FINAL REPORT OF MINE EXPLOSION
PURSGLOVE NO. 2 MINE, PURSGLOVE COAL MINING COMPANY
PURSGLOVE, MONONGALIA COUNTY, WEST VIRGINIA
JULY 9, 1942

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INTRODUCTION

A gas and coal-dust explosion occurred in the Pursglove No. 2 mine of the Pursglove Coal Mining Company, Pursglove, Monongalia County, West Virginia, at about 4:12 p.m., July 9, 1942. Twenty men were killed by burns and violence as a result of the explosion. A total of 73 men was in the mine at the time, and 53 escaped without assistance and without injury. Some of the men that escaped were not aware that an explosion had occurred, and the foreman from the 40 face north section did not learn of the explosion until he had traveled to the main haulage entry to investigate the cause of the electric power failure.

The main-automatic, electric-power, direct-current circuit breaker opened the circuit on the surface; however, the operation of the ventilating fan was uninterrupted.

The explosion was local in character and confined to the 20 and 24 bleeder sections. Indications of extreme violence were observed in the affected area, but relatively little property damage was sustained. The authors believe that the expansion of hot gases into a multiple set of entries, pillared area, and abandoned area outby the explosion area; the wetness of some of these areas; and the rock-dusted haulage entries localized the explosion.

The evidence, found following the disaster, indicates several possible causes, all of which have been investigated carefully. These possibilities are summarized in the body of this report. A possible origin, appearing to stand out more prominently than others, was a cave of roof located 200 feet inby 15 west entry on 20 bleeder entry that, from coke deposits on the roof of the cavity and on the caved material, indicated a fall had occurred prior to the explosion. The caved rock averaged about 8 inches in thickness and had a flat surface of about 300 square feet. The caving of this rock could have formed a cloud of highly inflammable coal dust (shown by tests) which could have been ignited when the fallen trolley wire contacted the rail.

The first notification of this disaster that was received by the Bureau of Mines was a telephone message to Mr. A.K. Bloom, Federal mine inspector, Morgantown, West Virginia, from Mr. A. Bryce, State mine inspector in that district.

Mr. Bloom advised Mr. G. W. Grove, of the Pittsburgh Bureau of Mines station, immediately after receiving this information. The latter notified Mr. W. D. Walker, Federal mine inspector, Fairmont, West Virginia, who arrived at the mine at 8:30 p.m. Messrs. Nairn, Federoff, and Null, Federal mine inspectors, Waynesburg, Pennsylvania, were also notified and arrived at the mine at 9:15 p.m. Messrs. Griffith and Kingery arrived from Pittsburgh, Pennsylvania at 11:30 p.m. Mr. G. W. Yeager, Federal explosives investigator, arrived at the mine some time earlier in the evening.

GENERAL INFORMATION

Location and Operating Officials

The Pursglove No. 2 mine is located on the Scotts Run branch of the Monongahela Railroad, in the town of Pursglove, Monongalia County, West Virginia, and is operates by the Pursglove Coal Mining Company. This company operated one other mine, developed in the Pittsburgh coal bed, which is opened by a slope and located in the same town.

The officials of the Pursglove Coal Mining Company are as follows:

Joseph Pursglove, Sr.	President	Cleveland, Ohio
David Pursglove	General Manager	Pursglove, W. Va.
Mike Molnar	Mine Foreman	Pursglove, W. Va.
Samuel Pursglove, 3rd	Safety Engineer	Pursglove, W. Va.
Albert Hood	Chief Engineer	Pursglove, W. Va.

Employees and Production

Approximately 297 men are employed underground and 65 men on the surface, working three shifts, and producing an average of 2,800 tons of coal per day. The mine has produced a maximum tonnage of 3,300 tons of coal in one day.

Type of Mine

The mine is opened by three drifts and one shaft. The drift entries are used for haulage and intake air courses. These entries are spaced about 150 feet and 215 feet apart. The shaft is 180 feet deep, is lined with concrete for 40 feet down from the collar, and is located about 7,200 feet from the drift portals. The shaft is used exclusively as an upcast airshaft and, with its present facilities, cannot be used as an escapeway from the mine.

Coal Bed

The mine is operated in the Sewickley coal bed that averages 60 inches in thickness, with an average of 54 inches in thickness in the affected area. The coal bed dips slightly to the northwest and is undulating. The coal is high-volatile bituminous, is friable, and has a well-defined cleavage.

A run-of-mine-coal analysis of a sample of coal taken from this mine, listed in T.P. 626 (Analysis of West Virginia Coals), on an "as received" basis, is as follows:

	Percent
Moisture	2.5
Volatile matter	34.3
Fixed carbon	52.0
Ash	11.2

This shows that the ratio of volatile to total combustible matter is 0.397. This ratio indicates that the coal dust is readily ignitible and will propagate an explosion.

Dust samples collected in 20 bleeder haulage and parallel entries, listed in table 2 as can Nos. B-778, J-764, K-773, M-718, K-765, and M-729, were subjected to ignitibility tests at the Bureau of Mines experimental mine laboratory at Bruceton, Pennsylvania.

All of these samples of dust ignited readily in these tests and it was necessary to add 65 percent of inert dust to M-729, M-718, and J-764; 70 percent to samples K-765 and B-778; and 80 percent to sample No. K-773 to prevent ignition. No. K-765 is a road grab sample, where the fall had been cleaned up, about 200 feet inby 15 west on 20 bleeder haulage entry; M-729, another road grab sample, was collected about 15 feet outby this point. Samples Nos. B-778, J-764, K-773, and M-718 were collected, in the standard way on the 20 bleeder haulage and parallel entries, nearby the point where sample No. K-765 was collected. These tests indicate that the dust in this area was ignitible and would propagate a coal-dust explosion.

A standard method is employed for making these tests as follows:

A small quantity of the dust to be tested is projected into an electric oven heated to a temperature of 700° C. or 1,292° F. If the dust ignites (explodes), inert dust (Fullers earth) is added incrementally until no ignition occurs. By this method, samples of combustible dust can be tested quickly, and their relative ignitibility and the necessary addition of inert to prevent their ignition can be determined.

UNDERGROUND MINING METHODS, CONDITIONS, AND EQUIPMENT

Method of Mining

The mine is generally laid out with reference to butts and faces. Main cross entries are driven in sets of two, three, and four, and are driven 14 to 20 feet wide on 40- and 60-foot centers. A modified Connellsville block method of mining is used in developing rooms, and room entries are driven 20 to 25 feet wide on 80-foot centers. Some pillars are recovered, and where pillars are extracted an effort is made to maintain an angle and extraction sequence.

The coal is undercut with nonpermissible-type mining machines, is blasted with permissible explosives and Cardox blasting devices, and is loaded with permissible mechanical loading machines which are not maintained as such.

The roof in the mine ranges from medium to good. Wooden crossbars, set on wooden posts, are used where bad roof conditions are encountered in entries. Posts with cap pieces and crossbars are used in rooms.

Printed rules and sketches are issued to employees and are posted on bulletin boards. These, however, are not fully complied with.

Ventilation and Gases

The mine is ventilated by a Jeffrey 4- by 12-foot, reversible, centrifugal fan, belt driven by a 2,200-volt, alternating-current, 50-horsepower electrical motor, located on the surface near the single-compartment, 14-foot-diameter, circular shaft. The fan installation is provided with "explosion" doors. The fan is offset and is connected to the shaft by a sheet-steel air duct about 25 feet in length.

The fan is operated exhausting and, at the time of the inspection, was producing 72,800 cubic feet of air per minute at a 1.4-inch water-gage pressure. During the inspection, the fan speed was increased and the fan is now producing 93,400 cubic feet of air per minute at a 2.2-inch water-gage pressure.

The air enters the mine through the three drift openings. Two splits of air are used, one split ventilating all active working places and some of the pillared and abandoned places on the right side of the main haulage entries. The other split ventilates all of the active workings and some of the pillared and abandoned areas on the left side of the main haulage entries.

The split of air ventilating the affected area traversed all of the inby active, pillared, and abandoned areas to the north and west of the main haulage

entry. The return air from these areas was circulated over the 20 north bleeder haulage entry to active pillar workings and was returned through the 24 north bleeder haulage entry, 15 west haulage entry to the intersection of 20 north haulage entry, and thence to the fan through the abandoned area outby 20 north haulage entry.

The mine is rated as gassy by the West Virginia Department of Mines.

The analyses of air samples collected at various points in the mine, following the explosion and after a portion of the mine had resumed operation, are shown in table 1.

Air measurements made and air samples collected at four different points, necessary to obtain the full volume of air, near the bottom of the upcast airshaft, show that the main return airways from this mine carry methane gas in percentages from 0.12 to 0.37. This indicates that the mine liberates 252,963 cubic feet of methane in 24 hours. Also, samples collected at Station A-6 (see mine map), from air that would normally have been intake air for the affected area, carried an average of 1.055 percent methane; the air reading at this point was 9,375 cubic feet of air per minute, indicating a gas liberation from the area traversed by this current of 142,425 cubic feet in 24 hours, or 61 percent of the total for the entire mine.

Drainage

There are several local sags in the strata throughout the mine in which water collects and there are some parts where the floor is wet; however, the mine is generally dry and dusty. Water is pumped to central collecting points by small electrically driven reciprocating pumps and then is pumped to the surface through boreholes, or is run by gravity through boreholes to the mining operations of the Pittsburgh coal bed, which underlies a portion of this mine but not the affected area.

Coal Dust

Much coal dust is produced during blasting, cutting, drilling, and loading operations. Considerable spillage of coal from mine cars also was observed along haulageways. All loose coal is not cleaned up at working faces and much fine dust, carried by the ventilating current, was deposited on the roof, ribs, and timbers. No water is used for allaying coal dust during any of the face or haulage operations.

To lessen the coal-dust ignition hazard:

1. Machine coal cutting should be wetted as the cutting is being done.

TABLE 1. - Analyses of air samples collected in Pursglove No. 2 mine
Pursglove Coal Mining Company
Pursglove, Monongalia County, West Virginia
July 9, 1942

Bot. No.	Location in mine	Percent				Cubic feet air per minute	Cubic feet methane in 24 hours
		Carbon dioxide	Oxygen	Methane	Nitrogen		
225	Station A-1	0.36	20.36	0.14	79.14	-	-
226	A-2	.51	19.54	.28	79.67	-	-
720	A-3	.11	20.78	.27	78.87	4,800	18,662
873	do.	.10	20.77	.27	78.86		
864	A-4	.08	20.69	.39	78.84	5,400	30,326
626	A-5	.11	20.66	.26	78.97	8,964	34,207
874	do.	.11	20.67	.27	78.95		
719	A-6	.11	20.52	1.01	78.36	9,375	142,425
730	do.	.12	20.53	1.10	78.25		
893	A-7	.17	20.65	.12	79.06	17,675	30,542
863	A-8	.48	19.98	.47	79.07	-	-
894	A-9	.14	20.63	.19	79.04	3,000	8,208
219	A-10	.15	20.63	.20	79.02	-	-
721	A-11	.18	20.66	.22	78.94	-	-
220	A-12	.25	20.41	.33	79.01	-	-
528	A-13	.27	20.35	.14	79.24	11,025	22,226
527	A-14	.27	20.45	.15	79.13	8,910	19,245
531	A-15	.21	20.53	.16	79.10	12,950	20,836
532	do.	.20	20.42	.37	79.01	13,800	73,526
625	A-15	.26	20.39	.28	79.07	34,300	138,297
729	do.	.24	20.50	.12	79.14	11,750	20,304
541	Full return at fan	.24	20.43	.25	79.08	72,800	267,321
542	do.	.25	20.47	.26	79.12		
543	Station A-27	.11	20.51	1.10	78.28	7,440	117,849
997	do.	.10	20.51	1.10	78.29	-	-

2. The face regions should be wetted before and after blasting.

3. Water should be sprayed on the coal pile while it is being loaded mechanically.

4. The coal face, and the working place 40 feet therefrom, should be wetted to allay the coal dust.

5. The mine cars should not be overloaded, allowing the coal to shake off during transportation.

6. The empty and loaded cars should be sprayed with water to prevent dust from being distributed along the haulageways.

The above practices are suggested to allay the dust at the point of its formation and elsewhere, and to prevent it from rising and being carried and spread widely by the air current. The use of water at the working face can best be effected by having water lines extend to each face and wetting the dust by spraying it with water from a hose. The installation of sprinklers along haulageways will prevent the blowing of dust from the tops of fast-moving trams.

Some hand rock-dusting has been done in active working faces. A low-pressure, track-mounted, rock-dusting machine, equipped with a 6-foot long, large diameter hose, is used to rock-dust haulage entries in which trolley conductors are installed.

Table 2 lists the analyses of dust samples collected in the affected area of the mine during the investigation. The locations of sampling points are shown on map S-114 in the appendix of this report.

Dust samples collected at points D-1, D-7, D-8, D-2, D-3, D-4, D-5, and D-6, all within the explosion area, range in combustible content from 50.4 to 81.9 percent. The roof-and-rib samples average 72.7 percent combustible and the road samples 73.4 percent combustible, with an overall average of 73.05 percent combustible. Also, the size tests on these samples show that from 19.7 percent to 69.6 percent of this dust will pass through a 200-mesh screen. The percentage of combustible and the extreme fineness of this dust would undoubtedly permit the ignition and rapid propagation of an explosion.

Dust samples collected at points (D-9, D-10, D-11, D-12) (D-14, D-15, D-16, D-17), and (D-18, D-19, D-20, D-21), all adjacent to the explosion area, range in combustible content from 2.6 to 77.6 percent. The roof-and-rib samples average 43.2 percent combustible and the road samples 61.6 percent combustible, with an overall average of 52.4 percent combustible. Some of the areas where these samples were collected had been rock-dusted, resulting in a lower combustible, higher incombustible, content of the dust. This condition is believed to have contributed materially in preventing the further spread of the explosion.

TABLE 2. - Analyses of dust samples collected in Pursglove No. 2 mine
Pursglove Coal Mining Company
Pursglove, Monongalia County, West Virginia
July 9, 1942

Can No.	Location in mine	Kind of sample	Percent			Amount coke particles present	Cumulative	Remarks
			Combustible V.M. + F.C.	Incombustible moisture + ash	Through 20-mesh		100 percent through 20-mesh percent through 200-mesh	
1/B-683	Station D-1	Roof & rib	50.4	49.6	89.0	Very large	59.0	Explosion area.
1/B-873	do.	Road	67.7	32.3	68.9	Large	19.7	do.
B-778	Station D-7	Roof & rib	72.7	27.3	92.6	Very large	-	do.
J-764	do.	Road	72.5	27.5	92.6	Large	-	do.
K-773	Station D-8	Roof & rib	73.8	26.2	93.4	Large	69.6	do.
M-718	do.	Road	72.1	27.9	68.4	Large	21.8	do.
K-899	Station D-2	Roof & rib	81.9	18.1	73.8	Large	19.9	do.
M-727	do.	Road	76.3	23.7	68.9	Large	20.1	do.
M-908	Station D-3	Roof & rib	77.8	22.2	78.1	Medium	50.6	do.
L-612	do.	Road	79.0	21.0	67.3	Medium	21.4	do.
E-877	Station D-4	Roof & rib	78.3	21.7	95.3	Medium	76.6	do.
H-981	do.	Road	74.1	25.9	70.4	Very large	23.2	do.
M-522	Station D-5	Roof & rib	75.0	25.0	81.0	Large	63.5	do.
M-509	do.	Road	78.5	21.5	64.3	Large	25.1	do.
1/M-776	Station D-6	Roof & rib	71.8	28.2	90.2	Medium	65.9	do.
1/K-646	do.	Road	66.9	33.1	55.2	Small	24.8	do.
1/J-523	Station D-9	Roof & rib	16.4	83.6	83.3	None	59.4	Bordering explosion area.
1/K-961	do.	Road	36.3	63.7	72.0	None	27.9	do.
1/J-593	Station D-10	Roof & rib	44.9	55.1	68.7	None	23.6	Explosion area.
1/K-638	do.	Road	74.0	26.0	44.0	None	-	do.
1/L-271	Station D-11	Roof & rib	26.6	73.4	75.9	None	51.4	do.
1/L-468	do.	Road	38.6	61.4	66.3	None	14.2	do.
1/J-506	Station D-12	Roof & rib	2.6	97.4	86.3	None	85.4	do.
1/M-645	do.	Road	62.8	37.2	64.1	None	-	do.

See footnotes p. 10.

TABLE 2. - Analyses of dust samples collected in Pursglove No. 2 mine
Pursglove Coal Mining Company
Pursglove, Monongalia County, West Virginia
July 9, 1942 (Cont'd.)

Can No.	Location in mine	Kind of sample	Percent			Amount coke particles present	Cumulative 100 percent through 20-mesh percent through 200-mesh	Remarks
			Combustible V.M. + F.C.	Incombustible moisture + ash	Through 20-mesh			
K-765	Outby fall on 20 bleeder haulage road	Grab	70.0	30.0	68.0	Medium	-	Explosion area.
M-729	Underfall on 20 bleeder haulage road	Grab	63.3	36.7	64.5	Medium	-	do.
Lab.No. B-82059	Deposit on roof in cavity from roof fall - haulage road, 20 bleeder section, 200' inby 15 butt	Grab	-	-	-	Medium	-	do.
1/M-906	Station D-14	Roof & rib	28.6	71.4	78.6	None	-	Adjacent to explosion area.
1/J-951	do.	Bottom	39.8	60.2	71.1	None	-	do.
I/M-879	Station D-15	Roof & rib	26.0	74.0	80.6	None	-	do.
I/J-966	do.	Bottom	47.4	52.6	70.3	None	-	do.
M-728	Station D-16	Roof & rib	70.2	29.8	73.4	None	-	do.
M-887	do.	Bottom	75.1	24.9	59.6	-	-	do.

See footnotes p. 10.

TABLE 2. Analyses of dust samples collected in Pursglove No. 2 mine
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July 9, 1942 (Cont'd.)

Can No.	Location in mine	Kind of sample	Combustible V.M. + F.C.	Incombustible moisture + ash	Through 20-mesh	Amount coke particles present	Cumulative 100 percent through 20-mesh percent through 200-mesh	Remarks
J-831	Station D-17	Roof & rib	75.4	24.6	58.7	-	-	Adjacent to explosion area.
F-956	do.	Bottom	77.2	22.8	55.1	-	-	do.
J-33	2/Station D-18	Roof & rib	71.5	28.5	53.6	-	-	do.
B-822	2/ do.	Bottom	62.7	37.3	33.7	-	-	do.
1/M-800	2/Station D-19	Roof & rib	13.2	86.8	73.8	-	-	do.
1/K-828	2/ do.	Bottom	52.0	48.0	68.1	-	-	do.
M-355	2/Station D-20	Roof & rib	74.6	25.4	70.0	-	-	do.
M-782	3/ do.	Bottom	74.3	25.7	24.3	-	-	do.
J-17	3/Station D-21	Roof & rib	79.4	20.6	31.7	-	-	do.
G-616	3/ do.	Bottom	77.6	22.4	15.5	-	-	do.

1/ rock-dusted.
2/ damp.
3/ wet.

The effect of rock-dusting can be observed by examining the dust samples of rock-dusted entries. The combustible content of these samples ranges from 2.6 percent to 44.9 percent, averaging 22.6 percent for roof-and-rib samples. Bottom samples ranged from 36.3 percent to 74.0 percent, averaging 50.1 percent combustible. The average of all rock-dusted samples was 37.1 percent combustible content. Comparing this percentage with the 73.5 percent combustible content of coal dust within the explosion area, it can be assumed that had this area also been rock-dusted, the explosion would have been local in extent and the loss of life may have been reduced.

Haulage

All hauling is done by trolley and cable-reel (single-conductor, trailing-cable) types of locomotives operating on 550 volts direct current.

Track gage is 48 inches, and the rails used on main entries are 50- and 60-pound, with 25-pound rails on producing entries and rooms.

Adequate and uniform clearance is not maintained, and manholes are not placed by doors and at regular intervals along haulage roads.

All trolley conductors in 20 and 24 bleeder sections and 15 west haulage were installed on return airways.

Coal is transported to the surface from one of the drift portals in 3-ton, metal-reinforced wooden cars and steel cars. Coal is dumped at the tipple by a rotary dump. Mine cars are not provided with brakes.

Lighting

Edison Model "K" electric cap lamps are used by all underground employees. Permissible flame safety lamps are used by all mine officials for inspecting and testing. These officials purchase and maintain their own safety lamps.

Persons designated as shot-firers and cutting-machine operators are not provided with flame safety lamps for gas testing.

Some points along the haulage system are lighted by means of incandescent electric lights, two lamps connected in series across the 550-volt, direct-current power circuit.

Explosives

Hercoal 1-C permissible explosives are used to break both coal and rock. Cardox blasting devices are used to break coal. Hercules No. 6 and

Atlas No. 6 electric detonators are used to detonate explosives Edison electric cap lamps, equipped with nonpermissible, exposed contact terminals are used to fire shots. Shots are fired singly and at any time during the working shift It was reported, however, that multiple firing is permitted and practiced when blasting small "stumps" of coal. The blasting out of these small blocks of coal weakens the roof and caving occurs, thus reducing the overburden stress in pillar extraction work Persons designated by the management as shot-firers carry the explosives to the face in open-top wooden boxes or rubberized canvas bags. The detonators are carried in small wooden boxes, in their original paper containers, or else in the pockets of the shot-firers' wearing apparel. Explosives and detonators are transported underground in an insulated explosives car, during the third or midnight working shift.

The explosives are stored on the working sections of the mine, in strong wooden boxes with hinged covers. These are provided with facilities for padlocking; however, none of the boxes was locked. On some of the sections, unaffected by the explosion, the hinged covers of magazines were found open. These magazines have a capacity of two 50-pound cases of explosives and they are away from the working faces and 25 feet or more from all electrical conductors. The electric detonators are stored in their original containers along the rib, or they are placed in empty explosives boxes that are nailed to posts. The detonators are kept some distance away from where the explosives are stored. The Cardox shells, size 2.31 - 130, are stored against the rib, usually anywhere in the working sections.

Electricity and Machinery Underground

The mine is completely mechanized and all machinery is operated by 550-volt, direct-current, electric motors, excepting three main water pumps that are driven by alternating-current motors.

The mine uses eight 7-BU and two 14-BU type Joy loading machines to load all coal. These machines are permissible type but are not maintained in a permissible condition. The coal is undercut by ten Jeffrey 35-B and 35-BB mining machines, none of which are in permissible condition.

One permissible-type, Chicago Pneumatic post-mounted drill and thirteen hand-held, nonpermissible, electric drills (consisting of 12 Chicago Pneumatic drills and one Jeffrey drill) are used to make boreholes in the coal. The drills are provided with fuse-type nips, but the fuse connections in some instances have been bridged with copper or iron wires. The entire fuse assembly in the drill casings has been removed and connections are made directly to the motor windings. The drill-motor, two-conductor, electric transmission cable is connected by a jack-type power connector, that is installed on the mining machine, and a separate single-conductor cable is used for the ground connection. The neutral conductor and the protective

ground wire connections are made by attaching them to the mining machine or to the track rails.

Both the loading-machine and the cutting machine cables are two conductor, rubber covered and are provided with fused nips; the track or neutral conductor is attached by a rail hook. Temporary splices are made by twisting or knotting together the conductors, and the conductors are insulated with friction tape One of the cables had twenty-three splices of this type.

The cable-reel locomotives were equipped with single-strand-cable conductors, that are covered with cotton braid The nips on trolley cable-reel locomotives are provided with a long copper wire extension for "stinging" along the trolley conductor, and these are not fused. On the low coal sections, it was stated that the regular practice is to use the nip or "stinger" when tramming.

There is no electrical conversion equipment installed underground. The electrical power enters the mine through a borehole and is conducted to the various sections by trolley and feeder conductors. The track-rail joints on the main haulageway have been electrically welded and serve as a neutral electrical conductor.

The electric power circuit for the sections consists of a trolley conductor supported on insulators, suspended from the roof, and a copper return wire parallel and adjacent to the track rails The mine track is not bonded. The neutral electrical conductor is spiked to the track rails at intervals.

"Jumper" wires are used in lieu of electrical switches and trolley frogs. These "jumper" wires are also used at some track turn-out switches, where very low roof is encountered, to bridge the trolley wire at these points The "jumper" wires were carried both overhead and under the track, and their terminals are usually hooked to the trolley conductor inby and outby the track switch. There were at least two of these "jumper" attachments in the explosion area The trolley conductors in the explosion area were installed in return air and had been extended in one case to within 20 feet of the face and active pillar workings.

GENERAL SAFETY CONDITIONS

First Aid and Mine Rescue

Approximately 80 percent of the employees working at the mine were trained in the Bureau of Mines methods of first aid several years ago; however, additional training in first aid has not been conducted in recent years.

There is one fully equipped, underground first-aid station located in a breakthrough along the main haulage entry, near the 20 north intersection. Two other first-aid stations, located elsewhere in the mine, are partially equipped.

Injured employees are taken to the doctor's office, which is located about 3/4 mile from the drift portal. The nearest hospital is located about 6 miles away, at Morgantown, W. Va

It is reported that about 50 men, now employed at the mine, have at some time completed a course in mine rescue training. The company does not maintain a fully equipped mine rescue station or mine rescue teams; however, 10 All-Service gas masks and 8 extra canisters, all in good condition, are kept in one of the office buildings on the surface. These gas masks were used during the exploratory work following the explosion.

The West Virginia Department of Mines maintains a fully equipped mine rescue station near Maidsville, West Virginia, about 5 miles from this mine, and also employs two mine rescue crews of six men each. These crews are given additional mine rescue training monthly

Safety Organization

A safety inspector was employed at the mine at the time of the disaster; however, it was reported that this man had only been employed for this job a few weeks prior to the explosion

No regular safety meetings are held and there is no active chapter of the Holmes Safety Association. Regular monthly meetings, of all mine officials, are held to discuss problems involving safe and efficient operation of the mine

From personal experience and information gleaned by interviewing the managing officials and other employees, the attitude toward safety, prior to this year, has been exceptionally good. In the past several months, however, there appears to have been considerable "let down" or laxity in precautionary measures and effort The present demand for coal, undoubtedly, is a contributing factor in the current more or less apathetic attitude toward safety.

Supervision and Discipline

The company employs a total of 33 mine officials at this mine, as follows: a mine foreman; a general assistant mine foreman; two night mine foremen; one safety engineer; one fire boss; and 27 other assistant mine foremen and facebosses. There is an assistant mine foreman or faceboss for about every ten employees. Not all of the facebosses have been certified by the West Virginia Department of Mines.

The number of officials at this mine appears to be adequate, but the proficiency and experience of some may be questioned

Fire Fighting

No fire-fighting organization is maintained and little or no fire-fighting equipment or facilities, excepting rock dust, are available in the event of an emergency.

PREVIOUS EXPLOSIONS IN THIS OR NEARBY MINES

So far as is known by the writers, this is the first explosion to occur in this mine. Two explosions have occurred in mines operating in the same coal bed, one in an adjacent mine and another at Arnettsville, West Virginia, a distance of about 8 miles. These are as follows:

Company	Mine	Location	Date	No. killed
Crown Coal Company	Yukon	Arnettsville, W Va.	3/26/30	12
Schriver Coal Company	Schriver	Pursglove, W. Va.	1/16/33	2

MINE CONDITIONS IMMEDIATELY PRIOR TO DISASTER

At the time of the explosion, 4:12 p.m , the weather was warm and clear.

The mine ventilating fan was operating normally The working crews had just arrived in their working sections It was 3 minutes before their regular starting time (4:15 p m.). The employees from the preceding shift had arrived on the surface. The day-shift assistant mine foreman from the 20 bleeder section (affected area) was talking via telephone, from the outside mine foreman's office, to the night mine foreman, who was underground at the telephone station, when the explosion occurred.

STORY OF THE EXPLOSION AND RECOVERY OPERATIONS

About 4:12 p.m., three minutes previous to the second shift's starting time, a concussion was felt, and dust was seen coming from the mouth of 20 north haulage entries, at the junction of the main haulage entry, by the night foreman. The night foreman was talking by telephone to one of the day-shift foremen who was at the outside mine foreman's office. The underground telephone station is located about 30 feet inby this junction. After a hurried investigation of the disturbance at the 20 north haulage intersection and vicinity, the night foreman immediately telephoned the foreman who was located on the surface and advised him that something serious, probably an explosion, had occurred in the 20 north sections. The night foreman was instructed by the mine foreman to open the trolley-conductor sectionalizing switches to all trolley and feeder power conductors inby that point. He was also instructed

to contact all other foremen in the mine immediately, remove all available men from the mine, and that help would be sent as soon as possible.

The men working in the south section of the mine felt a concussion, and at the same time observed that the electric power had been cut off; realizing that something serious had happened, these men started to walk outside.

The men working in the west section of the mine did not notice any unusual occurrence, but because of the electric power failure, the assistant foremen of the two sections went to the mine telephone station to determine the cause. When they arrived at the telephone, they were informed by the night foreman that an explosion had occurred and instructed to remove their men from the mine. Fifty-three men escaped uninjured and unassisted, by walking out of the mine.

A rescue party was immediately organized on the surface. This party, consisting of the safety director and six other company officials, entered the mine and joined seven other officials at the mine foreman's office, located about 2 miles inby the drift openings.

The night foreman attempted to reach the affected area by traveling 20 north entry haulageway, but found it impossible to reach the affected area because of afterdamp

A rescue crew, equipped with All-Service gas masks, started to explore the affected area by traveling the trackless and temporarily abandoned 24 north entries.

Messrs Alex Bryce, State mine inspector of the Department of Mines of West Virginia, stationed at Morgantown, and Federal mine inspector A. K. Bloom, of Morgantown, West Virginia, joined the rescue party about 9:00 p.m., near the working section on the 24 face bleeder entries.

The 15 west entries, and part of the 20 face bleeder entries, were explored. A burning cap piece was discovered on 15 west haulage entry and was extinguished.

Two bodies were found about 900 feet inby on the 24 bleeder haulage entry.

The remaining area of the 24 north bleeder entries was explored and 9 additional bodies were found. At this point of the rescue operations, Messrs. W. D. Walker, Federal mine inspector of Fairmont, West Virginia, and P. J. McGraw, State mine inspector of the West Virginia Department of Mines, Farmington, West Virginia, arrived and assisted with the recovery work.

The 20 face bleeder section was then explored and 8 other bodies were found. This made a total of 19 bodies located, with one missing. The work of recovering the bodies and searching for the missing body was accomplished by changing the ventilation and exploring the 20 north heading and 20 north bleeder haulage entries, by carrying the ventilation in advance of the recovery party.

The last body was located about 3:00 p.m., July 10, and all bodies were removed from the mine by 4:30 p.m. The working faces of the affected area are approximately 3 5 miles from the mine opening.

Three West Virginia State mine rescue teams arrived at the mine on the night of the explosion, but were not used during either the exploration or recovery operations

Other inspectors of the Department of Mines of West Virginia, who assisted in the recovery operations, were Messrs. P F. McLinden, inspector-at-large, and Joseph Bierer, N G. Dobbie, James Sharkey, and G. R. Waddell, State mine inspectors

The other Bureau of Mines representatives who assisted were Messrs. A J. Nairn, V D. Null, and J. T. Federoff, Federal mine inspectors, and F. E. Griffith, mining-electrical engineer, and D. S. Kingery, assistant mining engineer from the Pittsburgh station.

FORCES

Forces of the explosion are indicated on the map of the mine, a copy of which is contained in the appendix to this report. Evidence indicates that appreciable forces traveled outby the 24 bleeder haulage and parallel entries, and also inby to the pillared faces of these entries, carrying to the pillared faces of 20 bleeder section, and then both inby and outby along 20 bleeder haulage and parallel entries.

Much coke deposition was observed on timbers, roof, ribs, and on some machinery and equipment in the 20 and 24 bleeder sections. All roof, rib, and floor samples, shown in table 2, show large, medium, or small amounts of coke particles. These coke depositions and coke particles indicate that coal dust "played a major role" in the probable ignition and propagation of the explosion.

EXTENT OF FLAME AND VIOLENCE

The flame of the explosion, as shown on the mine map, was confined to the 20 and 24 bleeder sections and outby to include 15 west entries to the intersections of 20 and 24 bleeder entries. The violence extended over a wider area than the flame propagation, as shown on the mine map.

PROPERTY DAMAGE

The damage to the mine property consisted of blowing out all the wooden stoppings and doors on 15 west entry to the intersection of 20 and 24 bleeder entries, and several stoppings were destroyed outby 20 north haulage entry. These are indicated on the mine map.

The mine track, at several points in the affected area, was damaged and blown out of alinement.

Several mine cars, locomotives, and other machinery were blown off the track and some were damaged.

STATE INSPECTORS' CONCLUSIONS

A joint investigation of the disaster was conducted by representatives of the West Virginia Department of Mines and the United States Bureau of Mines. The investigators for the West Virginia Department of Mines were N. P. Rhinehart, chief; Peter F. McLinden, inspector-at-large; P. J. McGraw, Alex Bryce, M. G. Dobbie, inspectors; and P. M. Barlow, electrical inspector. The investigators for the Bureau of Mines are W. D. Walker, A. K. Bloom, coal mine inspectors; D. S. Kingery, associate mining engineer; and F. E. Griffith, mining-electrical engineer.

Following the investigation, and after a conference that was held in Franklin Hotel, Morgantown, West Virginia, on July 24, 1942, the State mine inspectors and Bureau of Mines representatives essentially agreed on the conclusions and most probable cause of the explosion.

SPECIAL INVESTIGATION CONDUCTED

A special investigation of the disaster was made by W. G. Wambsly, of the West Virginia State Police, Department of Criminal Investigation, to determine whether there was any possibility that the explosion may have been caused by sabotage.

Several specimens of material obtained from the explosion area were sent to the Edgewood Arsenal Experimental Laboratories, Edgewood, Maryland. These specimens were delivered to the Arsenal by Sergeant K. V. Shanholtzer, chemist, Chemical Identification Bureau, West Virginia State Police; Joseph Bierer, district mine inspector, West Virginia Department of Mines, Charleston, West Virginia; and A. K. Bloom of Morgantown, West Virginia, a Federal coal mine inspector.

The officer in charge of the Analytical Department viewed the specimens and stated that it could not be determined from the specimens presented

whether sabotage was indicated; consequently, no detailed examination was made of any of the specimens at the Arsenal.

SUMMARY OF EVIDENCE, PROBABLE CAUSE, ORIGIN, AND PROPAGATION

Some of the conditions which prevailed immediately before the explosion, and the salient facts found after the explosion, were:

1. The workmen in the affected area had been in their working sections only a short time before the explosion.

2. The explosion occurred approximately 3 minutes before men on that shift were scheduled to begin working

3. Insofar as could be determined, by careful inspection, no electrical equipment was operating in the affected area at the time of the explosion.

4. The trolley wire and the unbonded track, in one case, extended to within 20 feet of the working face.

5. The haulage, by electric trolley-pole locomotives from both of the affected sections, was in return air.

6. No coal was being blasted at or immediately before the time of the explosion.

7. No methane gas had been reported in the two sections for several weeks prior to the explosion, nor was any methane detected, with a flame safety lamp, by the assistant foreman when he made his rounds a few hours before the explosion.

8. During the recovery operations July 9 and 10, tests for methane were made in the affected sections by using a flame safety lamp. No methane was detected by this method. On July 11, a methane detector was used in the affected area and showed a maximum of 0 20 percent methane.

9 The air used to ventilate the explosion area was circulated over active, pillared areas and abandoned workings before reaching the affected area.

10. After mining operations had been resumed in other parts of the mine, air samples were obtained from the ventilating current which normally would have been coursing to the affected area. One of these air samples contained 1.10 percent methane.

11. All mining operations in the affected area were confined to pillar extraction work, and there was evidence of considerable pressure on pillars causing the floor to break in numerous places.

12. By using a methane indicator, Bureau of Mines investigators detected a maximum of 0.20 percent methane from floor-break crevices throughout the affected area. Air samples were taken from floor-break crevices by inspectors of the West Virginia Department of Mines, and were analyzed by Orsat apparatus. The Bureau of Mines was informed that one of these samples contained 1.4 percent methane. The Bureau of Mines tests, at the same locations, with a methane indicator were made at various times before and after air samples had been obtained by the State inspectors, and the Bureau of Mines tests showed a maximum of 0.20 percent methane.

13. Methane may be liberated suddenly from a break in the floor and may have been ignited by sparks from the unbonded track. This possibility, however, appears remote, since no electrical machinery was in operation at the time of the explosion and methane could be found only in small amounts

14. No gas or oil wells had been penetrated for some months prior to the explosion, and none was being encountered at the time of the explosion.

15. Two explosives magazines of small box type were located within the explosion area One magazine was destroyed and its explosives were scattered 100 feet from the magazine. Some of the explosives had burned. No craters were left to indicate the explosives had been detonated, nor was any debris impinged on the rib or roof to indicate explosives had been detonated. The nearest bodies were approximately 200 feet from the original location of this magazine A quantity of electric detonators was found near the rib, 80 feet inby the original location of the magazine.

The second magazine was damaged, and had been moved approximately 12 feet from its original location One 50-pound wooden explosives box was thrown about 3 feet from the magazine and had lodged against a post. The inside of this container was badly charred, and the coal beneath was coked several inches deep, indicating that the contents of this container had burned. Another box, nearly full of explosives, remained in the magazine. The contents of this box were not damaged or burned Some loose explosives were scattered around the magazine for a radius of 12 feet or more. Some of these had burned.

Detonators were stored around the corner of the rib from the second explosives magazine. These were scattered over a wide area and some had detonated. The body of a shot-firer was about 10 feet from the magazine, lodged against a post. This body was burned severely, but was not mutilated.

16. The combustible content of coal-dust samples collected ranged from 50 4 to 81.9 percent Ignition tests conducted on some of these samples indicated that this dust could be ignited readily and could propagate violently the flame of an explosion.

17. Three caves of roof occurred. Two of these occurred at the intersections of 20 bleeder haulage and the west parallel entries, the other at the third breakthrough inby on 20 haulage entry from the intersection. These locations are shown in detail map S-115 and S-116. (See appendix.)

The two caves of roof at the intersection, obviously, occurred after the explosion. This was indicated by the absence of debris, coke, or soot deposits on the caved roof material and in the cavities.

Debris, coke, and soot deposits were found on some of the fragments of the large boulder or "slab" of rock that caved at the third breakthrough on 20 bleeder haulage, and the cavity in the roof at this point has thin depositions of coke and soot similar to the roof inby and outby this location (by tests medium in amount of coke particles, Laboratory Test No. B-82059. See Appendix). The boulder had been broken and thrown off the track, during the initial recovery work, to facilitate the removal of bodies and materials by mine cars. The trolley wire had been pulled from the insulated hangers by the boulder, and a hole about 1/2 inch deep and 3/4 inch long, was fused in the ball of the track rail where the trolley wire presumably had contacted it. This fused spot on the rail was about 45 feet outby the caved boulder; also, the trolley conductor showed evidence of fusing, caused by an intense electric arc, about 10 feet outby the boulder. The track at this point showed no evidence of recent fusing; however, small depressions in the rail, caused by the action of an electric arc, could have been obliterated by the passage of mine cars and other equipment over this track before this point was investigated by the Bureau of Mines representatives.

From the foregoing, the writers conclude that the following is the most probable cause and origin of the explosion:

1. That the fall of rock from the roof at the third breakthrough on 20 bleeder haulage threw a cloud of coal dust into suspension in air contaminated with methane;

2. That when the rock fell, it caused a 550-volt trolley conductor to contact the track rail or parallel neutral electrical conductor;

3. That an electric arc resulted and that this arc ignited the coal-dust, gas, and air mixture, causing an explosion which was propagated to other areas by coal dust.

LESSONS LEARNED FROM THE CONDITIONS AS THEY RELATE TO THE EXPLOSION

In the opinion of the writers, there are three outstanding lessons learned from this explosion. These are:

1. That this explosion again emphasizes the need for adequate rock-dusting in all bituminous-coal mines.

2. That, in gassy mines, active working places should not be ventilated by air that has passed over other active or abandoned workings.

3. That all trolley and feeder conductors, and electrical machinery other than permissible types, should be installed and operated in pure air only.

RECOMMENDATIONS

The following recommendations are made with the belief that their adoption will materially lessen the chances of an explosion occurring in this mine in the future:

Ventilation

1. The ventilation system of this mine should be changed to eliminate haulage on return air.

2. Ventilation near face regions should be improved, keeping all but the last breakthrough closed with incombustible stoppings and conducting air to the face of workings with line brattice where necessary.

3. Mining-machine and loading-machine crews should be equipped with permissible flame safety lamps, and be required to make frequent tests for gas.

4. Some auxiliary source of power should be provided for the fan to serve in the event of power failure.

5. The ventilating system should be split to provide each separate loading crew with an individual split of air.

6. Doors should be eliminated, so far as possible, by the use of overcasts, and where doors are used, they should be hung in pairs to form air locks.

7. All stoppings should be constructed of incombustible material.

8. Abandoned or worked-out areas of the mine, that cannot be thoroughly ventilated and inspected, should be sealed with tight incombustible stoppings.

9. An additional shaft should be located near the advance workings to improve ventilation and to provide an additional escapeway.

Coal Dust

1. Water should be used on cutting machines and loading machines, before and after blasting, and on loaded cars, to allay coal dust.

2. Accumulations of coal dust should be promptly cleaned up and loaded out.

3. Rock dust should be applied along all airways, entries, haulageways, rooms, and crosscuts to within at least 40 feet of the working face, in sufficient quantities that the incombustible content will be at least 65 percent.

4. Rock-dust samples should be collected regularly throughout the mine and analyzed to determine when redusting is necessary.

Explosives

1. All shots should be fired with permissible shot-firing devices.

2. Underground storage boxes or magazines should be kept locked at all times, except when in use.

Electricity

1. All electrical equipment used at or near the face should be permissible type, and should be maintained in permissible condition.

2. Trolley or cable-reel locomotives should be operated only in pure air, and should not be operated beyond the last open breakthrough.

3. The trolley or feed wire should not extend beyond the last open breakthrough nor extend closer than 150 feet of the pillar workings.

4. All underground electrical equipment should be protected against overload.

5. Splices in trailing cables used underground should be made mechanically strong, electrically continuous, and well insulated.

6. The practice of nipping or "stinging" by men operating cable-reel locomotives should be prohibited.

7. Haulage tracks should be bonded at each joint, with crossbonds spaced at least every 200 feet, and at switches.

8. The use of "jumper" wires in the trolley and feeder systems should be discontinued.

9. Permissible junction boxes should be used when making power connection at the working faces.

General

1. Where pillars are extracted, they should be mined in sequence so that an even pillar line can be maintained.

2. The roof of all haulage and traveling ways should be carefully examined for loose material at least once each working shift, by an official. Any loose material found should be promptly taken down or secured.

NOTE: A Safety Inspection Report will be submitted and supplementary recommendations will be made.

ACKNOWLEDGMENT

The writers wish to acknowledge the courtesies extended and the help given by the officials of the Pursglove Coal Mining Company, who gave, without reservation, information requested in connection with this investigation.

The cooperation of Mr. N. P. Rhinehart, Chief of the West Virginia Department of Mines, and of the several State mine inspectors who were present, is also hereby gratefully acknowledged.

Respectfully submitted

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Senior Coal Mine Inspector

A. K. BLOOM
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D. S. KINGERY
Assistant Mining Engineer

Approved:

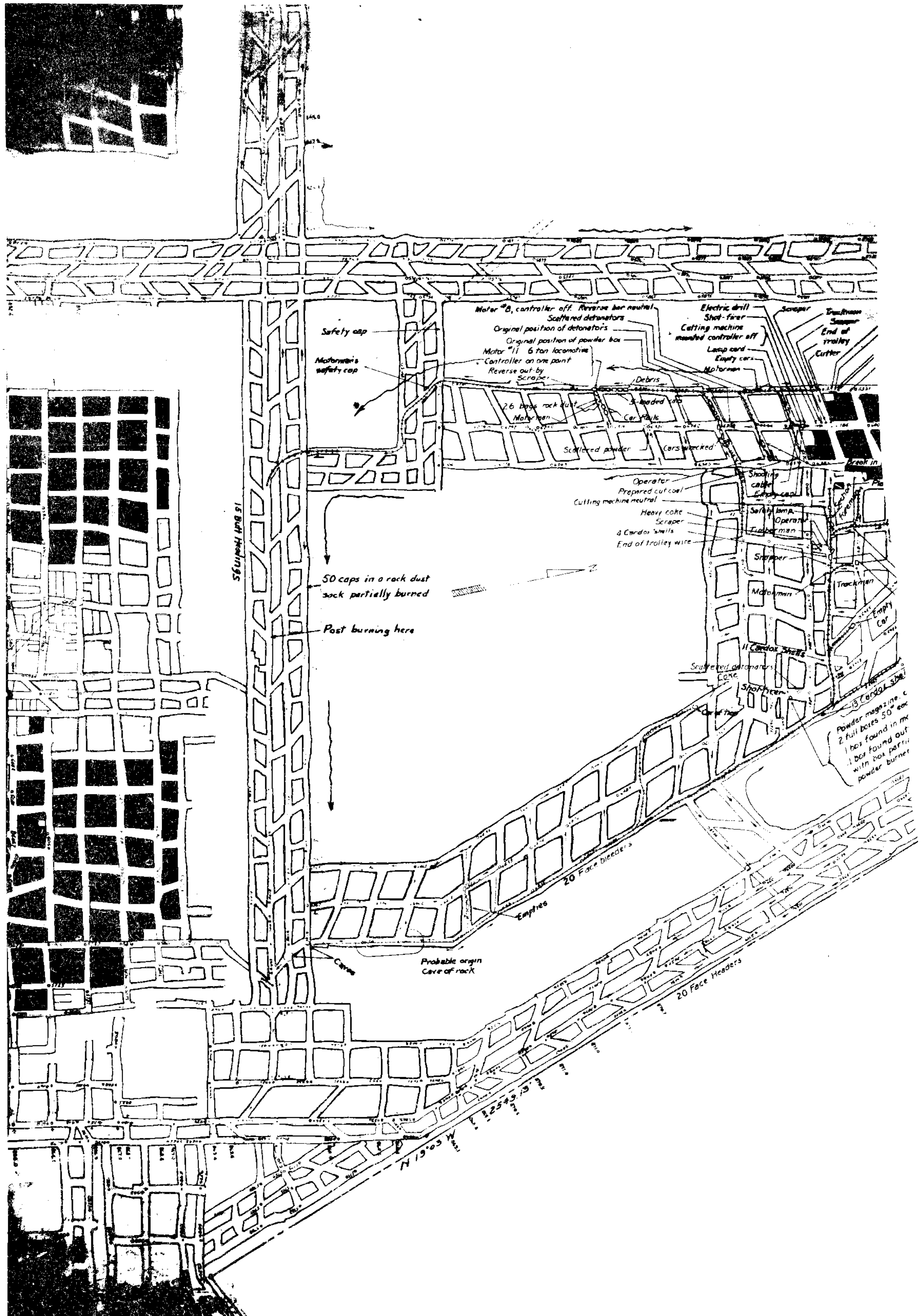
E. H. DENNY, Chief
Coal Mine Inspection Division

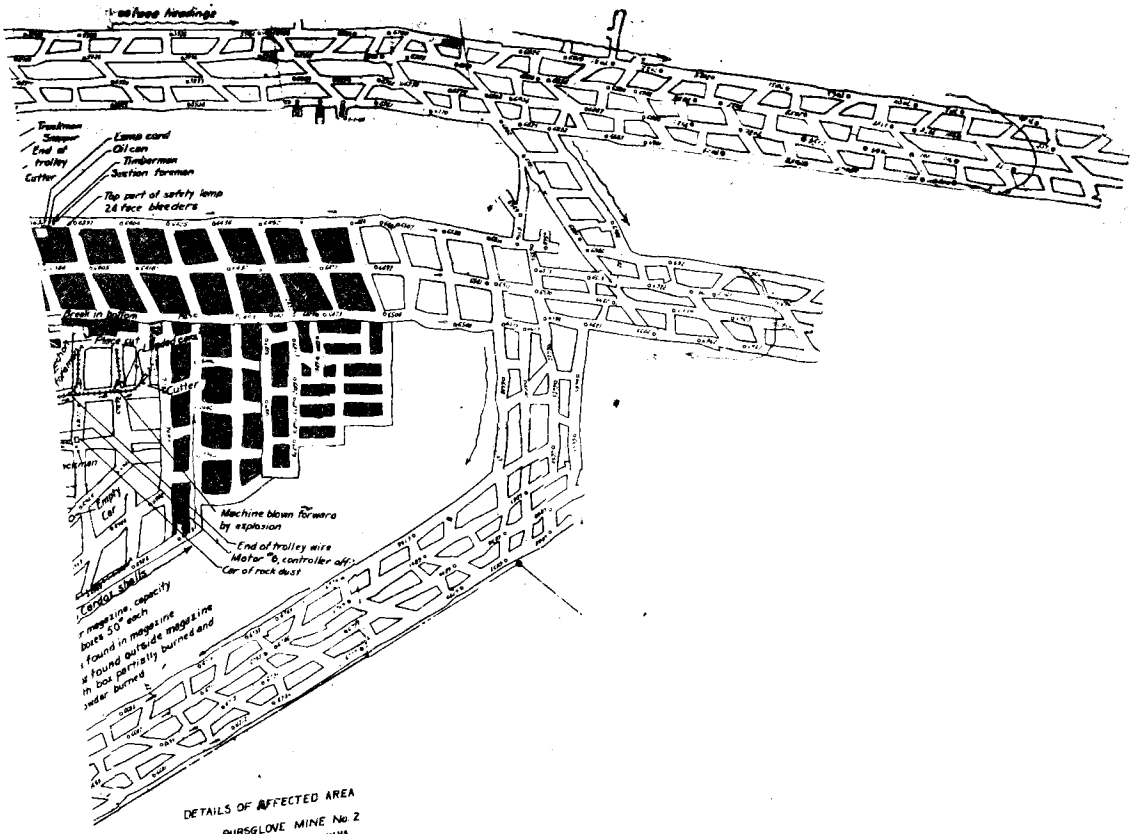
D. HARRINGTON, Chief
Health and Safety Branch
EC 8/8/42

APPENDIX A

APPENDIX B

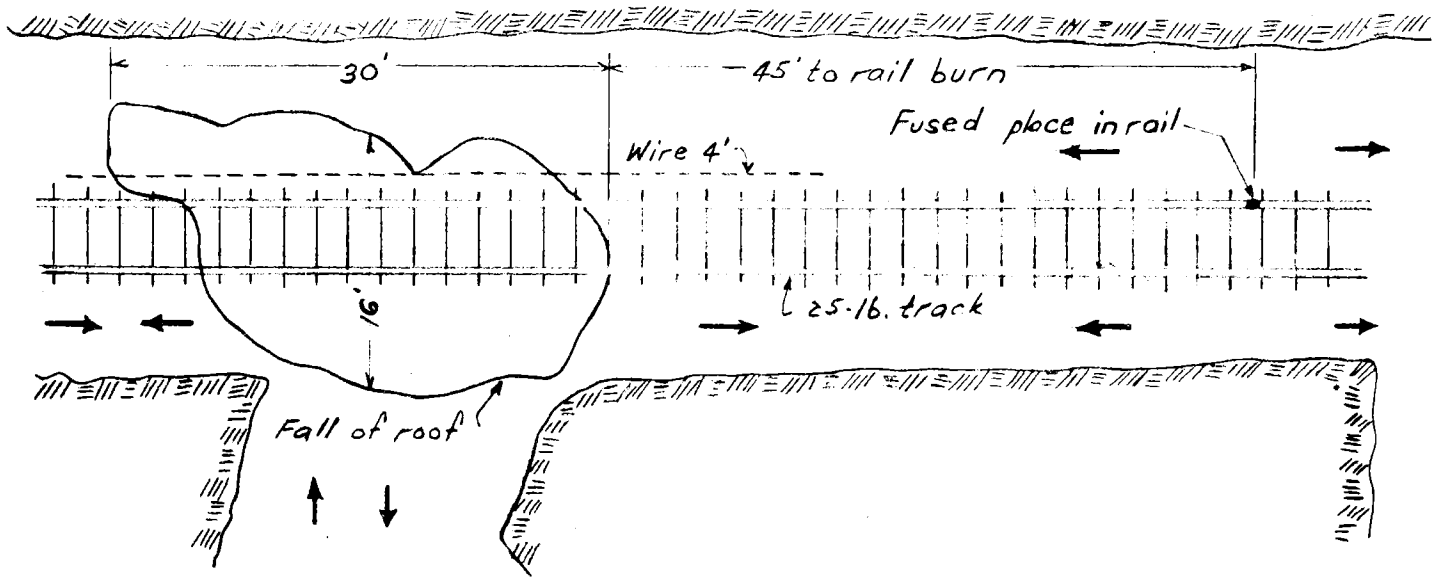

Single compartment Shaft
Drift opening
THE PURSGLOVE COAL MINING COMPANY
A-13
A-14
Too wet
D-12
D-11
D-10
FLAME AREA
A-27
A-6
A-12
A-11
D-23
D-22
D-8
D-9
Overcast
A-7
D-7
D-2
D-3
D-4
A-9
A-10
D-6
A-5
A-4
D-5
D-20
D-21
D-19
D-18
D-16
D-17
A-25
LIMIT OF FORCES
A-16
A-18
A-19
LEGEND
D-10 Dust sample. A-10 Air sample.
Limit of forces. Flame area.
Direction of ventilation.
PURSGLOVE No. 2 MINE; PURSGLOVE, W. VA.

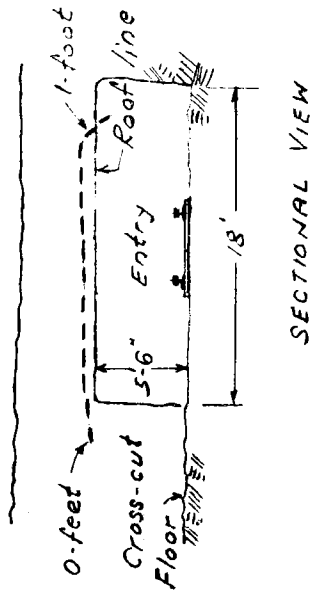

Motor #8, controller off. Reverse bar neutral
Scattered detonators
Original position of detonators
Original position of powder box
Motor #11 6 ton locomotive
Controller on one point
Reverse out-by
Scraper
Debris
26 bags rock dust
5-loaded cars
Motorman
Car Rails
Scattered powder
Cars wrecked
Electric drill
Shot-firer
Cutting machine
mounted controller off
Lamp cord
Empty cars
Motorman
Scraper
Trackman
End of
trolley
Cutter
Break in
Operator
Prepared cut coal
Cutting machine neutral
Heavy coke
Scraper
4 Cardox shells
End of trolley wire
Shooting
cable
Safety lamp
Operator
Timberman
Scraper
Trackman
Motorman
Empty
Car
11 Cardox Shells
Scattered detonators
Coke
Shotfirer
13 Cardox she
Safety cap
Motorman's
safety cap
15 Butt Headings
50 caps in a rock dust
sack partially burned
Post burning here
20 Face bleeders
Empties
Caves
Probable origin
Cave of rock
20 Face Headers
N 19°05' W



DETAILS OF AFFECTED AREA
PURSGLOVE MINE No. 2
PURSGLOVE W.VA.

APPENDIX C





Enlarged sketch of fall location, probable locus of explosion.
Pursglove No. 2 Mine; Pursglove, W. Va.