FINAL REPORT OF MINE EXPLOSION
PRACO NO. 10 MINE, ALABAMA BY-PRODUCTS CORPORATION
PRACO, JEFFERSON COUNTY, ALABAMA
MAY 11, 1943

By
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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

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INTRODUCTION

A gas and dust explosion occurred in the Praco No. 10 mine of the Alabama By-Products Coroporation at about 4:10 a. m. May 11,1943, and a second explosion occurred about 25 minutes later.

There were 24 men in the mine at the time of the explosion.

The explosion was local in character, being confined to the 22 north entry and air course, and the main slope entry and air course. Ten men were killed by violence, burns, and afterdamp, one man died the following day and one man died 8 days after the explosion from the effects of burns, violence, and afterdamp. Three others in the area of the explosion were severely burned but will probably recover. Nine men working in other sections of the mine were not affected by these explosions and escaped uninjured.

The initial explosion was caused by the ignition of a body of methane by means of an electric arc produced in the car-hoist control switch at the conveyor-loading point in 22 north heading and was propagated throughout the affected portion of the mine by methane and coal dust.

Word of the explosion was received by D. J. Parker, Supervising Engineer, District D, Bureau of Mines about 5:50 a. m. Mr. Parker in turn notified Mr. C. E. Saxon, and Mr. Saxon arrived at the mine about 7:00 a. m. with the Bureau of Mines' rescue truck and equipment. Messrs. D. J. Parker, H. N. Smith and Jas. B. Benson arrived at the mine about 30 minutes later.

Upon arriving at the mine Mr. C. E. Saxon immediately assembled the oxygen breathing apparatus, and accompanied by the following persons entered the mine: F. L. Weston, A. G. Crane, O. H. Youngblood, J. A. Ivie and Dabney Ramseur, State Mine Inspectors; W. C. Chase, 2 mine-rescue teams, Alabama By-Products Corporation and others. By the time the above group reached the explosion area, the local mine officials and employees who had previously entered the mine, had rescued the five injured men, and partly restored temporary ventilation.

Further recovery work and restoring of ventilation was done by the rescue teams working under oxygen. The ten bodies were located by 8:15 a. m. Mr. E. J. McCrossin, Chief, State of Alabama, Department of Industrial Relations, Division of Safety and Inspection, H. N. Smith and Jas. B. Benson of the Bureau of Mines entered the mine at 9:00 a. m. and assisted with the recovery of the bodies. All bodies were brought to the surface at 10:50 a. m. May 11, 1943.

The Bureau of Mines representatives participated actively in the recovery operations underground and in perfecting a surface organization to supplement the underground work. Close cooperation existed between the representatives of the Bureau of Mines and the State of Alabama, Department of Industrial Relations, Division of Safety and Inspection, and officials of the company.

GENERAL INFORMATION

Location and Operating Officials

The Praco No. 10 mine of the Alabama By-Products Corporation is at Praco, Jefferson County, Alabama, about 30 miles northwest of Birmingham, Alabama, on a branch of the Louisville and Nashville Railroad. Other coal mines operated by this company are:

Mine	Location
Bradford	Dixiana, Alabama
Barney	Cordova, Alabama
Samoset	Dora, Alabama
Colta	Flat Creek, Alabama
Labuco	Labuco, Alabama
Praco No. 7	Praco, Alabama
Praco No. 7-1/2	Praco, Alabama

The officials of the company are:

J. W. Porter	President	Birmingham, Alabama
P. H. Haskell, Jr.	General Manager	Birmingham, Alabama
W. C. Chase	General Superintendent	Birmingham, Alabama
M. E. Haworth	Chief Engineer	Birmingham, Alabama
H. J. Hager	Superintendent	Praco, Alabama
Frank Hillman	Safety Director	Flat Creek, Alabama
D. G. Laird	Mine Foreman	Praco, Alabama

Employees and Production

Two hundred twenty men were employed at this mine. Of this number, 10 were employed at the surface plant, and 210 were employed underground.

The underground employees were divided by shifts as follows: day shift, 105; night shift, 80; "owl" or third shift, 25. Coal is hoisted on the day and night shifts. The average daily production was 880 tons of coal. The total production for the year 1942 was 196,075 tons of coal.

Openings

The mine is opened by three slopes; the main hoisting slope is driven in the coal bed from the surface, the return-airway slope is connected to the surface by a shaft about 50 feet deep, and the manway slope is connected to the surface by a slope about 70 feet long, driven through the overlying strata. The slopes are about 6,000 feet in length, and the coal bed dips four percent in a southwesterly direction.

Nature of the Coal Bed

The mine is in the Mary Lee coal bed, having a total thickness of 84 inches in this locality. The usual bands of impurities, characteristic of the Mary Lee coal bed, are present. Because of the impurities, most of the mining is being done in the upper bench, which ranges from 44 to 54 inches in thickness. From two to three feet of bottom is lifted in the haulage entries to provide headroom.

The coal is of bituminous rank, in the medium volatile matter range, friable, and crushes easily.

The immediate roof consists of a hard blue shale that varies in thickness. Pots are encountered frequently in the immediate roof. The main roof is composed of hard blue shale and sandstone of variable thickness. Prominent slip planes and faults, which are common in the Mary Lee coal bed, are also present. The cover over the coal bed ranges from 0 to 500 feet.

Analysis of Coal

A composite of four samples of coal collected by the Bureau of Mines in the nearby Labuco mine, operated in the same bed of coal by this company, on January 14, 1921 was analyzed in the coal laboratory of the Bureau of Mines at Pittsburgh, Pa. The coal, which is representative of the Mary Lee coal bed in this locality, contained 2.9 percent moisture, 27.0 percent volatile matter, 58.0 percent fixed carbon, 12.1 percent ash, and 1.3 percent sulphur.

The ratio of the volatile matter to total combustible matter of the coal, expressed by the formula $\frac{\text{Volatile Matter}}{\text{Volatile Matter} + \text{Fixed Carbon}}$ is an index of the explosibility of the coal. This ratio is: $\frac{27.0}{27.0 + 58.0} = 0.317.$

Bureau of Mines tests and experiments have shown that coal dust having a volatile matter to total combustible matter ratio in excess of 0.12 is explosive. The explosibility of coal dust increases as this ratio increases. It is obvious, therefore, that the coal dust in this mine is highly explosive and would readily propagate an explosion.

UNDERGROUND MINING METHODS, CONDITIONS, AND EQUIPMENT

Methods of Mining

The main slope entries are driven in sets of three entries. The middle entry is opened in the outcrop and serves as the haulageway and intake airway. The left parallel entry serves as the manway and is also used as an intake airway. The right parallel entry serves as the return airway and is connected to the surfacw by an unlined shaft about 50 feet deep. A fault was encountered in the main slope entries in the vicinity of 21 north, and from this point to the face, only two entries have been driven.

The main haulage entry is about 15 feet wide; the entire coal bed is mined, and the roadway is about 6-1/2 feet high. The right and left parallel air courses of the main slope are 25 to 30 feet wide, and driven in the top bench of coal, thus these airways range from 44 to 54 inches in height. At the present time the main slope haulageway is being driven 25 to 30 feet in width, and two to three feet of bottom material, for a width of ten feet, is being lifted to provide headroom.

The room entries are driven in pairs on 60-foot centers at intervals of 200 to 350 feet. These entries are 25 to 30 feet wide, and two to three feet of bottom material, for a width of ten feet, is lifted and gobbed in the entry used as a haulageway.

All room entries are driven to the right from the main slope. There is a barrier pillar on the left of the main slope. Two openings have been driven through the barrier pillar to connect this mine with the Praco No. 7 mine. One of the openings is sealed with a gob stopping; the other is used as a return airway for the No. 10 mine substation.

The crosscuts between the entries and air courses do not exceed 60 feet apart.

Rooms are turned on 70-foot centers from the entry side, and driven 30 to 35 feet in width through to the air course of the adjacent entry. The general practice is to drive rooms on the retreat; however, some rooms have been driven on the advance. Crosscuts between rooms are turned at 50-foot intervals. Pillars are not recovered.

Twenty two room entries have been turned to the right off the main slope. All of the room entries outby 16 north are worked out. Present operations are confined to the rooms and entries from 16 to 22 north, inclusive, and the slope entry and air course. A squeeze has seriously affected the worked-out area between 1 north and 15 north.

The present system of driving rooms is a modification of the system employed in the 12, 13, and 14 north entries, part of the area affected by the squeeze. A block of coal, 75 to 150 feet wide, has been left along the 14 north air course for the purpose of preventing the squeeze from extending to the area inby 14 north.

The coal is undercut in the coal with nonpermissible shortwall mining machines to an average depth of 6 feet. The machine cuttings are loaded out before blasting.

Eleven chain-type conveyors, operated by nonpermissible electrical equipment, are used for conveying coal from the faces to the mine cars on the entries. The remainder of the output is loaded directly into cars by hand.

Timber sets and posts used for roof support on entries are not recessed into the ribs, and guardrails are not used. All permanent timbering is performed by timbermen in accordance with systematic timbering rules which have been established. The rule requiring miners to set safety posts at the working faces where needed, is not fully complied with.

A continuous clearance of 30 inches is not maintained on the walkway side of haulageways, and shelter holes are not provided at regular intervals.

Ventilation and Gas

The ventilating current for this mine is induced by means of an electrically driven 3-by 6-foot centrifugal fan operated exhausting against a water-gage pressure of about 3 inches.

The fan is connected to the airshaft by a wooden duct which is convered with roofing paper. The fan is offset about 40 feet from the shallow airshaft and the wooden duct is provided with explosion doors; however, with this fragile and combustible duct, explosion doors are not necessary. In the event of an explosion where the forces extended to the surface, the duct would most likely be demolished and ventilation interrupted for an extended period until repairs could be made.

The air current is not readily reversible and a separate source of power is not provided for the fan. A spare motor is kept in the fan house. Power is supplied from a nearby transformer station and the fan is not provided with an independent source of power.

The fan is not provided with a recording pressure gage or controls to give alarm and cut off power automatically from the mine when the fan slows down or stops.

Grass and weeds are permitted to grow close to the fan house and the wooden fan duct. The fan is operated continuously, but is not inspected daily.

Air measurements, made in the wooden duct which connects the fan to the mine, by Federal coal mine inspectors Alexander Jack and H. N. Smith showed that the fan was exhausting approximately 44,440 cubic feet of air a minute, on June 23, 1942. A copy of the April 1943 monthly air report furnished to the Bureau of Mines by the company shows that the fan was exhausting approximately 39,310 cubic feet of air a minute. Air measurements taken in the fan duct by representatives of the Bureau of Mines show that the fan was exhausting approximately 28,470 cubic feet of air a minute on May 12, 1943. Thus a decided decrease in the quantity of air in the mine, resulted between April and May 12, 1943.

The air enters the mine through the main slope haulageway and manway openings. The ventilating current is coursed through the mine as one continuous current, except for the small split at the substation, the direction of the flow being to the main slope heading, thence to 22 and 21 north, 1st right off 21 north, 20, 19, 18, 17, 16, 15 and 14 north entries. From the 14 north entry the air travels through the slope return air course and the old workings affected by a squeeze to 10 north. Between 9 and 10 north only two entries were driven, and these are both intake airways. Since no return air course exists between 9 and 10 north, it is necessary for the return air current to travel through the worked-out area affected by the squeeze. From 9 north the air travels through the slope return air course and old workings affected by a squeeze to 3 north. Because the slope air

course was discontinued for about 250 feet immediately inby 2 north, the return air current must travel through 3 north and old workings seriously affected by a squeeze to 1 west, thence to 2 north, the slope return air course, and the upcast shaft.

The air is coursed through the working sections by means of single doors installed at the entrance to each cross or room entry; gob stoppings plastered on one side; brattice-cloth stoppings, and line brattice.

Because doors are erected singly at the entrance to room entries, the air current is short-circuited every time a door is opened and all sections inby a door that is open receive no ventilation.

The mine is rated gassy by the State of Alabama, Department of Industrial Relations, Division of Safety and Inspection. One fire boss is employed to make a preshift examination of the mine. Section bosses make preshift examinations for the oncoming shift. Officials, shot-firers and machine operators make tests for gas during the shift. A ventilation inspector is employed to make tests for gas with a permissible methane tester at least weekly.

On Monday, May 11, the canvas check on 22 north haulageway between the slope entry and air course, was replaced by a wooden door that was put into service about 4:00 p. m., approximately 12 hours before the explosion. The lower half of the stopping in the slope air course, between 22 north entry and air course was constructed of gob and the upper half of brattice cloth.

There was a gob stopping in the first crosscut of 22 north, and canvas checks had been hung in the second and third crosscuts. The fourth or inby crosscut was open. During the third shift a fifth crosscut was made thus leaving two open crosscuts and two and one-half canvas stoppings, outby the face of 22 north entry at the time of the explosion.

During the lifting of the bottom in 22 north entry, gas feeders were encountered in the floor, in the vicinity of the conveyor-loading point. These gas feeders continued to be exposed as the gradual lifting of bottom was advanced toward the face. The gas feeders are more pronounced near the face of the freshly lifted bottom and gradually diminish in the quantity of gas emitted on the outby end as the lifting of bottom is advanced.

Because of the gas feeders in 22 north, the general mine foreman requested the ventilation inspector to go to the 22 north the evening before the explosion to take air measurements and methane-indicator readings. The ventilation inspector reports that on Monday, May 10,1943 at 8:00 p. m., approximately 8 hours before the explosion, the following observations and measurements were obtained: Return air current from 22 north, taken 30 feet outby the loading point, was 4,550 cubic feet of air a minute, methane content 0.40 percent; just inby from the loading point, the methane content was 0.80 percent; six feet inby the last noticeable gas feeder, the methane content of the air was 0.30 percent; at the face of 22 north entry the methane content was 0.27 percent; at the last open crosscut

in 22 north entry, 2,100 cubic feet of air a minute was passing and the methane content was 0.27 percent; return air in 21 north door frame showed 0.25 percent methane content.

The third shift foreman inspected the 22 north working places at 1:15 a. m., approximately 3 hours before the explosion. While in the 22 north air course, the foreman observed that the mining machine man was preparing to shoot, and the foreman secured the machine man's flame safety lamp and made a test for gas and found the place clear. He did not test for gas at the face of the entry because the machine operator stated that he had just examined the face and found it free of gas. On his way from 22 north faces, the foreman made no tests for gas in the vicinity of the gas feeders, stating that they had not been reported to him by the foreman on the previous shift and that he had no knowledge of the feeders.

The fire boss examined the 22 north working places and the vicinity of the gas feeders at about 3:00 a. m., approximately one hour before the explosion, and reported the section free of methane.

Air samples, taken during the investigation and after normal ventilation was restored, are shown in table 1. The sampling locations are shown on the map of the mine, appendix "A"

An average of samples Nos. 440 and 433, taken at the fan the day following the explosion and air samples taken in the same location in June 1942, show that the mine is liberating approximately 74,000 cubic feet of methane every 24 hours.

Sample No. 422 was taken on May 11, approximately 9 hours after the first explosion, in the return of 22 north and contained 0.79 percent methane. At the time this sample was taken, temporary ventilation had been restored for about 5 hours, but the ventilating current was such that it could not be measured with an anemometer.

Sample No. 411 was taken on May 12, in the slope return air course just outby 22 north, after normal ventilation had been restored and while the mine was still idle. This sample shows that the area inby this point was liberating approximately 22,000 cubic feet of methane every 24 hours.

Sample No. 396 was taken on May 12, in 22 north heading just outby the last open crosscut, after normal ventilation was restored, and shows that the area inby this point was liberating approximately 3,000 cubic feet of methane every 24 hours.

Samples Nos. 411 and 396 indicate that the greater part of the methane present in the return air current from 22 north is being liberated by the gas feeders in the floor.

Numerous tests for methane were made in face areas with permissible methane detectors during the investigation and only small percentages (0.05 before normal ventilation was restored to 0.12 after normal ventilation was restored) of explosive gas were found.

Table No. 1 follows.

Table 1 - Analyses of Air Samples Collected in
Praco No. 10 Mine, Alabama By-Products Corporation
Praco, Jefferson County, Alabama
May 11-12, 1943

Bottle No.	Date and Time	Location in Mine	Percent				Cu. Ft. Air Per Minute	Cu. Ft. Methane in 24 Hours
			Carbon Dioxide CO_2	Oxygen O_2	Methane CH_4	Nitrogen N_2		
422	5/11/43 1:15 p.m.	22 north hdg. just inby main slope air course	0.07	20.75	0.79	78.39	Still Air	
415	5/11/43 1:35 p.m.	Face 22 north hdg.	0.12	20.79	0.51	78.58	Still Air	
243	5/11/43 1:45 p.m.	Face 22 north air course	0.14	20.65	0.34	78.87	Still Air	
500	5/11/43 2:00 p.m.	Face main slope hdg.	0.10	20.74	0.62	78.54	Still Air	
409	5/11/43 2:10 p.m.	Face main slope air course	0.10	20.74	0.57	78.59	Still Air	
410	5/11/43 2:20 p.m.	Slope air course 20 inby north air course	0.10	20.89	0.06	78.95	Still Air	
194	5/11/43 2:35 p.m.	22 north hdg. just inby slope air course	0.14	20.74	0.78	78.34	Still Air	
193	5/11/43 2:45 p.m.	Face 22 north hdg.	0.13	20.77	0.46	78.64	Still Air	
435	5/12/43 10:40 a.m.	Main slope air course inby 22 north	0.06	20.90	0.04	79.00	4,184	2,410
396	5/12/43 11:15 a.m.	22 north hdg. out-by last crosscut	0.07	20.85	0.12	78.96	1,740	3,007
412	5/12/43 11:40 a.m.	22north hdg. just inby main slope air course	0.07	20.86	0.26	78.81	3,500	13,104

Table 1 (contd.) Analyses of Air Samples Collected in
Praco No. 10 Mine, Alabama By-Products Corporation
Praco, Jefferson County, Alabama
May 11-12, 1943

Bottle No.	Date and Time	Location in Mine	Percent				Cu. Ft. Air Per Minute	Cu. Ft. Methane in 24 Hours
			Carbon Dioxide CO_2	Oxygen O_2	Methane CH_4	Nitrogen N_2		
411	5/12/43 1:20 p.m.	Main slope air course just outby 22 north hdg.	0.07	20.82	0.18	78.93	8,640	22,395
434	5/12/43 1:30 p.m.	22 north hdg., just inby slope air course	0.07	20.87	0.18	78.88	4,400	11,405
440	5/12/43 2:15 p.m.	Main return at fan	0.42	20.25	0.19	79.14	28,470	77,894
433	5/12/43 2:20 p.m.	Main return at fan	0.39	20.26	0.17	79.18	28,470	69,695

From the above samples, and the fact that an accumulation of explosive gas did not occur during the period of temporary ventilation when air readings could not be obtained with an anemometer, indicate that there was a short-circuit of the air current outby the point of ignition, thereby permitting methane to accumulate in 22 north.

Drainage

The mine is naturally wet and numerous pumps are employed to dewater the mine. However, many areas exist throughout the mine where the ribs, roof and floor are dry.

Dust

As previously stated the ratio of volatile matter to total combustible matter of the coal in this mine is 0.317, and the coal dust is therefore highly explosive.

Coal dust is thrown into suspension during cutiing, loading, blasting and transporting operations. All rooms are driven to the rise and consequently are dry. Mining operations in rooms are the principal sources of dust formation.

Rock dust is applied by hand to within 20 feet of the faces of all live workings. A low-pressure rock-dusting machine is used for applying rock dust in haulageways to supplement the hand rock-dusting, but is not used in airways or rooms. Periodic sampling of dust is not done and the need for additional applications is determined only by observation. Water or wetting agents are not used to allay dust during mining operations. Respirators are not worn by employees working in dusty atmospheres.

A total of 15 samples of roof, rib and floor dust were collected in connection with this investigation. The locations at which these samples were collected are shown on the map in appendix "A". The samples were analyzed at the coal laboratory of the Bureau of Mines, Pittsburgh, Pa., and the results of the analyses are shown in table 2.

From table 2 it will be noted that only two (Nos. H-4 and B-768) of the fifteen samples collected showed an incombustible content in excess of 65 percent. These samples were collected near the outby edge of the explosion area.

The remaining thirteen samples were collected in the explosion area and contained from 37.1 to 78.6 percent combustible material and indicates that the dust in the explosion area was capable of entering into an explosion.

Haulage

The main haulage from the 13 north side track to the tipple is accomplished with a rope-haulage system. This system extends about 6,000 feet on a grade of 4 percent. Secondary haulage is by means of a 13-ton electric trolley locomotive. Gathering haulage is accomplished with 6-ton combination trolley and cable-reel locomotives. Main and secondary haulage is in intake air. With the exception of the main slope, the gathering haulage is in return air.

Table 2 - Analyses of Dust Samples Collected in
Praco No. 10 Mine, Alabama By-Products Corporation
Praco, Jefferson County, Alabama
May 11-12, 1943

Can No.	Location in Mine	Kind of Sample	Percent			Remarks (Coked Particles Present)
			Combustible V. + F.C.	Incombustible moisture + ash	Through 20-mesh	
K-734	22 north heading 15 feet inby main slope air course	Roof-rib	72.1	27.9	52.2	Large amount
K-158	22 north heading 15 feet inby main slope air course	Floor	70.3	29.7	50.3	Largest amount
B-774	22 north air course just inby main slope air course	Floor	75.4	24.6	60.8	Small amount
K-671	22 north air course just inby main slope air course	Roof-rib	75.5	24.5	67.8	Medium amount
K-454	Slope heading 30 feet outby turn	Roof-rib	62.6	37.4	54.4	Trace
R-240	Slope heading air course, 30 feet outby turn	Roof-rib	75.2	24.8	68.7	Large amount
U-922	Slope heading air course, 30 feet outby turn	Floor	78.5	21.5	51.5	Large amount
K-879	Slope heading air course at 2nd crosscut back of face	Roof-rib	72.7	27.3	62.8	Small amount

Table 2 (contd.) Analyses of Dust Samples Collected in
Praco No. 10 Mine, Alabama By-Products Corporation
Praco, Jefferson County, Alabama
May 11-12, 1943

Can No.	Location in Mine	Kind of Sample	Percent			Remarks (Coked Particles Present)
			Combustible V. +F.C.	Incombustible moisture + ash	Through 20-mesh	
K-864	Main slope air course 20 feet outby 22 north	Roof-rib	70.7	29.3	84.1	Large amount
L-11	Main slope air course 22 feet outby 22 north	Floor	76.6	23.4	53.8	Large amount
R-377	Main slope heading 55 feet outby 22 north	Roof-rib	37.1	62.9	76.6	Large amount
H-14	Main slope heading 55 feet outby 22 north	Floor	51.3	48.7	58.9	Large amount
H-4	Main slope heading at 3rd crosscut inby 21 north	Roof-rib	7.1	92.9	97.4	Trace
B-768	Main slope heading at 3rd crosscut inby 21 north	Floor	19.4	80.6	79.2	Trace
V-852	22 north heading 15 feet outby face	Floor	78.6	21.4	45.3	Trace

The signal system on the slope haulage consists of bare wires, energized with 80 volts. Bell signals are relayed to the hoisting engineer by short-circuiting the circuit with any convenient metal.

Cables are spliced underground by using metal rings and covering the joints with insulating tape. Numerous splices were observed in the cables of mining machines, gathering locomotives and drills. The track is not well-bonded.

Motors and frames of electrical equipment are not provided with grounds. Copper wire of too large carrying capacity is frequently substituted for fuses in the electrical circuits.

The mechanical equipment is maintained in fair condition, but weekly inspections are not made, and records are not kept.

Explosives and Blasting Practices

All blasting in the mine is done with permissible explosives which are transported into the mine, in the original containers, during the third shift. A wooden mine car that is equipped with hinged lids and insulated with a section of rubber belting on the bottom is used for transporting the explosives underground. From the terminal of the rope haulage system, the explosives car is hauled by trolley locomotive. Explosives in the original containers are placed in the wooden distributing magazines at the entrance to each section. The distributing magazines are not provided with devices for locking, are accessible to unauthorized persons and are placed too close to the working faces and power lines.

The explosives are transported from the distributing magazines to the working faces in rubberized bags by the shot-firers, who do the blasting.

Detonators are transported into the mine in leather bags by the shot-firers who walk into the mine.

Primers are made up at the working faces. No. 6 electric detonators, having 8-foot leg wires, are used. The leg wires are kept shunted until wired in series and ready to be discharged. Holes are charged with two to three sticks of explosives 1-1/8 by 8 inches in size, and 8 to 10 holes are fired simultaneously in each working face with a ten-shot nonpermissible magneto-type blasting device. Rock dust is used for stemming, and tamping is is done with a wooden stick.

Blasting cables are duplex rubber-covered and about 125 feet in length.

Shot firers make tests for gas with a permissible flame safety lamp before and after blasting. Accurate explosives-disposition records are not kept.

First Aid and Mine Rescue

Information obtained from the company safety director reveals that 80 men have been trained in first aid. Eight employees of the Praco mines are trained in mine rescue, and these employees receive additional training

Lighting

Incandescent electric lights are installed at infrequent intervals along the main haulageway inby the 11th north, but lights are not installed at doors and switches. The wires of the light circuits are connected to the trolley wire hangers, but they are not supported by insulators, guarded or provided with fuses.

Permissible flame safety lamps are used by the underground officials, shot-firers, and machine operators for gas-testing purposes. Permissible electric cap lamps are used by all underground employees for illumination.

Smoking is not permitted underground; however, a cigarette, about one-half of which had been smoked and snuffed out, and two matches were found in an unburned cigarette package, near the right rib and 17 feet from the face of 22 north heading, shortly after temporary ventilation had been restored. Employees are said to be searched for smoking materials at infrequent intervals.

Eletricity and Machinery Underground

Electric power is purchased from the Alabama Power Company at 2,300 volts alternating current. Power is transmitted into the mine through armored cables in boreholes to the three-stage pump, and the underground substation opposite 11 north entry where the alternating current is converted to 250 volts direct current for mine use.

The substation is of fireproof construction but is not provided with fire doors. It is ventilated with a separate split of air; the return air going to the Praco No. 7 mine fan.

Trolley and power wires are reasonably well-installed, and guarded at places where men are required to pass under them. Sectionalizing switches are installed at the entrance to cross or room entries, and at intervals of 2,000 feet along the main haulageway. With the exception of the three-stage pump, all underground electrical equipment is operated with 250-volt direct-current power.

All electrical equipment used in the mine is nonpermissible, and with the exception of that used in the main haulageway and the substation, the equipment is operated in return air.

The underground electrical equipment consists of the motor-generator set; the three-stage pump; numerous other pumps of various sizes and kinds; one - 13-ton trolley-type locomotive; five - 6-ton combination trolley and cable-reel locomotives; eleven shortwall mining machines; numerous electric drills; eleven chain-type conveyors; one low-pressure rock-dusting machine; one portable air compressor; and numerous car hoists.

Haulage inby the 13 north sidetrack is controlled by a block-signal system. Two telephones are installed in the mine; one at the 13 north sidetrack and the other at the 17 north foreman's shanty. These telephones are connected to the telephones on the surface.

twice a year from representatives of the Bureau of Mines. Thirty employees of the Praco mines completed the Bureau of Mines accident prevention course during August 1938.

Employees have not been trained recently in first aid, and only those trained in mine rescue are instructed in the use of barricades.

The underground first-aid supplies are inadequate.

The company does not maintain a mine rescue station; however, five all-service gas masks are usually maintained at each of the mines owned by this company. Self rescuers are not carried by the underground employees.

Safety Organization

The safety organization at this mine consists of a safety director who investigates all serious and fatal accidents at this and 7 other mines operated by this company. The safety director also makes inspections relative to hazardous and other conditions involving health and safety of the employees. Reports of his investigations and inspections are made to the superintendents.

In addition to the safety director, a ventilation inspector is employed to check the mine air with an electrical methane detector, and measure the volume of air in the various parts of this and two other mines operated in this division by this same company.

Safety meetings, in which employees and management participate, are not held. Bulletin and poster boards are maintained and printed safety rules, in pamphlet form, are furnished to all employees.

Supervision and Discipline

The underground supervisory personnel consists of a superintendent, a mine foreman, and three general assistant mine foremen during the day shift; one mine foreman, and two general assistant foremen during the second shift; and an assistant foreman, not certified, and one certified fire boss during the third shift. A safety director makes periodic inspections underground and a ventilation inspector tests for gas with a permissible methane detector and takes air measurements with an anemometer once each week. Each working area is concentrated and not more than 30 men are under the direction of an assistant foreman each shift. Each conveyor crew, consisting of four men, is under the supervision of the mining machine operator, who is designated as crew leader and who also serves as shot-firer. The activities of each crew are confined to one working place. The assistant foremen visit each working place at least twice during the shift and have no other duties except the direction of the workmen under their supervision. Most of the auxiliary workmen are supervised by the mine foreman. At least five visits are made to each working place each 24 hours by underground officials.

Each faceboss and mining machine operator, and other supervisors are equipped with permissible flame safety lamps for gas-detection purposes;

however, they are not required to record the results of their inspections and a record book is not kept for this purpose.

Only one fireboss is employed, his duty being to make a preshift inspection of the entire mine before the day shift enters the mine.

Each assistant foreman is required to examine the sections under his direction for methane, and to report his findings at the end of the shift to the mine foreman, who in turn reports to the foreman on the succeeding shift. However, the foreman on the third shift, on the morning the explosion occurred, stated that no report had been made to him that gas feeders had been encountered in the floor in the 22 north section.

It is believed that an adequate number of supervisors are provided in this mine, but supervision and mining practices are substandard.

The safety rules are not rigidly enforced and, because of an inadequate labor supply, discipline is not being enforced except in aggravated cases.

Fire Protection Underground

Fire-fighting facilities are not provided underground except for the sand and rock dust stored in the substation and a few bags in the various sections. Chemical fire extinguishers have not been provided for locomotives or other portable electrical equipment or at permanent electrical installations underground except at the substation where a small chemical fire extinguisher is provided.

Previous Explosions in this or Nearby Mines

According to the records previous major explosions have not occurred in this mine; however, a number of major mine disasters have occurred in the Birmingham district in mines which are operated in the same coal bed.

Some of these explosions are listed as follows:

Date	Mine	Location of Mine	No. lives lost
5-5-10	Palos No. 3	Palos, Ala.	83
4-8-11	Banner	Littleton, Ala.	128
11-4-16	Bessie	Palos, Ala.	30
6-13-17	Banner	Littleton, Ala.	6
11-23-20	Parrish	Parrish, Ala.	12

In addition to the above, three local gas explosions have occurred in the adjoining Praco No. 7 mine as follows: On September 11, 1933, two local gas explosions occurred about 2,000 feet apart, at approximately the same time. Three men were burned by one ignition of gas, and one man by the second ignition of gas.

Five men were burned by a local gas explosion of March 10, 1939, when gas was ignited by sparks from an open-type portable electric coal drill.

Mine Condtions Prior to Explosion

The weather was cloudy on the day of the explosion, and there was a steady rain during the night which ceased at about 5:30 a. m. on the morning of the explosion. A recording barometer at the official weather bureau in Birmingham, Alabama, about 30 miles from the mine, indicated a gradual drop in atmospheric pressure from 29.38 inches of mercury at 9:00 a. m. Monday, May 10, to 28.96 inches of mercury at 5:00 a. m. Tuesday, May 11, 1943. There was an 0.08-inch drop from 4:00 a. m. to 5:00 a. m. Tuesday, May 11, 1943. It is doubtful that this drop in atmospheric pressure (0.42 inches of mercury) in a period of 20 hours, had any appreciable effect on the liberation of explosive gas into the mine workings.

The mine was operating normally on the day of the explosion. The district mine inspector of the Sate of Alabama, Department of Industrial Relations, Division of Safety and Inspection, had inspected the area of the mine in which the explosion occurred on the previous day. According to the statements of this inspector, gas feeders were observed in the vicinity of the conveyor-loading point. Other than this, no gas was detected with a permissible flame safety lamp during the inspection and no abnormal ventilating conditions were observed. This observation was confirmed by company officials who accompanied the State inspector.

STORY OF THE EXPLOSION AND RECOVERY OPERATIONS

At the time of the explosion, the regular third or "owl" shift was working in the mine and was composed of 24 men employed as follows: two face conveyor crews of four men each, working in 22 north heading and air course; one conveyor loading-point attendant 170 feet outby the face of 22 north heading; three supply men delivering timbers in 22 north heading, two at the face and one outby the face; one motorman and one brakeman just inby the door on 22 north heading; one pumper on the slope haulageway about 100 feet inby 22 north turnout; three supply men delivering conveyor pans and chains near the face of 20 north heading; the foreman in 18 north inby the door; two road cleaners on the main slope haulageway near 17 north turnout; one road cleaner in 17 north; one electrician on the main slope haulageway at 13 north sidetrack; and the fire boss in the manway outby 11 north.

All of the above employees were about their usual duties, when the conveyor loading point attendant put in the switch to start the car hoist. At the instant the switch made contact, an electric arc was created which ignited the gas, causing the explosion. The conveyor loading-point attendant, one of the supply men approximately 50 feet inby the loading point, the motor crew and the pumper managed to escape from the explosion area severely burned and injured. The remaining ten employees in 22 north heading and air course were killed by violence, burns and afterdamp.

Of the five who escaped from the explosion area, two died. The supply man who was about 50 feet inby the point of ignition, died about 25 hours after the explosion, and the motorman who was just inby the 22 north door died 8 days after the explosion. The other three will recover.

Observations after the explosion and the positions of the bodies indicate that the men were alive for a short time after the ignition. Only one body was found in the vicinity of the working face, and one of the victims had traveled approximately 248 feet before collapsing. The bodies were found in various positions, some were face down, some face up and others on their sides.

The conveyor loading-point attendant was blown outby about 20 feet and received severe burns of the head, face, neck, wrists and back of the right shoulder. He received no injuries from the forces of the explosion; however, his clothing was ignited but he was able to extinguish the flame unassisted. He remained conscious, and as soon as the forces of the explosion ceased, he groped his way to the entrance of 22 north, where one of two electric lights on the slope heading was still burning, and he was able to discern two men; one, who later turned out to be the brakeman, who had just started to crawl up the slope heading (the brakeman was sitting on the gob near the car hoist at the time of ignition); the other was the motorman. At this point the conveyor loading-point attendant and motorman were joined by the supplyman. The conveyor attendant suggested that they start up the slope and get as far toward the surface as possible. It was impossible for them to see because of the dust in the atmosphere, and they had to feel their way along the track.

The pumper, who was walking up the slope heading, midway between the slope heading loading point and the 22 north turnout, when the explosion occurred, was blown back over the cars at the slope loading point, receiving burns of the head, neck, face, wrists and ankles, which were less severe than the burns of the others, and a severe laceration of the forehead and scalp. He groped his way toward the face where bottom had been lifted in the slope heading, and from this was able to recognize where he was.

He reversed his direction and crawled up the slope passing the two injured members of the motor crew at the entrance to 22 north. The sleeve of one of the motor crew was burning; he advised him of this and suggested that they go up the slope as far as they could. The brakeman followed the pumper up the slope, but the motorman remained a minute or so and accompanied the two injured men from 22 north.

The foreman who was standing on the bumper of a car, just inby 18 north door, was blown into the car and slightly stunned, and other than having his jacket blown off was not injured. The remaining employees in the mine felt the force of the blast, but were not injured.

The road cleaner in 17 north continued at work and completed his shift at 6:00 a. m., unaware of the explosion.

The supplymen in 20 north worked two or three minutes after the blast, completing their work in 20 north. The power remained on the trolley wire and these men started out of 20 north on a trolley-type locomotive. They had not traveled far when they encountered a cloud of dust and smoke.

Increasing their speed, they traveled to the main slope to 17 north shanty where they met other employees including some of the injured.

The road cleaners on the main slope near 17 north, left their car and motor and started walking toward the surface. In the meantime, the fire boss, who was in the manway on his way to the surface, returned to ascertain the cause of the disturbance.

The foreman, realizing that something had happened, proceeded to the slope haulageway where he found that the force of the explosion had wedged the 18 north door in its frame, and after a little difficulty, he managed to free the door by using a steel mine tie as a lever. He then ran up the slope where he met the two road cleaners in the vicinity of the 17 north foreman's shanty. The foreman immediately attempted to contact the surface by telephone but was unable to get any response. After ringing the telephone a few minutes, the electrician at 13 north answered, and the foreman instructed the electrician to continue ringing the surface and to advise those on the surface that "something awful had happened in the mine and to send them help." In the meantime, the foreman instructed one of the road cleaners to walk to the surface and deliver the same measage. The foreman then told the second road cleaner to continue to ring the telephone for help, and that he would try to go down the slope to see what had happened.

The foreman went down the slope but could not proceed beyond 18 north because of the dust and smoke. He returned to the pump on the slope outby 18 north, obtained a drink of water and again attempted to go down the slope but could not advance beyond 18 north because of the dust, smoke and lack of visibility. He was about to retreat up the slope when he saw a light coming up the slope, which proved to be the pumper who was too exhausted and scared to talk. Just as the pumper approached the foreman, andother light approached and this turned out to be the brakeman who told the foreman there had been an explosion in 22 north.

The foreman accompanied the two injured men to 17 north shanty where they secured the locomotive and car which the road cleaners had been using, and accompanied by the road cleaner rode to the 13 north shanty. Just as they approached the shanty the fire boss arrived.

Upon learning what had happened, the fire boss and the electrician took the locomotive and mine car and rode to 17 north shanty to get first-aid material for the injured, and to cut-off the electric current inby 17 north. Just as they arrived at the 17 north shanty, they met the conveyor loading-point attendant and the supplyman from 22 north walking up the slope toward the surface. They immediately loaded the first-aid material in the car and were about to pull the switch cutting off the power inby 17 north when they saw the headlight of a locomotive coming up the slope. They delayed pulling the switch until the locomotive and crew arrived, which proved to be the supplymen from 20 north.

As the three injured men, consisting of the motorman, supplyman and conveyor attendant, were making their way up the slope, they stopped to rest just below 20 north turnout. After resting for a few moments, the

conveyor attendant suggested that they continue up the slope. The motorman replied that he could not make it any farther.

When the three uninjured supplymen came out of 20 north on their locomotive, they saw the injured motorman with his clothing on fire, on the slope haulageway just inby 20 north turnout. They did not stop to offer assistance, being in a state of fright.

About 25 minutes after the first explosion, and just as the three uninjured supplymen were approaching the fire boss, electrician and two injured men at 17 north, a second explosion occurred. According to statements of six of these men, the second explosion was more violent than the first.

The power was immediately cut-off all points inby 17 north, and the seven employees mentioned above immediately proceeded to 13 north shanty on locomotives and in mine cars.

When the second explosion occurred, the two injured employees who were at 13 north shanty, became frantic, refused to remain in the mine for first-aid treatment and started to walk to the surface. Because of their condition, the foreman accompanied them to the surface.

Continued attempts by the road cleaner at 13 north to contact the surface by telephone were unsuccessful.

After arriving at 13 north the two injured men from 22 north were given first-aid treatment. Upon learning that contact had not been made with the surface, the fire boss directed the electrician to walk to the surface to get help and to have the hoisting engineer lower the man-trip in order that they might send the injured men to the surface.

The electrician had traveled about two-thirds of the way to the surface, when contact was established with the hoisting engineer by telephone. The hoisting engineer reported for duty between 5:30 a. m. and 6:00 a. m., in time to hoist the third shift man-trip from the mine. The electrician returned to 13 north on the man-trip, and the two injured men and two supplymen were sent to the surface on the man-trip.

The fire boss and electrician then returned to 17 north on a locomotive and from there proceeded on foot, down the slope, checking the stoppings and doors as they went. They found the motorman, still conscious, lying on the slope haulageway at the first crosscut inby 19 north.

The fire boss and electrician carried the motorman, on a stretcher, to the locomotive at 17 north. Just as they were preparing to leave 17 north with the injured man, they met the general mine foreman, ventilation inspector and others.

After issuing instructions for removing the injured motorman to the surface, the general foreman directed the restoring of temporary ventilation in the affected area.

When the supplyman, who had gone for help, reached the surface, he notified the lampman and a fire boss from No. 7 mine of the explosion. They in turn notified the superintendent by telephone. The superintendent immediately notified the local mine officials and the officers of the company in Birmingham by telephone. The general superintendent immediately notified the chief of the State of Alabama, Department of Industrial Relations, Division of Safety and Inspection, and the supervising engineer, District D of the U. S. Bureau of Mines, by telephone.

The mine superintendent joined those underground shortly after the restoring of temporary ventilation was begun and assumed charge of the recovery operations.

Temporary canvas stoppings were erected in the six crosscuts between the slope heading and air course just outby the 22 north heading where the plastered gob stoppings had been blown out. A canvas check was erected at the entrance to 22 north where the door had been blown out. Canvas stoppings were erected in the first crosscut in the slope heading just inby 22 north and across the slope heading just inby the second crosscut below 22 north, where the gob stopping had been blown out. The temporary air current traveled through this crosscut to the slope air course where a canvas stopping was erected in the slope air course between 22 north heading and air course, deflecting the air current into 22 north air course. Canvas stoppings were then erected in the succeeding 3 crosscuts between 22 north heading and air course.

All of the above recovery operations were conducted without the use of respiratory or other equipment, except a permissible flame safety lamp and a permissible methane detector.

State Mine Inspector O. H. Youngblood, Staples Bailey, Chief Mine Inspector for the Woodward Iron Company, and C. E. Saxon of the Bureau of Mines arrived at 22 north about 7:40 a. m. in company with officials and and two mine rescue teams of the Alabama By-Products Corporation. At this point, a conference was held with the superintendent regarding conditions. It was decided to explore the 22 north heading and air course, and continue the construction of temporary stoppings.

Messrs. Youngblood, Bailey and Saxon in exploring the 22 north air course, encountered carbon monoxide. From that point on, the remainder of the 22 north heading and air course were explored and all bodies located by the two mine-rescue teams wearing oxygen breathing apparatus.

Shortly thereafter, temporary canvas stoppings were erected between the heading and air course restoring temporary ventilation which permitted the exploration party to travel through the remainder of the affected area. The bodies were loaded onto stretchers and placed in cars on the slope by 9:40 a. m.; all of the bodies had reached the surface at 10:50 a. m. May 11, 1943.

INVESTIGATION OF CAUSE OF EXPLOSION

An investigation of the explosion was conducted immediately after ventilation was restored in the mine, and the bodies of the victims had been recovered.

The investigating party consisted of: E. J. McCrossin, Chief, State of Alabama Department of Industrial Relations, Division of Safety and Inspection; H. J. Gentry, chief mine inspector; A. G. Crane, O. H. Youngblood, H. T. Williams, J. H. Chapman, Dabney Ramseur, J. A. Ivie and T. L. Weston, State mine inspectors; W. C. Chase, general superintendent; Frank Hillman, safety director; H. J. Hager, superintendent, and D. F. Laird, officials of Alabama By-Products Corporation; and C. E. Saxon, J. B. Benson and H. N. Smith of the Bureau of Mines. A preliminary investigation of the entire area was made by this party on May 11, 1943, and a more detailed investigation of the area was conducted by E. J. McCrossin, H. J. Gentry, H. J. Hager, J. B. Benson, and H. N. Smith on May 12, 14, 15 and 17, 1943.

CORONER'S VERDICT

The Jefferson County Coroner made an investigation into the cause of the death of the victims of the explosion, but an inquest was not held.

PROPERTY DAMAGE

The property damage as a result of this explosion was not extensive. With the exception of only slight damage to one cable-reel locomotive, the mine equipment was not greatly disturbed.

Damage to the ventilation facilities consisted of the destruction of twelve gob stoppings, one wooden door and two brattice-cloth stoppings. Two sets of timbers, approximately 420 feet outby the 22 north entry on the main slope haulageway, were blown out by the explosion, but the resulting roof falls were not extensive. Two sections of wooden trolley wire guards near the door at 22 north and one-half of a section of a trolley wire guard at the conveyor-loading point was torn down, but none of the trolley wires or haulage tracks was disturbed.

The explosion resulted in three days lost time in the operation of this mine. Because of the explosion, one day's time was lost in the Nos. 7 and 7-½ mines which are adjoining mines. Normal production was not reached until the following week, consequently much production from this 3300-ton a day plant was lost.

Forces

The forces of the explosion traversed the entire area of the workings from the point of origin at the conveyor loading-point in 22 north, 215 feet from the main slope entry, and extended out into the main slope entries, down to the faces of the main slope entries and up the main slope entries to a point approximately 420 feet outby the 22 north entry, where evidence indicated the forces began to dissipate as there was no evidence of disturbance outby this point. However, a survivor working at 13 north on the main slope haulageway stated that the concussion resulting from the explosion and dust thrown into suspension in the air reached this point.

The area in Nos. 17, 18, 19, 20 and 21 north and 1 right 21 north was explored and no evidence of disturbance was found.

The lines of force as indicated by the direction in which stoppings were blown out, the direction in which timbers, cover plates of a locomotive and the deposition of coke on timbers are further evidence that the explosion originated at the conveyor loading station in the 22 north.

A shield from the mining machine in the 22 north entry was found 18 inches behind the machine; however, the mining machine operator had cut the face of the entry from the right rib toward the left rib to where some loose coal from the previous cut had not been loaded out. The machine controller was in the "off" position and the friction controls were released, indicating that this machine was not operating at the time of the explosion and that the shield had been previously removed for oiling.

The mining machine in the 22 north air course was in cutting position. The air course at the face is 27 feet wide, and 9 feet of the face had been undercut; 10 feet was ready for cutting and coal was being loaded from the remaining 8 feet. The mining machine control was in the "off" position and a nonpermissible coal drill was 4 feet diagonally to the right of the mining machine. Three holes had been drilled in the face of the air course where the coal had been undercut, and the drill cable was disconnected from the source of power. A coal drill, which evidently was not being used, was alongside of the air course conveyor, about 25 feet from the face. Two coal shovels near the coal pile on the left rib indicated that two men were loading coal when the explosion occurred.

The force through the second crosscut from the face in the main slope entries was so great that a conveyor chain was thrown out of the conveyor pans; a control switch for the conveyor was blown from this crosscut into the main slope entry, and the conveyor which had been extended 170 feet in the main slope entry was blown from its foundation and moved forward about 12 inches.

A pump motor on the main slope entry, in direct line with 22 north, was blown from its foundation, and three cases of explosives, in the first crosscut between the main slope entry and air course outby the 22 north, were spilled from the boxes and were scattered in the main slope haulageway, but there was no evidence of any of the explosives having been detonated and there was no indication of explosives having been ignited by the explosion anywhere in the explosion area.

Evidence of Heat or Flame

Visible evidence of flame was indicated by the deposition of coke on timbers in the entire area of 22 north, extending inby to the fifth crosscut in the main slope air course, and outby on the timbers and on coal in the mine cars at the conveyor loading point in the main slope entry and on the timbers on the main slope haulageway about 55 feet outby 22 north. Charred paper rock-dust bags were found on the second loaded mine car in the main slope entry and at the pump on the slope haulageway at 22 north. Details of this evidence are shown in appendix "B".

Dust samples taken from the explosion area and examined and analyzed in the Coal Laboratory of the Bureau of Mines, Pittsburgh, Pennsylvania, indicate coked particles present in all samples. The largest amount was

in sample (K-158) taken from the floor in the 22 north 15 feet inby the main slope air course. Sample (K-734) rib and roof at this point shows a large amount.

Samples (H-4) rib and roof and (B-768) from the floor taken in the main slope haulageway at the third crosscut inby 21 north show a trace of coked particles present.

Sample (K-879) roof and rib in the slope air course at the outby rib of the second crosscut from the face shows a small amount. A floor sample could not be obtained at this location because of standing water two inches deep.

An enclosed switch used to control the room hoist electric circuit was installed on a board 1 by 8 by 20 inches in size on the right rib opposite the conveyor loading point. All of the insulating material in this switch was burned and the upper inby corner of the board was charred. The interior of the box indicated previous flashing as the segments of the switch were burned. A section of 1-by 4-inch wooden trolley wire guard at the loading point was burned through in several places and the parallel piece of shielding remained in place but was charred. A section of the side board of the car at the conveyor was burned, charred to a depth of 1/8 inch and was probably caused by the first explosion which blew down the timber supporting two open knife switches at the conveyor loading station which allowed the "live" wires to ground against the wheel of the mine car causing an intense electric arc.

A total of 15 employees were in the flame area, 14 being in the 22 north and one on the main slope haulageway 100 feet inby the 22 north. This man was burned on the wrist, ankles, neck, head and face, but the burns were not as severe as those received by the workmen in the 22 north. The location of these employees at the time of the explosion is shown in appendix "A"; they being designated as numbers 1 to 15 inclusive.

The area inby 21 north where the explosion forces were dissipated, had been driven through a rock fault and had previously been rock-dusted. On the main slope haulageway at this point, the analyses of dust samples (H-4) from rib and roof show combustible 7.1 percent, and the floor sample (B-768) contained 19.4 percent.

In the slope air course opposite this location water had accumulated to a depth of 8 inches for a distance of about 40 feet, and the ribs and roof were rock-dusted; however, the rock dust had not been applied as thoroughly in the air course as it had in the haulageway.

Analyses of dust samples collected in the 22 north entry and air course and in the main slope entry and air course show combustible matter in excess of 35 percent in 12 of the 15 samples. One sample shows 51.3 percent, one 62.6 percent and the remaining 10 show combustible matter ranging between 70.3 percent and 78.6 percent. These results further show the lack of adequate rock dust to neutralize the explosibility of the coal dust in the explosion area. Had the area been thoroughly rock dusted, flame

propagation would undoubtedly have been less extensive. The cross-sectional area of the openings in the explosion section were not sufficiently extensive to permit rapid dissipation of the forces, thus the extended area of force.

SUMMARY OF EVIDENCE

A statement from the loading-point attendant who escaped from the point of origin and survived is as follows: "Gas was ignited by an electric arc from an open-type switch when I closed the switch to move a trip at the conveyor loading point." This switch was used to control the power circuit connected to a room hoist motor.

The control switch was in such condition that it could easily ignite gas and the loading-point attendant stated that the arc occurred every time the switch was opened or closed. Methane had been liberated from gas feeders in the floor in 22 north entry for two days prior to the explosion.

The company ventilation inspector was sent into the 22 north entry on the second shift, Monday, May 10, by the day mine foreman, and at 8:00 p. m., 8 hours before the explosion occurred, gas tests were made with a permissible methane detector just inby the conveyor-loading point and showed 0.80 percent methane.

According to reports, the company ventilation inspector did not notify the foremen of the first, second or third shift concerning the results of his inspection and it was also reported that a written report of the ventilation inspector's findings was made and left in the mine superintendent's office, the superintendent was not notified, and this report was not available to the superintendent until the moring following the explosion.

Apparently no attempt was made to withdraw the workmen from 22 north section following the ventilation inspector's examination.

There was no evidence to show that an attempt was made to improve ventilation after 0.80 percent methane had been detected. One permenant stopping had been erected in a crosscut between the entry and air course in 22 north and two crosscuts were closed with temporary stoppings of brattice cloth.

The last two crosscuts from the face were open.

Near 8:00 p. m., eight hours before the explosion occurred, air measurements taken in the last open crosscut from the face showed 2100 cubic feet of air a minute.

The entire mine was ventilated with one continuous current of air except for a small split to ventilate an underground substation.

A lack of adequate airways and a proper ventilation system existed in the mine. The volume of air in the 22 north section was inadequate before the explosion occurred.

Coal was being produced only in the 22 north entry during the third shift, and there was no evidence that shots were being fired anywhere in the explosion area at the time of the explosion.

All doors used in connection with coursing the air through the mine were installed singly.

Any one of the doors installed between the slope entry and air course, if left open, would cause a short circuit of the ventilation from all sections inby the door.

One of the doors between the slope entry and air course, between 15 north and 22 north, was apparently left open which resulted in the air current being short-circuited and permitted an explosive mixture of methane to accumulate in 22 north.

The lack of combustible material, the presence of moisture, and the use of rock dust as indicated by results of analyses of dust samples, (H-4 and B-768) Table 2, prevented further propagation of the explosion.

Chemical analyses (Bottle No. 422) of an air sample taken in 22 north after temporary ventilation had been restored showed 0.79 percent methane.

Deposits of coke indicate that coal dust contributed to the extent and violence of the explosion.

Although smoking is prohibited in the mine, some survivors stated that smoking is done outby the working faces. Smoking material and two matches were found near the right rib in the 22 north entry about 17 feet from the face. This material included one partly burned cigarette and two unburned matches, enclosed in the manufacturer's packing container.

All of the electrical mining equipment and electrical switches in the mine are nonpermissible type and practically all gathering haulage is with trolley and cable-reel locomotives in return air.

PROBABLE CAUSE OF THE EXPLOSION

It was reported that the door between the main slope entry and air course at 22 north entry was erected during the second shift on Monday, May 10, and was damaged at the beginning of the third shift when the brakeman let the door swing against a moving trip. The door was repaired temporarily by the locomotive crew. Although the damage to the door was slight, a small quantity of air was being short-circuited between the main slope entry and air course at the entrance to 22 north. Less than an hour before the explosion occurred, an employee working near the 17 north entry on the main slope haulageway was ordered to move some cars with a locomotive in the 17 north entry. Unaccompanied, it was necessary for this workman to pass through the doorway at the 17 north with a locomotive, and as no one was available to assist this employee to open and close this door, it is probable that the 17 north door was blocked open during the period the cars in 17 north were being moved, and the workman returned to the main slop haulageway.

With this door open, a complete short-circuit of the ventilating current would result, and methane could accumulate inby this point.

After careful consideration of information gathered during the recovery work and investigation, and the testimony given by the survivors who were in the explosion area, it is concluded by the Bureau of Mines investigators that the explosion resulted from an ignition of an accumulation of methane, the ignition source being an electric arc from a nonpermissible electric switch at the conveyor-loading point in 22 north entry.

The main fan is about 1,000 feet from the tipple, is isolated, and unattended. It is belt driven and is not equipped with a water gage or recording pressure gage or safety controls. A hand-operated oil switch is used to control the power circuit, and when the fan stops, it is necessary for an employee to go to the fan to start it.

As inclement weather conditions existed about the time the explosion occurred, the theory that the fan was not operating cannot be entirely overlooked, although the Federal investigators could not find evidence to substantiate a fan stoppage.

STATE MINE INSPECTORS' CONCLUSIONS

The State mine inspectors and company officials who participated in the investigation conclude that an interruption in the ventilating current, caused by short-circuiting of the air current when a door was left open, was responsible for an accumulation of explosive gas emanating from gas feeders from the floor inby the loading point in the 22 north entry, and the explosion was initiated by an electric arc from a nonpermissible electric switch at the conveyor-loading point. The State mine inspectors and company officials have not definitely concluded which door was open. Although they are of the opinion that the damaged 22 north door and the period of time this door was open while trips were being shifted, could have short-circuited the air sufficiently long to permit an explosive mixture of methane and air to accumulate in the 22 north entry.

LESSONS TO BE LEARNED FROM THE CONDITIONS AS THEY RELATE TO THE EXPLOSION

1. The need for positive ventilation, properly coursed to all underground working places to properly dilute and remove explosive gas from the mine, apparently was not given due consideration.

2. Pure intake air should be taken into the mine and conducted directly to the active workings in quantities sufficient to dilute, carry off and render harmless all gas liberated. The amount of air furnished to each section should be somewhat in excess of the minimum requirements in order to take care of unusual conditions.

3. The air currents should be split and each section furnished an independent current of air.

4. The ventilating system should incluede the elimination of doors and be so designed that ventilation interruptions cannot occur.

5. Too much risk is involved to place reliance for continuous ventilation on a single mine door, or on a mine fan inadequately equipped.

6. Bare electric power wires or open-type electric motors or switches or other electrical equipment that produce arcs or sparks should not be allowed in return air in this mine in regions where there is much fine inflammable coal dust, or in areas that are apt to contain explosive gases.

7. Mines in which explosive gas is liberated and classed as gassy should be worked as such with permissible equipment including locomotives, cutting machines, drills and any and all stationary or mobile electrical equipment placed or operated in any but fresh intake air. In addition to the gas regularly given off, sudden and unusual liberations of gas in large quantities may occur at any time; therefore, such mines should be developed and operated so that no arc or open flame is present in the event that accumulations of gas occur, whether suddenly or otherwise.

8. The difficulty of identifying bodies and accounting for the employees in the mine following the explosion exemplifies the necessity for a positive check-in-and-out system, with a requirement that all employees carry a positive means of identification on their person at all times while underground.

RECOMMENDATIONS

The following recommendations, many of which were made during a Federal inspection of this mine in June, 1942, are made in the belief that their adoption will materially lessen the chances of an explosion occuring in this mine in the future.

Methods of Mining

1. In main haulageways, where posts or timber sets are used for supporting the roof or sides, they should be hitched into the rib or wall. If this is not practicable, substantial guard rails should be placed along, or spacers between, the posts.

2. Rules requiring that safety timbers be set promptly, should be strictly enforced.

3. On all trolley haulageways there should be a continuous clearance on the side opposite the trolley wire of at least 30 inches from the nearest obstruction to the farthest projection of moving equipment.

4. Shelter holes should be available along all haulageways; they should be suitably marked and not over 60 feet apart on the clearance side, not more than 4 feet wide and not less than 5 feet deep, and 6 feet in height or as high as the traveling space if it is less than 6 feet.

Ventilation and Gas

1. The main fan should be:

a. Connected to the air shaft by a fireproof duct, equipped with explosion doors.

b. In a fireproof housing.

c. Installed to permit prompt reversal of air flow.

d. Provided with at least two independent sources of power immediately applicable or a secondary fan unit. The fan should be attended constantly or be provided with an automatic starting device.

e. Provided with a recording pressure gage.

f. Provided with a device to give alarm and cut off the power automatically from the mine when the fan slows down or stops.

g. Should be inspected daily, and a written report kept.

2. All combustible material should be removed from the vicinity of the fan.

3. The ventilation system should be redesigned so that each section will be ventilated with a separate split of pure intake air.

4. Splitting of the air should be accomplished with over-casts substantially constructed of incombustible material.

5. A sufficient number of entries with adequate cross-sectional area should be provided to permit the free flow of air into and out of the mine. The return air course should be connected between the 2 and 3 and the 9 and 10 north entries. Reliance should not be placed upon old workings (especially areas affected by a squeeze) to serve as return airways.

6. Doors should not be used to control the ventilation except where absolutely necessary.

7. Where it is necessary to use doors to control the ventilation, they should be erected in pairs to form air locks, so that when one door is open the other, having the same effect on the ventilating current, can remain closed. All doors should be erected so as to be self-closing.

8. All worked-out and abandoned areas that cannot be regularly inspected and thoroughly ventilated should be sealed with stoppings constructed of substantial fireproof material and provided with some means of bleeding-off the gas into the return.

9. Stoppings between intake and return airways should be constructed substantially of incombustible material except that one temporary stopping of wood or brattice cloth may be erected between the face of entries and the first outby stopping. These stoppings should be completed promptly as the passageways are advanced.

10. The quantity of air reaching the last open crosscut on any pair of working entries, headings, gangways or the maximum inby point of a split, should be at least 6,000 cubic feet a minute.

11. When the air immediately returning from a split that ventilates any group of active workings contains more than 0.5 percent of inflammable gas, as determined by chemical analyses in duplicate, or by other recognized means of accurate detection, the workings of that split should be considered hazardous and require improved ventilation.

Dust

1. Provision should be made to apply water on the cutter bars of all mining machines, or to spray water on the dust as it emerges from the kerf, and the coal cuttings should be kept wet as the cutting is being done.

2. All working places should be thoroughly wetted with water in the face regions before and after blasting.

3. Water should be applied to the coal as it is being loaded onto the conveyors.

4. The tops of loaded cars should be thoroughly wetted in the working places to avoid the distribution of coal dust along haulageways.

5. The coal face and the working place 40 feet therefrom should be kept free of coal dust by the use of water.

6. Haulage entries and working places should be kept clean and free from spilled coal and coal dust.

7. Rock dust should be applied to every mine surface, on haulage entries, return airways, crosscuts and rooms, to within at least 40 feet of the working faces.

8. The rock dust should be applied to the top, bottom and sides of all openings of every description and other mine surfaces in such quantities that the incombustible content of the dust will not be less than 65 percent. If gas is present in the air current, 1 percent additional rock dust should be applied for each 0.10 percent gas present.

9. Dust samples should be collected at frequent intervals at representative points in the mine to maintain a check on the condition of the dust as to explosibility. Redusting should be done before incombustible content falls below the limit stated in the preceding recommendation.

10. Return airways, trackless entries and other openings that have not previously been cleaned, should be cleaned of fine coal dust before rock dust is applied.

11. Provision should be made in stoppings between intake and return airways to convey rock dust into the trackless entries by means of the hose of a high-pressure rock-dusting machine or other adequate method. Air-tight trap doors or capped pipes are suggested if a high-pressure rock-dusting machine is used.

3. The distributing magazines should be kept securely locked except when explosives are being put into storage in them or issued from them.

4. Each employee charged with a custody or distribution of explosives should possess a foreman's license. Unlicensed employees should not issue or distribute explosives; however, no license is required for employees who purchase or receive from the licensed foreman explosives for use in the mine for the conduct of their work.

5. Accurate daily records should be kept of the amounts of explosive received, issued from, and returned to the distributing magazines.

6. Only one person should be in charge of a magazine, but sufficient authorized persons should be licensed in order to insure constant supervision of the magazine without interruptions.

7. Shots should be fired only in a permissible manner and with a permissible blasting device.

8. Explosives should not be taken to the face of any working place while the electrical equipment is in operation.

9. Closed wooden or nonconductive plastic boxes should be used for transporting explosives to the working faces since the rubberized bags are seldom closed and frequently defective.

First Aid and Mine Rescue

1. All employees at this mine should receive first-aid training.

2. Additional first-aid training should be given to all the employees of this mine annually.

3. A selected number of men, at least 12, should be trained in mine rescue work at this mine, and additional mine rescue training should be given monthly.

4. Mine officials should take the Bureau of Mines advanced mine rescue course when such course is available, and all underground employees should be instructed in the use of barricades.

5. Adequate first-aid material should be provided on the surface and underground and kept in clean, usuable condition.

6. Self-rescuers should be a part of each underground employee's equipment.

Safety Organization

1. Safety meetings, including officials and employees, should be held at least monthly.

Electricity and Machinery Underground

1. Trolley wires and bare feeder wires should not be installed in the mine in other than pure intake air.

2. All electrical equipment used at or near the face or workings, such as mining machines, mechanical loading machines, drills and other electrical equipment, should be permissible type, and this equipment should be maintained in a permissible condition.

3. Such equipment should be operated and maintained in accordance with the instructions contained in the caution statements on the approval plates.

4. The power for all electrical equipment used in face regions should be obtained through nips equipped with fuses and located in pure intake air or through permissible junction boxes in other than pure intake air.

5. Open types of electric motors or switches or other electrical equipment that produce arcs or sparks should not be installed or used in return air in this mine in regions where there is much fine, dry inflammable coal dust or in areas that are apt to contain explosive gases.

6. When trailing cables become damaged, they should be replaced by standby cables, and the defective cables should be taken to the repair shop to be repaired. Only vulcanized splices, or splices covered with self-vulcanizing rubber tape, should be used.

7. Where the track is used for the return circuit of any electrical equipment, including gathering locomotives, both rails should be well bonded at every point, and crossbonds should be installed at least every 200 feet.

8. Underground electric stations should be in rooms of fireproof construction. Fireproof doors should be provided and arranged to close a automatically in case of fire. Electric stations include transformer installations, pumps, motor-generator sets, charging stations and all electrical equipment.

9. Telephone connections should be provided from the surface to within a few hundred feet of all working sections of the mine, and the telephones should be kept always available for service.

10. Signal wires should not carry in excess of 24 volts.

Explosives and Blasting

1. Underground distributing magazines should be fire-resistant, theft-resistant and well ventilated.

2. Underground distributing magazines should be a safe distance from the working face, at least 25 feet from power lines, and a safe distances from haulageways.

Supervision and Discipline

1. Each foreman should have a certificate of competency from the Alabama Department of Industrial Relations, Division of Safety and Inspection.

2. The supervisory officials should record the results of their inspections in a book provided for that purpose. These reports should be read and countersigned by the mine foremen daily.

3. The company safety rules should be rigidly enforced.

4. Smoking should not be permitted in any coal mine, and employees should be thoroughly searched at frequent intervals to prevent smoking articles and matches from being carried into the mine.

5. A positive check-in-and-out system should be established whereby the identity of all underground employees can be established easily. Each underground employee should carry a metal identification check on his person while in the mine.

Fire Protection Underground

1. Suitable fire extinguishers should be installed on all locomotives, cutting machines, mechanical loading equipment and at all permanent electrical stations.

2. A supply of rock dust for fire-fighting purposes should be kept on both sides of all mine doors and at all permanent electrical stations.

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Respectfully submitted,

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Principal Safety Instructor

Jas. B. Benson
Senior Mining Engineer

H. N. Smith
Coal Mine Inspector

APPROVED:
D. HARRINGTON

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VICTIMS OF MINE EXPLOSION IN PRACO NO. 10 MINE
ALABAMA BY-PRODUCTS CORPORATION, PRACO, ALABAMA

	Name	Age	Dependents
1.	Seburn Wood	18	Single
2.	Francis Dill	23	Wife, 1 child
3.	Henry Bert Beacham	18	Single
4.	John Files	34	Wife, 3 children
5.	Lovell Cook	25	Single
6.	Olin Quinn	35	Wife
7.	Cleve Walker	44	Wife
8.	Henry Merritt	34	Wife, 1 child
9.	Fred Blackledge	46	Wife, 1 child
10.	Raymond Kemp	22	Single
11.	Mack Feltman	29	Single, 1 over 18
12.	Lexie Coste	28	Wife

Total number of dependents - 15, except in case of Feltman, all dependent children listed are under 18 years of age. Dependents over 18 are not listed.