillate of the coal fires. Twenty-one samples collected from November 20 to December 9 did not contain ethane.

The analytical results of mine atmosphere samples were favorable almost from the time of sealing, and in January the company officials began making preliminary plans for reopening the mine. Such plans included procuring necessary supplies and equipment, methods for reopening and recovery, and drilling a borehole from the surface to C face main entries at a location between the Nos. 1 and 2 fans. This borehole was drilled to permit the collection of mine atmosphere samples, particularly during recovery operations, from an area ventilated at times by air from either of the two intake-air shafts. Having positive information concerning the quality of air in C face mains, which had to be traveled, during initial recovery operations was especially important, as it was planned to operate only the No. 1 fan and keep the man shaft and No. 2 fan shaft sealed during this period.

Conferences on reopening and recovering the mine, attended by a large group of company officials and representatives of the United Mine Workers of America, the West Virginia Department of Mines, and the Bureau of Mines, were held at Farmington, West Virginia, February 2; Charleston, West Virginia, February 16; Washington, D. C., March 4; and Farmington, West Virginia, March 8. During the February 2 meeting, company officials discussed the preparations that had been made for reopening and recovering the mine and outlined a suggested plan of procedure. Following some discussion on the feasibility of setting a date for reopening the mine, because of a difference of opinion on the amount of carbon monoxide in the atmosphere in the sealed area, Frank B. King, then Chief of the West Virginia Department of Mines, announced that the plans for recovery would be taken under advisement and a further conference on reopening the mine would be held at a later date, then adjourned the meeting. Again, after considerable discussion on the feasibility of setting a date for reopening the mine because of the possible presence of small amounts of carbon monoxide in samples of the mine atmosphere, the meeting of February 16 in Charleston was adjourned and a date for reopening the mine was not set. During the March 4 conference held with the Director of the Bureau of Mines in Washington, D. C., it was revealed that, for the first time, the presence of carbon monoxide in air samples collected from the sealed mine (March 1) was not detectable with the modified pyrotannic acid method of analysis.

Although several representatives of the Bureau of Mines recommended that the mine not be reopened for at least 30 days after the date the mine atmosphere was free of carbon monoxide, it was agreed that all interested parties meet at the mine in Farmington on March 8, 1955, and arrange to remove the seals from 3 of the mine openings on the first day thereafter when provisions for reopening the mine, mutually agreed upon, had been effected or were favorable. These provisions were: No trace of carbon monoxide in mine atmosphere samples; temperature at the bottom of the No. 2 fan shaft, 63 degrees Fahrenheit or less; a steady to slightly falling barometric pressure; the wind from the west or northwest; uniform weather conditions forecast; all preliminary work completed and supplies on hand; all rescue equipment checked; all participating personnel assigned to and acquainted with their specific duties; and the house for the fan motor ventilated by mechanical means.

In the conference at Farmington on March 8, conditions deemed necessary for reopening the mine were discussed in the presence of all participating personnel, plans of procedure were distributed and explained, and specific duties were assigned and defined. All other provisions having been fulfilled, it was decided that, if weather conditions on March 10 were as favorable as forecast, the day-shift crew would begin to remove the seal over the No. 1 fan shaft that morning. The analytical results of part of the air samples collected at several locations before sealing was completed, during the period while the mine was sealed, and for 6 days after the first seal was removed are shown in Table 1. These are only a small part of the samples but are representative of the hundreds collected.

Weather conditions were favorable on Thursday, March 10, and removal of the gunite from the seal over No. 1 fan shaft was started at 7:35 a.m. Air drawn from a tube inserted into the fan opening at 8:20 a.m. contained 55 percent methane. A small blower fan equipped with flexible tubing, located about 125 feet north of the No. 1 fan and so installed as to ventilate the main fan motor and drive belt enclosure, was placed in operation at 9:55 a.m. The explosion doors at the No. 1 fan were opened at 12:15 p.m., and the fan was placed in operation 7 minutes later; at 12:30 p.m., part of the seal was removed from the No. 1 intake air shaft; and at 3:10 p.m., the last of the explosion doors at the No. 1 fan were closed. Observers equipped with electric methane testers were stationed near the fan, on the highway 200 yards west of the fan, on a hillside 100 yards north of the fan, on the tipple tracks 200 yards south of the fan, and on top of the cleaning plant about 200 yards north of and above the fan. These observers made tests for methane continually, and as much as 2 percent methane was detected at considerable distances from the fan several times during the first 24 hours of its operation. Air exhausted by the No. 1 fan at 9:30 p.m. contained 43 percent methane, and the fan was operating at 3 inches of water-gage pressure. At 5:15 a.m. March 11, the fan went into a stall and the water-gage pressure dropped to 1.8 inches; the explosion doors were opened 2 inches immediately, but shortly afterward it was necessary to open the explosion doors completely to eliminate the fan stall. The several fan stalls that occurred during the first 48 hours of No. 1 fan operation were controlled similarly. Work of opening the slope seal (removing the clay with a clam-shell bucket and dump trucks) was started on March 10 and completed at midnight, March 11; the quantity of air entering the slope at this time was 7,000 cubic feet a minute; and the quantity entering the intake air shaft was 54,000 cubic feet a minute.

Air exhausted by the No. 1 fan was checked frequently by means of Qwik-Chek oxygen and carbon dioxide analyzers and Riken methane testers of 0-to-10- and 0-to-100-percent ranges. In addition to the analyses determined with these very useful instruments, air samples collected periodically at the No. 1 fan were analyzed with portable water Orsat apparatus. A sample collected at the No. 1 fan at 7:50 p.m., March 10, contained 3.5 percent carbon dioxide, 5.5 percent oxygen, and 44.2 percent methane; and another sample taken at this location at 1:30 a.m., March 12, contained 15.2 percent oxygen and 15.8 percent methane. A sample of the mine atmosphere on C face mains, collected at the new borehole at 3:05 a.m., March 11, contained 4.1 percent carbon dioxide, 0.6 percent oxygen, and 60.7 percent methane; but a sample collected at the same location about 12 hours later contained 20.7 percent oxygen and only 1.0 percent methane. Analytical results of the mine atmosphere samples collected at surface locations corresponding to underground areas inby C face mains indicated that either the ventilating system had been deranged by the explosion or the ventilating current induced by the No. 1 fan was slow in reaching the areas inby this borehole. A sample of the mine atmosphere collected at the sand hole at 1:05 p.m., March 11, contained 3.1 percent carbon dioxide, 5.7 percent oxygen, and 47.4 percent methane; another collected at the same location at 6:15 a.m., March 12, contained 2.6 percent carbon dioxide, 9.4 percent oxygen, and 38.9 percent methane; and a sample collected at the No. 2 fan shaft about the same time contained 3.7 percent carbon dioxide, 1.2 percent oxygen, and 67.8 percent methane.

The analytical results of the aforementioned samples and of numerous others collected at the several sampling locations after the No. 1 fan was placed in operation were discussed thoroughly by representatives of all the previously mentioned organizations during a conference at the mine on the morning of March 12. In this conference it was decided that the present ventilating system (No. 1 fan) was inadequate to clear the mine of methane and ventilate it as thoroughly and as rapidly as desired, and that the man shaft (intake) and No. 2 fan shaft should be opened and the No. 2 fan placed in operation. Immediately after this conference, work of opening the seal at the No. 2 fan shaft was started; it was opened completely at 4:00 p.m.; and work was begun to reinstall the fan duct. Air was exhausting from the No. 2 fan shaft at 6:20 p.m., when a violent rain and hail storm occurred. After the storm, which was of about 3/4-hour duration, it was observed that the air movement in the shaft had reversed to an intake. The No. 2

fan was started about 9:38 p.m., but the fan went into a stall and little air was exhausted from the shaft with the fan running, so the fan was stopped about 9:45 p.m., and work was begun immediately to remove the seal from the nearby man shaft. The No. 2 fan was again started about 11:30 p.m.; this time it did not stall, but it did not circulate a large amount of air. At 2:45 a.m., March 13, a company official had the No. 2 fan stopped and mine air containing methane immediately entered the fan house and motor room. All electric power was disconnected, entrance doors were closed, and a blower fan with tubing was started to clear the fan house and motor room of methane. The room was cleared and the No. 2 fan was restarted at 3:55 a.m. The quantity of air entering the man shaft at 8:45 a.m. was 97,200 cubic feet a minute, and slightly more than 5 percent of methane was present in the air being exhausted by the No. 2 fan at 11:00 p.m.

An air sample collected at the No. 1 fan shaft early in the morning of March 14 contained 19.5 percent oxygen and 3.3 percent methane; a sample collected about the same time at the No. 2 fan shaft contained 19.6 percent oxygen and 3.2 percent methane; and, as none of the samples collected after opening the mine contained carbon monoxide, the quality of the mine air indicated underground exploration could be started. Accordingly, about 9:00 o'clock that morning it was decided to have a recovery party travel down the slope, inspect the slope bottom, and, as outlined in the original plan, assist in hoisting the explosives car and a grease car to the surface. The first group of men consisting of a mine rescue team, and representatives of the company, Bureau of Mines, and the West Virginia Department of Mines entered the mine at 10:50 a.m., March 14. Shortly thereafter, another rescue team and a Federal inspector traveled down the slope to the slope bottom. An apparatus crew under oxygen explored the area immediately adjacent to the slope bottom, opened the doors on the supply track, then returned to the slope bottom and removed their oxygen breathing apparatus. During the afternoon of March 14, the rescue party explored open areas from the slope bottom to main north entries and to No. 1 shaft and helped remove the explosives car and the grease car to the surface.

A new group, including four oxygen breathing apparatus crews and two representatives of the company, the West Virginia Department of Mines, and the Bureau of Mines entered the mine at 4:00 p.m. and relieved the day-shift crew. The new group completed the exploration of the slope bottom entries, then explored the main north entries to the first overcast, the 4 left and 5 left sections off C face mains, and the main haulageway to near the mouth of 2 north entries. This crew also examined the area around the man shaft and the No. 2 fan shaft, found all entrances to the No. 2 shaft blocked by falls of roof, and discovered the bodies of three victims in diagonal entries west of and within 400 feet of the man shaft. All this exploratory work was done without the use of protective respiratory equipment. Six to ten percent of methane was found at numerous locations in return airways, outby working faces in 4 and 5 left off C face mains, near the man shaft and No. 2 fan shaft, and in the main west intake entries outby 2 north entries. Indications of slight to violent forces were encountered by the party as they proceeded from the slope bottom toward the man shaft. Practically the entire area explored by the party was covered with a light to heavy coating of fine coal dust or soot.

A third group, consisting of four apparatus crews with two representatives from each of the three aforementioned organizations, relieved the second group at 12:00 midnight. The midnight recovery crew continued the exploratory work and removed four bodies found near the man shaft to the surface. The fourth body was found while recovering the first three bodies.

Exploratory and recovery work were continued by the crews on a 3-shifts-a-day basis; but, after the first 24 hours, advance recovery work was slowed while an entrance to the No. 2 fan shaft was made, as each of the four openings to this shaft was blocked by roof falls. Removal and leveling of a fall one block west of the shaft and removal of material that had almost completely blocked the shaft were finished early March 17. While men were leveling and clearing the fall west of the fan shaft, the temperature increased rapidly from 58 to 90 degrees Fahrenheit in the south entrance to the shaft, and to 82 degrees in the Nos. 4 and 5 entries of the main west returns two blocks west of the shaft. The excessive heat in the Nos. 4 and 5 entries subsided within a week, but the temperature at the shaft remained over 80 degrees for several weeks. Crews of men continued the work at two ends of the roof fall blocking the south entrance to the fan shaft, but this entrance had not been opened and all work at the fan shaft was discontinued on March 19, when a fire rekindled near the man shaft. The roof fall in the south entrance as well as numerous other roof falls near the fan shaft and in the main west airways between 2 north entries and the shaft were later loaded out by means of a loading machine and shuttle cars.

While most of the men on the afternoon shift of March 16 worked at clearing and leveling roof falls west and southwest of the No. 2 fan shaft, the rest of the crew traveled to the second set of overcasts on 2 north entries and then examined the main west intake entries to the last inby entry of D face mains. Excessive amounts of methane encountered on the haulageway at each location prevented further travel. Exploring the main west return airways between 2 north entries and No. 2 fan shaft revealed that only No. 1 airway of the seven airways was open to travel, and several small falls and unsupported, loose roof were found in this airway. As this untimbered airway was, and would be for some time, the only entry open for coursing the return air to the No. 2 fan, the greater number of men on the recovery crews worked at leveling the roof falls and center-timbering the airway. The roof falls were leveled and timbering of the airway was completed March 17, when work of rebuilding the overcasts in 2 north entries was begun. Replacement of these overcasts was necessary at this time to re-establish ventilation in the 2 north entries and, as this work progressed, to cause an increasing quantity of air to flow through the main west intake airways at least as far as the openings to the main west returns at No. 528 well pillar, and possibly as far as the old 3 north entries. Twelve laborers entered the mine March 17 to rebuild the overcasts and work at the roof falls near No. 2 fan shaft. These were the first company employees, except officials and drivers, underground during the recovery operations; all previous work had been done by the mine rescue crews and officials. The overcasts were completed promptly, and work of reventilating the 2 north entries continued.

On March 15, six horses were taken into the mine and used to haul materials, supplies, and men from the slope bottom to the main west entries; and on March 16, hoisting equipment and a bucket normally used for shaft-sinking operations were placed in service at the man shaft, so that recovery parties could enter and leave the mine by way of the man shaft. Many supplies were also taken into the mine by means of the bucket.

About 1:00 p.m., March 19, while work of ventilating 2 north entries was being rushed, a rescue worker reported that smoke was issuing from a roof fall in the haulage entry leading from the main west entries to the underground shop. This roof fall was near the man shaft, and tests indicated carbon monoxide at 3 sides of the fall. All accessible openings to the fire area were examined and all men inby this area were withdrawn. Meanwhile most of the rescue workers were hoisted to the surface, plans were made to enclose the fire area with 9 seals, and supplies and materials were gathered for this work. The fire seals were built of tongue-and-groove lumber, plastered with wood-fiber cement, and the fire area was sealed completely at 8:30 p.m. The intake and return openings for the fire area were closed simultaneously, and all men, including State and Federal inspectors, were out of the mine by 8:45 p.m. All the seals except No. 9 were built without the use of protective respiratory equipment; the entire No. 9 seal was built by a mine rescue crew working under oxygen (See Appendix I).

Arrangements were made to procure enough liquid carbon dioxide to fill the sealed area with carbon dioxide in gaseous form; and 20 tons of liquid carbon dioxide were injected into the sealed area, beginning at 10:00 p.m., March 20. After the liquid carbon dioxide had been pumped into the fire area, analyses of air samples from the sealed area indicated that conditions were favorable to permit men to reenter the mine. One crew of men resumed their task of restoring ventilation in the 2 north entries, and others worked at replacing stoppings east of C face mains and south of 10 right entries. Near the end of the day shift on March 21, the first of 5 bodies was found, partly covered by the fall, at the outby end of a large fall that blocked No. 8 entry of 4 left off 2 north entries. That evening mine rescue crews began to clean up this fall by hand, using wheelbarrows to haul the rock outby, and this work was continued until the night of March 25, when the body of the fifth victim who had been working in this section was recovered (See Appendix J).

Re-establishment of ventilation in 1 south entries was begun on the night of March 22, and the bodies of the 3 victims who had been working in 2 left entries off 1 south were found in this section during the day shift of March 24. These men had not been burned nor had they been injured by violence of the explosion; they died from the effects of afterdamp. All the other underground victims were burned severely.

Clearing the 2 left entries of gas was a comparatively slow and tedious process because 2 of the normal returns from this section could not be replaced at the time, the third normal return was partly blocked and, therefore, lengthened by more than half a mile, and the volume of air directed into these entries could not easily be increased materially without diminishing the air current reaching the 4 left entries off 2 north where a rapid air flow was entirely necessary. As the north and west air splits became longer, short-circuiting of air increased through the falls and temporary stoppings in the connections between the main west returns and 10 right entries (the east air split). All the supplies for building the temporary stoppings and practically all the material, including water for the mortar, for building the permanent stoppings on both sides of 10 right entries had to be carried by the workmen a long, tortuous way over and around roof falls from C face mains to the several air connections. By March 27, replacement of the permanent stoppings along C face main entries had been completed, normal ventilation had been established in the main haulage entries from the slope to 2 north, and all the normally active parts of the mine except 3 north entries and 4 right off 3 north were reasonably free of gas and being ventilated by temporary measures. The 3 north section was partly filled with water, and it was decided not to attempt further work in the 3 north entries until electric power could be restored to the mine and the water pumped from the section.

From the time the fire area was sealed on March 19 until it was opened on March 29, 45 tons of liquid carbon dioxide was injected into the sealed area. How effective the use of the carbon dioxide was in controlling the fire is conjectural, as the seals were not as airtight or as satisfactorily placed as they might have been and the carbon dioxide gas escaped from the enclosed area continually.

A sample of air from the fire area, collected at the No. 2 seal at 8:15 p.m., March 20, contained 19.8 percent oxygen, 1.2 percent methane, and 0.2 percent carbon dioxide; another collected about the same time at No. 8 seal contained 18.5 percent oxygen, 1.2 percent methane, and 0.1 percent carbon monoxide. Shortly after these samples were collected, the first of 20 tons of liquid carbon dioxide was injected into the sealed area through a 2-inch pipe installed in the man shaft and thence through No. 2 seal. It was estimated that 1 pound of liquid carbon dioxide would expand to about 9 cubic feet of gas at atmospheric pressure; the space within the fire seals was estimated to be 380,000 cubic feet. To allow space for the carbon dioxide, the valve at No. 3 seal was cracked, and the carbon dioxide was injected at such rate that the pressure did not exceed 1/2-inch water gage. Elevation at the valve in No. 3 seal was 6 feet lower than the valve at No. 2 seal, 609 feet compared with 615 feet, respectively. Transferring the 20 tons of liquid carbon dioxide into the sealed area was completed about 1:00 p.m., March 21. Samples collected at the No. 2 seal at 5:30 a.m., March 21 contained 62.4 percent carbon dioxide, 5.6 percent oxygen, 0.7 percent methane, and 0.3 percent carbon monoxide; another sample collected at the same location at 9:15 a.m., March 22 contained 75.8 percent carbon dioxide, 4.2 percent oxygen, 2.2 percent methane, and no carbon monoxide. Samples collected about the same times March 21 and March 22 at No. 8 seal contained 33.9 and 44.8 percent carbon dioxide, 9.5 and 7.0 percent oxygen, 2.1 and 2.7 percent methane, and 0.4 and 0.3 percent carbon monoxide, respectively. Samples collected March 22 at No. 9 seal showed that the carbon dioxide was dispersed throughout the entire sealed area; however, samples collected between 10 and 11 p.m., at Nos. 2, 8, and 9 seals, on March 23 showed that the carbon dioxide was leaving the sealed area rapidly, as they contained 35.0, 45.9, and 48.0 percent carbon dioxide, respectively. Twenty-five additional tons of liquid carbon dioxide was injected into the sealed area as follows: 5 tons March 23, 10 tons March 24, and the last 10 tons March 28. The analytical results of a few of the hundreds of samples collected from the sealed area are listed in table 2.

As all accessible parts of the mine had been explored and ventilation therein established temporarily by March 28, representatives of the several organizations in conference agreed that the fire seals should be opened and the fire fought directly and loaded out, since it was believed that the bodies of those victims that had not been recovered remained in the sealed fire area, the analyses of air samples collected from the sealed area indicated that the carbon dioxide injected therein during the previous 8 days had kept the fire from spreading, and extinguishing the fire would require more effective sealing. It was also decided that electric power could be restored safely in the main haulage circuit from the slope to 2 north entries and used for cleaning up the fire area. A loading machine and shuttle cars for loading the material were moved from the 5 left off C face mains section, and water lines were installed to wet down and cool the material. The No. 9 or west seal was removed first, and then No. 8 or north seal. Loading was started from the north side and intake air was coursed from this side through the fire area and No. 9 seal to reach the No. 2 fan return (See Appendix I). Water was first applied to the fallen roof material about 12:40 p.m., March 29, and the first car of the material was loaded about 3:20 p.m. Work of loading this material progressed 3 shifts a day, 7 days a week from that time until the last car of material was loaded, June 1.

On April 8, 1955, a second loading machine and shuttle cars began loading and removing the fallen roof material on the No. 9 or west side; loading operations were continued on this side until April 15, when heat, fumes, smoke, and carbon monoxide in the area forced abandonment of this project. At this point of the operation, the No. 9 seal was replaced sufficiently to form a dam (to a height of 5 feet) and a regulator to control the quantity of air passing over the fire. The area was flooded to, and maintained at, a depth that did not seriously interfere with advancing operations. Return air samples were collected and temperatures recorded at the No. 9 dam several times each shift; at one time the temperature was 130 degrees Fahrenheit. Approximately 50 linear feet of entry had been cleared from the west side before loading operations were abandoned.

After a connection between the north side and the man-shaft side had been made, work in the north side was discontinued on April 29,

Table 2 - Analyses of Air Samples from Fire Area - March 20-29, 1955

Date	Location	PERCENT IN VOLUME				
		Carbon Dioxide	Oxygen	Carbon Monoxide	Methane	Nitrogen
3/20/55	No. 2 seal	0.2	19.8	0.0	1.2	78.8
3/20/55	No. 8 seal	0.7	18.5	0.1	1.2	79.5
3/21/55	No. 2 seal	62.4	5.6	0.3	0.7	31.0
3/22/55	No. 2 seal	75.8	4.2	0.0	2.2	17.8
3/21/55	No. 8 seal	33.9	9.5	0.4	2.1	54.1
3/22/55	No. 8 seal	44.8	7.0	0.3	2.7	45.2
3/22/55	No. 9 seal	47.6	7.4	0.2	4.2	40.6
3/23/55	No. 2 seal	35.0	12.0	0.2	3.5	49.3
3/23/55	No. 8 seal	45.9	6.0	0.3	4.3	43.5
3/23/55	No. 9 seal	48.0	5.4	0.2	5.2	41.2
3/24/55	No. 2 seal	60.2	7.2	0.0	2.7	29.9
3/24/55	No. 8 seal	46.8	5.8	0.2	3.5	43.7
3/24/55	No. 9 seal	58.0	5.2	0.2	4.3	32.3
3/25/55	No. 2 seal	42.5	10.5	0.0	3.6	43.4
3/25/55	No. 8 seal	56.6	4.0	0.2	4.7	34.5

(Cont'd) 2 Table 2 - Analyses of Air Samples from Fire Area - March 20-29, 1955

Date	Location	PERCENT IN VOLUME				
		Carbon Dioxide	Oxygen	Carbon Monoxide	Methane	Nitrogen
3/25/55	No. 9 seal	57.8	4.4	0.1	5.9	31.8
3/26/55	No. 2 seal	22.6	15.0	0.0	2.7	59.7
3/26/55	No. 8 seal	50.6	5.2	0.2	5.5	38.5
3/26/55	No. 9 seal	57.2	3.0	0.2	6.9	32.7
3/27/55	No. 2 seal	17.8	16.4	0.0	2.4	63.4
3/27/55	No. 8 seal	44.2	6.4	0.2	4.9	44.3
3/27/55	No. 9 seal	44.4	6.8	0.2	6.6	42.0
3/28/55	No. 2 seal	18.0	16.0	0.0	3.1	62.9
3/28/55	No. 8 seal	43.8	5.8	0.2	5.9	44.3
3/28/55	No. 9 seal	44.5	6.1	0.2	7.2	42.0
3/29/55	No. 9 seal	23.8	14.2	0.0	2.7	59.3

Figure 10. - Timbering in fire area.

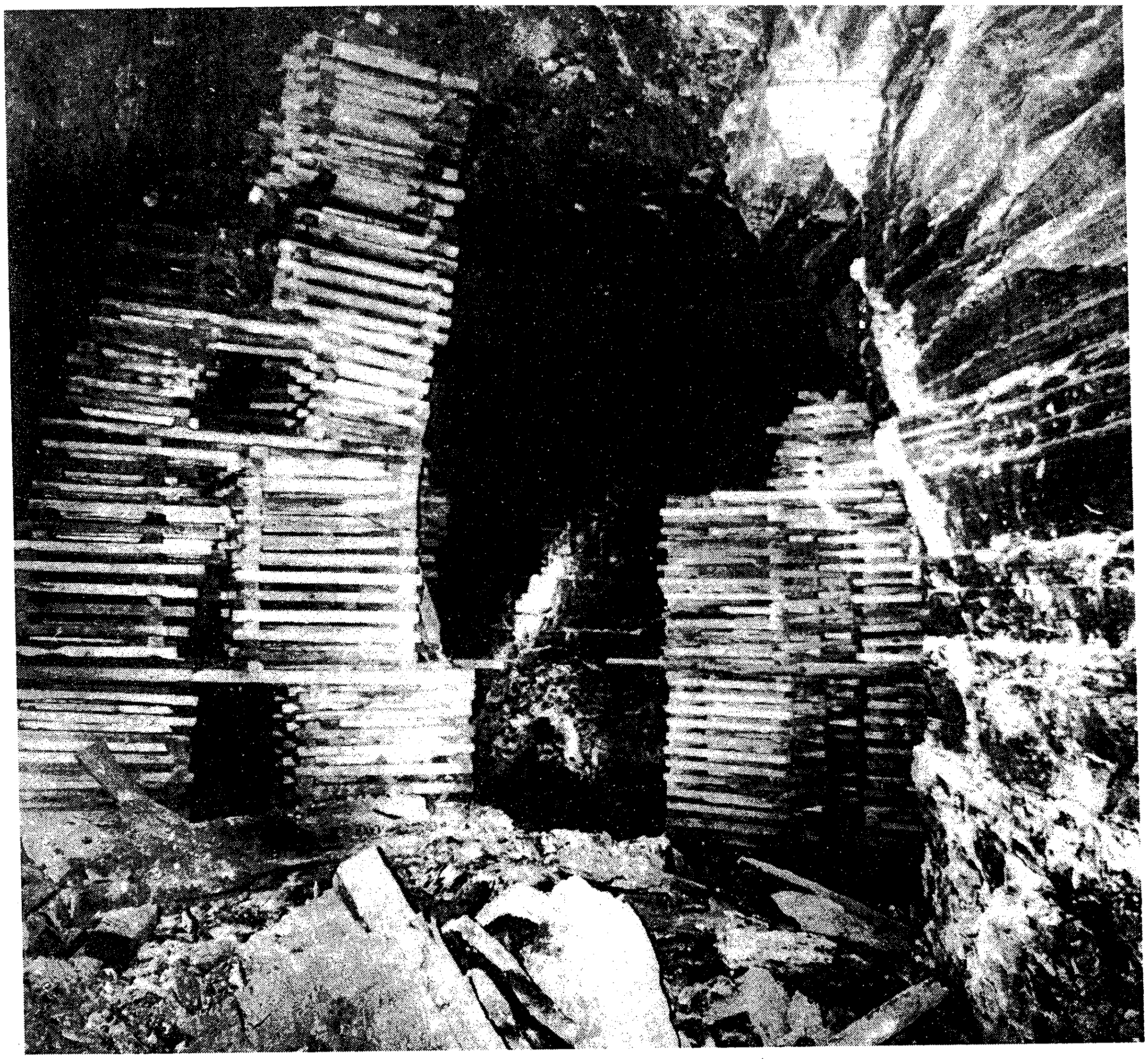


Figure 11. - Timbering in fire area.

because of the extreme height and very hazardous conditions existing at its first "Y" intersection, and the fall was attacked from the east or No. 1 side and continued therefrom until it was cleaned up. Bolting of the roof and ribs was started immediately in the east side and continued through and beyond the No. 2 intersection, but was stopped, in favor of cribs, primarily because the action of the steam (from water applied to the fire) resulted in breaking and falling of the shale roof and ribs between bolt sets.

The body of the first of the three victims in the fire area was recovered on May 18 in the straight entry west of and about 600 feet from the man shaft. The second body was recovered May 27 and the third and last body was recovered May 31 in the first chute east of No. 9 dam and about 800 feet from the man shaft (See Appendix I).

With each 10-foot advance of the entry, cribs were set from the mine floor to a height of 7 to 10 feet, allowing enough room for the free passage of moving equipment, then overlaid with crossbars within a few inches of each other. Three-inch-thick planks were laid over and at right angles to the crossbars, and at least two 6- by 6-foot, and occasionally 8- by 8-foot, cribs were built therefrom to the roof, with stringer bars through the cribs contacting opposite ribs at 6-foot intervals. Ninety-pound steel rails were used to augment the crossbar supports at two of the intersections, and a 6- by 6-foot intermediate crib was built at another. Although track with heavy wooden ties was in practically all of the openings, it was necessary to surface these roadways with 4-inch-thick planks to keep the loading machine and shuttle cars from bogging down in the soft water-soaked bottom.

Unlimited amounts of water at high pressure was available and used to cool and knock down the hot materials throughout the fire-fighting operations. Water pipes of 1- to 2-inch diameter, with a series of 1/8-inch perforations 4 feet from the pointed ends, were either driven or inserted in boreholes into the fall 10 to 30 feet in advance of the face and, in one case, through the point of a coal pillar, to control the fire before it was uncovered. Another innovation, perhaps, was the use of Cardox for blasting the huge fall. As the heated material precluded the use of explosives, and the fall was so compact as to necessitate blasting, more than 1,800 Cardox charges were fired in clearing the fall in this fire area alone. Unsuccessful use of a rubber-tire-mounted mining machine in removing the coal at the foot of the fall to induce tumbling of the overlying material was superseded by a similarly fruitless method, whereby a 70-pound steel rail bolted to the cutter bar of the machine was used in an attempt to rake down the overlying rock. Knocking down the compact material with streams from fire hoses at high pressure was generally little more successful, so that blasting with Cardox became almost an absolute necessity. Drilling of shot holes with a hand-held electric drill was often very dangerous and, at times, could not be accomplished due to the hard, hot rock encountered, so that more than a few Cardox charges were fired in crevices. The tendency of the discharged Cardox shells in such instances was to enter further into the rock fall; not one flying shell was observed.

Very little of the work was done with the aid of either gas masks or self-contained oxygen breathing apparatus, although two mine rescue crews, one of which remained on the surface while the other was underground, were available each shift during the entire fire-fighting operations. Burning and hot materials were encountered along the entries for almost the entire length of the fire area, 700 linear feet. The roof had fallen to an average height of 30 feet above the mine floor; at one location it had fallen to a height of 48 feet; and the entries were 16 to 26 feet in width. Extensive timbering, cribbing, and bolting were done in the area, and a company official stated that 247,981 board feet of cribbing timber, 2,492 16- and 18-foot crossbars, and 1,329 7-foot posts were used to timber the fire area, all of which was to be abandoned with the reopening of the mine.

Recovering the fire area was a very dangerous and difficult task extending through a long period, and all persons who worked on the project and those who supervised such work are highly commended for doing a difficult, dangerous job well. Two of the three men who suffered injuries resulting in loss of time during the fire-fighting operations were struck by falling roof material; the other was struck by a falling crib block. Two men received back injuries and the third man received a fractured wrist. Several other men received cuts and bruises from falling roof material.

On June 3, 1955, work of re-establishing permanent ventilation throughout the mine by replacing permanent stoppings and overcasts was continued on an enlarged scale. Extensive roof falls near the No. 2 fan shaft and at other locations were loaded out. A new opening was driven from the diagonal entries toward the No. 2 fan shaft to facilitate loading out the extensive roof falls in the area, and in order to keep rock-loading operations in intake air, air locks were constructed in these return airways. Haulageways, parallel entries, and back entries were cleaned of loose coal, coal dust, and debris. These areas were rock-dusted after they were cleaned. Practically all the loose coal, coal dust, and debris was removed with loading machines and shuttle cars, and rock-dusting was done by hand and with high-pressure machines.

On July 12, company officials requested that the Director of the Bureau of Mines arrange for a special inspection of the mine to permit resumption of coal production in the 4 and 5 left off C face mains sections. The special inspection, begun July 13, was completed July 20, and the inspectors recommended that the company be permitted to resume production of coal in the working sections off C face mains. Coal-producing operations were resumed in the 4 and 5 left sections on the midnight shift, Sunday, July 24.

Work of reconditioning and retimbering the No. 1 air shaft was begun the following week and was completed February 19, 1956. Water that had collected in the 2 north section was removed and work was again started August 29, 1955, to load out the roof fall in No. 8 entry of 4 left off 2 north entries. This roof fall was being loaded out in an attempt to ascertain the condition of No. 7 pillar place when the explosion occurred (See Appendix J). On September 9, a section of the three-conductor trailing cable to a shuttle car was uncovered; two nails had been driven into the cable and the untwisted battery ends of the blasting cable were found within 2 feet of the nails in the cable. The nails and the blasting cable were about 4 feet inby the place where the last of the five bodies had been recovered. The shuttle car was recovered on September 27 and brought to the surface September 29. The car was not damaged badly except for water in the motors, and the inby end of the trailing cable was in good condition. Work of loading out the roof fall was discontinued October 21, when it was discovered that the first stump between the "skinny" and No. 8 entry was crushed out. Nothing further of importance was found in the area, except that the blasting cable continued under the fall toward the face of No. 7 pillar place.

Work of rehabilitating 2 left off 1 south, main west, and 4 left off 2 north sections included removal of roof falls in airways and haulageways, replacement of stoppings and overcasts, re-establishment of permanent ventilation, cleaning up of loose coal, coal dust, and debris, and rock-dusting of the areas. This work was completed and coal production was resumed in 2 left off 1 south and main west sections November 29, 1955, and January 23, 1956, respectively. The 4 left off 2 north section was rehabilitated but was abandoned without resuming operation; however, a new working section was opened off the east side of 2 north entries outby 1 left entries on February 10, 1956.

The 4 right off 3 north section and the main north and 10 right entries were ventilated and examined but had not been recovered when this report was prepared; however, clean-up work was in progress in each of the three areas.

INVESTIGATION OF CAUSE OF EXPLOSION

Investigation Committee. The underground investigation of the cause of the explosion and fires was started March 15, 1955, continued intermittently, and completed January 28, 1956. Members of the official investigation committee were:

West Virginia Department of Mines

Julius C. Olzer	Chief
R. L. Graham	Director of Mine Rescue and Safety
W. M. Berry	Inspector-at-Large
Andrew Easton	Inspector-at-Large
C. I. Bennett	Inspector-at-Large
M. B. Horton	District Inspector
Joseph Withrow	Rock-Dust Inspector

United Mine Workers of America

Charles Ferguson	Safety Director
C. J. Urbaniak	President, District 31
Leonard Pnakovich	Vice President, District 31
Joseph Yablonski	International Executive Board Member, District 5
Thomas Tracy	Chairman, Mine Safety Committee, Local Union No. 4042
Paris Bryant	Mine Safety Committee, Local Union No. 4042
James Chambers	Mine Safety Committee, Local Union No. 4042

Jamison Coal and Coke Company

W. B. Jamison	Vice President
George W. McCaa	General Manager
L. H. Riggs	Superintendent
George C. Cain	Assistant Superintendent

Bituminous Coal Operators Association

M. J. Ankeny	Safety Director

United States Bureau of Mines

James Westfield	Assistant Director--Health and Safety
W. R. Park	District Supervisor
W. Dan Walker, Jr.	District Supervisor
John J. Dougherty	Subdistrict Supervisor
M. L. Davis	Safety Representative

A hearing was conducted at Farmington, West Virginia, on November 16, 1954, by Frank B. King, then Chief of the West Virginia Department of Mines, to learn as much as possible of the conditions and practices existing in the mine and the whereabouts of the victims immediately prior to the explosion. Mine officials and the two survivors of the explosion were interrogated during this hearing, the transcript of which is included in the preliminary report of this disaster.

Julius C. Olzer, Chief of the West Virginia Department of Mines, conducted an official inquiry and investigation of the explosion by interrogating 61 officials and employees of the company in the Marion County (West Virginia) Courthouse, February 7-9, 1956. The purpose of the inquiry was to hear and record all testimony relevant to conditions and practices in the mine prior to and on November 13, 1954, and to determine therefrom, if possible, the cause of the explosion. Some of the information thus obtained is included in this report.

Methane as a Factor in the Explosion. The mine is classed gassy by the West Virginia Department of Mines and by the Bureau of Mines. For many years, the mine officials have been finding methane in active and abandoned workings and have recorded many such findings. The rate of methane liberation from the mine during the February 1942 (first) Federal inspection was 701,485 cubic feet in 24 hours; and during the October 1954 Federal inspection, 3,248,568 cubic feet in 24 hours. Laboratory analysis of air samples collected from the sealed mine just prior to breaking of the seals indicated methane contents of as much as 67.5 percent, and gas in explosive concentrations was found in open workings during the early recovery operations. Line brattice was necessary to keep the main west faces and falls in 2 north clear of gas as late as January 1956, and small gas feeders were observed at the faces in one of the main west entries and in one of the 2 north entries; these faces were wet.

It is believed that the 2 north gob area was filled with methane in concentrations ranging from below, through, and above the explosive limits, since this area could not possibly have been ventilated with the system of ventilation described previously in this report. The fire-boss report for Sunday night, November 7, 1954, less than a week before the explosion, shows that gas was found on the gob in No. 7 pillar place of 4 left off 2 north, where the explosion originated. During the investigation, it was learned that gas had been found in 4 left off 2 north at least 4 times within 24 hours prior to the explosion and that gas had been found quite frequently in each of the 2 north sections while they were active, but the finding of gas that was detected and removed during the same work shift was seldom included in the daily mine record book. Company records show that gas in the amount of 1.7 percent was measured in a partial return (9,940 cubic feet a minute) air current outby the abandoned 1 left section off 2 north on November 6, 1954. Two of the mine officials stated that gas could be and was detected along the east fringe of this gob area and inby the line brattice in the so-called bleeder entry south of 1 left, but records of such findings were not available. Gas that was so detected was bleeding off the gob area into the air stream, an evidence of heavier concentrations within the gob. Certainly this gob was filled with methane during the period the mine was sealed, but long after normal ventilation had been re-established in 2 north, as much as 40 percent methane was found along the east edge of the gob outby 4 left, and line brattice, check curtains, and stoppings had to be installed to conduct air along the gob.

It is believed that pressure developed by the ignition of gas and coal dust in No. 7 pillar place of 4 left off 2 north forced more gas within or near explosive concentrations from the gob into the openings all along the 2 north pillar line. Evidence of slow-burning gas was found along the edge of virtually the entire length of the gob. Burning of some of the coal dust thrown into the air by forces of the explosion, together with the gas in the same area, would consume all the oxygen available and tend to limit the violence of the explosion as it was propagated outby along the gob. Very little violence was evident at the south end of 1 left section, where forces of the explosion converged into the 2 north entries, as the 2 overcasts at this location were only slightly damaged and the 2 stoppings across No. 3 entry of 2 north were not damaged. How far the flame from gas so ejected from the gob extended in 2 north entries can only be conjectural; however, it is certain that the normal methane content (1.7 percent) of the return air in the west 2 north airways between 1 left and main west aided materially in propagating the explosion.

Fragile, globular coke droplets adhering to the roof and/or ribs, and coke streamers and soot streamers, all indicative of slow-burning gas, were found at several places in 4 left off 2 north, especially in No. 8 crosscut between Nos. 7 and 8 entries, which is near the point where the explosion started, and at other locations in 2 north, 10 right, main west, and 3 north entries. Undoubtedly gas that burned at some of these locations was a distillate of the deep-seated fires that broke out after the first explosion, but such burning at places isolated from the fire areas, such as in crosscuts adjacent to old high falls, is believed to have resulted from the ignition of gas that may have aided in propagation of one or more of the explosions.

Flame. As mentioned previously, the first explosion was the most extensive and forces of this explosion were the greatest, as this was the only one that was recorded by a seismograph in Morgantown, West Virginia, about 17 air-miles distant. Evidence of forces of this explosion extended to the surface through the man shaft, No. 2 fan shaft, the slope, and Plum Run borehole; therefore, flame propagating the explosion likewise probably extended from the point of origin (4 left off 2 north) farther through the underground workings than flame from the subsequent explosions. It is doubtful but possible that flame of the subsequent explosions extended beyond flame limits of the first explosion in some areas of the mine, particularly as the points of origin of the subsequent explosions will never be known, although it is believed that these explosions originated near the No. 2 fan shaft and man shaft.

Evidence of heat or flame, in the form of ashes, coke, soot, partly burned paper, or charred timbers, was observed at locations throughout the entire length of 2 north section and the main west intake and return entries, in D face and E face mains and in the entries leading to the man shaft south of main west, throughout 10 right entries and in main north to near the overcast at 1 face west, throughout 3 north entries, in 1 south entries to near 4 left, and in C face entries to near 7 right. The distance from the working places in 4 left off 2 north to the man shaft is roughly 8,000 feet; and from the main west faces to the overcast on main north, 18,300 feet.

Large fires burned at the junction of 2 north and the main west returns, extending into 2 north and east and west of the junction, in the main west returns between 2 north and 3 north, in 1 south at 3 left entries, around the No. 2 fan shaft and west of the man shaft, at two locations in 10 right, and in the return entries east of the No. 2 fan shaft. Minor fires had started at many other locations.

Bodies of the victims recovered in 4 left entries off 2 north and in the man-shaft vicinity were burned severely.

Evidence of explosives having been discharged by forces or flame was not found, although explosive cartridges in the main west, 3 north, and 10 right were scattered over a wide area; some of the cartridge casings were charred slightly or showed other signs of heat; some of the explosives cases remained intact; and many of the electric detonators at these locations, also scattered widely, had been exploded.

The trolley wire in the 2 north run-around at 4 left had been burned and broken when it was caught between a roof bolt and the inby end of a mine car that was up-ended by forces of the explosion. Evidence of electric arcing was observed on the wire, the roof bolt, and the end of the steel car. Another trolley wire was found burned through electrically near the end of the new 10 right haulageway; however, it was verified that this burning occurred some time prior to the explosions.

Four hundred and eleven mine dust and seven special coke samples were collected in the affected area. The special coke samples were of coke that adhered to metal, wooden, and coal-rib surfaces in 2 north section. They consisted of coke and coal fragments of fine to coarse particle size, with coke fragments predominant. Some of the coal fragments showed no visible effect of heating; others were slightly swollen from heating. Many of the coke particles were spherical cellular masses of coke described as cenospheres, which are of a type formed by heating of coal particles while suspended in hot gaseous atmosphere. Coking will take place at comparatively low temperature in the presence of 65 percent incombustibles, but microscopic examination did not reveal the presence of limestone dust in these samples. Coke that appeared to be similar to the samples analyzed, and in thickness ranging from a fraction of an inch to more than 3 inches, was plastered on the lips of machine cuts in the roof, on timbers, roof bolts, falls, ribs, and other surfaces at literally hundreds of locations in 2 north, 3 north, main west, 10 right, and main north sections.

The results of analysis for incombustible content and tests for coke in the mine dust samples are shown in Table 3 and Appendix B. The presence of coke in the mine dust samples is one of the criteria by which extent of the flame area was fixed, even though it is quite possible that such coke in main north entries may have been blown therein by an explosion other than that by which or in which it was formed. It will be noted that only 339 of the 411 samples were examined for coke and that, in order to obtain more nearly representative samples, an effort was made in several instances to remove coke and soot from the sampling location before the sample was collected. More than 76 percent (259) of the 339 samples contained coke in quantities ranging from traces to very large amounts. Only one of the many samples (No. 54) collected in 2 north section did not contain some coke; this sample was collected in No. 7 entry, between Nos. 4 and 5 crosscuts of 4 left off 2 north, in which entry two other samples were collected, one inby and the other outby this location. All the samples collected in the main west headings and return airways, in 10 right entries, and in 1 south entries (outby 2 left) show various amounts of coke, as do those taken in C face entries inby 7 right and in main north entries inby No. 185 crosscut. Although the 29 samples taken in 3 north were inadvertently not examined for coke, it is almost certain that these samples contained much coke, since coke was plastered on concrete piers, coal ribs, and lips of machine kerfs throughout the area sampled, and coke was streamlined on the inby sides of posts in No. 8 entry near the substation.

Seventy-four percent (304) of the 411 samples contained less than 65 percent incombustible, the minimum amount required by the Federal Coal Mine Safety Act. Inasmuch as practically all of these samples were taken in areas affected at least slightly by forces of the explosion, they are not truly representative of mine dust conditions prior to the explosion, as burning of coal dust in suspension increases the incombustible content of the mine dust, and the unburned coal dust thrown into suspension and deposited on rock-dusted surfaces decreases the incombustible content. It is certain, however, that sufficient inert matter was not present to prevent propagation of an explosion. Large accumulations of fine coal and coal dust remained on the floor and along the ribs, and there was little evidence of rock dust having been applied at many places in the back and parallel entries even though other parts of these entries were blanket rock-dusted. Ribs and roof throughout parts of the affected area were "scoured"; i.e., almost devoid of either rock dust or coal dust; and the floor at several places was swept clean.

Of the 107 samples that contained 65 percent or more incombustible, 43 were collected in the haulageways and 64 in the back entries and in entries parallel to the haulageways and connected thereto by open crosscuts. The incombustible content of the 71 samples collected in the haulageways ranged from 25.5 to 99.6 percent and averaged 70 percent, which indicates that the haulageways in general were well rock-dusted before the explosion occurred. Since only 64 of the 340 samples taken in back and parallel entries at corresponding locations contained more than the required minimum amount of incombustible, it is reasonable to conclude that these entries were not rock-dusted adequately prior to the explosion.

Twenty-four dust samples were collected in 4 left entries off 2 north; only 1 of the 13 collected in the intake airways contained more than the minimum amount of inert material required by the Federal Coal Mine Safety Act; but all 11 of those taken from the back entries contained more than 70 percent incombustible. Fifty-five samples were taken in other parts of 2 north section; only 5 of the 34 taken in back entries and parallel entries, 7 of the 13 from haulageways, and none of the 8 taken at locations near the pillared sections contained 65 percent or more inert material. Only 3 of 69 samples collected in the main west return airways contained sufficient incombustible, and all but 1 of these 148 samples contained some coke.

Samples collected in the 4 intake airways just outby the last crosscuts of 5 left off C face, a development section affected very slightly by forces of the explosion, did not contain sufficient incombustible, but the samples taken in the 3 back entries, which had been blanket rock-dusted, contained 67.8 to 93.9 percent incombustible. Six of the seven samples collected across 5 left entries off C face about 400 feet outby the locations of the last-mentioned samples contained ample incombustible.

Similar rock-dust conditions are indicated by analyses of the 22 dust samples collected in an area 100 to 1,000 feet from the faces in 4 right entries off 3 north, another development section in which evidence of forces was practically negligible. It is significant that this area had been rock-dusted within a few hours before the explosion and that none of the samples contained coke. Not one of the 7 samples, one from each of the 7 entries, collected just outby the last crosscuts and 100 to 140 feet from the faces of 4 right contained as much as 46 percent incombustible; and 12 of the 14 samples taken from the intake airways, entries Nos. 3 to 6, contained less than 48 percent inert material; but the 5 samples taken in the return airways outby the mine-car loading point, which areas had been blanket rock-dusted, contained 80.7 to 96.4 percent incombustible. Dust samples were not collected in the outby half of 4 right entries nor in the adjacent inby part of 3 north entries because this area had become inundated after the explosion and water was being pumped therefrom in February 1956.

A comparison of the incombustible contents of the 411 samples collected after the explosion with those of the 24 samples collected during the 3 routine Federal inspections made within 10 months prior to the explosion must be limited to dust conditions in the haulageways and face regions, as 19 of these 24 samples were taken in haulageways, 4 in back entries near the working faces, and 1 in a trackless entry near the face. As mentioned previously, the incombustible content of the samples collected before the explosion was well above requirements, and observation and the analyses of samples collected in haulageways and in back entries near the working faces after the explosion indicated generally adequate rock-dusting.

Forces. Evidences of forces indicating the direction of explosion travel were generally conflicting in the individual sets of entries because of the four explosions; however, little difficulty was experienced in discerning the direction of forces at and near the junctions of the principal entries. As stated previously, the first explosion must have been the most violent and most extensive, since the disturbance created thereby was the only one that was recorded by a seismograph and the forces of which were easily discernible at the slope portal; therefore, the investigators determined the point of origin and the probable path of propagation of only the first explosion. Only the apparent displacement of heavier objects and those directly in the path of the explosion, such as stoppings across entries, were considered in delineating forces; but in the comparatively few instances where this was not evident, such determination was made by the direction of streamlined dust and coke on the floor and posts and/or plastered coke on other fixed objects.

There was some conflict of forces near the point of explosion origin, but forces generally emanated from No. 7 pillar place of 4 left entries off 2 north, went out 4 left, thence south in 2 north entries to the junction of 2 north with the main west return and intake airways, and east and west through these airways. Forces going west expanded into the shop entries (through these to the man shaft), the 1 south and 3 north entries, and continued to the faces of the west mains, where evidence of extreme violence was greatest of all observed. Forces extending east from 2 north junction blew out of the man shaft and No. 2 fan shaft, and continued east through the main west and 10 right entries and south through the main north and C face main entries to the haulage slope portal. Men working at the top of the No. 1 fan shaft did not feel the effects of the explosion.

Evidence of great violence was lacking at and near the point of origin; there was, however, considerable evidence of slow-burning gas on the roof in a large area immediately outby; and emanation of forces therefrom was determined by partly burned brattice cloth blown into Nos. 7 and 8 entries outby No. 8 crosscut, by deposition of coke on nearby face equipment, and by dust blown into recesses of the equipment. The explosion traveled out (east) the 4 left entries and radiated in three directions, north, south, and east, from the junction of 4 left and 2 north entries. The 3 permanent stoppings in crosscuts between Nos. 2 and 3 entries, the 1 between Nos. 1 and 2 entries, and the 6 between Nos. 6 and 7 entries of 4 left, all parallel with the line of early forces, remained intact; but the one stopping across No. 1 entry of 4 left, the man-door in the stopping across No. 2 entry, and a trip of empty cars in No. 5 entry were blown east (toward 2 north entries) and 4 of the cars derailed; and the regulator across an opening between 4 left and 3 left entries was blown south (toward 3 left). At the junction of 4 left and 2 north, permanent stoppings across Nos. 1, 2, and 3 entries of 2 north, which were a continuation of those stoppings on the south side of 4 left, were blown south; a stopping across No. 2 entry of 2 north, in line with those on the north side of 4 left, was driven north; 3 empty mine cars in No. 5 entry were driven north and 2 were derailed; and stoppings in crosscuts of 2 north, corresponding to Nos. 1, 2, 3, and 6 entries of 4 left, were blown east. The explosion propagated at variable velocity along the gob and through old openings west of 2 north entries and through the back entries (return airways) on each side of 2 north to reach the main west return and intake airways. Violence appeared to have been greatest in the west back entries of 2 north as the explosion approached the main west airways; all the stoppings in the first 12 crosscuts of 2 north, all the stoppings across the main west returns at the 2 north junction, and 3 of the 4 overcasts at this junction were blown east.

A 400-foot-wide pillar separates the 2-1/2-mile-long main west return airways from the main west intake and 10 right entries. These airways are connected at the extreme ends of the main west returns (main north and 3 north) and at six other locations. The direction of forces was practically the same in these parallel airways; it is assumed, therefore, that the explosion traveled through each set of airways at almost the same time and that the forces thereof joined at or near the several connections. The connecting openings at C face mains and at No. 528 well were inaccessible during early recovery operations because of roof falls, and those at No. 96 well, the diagonals near No. 2 fan shaft, and old 3 north entries were barely accessible.

On reaching the mouths of 2 north entries, forces of the explosion expanded east and west into the west main return and intake airways from their respective junctions with 2 north. Following the path of forces westward through the intake airways: Virtually every one of the concrete-block stoppings in crosscuts between the entries from 2 north to the faces was blown out and, with very few exceptions, away from the haulage entry; all the stoppings in crosscuts between Nos. 6 and 7 entries, from 2 north entries to the shop-entry overcasts, were blown south; the stopping across No. 7 entry inby the overcasts and the stopping across No. 1 entry outby the overcasts were blown west; the overcasts were blown south and west; and the two regulators across the shop entries and the stoppings across the mouths of D face and E face main entries were blown south. Two large piles of steel ties in No. 2 entry between D face and E face mains were scattered about, concrete-block walls along the haulageway outby well No. 528 were partially destroyed, the steel-rail supports topping these walls were bent and moved westward, and 2-foot-square concrete-block roof supports were dislodged or broken. Seven large reels of heavy electric cable at crosscut No. 307 were tossed about, and 3 of the reels were broken to their spindles. At the junction with 1 south entries, stoppings across Nos. 1 and 2 entries of main west and two concrete-block roof supports in the haulageway were blown west, the 3 overcasts were demolished and blown west, and a stopping across No. 4 entry of 1 south was blown south. At old 3 north, 1 of 2 stoppings across each of Nos. 6 and 7 entries was blown west and the other blown east; this may be attributed to forces coming out of the main west returns, by way of the old 3 north entries, between these pairs of stoppings. At the 3 north junction, 2 stoppings across No. 7 entry of west mains, 2 across No. 6 entry, and 1 across No. 5 entry were blown west. Part of the forces traveling through the main west returns here united with those in the intake airways.

The large fire in the main west returns either obliterated or complicated minor indications of the direction of forces in these entries, and only large roof falls offered resistance to the westward forces in the first 2,500 feet of these entries inby 2 north. Although coke was plastered on the lips of top cuts, on roof bolts, and on pillar corners at many places, indicating westward forces in this area, the first concrete evidence of such forces was found at the face of No. 7 entry (discontinued here because of an oil well pillar) opposite E face entries. Here, much fine coal and dust had been piled against the face and blown into crevices, and nearby in No. 5 entry, bags of rock dust had been blown west and south. About 500 feet inby this point, beyond the fire area, crossbars and posts in Nos. 3 and 4 entries were blown west, and coke was streamlined on standing posts and on roof bolts protruding 2 feet below the roof. The floor in Nos. 1 and 2 entries just inby No. 170 well pillar was swept clean and the debris deposited westward. At the junction of the main west returns with 3 north entries, all the stoppings in crosscuts between Nos. 6 and 7 entries and between Nos. 2 and 3 entries of 3 north and the two sets of overcasts (6) were swept west, those stoppings across 3 north entries inby the overcasts were swept north, and those across the entries outby the overcasts were swept south. The forces moving south from this junction joined with forces moving through the main west intake airways at the 3 north junction; those moving north swept inby two stoppings that were across No. 7 entry just inby Nos. 20 and 30 crosscuts, the only stoppings across the entries outby the junction with 4 right, and entered 4 right entries.

Combining of forces at the 3 north junction resulted in considerable violence and, subsequently, in conflicting evidence of forces in the 2,300-foot stretch of main west entries from this junction to the faces. However, 7 of the 8 stoppings and regulators across 5 of the entries were blown toward the faces (west); fine coal and dust were piled against, and coke was plastered on, some of the faces; and a large piece of brattice cloth, partly burned, was blown tightly into a kerf in the top coal at the face. One rail was broken and another badly bent in the run-around track, on which cars had been standing, less than 200 feet from the faces. The mine cars were blown around and battered, the bodies of 5 of them were separated from their trucks, and much damage was done to the face electrical equipment. One shuttle car had been blown inby against the loading machine, then struck by a mine car, which was later whirled about and blown outby; however, indications were that most of the heavy equipment was affected by forces moving outby. Electric detonators from a storage box 650 feet from the faces were scattered outby and many of them exploded. Coke was plastered in all directions in this area, and there was evidence of slow burning on the roof coal near the faces of Nos. 1 and 2 entries. Gas continued to bubble from these faces during recovery operations.

In 1 south entries, the three overcasts at 1 left were destroyed and concrete blocks therefrom scattered south. A plastic trolley guard at 2 left junction was sand-blasted to pieces and the ends cut to a feather edge, but the material was not burned. Evidence of great violence was not observed in 2 left entries off 1 south, in which 3 of the victims were found; but the forces from 1 south entered these entries, the pillared area south of 2 left, and 1 left entries; and a fire burned in the abandoned 1 south entries at 3 left.

Ascertaining the direction of forces of the first explosion in the area immediately east and south of the 2 north junction with the main intake and return airways, toward the No. 2 fan shaft and the man shaft, was virtually impossible because evidence of such forces was either destroyed or altered by the subsequent explosions, at least one of which is believed to have originated at or near the shafts, and all of which affected the shafts. There were many large roof falls and much deep fire in the main west returns from 2 north to the fan shaft and almost a complete lack of heavy movable objects in these airways; however, it has already been established that forces coming out of 2 north entries moved east through the main west returns toward the fan shaft and southeast through the shop entries toward the man shaft, and that they emerged from both shafts. The regulator in the diagonal entry near the fan shaft, the stoppings and regulators in the C face main entries between the main west intakes and returns, and 3 of 5 stoppings at No. 96 well pillar were blown south; 2 others at No. 96 well were inaccessible because of roof falls. Eastward movement of forces in these entries was indicated by 1 stopping across No. 6 entry at No. 86 well and 3 stoppings across No. 5 entry at No. 96 well blown east, crossbars blown east and piled against roof falls in Nos. 1, 2, 3, and 4 entries about 1,200 feet from the east faces of these entries, crossbars swung east in No. 6 entry and debris at an old loading point in this area eroded from the west side, timbers blown east and piled against the rib in the next to the last east crosscut, and a stopping and a regulator in the last two connections between 10 right and the main west returns moved south. All the entries were obstructed considerably by high roof falls, many of which had occurred before the disaster, but the entries were nearly blocked at the east end of No. 96 well and in a 300-foot stretch about 1,200 feet from the east faces of the entries. Violence in these entries appeared to have been greatest and evidence of forces most conflicting in the last-mentioned area.

No attempt was made to determine the direction of forces in the main west intakes between 2 north and C face mains or in the man-shaft area because of the mass of conflicting evidence. Installations and equipment either destroyed or damaged by violence, roof falls, and/or fire therein included the main pumping station, dispatcher's station, supply room, repair shop, mine foreman's office, an overcast and a man-trip waiting station near the man shaft, a rock-dusting machine, a welding truck, a fire truck, haulage locomotives, electric jeeps, and covered man-trip cars. A trip of empty cars on the 2 north sidetrack was wrecked, and one car in the middle of the trip was blown lengthwise into a crosscut south of the sidetrack.

Forces were extremely violent at the "Y" junction of the main west intakes, C face main, and 10 right entries; the 10 right entries are a continuation of the main west entries eastward from this point. A large triangular concrete pier at this junction was blown into the roadway, several large, square concrete piers were either totally or partly demolished, and the trolley wires and a million-circular-mil feeder cable were severed and torn from their hangers by a unison of forces traveling east through the main west intakes and south from the main west returns. Deep fire had burned in 10 right haulageway, and all the entries and crosscuts 100 to 250 feet east of the junction were closed by roof falls. Evidence of great forces was not observed in 10 right entries immediately east of C face mains, but 3 cases of explosive in No. 6 entry at No. 8 crosscut were nearly covered by debris blown east, a mine car in No. 4 entry inby No. 10 crosscut was moved eastward but not derailed, and timbers in No. 6 entry at No. 16 crosscut were blown east. Two stoppings in the openings west of No. 96 well were blown north. Three stoppings and a regulator in each of 3 sets of so-called bleeder openings connecting 10 right entries with the worked-out 9 right entries were blown south (toward the old workings), and fire of varying intensity had burned in the second set of bleeders and in the adjacent Nos. 1, 2, and/or 3 entries of 10 right for about 1,700 feet eastward. Much debris was blown east against a roof fall in No. 4 entry at No. 30 crosscut, bags of rock dust were scattered eastward in No. 5 entry at No. 33 crosscut, and timbers were blown east and piled against a fall in No. 7 entry at No. 33 crosscut. Violence in the 10 right entries was greatest and forces most conflicting near the east ends, where the entries were turned to encircle No. 41 well pillar and roof falls blocked some of the openings. Crossbars were scattered in all directions, stoppings across the entries were blown east or west, and two stoppings in 10 right crosscuts corresponding to Nos. 1 and 2 entries of main north were blown south.

Southward movement of forces from 10 right entries through the main north entries toward the haulage slope were indicated by 10-inch steel "I" beams in the main north entries, including those at an old battery-charging station in No. 1 entry, blown south off their supporting pins, the ends of power cables in No. 2 entry torn from their hangers and blown south, a large number of timbers blown south against a roof fall in No. 4 entry, an elevating conveyor damaged by violence in No. 2 entry at the twelfth crosscut outby 10 right, and the top of the overcast lifted and damaged slightly. One stopping in old workings east of main north was blown east. Violence of the explosion in main north entries decreased rapidly after the forces expanded into the aforementioned old workings. Only minor indications of force were found in these entries outby the overcast.

Forces traveling south in C face main entries wrecked a trip of empty cars on the sidetrack just outby west mains, blew out wood-tie cribs, and scattered the ties and other debris along the main haulageway. The floor at several places in the back entries was swept clean. The regulator across No. 1 entry of C face mains inby 5 left entries was blown south, and considerable refuse, including a mangled steel sign from 8 right, was blown into the inby entrance to 5 left, but neither the overcasts at 5 left nor those at 4 left were damaged. Twelve of the first 20 stoppings between C face mains and the worked-out areas of 8 right and 9 right entries were blown toward the old workings. Forces of the explosion, dissipated in this abandoned area and 5 left and 4 left entries, diminished gradually as they passed through C face mains toward 9-10 left entries. Physical damage occurring outby 4 left entries was almost negligible. Scattered papers and streamlined debris and dust on the roadways, and wind-swept ribs were the principal indications of force outby 4 left entries.

Evidence of Activities. Seven of the twenty-four men who entered the mine the morning of November 13 had returned to the surface before the explosion occurred; 4 of the 24, the rock-dusting crew, had completed their work and were walking toward and within 400 feet of the man shaft (main intake); the pumper was on a jeep proceeding toward and within 600 feet of the man shaft; and 2 mechanics who had been working in 4 left off C face were riding on a locomotive, pushing a welding truck toward the repair shop, within 800 feet of the man shaft. The 2 mechanics who were working near the foot of the slope had finished their task about 15 minutes prior to the explosion and were on the slope bottom awaiting a ride up the slope. They walked to the surface unassisted.

The location of the locomotive and the derailed jeep, against each other and at least 900 feet from the working places in 2 left off 1 south, indicates that this equipment was being operated at the time of the explosion by the 2 mechanics and the maintenance foreman who had worked near the faces of 2 left. These men had finished their assignment and were apparently on their way to the man shaft. A section foreman and 4 other workmen, constituting a production crew, assigned to pillar work in 4 left section off 2 north were the only persons at or near any of the working faces when the explosion occurred.

According to the measurements given, which can only be approximated, the task set for the production crew in 4 left off 2 north would include the removal of 3, or possibly 4, cuts of coal from a pillar lift, timbering and roof-bolting in this area, setting breaker posts, and drilling and blasting 5 pillar stumps before a fall could be made to attain the desired pillar alinement. A high roof fall in No. 8 entry of 4 left necessitated deviation from the normal pillaring plan for removal of the No. 7 pillar between Nos. 9 and 10 crosscuts and the last lift in the No. 7 pillar immediately inby. Starting at a point in No. 8 entry about 24 feet inby No. 9 crosscut, an 18-foot-wide lift was driven about 25 feet into the No. 7 pillar; and an 18-foot-wide "skinny", leaving a 5-foot-wide fender, was driven at right angles therefrom, through this pillar and No. 10 crosscut and into the No. 7 pillar inby (See Appendix J). Usually, with each 8- to 8-1/2-foot cut, this fender would have been sheared through to the fall in No. 8 entry. Whether the inby pillar had been recovered during the shift immediately prior to that in which the explosion occurred is conjectural, as testimony offered during the hearings on the explosion was contradictory. However, it is certain that during this shift the first cut in the inby (top) lift of the No. 7 pillar just outby the caved No. 10 crosscut had been started about 21 feet from the crosscut and to the left of the "skinny". This lift was to be driven 18 feet in width, and the usual triangular-shaped stumps left as the fender.

The assistant mine foreman, who returned to the surface shortly before the explosion occurred, visited No. 7 pillar place and talked to the section foreman in 4 left off 2 north entries about 1:15 p.m. At that time the section foreman said that he did not believe the pillar lift would be completed, as he thought another cut of coal would have to be removed, and that he would have the mining machine taken to the face and a shear cut made to determine the size of the remainder of the lift. Either the shear cut was not made or only a small cut of coal had to be removed to complete the lift, as the mining machine was in No. 8 crosscut near No. 6 entry when the explosion occurred. Although it is assumed that only the pillar stumps were being blasted to induce a roof fall, it is possible that the last cut of coal in the lift was being blasted at the same time. Apparently the hand-held electric drill had been used shortly before the explosion occurred, as the drill and two tamping sticks were at the northwest corner of No. 7 entry and No. 8 crosscut, and the drill cable was lying on the floor doubled and extending under the roof fall in No. 8 entry. One of the two shuttle cars was under this fall at No. 9 crosscut; the rubber-tire-mounted roof-bolting machine was in No. 7 entry, 28 feet inby No. 8 crosscut; the caterpillar-mounted loading machine was in No. 7 entry, 45 feet outby No. 8 crosscut; and the other shuttle car was in No. 4 entry near the loading point. A shot-firer's carrying bag containing 4 instantaneous electric detonators was in No. 8 crosscut near No. 8 entry.

There were definite indications that blasting was being done in the top lift of No. 7 pillar just outby No. 10 crosscut when the explosion occurred. As mentioned previously, the untwisted battery ends of a blasting cable extending under the roof fall and toward the pillar lift were lying within 2 feet of nails driven into the shuttle-car trailing cable in No. 8 entry about 10 feet outby No. 9 crosscut. Also, the bodies of the five victims on the section were lying along No. 8 entry between Nos. 8 and 9 crosscuts, with their heads outby as though the victims had been moving away from the explosion. The most inby body was about 4 feet outby the battery ends of the blasting cable, and a spool of cotton-insulated copper wire for connecting shots was near the hand of the farthest outby body.

Neither the assistant mine foreman nor the fire boss who were in the 4 left section shortly before the explosion occurred entered the No. 7 pillar place or examined for gas at any point along the pillar line. It was customary for the section foreman in charge of an active section to make gas examinations and reports thereon. Assuming that the section foreman examined the working place for gas just before blasting, it is quite possible that gas on the gob side of the stumps was ignited by the shots or that a roof fall occurring in the adjacent gob area immediately before the shots were fired would force the gas therefrom into the working place.

Point of Origin. The consensus of the Bureau of Mines investigators is that the first explosion originated in No. 7 pillar place of 4 left off 2 north entries, as all conditions necessary for an explosion existed at the time in this working place and at no other location, and forces emanated from No. 7 pillar place and 4 left entries.

Factors Preventing Spread of Explosion. As shown on the mine map (Appendix B), forces of the explosion extended throughout all open accessible workings from the faces of the main west intake entries to the slope, into all the adjacent worked-out areas, and to the surface through the man shaft, No. 2 fan shaft, and the haulage slope. Forces extending south through C face main entries spread into the vast worked-out areas east and west of these entries and into 4 and 5 left entries, and diminished rapidly as they moved toward the slope. The outby portions of 4 and 5 left entries were rock-dusted adequately. Forces moving south through main north entries extended into the large abandoned area east of these entries and subsided rapidly as they moved toward the slope. Evidence of flame was not observed south of these points of pressure dispersion.

An explosion in extensive mine workings is such a complex phenomenon that no one can explain with certainty all the reasons for its devious path, fluctuating violence, changing flame shape, the distance of flame travel and other characteristics. What happens at any point along the path of an explosion depends to an important degree on its past history. The air in advance of the explosion flame is preconditioned; i.e., mixed with mine dust and/or gas, precompressed, and preheated. These processes are affected by the availability of fuel, the availability of oxygen, the distribution and amount of rock dust or other quenching agent, the nature and potency of the ignition zone, and the geometry and other properties of the mine passageways.

The first explosion had a powerful initiating source in the form of a large body of gas along the pillar line on the west side of 2 north, together with fine coal dust dispersed from the mine surfaces. As the flame propagated it was fed by additional inadequately neutralized coal dust which was available in at least some of the entries, and perhaps by occasional pockets of gas. This accounts for the development of a truly widespread explosion.

Factors acting in combination that are believed to have limited even further spread of the first explosion include: (1) The diluting and quenching effect of rock dust; the average incombustible content of the 411 mine dust samples was nearly 50%; (2) the cooling effect of the extensive rib, roof, and floor surfaces of the numerous entries in the path of the explosion, which abstracted an appreciable portion of the energy from the flame; (3) the aforementioned effect of expansion of the gaseous combustion products through the man shaft, No. 2 fan shaft, and the large worked-out areas; expansion or venting behind a flame results in a reduction of flame speed; and (4) the lack of oxygen at places in the path of the explosion; normal air will not support the complete combustion of nearly all the coal dust and/or gas that may be thrown into suspension in the path of the flame. These conditions resulted in gradual reduction of flame velocity and in lowering of flame temperature, ultimately below the ignition temperature of the dust.

Summary of Evidence. Conditions observed in the mine during recovery operations and the investigation following the disaster, together with information available from previous Federal coal mine inspection reports and that obtained from company officials and workmen, provided ample evidence as to the cause and the origin of the first explosion. The evidence from which the conclusions of the Federal investigators are drawn is summarized as follows:

1. Forces of the first explosion were greatest and are believed to have extended throughout most of the mine. The fires and subsequent explosions were a direct result of the first explosion.

2. Of the 17 men who were in the mine when the explosion occurred, only 5 were at or near a working face; these men were producing coal in No. 7 pillar place of 4 left off 2 north entries. Five mechanics were in intake air at locations not reached by flame of the explosion, and the other 7 men were near the man shaft, a main intake airway.

3. The production crew assigned to complete a pillar lift in 4 left off 2 north entries was blasting when the explosion occurred. This crew may have been hurried in their work as they had been instructed to be out of the mine before 2:00 p.m.

4. The 5 men in 4 left off 2 north section moved very little after the initial explosion, the position of the bodies showed that they were moving outby but were killed in their tracks.

5. Blasting was being done in the top lift of No. 7 pillar place just outby No. 10 crosscut (4 left off 2 north entries) when the explosion occurred; the untwisted battery ends of a blasting cable extending towards the pillar lift were lying within 2 feet of nails driven into the shuttle-car trailing cable in No. 8 entry about 10 feet outby No. 9 crosscut.

6. Shots in pillar stumps were usually fired 2 at a time, nonpermissibly, with a single-shot blasting unit. All explosive charges in stumps of a pillar lift were occasionally wired together and the shots fired simultaneously, and electric power for such blasting was obtained from the 275-volt mine electric circuit.

7. It will never be known whether the explosives used for blasting in 4 left section on November 13, 1954, were part of any lot tested for permissibility, but explosives from 2 of 7 lots taken from the surface magazine immediately after the explosion failed to pass the gallery test.

8. The mine records show that methane was detected with a flame safety lamp on the gob adjacent to No. 7 pillar place 6 days before the explosion; the investigation revealed that methane had been found, but not reported, in the 4 left off 2 north section, particularly in No. 7 pillar place, at least 4 times within 24 hours prior to the explosion; and the adjacent gob was filled with explosive gas as this gob area could not possibly have been ventilated. Furthermore, the air current that passed by the east fringe of the 2 north gob area showed an increasing methane content from 1.5 to 1.7 percent in the several examinations during the previous 2 months.

9. Check curtains used to conduct air in the face regions were normally rolled up and tied in place to facilitate shuttle-car haulage,

and, reportedly, line brattice was not used in pillar lifts except when gas was encountered. Although gas had been detected during each of the 2 previous shifts, line brattice was not installed in No. 7 pillar lift at the time of the explosion.

10. Before the explosion, line brattice had been installed in 4 crosscuts between Nos. 1 and 2 entries of 2 north inby 4 left in an attempt to keep the completely caved No. 1 entry clear of gas, and for a similar purpose a line brattice was extended 100 to 150 feet into the so-called bleeder entry south of 1 left off 2 north. Long after normal ventilation had been re-established in 2 north section, line brattice, check curtains, and stoppings had to be installed to conduct air along the east fringe of 2 north gob area outby 4 left, where as much as 40 percent methane was detected.

11. A source of ignition was not present in any working place except No. 7 pillar place of 4 left off 2 north entries, where gas or dust could have been ignited by flame from explosives fired in a non-permissible manner or by an electric arc from the detonator leg wires, connections between the leg wires and the blasting cable, or the blasting cable ends contacting the nails in the energized trailing cable of the shuttle car.

12. Examination of the mine map, records of air measurements, accessible openings to the pillared area west of 2 north, and the so-called bleeder entry along the south end of 1 left off 2 north entries shows definitely that a positive flow of air could not have traveled through the pillared area off 2 north entries.

13. Records of the fire-boss examinations of all working sections, which include air measurements made in the return airways of these sections, list no unusual condition observed during either of the 2 shift before the explosion. Officials who examined all the working sections and intake airways and who made air measurements and methane-content determinations in all main and split returns except 2 north outby 1 left within 6 hours before the explosion reported mine conditions normal in every respect.

14. Officials who worked in or visited the 4 left off 2 north section stated that roof falls had been made along the north end of the pillar line shortly after the beginning of the 10:00 p.m. to 6:00 a.m. shift, November 12-13, and before 10:30 a.m., November 13. Contradictory testimony was given concerning the finding of gas in the area immediately before and after the first fall occurred.

15. All trolley and feeder wires were installed in intake air, and an ignition source was not present in any of the return airways. There was no evidence of trolley or other power wires having been dislodged by roof falls prior to the explosion.

16. Face electric equipment was not being operated in any working place at the time of the explosion; certainly, power was conducted

to the shuttle car in No. 8 entry of 4 left off 2 north entries, but the car was not being operated at the time; and there was no evidence that the electrical parts of the car, other than the trailing cable, contributed in any manner to the explosion.

17. The change in barometric pressure is considered too slight to be a factor in the explosion.

18. The fan pressure changes during the period 9:00 a.m. to 1:45 p.m., November 13, were not unusual and were not significant to the explosion, as 4 times during the previous fortnight, similar decreases in No. 1 fan pressure were accompanied by like increases in No. 2 fan pressure at the same time of day.

19. Although the mine property was penetrated by more than 100 oil and gas wells, there was no evidence to support a contention of natural gas having entered into the explosions.

20. Loose coal and coal dust 3 to 8 inches in depth had been left along the greater part of the ribs of advancing entries, and larger amounts of loose coal and coal dust were on the floor along the greater part of the older back and parallel entries.

21. Large amounts of rock dust had been applied, especially in face regions and haulageways, and a cover of rock dust 1 to several inches in depth was on the floor of sectional back entries as well as on the floor at some places in older back and parallel entries.

22. Sufficient rock dust had not been applied on the roof and ribs at several places in advancing entries or at many places in parallel and older back entries, even though other parts of the back and parallel entries were blanket rock-dusted.

23. It would appear that blanket rock-dusting at scattered locations in the older back and parallel entries was done in an effort to provide rock-dust barrier protection and to compensate for inadequate rock-dusting on the roof and ribs in the same area, and on the floor, ribs, and roof at other locations in these entries. The apparent ease with which the explosion traveled through the blanket rock-dusted areas shows that excessive rock dust on the floor in parts of an entry will not compensate for rock-dust deficiencies in other parts of the entry, especially when excessive coal dust is present in such entries.

24. Section foremen and employees acknowledged that some of the hazardous practices that contributed to this disaster were known by them to be dangerous and that such practices were not permitted or performed when high company officials or State or Federal inspectors were present.

Cause of the Explosion. The Federal investigators are of the opinion that the first explosion resulted from firing, in a nonpermissible manner, 2 or more charges of explosives in an explosive mixture of methane and air; that either the flame of the explosives or an electric arc produced by short-circuiting of the blasting wires was the igniting agent; that coal dust raised by blasting entered into the explosion immediately; that in 2 north section the explosion was propagated by methane from the pillared area west of 2 north entries and also by coal dust; that propagation throughout the greater part of the rest of the mine was by coal dust; and that propagation was possibly aided by methane that may have accumulated over extensive falls in the airways.

RECOMMENDATIONS

The following recommendations are made to prevent similar disasters:

1. Permissible explosives should be charged and fired in a permissible manner.

2. Permissible explosives should be fired only with permissible blasting units.

3. Shot holes less than 6 feet in depth should be charged with not more than 1-1/2 pounds of explosive. Charges exceeding 1-1/2 pounds, but not exceeding 3 pounds, should be used only if the shot holes are 6 feet or more in depth, the explosive cartridges are in a continuous train with all cartridges in contact with each other, and with the end cartridges touching the back of the hole and the stemming respectively.

4. Explosive charges in or over pillar stumps should have a firm unbroken burden of at least 18 inches in all directions.

5. In view of the difficulties and hazards encountered in blasting pillar stumps previous to the explosion, a method of extracting pillars should be adopted that will reduce to a minimum the number of stumps left temporarily for protection. Regardless of the method of extraction, all stumps in a pillar lift should be blasted simultaneously.

6. Examinations for gas should be made immediately before firing each shot or group of multiple shots; shots should not be fired in any place where methane can be detected with a flame safety lamp.

7. Foremen should record clearly, in the daily report book provided for that purpose, the location and nature of any danger (including gas detected) observed by them or reported to them during the work shift; the report should also show what action, if any, was taken to remedy the danger. Frequent reporting of gas in an area should be investigated by higher officials and remedial action should be taken promptly.

8. The practice of tying up check curtains for any reason should be discontinued. Every check curtain should be kept in place except when equipment is passing, or other temporary means should be used to deflect air to the working faces.

9. Line brattice should be maintained close enough to the working face to provide an air current of sufficient volume and velocity to dilute and sweep away all flammable or harmful gases.

10. When roof falls or other adverse conditions require deviation from the normal pillaring system, more than ordinary precautions should be taken to provide adequate ventilation at the working face. Work at the face should be discontinued if such measures fail to keep the working place and the immediate adjacent gob clear of gas.

11. A system of bleeder openings and air courses providing for a positive movement of air through and/or around abandoned or caved areas, sufficient to prevent a dangerous accumulation of gas in such areas and to minimize the effect of variations in atmospheric pressure, should be included in all future pillaring plans.

12. Coal dust and loose coal should not be permitted to accumulate in dangerous quantities in any active underground workings.

13. The floor, from rib to rib, in working places should be cleaned up and reasonably free of loose coal and coal dust before rock dust is applied.

14. Rock dust should be distributed uniformly on the roof, ribs, and floor and maintained in such quantity that the incombustible content of the combined rock dust, coal dust, and other dust will not be less than 65 per cent, plus 1 percent for each 0.1 percent of methane present in the ventilating current.

15. Dust samples should be collected and analyzed periodically to determine the effectiveness of rock-dust applications.

16. Insofar as practicable, the weekly inspections of airways should include examinations for gas over all accessible roof falls, and these areas should be ventilated sufficiently to remove any standing gas.

17. Permissible face electrical equipment should be maintained in permissible condition.

18. All foremen and employees should comply with company safety rules and State and Federal laws and regulations covering mining conditions and practices. No foreman should assign other employees to perform any task in a manner that would violate any law, rule, or regulation, but rather should insist on full compliance therewith at all times.

ACKNOWLEDGMENT

The writers acknowledge gratefully the courtesies extended and the help given by officials of the operating company, officials and other members of the United Mine Workers of America, and representatives of the Bituminous Coal Operators Association, the West Virginia Department of Mines, and the United States Bureau of Mines, who gave freely all information requested in connection with this investigation.

Respectfully submitted,

W. R. Park

W. R. Park
District Supervisor

W. Dan Walker Jr.

W. Dan Walker, Jr.
District Supervisor

John J. Dougherty

John J. Dougherty
Subdistrict Supervisor

M. L. Davis

M. L. Davis
Safety Representative

Approved by:

James Westfield

James Westfield,
Assistant Director -- Health and Safety

Thos. H. Miller

Thomas H. Miller,
Acting Director

APPENDIX A

VICTIMS OF EXPLOSION, NO. 9 MINE

JAMISON COAL AND COKE COMPANY

November 13, 1954

Name	Age	Occupation	Marital Status	Children Under 18 Years of Age
George C. Alberts	51	Section Foreman	Married	None
Russell W. Morris	51	Maintenance Foreman	Widower	None
Harry C. Dunmire	51	Maintenance Foreman	Married	2
Carrol Ice	51	Cutting-Machine Operator	Divorced	
Charles Korsh, Jr.	34	Machine Operator	Married	1
Louis L. Beafore	29	Roof-Bolter	Single	
Nick Koverbasich	37	Shuttle-Car Operator	Single	
Charles L. Fluharty	33	Rock-Duster Motorman	Married	2
Robert L. Sanders	36	Rock-Duster	Married	3
Harry Floyd, Sr.	62	Pumper	Married	None
Matt Menas	43	Mechanic	Married	2
Lonnie Hartzell	49	Mechanic	Married	None
Clyde R. Keener	63	Mechanic	Divorced	None
Joe Opyoke	44	Mechanic	Married	1
Joe Gregor	47	Dispatcher	Married	2
Howard Jenkins (Killed on surface)	38	Lampman	Married	3

APPENDIX C - LOCATION AND CONDITION OF VARIOUS PIECES OF MINING EQUIPMENT

NO. 9 MINE, JAMISON COAL AND COKE COMPANY, FARMINGTON, MARION COUNTY, W. VA.

Equipment	Permissible Type	Permissible Condition	Remarks
Main west section			
Jeffrey hand-held drill	Yes	No	Two broken seals, four temporary splices in trailing cable
Joy 11-BU loader	Yes	No	Damaged headlight, no junction box for pump motor, broken hose conduit on pump motor power wires, one bolt missing and opening in excess of 0.004-inch on light resistance cover, damaged trailing cable conduit
2 - 60E shuttle cars	No	No	OK
Roof-bolting machine	Yes	Yes	OK
10-RU cutting machine	Yes	No	Rear light lens broken, hose conduit broken on headlight
Rock-dusting machine	Yes	No	Blown apart
No. 2 Air shaft			
Roof-bolting machine	Yes	No	Reset safety switch not operating, bolts and nuts missing on contactor control, openings in excess of 0.004-inch

Equipment	Permissible Type	Permissible Condition	Remarks
Joy 11-BU loader	Yes	No	Opening in resistance cover in excess of 0.004-inch, seals missing
60E shuttle car No. 434	No	No	Broken headlight lens, loose headlight packing gland, hose conduit pulled from packing gland, seals missing
60E shuttle car No. 425	No	No	Broken packing gland on reset station
<u>2 North Airways</u>			
Shuttle car No. 435	No	No	Broken hose conduit and damaged power cable to right traction motor, opening in excess of 0.004-inch on cover plate of contactor box, hose clamp missing on pump motor conduit
Joy 11-BU loader	Yes	No	Loose headlight packing gland
<u>4 Left 2 North</u>			
60E shuttle car	No	No	Broken hose conduit on power leads to both traction motors, broken packing gland on contactor box, missing seals, damaged packing gland on headlight, many temporary splices in trailing cable
10-RU cutting machine	Yes	No	Broken hose conduit on rear headlight, many temporary splices in trailing cable

Equipment	Permissible Type	Permissible Condition	Remarks
Joy 11-BU loader	Yes	No	Opening in excess of 0.004-inch on cover of rear headlight resistance, loose headlight packing gland, many temporary splices in trailing cable
<u>2 left 1 South</u>			
Joy 11-BU loader	Yes	No	One loose and one broken headlight packing gland, loose headlight lens
<u>Spare Equipment - 3 North Airways</u>			
60E shuttle car	No	No	Broken hose conduit on the right and left traction motor power leads, lock washers missing on contactor control cover, many splices in the trailing cable
Joy 11-BU loader	Yes	No	Many splices in the trailing cable
<u>5 Left off C Face</u>			
Joy 11-BU loader	Yes	No	3 openings in excess of 0.004-inch on contactor control cover and headlight resistance cover, 3 hose conduits not clamped, bolts broken on cover plate of headlight resistance, trailing cable has many temporary splices
60E shuttle cars	No	No	Many splices in trailing cables
Jeffrey A7 drill	Yes	No	Seals missing and 19 splices in trailing cable

Equipment	Permissible Type	Permissible Condition	Remarks
10-RU cutting machine	Yes	No	Openings in excess of 0.004-inch on contactor and resistance cover lid, loose headlight lens
Roof-bolting machine	Yes	No	Splices in the trailing cable with exposed wires
<u>4 Left off C Face</u> Joy 11-BU loader	Yes	No	2 openings in excess of 0.004-inch on headlight resistance cover lid, broken hose conduits and loose packing gland on headlight, trailing cable with many poorly made temporary splices
10-RU cutting machine	Yes	No	Loose packing gland and broken lens on headlight, 3 temporary splices not made in a workmanlike manner
60E shuttle cars	No	No	Many splices in trailing cables
Jeffrey A7 hand-held drill	Yes	No	12 splices in trailing cable
<u>4 Left off C Face</u> Joy 11-BU loader	Yes	No	Opening in excess of 0.004-inch on contactor cover lid, seals missing on inspection covers, packing gland broken and openings in excess of 0.004-inch on headlight resistance
60E shuttle cars Nos. 429 and 435	No	No	Many splices in trailing cables

Equipment	Permissible Type	Permissible Condition	Remarks
Jeffrey A7 hand-held drill	Yes	No	1 bolt missing on top control cover plate, wires exposed in the temporary splices of the trailing cable
10-RU cutting machine	Yes	No	Broken headlight lens and lock washers missing from control cover bolts
Roof-bolting machine	Yes	Yes	OK
<u>5 Left off C Face</u> Nos. 1 and 2 60E shuttle cars	No	No	Loose headlight lenses, missing lock washers and missing seals, many splices in trailing cables
10-RU cutting machine	Yes	No	Many lock washers missing from control covers
Joy 11-BU loading machine	Yes	No	Loose headlight lens, loose packing gland, and seals missing
Roof-bolting machine	Yes	Yes	OK
Jeffrey A7 hand-held drill	Yes	Yes	OK

Equipment	Permissible Type	Permissible Condition	Remarks
<u>4 Right off 3 North</u> 60E shuttle car No. 431	No	No	Loose bolts on contactor control cover, several seals missing, broken hose conduit on power leads to traction motor, and broken rear headlight lens
60E shuttle car No. 36	No	No	Lock washers missing on contactor control cover and 8 temporary splices in trailing cable
Battery-powered shuttle car converted into 250-volt roof-bolting machine	No	No	Broken headlight lens and much accumulated oil spillage and coal dust on the machine
Mobile hydraulic drill	Yes	No	Ten temporary splices in trailing cable
10-RU cutting machine	Yes	No	Broken hose conduit on headlight power circuit and 4 temporary splices in trailing cable
11-BU loading machine	Yes	No	Openings in excess of 0.004-inch on main resistance and headlight resistance cover lids

APPENDIX D

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES, REGION V

September 1, 1955

Report on the Relationship of Petroleum and Natural Gas Operations to the Explosions and Fire at the Jamison Coal and Coke Company, No. 9 mine, Farmington, Marion County, West Virginia, on November 13, 1954.

/s/ William E. Eckard
William E. Eckard
Petroleum Engineer

/s/ Frank J. Stortz
Frank J. Stortz
Mining Engineer

Approved:

/s/ Sam S. Taylor
Sam S. Taylor, Chief, Division
of Petroleum Technology, Region V,
Appalachian Experiment Station,
Morgantown, West Virginia

INTRODUCTION

This investigation was initiated on November 14, 1954, upon receipt of a telephone call by Mr. John J. Dougherty, Subdistrict Supervisor, Health and Safety Activities, District C, Morgantown, West Virginia, to Mr. Sam S. Taylor, Chief, Division of Petroleum Technology, Region V, Morgantown, West Virginia, requesting advisory assistance on the relationship of petroleum and natural gas operations to the explosions and fire at the Jamison Coal and Coke Company, No. 9 mine, Farmington, Lincoln District, Marion County, West Virginia, on November 13, 1954.

This report presents data on the exploitation, development, and transportation of petroleum and natural gas from strata underlying the coal mine. Data that might have any bearing on the mine explosion were collected in as much detail as was available. The area investigated, bounded by a line drawn some 1,000 feet outwards from the mined area, contains 103 known oil and gas wells; 23 of these wells are a portion of a 111-well project for secondary recovery of oil by gas injection. An abandoned 3-well gas storage pool is located about 1,500 feet east of the eastern boundary of the mine and about 3,500 feet from the nearest mined area in the No. 9 mine. Gas pipelines, ranging from 3-inch gathering lines operating at pressures of from 5 to 7 p.s.i. to a 16-inch transmission pipeline operating at a pressure of about 150 p.s.i., and four 6-inch oil transmission pipelines traverse the property.

Map No. 1 shows the status and location of each well, the size and location of coal pillars around each well, and location of surface pipelines as of November 13, 1954. The general extent of mining operations in the Pittsburgh coal seam is also shown. The oil and gas wells were accurately located on the surface and plotted on the mine map by Jamison Coal and Coke Company engineers. These engineers also plotted on the mine map the size and shape of the coal pillars left around each well as required by the West Virginia mining laws. A careful search of oil and gas company, State, and U. S. Government Geological Survey maps was made for unknown or uncharted wells; none was found.

Information was gathered from: (1) The Jamison Coal and Coke Company, Farmington, West Virginia; (2) Hope Natural Gas Company, Clarksburg, West Virginia; (3) South Penn Natural Gas Company, Parkersburg, West Virginia; (4) West Virginia Department of Mines, Oil and Gas Division, Charleston, West Virginia; (5) West Virginia Geological Survey, Morgantown, West Virginia; (6) Consolidation Coal Company (W. Va.), Monongah, West Virginia; and (7) Huntley and Huntley, Pittsburgh, Pennsylvania.

As of November 13, 1954, the area investigated contained 20 active gas wells, 1 inactive gas well, 20 active oil wells subjected to gas drive, 2 active gas-injection wells, 1 inactive gas-injection well, 35 plugged wells, and 24 wells classified as abandoned for the purpose of this report because plugging records for those wells were not located during the investigation. The well data for each well are summarized and tabulated in Appendix No. 1, Table No. 1.

Formations containing oil and gas underlying the mine are of Pennsylvanian, Mississippian, and Devonian ages and trend generally in a northeast-southwest direction extending far beyond the limits of the No. 9 mine boundaries. Commercial quantities of oil have been produced from the Big Injun sand, located about 1,340 feet below the Pittsburgh coal; however, oil was also reported to have been produced from the Gas sand, Big Dunkard, Fifty-foot sand, and Fifth sand. Natural gas has been produced from the Gas sand about 650 feet below the coal; the Fifty-foot sand, about 1,920 feet below the coal; the Gordon Stray sand, about 2,175 feet below the coal; the Fourth sand, about 2,275 feet below the coal; and the Fifth sand, about 2,390 feet below the coal. Commercial quantities of oil have been produced from the Big Injun sand west of a general line drawn northeast-southwest on the mine map through the junction of Main West Airways and 2 North and through 2 left 1 South. East of this line the Big Injun sand contains gas.

DRILLING HISTORY

The first well drilled in the area was oil well No. 501. This well is located about 500 feet west of the town of McClellan, Marion County, West Virginia, and was spudded in during July 1892. Well No. 528 drilled in 1892 and located about 200 feet north of the Plum Run Power borehole was the first gas well. Well No. 161 was completed during February 1941, and it is the last well drilled in the area investigated.

SECONDARY RECOVERY OF OIL BY GAS INJECTION

The production of oil from 20 oil wells producing from the Big Injun sand is stimulated by the injection of gas through wells Nos. 584 and 607. Well No. 521, another gas-injection well, has been inactive since July 1954 because the sand would not take a sufficient volume of injected gas.

These 20 oil wells and 3 injection wells are a part of a larger gas-injection project which was reported by the West Virginia Secondary Recovery Study Committee and the Interstate Oil Compact Commission. This report was titled, "Summary of Secondary Recovery Operations in West Virginia to January 1, 1954."

The injection project is in the Mannington oil field located in both Lincoln and Mannington Districts, Marion County, West Virginia. This field was discovered in 1890. Oil is produced from the Big Injun sand at an average depth, for the entire project, of 2,075 feet. Primary oil-production methods were used until 1925 when the first gas was injected and the project was named the Blackshere gas-injection project. As of January 1, 1954, the project contained 99 producing wells and 12 injection wells. The daily production was published as 87 bbl. of oil and 50 bbl. of water.

The portion of the Blackshere gas-injection project investigated was initiated during 1935 and discontinued in 1945. Operations were resumed in 1950, with an initial wellhead injection pressure of about 310 p.s.i. which dropped off to settled injection pressure of some 250-265 p.s.i. The total metered volumes of gas injected and the average pressure at which that volume was injected for selected months is listed below:

Well No.	Month - Year	Volume, M c.f.	Avg. pressure, p.s.i.
521	July 1954	864	- -
584	Jan. 1954	1084	- -
	Feb. 1954	2099	- -
	Oct. 1954	1736	255
	Nov. 1954	1200	225
	Dec. 1954	1650	230
607	Oct. 1951	1674	- -
	Nov. 1951	1254	- -
	Jan. 1954	1070	- -
	Feb. 1954	2300	- -
	Oct. 1954	2000	265
	Nov. 1954	1440	250
	Dec. 1954	1400	250

It might be well to mention that there is no relationship between total metered volume injected and wellhead injection pressure. Compressor plant shutdown, field maintenance work, and freezing of gas lines during the winter months, for example, will vary the volume and pressure of injected gas. The operator of this project reported that the gas lines leading from the compressor plant, located off the mine property in a south-westerly direction, are all tied in together. Thus a fairly constant volume of gas enters the lines and if, for example, one gas-injection well is not operating, the normal volume of gas for that well will be injected into the other gas-injection wells. This type of operation will not permit a constant rate of injection for an individual well. No unusual circumstances were noted during this investigation or were reported by the gas-injection project operator either prior, during, or after the explosion in the mine.

GAS WELLS

The gas wells which penetrate the area investigated are owned and operated separately by individuals and large gas companies. The wells were checked by the West Virginia Department of Mines and coal company and gas company representatives during a period of a few days after the explosion and no unusual circumstances were noted. One company, which owns and operates a large number of the gas wells, checked their flowing wellhead pressures on November 14, 1954, and reported the pressures ranged from 5 to 7 p.s.i., normal.

The largest original production of natural gas recorded in the area investigated was 20 MM c.f.d. from well No. 21 which produced from the Fifty-foot and Fifth sands and was tested during 1902. The latest production test, during 1954, showed its open flow to be 82 M c.f.d. The closed-in or formation pressure built up to 60 p.s.i. in 24 hours, which was the highest pressure recorded for wells tested in 1954. During that year, well No. 23 produced at a rate of 130 M c.f.d., the largest natural gas producing well, and well No. 528, the smallest, produced 9 M c.f.d.

PLUGGED AND ABANDONED WELLS

Of the 35 wells on which a record of plugging was obtained, 15 were plugged prior to the enactment of the 1929 West Virginia Oil and Gas Law. Well No. 57, plugged in 1954, was the last well plugged in the area. The complete plugging record for these plugged wells is not given in Appendix I, Table 1, but is available.

The 24 wells listed as abandoned are wells on which records of plugging were not obtained. Twenty-three of these wells were abandoned prior to the enactment of the West Virginia Oil and Gas Laws in 1929. Well No. 660 was sold by the gas producing company for abandonment in 1945 and reported plugged in 1948, but a plugging record was not found; however, this well is located 200 feet west of the southwestern portion of the mine.

UNDERGROUND STORAGE OF NATURAL GAS

The abandoned 3-well project for the underground storage of natural gas is located about 1,500 feet east of the eastern edge of the No. 9 mine property in the Pitzer's Run area. These wells are numbered 9520, 9521, and 9522 on Map No. 1. The meager records of the history and operation of this project indicate gas was first injected in 1936 into wells No. 9520 and 9522, completed in the Gas sand at an average depth of 1,163 feet during 1916. The field was small, the area being reported as only about 125 acres with the largest volume of gas stored about 102 MM c.f.d. The third well in this project, No. 9521, was drilled during 1947. Available data on each of these three wells are as follows:

Well No. 9520

This well was completed during 1916 to a total depth of 1,206 feet. The Pittsburgh coal was logged from 480 to 491 feet; the Gas sand was encountered at 1,150 to 1,201. Gas was produced from a depth of 1,178 to 1,187 feet in the Gas sand. The original formation or rock pressure was recorded as 250 p.s.i. after the well had been shut in for 24 hours. The original open flow was 1,700 M c.f.d. Production of gas from this well was tested on August 27, 1954, and was calculated as 19 M c.f.d.; the formation pressure on that date built up from zero to 26 p.s.i. in 60 minutes. Flowing wellhead pressure on November 14, 1954, was 7 p.s.i., normal.

A string of 10-inch casing was cemented at a depth of 535 feet, a string of 8-1/4-inch casing was bottomed at 1,206 feet, and a string of 3-inch tubing with an anchor packer 45 feet off bottom was set also at 1,206 feet. Records do not indicate how the injection or production of gas was accomplished.

Well No. 9521

This well was completed during 1947 to a depth of 1,227 feet. Pittsburgh coal was logged from 512 to 520 feet, the Gas sand was encountered at a depth of 1,178 feet, the bottom being unrecorded. Gas was produced as follows: 30 M c.f.d. from 1,192 to 1,195 feet, 509 M c.f.d. from 1,192 to 1,210 feet and 569 M c.f.d. from 1,192 to 1,216 feet. The original formation pressure built up to 93 p.s.i. in 24 hours. The original open flow of 569 M c.f.d. was increased to 823 M c.f.d. after the Gas sand was shot with 60 quarts of nitroglycerine. On March 17, 1954, this well was tested and produced at a rate of 30 M c.f.d. through 2-inch tubing with the formation pressure building up to 11 p.s.i. after the well was shut in for 1 hour. The flowing wellhead pressure on November 14, 1954, was 7 p.s.i., normal.

A string of 8-1/4-inch casing was installed to a depth of 564 feet, the 6-5/8-inch string was bottomed at 1,024 feet. On August 29, 1947, a string of 3-inch tubing, 1,227 feet long, was installed. This string of 3-inch tubing was made up as follows: 1,182 feet of 3-inch tubing, 3 feet of a 6-5/8 x 3-inch packer, 42 feet of 3-inch line perforated with 62, 1-inch holes starting 5 feet below packer and extending to bottom.

The well was shut in for two weeks to check for leaks, then connected into the storage line on September 16, 1947.

Well No. 9522

This well was completed during 1916 to a depth of 1,206 feet. The Pittsburgh coal was logged from 495 to 499 feet. The top of the Gas sand was located at 1,161 feet with gas being encountered at 1,181 to 1,191 feet. Original formation pressure was recorded as 127 p.s.i. after 24 hours, in a string of 2-inch tubing. On June 22, 1954, the well was cleaned out and tested at 26 M c.f.d. of gas with the formation pressure building up to 14 p.s.i. in 60 minutes through 2-inch tubing. The flowing wellhead pressure on November 14, 1954, was 7 p.s.i., normal.

A 10-inch string of casing was cemented in at 526 feet on February 3, 1917, a string of 8-1/4-inch casing was bottomed at 1,161 feet, and a 1,206-foot string of 2-inch tubing with a packer located 42 feet off bottom was bottomed at 1,206 feet.

Records on the storage project indicate the top operating pressure was about 250 p.s.i., which was the original formation pressure recorded in well No. 9520. Storage of gas was discontinued in 1950 when the operating company sold the wells. The purchaser of these three wells converted them to gas producers and on November 13, 1954, they were active gas wells.

The three ex-storage wells are, as mentioned above, located east of the eastern property line of the coal company. Records indicate that coal-mining operations around these wells took place in 1951 in the mine east of the No. 9 mine. It is unlikely that these three wells liberated gas into the No. 9 mine as they are located in another mine and are producing gas daily at a steady wellhead pressure.

Some apprehension has been voiced concerning the possible migration of gas from the Logansport storage field, Marion and Wetzel Counties, West Virginia. This field is located approximately 7.5 miles west of the mine. Its capacity has been reported as about 1.4 MMM c.f.d. It seems nearly impossible that a substantial volume of gas would leak from the field, migrate to the vicinity of the No. 9 mine, and not be detected by the storage operator or affect other coal-mining operations in the area.

OIL AND GAS PIPELINES

A number of gas and oil lines traverse the surface over the No. 9 mine. Only those lines of 6-inch diameter or larger are shown on Map No. 1. All lines were walked by operating company personnel immediately after the explosion and no leaks were reported to the State Department of Mines.

The pressure carried by the 10- and 16-inch natural gas transmission pipelines which transport gas north toward Pittsburgh, Pennsylvania, over the Plum Run area was recorded each hour. These pressures for November 13, 14, and 15, 1954, are tabulated in Appendix No. 1, Table No. 2. The variation in pressure is caused mainly by the demand for natural gas for cooking and space heating in the Pittsburgh, Pennsylvania, area. As the demand increases, the pressure in the line decreases. If a break in a gas pipeline had occurred, the pipeline company would have detected it because of a sudden pressure drop in the line and persons living in the vicinity could have heard the loud noise of gas flowing from the break.

GAS SAMPLES

Samples of gas from the sealed mine and from certain wells were taken both by Pittsburgh Consolidation Coal Company personnel and by the U. S. Bureau of Mines. These samples were analyzed by the Bureau on a mass spectrometer at the Bruceton, Pennsylvania, office. The results of these analyses are shown in Appendix No. 1, Table No. 3. Gas samples on November 18 and 20, 1954, were taken by the coal company; all others were taken by the Bureau.

Well No. 528, from which a sample of gas was taken, is located about 200 feet north of the Plum Run Power borehole and is an active natural-gas producing well which produced about 9 M c.f.d. during November 1954 from the Gordon (probably Stray), Fourth, and Fifth sands. The well encountered the Pittsburgh coal at a depth of 490 feet and was cased with 6-5/8-inch to 1,557 feet and 5-3/16-inch to 1,843 feet.

Records supplied by the operating company show the following monthly production from well No. 528 for the fall of 1953 and the year 1954:

	1953 (M c.f.)	1954 (M c.f.)
January		192
February		307
March		231
April		308
May		383
June		254
July		267
August		383
September	134	332
October	171	322
November	185	269
December	192	148

Well No. 96 located in 10 Right, 1,500 feet east of C Face, was a natural gas well plugged in 1927. This well, because gas under slight pressure was issuing from cracks in its surface concrete monument, was suspected by the coal company of contributing to the explosion. The well was uncapped and a sample of gas taken; another sample of this gas was taken about a month later.

It is regrettable that an uncontaminated sample of the gas normally found in the No. 9 mine (before the explosion) was not obtained. A comparison of this gas with the three samples taken from two wells might indicate whether natural gas was leaking into the mine; however, samples of gas from the Pittsburgh coal seam have been taken and reported[1/] as follows:

> ". . . Several wells near Hundred, Wetzel County, [about 14 air miles northwest of the Jamison No. 9 mine] are producing considerable volumes of gas (as much as 380 M c.f. per day) from Pittsburgh coal at an approximate depth of 750 feet. Samples 1-6 (Table 1) were collected in this area from the Pittsburgh coal. Well No. 3 was completed a few weeks prior to the taking of the samples. The original pressure on the coal gas was 100 pounds per square inch. The gas from the coal in this area contains the same constituents as those of the gases from the other producing formations in the area but the ratio of the heavier hydrocarbons to the lighter fractions is greater than that indicated by the usual analyses. The ratio of the various hydrocarbons to one another is more similar to the shale gas than any other.
>
> "The fact that these coal gases (Samples 1-6) contain considerable quantities of ethane and higher fractions indicates that the supposition that mine gases contain methane as the only saturated hydrocarbon may not always be correct, and that mine gases sometimes are produced in the same manner and from the same type of source material as natural gas, the coal merely playing the role of a reservoir trap, just as the various sands do. However, faulty plugging and defective casing offer ready access for the natural gas in other formations to permeate the coal. * * * * Very few data are available about the composition of the gas from undisturbed coal, that is back of the fracture and drainage belt. The meager information that is available indicates that the gas ordinarily consists of 90-98 percent methane, 2-10 nitrogen, and zero to several percent carbon dioxide."

1/ Price, Paul H., and Headlee, A.J.W., Natural Coal Gas in West Virginia: A.A.P.G. Bulletin, Vol. 27, No. 4, April 1943, pp. 530-537.

Table 1.2/ - Analysis of Natural Coal Gas

Well sample No.	County	Town	Coal seam	Methane	Ethane	Propane	Butanes Iso-	Butanes N-	Pentanes*	Nitrogen	Carbon dioxide
1	Wetzel	Coburn	Pgh.	83.56	8.40	3.68	0.40	1.04	0.36	2.10	0.45
2	"	"	"	92.96	1.62	0.12	0.01	0.05	0.04	3.10	2.10
3-A	"	Allen Chapel	"	96.841	1.14	0.287	0.014	0.31	0.017	1.62	0.04
4	"	Hundred	"	92.215	0.749	0.097	0.02	0.016	0.003	1.90	5.0
5	"	"	"	92.868	0.516	0.170	0.01	0.031	0.005	6.30	0.10
6	"	"	"	92.76	2.02	0.85	0.12	0.34	0.18	3.73	- -

*These analyses are low-temperature fractional distillation analyses by the West Virginia Geological Survey gas laboratory.

2/ Only part of Table 1 reproduced from reference given in footnote 1/.

Samples of gas from the Pittsburgh coal seam have recently been taken by the writers in connection with another investigation. On April 25, 1955, two samples of gas were taken from the working face in the Main East Section of No. 93 mine, Consolidation Coal Company (W. Va.). This location is about 8.5 miles northeast from the No. 9 mine, Jamison Coal and Coke Company. These samples were obtained by drilling a 2-inch-diameter borehole 8 feet into the solid coal. Mass spectrometer analysis of the gas was made at the Bruceton, Pennsylvania, office and was as follows:

Sample No. Depth, feet	1 360 feet	2 360 feet
Carbon dioxide, percent	0.5	0.3
Methane	99.5	99.7
Ethane	(max.) 0.015	(max.) 0.015
Propane	-----	(max.) 0.01
Maximum higher hydrocarbons	0.01	0.02
Air (free)	16.4	3.4

These analyses (Table 1 and the above data) suggest that a wide variation can exist in the composition of gas from the Pittsburgh coal seam. However, the samples of gas, taken from various points at the surface, from the sealed No. 9 mine, do not indicate more than a trace of saturated hydrocarbons of a higher molecular weight than methane. From the analyses listed in Appendix I, Table 3, it will be noted that only traces of ethane were ever found in the mine atmosphere during the period November 20, 1954, to February 9, 1955, the greatest percentage being 0.09 from the No. 2 fan shaft on February 9. These data indicate that a sufficient volume of gas, containing ethane or higher saturated hydrocarbons, did not leak into the mine so as to be collected at the sampling points. The data[3] previously reported shows that the trace of ethane could be from the gas liberated normally from the coal.

WELL NO. 96

On January 3, 1955, during an inspection trip to all wells which penetrate the coal mine, a coal company employee detected gas issuing from cracks in the concrete monument of this well. On January 5, 1955, with the permission of the State Department of Mines, and a representative of the Bureau present, the coal company destroyed the monument and uncapped the well. The 10-inch casing was found at the surface, it was left in the well when it was plugged in 1927; a 6-foot length of 2-inch pipe with a burlap packer was provided at the surface for the venting of gas through the concrete monument. This

3/ See footnote 1.

2-inch pipe had been plugged with mud, stones, etc., probably by children, and thus a small volume of gas under very low pressure had vented through the monument. The well was then capped with a wooden plug cemented in place and provided with a 1/4-inch pipe connection so that the wellhead pressure could be measured. From January 3 to February 9, 1955, the WHP was not recorded more than twice a day. A listing of all the WHP measurements taken by the coal company and converted to pounds per square inch gage is recorded in Appendix I, Table 4. Between January 3 and February 21, 1955, the WHP varied between 0.10 and 0.80 p.s.i. with an unweighted average of 0.40 p.s.i.

During the afternoon of February 21, 1955, the well was uncapped by the coal company to determine the depth to water and the hole depth. A steel line measuring tape with a weight, similar to a window sash weight, on the end of the tape, was lowered into the 10-inch casing. The water level was determined to be at 631 feet, 21 feet below the bottom of the coal and the weight would not go below 665 feet. Available records indicate the bottom of the cement, cementing the 10-inch casing, is at 659; however, the records also state 671 feet of 10-inch casing was put in the 16-inch hole. It is believed the casing is bottomed at 659 feet. After these measurements were taken, the well was recapped as before and the WHP recordings continued. The WHP at 7:30 a.m. on February 22 was 0.98 p.s.i., and it continued to increase until 10:30 a.m. on February 24 at which time the WHP peaked at 16.52 p.s.i. It fell off slowly, until at 2:45 p.m. the next day it was 15.52 p.s.i. No readings were taken until 9 p.m. that evening, when the WHP was recorded as 1.0 p.s.i. Between that time and 12 p.m. on March 9, 1955, the WHP varied between 0.89 and 4.0 p.s.i. with an unweighted average of 1.51 p.s.i.

This unusual pressure increase was studied along with the pressure variations of the No. 2 fan shaft at the mine (elev. 1,206 feet), temperature changes, and barometric pressure recorded at Monongah, West Virginia, 8 miles southwest of the mine (elev. 885 feet). The wellhead elevation was estimated at 1,210 feet. No unusual pressure surges were noted to cause, or because of, the pressure increase in well No. 96.

The lack of data on the present condition of the well is regrettable; no explanation for the behavior of the well can be given without a great deal of speculation and stretching of the imagination; however, the data suggests one of the following might have occurred:

(1) The first wellhead plug could have leaked while the second was tight.

(2) In the process of probing the 665-foot level of the well on February 21, 1955, an opening could have been made which lowered the water level from 631 feet and permitted gas to enter the

well. The water level subsequently built up and shut off the gas, which leaked from the well.

(3) Gas entered the casing from some unknown source building the WHP up to 16.5 p.s.i. and at the same time lowering the water level from 631 feet to a level below the casing shoe at 659 feet. If the rock strata below the casing shoe had caved, thus increasing the hole diameter, an increased rate of pressure decline would be expected.

The rapid dissipation of pressure during February 25 could also be from a failure to close a wellhead valve or the failure of the wellhead, although the records do not indicate such an occurrence.

A simple calculation of the volume of gas expanded to atmospheric pressure (assuming isothermal conditions) which would cause a pressure increase from an unweighted average of 0.4 p.s.i. to the peak at 16.5 p.s.i. resulted in an answer of 367 cubic feet. The pressure built up over a period of from about 6 p.m., February 21, to 10:30 a.m., February 24, or 64.5 hours. This indicates an average built up of 5.7 cubic feet of gas per hour, or 137 cubic feet per day. It is of interest to note that an air volume measurement taken by Mr. W. D. Baldwin, Federal coal-mine inspector, during normal operating conditions in the month of October 1954 showed 56,200 cubic feet of air returning along the east approach to the No. 2 fan. The volume of air sweeping the south and east sides of the coal pillar protecting this well and flowing through the regulator into the main returns and then west to the No. 2 fan shaft is not known. An air sample taken at the same time by Mr. Baldwin showed 0.76 percent methane which indicates 615,053 cubic feet of methane per day flowing into the air shaft from an easterly direction. It is unlikely that a calculated volume of 137 cubic feet of gas, if it did flow into the mine, from well No. 96 would be noticed.

This report by Mr. Baldwin also records the total daily volume of methane being exhausted from the mine on the date or days he took air samples as 3,247,000 cubic feet.

NO. 2 NORTH AREA

Three wells have penetrated the Pittsburgh coal seam in the 2 North area of this mine. Well No. 176 was drilled in 1889 and abandoned the following year. The only surface evidence of the well is a slight mound of drill cuttings about 15 feet in diameter in a corn field and a slight mound of coal ashes. No records were found other than that the Pittsburgh coal bed was located at a depth of 590 feet, the Big Injun sand was logged at 1,920 feet and two figures of total depth 2,060 and 2,960; the depth of 2,060 is believed to be correct.

Well No. 183, drilled in 1907 and abandoned two years later, was drilled to a depth of 3,094; the coal was found at a depth of 673 feet. Gas was reported from the Fifty-foot and Fifth sands; originally about 2.5 barrels of oil per day was produced from the Fifth sand. The only record of plugging found was, "Dry hole plugs placed at 1,395 and 2,080." There is little surface evidence of this well, only a small sink hole filled with tree branches in an open pasture.

Well No. 177 was drilled in 1916 and plugged, under permit No. MAR 361, West Virginia Department of Mines, Oil and Gas Division, during 1942. The only gas production reported was from the Gordon Stray at a depth of 2,915; the coal was encountered at 673 feet. The well was plugged from a total depth of 2,924 feet to the surface; 692 feet of 10-inch casing was left in and a 2-inch vent pipe, set through the coal, was provided. The annular space between the 2-inch and 10-inch was filled with clay. A very small volume of gas could be heard, bubbling through water, through holes in the surface portion of the 2-inch vent. Samples were taken on two different occasions but both contained 100 percent air.

As well No. 177 is provided with an open vent from below the coal to the surface, it is logical to assume that any gas produced in the well from below the coal would be vented at the surface.

Wells Nos. 176 and 183 are not provided with such vents; however, from the mine ventilation map, provided by the coal company, it can be noted that the coal pillars left to protect these wells and also well No. 177 are on the return side of the ventilation system.

The accessible portions of the pillar protecting well No. 183 were inspected. No unusual cracks or fractures were observed, nor was gas detected issuing from the pillar. The coal pillar protecting well No. 177 could not be inspected because it is located inby a gob area; the pillar protecting well No. 176 could not be inspected because it was not accessible.

WELL PILLARS

The usual mining practice in this mine was to leave a solid block of coal 200 feet on a side around each well which penetrated the mine. Some of the pillars are not square but at least 100 feet of coal is left between the well and mining operations. To the writers' knowledge, the production of petroleum or natural gas was not affected by the explosion in the mine and thus the 100 feet of coal protecting a well is sufficient protection.

CONCLUSIONS

From the study of available data and engineering judgment, the following conclusions can be made:

(1) The pipelines crossing the mine area did not contribute to the explosions.

(2) The abandoned 3-well underground gas storage project did not contribute to the explosions.

(3) No uncharted or unknown wells were found by a study of all available maps.

(4) After a study of the operating records of the secondary recovery of oil by gas injection project, and discussions with management and their engineers, no evidence could be found which cast suspicion that this operation contributed to the explosion.

(5) No evidence was found that the production of natural gas contributed to the explosion.

(6) Because of a lack of proper data the actions of well No. 96 cannot be explained; however, it is on the return side of the mine ventilation system and is, thus, not believed to have contributed to the explosion.

(7) No evidence was found to suspect that the wells in the 2 North area contributed to the explosion.

(8) The coal pillars left to protect oil or gas wells are of sufficient thickness to protect a well from an explosion of this magnitude.

RECOMMENDATIONS

Although an intensive investigation was made of petroleum and natural gas operations in the No. 9 mine area, and only normal operations were found, to be absolutely positive that these operations had no relationship to the disaster, the following program is recommended.

The coal company should first determine what type of gas is found in their mine and a log, for perhaps a 30-day period, kept showing volumes and types of gas passing a large number of critical points inside the mine. This type of information will show where gas is entering the mine, the variation of the composition of gas, if any, and the general location for testing of wells; however, none of the wells should be completely eliminated from the test procedure because gas will migrate over long distances if conditions are perfect for such migration.

The simplest and cheapest method which the coal company could use to test an active well is to kill the well by packing off the producing formation, or formations, and build up the pressure inside the well casing with either an odorant or an inert gas, such as helium. The highest producing formation pressure recorded at a gas wellhead during 1954 was 60 p.s.i. in 24 hours from well No. 21. It is believed that a wellhead pressure of 100 p.s.i. would be sufficient for a test; this should be well above the formation pressure. As the WHP of the two active gas-injection wells varies between 250-265 p.s.i., this pressure should be applied to them.

If this pressure were applied to the well, the well shut in and the WHP recorded with a pressure recording meter, a leaky casing could be detected. If men were stationed inside the mine to smell the odorant, or sample the gas for helium analysis, positive evidence, if any, would be found for suspecting a well.

This same procedure can be used for all plugged wells or abandoned wells, but they, of course, must first be cleaned out before testing.

APPENDIX E

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Washington 25, D. C.

November 17, 1955

GEOLOGIC ASPECTS OF THE JAMISON #9 MINE EXPLOSION

/s/ Russell G. Wayland
Russell G. Wayland

Approved:

/s/ Thomas B. Nolan
Acting Director

GEOLOGIC ASPECTS OF THE JAMISON #9 MINE EXPLOSION

On Saturday afternoon, November 13, 1954, a disastrous explosion at the No. 9 mine of the Jamison Coal and Coke Company, Farmington, Marion County, West Virginia, took 16 lives. The mine was sealed completely until March 1955, and the work of repairing the explosion damage continued through the year.

By memorandum of November 26, the Director, Bureau of Mines, requested the Director, Geological Survey, to assign a geologist to work with Bureau of Mines engineers in the investigation of the disaster, including those engineers investigating the relation of natural gas wells, oil wells subjected to gas drive, plugged and abandoned wells, and natural gas storage operations to the disaster. This report is to summarize the results of that geologic investigation.

On several occasions Mr. James Westfield, Assistant Director for Health and Safety, reviewed the status of Bureau of Mines investigations with the writer. On December 8-10, 1954, Mr. Malcolm L. Davis, Bureau safety engineer, took the writer to Morgantown, West Virginia, to review collected data with Messrs. J. J. Dougherty, S. S. Taylor, William E. Eckard and F. J. Stortz of the Bureau; Messrs. James F. Pepper and Wallace DeWitt of the Geological Survey; and Dr. Paul H. Price, Director of the West Virginia Geological Survey. A visit to the mine offices with Messrs. Eckard and Stortz was also made for discussions with Messrs. W. B. Jamison and G. W. McCaa of the mining company. One result of this visit was the subsequent preparation from available survey data by Mr. J. Garcia, the mining company surveyor, of a structure contour map of the mine on the base of the mined bed, the Pittsburgh coal.

On February 17 and 18 the writer again visited the mine offices with Mr. Eckard to review the contour map and the extensive data on the 103 oil and gas wells which were being investigated, and to study the fracture system in the mine as reflected by the pattern of clay dikes and roof falls on the 1:1200 mine maps (1 inch = 100 feet).

On June 22 the writer travelled to the mine with Mr. Davis for two days underground and half a day of surface observations. In the underground visits the writer accompanied Messrs. Davis, Stortz, and Eckard of the Bureau; Ray Henderson, assistant chief engineer of Consolidation Coal Company (West Virginia); and Lawrence Riggs, mine superintendent-elect of Jamison No. 9. Messrs. Davis and Eckard joined the surface investigation June 25.

Acknowledgement is made to all persons mentioned above and to Messrs. C. B. Read, Paul Averitt and James Trumbull of the Geological Survey who reviewed the available material with the writer and gave valuable suggestions.

Regional geologic setting of the Jamison No. 9 mine

Marion County lies along the eastern flank of the Appalachian Basin in an area of broad, gentle folding. From the county geologic map it is observed that the axis of the Brownsville Anticline comes from the northeast directly toward the mine area but changes to a southerly direction near the northeast corner of the mine. The Wolf Summit Anticline comes from the southwest on the line of the northeast extension of the Brownsville Anticline but dies out south of the mine area near Farmington.

Between the two anticlines south of the mine area is the northward-plunging Shinnston Syncline which dies out in the mine area. The newer mine workings in the northwest corner of the mine area lie beyond the broad buckling at the north end of the Shinnston Syncline. The beds there have a gentle northwestward dip of $2\frac{1}{2}$ percent or less.

The immediate roof rock in the mine area is a 32-foot thick dark shale.

Fracturing patterns in the Jamison No. 9 mine

Clay dike system

A fracture pattern is expressed in the coal and roof by clay dikes, locally known as clay veins. It appears to be related to the broad regional buckling described above. A zone of these dikes is recorded on the mine maps running from the southwest to the northeast corner of the mine. Individual dikes may be curved or may have any compass direction, but the mine maps show that collectively the predominant strike directions of the clay veins are northeast and northwest. The northeast trending dikes are as often truncated by as truncating northwest trending dikes. Not all dikes have been mapped by the surveyors, but a great many that are long enough to pass through several successive pillars are shown.

Most of the clay dike zone is in old workings now inaccessible. A few were observed by the writer in new workings at the northeast side of the mined area, and their strikes were noted to have been correctly mapped. Dips are not mapped; where observed by the writer they were widely variable. Elsewhere in the new workings on the north and west edges of the mine area the clay dikes are rare or missing.

Faces and butts system

Independent of the clay dike system is the well-developed, pervasive "faces and butts" system. This cleat system is so uniform in the mine and, it is understood, in adjacent mines, that Mr. Henderson could tell the writer that the faces direction is N. 12°30'E and the butts direction N. 77°30'W. Nearly these same cleat directions are found in adjacent counties. Numerous brunton compass readings by the writer in No. 2 North Section, the northwest corner of the mine area, averaged at approximately these directions, both for the coal itself and for the roof rock where exposed by fresh roof falls. Both faces and butts are near vertical, although it is the writer's impression that most faces dip steeply west and most butts steeply south in the area studied. Thin films of calcite and other minerals may be present.

The faces and butts system is evidently of more significance in present mining operations than is the clay vein system. Roof falls are particularly common in mining openings elongated in the faces direction. The panels of No. 2 North Section were angled at S. 80°W., or 22°30' off butts direction, in an experiment designed to reduce the number of such falls, according to Messrs. McCaa and Henderson. Where roof falls have nevertheless taken place in No. 4 panel of No. 2 North Section, their elongation is more related to faces and butts directions than to pillar lines, the writer observed. The same applied to two observations of bottom heaving.

Drainage-related fracture zones

The altitude of the Pittsburgh coal seam in the newer workings of the mine ranges from 490 to 690 feet above sea level; in No. 2 North Section it ranges from 490 to 550 feet. The maturely-dissected surface over these newer workings ranges from 1040 to 1060 feet above sea level. In half a mile the overburden on the Pittsburgh coal seam may range from 460 feet to 940 feet, as at the village of McClellan and eastward, or from 580 feet to 900 feet over No. 2 North Section. Evidently the relief of pressure on the coal seam due to erosion of the valleys causes some heaving of the entire section along the courses of the deeper valleys. This tends to open up the butts and faces and causes zones of what is locally known as "snap roof." In recognition of this feature, a pillar over a mile long has been left in the "face" direction under Plum Run between new and old workings on the west side of the mine area. Where the writer observed this particular fracture zone in Main West Headings there was no noticeable introduction of ground water, but falls were bad and roof bolting was extensively used, supplemented by beams and other supports. Another such zone is recognized under Little Dunkard Mill Run in the northeast corner of the mine, and still other such zones under the deepest valleys have been temporarily avoided. Heavy new falls during the explosion in the vicinity of the shafts in Atha's Run may be related to this feature.

Possible significance of fracturing patterns in the explosion

It is known that readings of the methane content of the mine atmosphere were made the morning of the explosion at various places throughout the mine until as late as 35 minutes before the explosion. None of these readings indicated any unusual concentration of gas. It is accordingly assumed that if it was a gas explosion, the gas was introduced rather quickly in considerable volume. If it was coal gas, some such mechanism as a roof fall might have forced gas into the vicinity of miners who may accidentally have ignited it. The fracture system is in this case only of interest in that it facilitates roof falls. However, if it was natural gas from a well, a fracture system is nearly necessary to explain how gas in quantity could get quickly into a mine opening from a well, either through the 100-foot-radius well pillars left in the coal or through the adjacent rock strata.

Experts of the Bureau of Mines, the coal mining company, the West Virginia Department of Mines, and United Mine Workers, will decide where the initial explosion took place and whether the initial explosion was a gas or a dust explosion; if a gas explosion, they will also decide whether coal gas alone would have been sufficient or the introduction of natural gas from one or more of the numerous oil and gas wells penetrating the mine is indicated. This determination is yet to be made officially. In the meantime it is understood that the finger of suspicion points primarily at an initial explosion in No. 8 or 7 entries, No. 4 Left Panel of No. 2 North Section. With this in mind, the writer concentrated his observations underground and on the surface in this area, although other areas underground were visited.

Fourth Left Panel, No. 2 North Section

In the 8th or 7th entry of this panel, where 5 men were working at the time of the explosion straightening a pillar line, coal gas was certainly present in the gob to their west and south and might have been forced out by a roof fall. If natural gas was involved, Holes No. 177 and 183 are suspect largely because of their proximity to the probable scene of the initial explosion. Access to the only side of the pillar of Hole No. 177 that has been exposed is now denied by 800 feet of gob. It was drilled near the bottom of a gulch and may therefore be in a drainage-related fracture zone, but this can only be conjecture since there is nothing to be seen either on the surface or underground.

The pillar of Hole No. 183 is accessible. Examination of it showed no notable fracturing toward its center. Calcite has deposited on "butts" fractures at the southwest corner and there are extensive roof falls along the east pillar line in the "face" direction. Minor falls are at the center of the west pillar line and in crosscuts south of the pillar. Some of the north-south falls may be facilitated by drainage-related fracturing due to the gulch overhead.

There are very few outcrops on the surface near No. 4 Left Panel. The only ones found were along the top of the east-west ridge at the head of the Plum Run drainage. They consist of cross-bedded sandstones of the Dunkard group, and their fracturing seems to correspond with the faces and butts directions observed below in the Pittsburgh coal.

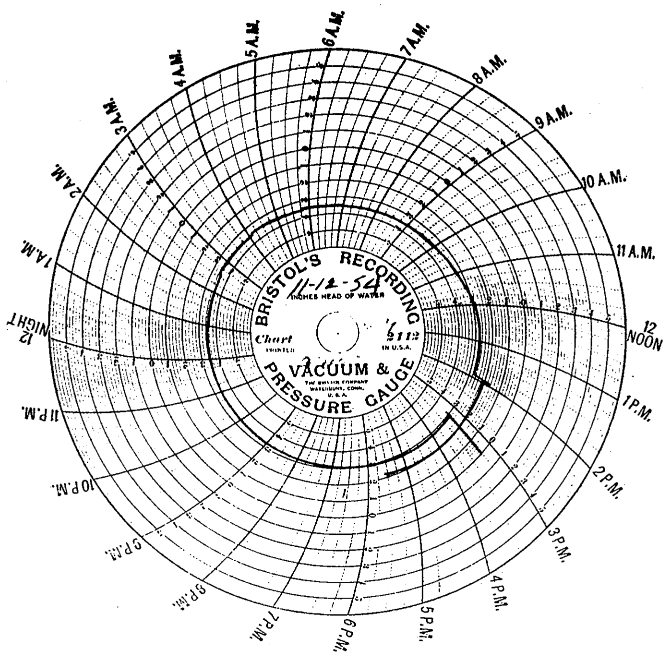
When the roof falls in No. 4 Left Panel are all cleaned up and the entries drained, a geological re-examination prior to any rock dusting may be warranted if there is still suspicion on engineering grounds that natural gas may have been involved in an explosion initiated in that area. However, it is noted that Messrs. Eckard and Stortz concluded on September 1 that they had no evidence to suspect that the wells in the No. 2 North Section contributed to the explosion.

The gas storage pool at Logansport

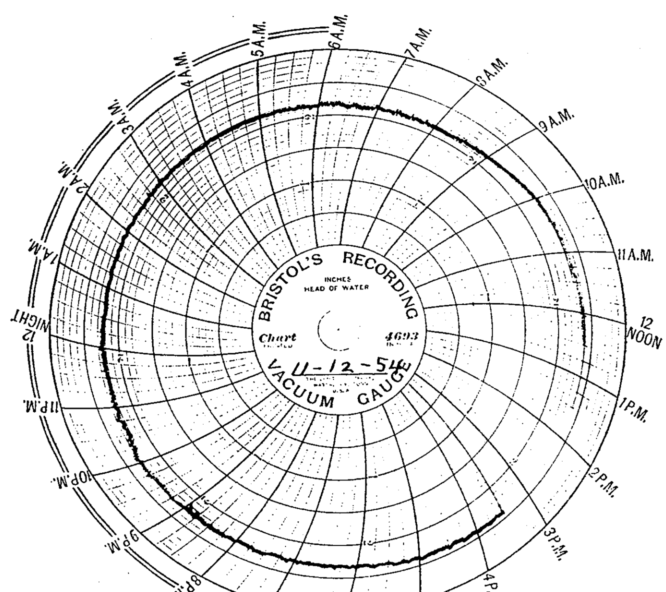
The only gas storage pool presently in operation anywhere near the mine is seven miles west at Logansport and stratigraphically two thousand feet below the Pittsburgh coal. While there is some public speculation that natural gas from that pool saturated the intervening rocks, the writer considers it most unlikely, and sudden injection of Logansport storage gas into the Jamison mine as even more unlikely.

Other oil or gas wells penetrating the Jamison mine

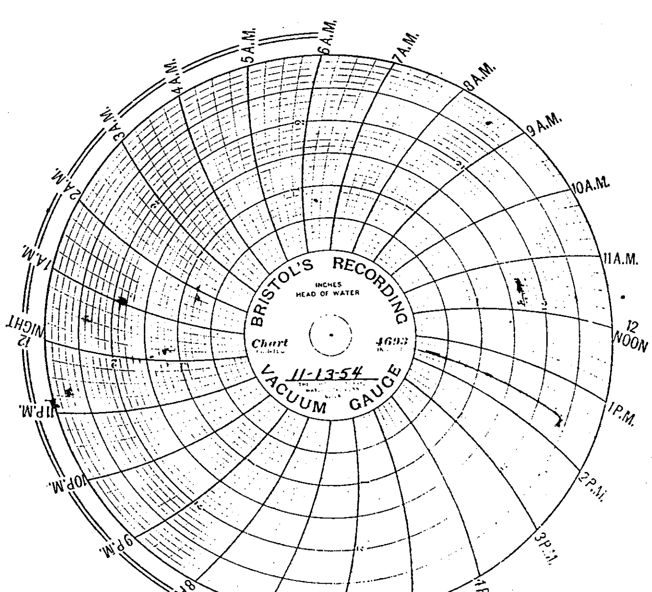
Any of these wells that are plugged or abandoned could be suspect if engineering evidence showed that the initial explosion was in their vicinity, and if the well logs and plugging information collected by Messrs. Eckard and Stortz had shown that pressures were built up in the wells at depths approximating the Pittsburgh seam. Such gas need not have been natural gas in the normal sense, but could also have been coal gas from overlying coal seams if the plugging was such as to permit the gas to channel downward. However, in view of the conclusions reached by Eckard and Stortz in their report of September 1, 1955, no further geological investigation seems warranted.



NO. ONE FAN
(OLD FAN)

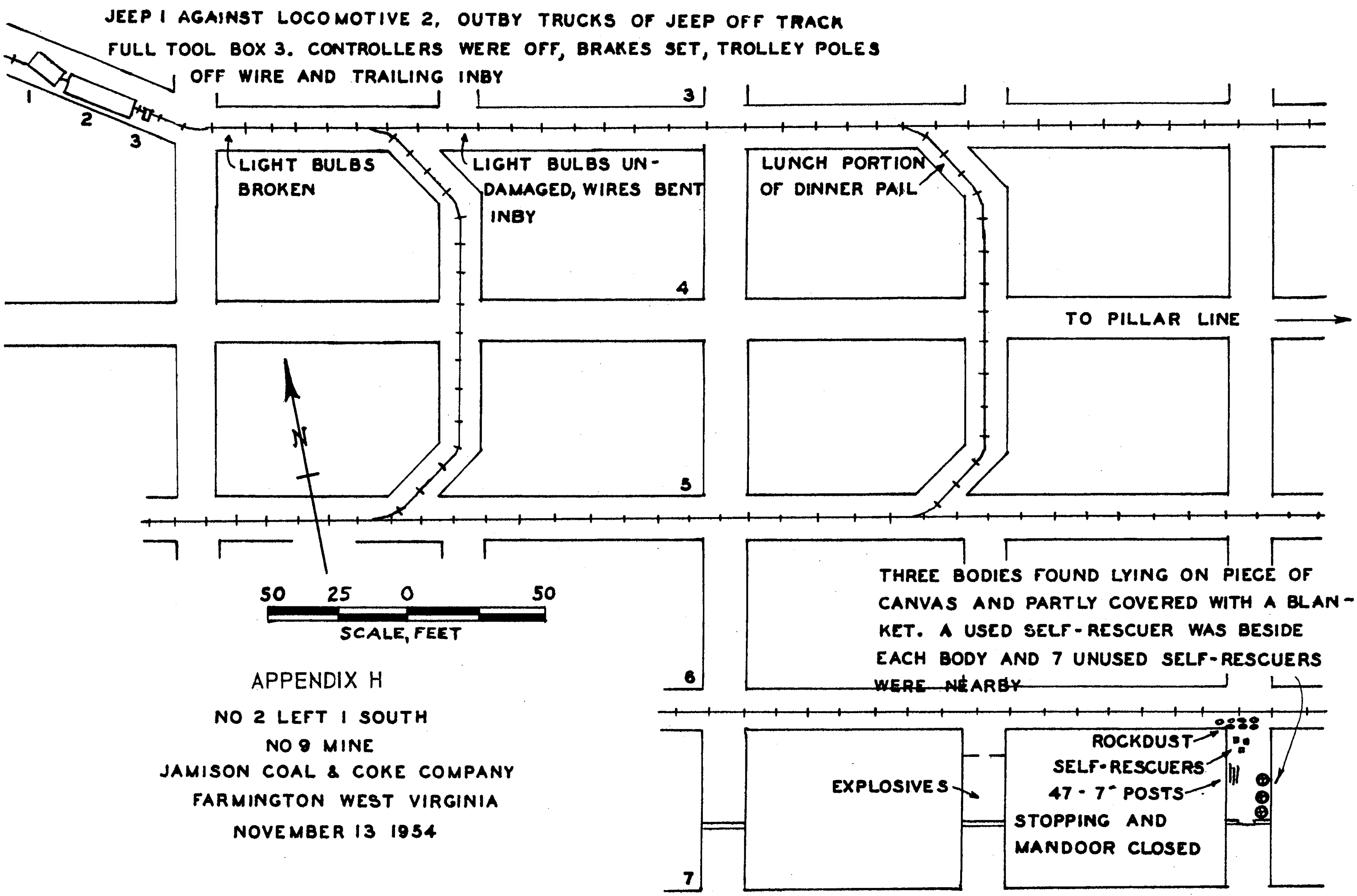


NO. TWO FAN
(NEW FAN)



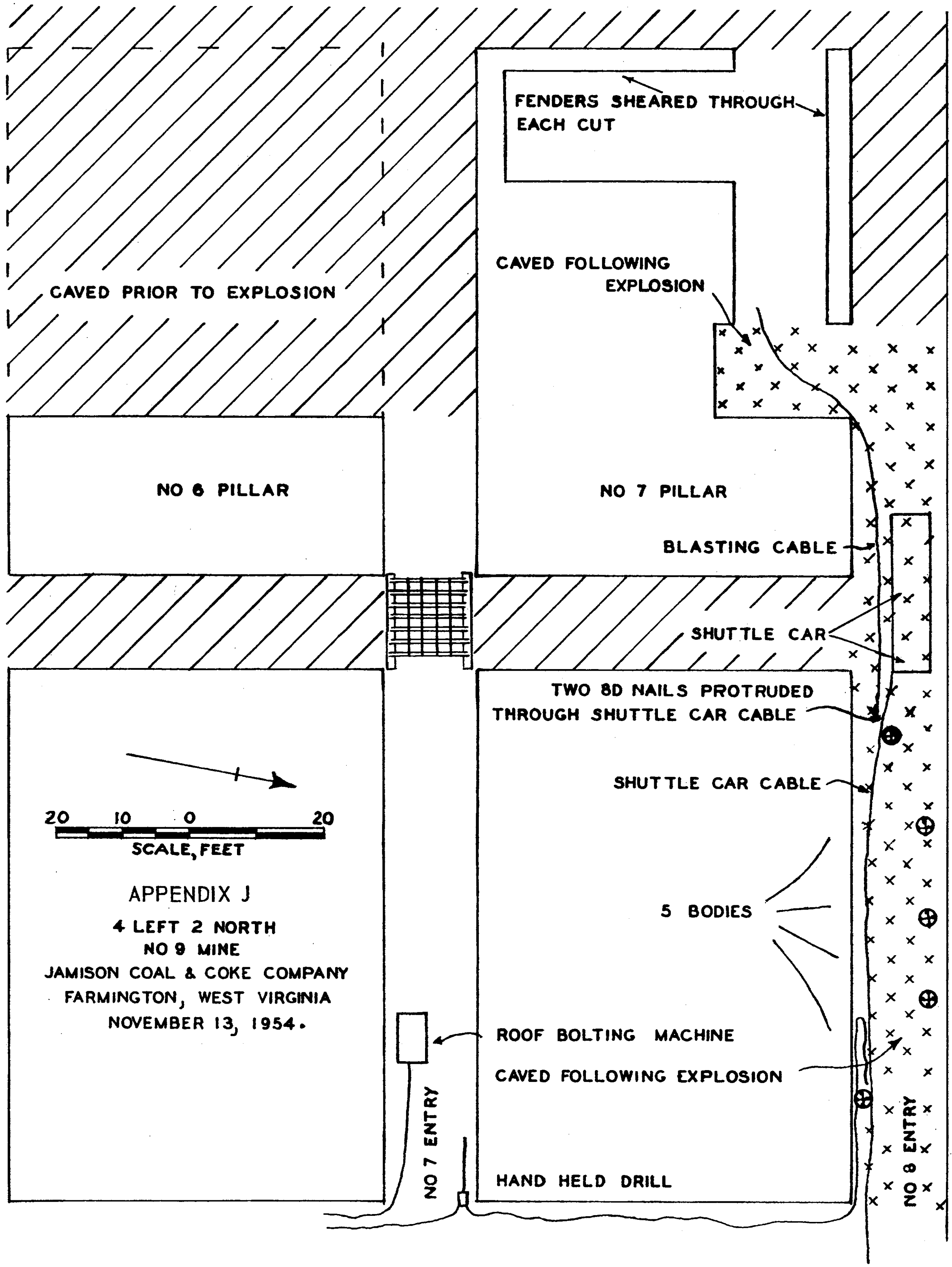
NO. TWO FAN
(NEW FAN)

APPENDIX F



APPENDIX H

NO 2 LEFT 1 SOUTH
NO 9 MINE
JAMISON COAL & COKE COMPANY
FARMINGTON WEST VIRGINIA
NOVEMBER 13 1954


FENDERS SHEARED THROUGH EACH CUT
CAVED FOLLOWING EXPLOSION
CAVED PRIOR TO EXPLOSION
NO 6 PILLAR
NO 7 PILLAR
BLASTING CABLE
SHUTTLE CAR
TWO 8D NAILS PROTRUDED THROUGH SHUTTLE CAR CABLE
SHUTTLE CAR CABLE
20 10 0 20
SCALE, FEET
APPENDIX J
4 LEFT 2 NORTH
NO 9 MINE
JAMISON COAL & COKE COMPANY
FARMINGTON, WEST VIRGINIA
NOVEMBER 13, 1954.
5 BODIES
ROOF BOLTING MACHINE
CAVED FOLLOWING EXPLOSION
NO 7 ENTRY
NO 8 ENTRY
HAND HELD DRILL