



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

(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 heading.
345	b	1.15	35.30	58.80	4.75	1.35	14449	
26277	a	2.70	35.60	55.90	5.71	1.41	14083	Face 22nd N heading.
361	b	1.20	36.15	56.85	5.80	1.43	14301	
26278	a	2.58	35.67	56.15	5.60	1.27	14024	Face 2nd C off 23 N heading.
56	b	1.25	36.15	56.92	5.68	1.29	14216	
26279	a	2.54	34.91	57.72	4.83	1.17	14269	Face Room 70 18 N heading.
20258	b	1.05	35.45	58.60	4.90	1.19	14488	
26280	a	3.39	33.08	58.59	4.94	1.49	14143	Face of 19 N. heading.
428	b	1.15	33.85	59.95	5.05	1.52	14470	
26281	a	2.71	34.67	57.43	5.19	1.26	14373	Composite Analyses for samples, 26276-26280.
	b	1.08	35.25	58.39	5.28	1.28	14395	

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 $2\frac{1}{2}$ 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 29" 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.	Mois- ture	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	^x 84181	.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.	Moist- ure	Ash	Mosit- 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.
11	84438	.373	4.6	28.4	33.0	1400	31.9	68.1	953.0	52.7	33.2	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 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 volatile 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 $1\frac{1}{2}$ 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 Belbe 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 exhausting.

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.

Goob 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. movement	no air	.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. movement	no air	.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.

