Reports

Belle Ellen #2

R E P O R T

on

BELLE ELLEN NO. 2 MINE EXPLOSION

BESSEMER COAL IRON & LAND COMPANY

FEBRUARY 2, 1922

by

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Birmingham, Alabama,
May 1, 1922.

I N D E X

INTRODUCTION

A gas explosion occurred about 2:15 p.m. February 2, 1922 in Belle Ellen No. 2 Mine operated by the Bessemer Coal Iron & Land Company, Belle Ellen, Alabama, and resulted in the death of nine colored miners and slightly injuring two others. The explosion originated near the face of the first left aircourse and according to the evidence collected was caused by ignition of an accumulation of gas by open carbide lamp. The explosion was confined to the first left off the ninth right entry. The mine was in full operation at the time of the explosion with approximately 200 men underground. This mine is worked with convict labor under contract with the State of Alabama. Free labor is used for the more important positions such as mine foreman, fire bosses, under foreman and the like.

Location: Belle Ellen No. 2 mine is situated about one-quarter mile north east of Belle Ellen, the railroad station. The mining camp of Belle Ellen is situated in the northeastern part of Bibb County, Alabama, on a branch of the Southern Railroad which leaves the main line at Ardella, approximately 38 miles south of Birmingham. The route is via Birmingham Mineral (L & N R.R. Co.,) which uses the Southern tracks from Gurnee Junction to Blocton.

Ownership and Operators: Belle Ellen No. 2 Mine is owned and operated by the Bessemer Coal Iron & Land Company. This company has offices in the American Trust and Saving Bank Building, Birmingham, Alabama,. The officials of the Company are:

H. L. Badham, President,

W. C. Hutcheson, General Manager,

J. R. Pruett, Superintendent,

G. D. Cummings, Mining Engineer,

W. F. Belcher, Mine Foreman,

Geology: Belle Ellen mine is located in the Cahaba coal field of the Birmingham District. The mine is working the Youngblood seam which is one of the many coal beds found in the Cahaba field. The bed averages 32 inches in thickness and is a good grade bituminous. About 400 feet above the Youngblood seam is the Woodstock seam which will average about 36 inches and 400 feet above the Woodstock seam is the Thompson which will average in the neighborhood of 72 inches. The mine is opened by a slope which at the portal pitches about 23 degrees and flattens at 6600 feet from the portal. The cleat is not very well defined. Faults are not frequent but rolls occur in the bed quite often. The roof proper is sandrock, while the immediate roof is a fairly hard slate and will approximate 11 inches in thickness. The bed varies from 26 to 40 inches in thickness. The principle impurity in the Youngblood seam is a three inch rash which lies in contact with

slate roof.

Table I gives five typical sections of the coal bed as measured.

TABLE I

Sections of Coal Bed, Belle Ellen No. 2 Mine.

Measured by E. B. Sutton.

Can No. Lab. No.	345 26276		361 26277		56 26278		20258 26279		428 26280	
	Ft-	In	Ft-	In	Ft-	In	Ft-	In	Ft-	In
Roof: Sandstone.										
x Rash	0	3	0	3	0	4	0	2	0	3
Coal	3	4	2	9	2	0	2	8	0	10
Mother coal	-		-		-		-		0	1
Coal	-		-		-		-		0	11½
Floor: Fireclay.										
Thickness of bed.	3	7	3	0	2	4	2	10	2	4½
Thickness of coal sampled	3	4	2	9	2	0	2	8	2	1½

(x) Excluded from sample.

Coal Analyses: Under date of October 10, 1916, the coal bed at this property was sampled by E. B. Sutton, mining engineer, U. S. Bureau of Mines at five representative locations. The analyses were made by A. C. Fieldner, Chemist, U. S. Bureau of Mines, in the Bureau's coal laboratories, Pittsburgh, Pennsylvania. The results are given on both " as received" and " air dried" basis.

ANALYSES OF COAL SAMPLES TAKEN FROM BELLE ELLEN NO. 2 MINE.

TABLE II.

Lab. No.	Symbol	Moisture	Volatile matter	Fixed Carbon	Ash	S.	B.T.U.	Location
26276	a	2.72	34.74	57.87	4.67	1.33	14218	Face 19th S
345	b	1.15	35.30	58.80	4.75	1.35	14449	heading.
26277	a	2.70	35.60	55.90	5.71	1.41	14083	Face 22nd N
361	b	1.20	36.15	56.85	5.80	1.43	14301	heading.
26278	a	2.58	35.67	56.15	5.60	1.27	14024	Face 2nd C
56	b	1.25	36.15	56.92	5.68	1.29	14216	off 23 N heading.
26279	a	2.54	34.91	57.72	4.83	1.17	14269	Face Room 70
20258	b	1.05	35.45	58.60	4.90	1.19	14488	18 N heading.
26280	a	3.39	33.08	58.59	4.94	1.49	14143	Face of 19
428	b	1.15	33.85	59.95	5.05	1.52	14470	N. heading.
26281	a	2.71	34.67	57.43	5.19	1.26	14373	Composite Analyses for
	b	1.08	35.25	58.39	5.28	1.28	14395	samples, 26276-26280.

a-= Coal " As received"
b = Coal " Air Dried"

It will be noted by referring to the foregoing table of analyses that the moisture content ranges between 2.54% and 3.39% on " as received" basis; volatile matter 33.08% to 35.67%; fixed carbon 55.97% to 58.59%; ash 4.67% to 5.71%; sulphur 1.17% to 1.49%; B.T.U. ranges from 14143 to 14218.

Roof and Floor: The roof proper is sandstone, while the immediate roof is slate. The roof stands remarkably well and requires very little timbering except in gob entries. Fully 50% of the perimeter in brushed entries is rock surface. The floor is a medium soft and

smooth fire clay.

Production and Employment: At the time of this investigation the mine worked two shifts employing convict labor. Two hundred men were employed underground on the day shift, fifty on the night shift and fifteen men were employed on the surface. According to the State Mine Inspector's report for the year 1920, 163,294 tons of coal were produced in 310 working days by 264 men; or the average daily output for the year 1920 was 526 tons. For the year 1921, 297 men produced in 301 working days 125,943 tons giving an average daily production of 418 tons. For the years 1920 and 1921, the tonnage per man per shift averaged 2 and 1.5 tons respectively.

Mining Methods: Belle Ellen No. 2 mine is opened by a slope that varies in pitch from 23 degrees to 0 degrees. At an approximate distance of 6600 feet from the mine portal, the coal bed is practically flat. The slope is laid with double track and averages sixteen feet wide. The mine is developed by the ordinary room and pillar system and is not laid out with reference to butts and faces. The distance between level and cross entries averages 250 feet. The width of main and side entries is 9 feet. Rooms are driven about 30 feet wide for and average depth of 200 feet with an intervening pillar of 40 feet.

Main entries are driven wide and gobbed with roof brushings. Aircourses are driven about nine feet wide and are not brushed. Coal is shot from the solid with permissible explosives. In narrow work a cutting of 2½ to 3 feet is placed by pick to relieve the shots. Four to eight lines of props spaced at three foot centers are used for timbering in rooms. Entries do not require timbering to any extent but it is practice to place a few lines of props in gob entries.

Haulage: Coal is hauled by mules and ropes in loose gate wooden cars. Empty cars weigh about 1500 pounds and hold about 2,000 pounds of coal. The track gage on main and side entries is 36 inches, weight of rails 30 pounds. Wooden rails are used in room work. Cars are not " topped" excessively but there is considerable spillage thru insecure and loose ends of cars. Coal is hauled to the surface by 20" x 48" first motion "Hardie -Tynes engine," and washed by a Montgomery washer.

Lighting: The miners all use open carbide lamps. Electric lights are used at main partings and at infrequent intervals along main haulage entries.

ANALYSES AND SIZING TESTS OF ROAD DUST SAMPLES ON "AS RECEIVED BASIS" TAKEN FROM BELLE ELLEN NO.2 MINE.

TABLE III.

No.	Lab. No.	Ratio V.M./F.M.+F.C.	Moisture	Ash	Moist-plus Ash	Wgt sample grams	% on 20 mesh Rejected	% thru 20 M Analyzed	Wgt thru 20 M grs.	% thru *48 mesh	% thru *100 mesh	% thru *200 mesh	Remarks.
1	84176	.380	2.6	26.8	29.4	1260	30.0	70.0	882.0	59.9	38.4	22.2	Outside explosion zone 1st L off 9th Right.
2	84177	.377	2.9	24.2	27.1	1280	27.8	72.2	924.0	62.6	40.6	22.0	Outside explosion zone 1st L off 9th Right.
3	84178	.373	2.6	22.3	24.9	1268	25.1	74.9	950.0	62.9	39.8	22.0	Near Border explosion zone, 1st L off 9th Right.
4	84179	.377	3.5	26.3	29.8	1340	33.4	66.6	892.5	58.6	34.5	15.6	Within explosion zone off 9th right.
5	84180	.388	3.2	37.9	41.1	1797	37.2	62.8	1128.0	64.7	41.4	24.2	Within explosion zone, ribs 1st L off 9th Right.
6	x84181	.371	2.5	25.0	27.5	245	20.8	79.2	194.0	74.8	56.4	32.9	Within explosion zone ribs 1st L off 9th Right.
7	84434	.381	5.7	28.8	34.5	1654	46.3	53.7	888.0	42.7	18.6	6.4	Roadway 5th L off 22nd N without explosion zone.
8	84435	.374	3.9	18.9	22.8	1249	30.6	69.4	867.0	54.5	31.5	14.9	Roadway 10th Right off new slope.
9	84436	.384	3.1	31.8	34.9	1291	32.4	67.6	872.0	54.9	31.6	16.3	Roadway 22nd N at 27th N.
10	84437	.384	5.6	27.5	33.1	1131	31.5	68.5	785.0	52.4	28.6	15.1	Roadway 22nd N bet 5th Right & 5th L.

TABLE III. (continued)

No.	Lab. No.	Ratio V.M. / F.M.+F.C.	Moisture	Ash	Mositplus Ash	Wgt sample grams	% on 20 mesh Rejected	% thru 20 M Analyzed	Wgt thru 20 M grs.	% thru *48 mesh	% thru *100 mesh	% thru *200 mesh	Remarks.
11	84438	.373	4.6	28.4	33.0	1400	31.9	68.1	953.0	52.7	33.1	19.3	Roadway 10th Left off new slope.
12	84439	.381	4.4	29.1	33.5	1193	27.2	72.8	868.0	61.5	38.5	19.4	Roadway 3rd Left off 22nd N.
13	84440	.379	4.9	24.2	29.1	1162	26.9	73.1	849.0	62.4	39.7	22.2	Roadway new slope bet- 7 & 8 Right.
14	84441	.385	3.4	32.2	35.6	1440	27.0	73.0	1051.5	57.5	37.9	21.8	Roadway 6th Left off 22nd N.
15	84442	.411	5.6	42.9	48.5	1195	23.0	77.0	920.0	59.7	36.3	20.0	Roadway 5th Right off 22nd North.
16	84443	.391	10.9	39.0	49.9	1135	58.1	41.9	1378.0	13.6	5.3	2.8	6th Right Roadway off 17th N.
17	84444	.388	5.6	31.9	37.5	1118	21.4	76.6	879.0	62.4	39.6	22.2	Roadway 3rd Left off 22nd North.
18	84445	.374	3.1	23.6	26.7	1469	30.1	69.9	1026.5	59.4	38.8	21.3	Roadway 9th Right off new slope.
Average		.382	4.3	28.9	33.2	1257	31.2	68.8	905.6	56.5	35.0	18.9	

Note: The foregoing road dust samples were collected in the mine under normal operating conditions.

x Rib dust samples taken from ribs estimated area 60 square feet.

* The percentages thru 48, 100, and 200 mesh screen are cumulative percentages; the weight thru 20 mesh screen represents 100%.

Road Dust: During the course of the investigation of Belle Ellen No. 2 mine, 17 samples of road dust and one sample of rib dust were taken at representative locations thruout the live working places of the mine. By referring to Table III it will be noted that sample Nos. 1 and 2, Lab. Nos. 84176 and 84177 were taken in the 1st left off 9th right just outside of the explosion zone. Nos. 3, 4, and 5, Lab. Nos. 84178, 84179, 84180, respectively, were taken at the border and within the explosion area. No. 6, Lab. No. 84181 was a sample of rib dust taken within the explosion area in the 1st left off 9th right entry. Sample No. 7 to No. 18, inclusive, Lab. Nos. 84434 to 84445, inclusive, respectively were taken along roadways without explosion area in other live sections of the underground workings. Table III gives the analyses together with the sizing tests of all samples taken. The roadways in the 1st left off 9th right were found to be dry on days of the investigation and road dust was fully 2 inches deep, The roadways in some sections of the mine were damp to wet, while others were fairly dry.

The Bureau's experiments in relation to the explosibility of coal dust have demonstrated that the principle factors that determine the explosibility of coal dust are: fineness, ratio of volatile matter to fixed carbon and percentage of non-combustibles present. Coal dust that is too fine to go thru the 20 mesh sieve is considered non-explosive but coal dust that will go thru a 20 mesh sieve is explosive and its relative sensitiveness to explosibility is increased by increasing the percentage of coal

finer than 20 mesh, that is to say, coal dust all passing thru 20 mesh and having a certain amount that will pass a 100 or 200 mesh is more explosive in proportion to the percentage of 100 or 200 mesh dust present. Pittsburgh coal dust that passes 20 mesh and has as much as 30% of 100 mesh dust present, produces a strong explosion but when all passes 100 mesh and has 30% of 200 mesh, the explosion is violent and the violence increases as t the percentage of 200 mesh is increased.

The ratio of volatile matter to the fixed carbon is an index of the ease of the explosibility of coal dust - the higher the volative matter the more easily the dust is ignited. The average ratio of volatile matter to fixed carbon for all samples collected is .382 and since the average incombustibles (moisture plus ash) is not more than 33.2%, the samples all fall, with the possible exception of No. 15, Lab. No. 84442, within the zone of explosibility when compared with Pittsburgh coal dust that has a ratio of .40. To render this dust non-explosive, there should be added either sufficient rock dust to bring the total inert material up to 80% when there is as much as 2% gas present, or sufficient water should be added to bring moisture content between 15 or 20%. When coal dust has little shale dust mixed with it, the dust should be made wet until it is a pasty mass. Referring to Table III, road dust sample No. 10 Lab. No. 84437 as being fairly representative of normal dust conditions, it would be necessary to add about 47% of rock or shale dust or about 10 to 12% of moisture.

Rock Dusting and Rock Dust Barriers: There is no method for rendering road dust inert by application of rock or shale nor are rock dust barriers used for the possible isolation of an explosion in this mine.

Explosives: Permissible explosives, primed with cap and fuse, are used for blasting coal and rock. About 225 pounds of explosives are used daily to produce an average daily output of 425 tons. Shooting is done by the miners at any time during the shift. Clay tamping dug from fire clay bottom is used for stemming. Drill holes average 1½ inches in diameter and are usually charged with one stick of permissible. Explosives are carried into the mine in sacks and kept generally in locked boxes. Miners (convicts) are only given enough explosives for the days task.

Dust and Sprinkling: Generally speaking this mine is naturally dry. This fact is substantiated by reference to table III which shows the average moisture content for all road samples taken at 4.3%. It will be noted that moisture in road samples taken along roadway of the first left off 9th right entry, the explosion zone, shows the maximum moisture content to be 3.5%. Sample number 6, laboratory No. 84181, rib dust sample taken from ribs of the 1st left entry shows a moisture content of 2.5%. It will be further noted that samples 7 to 18 inclusive, taken at representative places in other live working sections that the moisture content ranged from 3.1% to 5.7% and in one instance was 10.9%. It was observed that ribs,

roof and roadways in the effected section on days of the investigation were dry. Sprinkling in the effected section was done in a desultory way by cars, while in other parts of the mine sprinkling is done by hose at infrequent intervals. There appears to be no systematic arrangement for sprinkling. In order for sprinkling to be most effective, ribs and roof in entries as well as rooms should be washed clean of all dust accumulations and roadways made wet to a pasty mass at frequent intervals.

Ventilation: For details as to method of ventilating Belle Ellen No. 2 mine refer to map which is a part of this report. The mine is ventilated by two centrifugal fans, Buffalo Blower type, one known as the north fan and the other the south fan. At the time of the explosion both fans were exhausing.

The main hoisting slope serves as the main intake. The mine is ventilated on a combination of the split and continuous system. Under date, February 4, the quantity of air returning from the southside fan measured 55,200 cu. ft. as against 40,145 cu. ft. for the northside fan. In other words, approximately 100,000 cu. ft. of air was returning from the mine workings at the time this investigation was conducted.

Gob stoppings built of two rock walls, approximately 4 feet apart, filled and faced with a mixture of clay and cement; canvas brattices, overcasts, and single doors were the means used to course and deflect air currents.

TABLE NO. IV

ANALYSES OF MINE AIR SAMPLES TAKEN FROM BELLE ELLENN NO. 2 MINE.

Lab. No.	Date	Location	Q	CO_2	O_2	CO	CH_4	N_2	Remarks.
16371	2/16/22	Return a.c. 10th left new slope.	3710	.27	20.44	.00	.28	79.01	
16372	2/16/22	22nd North Main Return.	10900	.25	20.42	.00	.26	79.07	
16373	2/16/22	22nd North Ret- 7th left.	16200	.20	20.76	.00	.14	78.90	
16369	2/17/22	Return 6th Rt. a.c. off 17th North.	2300	.37	20.22	.00	.07	79.34	
16370	2/16/22	New Slope Return from 9 & 10 Rts.,	10000	.20	20.55	.00	.26	78.99	
16186	2/4/22	25' outbye last c.c. left a.c. Return from 1st left.	1400	.13	20.77	.00	.14	78.96	
16187	2/4/22	Face blind c.c. 1st left off 9th Right.	no air movement	.15	20.63	.00	1.01	78.21	35' inby last open c.c. no line curtain used to carry air.
16189	2/4/22	Main Return from S.S. in manway near upcast.	55200	.27	20.50	.00	.07	79.18	
16190	2/4/22	Main return from southside in manway inbye from upcast.	55200	.27	20.48	.00	.07	79.18	
16191	2/4/22	Main slope a.c. North side.	40145	.22	20.62	.00	.01	79.15	
16193	2/4/22	In cavity near face 1st left a.c. off 9th Right.	no air movement	.13	18.15	.00	9.85	71.87	This cavity undoubtedly was filled with gas by gas feeder at face.

All the above samples were taken at representative places in the mine. The mine was in operation at the time of sampling. Samples taken in the 1st left entry are fairly representative of conditions prior to the explosion. Ventilation had been restored in the 1st left the day before samples were collected.

It was found that no line curtain was used to conduct ventilating current to the faces of the 1st left heading and aircourse. The face of the 1st left heading was 35 feet from the last open crosscut and the face of the 1st left aircourse was found to be 21 feet from the rib of the last open crosscut.

It is felt that considerable improvement towards the prevention of the accumulation of gas in advance workings could be effected by the more efficient use of line brattices. This explosion is at least partially traceable to the non-use of line curtain to clear the faces of the 1st left heading and aircourse.

Gas and Mine Air Samples: By referring to Table No. IV, it will be noted that the gas content from the southside and northside fans with 55,200 cu. ft. and 40,145 cu. ft. returning, contained .07% and .01% CH_4 respectively or the total gas emitted per minute from the mine workings, approximates 45 cu. ft., or 2700 cu ft. per hour.

It will be noted by referring to Lab. No. 16193, sample taken in cavity near face of the 1st left aircourse, contained 9.85% marsh gas. Again referring to Lab. No. 16187 taken at the face of the blind crosscut about 5 feet back from the face of the 1st left heading contained 1.01% marsh gas. The last open crosscut was 35 feet from the face of the heading and the face of the blind cross cut from the rib of the 1st left heading was found to be 23 feet. Lab. No. 16186 taken in the 1st left aircourse 25 feet outbye from the last open cross cut showed .14% CH_4 with

1400 cu. ft. of air flowing. None of this air, however, swept the advance faces inbye from the last open crosscut. Lab. No. 16370 which is fairly representative of the return from the 9th and 10th right entries and side entry thereof showed .26% CH_4 with 10,000 cu. ft. of air circulating.

On the days of the investigation, gas was found with an approved safety lamp in the advance workings beyond the last open crosscut in the 1st left entry. On the morning previous to the explosion the fire boss on his regular "round" found dangerous quantities of gas at the faces of the 1st left heading and aircourse. The gas was cleared out according to the statement of the mine foreman, by the mine foreman and fire-boss, the morning previous to the explosion but no line curtain was placed to keep faces clear of gas.

STORY OF EXPLOSION

The explosion occurred about 2:15 p.m. February 2, 1922, while the mine was in full operation and originated near the face of the 1st left aircourse off 9th right. The fire boss on his examination of the 1st left heading and aircourse, on the morning of the explosion marked both places out as they contained dangerous quantities of gas. Under the supervision of the mine foreman these places were cleared of gas about 8 a.m. and pronounced safe. A fall of roof occurred sometime during the morning about 15 feet back from the face of the aircourse. The cavity made by this fall measured 14 feet long, 5 feet wide at the bottom and tapered to 3½ feet at the roof; and was 2½ feet deep.

The face of the aircourse had been shot previous to the explosion and it is believed released a feeder of gas that filled this cavity in the roof. The men who worked the face of the 1st left aircourse were presumably sitting on the left rib of the 1st left heading about 200 feet outbye from last open cross cut when the explosion occurred. The shift runner, after the face of 1st left aircourse had been blasted, immediately proceeded to make an examination before the men commenced to work and it is felt that he ignited this body of gas which was released by shots by an open carbide lamp. The mine foreman immediately upon learning what had taken place in the 1st left entry organized local rescue squads composed of assistant mine foreman and several "trusty convicts" and commenced the recovery of the victims. The ventilation was restored temporarily with brattice cloth. Rescue apparatus was not used by the recovery crew and as a result several of the rescuers suffered severe headaches from effects of after damp. U. S. Bureau of Mines truck No. I with J. M. Cobb foreman mine in charge, was conducting training work at Masena, Alabama, which is situated about five miles from Belle Ellen and when Mr. Cobb learned of this explosion he immediately called J. J. Forbes and he in turn instructed him to proceed to the scene of the trouble. Mr. Pruett, mine superintendent, advised later that all bodies had been taken from the mine and that there was no need of rescue apparatus or other assistance. Mr. Forbes got in touch with C. H. Nesbitt, chief state mine inspector, and both proceeded the following morning, February 3,

to Belle Ellen to make a joint investigation of the explosion. Mr. Forbes remained for two days at Belle Ellen and made a detail study as to cause of the explosion, made observations and collected data in the way of road dust, rib dust, and air samples.

INVESTIGATION

An investigation was made jointly by C. H. Nesbitt, chief state mine inspector of Alabama, S. M. Thompson, deputy mine inspector, Mr. Pruett, mine superintendent, Mr. Belsher, mine foreman, assistant mine foreman and J. J. Forbes of the U. S. Bureau of Mines.

Before going underground the investigators viewed the bodies of the victims at the prison and it was observed that 6 of the victims showed effects of burns while three showed no burns and evidently were killed by after damp.

The party proceeded into the mine by main slope thence to the 1st left off 9th right and the following facts were observed:
All stoppings inbye from room 6 off 1st left heading and between the air course and heading were blown towards the 1st left heading with the exception of the last two stoppings which were found intact. A curtain which was used to deflect air into room 5 off 1st left heading was intact and it is believed that the explosion died away at this point. The assistant mine foreman advised the investigators that two men were in the act of switching a car into room 5 at the time of the explosion and were thrown down by the force of the explosion. A nail keg with

one stick of powder and fuse attached was found intact between the 6th and 7th crosscuts from room 5. A dinner pail was observed on right rib, several feet inbye from this nail keg and evidently come from a point inbye. Some old working clothes were found about 10 feet inbye from the 6th crosscut on left rib and showed no burns.

The first body was found between the 6th and 7th crosscut inbye lying across the track. (Refer to map for details of evidence). This body was burned about arms and face. A mule was found 10 feet inbye from location of 1st body and underneath mule were two bodies severely burned. A trip of three loaded cars was found intact, but the inbye end of coal faces were coked and showed evidence of intense heat. The fourth body was picked up between the front end of loaded trip and mule,severely burned. A miner was engaged in raking car opposite room neck, as indicated on the map, when the explosion occurred. This man was burned about the face, arms and chest and was removed from the mine shortly after the explosion and put under the doctor's care. The fifth body was found, at end of loaded trip against the left rib, severely burned. Three other bodies were picked up between last car of trip and open crosscut unburned. These three men presumably worked in the blind crosscut near the face of the 1st left heading. The ninth body was found opposite open crosscut and it is believed that this was the shift runner who had proceeded into the face of the aircourse with open light to make and examination after shots had been fired, and ignited an accumulation of gas which resulted from fall of rock near the face.

Heavy deposits of coke were observed on inbye sides of props in last open crosscut while a much thinner deposit covered the outbye sides- all the props in the last open crosscut were intact. On the other hand heavy deposits of steel grey coke were found on the outbye sides of props in aircourse 15 feet outbye from last crosscut and a somewhat thinner deposit occurred on the inbye sides of these props. All props in aircourse were intact. A miner's cap was found in the aircourse a few feet inbye last open crosscut, and it is reported that a carbide lamp was picked up midway in this crosscut. There was loose coal at the face of the aircourse and two shot boots were observed in the coal face. These shots worked fairly well, and showed no conclusive evidence of being overloaded or misplaced. The faces of the left aircourse and heading were measured and found to be 21 and 35 feet, respectively, from last open crosscut. No line curtain was used to conduct the ventilating current to either faces. Gas was found at the faces of the heading, blind crosscut and aircourse the day of the investigation, also a small feeder could be heard at the face of the aircourse.

CONCLUSIONS

1. It is the investigator's belief that this explosion was caused by ignition of gas near the face of the 1st left aircourse by an open carbide lamp. It is believed this freshly blasted face released a gas feeder and this quantity of gas together with the gas which was being normally emitted from the coal caused an accumulation

inbye the last open crosscut. It was found that the face of 1st left aircourse was 21 feet from the last open crosscut and that no means were employed to conduct the ventilating current to the face.

2. The heavy deposits of coke on the outbye sides of props in the 1st left aircourse together with heavy deposits on inbye sides of props in the last open crosscut is indicative that the explosive force worked outbye in the aircourse and blew out the stoppings in the direction of the 1st left heading, thence traveled inbye with decreasing violence in the heading. The explosion wave was propagated to more or less degree by dry inflammable dust that was thrown into the mine atmosphere. It is felt that this explosion was stopped in its destructive path and confined to the locality of its origin by the large percentage of non-combustibles in the road dust together with rock surface exposed in the heading which approximates 55% of the heading perimeter. This exposed rock surface, it is felt acted, so to speak as a partial rock barrier.

3. By a careful study of Table No. IV, giving analyses of mine air samples collected at the faces of the 1st left entry and the return therefrom together with the samples taken in the main return from the mine shows conclusively that this is a gaseous mine. It was found that approximately 100,000 cu. ft. of air was returning from the mine workings, and this return is representative of a gaseous mine. It is felt that if this quantity of air was properly distributed and

conducted to advance workings by the use of line brattices, accumulations of gas such as occurred on the day of the explosion would undoubtedly be minimized. It apparently has been the practice after a place has been shot to make an examination with open light. This is an extremely dangerous practice and should be discouraged. Places should be examined before and after blasting by an official with approved safety lamp and if gas is found, means should be provided for clearing the faces of gas before permitting men to work.

4. During the days of this investigation, the roadways in the 1st left entry were found to be dry. This fact is further substantiated by reference to Table No. III, Nos. 1 to 6, inclusive, which shows moisture content in these road samples to range from 2.5% to 3.5%. It was also found that no sprinkling lines traverse the effected section and that aprinkling had been done in a desultory way by cars. Again referring to Table No. III, samples 7 to 18, inclusive, taken in various other representative places thruout the mine,,the moisture content ranged from 3.1% to 5.7% with the possible exception of laboratory No. 84443 which shows 10.9%; also the average moisture content for 18 samples is 4.3%. All of these samples are too low in moisture and are well within the explosibility range. It is apparent that the sprinkling system where pipe lines traverse underground workings was not efficiently used. It is felt that considerable improvement could be effected by the extension of sprinkling lines into the 1st left entries and that sprinkling in all sections of the mine be

prosecuted vigorously at frequent intervals and that the ribs and roof be thoroughly washed down and roadways maintained in a pasty mass.

5. It was found that shooting was done from the solid by the use of permissible explosives, also that clay tamping dug from the bottom fire clay was used for stemming and that blasting was done at any time during the working shift. It is felt that improvement could be effected in the method of blasting by the undercutting of coal with approved undercutting mining machines and blasting it down with permissible explosives when all men were out of the mine by a system of shot firers, using hand batteries with electric detonators.

6. It was found that steam was introduced to some extent in the intaking air current. It is believed that the humidification of this mine can be materially helped if the intaking air were preheated and exhaust steam subsequently introduced.

7. It was learned that the recovery of bodies was performed by officials and others without the use of oxygen breathing apparatus; and as a result several of the rescuers suffered from the effects of the after damp. This is a very dangerous practice and should be discouraged. It is felt that a far safer practice would be to maintain rescue equipment and a crew of competent rescue men well trained in rescue and recovery methods. This procedure would minimize the chance of rescuers losing their lives while doing recovery work. The records of the Bureau of Mines show where numerous rescuers not wearing self-

contained oxygen breathing apparatus have lost their lives while attempting to do recovery work in atmospheres charged with after damp which is prevalent after explosions and fires.

RECOMMENDATIONS

1. It is recommended that sprinkling lines be extended into all live working sections of the mine. Sprinkling to be most effective should be prosecuted thoroly and regularly in all sections of the mine including working faces. All dust being washed down from roof, ribs, timbers, and dust on the floor maintained in a pasty mass.

2. Care should be taken to carry a sufficient quantity of air to live working faces in order to dilute and render harmless all gas emitted under present operating practices.

3. It is recommended that before and after faces have been freshly blasted that an examination be made of such faces by a competent official for gas and if gas is found, means should be provided for its immediate removal before permitting men to work.

4. It is recommended that the present practice of firing shots by fuse at any time during the working shift and when all men are in the mine should be performed by competent shotfirers who would "fire" the mine by the use of electric detonators and blasting machine after all men had left the mine.

5. It is recommended that the practice of shooting from the "solid" should be discontinued and that electric coal cutting

machines of the permissible type, approved by the Bureau of Mines for use in gaseous mines should be used for undercutting the coal before blasting. It is further recommended that all electric underground equipment be confined to use only on intaking air currents.

6. Since dangerous accumulations of gas are likely to occur the adoption of closed lights is strongly recommended, preferably the electric permissible cap variety.

7. As an additional preventive measure for limiting a possible explosion from propagating thruout the mine it is recommended that rock dust barriers be installed in separate sections of the mine. For further particulars on rock dusting and rock dust barriers, refer to Bureau of Mines Technical paper No. 84 by Geo. S. Rice, chief mining engineer of the U. S. Bureau of Mines, Washington, D. C.

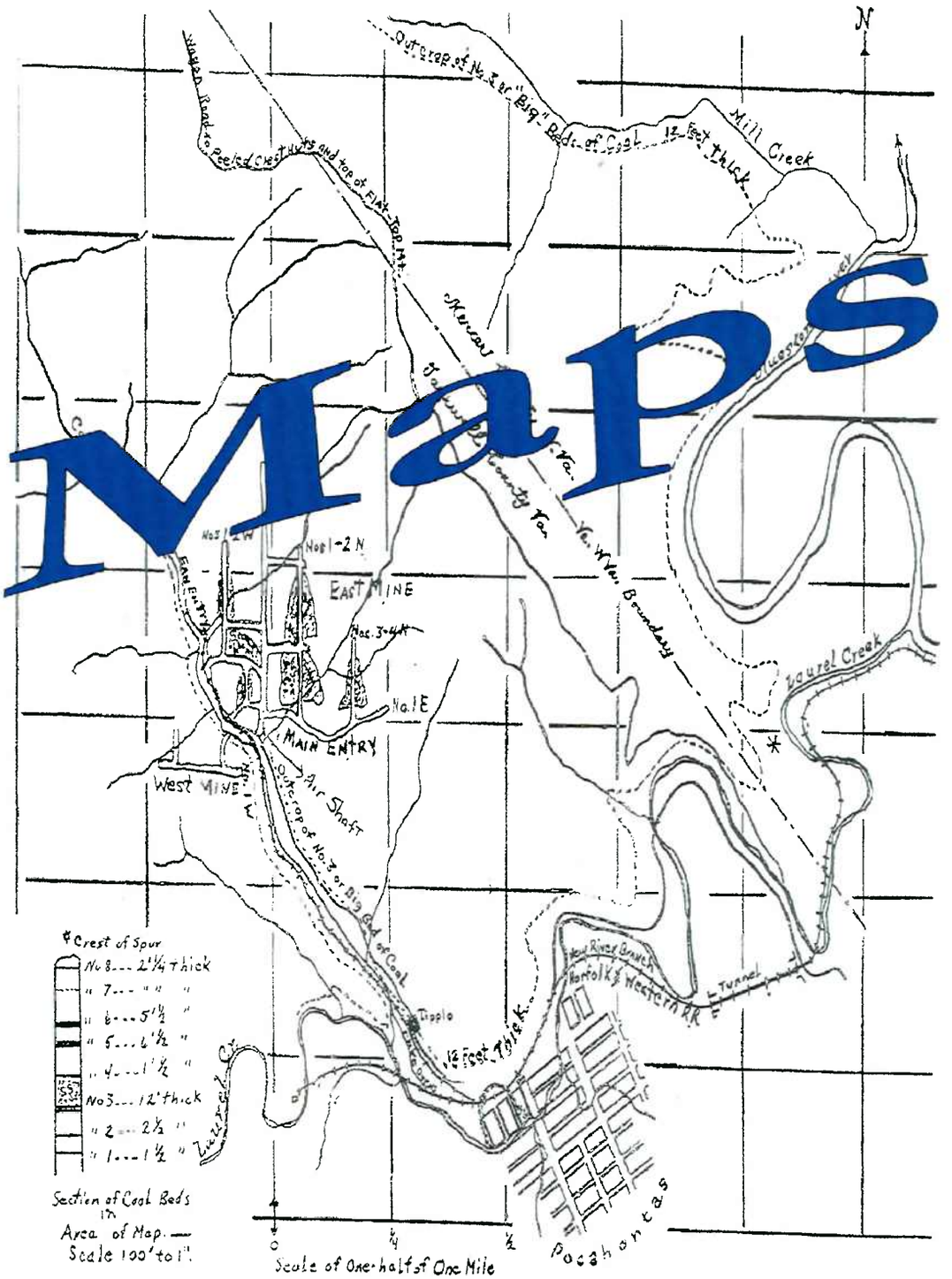
8. It is strongly recommended that oxygen mine rescue breathing apparatus together with a trained crew of rescue and first aid men be maintained for possible emergencies.

9. Great care should be taken to see that not more than 1½ pounds of permissible explosives be used per hole and that the present practice of tamping shots by incombustible stemming be continued.

Approved by: J. W. Paul

J. W. PAUL, 5/31

Chief of Coal Mining Investigations.



Map